PROTEGO® Technology

Volume 1

- **Flame Arresters**
- **Valves**
- **Tank Accessories**

PROTEGO
for safety and environment

Edition 2010

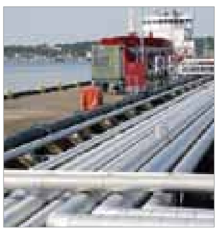
How to use this catalogue

The current PROTEGO® catalogue has a modular structure.

In Volume 1 the company is introduced and with the “Technical Fundamentals” and the “Safe Systems in Practice” a basic explanation of operation and use of PROTEGO® devices is provided allowing a pre-selection of the correct devices.

Following this pre-selection the user is guided to the Volumes 2 through 8 in which the devices are described in detail.

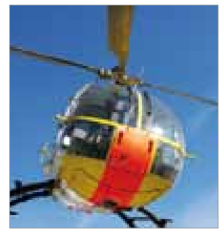
Typical Applications




- Storage Tanks and Loading Facilities
- Vapour-return at Petrol Stations
- Combustion Systems
- Chemical and Pharmaceutical Processing Systems
- Landfill and Biogas Systems
- Wastewater Treatment Systems

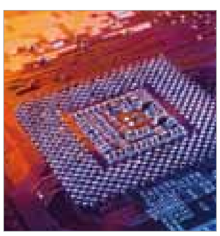


Exotic Applications

- Nitrous Oxide Supply in Clinical Applications
- Explosionproof Surface Drain at Heliports
- Storage of Whisky Barrels
- Production of Brandy

Special Applications


- Food Sterilization under Vacuum
- Wafer Production in IT Industry
- Methane Extraction Fan of Mines
- Vitamine Production
- Production of Tooth Paste and Mouthwash

Contents

Braunschweiger Flammenfilter is a family owned business with tradition and has been involved with the development of flame arresters, valves and tank accessories for industrial process engineering for more than 50 years. Over this period, the internationally registered trademarks PROTEGO®, FLAMEFILTER® and FLAMMENFILTER® have become a synonym for quality and functionality.

The products are developed in close collaboration with end-users, technical laboratories and testing authorities. The PROTEGO® research and development center - the largest of its kind - not only develops our products but is also available for general research projects and customer-related special developments. Nominal sizes up to DN 1000 (40“) are possible as well as higher pressures and temperatures.

PROTEGO® offers a comprehensive line of flame arresters, valves, and tank accessories that are tailored to meet market demands. The products are installed by industrial users for a wide range of applications: in tank farms for flammable liquids in industrial and military applications; in chemical and pharmaceutical processing facilities; in vapour combustion plants; in biogas, landfill gas and wastewater treatment facilities; in ship building; on oil platforms and in loading and unloading facilities. PROTEGO® products are autonomous Protective Systems or integrated in equipment. They are used in IT clean rooms, food sterilization, painting systems, aerospace industry and wherever explosive vapours can form, or where particularly sensitive low-pressure reducing valves are required.

PROTEGO® - for safety and environmental protection: We offer support during the planning phase by our trained engineers and provide with our worldwide network of partners safely operating systems starting from the design phase up to implementation.

Product-oriented seminars and training sessions are provided at Braunschweig to reinforce theoretical knowledge with practical experiments. Of course, seminars are offered near the customer to provide current information on safety engineering on the actual state-of-the-art.

Product quality is assured according to international standards. DIN ISO 9001/2008 and DIN ISO 14001 have been implemented for quite a while and have become a part of everydays practice.

The quality derived from producing in accordance with ATEX is the quality seal of reliability. To this we add the steering wheel symbol for supplies to the ship-building industry and the Factory Mutual symbol indicating compliance with international requirements. The international testing and approval institutions know us as a competent and reliable partner in their daily dealings with us and have issued over 5000 approvals.

Today, PROTEGO® is considered as the leading company in its field of business and operates worldwide with a network of subsidiaries, branches and representatives. The PROTEGO® group includes 11 distribution and service companies and over 50 representatives in the most important markets in every corner of the globe. Customers are promptly supplied with products, replacement parts and services by means of regional support centers.

PROTEGO®, FLAMEFILTER® and FLAMMENFILTER® are international registered trademarks of Braunschweiger Flammenfilter GmbH.

In the fields of safety and environmental protection, PROTEGO® is well known internationally for:

- **product innovation**
- **technological leadership**
- **technical advice and service**
- **problem solving**
- **product quality**
- **product availability and on-time delivery**
- **integrity and solidity**

PROTEGO® WORLD TEAM

Development

Flame arresters protect systems subject to explosion hazards from the effects of explosions. Ever since methane gas explosions were successfully suppressed in the mining industry in the mid-19th century by the development of the mine shaft lamp with a Davy screen, solutions have been found for making systems safer in modern hydrocarbon chemistry, where much more hazardous gases are used.

In addition, filling stations became necessary with the introduction of the automobile. With filling station tanks, the problem of explosive vapours arose, consisting of hydrocarbons and air that form around the tanks and loading equipment, which can ignite. Given the need for safe handling in dangerous atmospheres, the large oil companies advanced the development of protective devices for both industrial and military applications.

Initial successes were achieved with gravel pots that were used on fuel tanks. The entrance of an explosion in the atmosphere into the storage tank or into the connected line was stopped by the gravel, and the flame was extinguished. The tank remained protected. The problem with loose gravel, however, is the not reproducible flame arresting capability and the high pressure losses. In 1929, a new development was patented that replaced the loose gravel with wound corrugated strips of metal (Fig. 1a). Together with the patented shock-absorber, a protective device was developed that stopped detonative combustion processes in the pipe at minimum pressure loss. The PROTEGO® detonation flame arrester – developed by Robert Leinemann – was born (Fig. 1b). It was given its name many years later in 1954 when Robert Leinemann founded his company Braunschweiger Flammenfilter.

As chemical processes developed, the requirements on protective devices became increasingly complex. To this the requirements of environmental protection were added. Vapours from processes needed to be disposed in an environmentally friendly manner and supplied to combustion systems according to clean-air regulations. The continuously or only occasionally explosive mixture was sent to an ignition source during operation. These particular hazards had to be countered with special measures. PROTEGO® flame arresters offer reliable protection in plant systems; these flame arresters always correspond to the state-of-the-art as a result of continuous research and development.

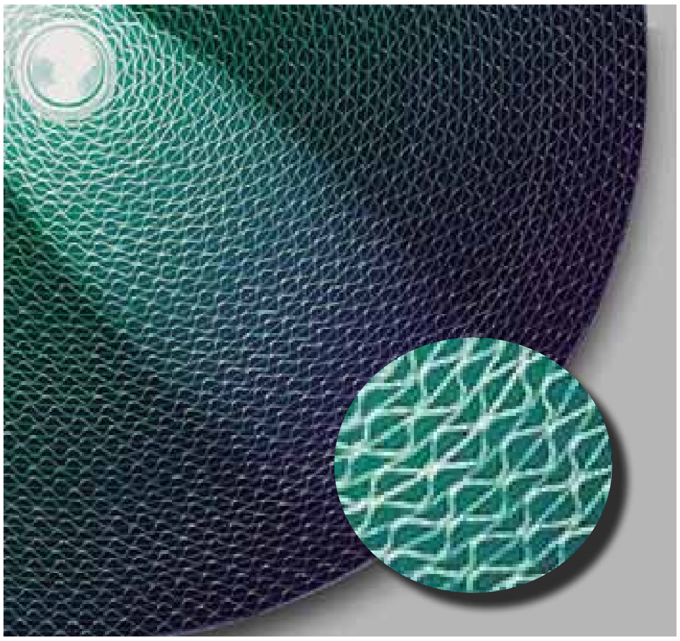


Figure 1a: FLAMEFILTER® wound out of corrugated metal strips

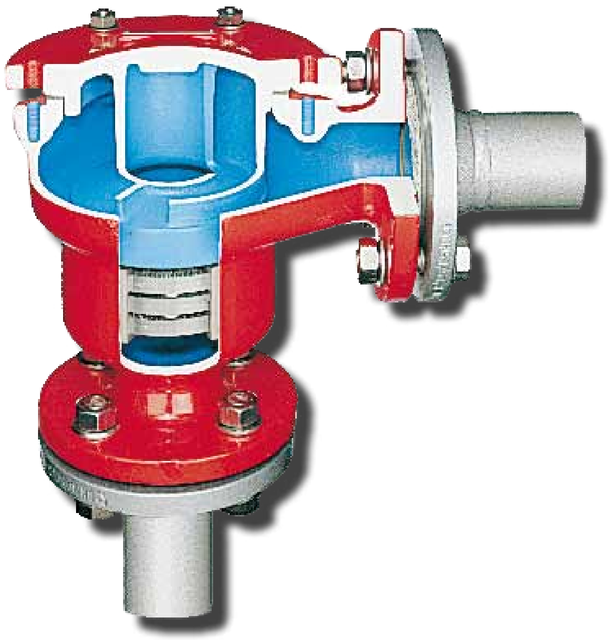


Figure 1b: Detonation Flame Arrester with Shock-Absorber

Combustion Processes

Explosive mixtures can burn in various ways. The following, among other things, can influence the combustion process: the chemical composition of the mixture, possible pressure waves, pre-compression, the geometric shape of the combustion chamber, and the flame propagation speed.

The relevant **combustion processes** for flame arresters are defined by international standards:

Explosion is the generic term for abrupt oxidation or decomposition reaction producing an increase in temperature, pressure or both simultaneously [also see EN 1127-1:1997].

Deflagration is an explosion that propagates at subsonic velocity [EN 1127-1:1997]. Depending on the geometric shape of the combustion area, a distinction is drawn between atmospheric deflagration, pre-volume deflagration and in-line deflagration.

Atmospheric deflagration (Fig. 2) is an explosion that occurs in open air without a noticeable increase in pressure.

Pre-volume deflagration (Fig. 3) is an explosion in a confined volume (such as within a vessel) initiated by an internal ignition source.

I**n-line deflagration** (Fig. 5) is an accelerated explosion within a pipe that moves along the axis of the pipe at the flame propagation speed.

Stabilized burning is the even, steady burning of a flame, stabilized at or close to the flame arrester element. A distinction is drawn between **short time burning** (stabilized burning for a specific period) and **endurance burning** (stabilized burning for an unlimited period) (Fig. 4).

Detonation is an explosion propagating at supersonic velocity and is characterised by a shock wave [EN 1127-1:1997]. A distinction is drawn between **stable detonations** and **unstable detonations** (Fig. 5).

A detonation is **stable** when it progresses through a confined system without a significant variation of velocity and pressure characteristic (for atmospheric conditions, test mixtures and test procedures typical velocities are between 1,600 and 2,200 meter/second). A detonation is **unstable** during the transition of the combustion process from a deflagration into a stable detonation. The transition occurs in a spatially limited area in which the velocity of the combustion wave is not constant and where the explosion pressure is significantly higher than in a stable detonation. NOTE: The position of this transition zone depends, among others, on the operating pressure and operating temperature, on the pipe diameter, the pipe configuration, the test gas and the explosion group and must be predetermined by experiments in each case.

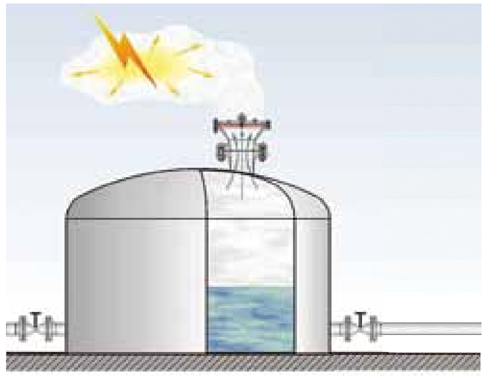


Figure 2: Atmospheric deflagration

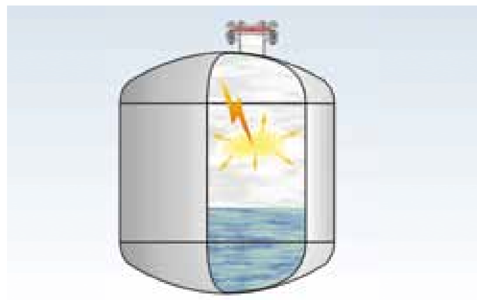


Figure 3: Pre-volume deflagration

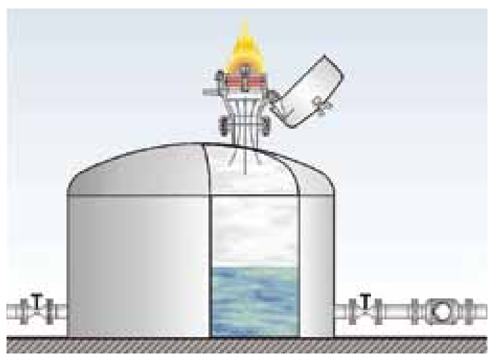


Figure 4: Stabilized burning

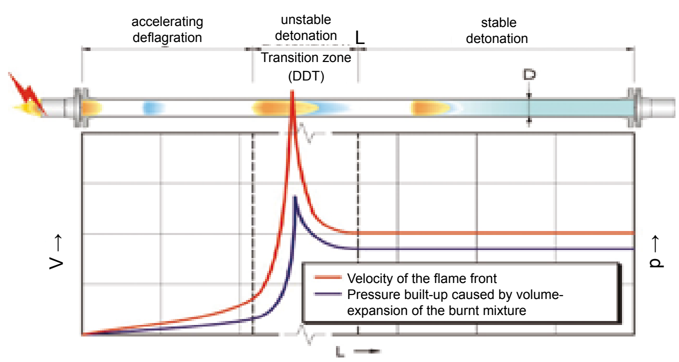


Figure 5: Deflagration – unstable detonation – stable detonation.
L= distance to ignition-source
D= Diameter of the pipeline
v= velocity of the flame front
p= pressure
DDT = Deflagration to Detonation Transition

Master Types

Flame arresters are subdivided into different types depending upon the combustion process (Endurance burning, Deflagration, Detonation and the various sub-groups) and in accordance to the installation (in-line, end-of-line, in equipment).

Master types are

a) static dry flame arresters
b) static liquid seal flame arresters
c) dynamic flame arresters

Working principle

a) Static dry flame arresters

Flame arrester elements made of wound corrugated metal strips can be manufactured with consistantly reproducible flame quenching gaps. The gap-size can be adjusted in accordance to the flash-back capability of the explosive mixture.

The FLAMEFILTER® is made of wound corrugated metal strips and forms the flame arrester element. The principle of flame quenching in small gaps is applied in PROTEGO® end-of-line flame arresters and PROTEGO® in-line flame arresters (volume 2,3,4, and 7).

When a mixture ignites in a gap between two walls, the flame spreads towards the non-combusted mixture. The expansion in volume of the combusted mixture pre-compresses the non-combusted mixture and accelerates the flame.

The flame is extinguished by heat dissipation in the boundary layer “s”, transferring it to the large surface of the gap-length compared to the gap-width “D” and cooling-down the product below its ignition temperature (Fig. 6).

The gap width and the gap length of the flame arrester element determines its extinguishing ability.

The narrower and longer the gap, the greater the extinguishing effectiveness. The wider and shorter the gap, the lower the pressure loss. The optimum solution between the two conditions is determined by experiments.

Original PROTEGO® technology

To protect against all of the previously mentioned combustion processes, PROTEGO® developed static dry flame arresters and optimized their design and had them undergo national and international certifications in prototype tests (Fig. 7a and b).

All static dry PROTEGO® flame arresters are based on the working principle of FLAMEFILTER®.

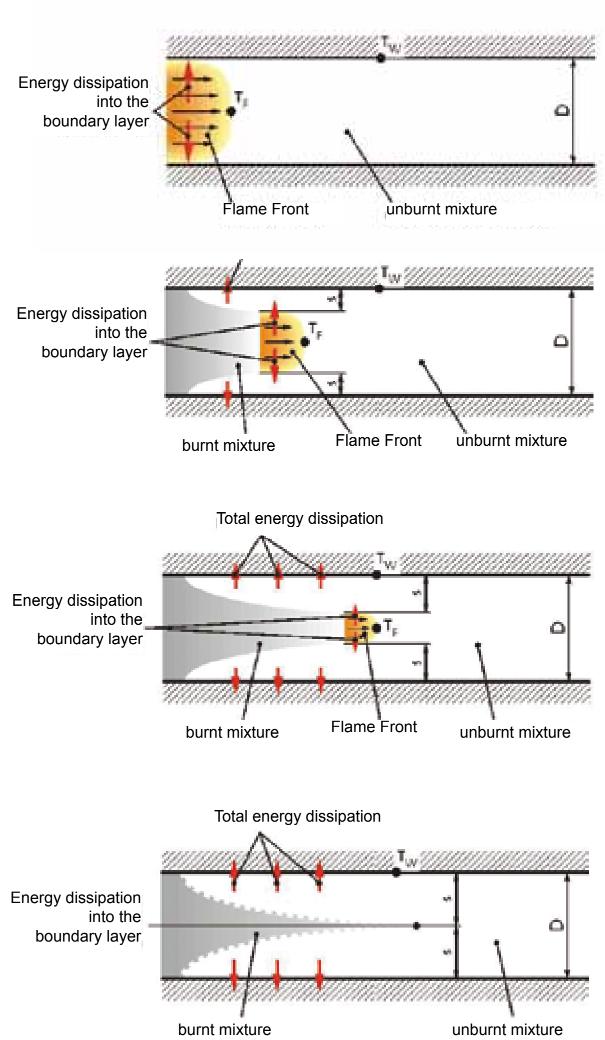


Figure 6:
Extinguishing the flame in the narrow gap (flame quenching) by heat transfer

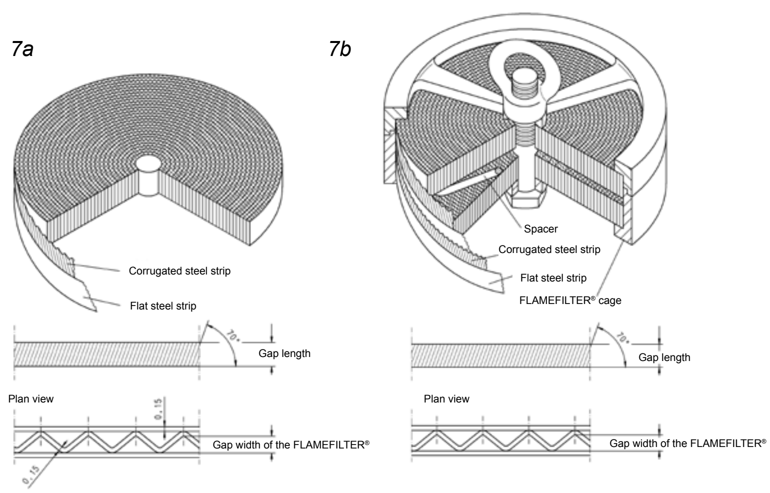


Figure 7:
FLAMEFILTER® (a) with gap widths and gap lengths and PROTEGO® flame arrester unit (b) with FLAMEFILTER®, spacer and FLAMEFILTER® cage

Definitions

1. **Flame arresters** (Fig. 8a) are devices that are installed at the opening of an enclosure or to the connecting pipe of a system of enclosures and whose intended function is to allow flow but prevent the transmission of flame.

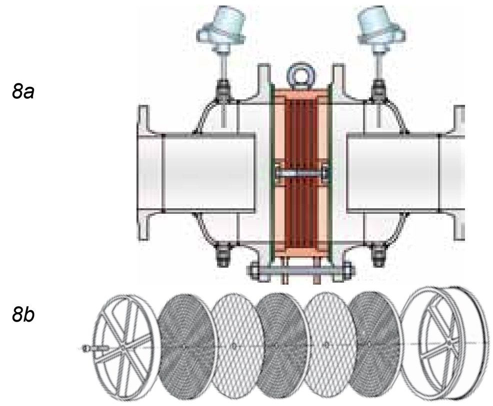


Figure 8: PROTEGO® flame arrester (a) and PROTEGO® flame arrester unit (b - modular design)

2. The PROTEGO® **flame arrester unit** (Fig. 8b and 7b) is that part of a flame arrester whose main task is to prevent the transmission of flames.
3. Several **FLAMEFILTER®** (Fig. 7a) form the PROTEGO® **flame arrester unit** (Fig. 7b and 8b) together with the spacers and enclosing cage.
4. Deflagration flame arresters or detonation flame arresters are required depending on installation and operating conditions. Depending on the mode of operation, resistance against stabilized burning (short burning, endurance burning) may be necessary.

b) Static liquid seal flame arrester

Liquid seal flame arresters are liquid barriers following the principle of a siphon where the liquid stops the entering deflagration and/or detonation and extinguishes the flame. Two different types exist.

1. The liquid product flame arrester: the liquid product is used to form a liquid seal as a barrier for flame transmission. The PROTEGO® liquid product flame arrester is an in-line or end-of-line detonation flame arrester (Vol. 4).

2. The hydraulic flame arrester: it is designed to break the flow of an explosive mixture into discrete bubbles in a water column and thus preventing flame transmission. The PROTEGO® hydraulic flame arrester is designed and certified to stop deflagrations, detonations and endurance burning combustions. It is tailor-made with regard to the specific customers requirements (Vol. 8).

When installing the PROTEGO® hydraulic flame arrester as in-line flame arrester, as vent header collection drum and back flow preventer in vapour collecting lines close to the incinerator, important safety measures have to be taken into consideration to assure the required explosion safety.

c) Dynamic flame arresters

High velocity flame arresters are designed to produce flow velocities under operating conditions which exceed the flame velocity of the explosive mixture thus preventing flame transmission. This principle is applied in PROTEGO® Pressure Relief Diaphragm Valves (Vol. 7) and in PROTEGO® High Velocity Valves (Vol. 7) with appropriate high set pressure. These valves must be closed before the flow velocity achieves critical values. Safety margins must be included.

Flame arresters are type-examined **Protective Systems** in accordance with 94/9/EC and are marked with CE. They are tested according to DIN EN 12874 in general. They are certified in accordance with the specific requirements of the standard. Any certification according to other international standards is shown by marking with the appropriate indication.

Explosion groups

Given their chemical composition, different gases have different flame propagation capacities and are therefore categorized into explosion groups corresponding to their hazard level. The yardstick for this is the **MESG** = **M**aximum **E**xperimental **S**afe **G**ap, a characteristic number measured in the laboratory for the flame propagation ability of the product. The MESG or **standard gap width** is the largest gap width between the two parts of the interior chamber of a test setup which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the external gas mixture through a 25 mm long gap, for all concentrations of the tested gas or vapour in air. The MESG is a property of the respective gas mixture [EN 1127-1:1997]. NOTE: The test setup and methods are specified in IEC 60079-1 A. The most explosive composition is close to the stoichiometric mixture of the gas/vapour-air mixture.

The following table shows the categorization of substances into the respective explosion group corresponding to their MESG (IEC 79-1, EN 12874).

Explosion group	Maximum Experimental Safe Gap [mm]	NEC/ NFPA	Reference Substances
I	1,14 ≤ MESG		Methane
IIA	0,9 < MESG < 1,14	D	Propane
IIB	0,5 ≤ MESG ≤ 0,9	C	Ethene / Hydrogen
subcategorized as			
IIB1	0,85 ≤ MESG ≤ 0,9	C	Ethene
IIB2	0,75 ≤ MESG < 0,85	C	Ethene
IIB3	0,65 ≤ MESG < 0,75	C	Ethene
IIC	MESG < 0,5	B	Hydrogen

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Please refer to more specific literature (especially technical information concerning safety ratings) for the MESG of individual substances, additional ratings and characteristic substance quantities. This information is provided by PROTEGO® upon special request.

As the pressure and temperature increase, the load on the flame arresters generally increases. Flame arresters that have been tested under atmospheric conditions are approved and can be used up to 60°C (140°F) and 1.1 bar (15.9 psi). If the operating temperature and/or the operating pressure is higher, the flame arrester must undergo a special examination for the higher operating parameters.

PROTEGO® offers flame arresters for the above mentioned explosion groups for higher pressures (>1.1bar abs, 15.9 psi) and higher temperatures (>60°C, 140°F) as required by the operating parameters.

Location of installation

Depending on the location of installation, the flame arresters must fulfill various protective tasks:

At the opening of a system part to the atmosphere
→ **End-of-line flame arrester**
At the opening of an equipment onto a connecting pipe
→ **Pre-volume flame arrester**
In the pipe
→ **In-line flame arrester**

PROTEGO® End-of-line flame arresters protect against atmospheric deflagrations and stabilised burning — either short time burning or endurance burning. They can only be connected on one side and can not be installed in the pipe. PROTEGO® end-of-line flame arresters can however be combined with valves (see page 16: Pressure and Vacuum Relief Valves with flame arresters).

PROTEGO® Pre-volume flame arresters are flame arresters integrated into the equipment (belong to the equipment) and are tested together with the equipment.

PROTEGO® In-line flame arresters protect against deflagration and/or stable and/or unstable detonations in pipes. They are installed in pipes and are not to be used as end-of-line arresters.

The flame arresters should be located according to their specified use. In the case of in-line deflagration flame arresters, make sure that the allowable L/D (L = distance between the ignition source and the installation location of the flame arrester, D = pipe diameter) is not exceeded and that the in-line deflagration flame arresters are not installed too far from the ignition source, so that they are not subject to a detonation because the path is too long. The allowable L/D is stated in the manufacturers manual of the flame arrester.

Selection

The effectiveness of flame arresters must be tested and approved. Flame arresters are categorized according to the combustion process and the installation site.

The selection criteria are described in the appropriate volumes. The different variations and wide range of types arises from the tailored solutions for different applications. PROTEGO® flame arresters are generally service-friendly due to the modular design of the flame arrester unit. Special details of the design (patented Shock Wave Guide Tube Effect SWGTE or Shock-absorber) enable a superior flow due to the minimum pressure loss.

Location of Installation	End-of-line			On-equipment	In-line		
Combustion process	Atmospheric deflagration	Atmospheric deflagration and short time burning	Atmospheric deflagration and short time burning and endurance burning	Pre-volume deflagration	In-line deflagration	Stable detonation and in-line deflagration	Unstable and Stable detonation and in-line deflagration
Application example	→ Tank, page 27 → Reactor, page 28 → Free venting, page 29			→ Blower → Vacuum pump (p. 32)	→ For vent header, page 27 → Combustion system, page 28 → Vapour return, page 29		
Products	→ Volume 2	→ Volume 2	→ Volume 2	→ Volume 3	→ Volume 3	→ Volume 4	→ Volume 4

PROTEGO® has the right flame arrester for all applications

- End-of-line flame arresters for atmospheric deflagrations: PROTEGO® Deflagration Flame Arresters, end-of-line, Volume 2
- End-of-line flame arresters for atmospheric deflagrations and short time burning: PROTEGO® Deflagration Flame Arresters, short time burning proof, end-of-line, Volume 2
- End-of-line flame arresters for atmospheric deflagrations and short time and endurance burning: PROTEGO® Deflagration Flame Arresters, endurance burning proof, end-of-line, Vol. 2
- Pre-volume flame arresters on equipment: PROTEGO® Deflagration Flame Arrester units on equipment, Volume 3
- In-line flame arresters for deflagrations: PROTEGO® Deflagration Flame Arresters, in-line, Volume 3
- In-line flame arresters for deflagrations and stable detonations: PROTEGO® Detonation Flame Arresters, in-line, Volume 4
- In-line flame arresters for deflagrations, stable and unstable detonations: PROTEGO® Detonation Flame Arresters, in-line, Volume 4

Development

Closed vessels or tanks filled with liquid products must have an opening through which the accumulated pressure can be released so that the vessel does not explode. Along the same lines, a vacuum has to be compensated for when the tank or vessel is drained so that it does not implode. Unallowable overpressure and negative overpressure (in the following also termed vacuum) will accumulate with loading and unloading procedure, steam cleaning processes, blanketing and thermal effects. Free openings enable a free exchange with the atmosphere or with connected pipe systems that are uncontrolled and unmonitored. Vent caps are used in this case (Fig. 1).

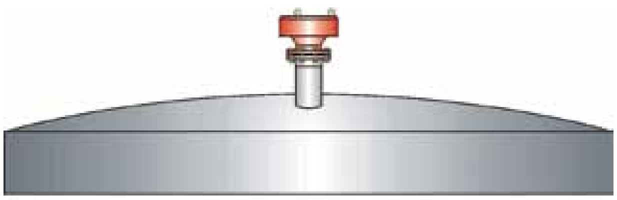

Figure 1: Free venting of the storage tank with PROTEGO® EH/0S

The vented product vapours can be poisonous, odorous, flammable, or simply represent the loss of product. They pollute the atmosphere.

The local concentration of chemical and processing plants and the associated environmental pollution have increased so much over the last 50 years, that valves are now to be used, especially in industrially developed countries, to keep the free opening cross-sections closed during operation and only permit emergency venting or relief.

The ventilation devices, which are in the form of pressure and vacuum relief valves, must not be shut off (Fig. 2).

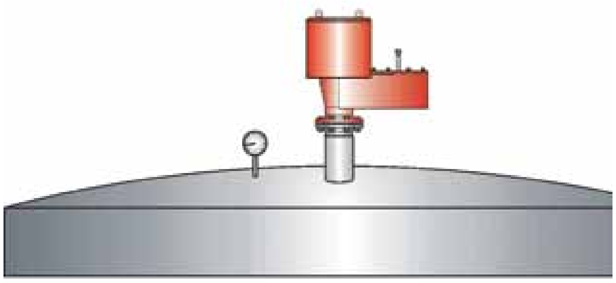

Figure 2: Venting of the storage tank with pressure and vacuum relief valve PROTEGO® VD/SV

These valves need to be simple and robust valves that do not require remote control, are trouble-free and reliably fulfill expected tasks: Maintaining and compensating pressure and vacuum.

Valve Technology

PROTEGO® pressure and vacuum relief valves have weight-loaded or spring-loaded valve pallets. When there is excess pressure in the tank, the pressure valve pallet guided in the housing lifts and thereby releases the flow into the atmosphere (Fig. 3a) until the pressure falls below the set pressure. The valve then reseats. The vacuum side of the valve is tightly sealed by the additional overpressure load. When there is a vacuum in the tank, the overpressure of the atmosphere lifts the vacuum disc and the tank is vented (Fig. 3b).

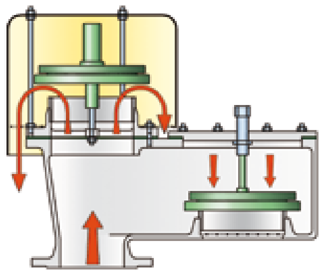

Figure 3a: Operation of the valve under pressure in the tank

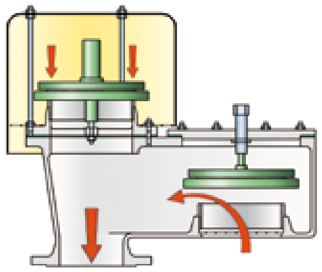

Figure 3b: Operation of the valve under vacuum (negative pressure) in the tank

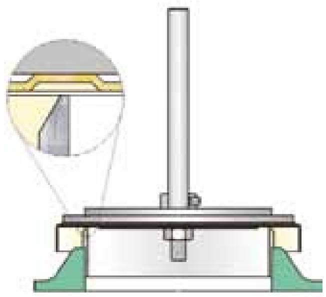

Figure 4: PROTEGO® full-lift pallet with air cushion seal

In principle, the diaphragm valve, which is loaded with liquid (as a weight), and the pilot-valve, which is self-controlled, operate in the same manner.

The weight-loaded valve pallets have different designs. A distinction is made between the full-lift pallet (Fig. 4 and Fig. 5 a, b) and the normal pallet (Fig. 6).

The sealing between valve pallet and valve seat is provided by an FEP air cushion seal, a metal to metal sealing, or PTFE flat sealing depending on the set pressure or on the application. The best sealing is obtained with a metal valve disc lapped to be seated on the metal valve seat (metal to metal). When the set pressures are low, an FEP air cushion seal provides a tight seal. The tightness of the PROTEGO® valves is far above the normal standard (DIN 3230 leakage rate B0 or API 2521) and hence meets the stringent demands of emission control regulations.

PROTEGO® **pressure and vacuum relief valves with full-lift pallet** discharge the flow within 10% overpressure from the set pressure to a fully opened valve (full-lift).

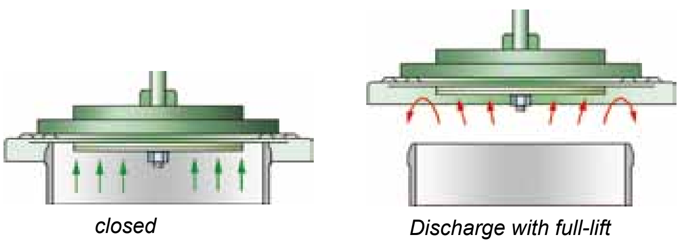

Figure 5a: Discharge with full-lift pallet and air-cushioned seal

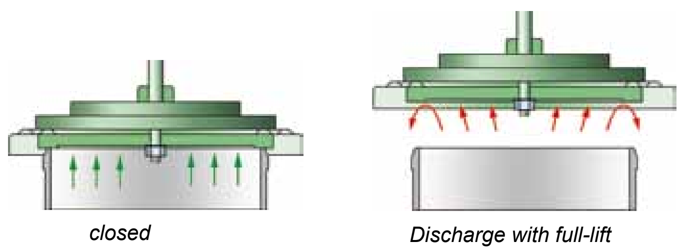

Figure 5b: Discharge with full-lift pallet and metal seal

This is attained by precisely harmonizing the diameter and height of the valve pallet rim with the adapted, machined and lapped valve seat. In addition, the flow-enhancing design reinforces the overall effect on the outflow side. These valve pallets are used in end-of-line and in-line valves.

PROTEGO® **pressure and vacuum relief valves with conventional pallets** discharge the flow within a 40% pressure rise with a proportional response.

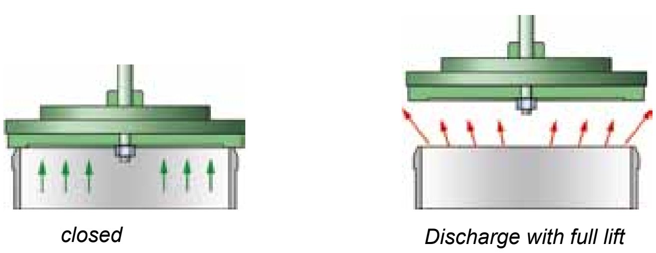

Figure 6: Discharge with normal pallet (flat with metal seal)

After the initial response, the rise in pressure is proportional to the discharged flow up to a full lift. When the back pressure in the connected pipeline is high or the valve is installed in combination with a pressure control valve, this method provides greater stability for the overall system. However, the overall flow performance is not as good as that of valves with full-lift valve pallets. These valve pallets (Fig. 6) are primarily used in in-line valves when required by operating conditions.

Depending on the design of the valve and the valve pallets, the design pressure and design vacuum (negative gauge pressure) is achieved with different overpressure (Fig. 7).
Unless otherwise agreed, the standard PROTEGO® valve design is for 10% technology.

Advantages of **PROTEGO® 10% technology**:

- Pressure conservation very close to the maximum allowable tank pressure
- Minimization of product losses
- Reduction of vapour emissions

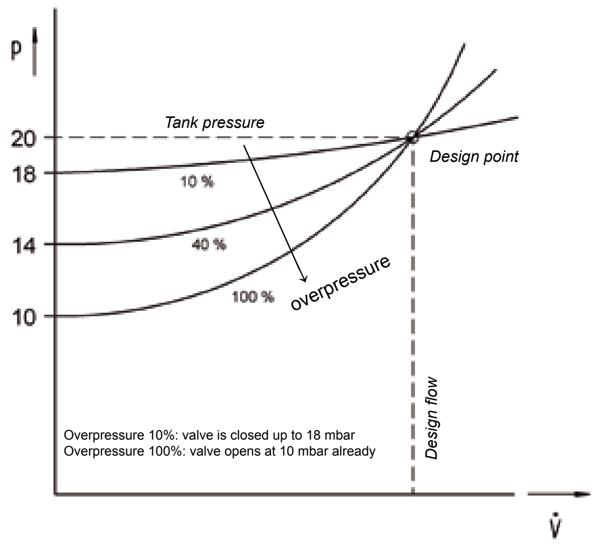

Figure 7: Opening characteristics of valves with different overpressure levels

The PROTEGO® **diaphragm valve** (Fig. 8) has a liquid load above the diaphragm.

The static liquid column is an indication of the set pressure. The flexible liquid-loaded diaphragm adjusts tightly to the metallic valve seat to provide an excellent seal. If the set pressure is exceeded, the diaphragm lifts and releases the cross-section for the flow to discharge. Due to the flexible diaphragm, these valves are used in weather-related low temperatures and with FEP diaphragms for sticky, polymerizing media. PROTEGO® diaphragm valves are the only valves worldwide which are frost-proof down to temperatures of -40°C (-40°F).

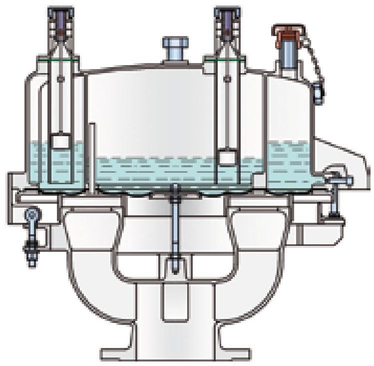

Figure 8: Diaphragm Valve PROTEGO® UB/SF-0

The self-controlled PROTEGO® **pilot operated valve** (Fig. 9) discharges the flow without requiring additional overpressure. Up to the set pressure until the pilot reacts, the valve remains sealed; it immediately opens in a full-lift after the set pressure is reached without overpressure and releases the cross-section of the valve (set pressure = opening pressure). As the pressure increases, the seal increases up to the set pressure. Once the flow is discharged and the pressure falls below the opening pressure, the valve recloses. PROTEGO® pilot valves are generally used as safety relief valves for low-temperature storage tanks or wherever the valve must be very tightly sealed up to the set pressure.

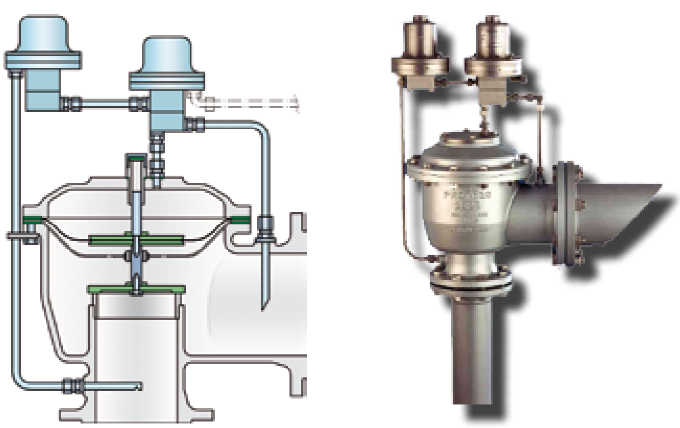

Figure 9: pilot operated pressure relief valve PROTEGO® PM/DS

The operating requirements regarding the amount of outbreathing and inbreathing capacity determine whether separate pressure valves and vacuum valves or combined pressure and vacuum relief valves are used.

Pressure and vacuum relief valves for maintaining pressure (vapour conservation)

Process-dependent pressure maintenance in systems is ensured by valves that take pressure vessel related parameters into consideration. Conventional safety valves are used for pressures above 0.5 barg (7.25 psig) according to EN-ISO 4126 and Pressure Equipment Directive PED 97/23/EC, API 526 and ASME VIII, Div.1, or other international standards. For pressures below 0.5 barg (7.25 psig), the pressure can be maintained with safety valves that are not subject to the regulations of Pressure Equipment Directive (PED). They need to meet other criteria however: Provide a good seal, be frostproof, trouble-free and easy to maintain. PROTEGO® pressure and vacuum conservation valves meet these requirements while being highly efficient, operate stable and offer safe function even at very low pressures due to the 10% technology. In addition emissions of the products are reduced.

National and international technical regulations for maintaining clean air serve as the basis for calculating savings (such as VDI 3479: "Emission Control - Marketing Installation Tank Farms", VOC Directive 1999/13/EC and 94/63/EC or API MPMS Chapter 19.1: "API Manual of Petroleum Measurement Standards - Chapter 19, Evaporative Loss Measurement, Section 1 - Evaporative Loss from Fixed-Roof Tanks, 3rd Edition"). The design of the tank, the paint, the insulation, and pressure maintenance via the valves influence - among others - the reduction of emissions.

The effect that pressure maintenance has on the reduction of product (vapour) loss improves as the set pressure of the valve approaches the maximum allowable tank pressure. The flow needs to be reliably discharged without the tank rupturing. A comparison of product loss at different overpressures clearly reveals the advantages of the 10% technology over the 40% overpressure and especially in contrast to a 100% overpressure: The specially developed design yields measurable savings by decreasing the accumulation up to the required performance (Fig. 10).

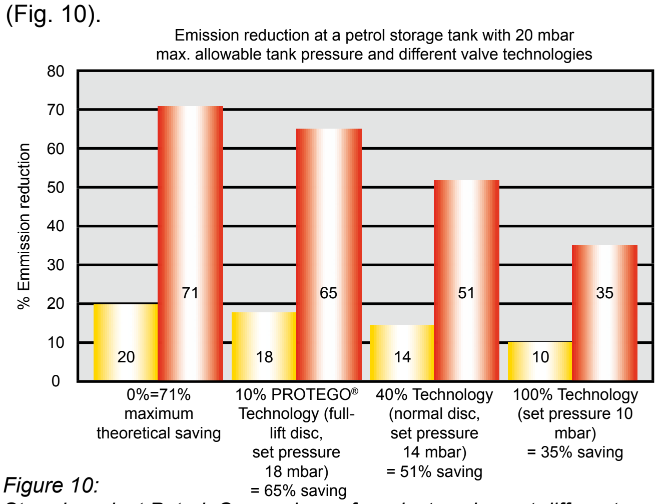

Figure 10:
Stored product Petrol: Comparison of product savings at different overpressure levels versus the free vented storage tank: Example of product loss at 20 mbar allowable tank pressure savings in % at different overpressure
0% = up to 20 mbar (8 in WC) the valve is closed (theoretical): more than 70% saving,
10%= only at a valve set pressure 18 mbar (7.2 in WC) the valve opens, 65% saving,
40%= at a valve set pressure 14 mbar (5.6 in WC) the valve opens, 51% saving,
100%=already at a valve set pressure 10 mbar (4 in WC) the valve opens: only 35% saving.

Pressure and Vacuum Relief Valves for Pressure Relief and Tank Breathing

Outdoor storage tanks and vessels are exposed to weather conditions such as heating up and cooling down (the tank must be able to breath). These influences must be considered in addition to filling and emptying capacities as well as inert-gas supply. They can be calculated with good approximation (see Venting Requirements of Aboveground Storage Tanks - Sizing and Calculation Formulas, Page 20). The valve opening pressure must not exceed the maximum allowable tank pressure which also is called the tank design pressure. The construction and design of the valve determines how this opening pressure is reached. Safety valves with conventional construction designed for pressure vessels with 0.5 bar (7.25 psi) overpressure require an overpressure of 10% above the set pressure to attain the opening pressure. Below 1 bar (14.5 psi) pressure, the maximum overpressure may reach 100 mbar (4 in WC), which is clearly above the 10% level. In contrast, PROTEGO® valves with the relevant technology meet the requirements of conventional safety valves with an overpressure of 10% even at low set pressures down to 0.003 bar (1.2 in WC).

Under normal operating conditions, it must be impossible to block off the venting system on the tank. The sizing of the pressure and vacuum relief system must be such, that the design pressure, i.e. the pressure and vacuum (negative pressure) in the tank, can not be exceeded under any operating conditions. The **pressure and vacuum relief valve** must discharge the maximum flow arising from the pump capacity, thermal and other influences. This valve is frequently called the vent valve.

When extremely high venting rates are required due to fire on the outside surface of the tank or malfunctions in special tank equipment (such as tank blanketing gas systems), additional **emergency pressure relief valves** must be used, especially when the tank roof does not have a weak seam (Fig. 11).

When a blanket gas system fails, large amounts of gas can flow into the tank. The excess gas must be discharged from the tank through the pressure relief system without exceeding the tank design pressure.

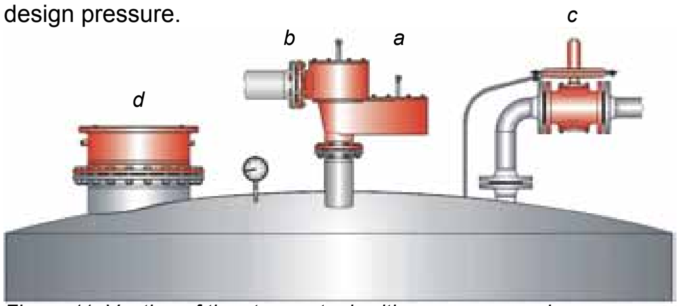

Figure 11: Venting of the storage tank with a pressure and vacuum relief valve PROTEGO® VD/SV-PA (a), piped into the vent header during operation (b), venting during operation via the nitrogen control valve PROTEGO® ZM-R (c), relieving in a fire-case through the emergency pressure relief valve PROTEGO® ER/V (d)

PROTEGO® valves fulfill the above metioned functions of maintaining and relieving pressure as **pressure relief valves, vacuum relief valves**, or **combined pressure and vacuum relief valves**. In the EN standard 14015, these valves are also termed pressure compensation valves, vacuum compensation valves, or combined pressure and vacuum compensation valves.

Location of installation

In general, PROTEGO® end-of-line valves are used for storage tanks, vessels or for ventilation lines. In pipes, PROTEGO® in-line valves are used as overflow valves, for backflow prevention and occasionally as (proportional) control valves. The great advantages are their simple design and large opening cross-sections. These valves operate trouble-free.

If the flowing products are explosive, in-line valves must have upstream detonation flame arresters to protect the system against accelerated combustions. End-of-line valves in this case of hazardous application, must be equipped with an end-of-line flame arrester to protect the system against atmospheric deflagration (see also Vol. 7).

Sizing of the Valves

The maximum possible volumetric flow, the maximum permissible pressures, and the operating data (process parameters) must be taken into account when sizing pressure/ vacuum relief valves.

Definitions:

Set pressure = the valve starts to open = adjusted set pressure of the valve at 0 bar back pressure

Opening pressure = set pressure plus overpressure

Reseating Pressure = Closing pressure = the valve recloses and is sealed

Overpressure = pressure increase over the set pressure

Accumulation (ISO) = pressure increase over the maximum allowable tank pressure of the vessel allowed during discharge through the pressure relief valve

Accumulation (EN) = differential pressure between the set pressure of the valve and the tank pressure at which the required flow rate is reached or the set vacuum of the valve and the tank internal negative pressure at which the required flow rate is reached (not used in this catalog)

Pressure loss = decrease in pressure within the valve at a given flow

Pressure loss curve (Flow Chart) = performance curve in the flow chart = the characteristics of the valves as the pressure in mbar (in WC) plotted against the flow in m^3/h (CFH)

Back pressure = pressure in the system, that acts against the flow out of the valve and that needs to be included as additional pressure on the valve pallet

The maximum allowable design pressure of an equipment, storage tank or vessel may not be exceeded. The maximum possible flow must be reliably discharged through the valve so that the maximum allowable design pressure of the equipment is not exceeded. Safety factors must be taken into account.

Operating states of pressure and vacuum relief valves: The valve is optimally sized when the operating point lies on the performance curve, i.e., when the attained maximum flow is discharged with the valve completely open without requiring an additional overpressure (with completely open valve) (full-load operating range A, Fig. 12).

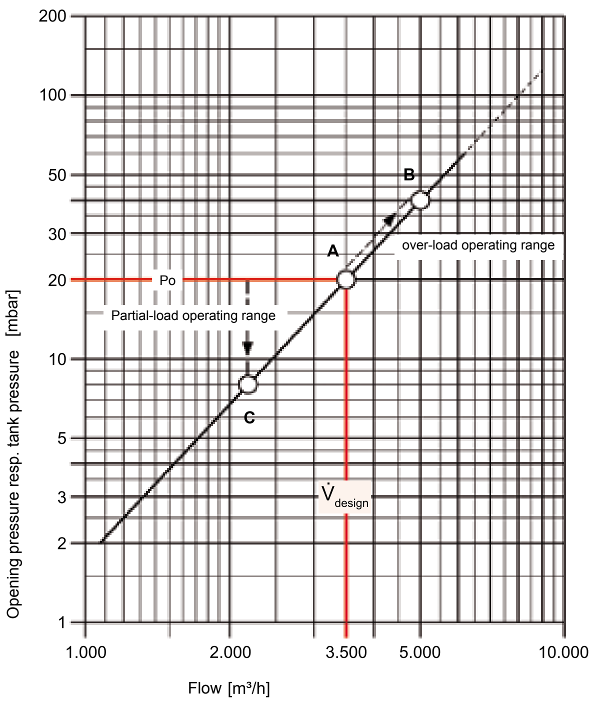

Figure 12: Design and operating points in the flow chart

When the design flow is not being reached during discharge the valve does not open completely. The valve pallet only lifts briefly, discharges the volume, and then recloses when the pressure falls below the set pressure. The reseating pressure depends on the design of the valve pallet and the geometry of the valve. There are partial-load operating ranges in which the full-lift is not reached (over-sized valves) and overload ranges in which an additional overpressure is required after a full lift to discharge the flow (under-sized valves). Within the overload range, the valve is stable; in the partial load range, the valve pallet can flutter due to instability. A proper sizing that takes possible operating conditions into consideration is therefore essential.

Example (Fig. 12):

Valve opening pressure	P_o = 20 mbar
Valve set pressure	P_{set} = 18 mbar (20 mbar - 10%)
A design flow	$\dot{V}_{design}$ = 3.500 m³/h
B over-load	$\dot{V} > \dot{V}_{design}$
C partial-load	$\dot{V} < \dot{V}_{design}$

Selection

The valves are selected using the above selection criteria depending on the **location of installation** and whether the valve is to **function** as a pressure relief valve, vacuum relief valve, or combined pressure and vacuum relief valve.

Location of Installation	End-of-line Valves				In-line Valves		
Function	Pressure Relief Valves	Vacuum Relief Valves	Pressure and Vacuum Relief Valves	Pressure Relief and Vacuum Valves, pilot operated	Pressure or Vacuum Relief Valves	Pressure and Vacuum Relief Valves	Blanketing Valves
Example of Use	→ Storage tank, page 27				→ Vent header, page 27		
Product	→ Volume 5	→ Volume 5	→ Volume 5	→ Volume 5	→ Volume 6	→ Volume 6	→ Volume 6

PROTEGO® has the right valve for all applications

For venting of storage tanks and vessels
→ PROTEGO® Pressure and Vacuum Relief Valves, end-of-line (Vol. 5)

As overflow valves or backflow preventers
→ PROTEGO® Pressure or Vacuum Relief Valves, in-line (Vol. 6)

For venting of tanks storing products at low temperatures and storing critical products

→ PROTEGO® Pressure / Vacuum Relief Diaphragm Valves, end-of-line (Vol. 5)

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Development

When storing flammable products or processing chemical products that can create explosive mixtures, the opening of the storage tank or vessel must be additionally protected with flame arresters. The task was to develop a device that combined the properties of a flame arrester and a valve into one design.

PROTEGO® valves with integrated flame arrester units have the unique advantage that the flame arrester units are external and hence easily accessible (Fig. 1 and 2).

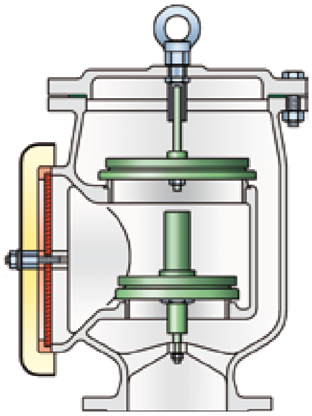

Figure 1:
Deflagration-proof pressure and vacuum relief valve PROTEGO® VD/TS

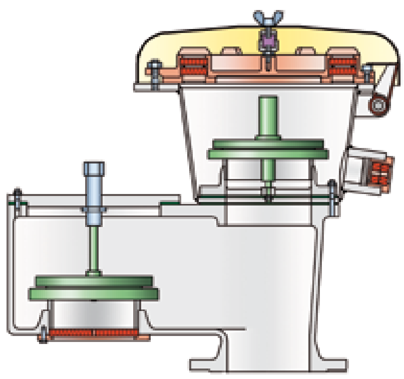

Figure 2:
Pressure and vacuum relief valve protecting against deflagration and endurance burning PROTEGO® VD/SV-HR

The operating conditions must be carefully considered. Depending on the possible combustion processes, protection must be provided against atmospheric deflagration, and/or short time burning, and/or endurance burning.

Valve Technology

The valve technology and function of the pressure and vacuum valves with integrated flame arrester units are equal to those without flame arrester units. It must be realized that the downstream flame arrester unit creates a certain back pressure which has no impact on the set pressure but influences the over-pressure behaviour. This is considered in the flow charts.

Pressure and Vacuum Relief Valves with Flame Arrester

Pressure and vacuum relief valves with integrated flame arrester units have the same tasks and functions as valves without flame arrester. They serve to **maintain pressure (vapour conservation), relief pressure** and enable **tank breathing**. For a detailed description, see page 11.

Flame Arrester

The valves also have an **integrated flame arrester unit**. The explosion group of the chemical products to be protected needs to be considered in the flame-transmission-proof selection of the valve. The chemical products are categorized into explosion groups IIA, IIB3, and IIC (NEC Group D, C, B) according to the MESG of the mixtures. The valves with flame arrester units are categorized in the same way. The valve is tested and approved for the explosion group.

The PROTEGO® **diaphragm valve** (Fig. 3) has a liquid load above the diaphragm. The static liquid column is proportional to the set pressure. The flexible liquid-loaded diaphragm adjusts tightly to the metal valve seat to provide an excellent seal. If the set pressure is exceeded, the diaphragm lifts and releases the cross-section for the discharging flow. Due to the flexible diaphragm, these valves are used in weather-related low temperatures and with FEP diaphragms for sticky, polymerizing media.

The PROTEGO® **diaphragm valve** (Fig. 3a) offers dynamic flame-transmission protection against endurance burning and an installed static flame arrester unit with flame-transmission protection against atmospheric deflagrations.

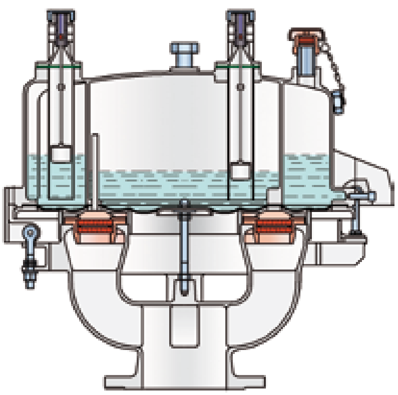

Figure 3: Diaphragm valve PROTEGO® UB/SF protecting against deflagration and endurance burning

Figure 3a: Endurance-burning test with diaphragm valve PROTEGO® UB/SF

The **high velocity valve** (Fig. 4) has special flame-transmission protection with a dynamic discharge between the valve cone and valve seat starting at a set pressure of +60 mbar (24 in WC). The high velocity valve is endurance burning proof.

Figure 4: Endurance burning-proof high velocity valve PROTEGO® DE/S with a connected deflagration-proof vacuum valve PROTEGO® SV/E-S

Location of installation

Valves with flame arrester units are always end-of-line valves since the heat must be released to the environment with no heat build-up to prevent transmission of flame. Otherwise the unallowable heat build-up would effect a heat accumulation at the flame arrester which finally results in a flash-back. They are primarily used for storage tanks and containers in which flammable liquids are stored or processed and for relief openings in process containers in which the occurence of explosive mixtures cannot be excluded.

Design and operating states of valves

The sizing and operating states of the pressure and vacuum relief valves are described on pages 14 and 15.

Selection

Since PROTEGO® pressure/vacuum relief valves with flame arrester units are always end-of-line valves, they are selected taking into consideration their function as a pressure valve, vacuum valve, or combined pressure and vacuum relief valve.

After the explosion group of the products and the possible combustion process have been determined, the valve can be selected regarding its flame-transmission protection. When selecting PROTEGO® valves with a flame arrester unit, one must establish whether flame-transmission protection is to be provided against atmospheric deflagrations or endurance burning. Endurance burning flame arresters include protection against atmospheric deflagrations. Flame-transmission-proof vacuum relief valves do not protect against endurance burning, but they are always deflagration-proof.

Location of Installation	**End-of-line Valve**				
Function	Pressure Relief Valve with Flame Arrester	Vacuum Relief Valve with Flame Arrester	Pressure and Vacuum Relief Valve with Flame Arrester	Pressure- / Vacuum Relief Diaphragm Valve with Flame Arrester	High Velocity Valve
Example of Use	→ Storage tank, Emergency venting / pressure relief, page 27				→ Storage tank, Tank ships, page 30
Products	→ Volume 7	→ Volume 7	→ Volume 7	→ Volume 7	→ Volume 7

PROTEGO® has the right valve for all applications.

For flame-transmission-proof pressure and vacuum relief of storage tanks and containers
→ PROTEGO® Pressure and Vacuum Relief Valves with Flame Arresters, end-of-line

For frost-proof application, for critical products, and for flame-transmission-proof pressure and vacuum relief of tanks and containers
→ PROTEGO® Pressure -/ Vacuum Relief Diaphragm Valves

For flame-transmission-proof pressure and vacuum relief of tank ships
→ PROTEGO® High Velocity Valves

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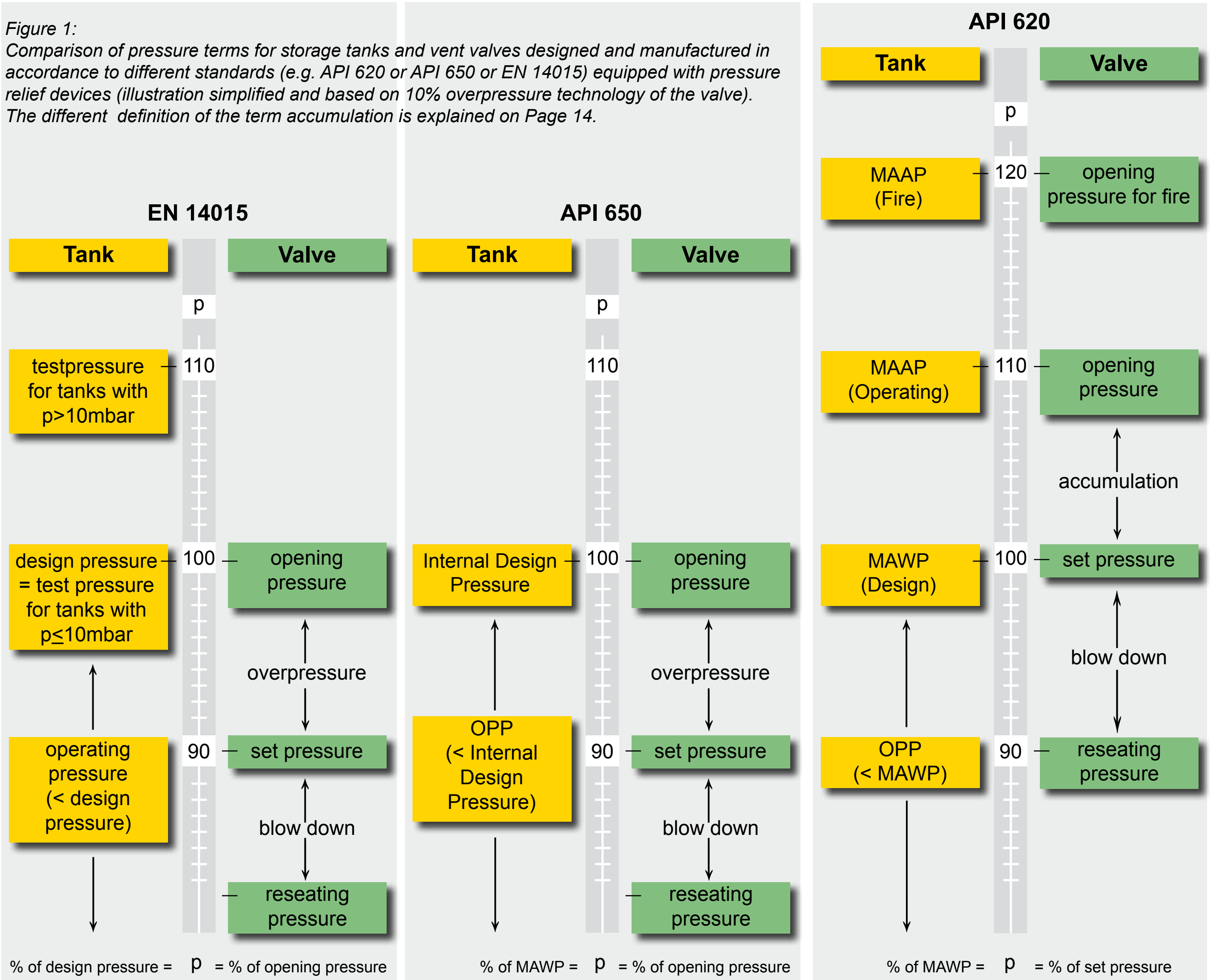
Pressure Terms and Definitions

Tanks storing flammable and non-flammable liquids are designed and manufactured in accordance to different standards: EN 14015, API 620 or API 650 are the most important standards worldwide. Depending on the standard different maximum tank pressures are allowable to relief the required massflow.

Fig. 1 shows the most common terms for tanks and valves in accordance to EN 14015, API 620, API 650, API 2000. This comparison clarifies the sizing of end-of-line relief valves featuring the 10% overpressure technology with a set pressure adjusted only 10% below the opening pressure. In accordance to **EN 14015** and **API 650** (**Fig. 1A** and **1B)** the design pressure or **MAWP** = **M**aximum **A**llowable **W**orking **P**ressure of the tank must not be exceeded not even in fire-case or system mal-function. Following **API 620** **(Fig. 1C)** the valve must relief the required regular massflow out of thermal influences and pumping at 10% above the design pressure (in general the MAWP) at the latest. For fire-case or emergency an overpressure of 20% is allowable: after exceeding the MAWP

Figure 1:
Comparison of pressure terms for storage tanks and vent valves designed and manufactured in accordance to different standards (e.g. API 620 or API 650 or EN 14015) equipped with pressure relief devices (illustration simplified and based on 10% overpressure technology of the valve).
The different definition of the term accumulation is explained on Page 14.



design pressure
= calculated pressure = Maximum Allowable Working Pressure (MAWP) to be not exceeded at all operating conditions. For fire and emergency conditions weak roof to shell attachment or emergency relief valves to be provided.

opening pressure
≤ design pressure;

set pressure = 0,9 x opening pressure for 10% overpressure technology.

Figure 1A

internal design pressure
= max. relieving pressure under operating condition, fire condition or emergency (max. relieving pressure for valve and emergency valve).

OPP = Operating Pressure

opening pressure
≤ internal design pressure

set pressure = 0,9 x opening pressure for 10% overpressure technology.

Figure 1B

MAAP
= Maximum Allowable Acumulated Pressure = max. relieving pressure under operating condition (max. relieving pressure for valve). Relief Pressure for fire-case or emergency condition relief at 20% excess overpressure.

Max. allowable set pressure
= MAWP for 10% overpressure technology.
MAWP = Maximum Allowable Working Pressure

Figure 1C

by maximum 20% the required emergency massflow must be relieved. **Fig. 2** shows the procedure to determine the set pressure for valves with different overpressure characteristics by considering the specific tank design pressure. These examples are for end-of-line relief valves only without a back-pressure originated by e.g. connected pipe-away-line. If the tank is designed in accordance to EN 14015 or API 650 the opening pressure must not exceed the design pressure (=MAWP) of the tank (Fig. 2A). The set pressure is a result of the opening pressure minus the overpressure of the valve which is a characteristic of the specific valve. If the tank is manufactured in accordance to API 620 the opening pressure may exceed the tank design pressure by 10% for regular breathing and 20% for fire-case (Fig. 2B). The set pressure again is the result of the opening pressure minus the valve-characteristic overpressure.

Figure 2:
Selection of the set pressure of the Pressure or Vacuum Relief Valve considering the tank design pressure and the valves characteristic overpressure (e.g. 10%, 40% or 100%). API 620 using the 20% over-pressure allowance for fire emergency.

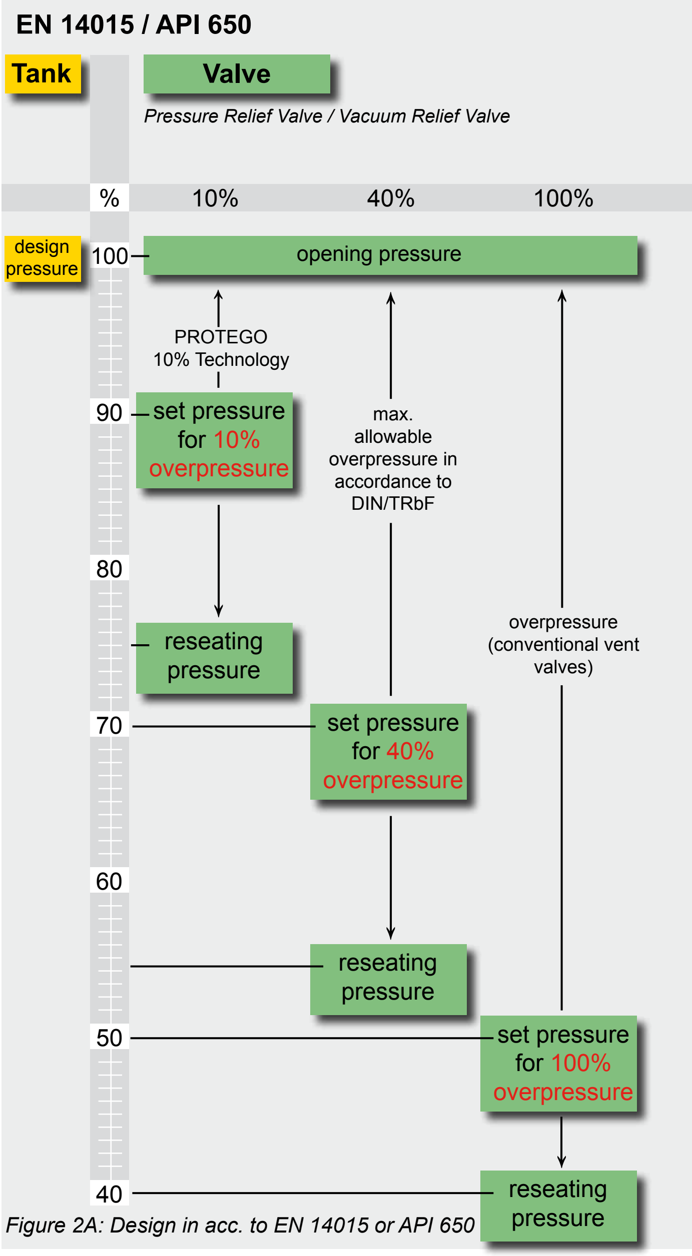


Figure 2A: Design in acc. to EN 14015 or API 650

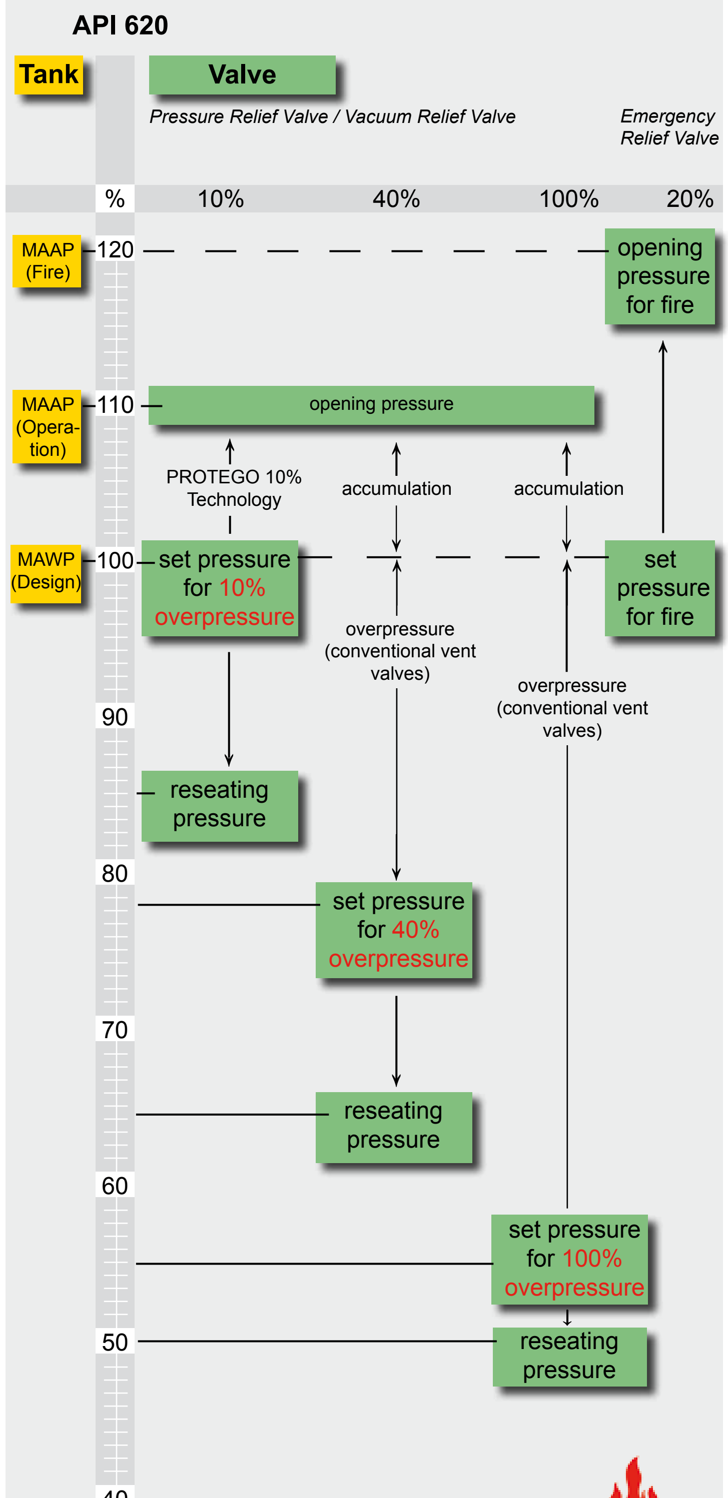


Figure 2B: Design in acc. to API 620

Calculation of the Out- and Inbreathing venting capacity in acc. to ISO 28300:

The maximum required venting capacity is the total amount of pump capacity and capacity out of thermal influences:

$$\dot{V}_{out} = \dot{V}_{thermal\ out} + \dot{V}_{pump\ in}$$

$$\dot{V}_{in} = \dot{V}_{thermal\ in} + \dot{V}_{pump\ out}$$

The calculation of the maximum required capacity out of the thermal influences is based on ISO 28300 with regard to above-ground storage tanks with or without insulation.

Thermal capacity for heating up $\dot{V}_{thermal\ out}$ in m³/h

$$\dot{V}_{thermal\ out} = 0{,}25 \cdot V_{Tank}^{0.9} \cdot R_i$$

Thermal capacity for cooling down $\dot{V}_{thermal\ in}$ in m³/h

$$\dot{V}_{thermal\ in} = C \cdot V_{Tank}^{0.7} \cdot R_i$$

- V_{Tank} is the volume of the tank in m³

  $V_{Tank} = 0{,}7854 \cdot D^2 \cdot H$
- R_i is a reduction factor for insulation (see ISO 28300)
- $\dot{V}_{pump\ in}$ is the filling rate to calculate the outbreathing capacity out of the maximum pump capacity in m³/h for products stored below 40°C and a vapour pressure p_{vp} < 50 mbar. For products stored at a temperature above 40°C or with a vapour pressure p_{vp} > 50 mbar the out-breathing rate must be increased by the evaporation rate.
- $\dot{V}_{pump\ out}$ is the emptying rate to calculate the inbreathing capacity of the pump in m³/h.
- C=3 for products with equal vapour pressure as hexane and storage temperature < 25°C
- C=5 for products with vapour pressures higher than hexane and/or storage temperature above 25°C (if vapour pressure not known, then C=5)

The mentioned calculation formulas are valid for latitudes 58° to 42°; other latitudes see ISO 28300.

Particular influences to be considered are e.g.:

- Failure of the nitrogen blanketing valve – Installation of an additional emergency relief valve to vent the non calculated flow which was not foreseen under operation
- Filling the empty hot tank with cold liquid product – Considering the additional flow due to the sudden cooling down when calculating the necessary vacuum capacity
- Exceeding the maximum given pump out capacity – Considering a safety factor when calculating the required inbreathing capacity

Calculation of the Out- and Inbreathing venting capacity in acc. to TRbF 20:

To calculate the out- and inbreathing capacity of storage tanks (e.g. tanks in acc. to DIN 4119 – aboveground storage tanks or DIN 6608 – horizontal underground or buried tanks) the calculation formulas of TRbF 20 are to be applied.

Calculation of the required capacity due to thermal influences:

Heating up $\dot{V}_E = 0{,}17 \text{ x} \left(\frac{H}{D}\right)^{-0{,}52} \text{x } V_{Tank}^{0{,}89}$

Cooling down $\dot{V}_A = 4{,}8 \text{ x } V_{Tank}^{0{,}71}$

Calculation of Out- and Inbreathing venting capacity in acc. to API 2000 5th edition / ISO 28300 Annex A:

The out- and inbreathing capacity of petroleum storage tanks can be calculated in acc. to ISO 28300 Annex A (approximately equivalent to API 2000 5th edition) if specific boundary conditions are fulfilled (see ISO 28300).

If required and when the tanks are specified and designed in accordance to **API 650,** the venting capacity is to be calculated in accordance to **API 2000** for in- and outbreathing as well as for emergency fire cases.

When calculating the required capacities in accordance to API 2000 5th edition / ISO 28300 Annex A, the flammable liquids must be verified with regard to their flashpoint. Different formulas must be applied for liquids with flash-point < 100°F (< 37,8°C) and for liquids with flashpoint ≥ 100°F (≥ 37,8°C). The maximum required venting capacity is the total amount of pump capacity plus capacity out of thermal influences. In contrast to the calculation acc. to EN 14015 and TRbF 20, the pump capacity must consider a factor for the in-breathing rate and the different flashpoints for the outbreathing rate.

Calculation of the inbreathing capacity:

$$\dot{V}_{in} = \dot{V}_{pump\ out} \text{ x } 0{,}94 + \dot{V}_{thermal\ in}$$

The thermal capacity $Thermal_{In}$ is rated in API 2000 5th ed. **Fig. 2A** (English Units) and **2B** (Metric Units) depending on the tank-volume. The maximum pumping capacity $\dot{V}_{\text{pump out}}$ is rated in accordance to the specified operating rates for emptying.

Calculation of the outbreathing capacity:

For liquids with flashpoint <100°F (<37,8°C)

$$\dot{V}_{out} = \dot{V}_{pumping\ in} \times 2{,}02 + \dot{V}_{thermal\ out}$$

For liquids with flashpoint ≥100°F (≥37,8°C)

$$\dot{V}_{out} = \dot{V}_{pumping\ in} \times 1{,}01 + \dot{V}_{thermal\ out}$$

The thermal capacity $\dot{V}_{thermal\ out}$ is rated in API 2000 5th ed. **Fig. 2A** (English units) **and 2B** (Metric Units) depending on the tank-volume and the flashpoint. The maximum pumping capacity $\dot{V}_{\text{pump in}}$ is rated in accordance to the specified operating rates for filling.

In case there is no weak roof-to-shell attachment, the venting for fire emergency case is to be realized through an emergency pressure relief valve. The required capacity for fire emergency case $\dot{V}_{\text{Fire}}$ is rated in accordance to API 2000 **Fig. 3A** (English Units) and **Fig. 3B** (Metric Units) depending on the wetted surface area of the tank.

Simplified formula for estimating calculation:

$$\dot{V}_{fire} = 208{,}2 \times F \times A^{0{,}82} \text{ for Metric Units in Nm}^3\text{/h}$$

$$\dot{V}_{fire} = 1107 \times F \times A^{0{,}82} \text{ for English Units in SCFH}$$

Insulation is considered with a factor F in API 2000 **Fig. 4A** (Englisch Units) and **4B** (Metric Units).

Requirements of Thermal Venting Capacity (English Units)

Tank Capacity	Tank Capacity	Inbreathing *Thermal in*	Outbreathing *Thermal Out* Flashpoint ≥ 100°F	Outbreathing *Thermal Out* Flashpoint < 100°F
Barrels	Gallons	SCFH Air	SCFH Air	SCFH Air
100	4.200	100	60	100
500	21.000	500	300	500
1.000	42.000	1.000	600	1.000
2.000	84.000	2.000	1.200	2.000
4.000	168.000	4.000	2.400	4.000
5.000	210.000	5.000	3.000	5.000
10.000	420.000	10.000	6.000	10.000
20.000	840.000	20.000	12.000	20.000
30.000	1.260.000	28.000	17.000	28.000
40.000	1.680.000	34.000	21.000	34.000
50.000	2.100.000	40.000	24.000	40.000
100.000	4.200.000	60.000	36.000	60.000
140.000	5.880.000	75.000	45.000	75.000
160.000	6.720.000	82.000	50.000	82.000
180.000	7.560.000	90.000	54.000	90.000

Excerpt of API 2000 5th ed.

Figure 2A

Requirements of Thermal Venting Capacity (Metric Units)

Tank Capacity	Inbreathing *Thermal in*	Outbreathing *Thermal Out* Flashpoint ≥ 37,8°C	Outbreathing *Thermal Out* Flashpoint < 37,8°C
m³	Nm³/h	Nm³/h	Nm³/h
10	1,69	1,01	1,69
20	3,37	2,02	3,37
100	16,90	10,10	16,90
200	33,70	20,20	33,70
300	50,60	30,30	50,60
500	84,30	50,60	84,30
1.000	169,00	101,00	169,00
2.000	337,00	202,00	337,00
3.000	506,00	303,00	506,00
4.000	647,00	388,00	647,00
5.000	787,00	472,00	787,00
10.000	1.210,00	726,00	1.210,00
20.000	1.877,00	1.126,00	1.877,00
25.000	2.179,00	1.307,00	2.179,00
30.000	2.495,00	1.497,00	2.495,00

Excerpt of API 2000 5th ed.

Figure 2B

Emergency Venting required for Fire Exposure Versus Wetted Surface Area (English Units)

Wetted Area A square feet	Venting Requirement $\dot{V}$ SCFH
20	21.100
40	42.100
60	63.200
80	84.200
100	105.000
140	147.000
180	190.000
250	239.000
350	288.000
500	354.000
700	428.000
1400	587.000
2800	742.000

Excerpt of API 2000 5th ed.

Figure 3A

Emergency Venting required for Fire Exposure Versus Wetted Surface Area (Metric Units)

Wetted Area A m^2	Venting Requirement $\dot{V}$ Nm^3/h
2	608
4	1.217
6	1.825
8	2.434
15	4.563
25	6.684
30	7.411
35	8.086
45	9.322
60	10.971
80	12.911
150	16.532
260	19.910

Excerpt of API 2000 5th ed.

Figure 3B

Environmental Factors for nonrefrigerated Aboveground Tanks (English Units)

Tank-configuration	Insulation Thickness inch	F - Factor
Bare metal tank	0	1.0
insulated tank	1	0.3
insulated tank	2	0.15
insulated tank	4	0.075
insulated tank	6	0.05
underground storage		0
earth covered storage		0.03
impoundment away from tank		0.5

Excerpt of API 2000 5th ed.

Figure 4A

Environmental Factors for nonrefrigerated Aboveground Tanks (Metric Units)

Tank-configuration	Insulation Thickness cm	F - Factor
Bare metal tank	0	1,0
insulated tank	2,5	0,3
insulated tank	5	0,15
insulated tank	10	0,075
insulated tank	15	0,05
underground storage		0
earth covered storage		0,03
impoundment away from tank		0,5

Excerpt of API 2000 5th ed.

Figure 4B

Conversion of operational flow into equivalent diagram flow for use of flow charts

To use the flow charts (pressure vs. flow diagram) by considering the operational and product data, it is necessary to convert the given operational flow $\dot{V}_{B,Gas}$ into the equivalent diagram-flow $\dot{V}_{Dia}$. This $\dot{V}_{Dia}$ then creates the same pressure loss as the actual operational flow.

1) Conversion of the operational flow $\dot{V}_{B,Gas}$ into the standard flow $\dot{V}_{N,Gas}$:

$$\dot{V}_{N,\,Gas} = \dot{V}_{B,\,Gas} * \frac{T_N * p_B}{T_B * p_N} = \dot{V}_{B,\,Gas} * \frac{p_B * 273{,}15K}{T_B * 1{,}013\ bar_{abs.}}$$

2) Conversion of the standard flow $\dot{V}_{N,Gas}$ into the equivalent diagram flow $\dot{V}_{Dia}$:

$$\dot{V}_{Dia} = \dot{V}_{N,\,Gas} * \sqrt{\frac{\rho_{N,\,Gas} * p_N * T_B}{\rho_{Dia} * p_G * T_N}}$$

$$= \dot{V}_{N,\,Gas} * \sqrt{\frac{\rho_{N,\,Gas} * T_B * 1{,}013\ bar_{abs.}}{p_G * 1{,}2\,\frac{kg}{m^3} * 273{,}15\ K}}$$

3) Calculation of the average density $\rho_{N,Gas}$ of a gas-mixture

$$\rho_{N,\,Gas} = (v_1 * \rho_{N,\,Gas\,1} + v_2 * \rho_{N,\,Gas\,2} + \ldots + v_x * \rho_{N,\,Gas\,x})$$

Terms

$\dot{V}$ = Flow m³/h (CFH)

p = Pressure bar abs (psi abs)

T = Temperature K

ρ = Specific density kg/m³ (lb / cu ft)

v = Volume fraction

Indices

N = Standard condition (at 1,013 bar abs and 273,15 K)

B = Operational condition (pressure and temperature in acc. to operation)

Gas = Actual product

Dia = Related to the Diagram, when using the flow chart for sizing (ρ_{Dia}=1,2 kg/m³ related density of air at 20 °C and 1,013 bar abs.)

G = related to the outlet of the device (p_G back pressure) for operating conditions

Safety Proceeding to Protect Hazardous Explosive Areas in Third-Party-audited processing plants

Step 1

Assessment of the possible combustion process based on Standards, e.g. EN 1127-1 General Explosion Protection Methods and EN 12874 Flame Arresters

- Deflagration in the atmosphere, in a pre-volume or in a pipeline
- Detonation in a pipeline, stable or unstable
- Endurance burning due to continous flow of vapours/gases in the pipeline or at the opening of a tank

Step 2

Classification of the products based on literature and international standards EN 12874, VbF, TRbF 20, NFPA, British Standard for liquids, gases, vapours and multiple component mixtures

- Liquids: subdividing in flammable, easy flammable and highly flammable due to the flash point of the liquid and verifying the ignition temperature.

The classification is following the VbF (previously) and the Ordinance on Hazardous Substances (Gef. Stoff VO):

Non water soluble		
previous	actual	
(A I FP< 21 °C)	FP < 0 °C (32°F)	Extremely flammable
	FP < 21 °C (70°F)	Highly flammable
(A II FP 21–55 °C)	FP 21-55°C (70-131°F)	Flammable
(A III FP 55–100 °C)		-

Water soluble		
previous	actual	
(B < FP 21 °C)	FP < 0 °C (32°F)	Extremely flammable
	FP < 21 °C (70°F)	Highly flammable
	FP 21–55 °C (70-131°F)	Flammable

FP = Flashpoint

Products with a flashpoint FP>55°C (>131°F) get flammable when being heated close to the flashpoint (ΔT = 5 degree safety margin as a rule of thumb).

Vapours: classification of the gas/vapour-air-mixtures in accordance to the MESG of the products or the mixture into the Explosion Groups I, IIA, IIB1, IIB2, IIB3, IIB and IIC (page 9) (NEC Group D, C and B).

Step 3

Consideration of the operational process parameters of the unburnt mixtures with regard to the impact on the combustion behaviour:

- OperatingTemperature
  ≤ 60°C (≤ 140°F) Standard, no particular requirements
  > 60°C (> 140°F) Special approvals necessary
- Operating pressure
  ≤ 1,1 bar abs(≤ 15.95 psi) Standard, no particular requirements
  > 1,1 bar abs(> 15.95 psi) Special approvals necessary

Step 4

Assessment of the overall system and classification into hazardous zones in accordance to frequency and duration of explosive atmosphere based on national and international regulations e.g. TRBS, IEC or NFPA/NEC.

- Zone 0

  A place in which an explosive atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently.

- Zone 1

  A place in which an explosive atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.

- Zone 2

  A place in which an explosive atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

To work out a risk assessment, the possible ignition sources must be evaluated under normal operating conditions as well as under special operating conditions like cleaning and maintenance work (see EN 1127-1):

effective ignition source:

- Steady and continuously under normal operation
- Solely as a result of malfunctions
- Solely as a result of rare malfunctions

Effective ignition sources are chemical reactions, flames and hot gases, hot surfaces, mechanical generated sparks, static electricity, lightning, electromagnetic waves, ultrasonics, adiabatic compression, shock waves etc.

Effectiveness of the ignition source is to be compared to the flammability of the flammable substance.

Step 5

Selection, number and location of the suitable Equipment, Protective System and Component must follow the requirements of national and international regulations (e.g. 94/9/EC)

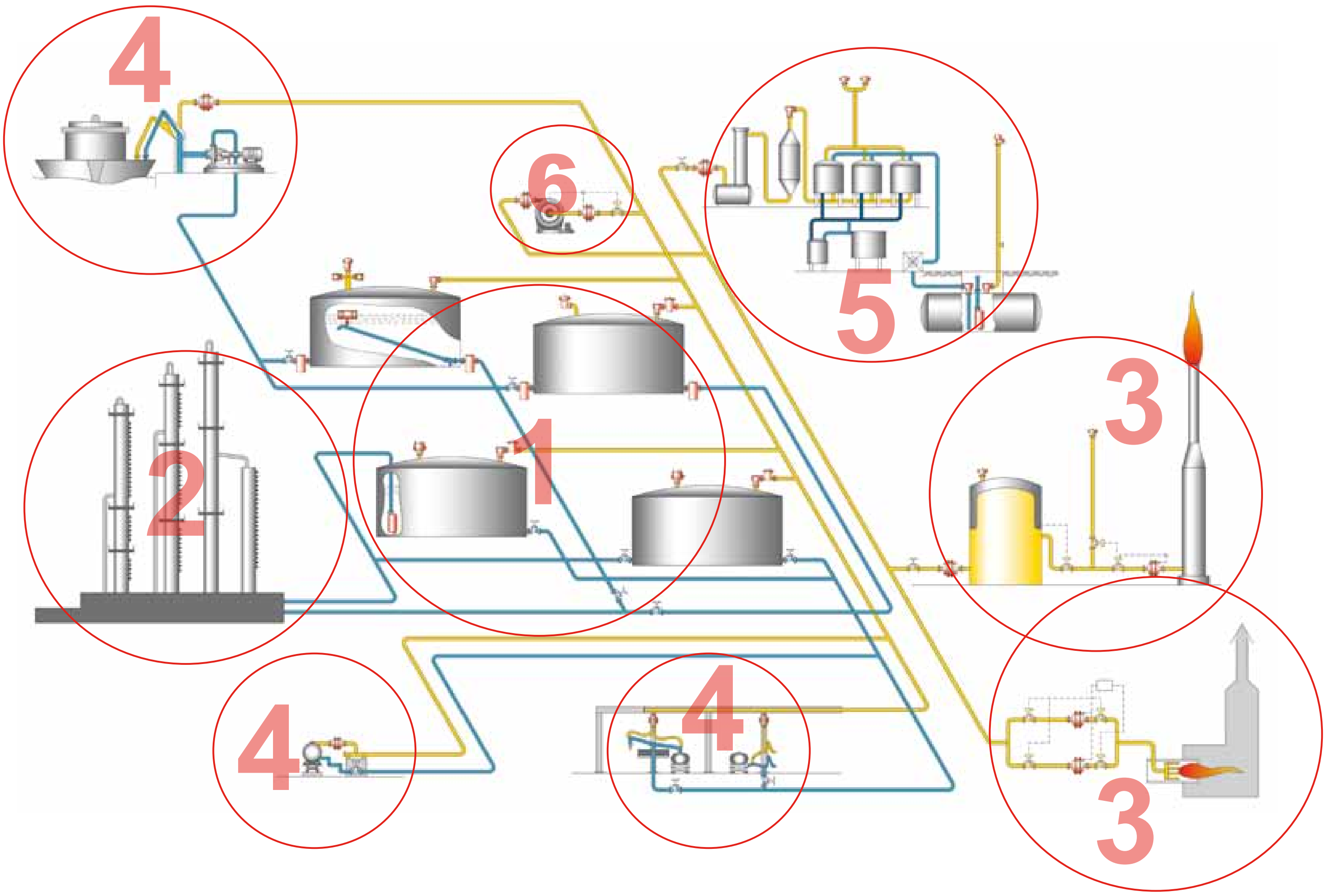
For equipment (blowers, agitators, containers etc.)

- In Zone 0 equipment categorized in group II cat 1
- In Zone 1 equipment categorized in group II cat 2
- In Zone 2 equipment categorized in group II cat 3

Flame arresters are Protective Systems and are not categorized. They must be type examination tested and approved by a Notified Body. They can be installed in all zones (zone 0, 1 or 2) and are marked with CE to state the conformity with all applicable requirements.

The procedure and the results of the risk assessment must be verified in the "Explosion Protection Document". The plant operator (employer) has to confirm that Equipment, Protective Systems and Components are in accordance with the law and are in compliance with the actual state-of-the-art. Process engineering, plant-layout, substances, zoning, risk assessment etc. are part of the protection concept and are determined in connection with the corresponding responsibilities.

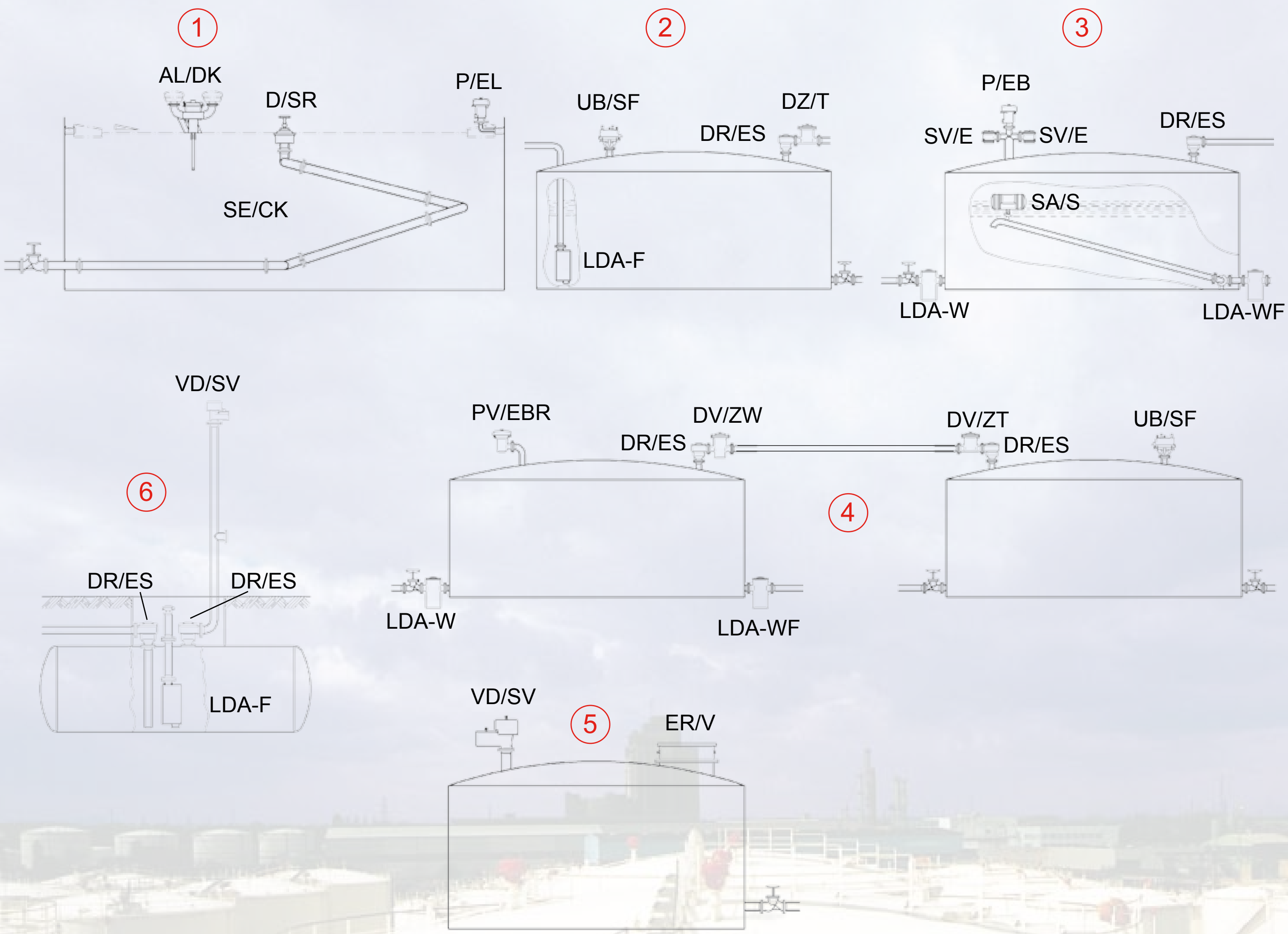
PROTEGO® safety devices are used in a wide range of industrial applications. A safe process requires reliable protection for every conceivable operating parameter. Practical examples show how systems can be made safe and how PROTEGO® devices can be incorporated into control loops. Engineers are responsible for properly harmonizing the overall system.



PROTEGO® devices offer safety and environmental protection

1. In Storage Tank Farms for Refineries and Chemical Plants
2. In Processing Systems for Chemical and Pharmaceutical Industries
3. In Vapour Combustion Systems and Flares
4. In Ship Building, Offshore Platforms and Loading Systems
5. In Vapour Recovery Units
6. As integrated Component of Equipment, Machines and Vessels

Applications are found in other areas such as in biogas and landfill gas systems, medical technology, food processing, airplane construction, automobile construction, IT clean-rooms, thin-layer manufacturing, etc. The process engineering is the special challenge for PROTEGO® engineers and users.



1 Floating-roof storage tank with floating-roof drainage system SE/CK (→ Volume 8), roof valve D/SR (→ Volume 8), stem-actuated valve AL/DK (→ Volume 8) and rim vent P/EL (→ Volume 5)

2 Fixed-roof storage tank for flammable liquids with pressure and vacuum diaphragm valve UB/SF (→ Volume 7), liquid detonation flame arrester LDA-F (→ Volume 4), in the protective gas blanket line DR/ES (→ Volume 4) with D/ZT (→ Volume 6)

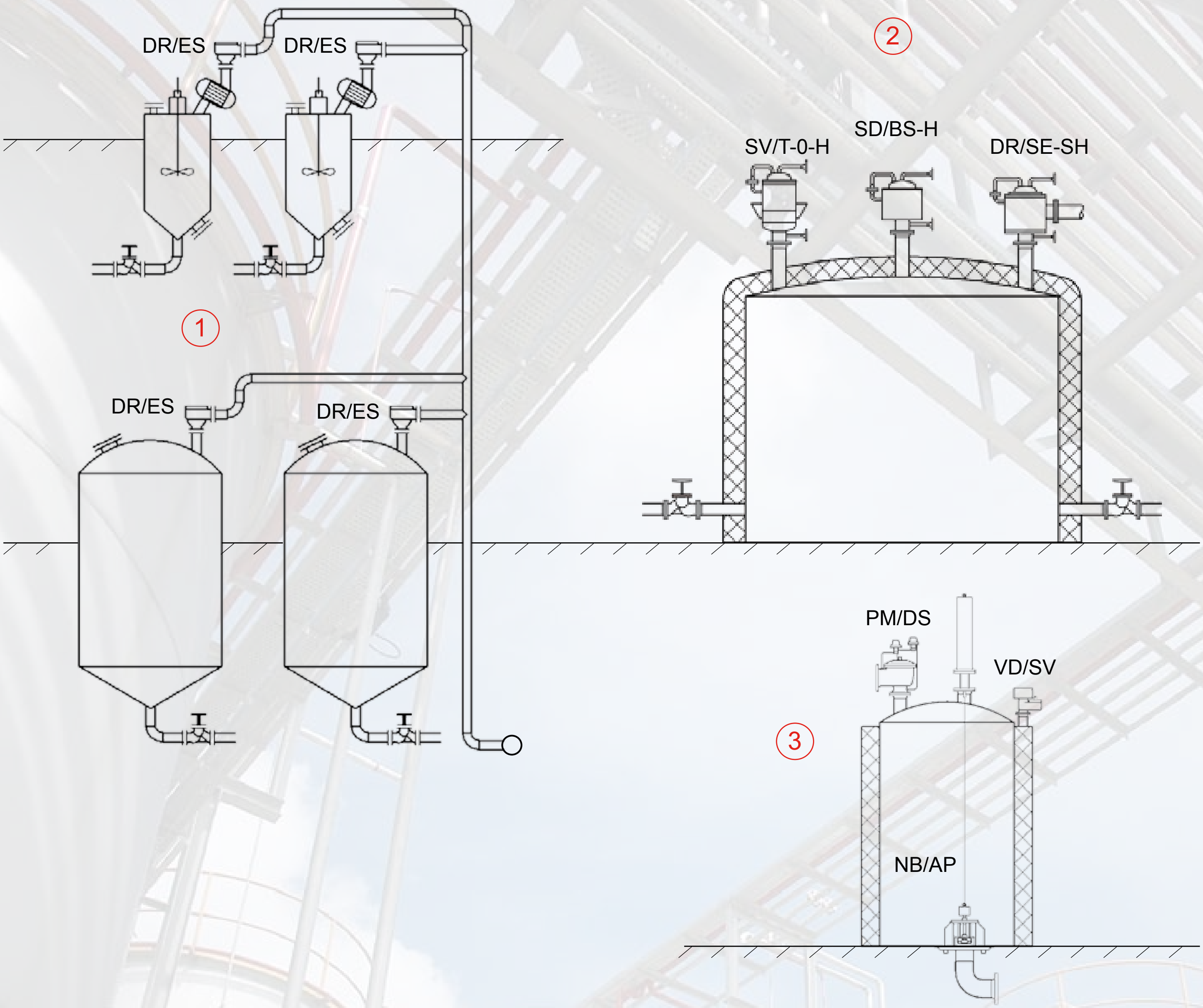
3 Fixed-roof storage tank for flammable liquids with separate pressure safety relief valve P/EB (→ Volume 7) and vacuum safety relief valve SV/E (→ Volume 7), liquid detonation flame arrester LDA-W (→ Volume 4) and/or LDA-W-F (→ Volume 4) in the filling and emptying line, float-controlled swing pipe system SA/S (→ Volume 8), detonation-proof gas displacement connection DR/ES (→ Volume 4)

4 Fixed-roof storage tank for flammable liquids with pressure and vacuum relief valve PV/EBR (→ Volume 7), pressure and vacuum relief diaphragm valve UB/SF (→ Volume 7), connection to gas vent header system with detonation flame arrester DR/ES (→ Volume 4) and in-line pressure and vacuum safety relief valve DV/ZT or DV/ZW (→ Volume 6), liquid detonation arrester in the filling line LDA-W and emptying line LDA-WF (→ Volume 4)

5 Fixed-roof storage tank for non-flammable liquids with pressure and vacuum conservation valve VD/SV (→ Volume 5) and emergency pressure relief valve ER/V (→ Volume 5) instead of weak seam

6 Underground storage tank with safety devices in the filling line LDA-F (→ Volume 4), detonation flame arrester in the drain line DR/ES (→ Volume 4), and in the vent line DR/ES (→ Volume 4) and VD/SV (→ Volume 6)

Chemical and Pharmaceutical Processing Facilities

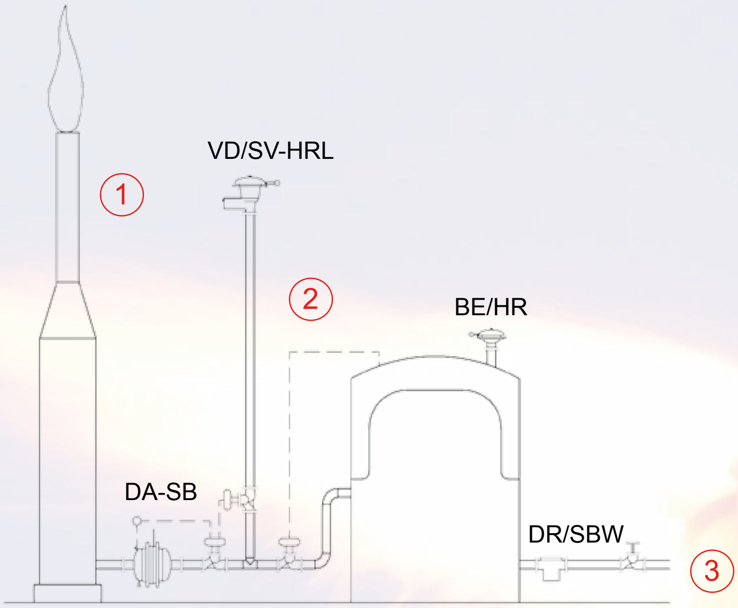


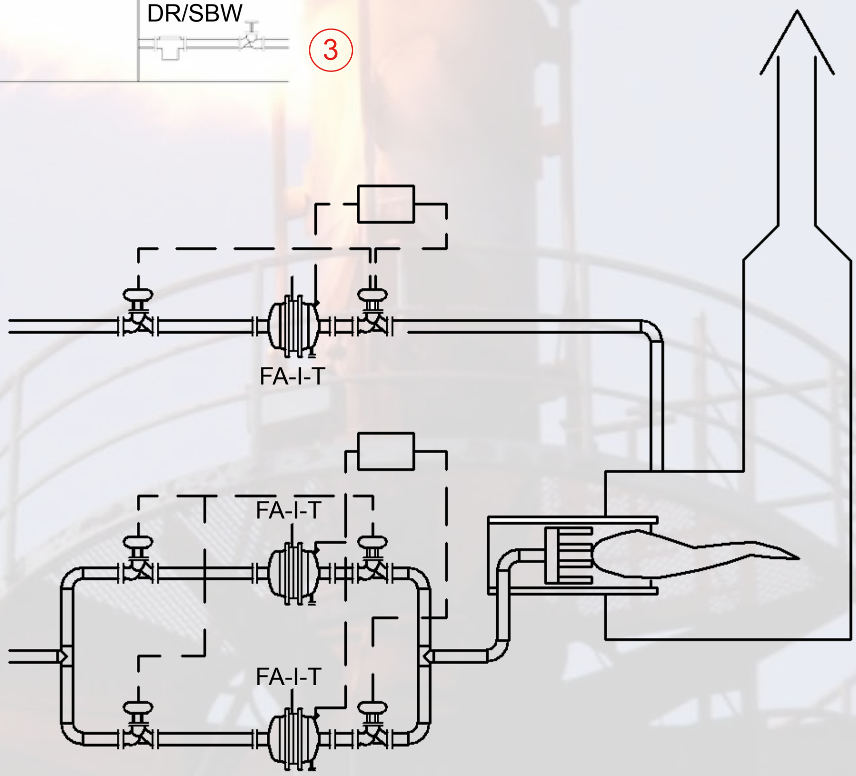
1. Ventilation of industrial mixers and process vessels in a common vapour vent header via detonation flame arresters DR/ES (→ Volume 4)

2. Venting of a storage tank for highly viscous liquids (such as bitumen) with super-heated pressure relief valve SD/BS-H (→ Volume 5) and ventilation with super-heated vacuum valve SV/T-0-H (→ Volume 5). Operational vacuum and pressure relief through a heated detonation flame arrester DR/ES-H (Vol. 4)

3. Low temperature storage tanks with pressure and vacuum relief valve VD/SV (→ Volume 5) for the insulation layer and with pilot-operated pressure-relief valves PM/DS (→ Volume 5) for the main tank. Pneumatically controlled bottom drain valves NB/AP (→ Volume 8) as a safety system in case a line ruptures.

Not shown: pressure conservation valves VD/SV (→ Volume 5) for silos with polyethylene granulate.





1. Flare pipes or ground flares with detonation flame arresters DA-SB (→ Volume 4)

2. Emergency pressure relief stack with endurance-burning-proof pressure and vacuum relief valve VD/SV-HRL (→ Volume 7)

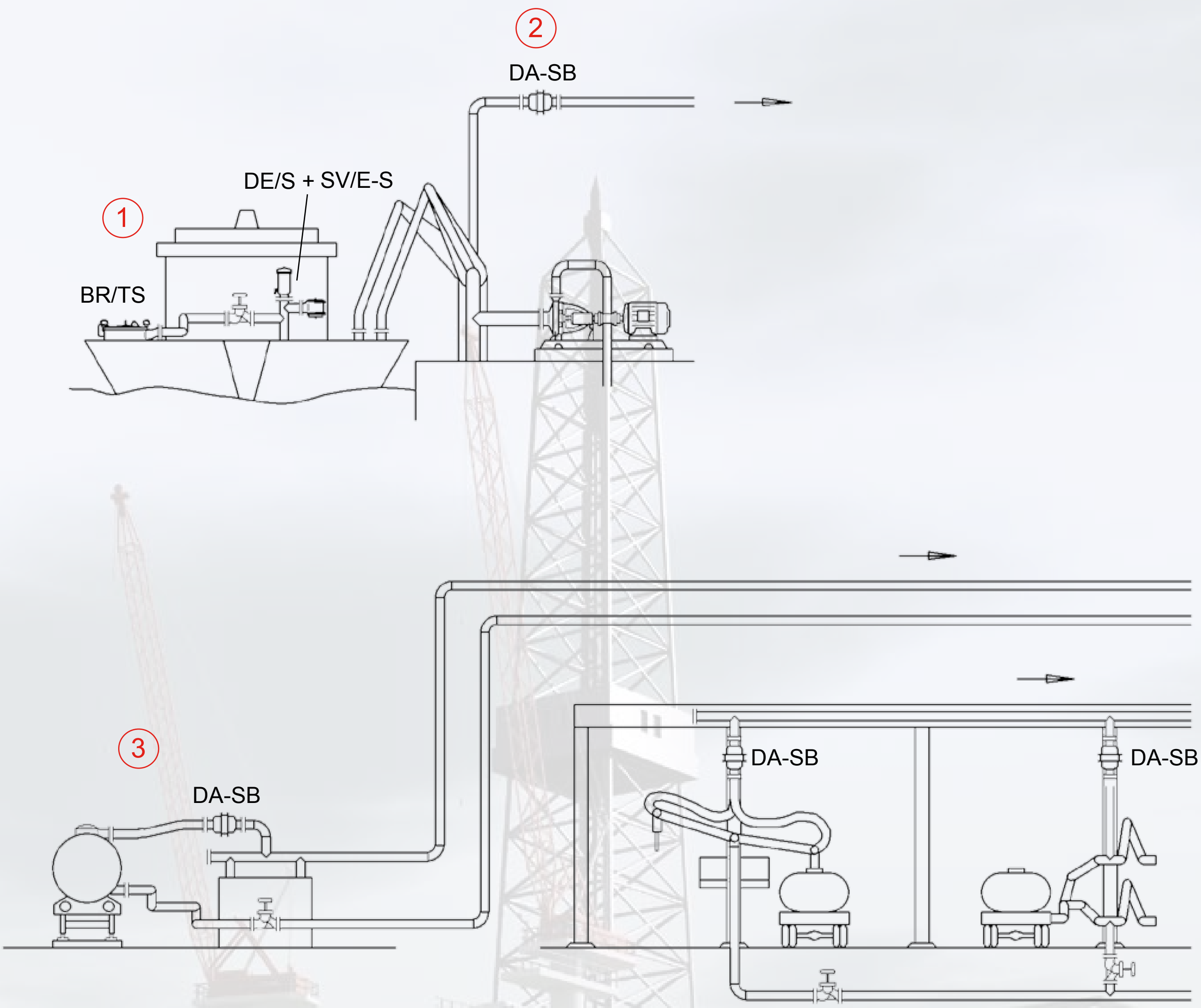
3. Gasholder with detonation flame arrester DR/SBW (→ Volume 4) in the gas supply and end-of-line deflagration flame arrester BE/HR (→ Volume 2), which protects against endurance burning, above the diaphragm

4. Temperature-monitored deflagration flame arresters FA-I-T (→ Volume 3) in the feed line for vapour combustion at the maximum allowable distance from the ignition source and in parallel for the sake of availability for servicing or emergency switching in case of an endurance burning on the arrester

Vapour pipeline from plant to vapour combustion unit with deflagration flame arrester FA-I-T (→ Volume 3) to protect the vent header collection line and the operating locations in the plant.

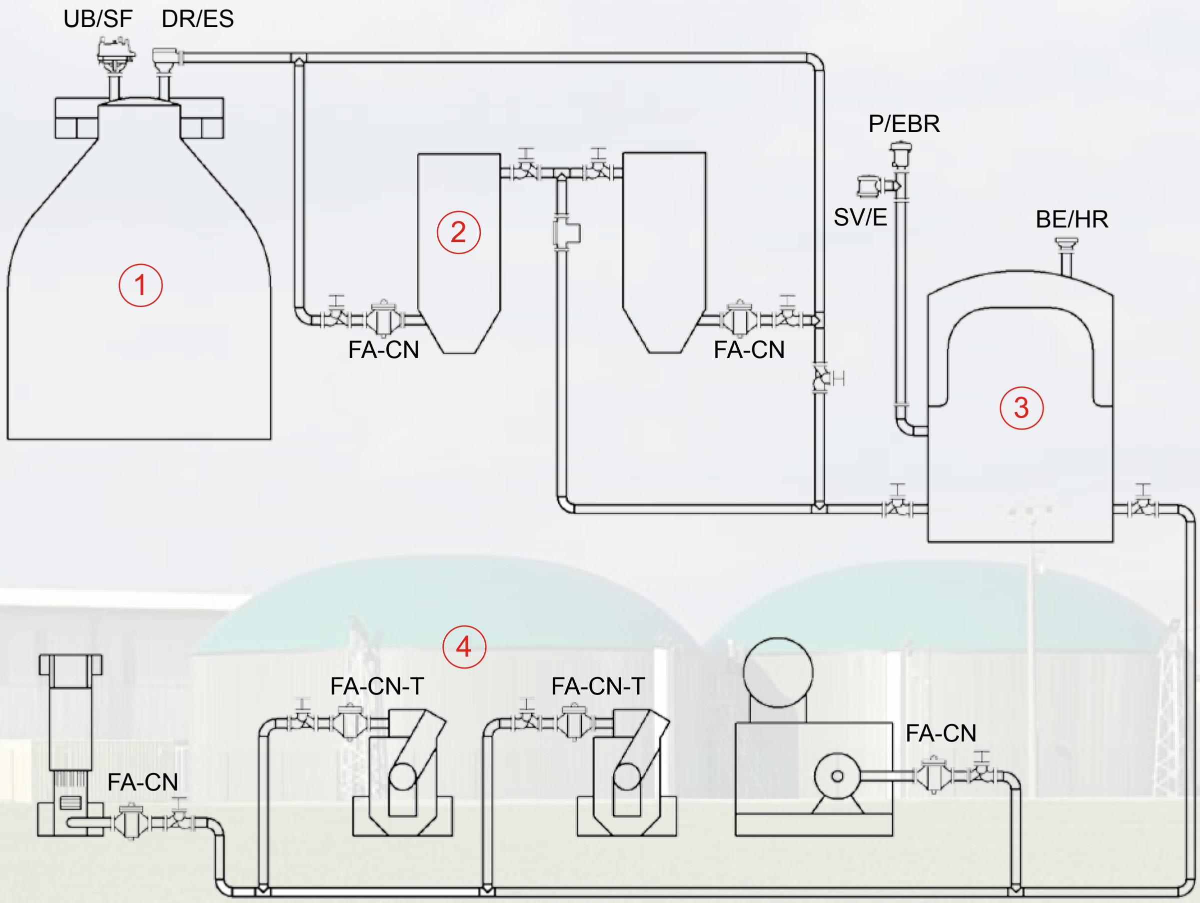
PROTEGO
for safety and environment

Ship Building, Offshore Platforms and Loading Systems



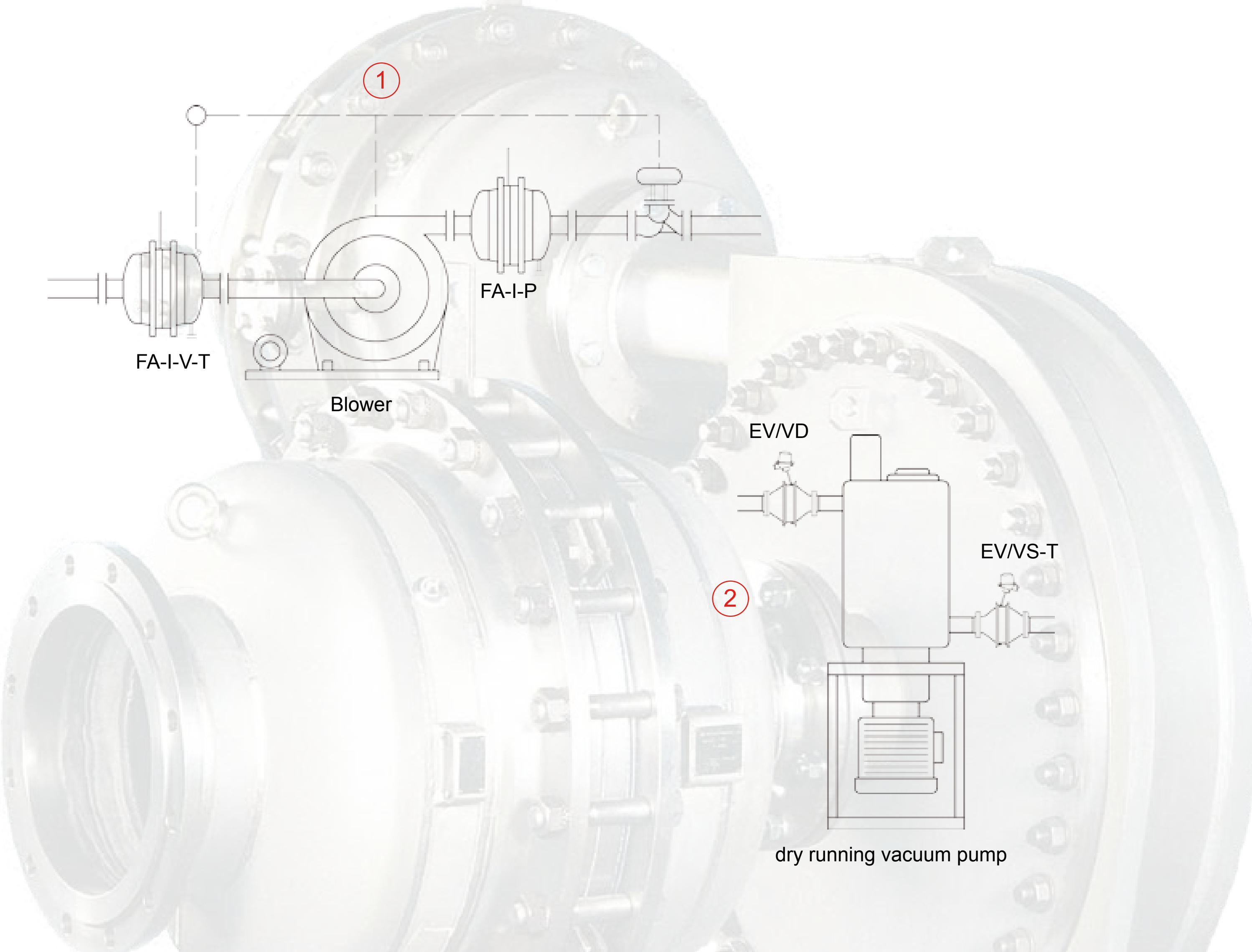
1. Tank ships for flammable products/chemical tankers with detonation flame arresters BR/TS (→ Volume 4) on the individual tank, endurance-burning-proof high-velocity vent valves DE/S (→ Volume 7), and explosion-proof vacuum flame arrester SV/E-S (→ Volume 7)
2. Detonation-proof connection of the gas return line at the loading terminal for flammable liquids with a detonation flame arrester DA-SB (→ Volume 4)
3. Detonation flame arresters DA-SB (→ Volume 4) in the gas displacement/gas return line from the loading stations for tank waggons and tank trucks

Not shown: Offshore platforms/drilling platforms with detonation flame arresters DA-SB (→ Volume 4) and deflagration flame arresters FA-CN (→ Volume 3), FPSOs (Floating Production Storage and Offloading) with IMO-approved detonation flame arresters DA-SB (→ Volume 4) and pressure and vacuum relief valves VD/TS (→ Volume 7), hydraulic control boxes with deflagration flame arresters BE-AD (→ Volume 2)



1. Protecting the sewage tower and storage tank with a frost-proof pressure and vacuum relief valve UB/SF (→ Volume 7) and with detonation flame arresters DR/ES (→ Volume 4) in the gas collection line
2. Protecting the desulphurization system with deflagration flame arresters suitable for temperature and pressure FA-CN, FA-CN-T alternatively FA-E (→ Volume 3)
3. Protecting the intermediate gasholder in the pressure and vacuum relief line with endurance burning proof deflagration flame arrester, end-of-line BE/HR (→ Volume 2), equipping the emergency vent stack with deflagration and endurance burning proof pressure relief valve P/EBR (→ Volume 7) and deflagration proof vacuum relief valve SV/E (→ Volume 7)
4. Ground flares, block-type thermal power stations, and diesel engine aggregates are potential sources of ignition for biogas (methane) air mixture. Suitable flame arresters must be installed in the pipe toward the system that consider temperature and pressure. Either temperature-monitored deflagration flame arresters FA-CN-T or FA-E-T (→ Volume 3) or - at a great distance from the potential ignition source - detonation flame arresters DA-SB or DR/ES (→ Volume 4) are used.

Flame Arresters as integrated Equipment Components



FLAMEFILTER®, flame arrester units or flame arrester as OEM components are product varieties, that are integrated by qualified manufacturers in their brand-name products.

1 Protecting pressure-resistant radial blowers as type-examined zone-0 blowers with integrated flame arresters FA-I-V-T and FA-I-P (→ Volume 3)

2 Protecting dry-running vacuum pumps with flame arresters EV/VS-T and EV/VD (→ Volume 3) at the inlet and at the outlet, which are tested and certified together with the vacuum pump. Other forms of protection with DR/ES and DR/ES-T (→ Volume 4) are possible.

Not shown: FLAMEFILTER® are used in gas analyzers to protect the explosive environment from explosions arising in the device from the ignition of the gases or vapours to be measured or analyzed. FLAMEFILTER® are installed in the pressure and vacuum relief openings of airplane fuel tanks to protect from external explosions.

Flame Arresters

Deflagration flame arresters, deflagration proof, short time burning proof, endurance burning proof

Vent caps without flame arresters

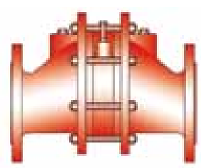
Explosion groups IIA, IIB1 to IB3 and IIC (NEC groups D, C, B)

Nominal sizes 15 to 800 mm (½“ to 32“)

Materials: ductile iron, carbon steel, stainless steel, Hastelloy, ECTFE-coated

Special designs according to customer specifications

Services and spare parts



Deflagration flame arresters, in-line, deflagration flame arrester units on equipment

Explosion groups IIA, IIB1 to IIB3 and IIC (NEC groups D, C, B)

Nominal sizes 10 to 1000 mm (¼“ to 40“)

Materials: ductile iron, carbon steel, stainless steel, Hastelloy, ECTFE-coated

Special designs according to customer specifications

Services and spare parts

Detonation flame arresters for stable detonations, for unstable detonations

Explosion groups IIA, IIB1 to IIB3 and IIC (NEC groups D, C, B)

Nominal sizes 15 to 800 mm (½“ to 32“)

Materials: ductile iron, carbon steel, stainless steel, Hastelloy, ECTFE-coated

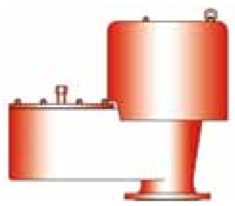
Special designs according to customer specifications

Services and spare parts

Overview of Products and Services

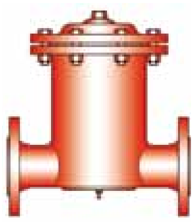
Valves

Pressure and Vacuum Relief Valves, end-of-line ....Volume 5



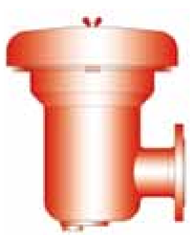
Pressure relief valves, vacuum relief valves, pressure and vacuum relief valves,
pressure relief and vacuum valves, pilot operated, pressure-/vacuum relief diaphragm valves
Pressure settings: 2 to 200 mbar (0.08 to 8 in WC)
Nominal sizes: 50 to 700 mm (2“ to 28“)
Materials: cast iron, carbon steel, stainless steel, Hastelloy, aluminum, PP, PE, PVDF, PTFE, ECTFE-coated
Special designs according to customer specifications
Services and spare parts

Pressure and Vacuum Relief Valves, in-line...Volume 6



Pressure or vacuum relief valves, pressure and vacuum relief valves, blanketing valves
Pressure settings: 2 to 500 mbar (0.08 to 20 in WC)
Nominal sizes: 25 to 300 mm (1“ to 12“)
Materials: carbon steel, stainless steel, Hastelloy, PP, PE, PVDF, ECTFE-coated
Special designs according to customer specifications
Services and spare parts

Pressure and Vacuum Relief Valves with Flame Arresters, end-of-line...Volume 7



Pressure relief valves, vacuum relief valves, pressure and vacuum relief valves,
pressure-/vacuum relief diaphragm valves, pressure relief valves, high velocity valves
Deflagration-proof and endurance-burning-proof or deflagration-proof only
Explosion groups IIA, IIB1 to IIB3 and IIC (NEC groups D, C, B)
Pressure settings: 2 to 200 mbar (0.08 to 8 in WC)
Nominal sizes: 50 to 300 mm (2“ to 12“)
Materials: ductile iron, carbon steel, stainless steel, Hastelloy, ECTFE-coated
Special designs according to customer specifications
Services and spare parts

Tank Accessories and Special Equipment

Safety bottom outlet valves, bottom drain valves...**Volume 8**
Level-gauging and sampling equipment
Swing-arm system, floating-roof drainage system
Floating-roof vacuum relief valves, skimming system, hydraulic flame arrester
Air-drying aggregates, sampling and draining valves
Services and spare parts

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires services, assistance during startup, and qualified maintenance for long-term trouble-free operations.

Technical advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover theory of technical fundamentals, examples of applications, and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our works or at the customers.

Installation and servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professionals to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you may use our authorized partners. The key is trained personnel who is sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region upon request.

Research and development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare parts service

We keep original spare parts ready in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

Appendix

Regulations, Laws, Standards and Technical Literature

Regulations and Laws

94/9/EC (ATEX 95) Directive of the European Parliament and the Council of March 23, 1994 on the approximate of the laws of the Member States concerning equipment and Protective Systems intended for use in potentially explosive atmospheres

1999/92/EC (ATEX 137) Directive of the Council on minimum requirements for improving the safety and health of workers potentially at risk from explosive atmospheres (individual directive according to article 16 of Directive 89/391/EEC)

94/63/EC Control of VOC emissions resulting from storage and distribution of petrol

97/23/EC Pressure equipment directive

1999/31/EC Directive on landfills

91/271/ EEC Directive on urban wastewater treatment

Ordinance on the use of equipment and protective systems intended for use in potentially explosive atmospheres – Ordinance on explosion protection, Federal Law Gazette I, 1996, No. 65 - German

Ordinance on equipment for the storage, filling, and transport of flammable liquids over land (VbF) in the version of 12/13/96 (Federal Law Gazette I, p. 1937) - German

Guidelines for avoiding hazards due to explosive atmosphere with collection of examples - Explosion flame arrester guidelines (EX-RL). German Trade Association of the Chemical Industry. Winter Pub. Co., Heidelberg - German

Law on technical equipment (equipment safety law) Beuth-Verlag, 1996 - German

Standards

EN ISO 28300: 2008 Petroleum, petrochemical and natural gas industries - Venting of atmospheric and low-pressure storage tanks, June 2008

ISO 16852: Flame Arresters - Performance requirements, test methods and limits for use, March 2006

EN 1127-1 Explosive Atmospheres. Explosion Prevention and Protection. Part 1: Basic Concepts and Methodology (October 1997)

EN 1012-2 Compressors and Vacuum Pumps. Part 2: Vacuum pumps, July 1996

EN 746-2 Industrial Thermo-Processing Equipment. Safety Requirements, May 1997

EN 12255-10 Wastewater Treatment Plants. Safety and Construction Principles, March 2001

EN 12874 Flame Arresters: Performance Requirements, Test Methods, and Limits for Use, Brussels, final draft, March 1999

EN 13463-1 Non-Electrical Equipment Intended For Use in Potentially Explosive Atmospheres. Basic Methods and Requirements, Apr. 2002

EN 13463-5 Non-Electrical Equipment Intended For Use in Potentially Explosive Atmospheres. Protection by Constructional Safety, Jan. 2001

EN 13980 Potentially explosive atmospheres, Application of quality management systems, Feb. 2002

EN 14015 Specification for the Design and Manufacture of Site-Built, Above-Ground, Vertical, Cylindrical, and Welded Flat-Bottomed, Steel Tanks for the Storage of Liquids at Ambient Temperature and Above, Feb. 2005, Appendix L: Requirements for Pressure and Vacuum Relief Systems

EN 50014, Electrical Apparatus for Potentially Explosive Atmospheres, General Requirements

EN 60079-10, Electrical Apparatus for Potentially Explosive Atmospheres, Part 10: Classification of Hazardous Areas, (September 1996)

33 CFR Part 154 Marine Vapor Control Systems (USCG-Rule)

API STD 2000 5th ed. 1998 Venting Atmospheric and Low-Pressure Storage Tanks, Nonrefrigerated and Refrigerated

API Publ 2210 3rd ed. May 2000, Flame Arresters for Vents of Tanks Storing Petroleum Products

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Appendix

Glossary

Term	Description	Source
accumulation	pressure increase over the maximum allowable working pressure of the vessel allowed during discharge through the pressure-relief device	ISO 23251 - 3.1
actual flow capacity	actual flow capacity is the flowing capacity determined by measurement	DIN 3320-75
adjusted set pressure	vacuum or gauge pressure at which under test stand conditions (atmospheric back pressure) valves commence to lift	-
ambient air	normal atmosphere surrounding the equipment and protection system	EN 13237 - 3.1
ambient temperature	temperature of the air or other medium where the equipment is to be used (IEV 826-01-04) (IEC 60204-32:1998) Note: For the application of the Directive 94/9/EC only air is considered	EN 13237 - 3.2
annular flame arresting unit	flame arresting unit consisting of annular crimped ribbons	-
atmospheric conditions	atmospheric conditions are pressures from 80 kPa till 110 kPa and temperatures from -20°C up to +60°C	ISO 16852 - 3.25
atmospheric discharge	release of vapors and gases from pressure-relieving and depressurizing devices to the atmosphere	ISO 23251 - 3.4
back pressure	the back pressure is the gauge pressure existing at the outlet side during blowing ($p_a = p_{ae} + p_{af}$)	DIN 3320-58
bi-directional flame arrester	a flame arrester which prevents flame transmission from both sides	ISO 16852 - 3.13
blow down	difference between set pressure and reseating pressures, normally stated as a percentage of set pressure	-
bottom drain valve	emergency valve at the tank bottom to shut immediately in case of downstream piping rupture	-
check valve	valve, that prevents backflow against flow direction	-
coating	protective painting with defined layer-thickness	
combustion air	air required to combust the flare gases	ISO 23251 - 3.19
component	„component“ means any item essential to the safe functioning of Equipment and Protective System but with no autonomous function	EN 1127 - 3.2
condensate drain screw	screw to drain the condensate	-
conventional pressure-relief valve	spring-loaded pressure-relief valve whose operational characteristics are directly affected by changes in the back pressure	ISO 23251 - 3.20
deflagration	explosion propagating at subsonic velocity (EN 1127-1:1997)	EN 13237 - 3.15
deflagration flame arrester	flame arrester designed to prevent the transmission of a deflagration. It can be an end-of-line flame arrester or an in-line flame arrester	ISO 16852 - 3.14
design pressure (tank)	max. permissible pressure of a tank in the space above the stored liquid	-

design pressure / design temperature (general design)	pressure, together with the design temperature, used to determine the minimum permissible thickness or physical characteristic of each component, as determined by the design rules of the pressure-design code	ISO 23251 - 3.23
design vacuum (negative gauge pressure)	max. permissible vacuum (negative gauge pressure) in the space above the stored liquid	-
detonation	explosion propagating at supersonic velocity and characterized by a stock wave (EN 1127-1: 1997)	EN 13237 - 3.18
detonation flame arrester	flame arrester designed to prevent the transmission of a detonation. It can be an end-of-line flame arrester or an in-line flame arrester	ISO 16852 3.15
detonation proof by-pass	dry-type detonation proof by-pass to keep a minimum liquid for safety reasons	-
diaphragm valve	valve, where the moving valve part consists of a diaphragm	-
emergency venting	venting required when an abnormal condition, such as ruptured internal heating coils or an external fire, exists either inside or outside a tank	ISO 28300 - 3.23
emergency venting valves	pressure relief valves for emergency venting	-
end-of-line flame arrester	flame arrester that is fitted with one pipe connection only	ISO 16852 - 3.23
endurance burning	stabilized burning for an unlimited time	ISO 16852 - 3.6
endurance burning flame arrester	flame arrester that prevents flame transmission during and after endurance burning	ISO 16852 - 3.16
equipment	„equipment“ means machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection and prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy, for the processing of material, and which are capable of causing an explosion through their own potential sources of ignition	EN 1127 - 3.5
equipment category	within an equipment group, a category is the classification according to the required level of protection. The categories are defined as given in A.6.	EN 13237 - 3.26
explosion	abrupt oxidation or decomposition reaction producing an increase in temperature, pressure or in both simultaneously	ISO 16852 - 3.7
explosion limits	limits of explosion range (EN 1127-1:1997)	EN 13237 - 3.29
explosive atmosphere	mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapors, mists or dusts, in which, after ignition has occurred, combustion spreads to the entire unburned mixture	EN 1127 - 3.17
flame arrester	a device fitted to the opening of an enclosure or to the connecting pipework of a system of enclosures and whose intended function is to allow flow but prevent the transmission of flame	ISO 16852 - 3.1
flame arrester cage	enclosure for the flame arrester element including spider rings	-
flame arrester element	crimped ribbon element	-

flame arrester element gap	flame arrester elements have profiles, which are more or less triangular. The flame arrester element gap is the triangular height of the flame arrester element	-
flame arrester housing	that portion of a flame arrester whose principal function is to provide a suitable enclosure for the flame arrester element and allow mechanical connections to other systems	ISO 16852 - 3.2
flame arrester set	combination of flame arrester elements with spacers	-
flame arrester unit	flame arrester cage with flame arrester elements and spacers	-
flame transmission proof	characteristic of a device to avoid flashback	-
FLAMEFILTER®	international trademarks by Braunschweiger Flammenfilter GmbH for flame arrester element made of crimped ribbon	-
FLAMEFILTER® cage	enclosure for FLAMEFILTER® including spider rings	-
FLAMEFILTER® gap	flame arrester element gap of a crimped ribbon element type FLAMEFILTER®	-
FLAMEFILTER® set	combination of FLAMEFILTER® with spacers	-
flammable gas or vapor	gas or vapor which, when mixed with air in certain proportions, will form an explosive gas atmosphere (EN 60079-10:1996)	EN 13237 - 3.44
flammable liquid	liquid capable of producing a flammable vapor under any foreseeable operating condition (EN 60079-10:1996)	EN 13237 - 3.45
flammable material	material which is flammable of itself, or is capable of producing a flammable gas, vapor or mist (EN 60079-10:1996)	EN 13237 - 3.46
flammable substances	substance in the form of gas, vapor, liquid, solid, or mixtures of these, able to undergo an exothermic reaction with air when ignited (EN 1127-1:1997)	EN 13237 - 3.48
flashback	phenomenon occurring in a flammable mixture of air and gas when the local velocity of the combustible mixture becomes less than the flame velocity, causing the flame to travel back to the point of mixture	ISO 23251 - 3.34
flashpoint	lowest temperature, corrected to a barometric pressure of 101,3 kPa, at which application of a test flame causes the vapor of the test portion to ignite under the specified conditions of test (ISO 13736:1997)	EN 13237 - 3.49
floating cover	structure which floats on the surface of a liquid inside a fixed roof tank, primarily to reduce vapor loss	EN 14015 - 3.1.22
floating roof	metallic structure which floats on the surface of a liquid inside an open top tank shell, and in complete contact with this surface	EN 14015 - 3.1.21
floating suction unit	mechanical device, sometimes articulated, installed in some tanks, which floats on the liquid surface and only permits product to be withdrawn from this point	EN 14015 - 3.1.28
foot valve flame arrester	a flame arrester designed to use the liquid product combined with a non return valve to form a barrier to flame transmission	ISO 16852 - 3.19.2
free vents	open vents	EN 14015 - 3.1.40

fusible link	component which melts at a defined temperature and which actuates another function (opening of hood, closing of valve)	-
gauging and sampling device	equipment for stating the liquid level within storage tanks as well as for sampling from any height within the stored medium	-
gauging nozzle	opening at a storage tank for gauging or sampling	-
gauging pipe	pipe within the storage tank for determining the liquid level and for sampling - in flashback-proof or regular design	-
gauging probe	device for determining the liquid levels in storage tanks	-
guide bushing	component for guiding e.g. the guide spindle of a valve pallet	-
guide rod	component (rod) for guidance of valve pallet	-
guide spindle	orthogonal to valve pallet section, central pipe for guiding the valve pallet	-
guide pipe	pipe for guiding the guide spindle of a valve pallet	-
hazardous area	area in which an explosive atmosphere is present, or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of equipment	EN 13237 - 3.55
hazardous explosive atmosphere	explosive atmosphere which, if it explodes, causes damage	EN 1127 - 3.19
heat release	total heat liberated by combustion of the relief gases based on the lower heating value	ISO 23251 - 3.36
heating jacket	closed room for heating of a device, which encloses the device fully or partly	-
high velocity vent valve (dynamic flame arrester)	pressure relief valve designed to have nominal flow velocities that exceed the flame velocity of the explosive mixture, thus preventing flame transmission	ISO 16852 - 3.18
housing	enclosure of a product or component	-
hydraulic flame arrester	flame arrester designed to break the flow of an explosive mixture into discrete bubbles in a water column, thus preventing flame transmission	ISO 16852 - 3.20
ignition source	any source with sufficient energy to initiate combustion (EN ISO 13702:1999)	EN 13237 - 3.62
ignition temperature (of a combustible gas or of a combustible liquid)	the lowest temperature of a heated wall as determined under specified test conditions, at which the ignition of a combustible substance in the form of gas or vapor mixture with air will occur	EN 1127 - 3.31
inert gas	non-flammable gas which will not support combustion and does not react to produce a flammable gas	EN 13237 - 3.68
inerting	addition of inert substances to prevent explosive atmospheres	EN 1127 - 3.21
in-line flame arrester	flame arrester that is fitted with two pipe connections, one each side of the flame arrester	ISO 16852 - 3.22
integrated temperature sensor	temperature sensor integrated into the flame arrester, as specified by the manufacturer of the flame arrester, in order to provide a signal suitable to activate counter measures	ISO 16852 - 3.24

leak rate	leakage of a device in volume per time (liter per second)	-
left-hand wound	orientation (angle) of gaps of crimped ribbon element	-
lift	actual travel of the valve disc away from the closed position	ISO 4126 - 3.3
limiting oxygen concentration (LOC)	maximum oxygen concentration in a mixture of a flammable substance and air and an inert gas, in which an explosion will not occur, determined under specified test conditions (EN 1127-1:1997)	EN 13237 - 3.64
lining	protective cladding with defined minimum/maximum thickness to protect against aggressive mixtures (e.g. acid)	-
liquid product detonation flame arrester	flame arrester in which the liquid product is used to form a liquid seal as a flame arrester medium, in order to prevent flame transmission of a detonation. There are two types of liquid product detonation flame arrester for use in liquid product lines: liquid seals and foot valves	ISO 16852 - 3.19
liquid seal (water seal)	device that directs the flow of relief gases through a liquid (normally water) on the path to the flare burner, used to protect the flare header from air infiltration or flashback, to divert flow, or to create back pressure for the flare header	ISO 23251-3.43
lower explosion limit (LEL)	the lower limit of the explosion range	EN 1127 - 3.8
maintenance	combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function	EN 13237 - 3.78
malfunction	the equipment, protective system and components do not perform the intended function	EN 1127 - 3.25
manifold	piping system for the collection and/or distribution of a fluid to or from multiple flow paths	ISO 23251 - 3.45
maximum allowable explosion pressure	calculated maximum explosion pressure which the equipment will withstand	EN 14460 - 3.7
maximum allowable pressure (pressure equipment)	maximum pressure for which the equipment is designed as specified by the manufacturer	97/23/EC (PED)
maximum allowable temperature (pressure equipment)	maximum temperature for which the equipment is designed as specified by the manufacturer	97/23/EC (PED)
maximum allowable working pressure (MAWP)	maximum gauge pressure permissible at the top of a completed vessel in its normal operating position at the designated coincident temperature specified for that pressure	ISO 23251 - 3.47
maximum experimental safe gap (MESG)	the maximum gap of the joint between the two parts of the interior chamber of the test apparatus which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the external gas mixture through a 25 mm long joint, for all concentrations of the tested gas or vapor in air. The MESG is a property of the respective gas mixture (EN 1127-1: 1997) Note: IEC 60079-1 A standardizes the test apparatus and the test method	-
maximum operating temperature	maximum temperature reached when equipment or protective system is operating at its intended operating conditions	-

measurable type (static flame arrester)	a flame arrester where the quenching gaps of the flame arrester element can be technically drawn, measured and controlled	ISO 16852 - 3.17.1
most easily ignitable explosive atmosphere	explosive atmosphere with a concentration of flammable substances which under specified conditions, requires the lowest energy for its ignition	EN 13237 - 3.87
nominal size, nominal diameter	(DN) a numerical size designation used for all components of a piping system, for which the external diameter or the size of thread is not indicated. The figure is rounded and has only an approximate relation to the machined dimensions	-
non-measurable type (static flame arrester)	a flame arrester where the quenching gaps of the flame arrester element cannot be technically drawn, measured or controlled (e.g. random such knitted mesh, sintered metal and gravel beds)	ISO 16852 - 3.17.2
normal pressure venting	outbreathing under normal operating conditions (pumping product into the tank and thermal outbreathing)	EN 14015 - 3.1.35
normal vacuum venting	inbreathing under normal operating conditions (pumping product out of the tank and thermal inbreating)	EN 14015 - 3.1.36
normal venting	venting required because of operational requirements or atmosheric changes	ISO 28300 – 3.7
opening pressure	the opening pressure is the vacuum resp. gauge pressure at which the lift is sufficient to discharge the predetermined mass flow; it is equal to the set pressure plus overpressure	DIN 3320 - 54
operating pressure	pressure in the process system experiences during normal operation, including normal variations	ISO 23251 - 3.49
operating temperature	temperature reached when the apparatus is operating at its rating	-
overpressure	pressure increase over the set pressure, at which the safety valve attains the lift specified by the manufacturer, usually expressed as a percentage of the set pressure	ISO 4126 - 3.2.3
pallet guidance	element of valve providing guidance of valve pallet	-
pallet type valve (disc valve)	valve with discoidal seal and axial guide	-
pilot-operated pressure relief valve	pressure relief valve in which the major relieving device or main valve is combined with and controlled by a self-actuated auxiliary pressure-relief valve (pilot)	ISO 23251 - 3.52
pilot-operated valve	valve actuated by a control device (pilot)	-
pipe away valve	pressure or vacuum valve to which a vent pipe may be connected	EN 14015 - 3.1.44
pressure	pressure unit used in this standard is the bar (1 bar = 10000 Pa), quoted as gauge (relative to atmospheric pressure) or absolute as appropriate	ISO 4126 - 3.2
pressure-relief valve	valve designed to open and relieve excess pressure and to reclose and prevent the further flow of fluid after normal conditions have been restored	ISO 23251 - 3.56
pressure/vacuum valve (PV valve)	weight-loaded, pilot-operated, or spring-loaded valve, used to relieve excess pressure and/or vacuum that has developed in a tank	ISO 23251 - 3.11

pre-volume flame arrester	flame arrester that, after ignition by an internal ignition source, prevents flame transmission from inside an explosion-pressure-resistant containment (e.g. a vessel or closed pipe work) to the outside, or into the connecting pipe work	ISO 16852 - 3.23
product	term product covers equipment, protective systems, devices, components and their combinations as well as software as defined in 3.4.2 of EN ISO 9000:2000 (EN 13980.2002)	EN 13237 - 3.95
protective screen	component, which provides free flow, but prevents entrance of foreign matter, for example animals	-
protective system	„protective system“ means design units which are intended to halt incipient explosions immediately and/or to limit the effective range of explosion flames and explosion pressures. Protective systems may be integrated into equipment or separately placed on the market for use as autonomous systems	EN 1127 - 3.36
quenching	cooling of a fluid by mixing it with another fluid of a lower temperature	ISO 23251 - 3.59
relieving pressure	pressure at the inlet of a relief device when the fluid is flowing at the required relieving capacity	ISO 28300 - 3.15
reseating pressure (closing pressure)	value of the inlet static pressure at which the disc re-establishes contact with the seat or at which the lift becomes zero	ISO 4126 - 3.2.4
right-hand wound	orientation (angle) of gaps of crimped ribbon element	-
safety shut-off valve	a safety shut-off valve is a valve which closes automatically to prevent a predetermined gauge pressure being exceeded	DIN 3320-2
safety valve	valve which automatically, without the assistance of any energy other than that of the fluid concerned, discharges a quantity of the fluid so as to prevent further flow of fluid after normal pressure conditions of service have been restored	ISO 4126 - 3.1
sampling and air bleed valve	flashbackproof and non flashbackproof taps or valves out- and inbreathing of parts of plant	-
set pressure	gauge pressure at the device inlet at which the relief device is set to start opening under service conditions	ISO 28300 - 3.19
set vacuum	internal negative gauge pressure at which a vacuum valve first opens	-
shock absorber	component to reduce the kinetic energy of a detonation	-
Shock-Wave-Guide-Tube (SWGT)	component for decoupling of shock wave and flame front: PROTEGO® patent	-
short time burning	stabilized burning for a specific time	ISO 16852 - 3.5
spacer	component, which lies on and between the crimped ribbon elements of a flame arrester unit	-
sparge pipe	pipe leading into the dip liquid of an hydraulic flame arrester	-
stabilized burning	steady burning of a flame stabilized at, or close to the flame arrester element	ISO 16852 - 3.4
stable detonation	a detonation is stable when it progresses through a confined system without significant variation of velocity and pressure characteristics	ISO 16852 - 3.10

static electricity	build-up of an electrical difference of potential or charge, through friction of dissimilar materials or substances e.g. product flow through a pipe	EN 14015 - 3.1.18
static flame arrester	a flame arrester designed to prevent flame transmission by quenching gaps	ISO 16852 - 3.17
stoichiometric air	chemically correct ratio of fuel to air capable of perfect combustion with no infused fuel or air	ISO 23251 - 3.73
storage tank storage vessel	fixed tank or vessel that is not part of the processing unit in petrochemical facilities, refineries, gas plants, oil and gas production facilities, and other facilities	ISO 23251 - 3.74
swing pipe unit	flexible pipeline with or without float within a storage tank for filling and emptying	-
swivel joint	part of a swing pipe system	-
temperature class	classification of equipment, protective system or component for explosive atmospheres based on its maximum surface temperature	EN 13237 - 3.111
temperature sensor	temperature sensor for monitoring the temperature	-
test pressure	pressure to test the mechanical stability of devices and or to test devices for leak	-
thermal inbreathing	movement of air or blanketing gas into a tank, when vapours in the tank contract or condense as a result of weather changes (e.g. decrease in atmospheric temperature)	ISO 28300 - 3.20
thermal outbreathing	movement of air or blanketing gas out of a tank, when vapours in the tank expand and liquid in the tank vapourizes as a result of weather changes (e.g. increase in atmospheric temperature)	ISO 28300 - 3.21
unstable detonation	detonation during the transition of a combustion process from a deflagration into a stable detonation. The transition occurs in an limited spatial zone where the velocity of the combustion wave is not constant and where the explosion pressure is significantly higher than in a stable detonation	ISO 16852 - 3.11
upper explosion limit (UEL)	the upper limit of the explosion range	EN 1127 - 3.9
valve lift	actual travel of the valve pallet away from the closed position, when a valve is relieving	-
valve pallet gasket	sealing element between valve pallet and valve seat	-
vent cap	end-of-line device for free out- and inbreathing of plant components. This device can be flame transmission proof	-
vent header	piping system that collects and delivers the relief gases to the vent stack	ISO 23251 - 3.78
vent pipes	pipes connected to pipe away valves	EN 14015 - 3.1.45
venting system	system, which consists of pipeline and devices for free out- and inbreathing of parts of plants	-
venting system with flame arresting capability	free vents or pressure and/or vacuum valves combined with a flame arrester or with integrated flame arresting elements	DIN EN 14015 - 3.1.42

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vessel	container or structural envelope in which materials are processed, treated or stored	ISO 23251 - 3.80
zone 0	place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is present continuously or for long periods or frequently	EN 13237 - 3.119-1
zone 1	place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally	EN 13237 - 3.119-2
zone 2	place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only	EN 13237 - 3.119-3
zones for gases/vapours	hazardous areas are classified into zones based upon the frequency of the occurrence and the duration of an explosive gas atmosphere, the definitions are only applicable to equipment group II	EN 13237 - 3.119

Excerpt of EN 12874

To help the manufacturers and users decide which flame arrester is the most suitable for their application, the following should be considered:

1. Service
Provide a brief description of the intended use for the flame arrester.

2. Analysis of gases or vapours
Provide full details of flammable and non-flammable components; which will allow the correct flame arrester design, explosion group and choice of materials to be made.

3. Molecular weight or density of gas or vapour
This will allow an equivalent air flow rate to be calculated for pressure drop determination.

4. Flow rate
This should be in volumetric terms, or sufficient information provided to allow a volumetric flow rate to be calculated. For storage tank applications the inbreathing and outbreathing requirements should be given, or sufficient information on the tank type, pressure resistance shape, dimensions, fill and empty rates provided to enable these parameters to be calculated.

5. Temperature ranges
For both design and operating conditions, the maximum and minimum temperatures will allow the correct element and mechanical design of the flame arrester housing to be made.

6. Pressure ranges
For both design and operating conditions, the maximum and minimum pressure will allow the correct flame arrester element and mechanical design of the flame arrester housing to be made. The maximum pressure at which a flammable mixture can ignite in the process should be highlighted if this is different to the normal operating pressure. For storage tank applications the pressure and vacuum requirements should be given.

7. Allowable pressure drop
This will enable the correct flame arrester configuration to be provided and is determined from the volumetric flow rate.

8. Type
Specify in-line, end-of-line, pre-volume, short time or endurance burning safe and stable / unstable detonation as required. For in-line types details of the piping between the flame arrester and possible source of ignition should be supplied in the form of a dimensioned sketch or isometric drawing.

9. Orientation
State the intended orientation of the flame arrester.

10. Pipe size
The nominal size of the connecting pipework should be stated.

11. Connection type
Provide details of the flanged or screwed connections.

12. Housing material
State the preferred material of construction; this may be checked by the manufacturer from an elevation of the mixture composition and operating conditions.

13. Element material
State the preferred material of construction; this may be checked by the manufacturer from an elevation of the mixture composition and operating conditions.

14. Construction
Care should be taken when using materials such as aluminium or plastics which can cause incentive sparking or electrostatic charging.

15. Documentation
State documentation requirements.

In addition PROTEGO® recommends:

Provision for fouling
When sizing the flame arrester take provision for fouling of the narrow gaps of the FLAMEFILTER®.

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	4,882 mm WC
	= 401.46 inch WC			
1 mbar	= 0.0145 psi	1 inch WC	=	249,09 N/m^2
	= 0.0295 inch Hg		=	2,4909 mbar
	= 0.4015 inch WC		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	32 + 1,8 T_C
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9$ (T_F - 32)
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	AC 44200	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means
CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	=	polytetrafluoroethylene
PVDF	=	polyvinylidene fluoride
PFA	=	perfluoralkoxy polymer
FPM 70	=	fluoropolimer elastomer
WS 3822	=	aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	=	ethylene chlorotrifluoro etylene
FEP	=	perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937 inch	1 inch		=	25,4 mm
1 m	= 3.2808 ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936 yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621 miles	1 mile		=	1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	=	6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	=	0,0929 m^2
	= 1.196	sq yards	1 sq yard	=	0,836 m^2
1km^2	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	=	16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21997	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26417	gal (US)	1 gal (US)	=	3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	=	0,028317 m^3
	= 6.290	petr. barrels	1 petr. barrel	=	0,15899 m^3

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85	ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214	mph	1 mph	=	1,60934 km/h
1 m^3/h	= 4.403	gal/min (US)	1 gal/min (US)	=	0,227 m^3/h
	= 3.666	gal/min (UK)	1 gal/min (UK)	=	0,273 m^3/h
	= 0.5886	cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367	lb/min	1 lb/min	=	27,216 kg/h
			1 cu ft/h	=	0,028317 m^3/h

Torsion

1 Nm	= 0.738 lb ft	1 lb ft	= 1,36 Nm

Density

1 kg/dm^3	= 62.43 lb/cu ft	1 lb/cu ft	= 0,016 kg/dm^3

Project Data

Quotation-No.	**Order-No.**
Project-No.	**Project Reference**
Valve / Flame Arrester Tag No.	**Tank / Vessel No.**

Storage Tank / Vessel

☐ aboveground		diameter	m/ft	design pressure	mbar/In W.C.	
☐ buried		height	m/ft	design vacuum	mbar/In W.C.	
☐ insulated		wall height	m/ft	pumping-in-rate	m³/h cu ft/min	
ins. thickness	mm / inch			pumping-out-rate	m³/h cu ft/min	
☐ blanketed		blank gas	step	design standard	DIN API	others

Stored Product Offgas/Vapour-Composition

Components Name	Formula	Vol.%	Flashpoint °C/°F	Haz. Group	MESG mm/inch	Ex-Gr.

Processing Plant

design temperature	°C/°F	design pressure	bar/psi		
operating temperature	°C/°F	operating pressure	bar/psi	back pressure	mbar/In W.C.

Installation

☐ in-line	☐ horizontal	distance to source of ignition	m/ft
☐ end-of-line	☐ vertical		

Function

☐ pressure	☐ endurance burning proof	☐ temperature monitored
☐ vacuum	☐ short-time burning proof	
☐ pressure/vacuum combined	☐ deflagration proof	☐ pressure monitored
☐ flame arrester	☐ detonation proof	☐ bidirectional

Valve and Flame Arrester Data

size nominal DN		flow $\dot{V}$	m³/h cu ft/min	density	kg/m³ lb/cu ft	
pressure nominal PN		inlet flange	DN	PN	form	
adjusted set pressure	mbar/In W.C.	outlet flange	DN	PN	form	
adjusted set vacuum	mbar/In W.C.	pressure drop Δp	mbar/In W.C.			

Material

pressure carrying parts	internals	lining

Inspection/Documentation

material certificate	works certificate	performance certificate

Piping Flow Diagram (excerpt) / Additional Remarks / Miscellaneous → refer to seperate sheet

Fill in and ☐ tick off, if applicable, delete unit, if not applicable

signed: date: approved: released:

Notes:

Notes:

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PROTEGO
for safety and environment

PROTEGO® Deflagration Flame Arresters
end-of line
and Vent Caps

Volume 2

Edition 2010

PROTEGO
for safety and environment

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

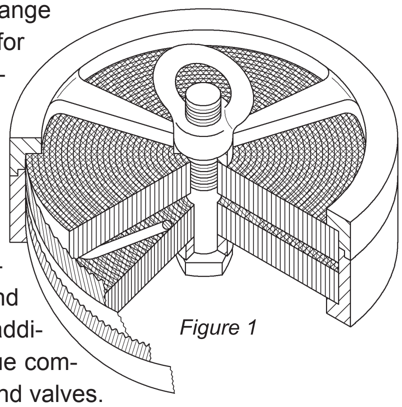


Figure 1

All of our devices are tested by independent national and international third parties in the world's largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.

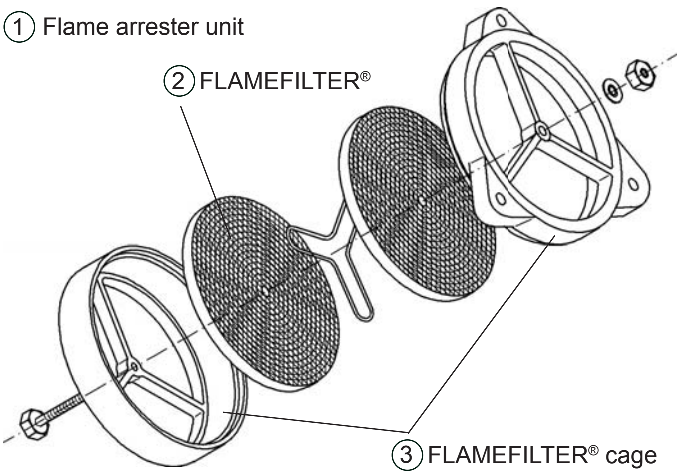
PROTEGO
for safety and environment

Function and description

The different combustion processes and installation locations of flame arresters are discussed in „Technical Fundamentals“ (Vol. 1). In this volume we present the PROTEGO® product range for end-of-line deflagration flame arresters and vent caps. These devices protect against atmospheric deflagration, atmospheric deflagration and short time burning or atmospheric deflagration and endurance burning, which also includes short time burning. Vent caps without flame arrester elements complete our range of end-of-line devices.

PROTEGO® end-of-line deflagration flame arresters are “state-of-the-art” safety devices which are installed on storage tanks, vessels or in process plants. They provide safe protection against atmospheric deflagration, short time burning or endurance burning if potentially explosive vapours are discharged. They mitigate the impact of atmospheric deflagration and prevent flame transmission to protect equipment which is not designed to be explosion pressure proof.

The main component is the PROTEGO® flame arrester unit (1), which stops the propagation of flames. The PROTEGO® flame arrester unit consists of one or two FLAMEFILTER® which are secured in a FLAMEFILTER® cage (3). The gap size and number of FLAMEFILTER® depend on the relevant data of the process media (i.e. explosion group, pressure, temperature).



Deflagration and short time burning proof end-of-line flame arresters are equipped with a temperature sensor, which detects a stabilized flame on the flame arrester element. If a flame is detected, measures shall be taken to extinguish the flame and prevent endurance burning.

Should venting of an explosive mixture over a long period of time be unavoidable and no secondary measure is implemented to extinguish a flame, devices which provide endurance burning protection shall be installed. **Deflagration and endurance burning proof end-of-line flame arresters** from PROTEGO®, are equipped with a fusible link, which melts if a flame stabilizes on the flame arrester element and then allows the weather hood to move into the open position. This allows the flame to transfer most of its heat directly to the environment, preventing flashback through the FLAMEFILTER®.

Vent caps without flame arrester elements, protecting against environmental impact (harsh weather conditions, bird nests, etc.) complete our product range.

In close cooperation with scientific institutions, PROTEGO® has developed safety devices which can be applied to all explosion hazardous locations and provide protection against atmospheric deflagration, short time burning and endurance burning. Our devices are subjected to type examination and certificates according to ATEX and other international standards are issued (CE, FM, Gost-R, GL, etc.).

A broad variety of types, designs, sizes and materials can be provided. Most importantly we have the capability to custom design and develop solutions in our test facility, which is the technologically most advanced in the world.

Special features and advantages

The following factors should be considered for selecting a device: **Deflagration protection, deflagration and short time burning protection** including temperature control or **deflagration and endurance burning protection**. **Vent caps** don’t have a flame arrester element.

With regard to operating conditions **higher temperatures** have to be considered if standard values for atmospheric operation are exceeded.

For selecting an appropriate device, the **explosion group** according to the MESG value must be considered.

The correct **approval** has to be chosen or may be requested.

The plant specification needs to be considered to select the appropriate connection and **size**.

Depending on the application, it may be important to select a device with a **heating jacket** or heating coil, but please note that not all devices are available with this feature. Electrical trace heating may be an alternative.

We provide special designs for **critical media** and product properties (i.e. viscosity, density, crystallization and polymerization).

Preferred applications

PROTEGO® end-of-line deflagration flame arresters and vent caps are mainly installed on storage tanks and vessels of the chemical, petrochemical and pharmaceutical industry in order to protect them.

Installation and maintenance

The modular design of the end-of-line deflagration flame arresters assures the easiest possible maintenance. For onsite maintenance purposes, the device has to be installed in a location where it can be easily accessed. For larger sizes it may be necessary to provide lifting equipment. With trained personal maintenance is most efficient.

PROTEGO® end-of-line deflagration flame arresters are installed in explosion hazardous areas. It is important to select the correct device for the specific application. The manufacturer´s statement of conformity confirms the tasks for which the deflagration flame arrester is suitable. The user documents proper use in accordance with the applicable safety regulations.

Selection

Based on main process data, the different types of devices can be selected from our product range:

- **Atmospheric deflagration proof, short time burning proof, endurance burning proof** or **vent caps**
- **Explosion group** of the processed mixture
- Standard or special operating conditions with **higher temperatures**

After that the following criteria have to be verified or selected:

- **Size** and type of connection
- **Approvals** according to ATEX, FM etc.
- **Heating jacket** or heating coil

After this pre-selection other details, such as material, coating etc. can be selected or defined in the data sheet.

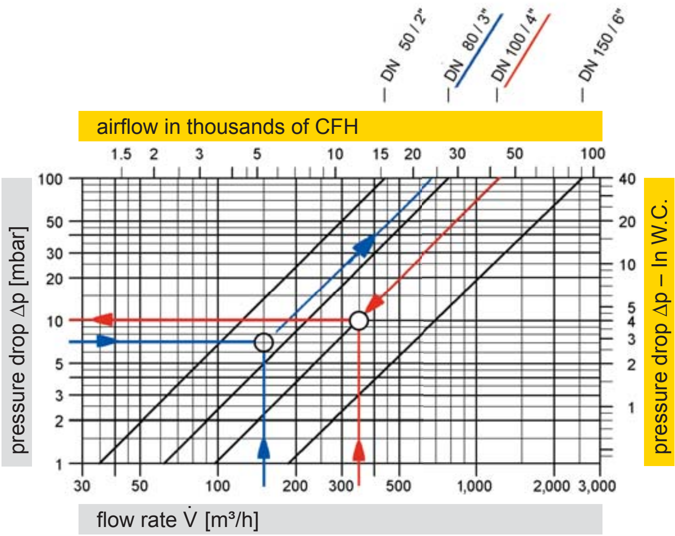
Should it not be possible to determine a device fitting your requirements, please do not hesitate to contact us: in many cases we can provide special designs or approvals.

Sizing

The size of the device is selected or double checked with our volume flow / pressure drop diagrams. Should clogging of the flame arrester element be likely a safety factor should be considered for sizing.

Given:	Flow rate $\dot{V}$ max. all. pressure drop	m^3/h or CFH Δp in mbar or In W.C.
Desired:	Size of the device	DN
Procedure:	Intersection point of straight line through the flow rate and maximum allowable pressure drop is above or on the size curve	

Given:	Flow rate $\dot{V}$ size of nozzle connection	m^3/h or CFH DN
Desired:	Pressure drop (flow resistance)	Δp in mbar or In W.C.
Procedure:	Intersection point of the straight line through the flow rate and size curve, horizontal straight line provides the pressure drop	



Guidance for calculating the volume flow or influence of density is covered in the "Technical Fundamentals" (see Vol. 1).

The device can be specified or ordered if all above steps are completed.

For special applications, please complete the process data sheet from Volume 1 to provide the necessary information for a quotation.

PROTEGO
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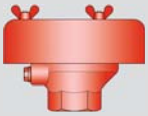
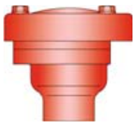
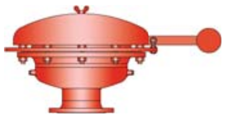
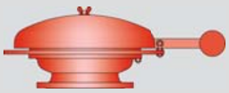
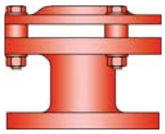
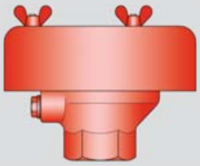
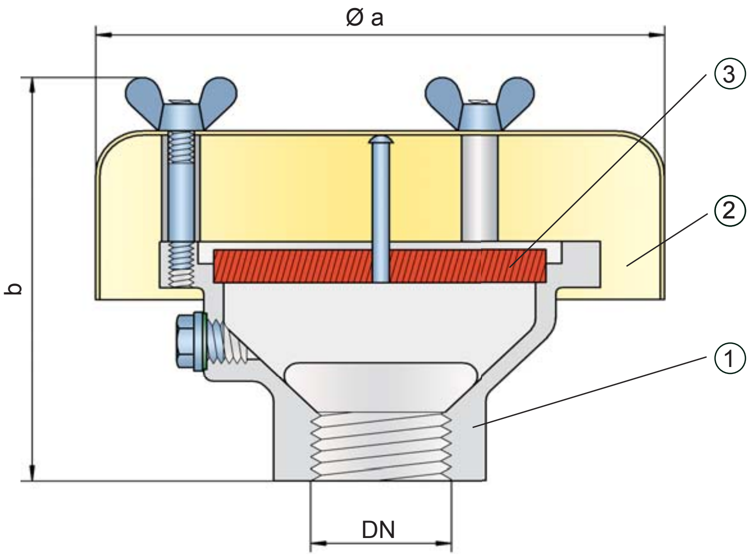
PROTEGO® Deflagration Flame Arresters, end-of-line, and Vent Caps

	Type	Size	Explosion group ATEX	Explosion group NEC	Approvals	X = Special design for higher temperatures	X = Heating jacket /heating coil	Page
Deflagration flame arrester, end-of-line								
	BE/AD	15 - 50 ½" - 2"	IIB3, IIC	C B	ATEX			8 - 10
	LH/AD	50 - 800 2" - 32"	IIB3, IIC	C B	ATEX FM	X		12 - 15
Deflagration flame arrester, short time burning proof, end-of-line								
	LH/AD-T	50 - 800 2" - 32"	IIB3, IIC	C B	ATEX FM	X		16 - 19
Deflagration flame arrester, endurance burning proof, end-of-line								
	BE/HZ	15 - 32 ½" - 1¼"	IIA	D	ATEX			20 - 21
	BE/HK	20 - 80 ¾" - 3" 20 - 32 ¾" - 1¼"	IIA, IIB3	D C	ATEX FM		X	22 - 25
	BE/HK-E	20 - 80 ¾" - 3"	IIB1	–	ATEX		X	26 - 28
	BE/HR	80 - 100 3" - 4"	IIA, IIB3	D C	ATEX FM		X	30-32

	Type	Size	Explosion group ATEX	Explosion group NEC	Approvals	X = Special design for higher temperatures	X = Heating jacket /heating coil	Page
Deflagration flame arrester, endurance burning proof, end-of-line (Continuation)								
	BE/HR-E	80 - 100 3" - 4"	IIB1	–	ATEX		X	34 - 36
	BE/HR 400	150 - 200 6" - 8"	IIA	D	ATEX		X	38 - 40
	LH/EB 400	150 - 400 6" - 16"	I	E	ATEX			42 - 44
Vent caps, end-of-line, without flame arrester unit								
	EH/0	20 - 80 ¾" - 3"						46 - 47
	EH/0S	100 - 600 4" - 24"						48 - 49
	E/KS	50 - 200 2" - 8"						50 - 51

PROTEGO® BE/AD





Function and Description

The PROTEGO® BE/AD end-of-line deflagration flame arrester provides protection against atmospheric deflagrations. The device is typically installed on vent lines of small vessels and plants which are not pressurized. For safe application it is important that an endurance burning situation can be excluded, so typically it is installed on vents lines which discharge vapour for a short time period only. The device prevents flame transmission from atmospheric deflagration into the vessel or plant.

The PROTEGO® BE/AD consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). The device is equipped with a metal weather hood. The FLAMEFILTER® gap size will depend on the devices intended use. Detailing the operating conditions such as the temperature, pressure, explosion group and the composition of the fluid, enables PROTEGO® to select the best end-of-line deflagration flame arrester for your application. The PROTEGO® BE/AD series end-of-line deflagration flame arrester is available for substances from explosion groups IIA to IIC (NEC groups D to B).

The standard design can be used with operating temperature of up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Weather hood provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- easy maintenance
- quick removal of FLAMEFILTER®
- available with threaded connection
- provides protection against atmospheric deflagration
- low operating and lifecycle cost

Design Type and Specification

Deflagration flame arrester, end-of-line, basic design **BE/AD**

Special designs available on request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	G ½" / 15	G ¾" / 20	G 1" / 25	G 1¼" / 32	G 1½" / 40	G 2" / 50
a	116 / 4.57	116 / 4.57	116 / 4.57	116 / 4.57	200 / 7.87	200 / 7.87
b	80 / 3.15	80 / 3.15	85 / 3.35	85 / 3.35	150 / 5.91	150 / 5.91

Table 2: Selection of explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	
< 0,5 mm	IIC	B	

Table 3: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection				
Design	A	B	C	Special materials upon request
Housing	Steel	Stainless steel	Hastelloy	
Weather hood	Stainless steel	Stainless steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Stainless steel	Hastelloy	

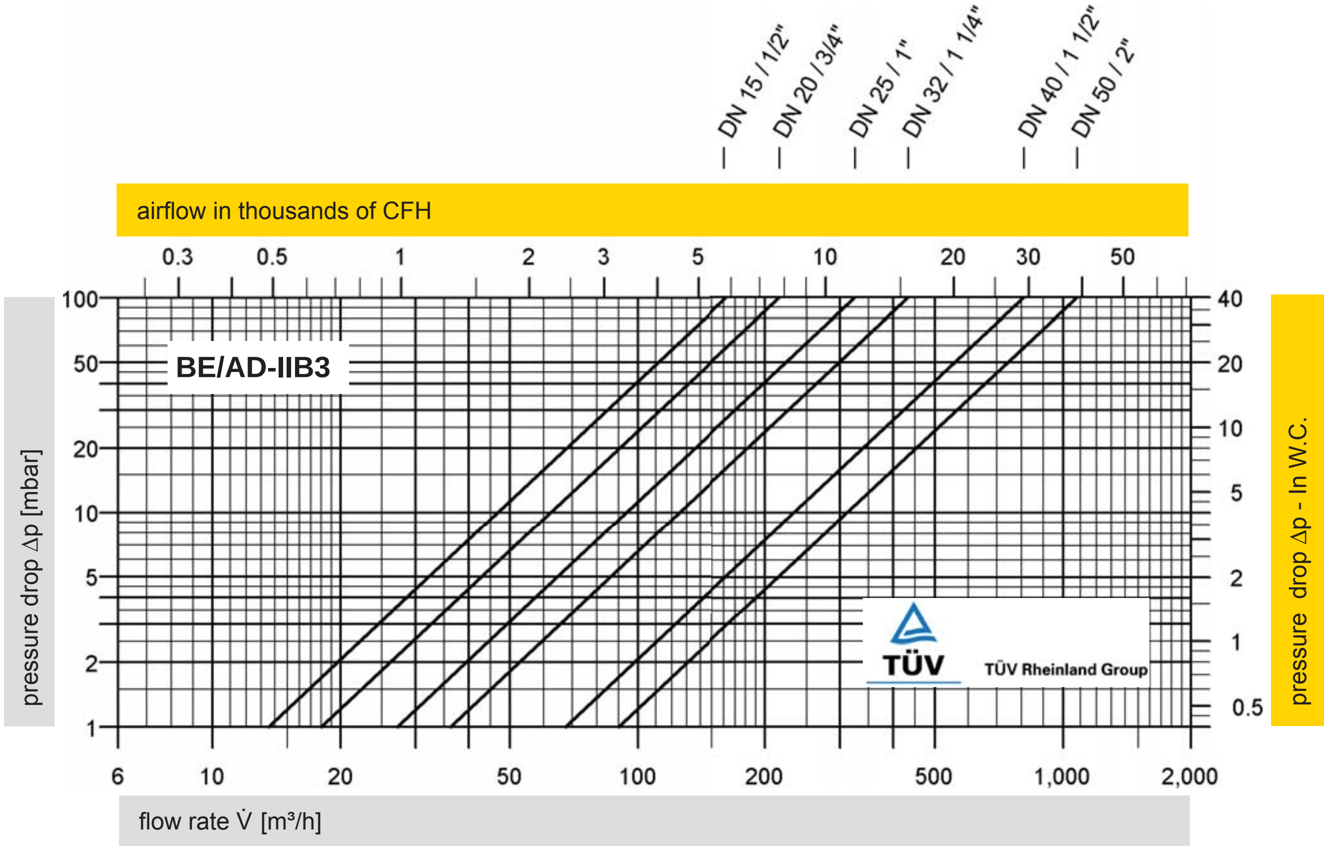
Table 5: Type of connection		
Pipe thread DIN ISO 228-1	DIN	other types of thread upon request

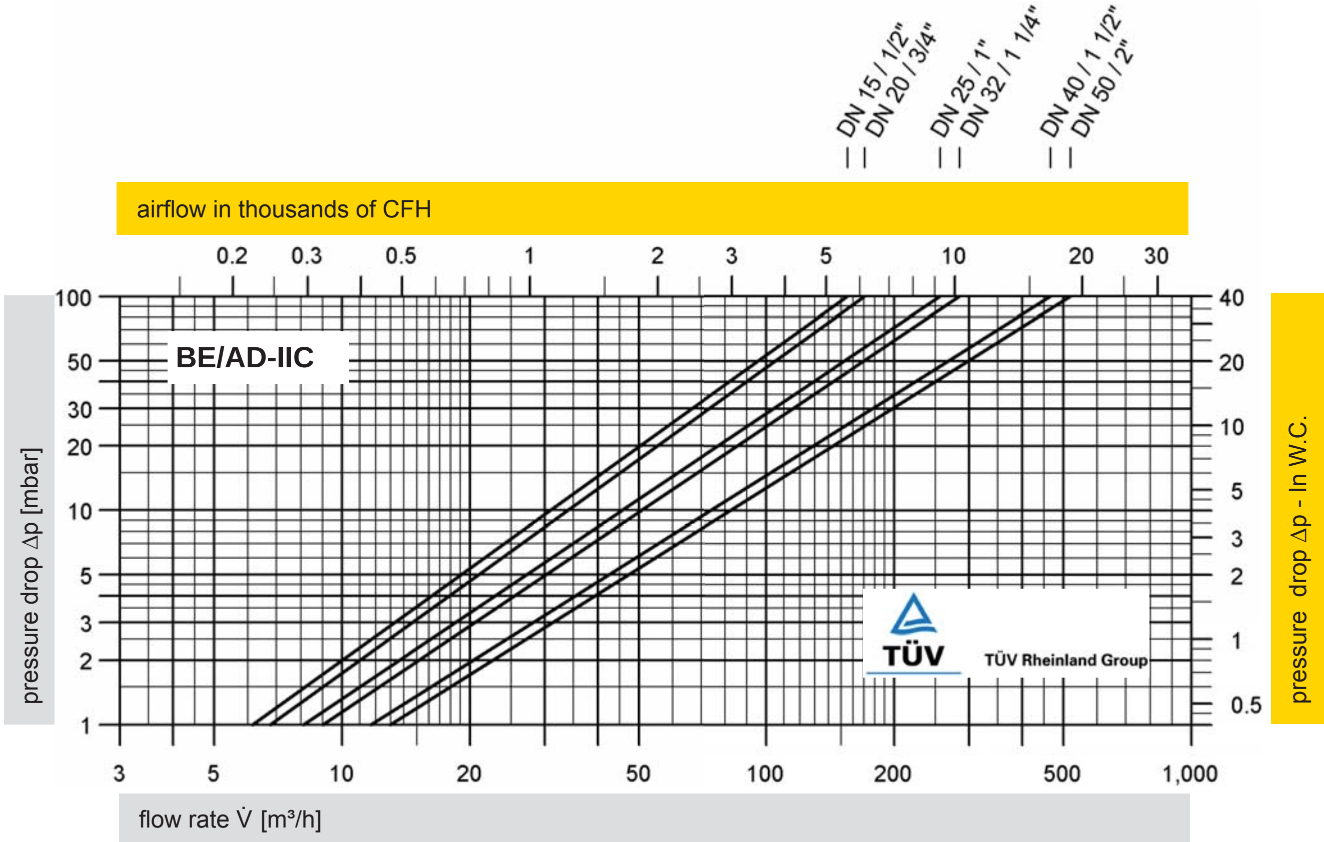
Type	Nominal size	Explosion group	Max. operating temperature	Material selection	Type of connection
BE/AD					
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5

Order example

BE/AD	–	2“	–	IIB3	–	T60	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

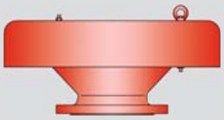




The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

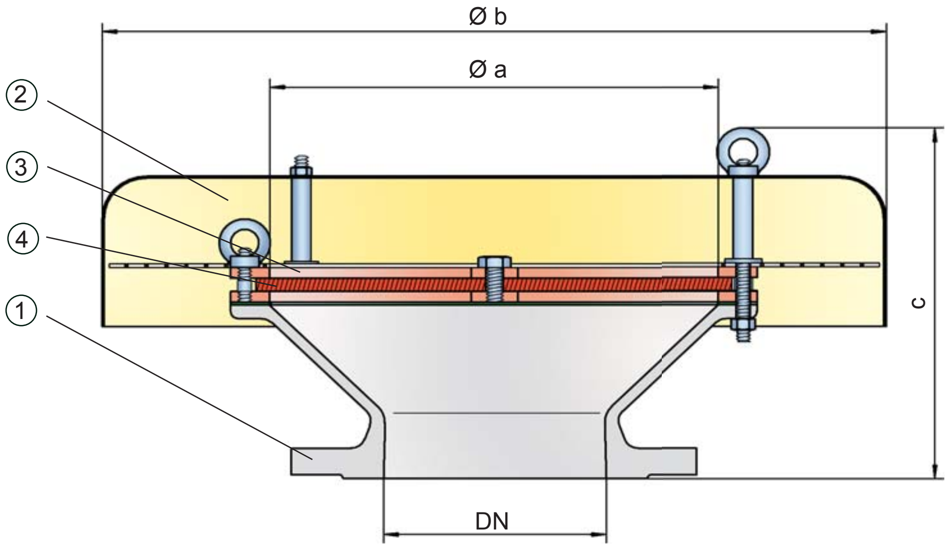
Notes:



Deflagration Flame Arrester, End-of-Line

PROTEGO® LH/AD

FM Approvals
Specification Tested



Function and Description

The PROTEGO® LH/AD end-of-line deflagration flame arrester provides protection against atmospheric deflagration. The device is typically installed on vent lines of vessels and plants which are not pressurized. For safe application it is important that an endurance burning situation can be excluded, so typically it is installed on vent lines which discharge vapour for a short time period only. The device prevents flame transmission from atmospheric deflagration into the vessel or plant.

The PROTEGO® LH/AD consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). The device is equipped with a metal weather hood. A protection screen is installed between the weather hood and the housing to keep animals out. The FLAMEFILTER® (4) gap size will depend on the devices intended use. Detailing the operating conditions such as the temperature, explosion group and the composition of the fluid, enables PROTEGO® to select the best end-of-line deflagration flame arrester for your application. The PROTEGO® LH/AD series end-of-line deflagration flame arrester is available for substances from explosion groups IIA to IIC (NEC groups D to B).

The standard design can be used with operating temperature of up to +60°C / 140°F. Devices with special approval can be obtained for higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- weather hood provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- available in sizes DN 50 (2“) – up to DN 800 (32“)
- easy maintenance
- cost effective spare parts
- available for elevated operating temperatures
- protection against atmospheric deflagration

Design Type and Specification

End-of-line deflagration flame arrester, basic design **LH/AD**

Special designs available on request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	a	b	IIB3	IIC
			c*	c*
50 / 2"	100 / 3.94	200 / 7.87	170 / 6.69	185 / 7.28
80 / 3"	150 / 5.91	240 / 9.45	180 / 7.09	195 / 7.68
100 / 4"	200 / 7.87	295 / 11.61	220 / 8.66	235 / 9.25
150 / 6"	300 / 11.81	550 / 21.65	260 / 10.24	270 / 10.63
200 / 8"	300 / 11.81	550 / 21.65	260 / 10.24	270 / 10.63
250 / 10"	400 / 15.75	600 / 23.62	355 / 13.98	365 / 14.37
300 / 12"	400 / 15.75	600 / 23.62	340 / 13.39	350 / 13.78
350 / 14"	600 / 23.62	800 / 31.50	390 / 15.35	400 / 15.75
400 / 16"	600 / 23.62	800 / 31.50	380 / 14.96	390 / 15.35
500 / 20"	700 / 27.56	1000 / 39.37	400 / 15.75	410 / 16.14
600 / 24"	800 / 31.50	1200 / 47.24	475 / 18.70	485 / 19.09
700 / 28"	1000 / 39.37	1400 / 55.12	505 / 19.88	515 / 20.28
800 / 32"	1200 / 47.24	1600 / 62.99	550 / 21.65	560 / 22.05

* measure c for connection DIN PN 10

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request
< 0,5 mm	IIC	B	

Table 3: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection

Design	A	B	
Housing	Steel	Stainless steel	Special materials upon request
Weather hood	Stainless steel	Stainless steel	
Protection screen	Stainless steel	Stainless steel	
Flame arrester unit	A	B	

Table 5: Material combinations of flame arrester unit

Design	A	B	
FLAMEFILTER® cage	Steel	Stainless steel	Special materials upon request
FLAMEFILTER®	Stainless steel	Stainless steel	

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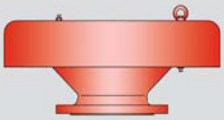
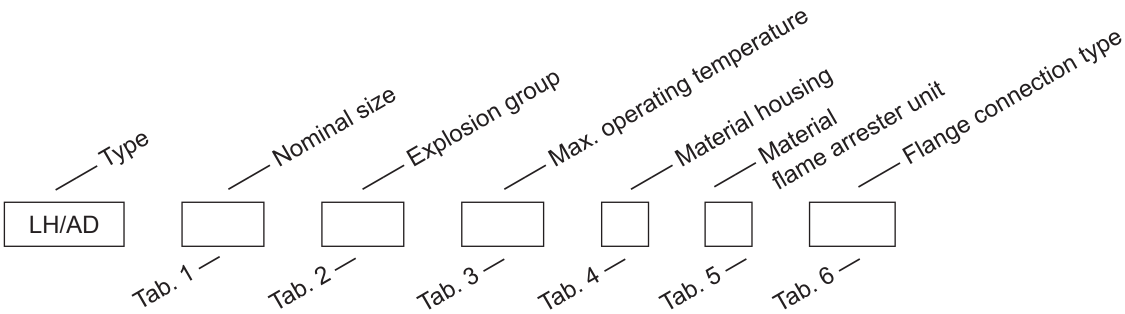


Deflagration Flame Arrester, End-of-Line

PROTEGO® LH/AD

FM Approvals
Specification Tested

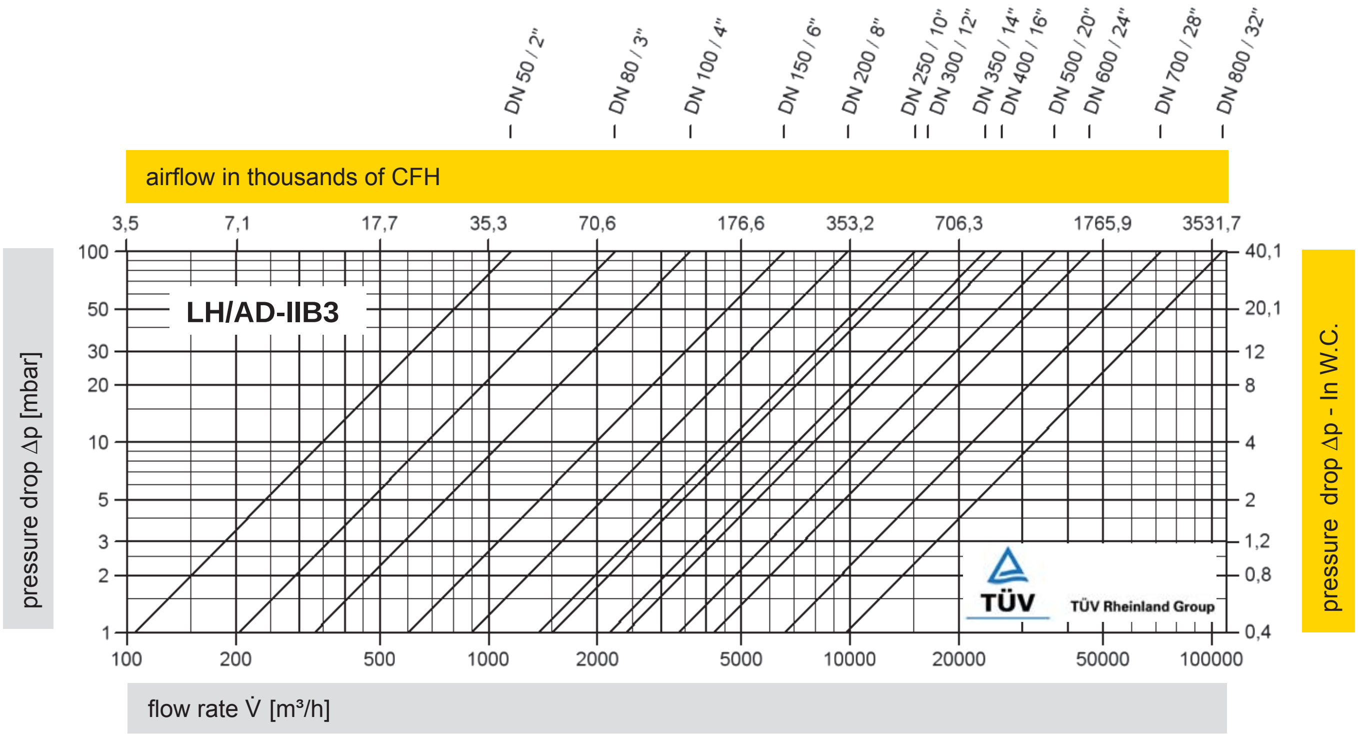
Table 6: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

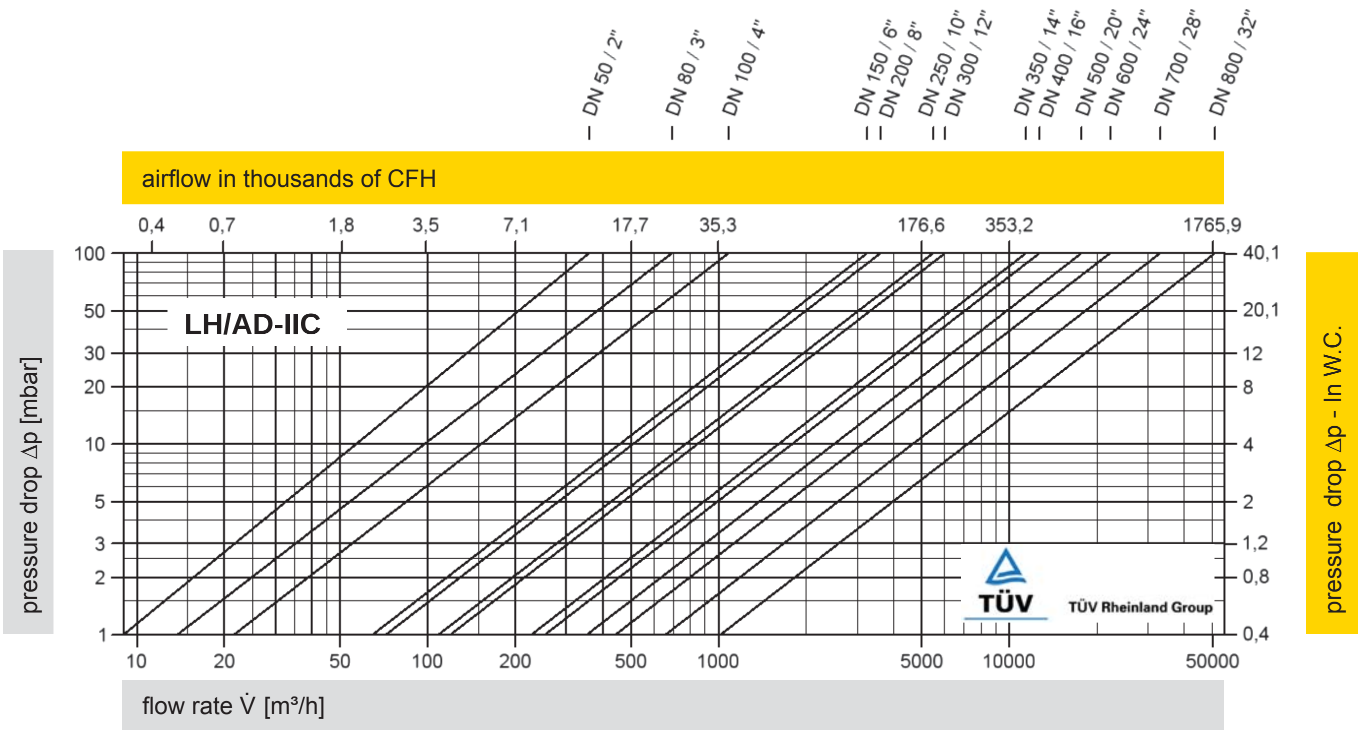


Order example

LH/AD	–	800	–	IIC	–	T60	–	A	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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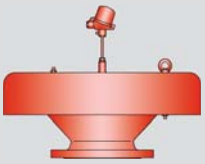
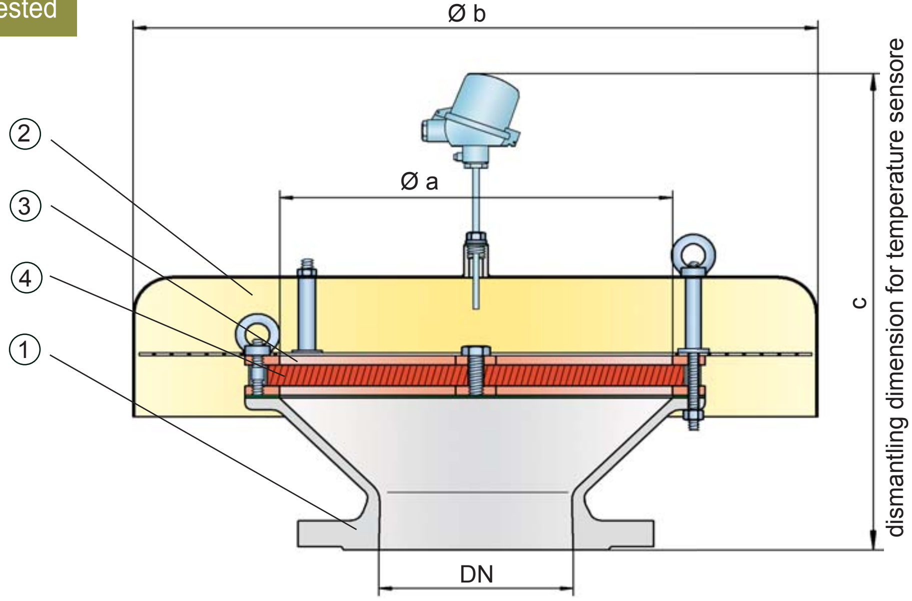


Deflagration Flame Arrester, short time burning-proof, End-of-Line

PROTEGO® LH/AD-T

FM Approvals
Specification Tested



Function and Description

The PROTEGO® LH/AD-T end-of-line deflagration flame arrester provides protection against atmospheric deflagration and short time burning on the flame arrester element. The device is typically installed on vent lines of vessels and plants which are not pressurized. The device is equipped with a temperature sensor which immediately detects a flame on the FLAMEFILTER® surface. After the flame is detected, a secondary measure, such as inerting or closing of a shut-off valve to block the vapour flow to the device, should activate within 60 seconds and extinguish the flame, so that the plant can operate safely. The device prevents flame transmission from short time burning and atmospheric deflagration into the vessel or plant.

The PROTEGO® LH/AD-T consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). The device is equipped with a metal weather hood. The FLAMEFILTER® (4) gap size depends on the devices intended use. Detailing the operating conditions such as the temperature, explosion group and the composition of the fluid, enables PROTEGO® to select the best end-of-line deflagration flame arrester for your application. The PROTEGO® LH/AD series end-of-line deflagration flame arrester is available for substances from explosion groups IIA to IIC (NEC groups D to B).

The standard design can be used with operating temperature of up to +60°C / 140°F. Devices with special approval can be obtained for higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- weather hood provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- available in sizes DN 50 (2“) – up to DN 800 (32“)
- easy maintenance
- cost effective spare parts
- available for elevated operating temperatures
- protection against short time burning and atmospheric deflagration

Design Type and Specification

End-of-line deflagration flame arrester, basic design **LH/AD-T**

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	a	b	IIB3	IIC
			c*	c*
50 / 2"	100 / 3.94	240 / 9.45	530 / 20.87	550 / 21.65
80 / 3"	150 / 5.91	295 / 11.61	560 / 22.05	580 / 22.83
100 / 4"	200 / 7.87	350 / 13.78	585 / 23.03	605 / 23.82
150 / 6"	300 / 11.81	600 / 23.62	630 / 24.80	655 / 25.79
200 / 8"	300 / 11.81	600 / 23.62	630 / 24.80	655 / 25.79
250 / 10"	400 / 15.75	800 / 31.50	750 / 29.53	770 / 30.31
300 / 12"	400 / 15.75	800 / 31.50	740 / 29.13	760 / 29.92
350 / 14"	600 / 23.62	1000 / 39.37	800 / 31.50	820 / 32.28
400 / 16"	600 / 23.62	1000 / 39.37	790 / 31.10	815 / 32.09
500 / 20"	700 / 27.56	1200 / 47.24	810 / 31.89	835 / 32.87
600 / 24"	800 / 31.50	1200 / 47.24	935 / 36.81	960 / 37.80
700 / 28"	1000 / 39.37	1500 / 59.06	975 / 38.39	995 / 39.17
800 / 32"	1200 / 47.24	1700 / 66.93	1015 / 39.96	1035 / 40.75

* measure c for connection DIN PN 16

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	
< 0,5 mm	IIC	B	

Table 3: Specification of max. operating temperature

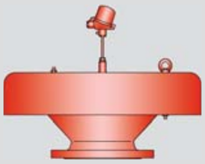
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection

Design	A	B	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Stainless steel	Stainless steel	
Protection screen	Stainless steel	Stainless steel	
Flame arrester unit	A	B	

Table 5: Material combinations of flame arrester unit

Design	A	B	Special materials upon request
FLAMEFILTER® cage	Steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Stainless steel	



PROTEGO® LH/AD-T

FM Approvals
Specification Tested

Table 6: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

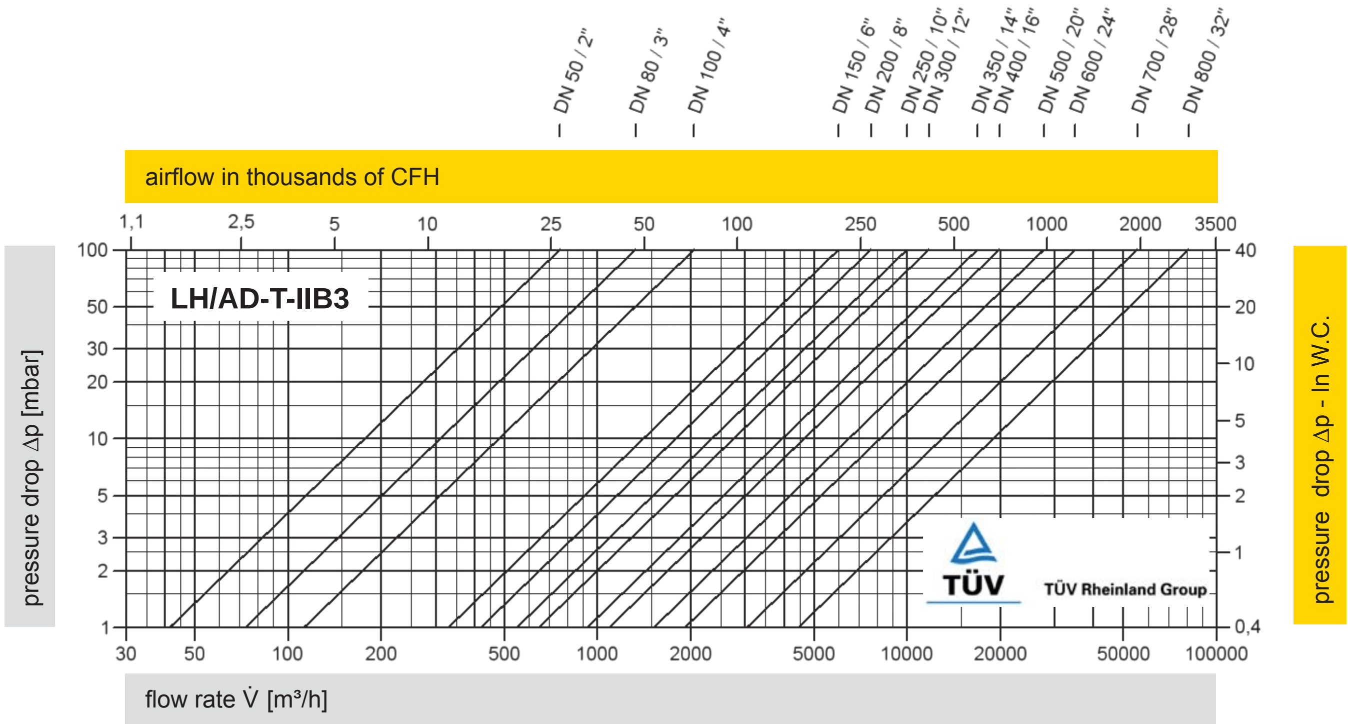
Type — Nominal size — Explosion group — Max. operating temperature — Material housing — Material flame arrester unit — Flange connection type

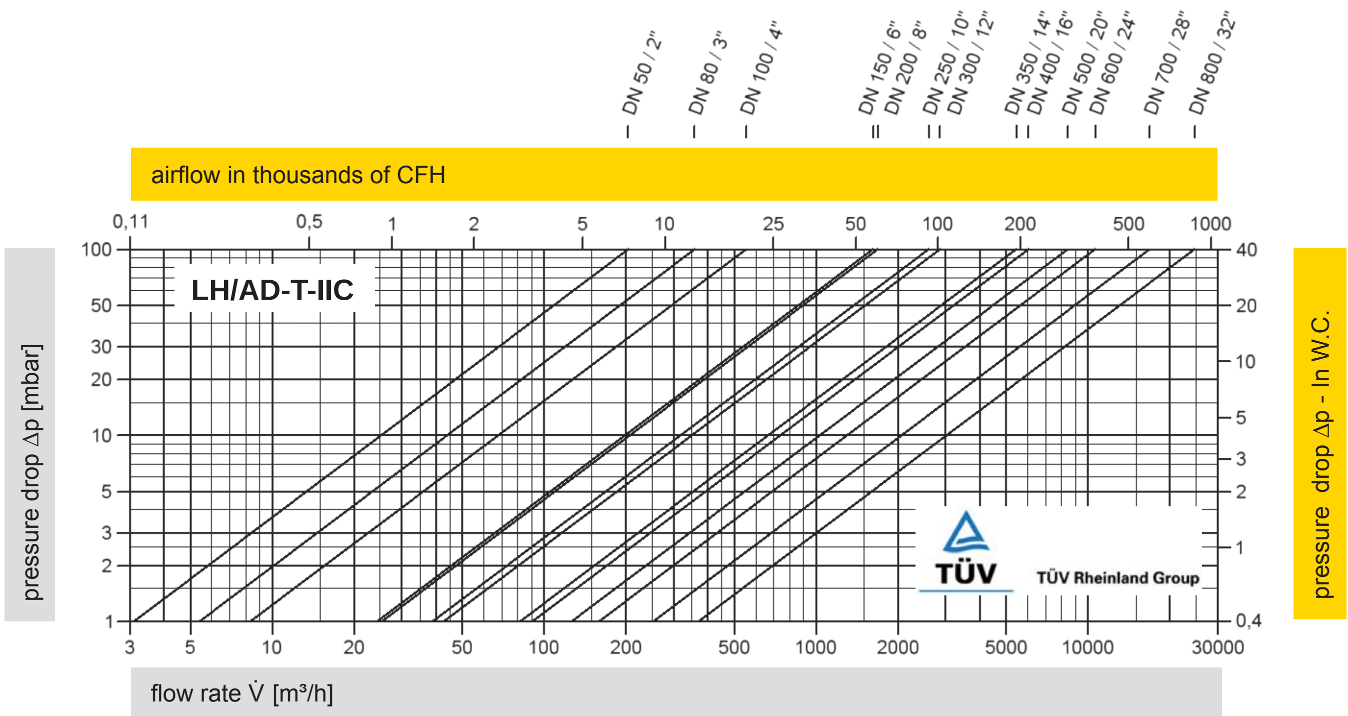
LH/AD-T						
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6

Order example

LH/AD-T – 800 – IIC – T60 – A – A – DIN

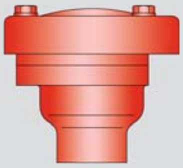
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





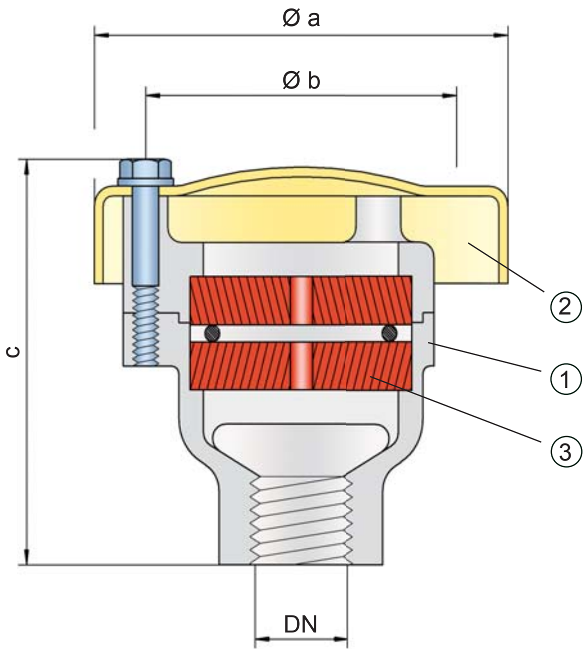
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HZ



The PROTEGO® BE/HZ consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit. The weather hood is made out of acrylic glass, which will melt when impacted by flames and allow heat to dissipate to the environment. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (3), which are installed in the housing.

The standard design can be used for operating temperatures up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other internationally accepted standards.

Function and Description

For many years the PROTEGO® BE/HZ end-of-line deflagration flame arrester has been successfully used to protect small vessels and plants which are not pressurized. The device provides protection against atmospheric deflagration and stabilized flames which can burn for very long time on the flame arrester element surface, so called endurance burning. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propagating into the vessel or plant.

Special Features and Advantages

- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- cost effective protection for small vessels and plants
- modular design allows replacement of single FLAMEFILTER®
- modular design results in low spare part costs
- protection against atmospheric deflagration and endurance burning

Design Type and Specification

End-of-line deflagration flame arrester, basic design **BE/HZ**

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	15 / ½"	20 / ¾"	25 / 1"	32 / 1¼"
a	87 / 3.43	87 / 3.43	114 / 4.49	114 / 4.49
b	80 / 3.15	80 / 3.15	100 / 3.94	100 / 3.94
c	85 / 3.35	85 / 3.35	90 / 3.54	90 / 3.54

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	

Table 3: Material selection for housing

Design	A	B
Housing	Steel	Stainless steel
Weather hood	Acrylic glass	Acrylic glass
Flame arrester unit	A	A,B

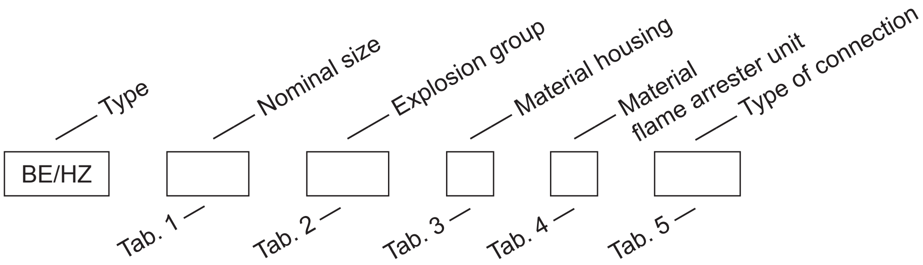
Special materials upon request

Table 4: Material combinations of flame arrester unit

Design	A	B
FLAMEFILTER®	Stainless steel	Hastelloy
Spacer	Stainless steel	Hastelloy

Table 5: Type of connection

Pipe thread DIN ISO 228-1	DIN	other types of thread upon request

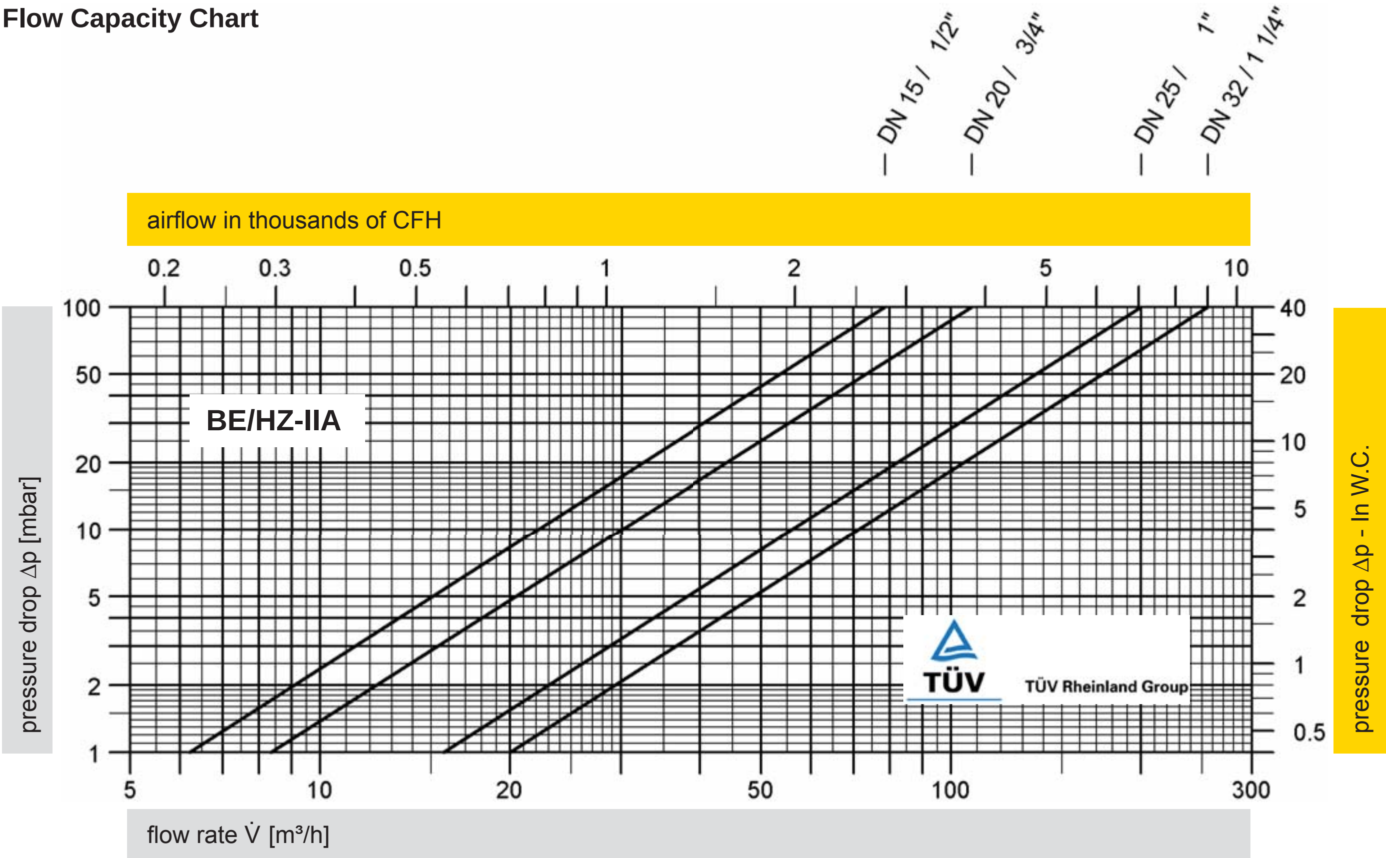


Order example

BE/HZ	–	½"	–	IIA	–	B	–	B	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



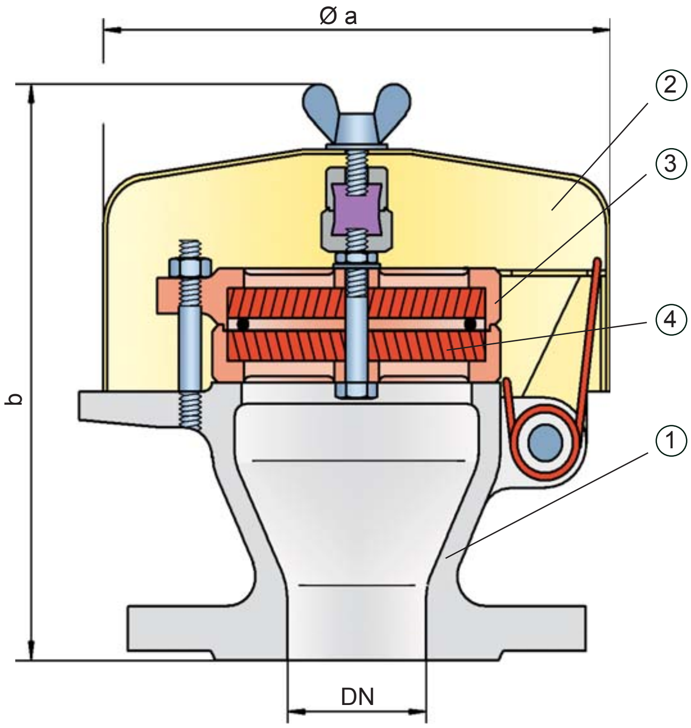
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HK

FM APPROVED

FM Approvals
Specification Tested



Function and Description

For many years the PROTEGO® BE/HK end-of-line deflagration flame arrester has been successfully used to protect vessels and plants which are not pressurized. The device provides protection against atmospheric deflagration and stabilized flames which can burn for very long time on the flame arrester element surface, so called endurance burning. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propagating into the vessel or plant.

The PROTEGO® BE/HK consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation the metal weather hood is in a closed position. If a stabilized flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and let the spring loaded weather hood move into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage. The FLAMEFILTER® gap size depends on the devices intended use. Detailing the operating conditions such as the temperature, explosion group and the composition of the fluid, enables PROTEGO® to select the best end-of-line deflagration flame arrester for your application. The PROTEGO® BE/HK series end-of-line deflagration flame arrester is available for substances from explosion groups IIA to IIB3 (NEC groups D to C MESG ≥ 0.65 mm). In a modified design, this device is also available for Ethanol applications.

The standard design can be used with operating temperature of up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood will open and signal the impact of a flame
- endurance burning protection for IIB3 and IIA vapour (NEC group C and D)
- fusible link is resistant against chemicals
- modular design allows replacement of single FLAMEFILTER®
- modular design results in low spare part costs
- protection against atmospheric deflagration and endurance burning

Design Types and Specifications

There are two different designs:

End-of-line deflagration flame arrester, basic design	**BE/HK - –**
End-of-line deflagration flame arrester with heating jacket	**BE/HK - H**

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

	DN	20 / ¾"	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"
	a	163 / 6.42	163 / 6.42	163 / 6.42	183 / 7.20	183 / 7.20	218 / 8.58	218 / 8.58
BE/HK-IIA	b	175 / 6.89	175 / 6.89	175 / 6.89	190 / 7.48	190 / 7.48	200 / 7.87	200 / 7.87
BE/HK-IIB3	b	180 / 7.09	180 / 7.09	180 / 7.09	-	-	-	-
BE/HK-FM-HC-D/C	b	175 / 6.89	175 / 6.89	175 / 6.89	190 / 7.48	190 / 7.48	200 / 7.87	200 / 7.87

Dimensions for deflagration flame arrester with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Material selection for housing

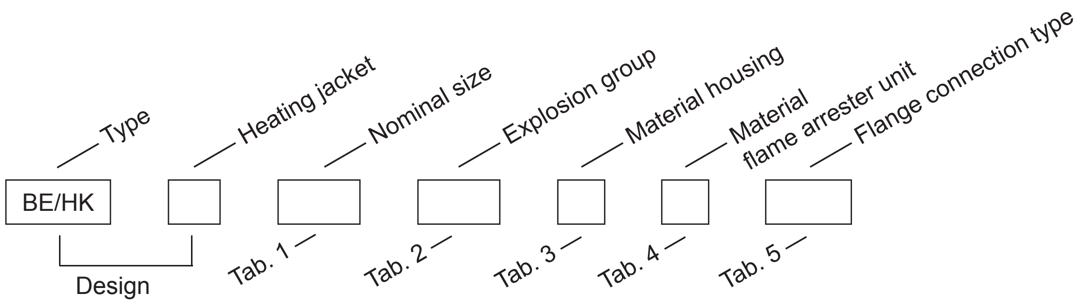
Design	B	C	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Steel	Stainless steel	
Flame arrester unit	A	A, C	

Table 4: Material combinations of flame arrester unit

Design	A	C	Special materials upon request
FLAMEFILTER® cage	Stainless steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Hastelloy	
Spacer	Stainless steel	Hastelloy	

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

BE/HK	–	H	–	80	–	IIA	–	B	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

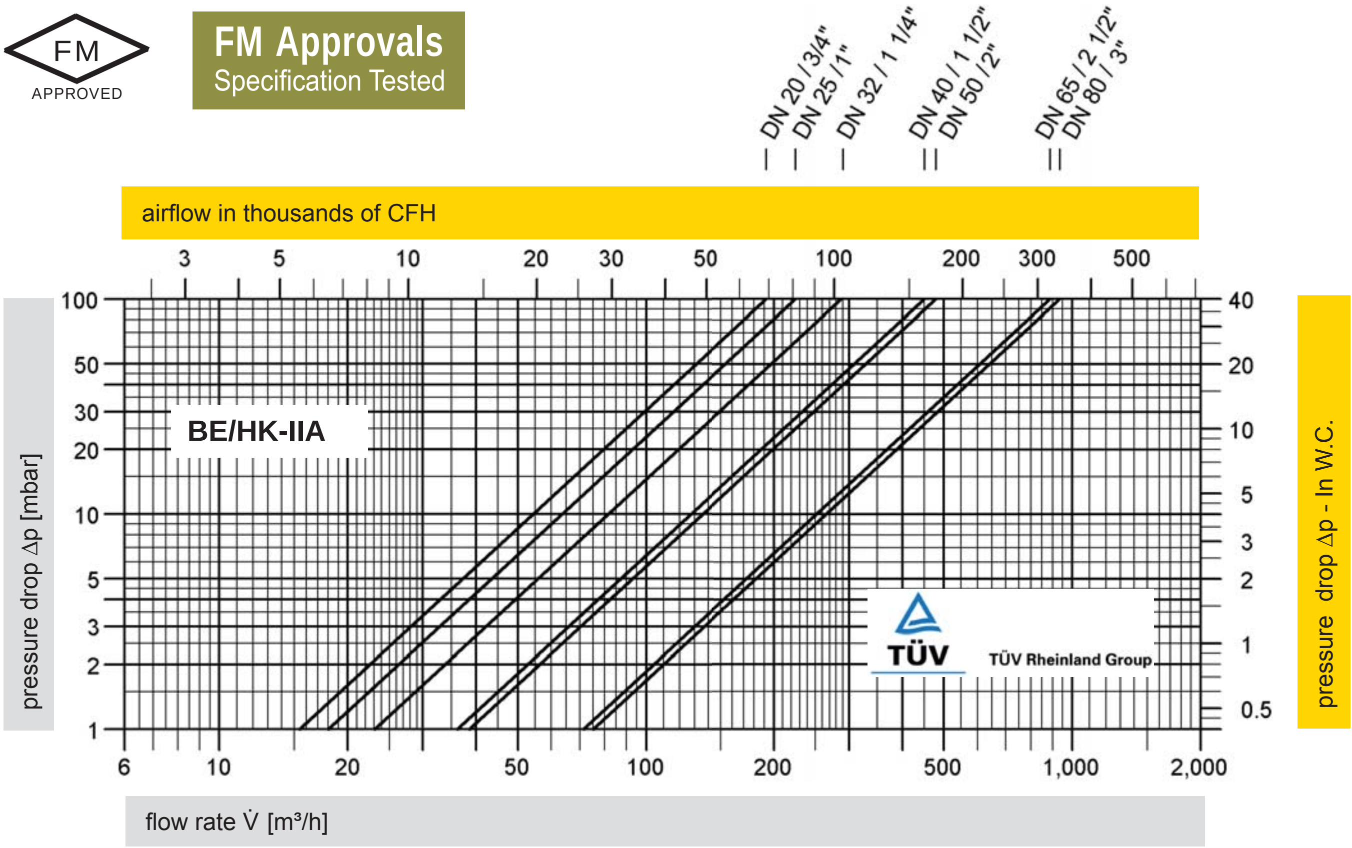
Deflagration Flame Arrester, endurance burning proof, End-of-Line

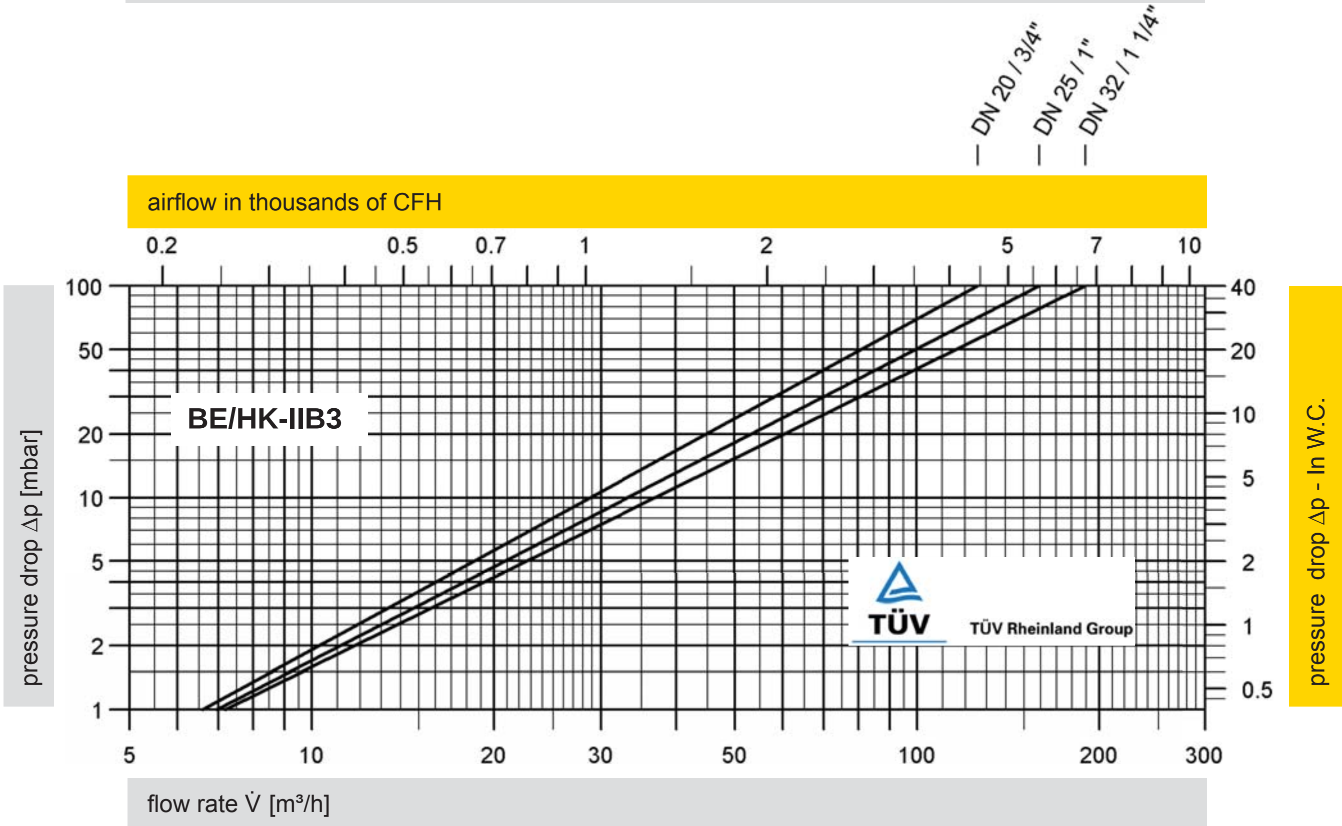
Flow Capacity Charts

PROTEGO® BE/HK

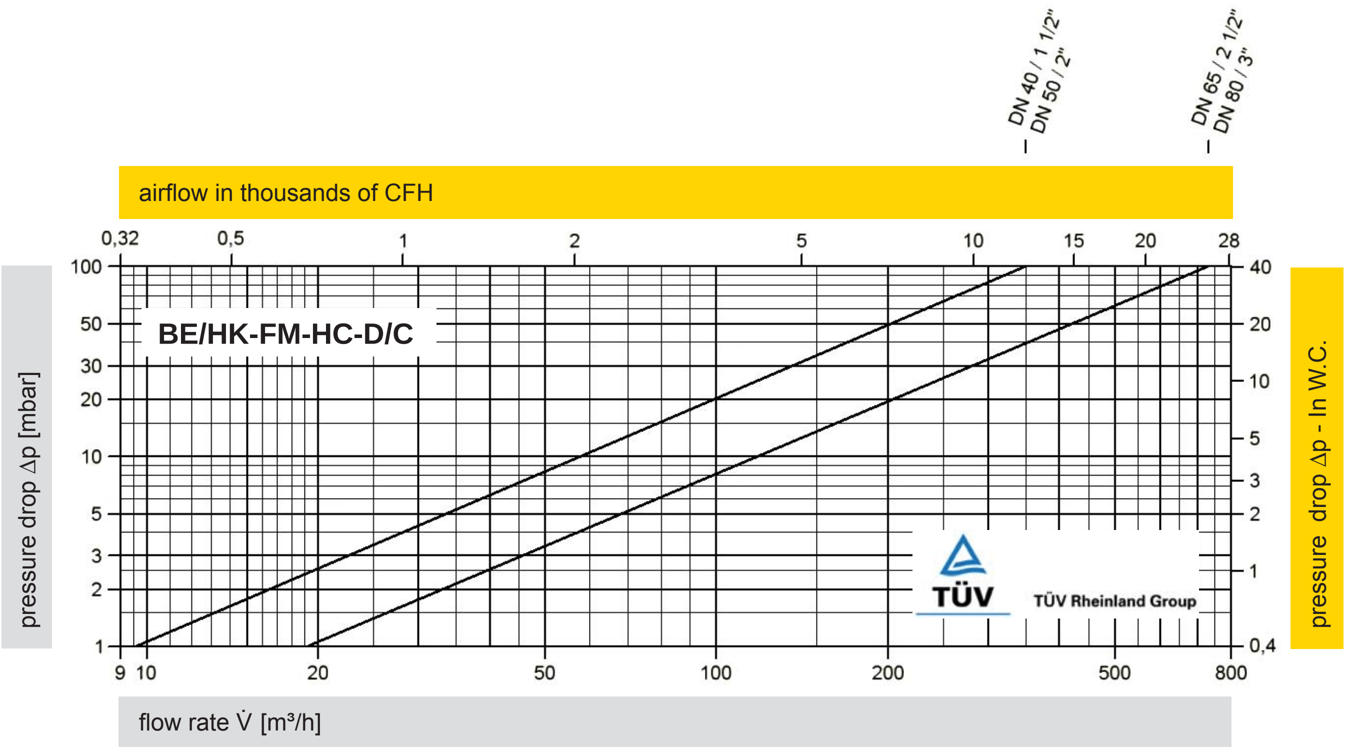
FM APPROVED

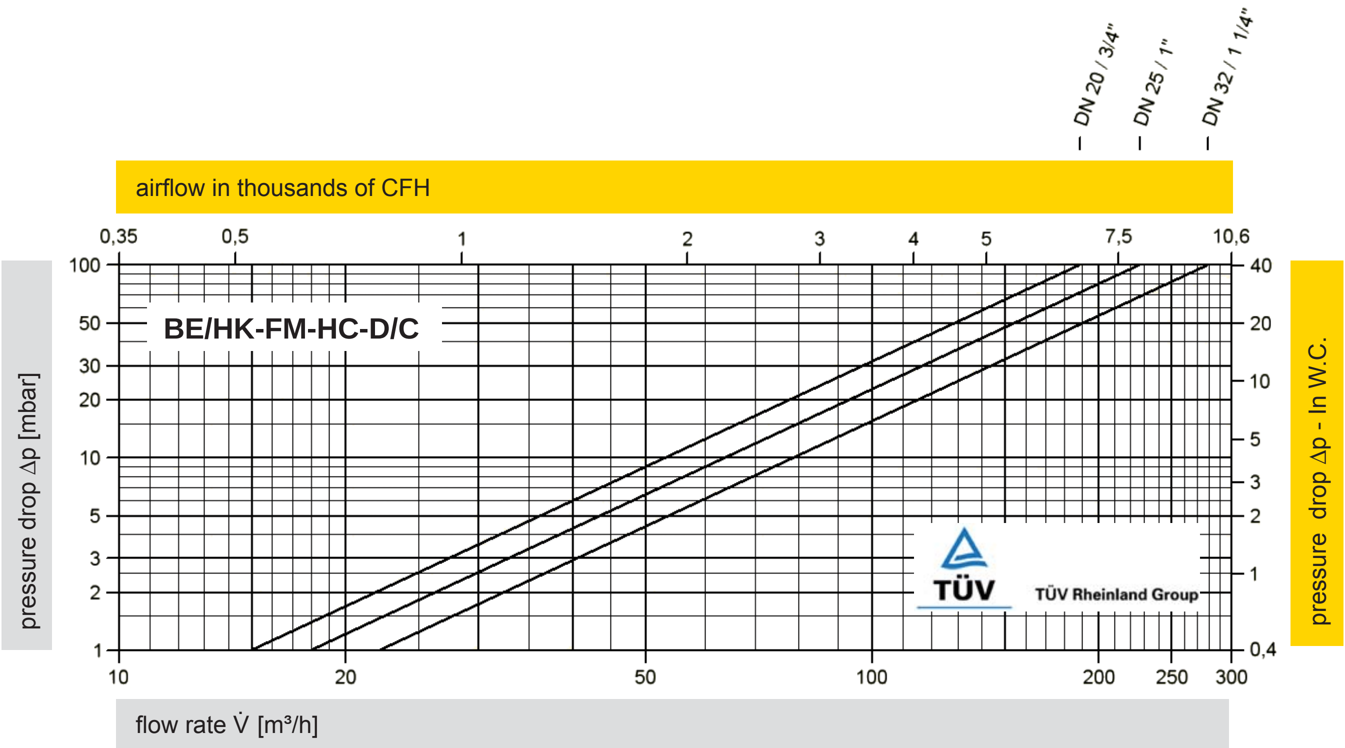
FM Approvals
Specification Tested





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.





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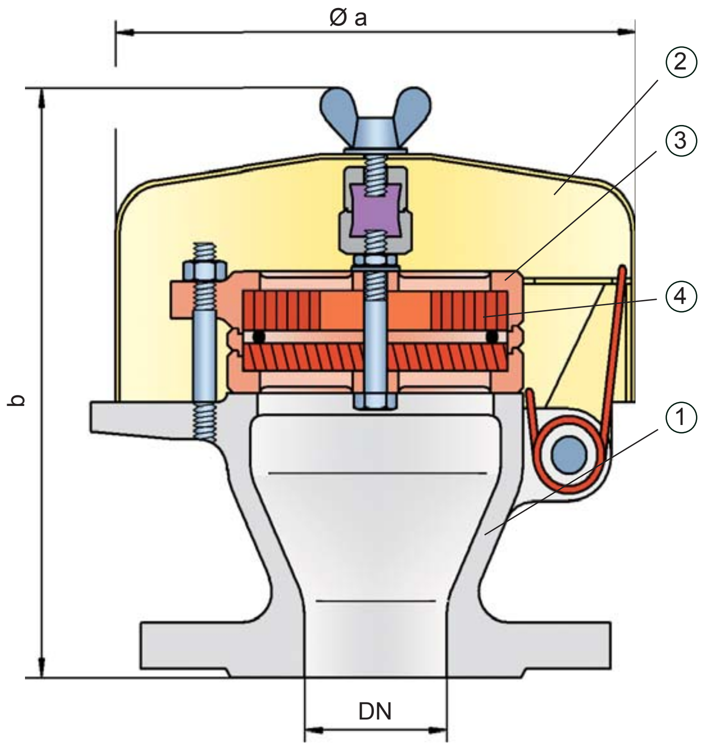
Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HK-E



Function and Description

The PROTEGO® BE/HK-E end-of-line deflagration flame arrester was specifically developed for vessels which are not pressurized and store Ethanol or other alcohols. The combustion of alcohol requires a modified flame arrester element design to provide protection against endurance burning. In addition, the device provides protection against atmospheric deflagration. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propogating into the vessel or plant.

The PROTEGO® BE/HK-E consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation the metal weather hood is in a closed position. If a stabilized flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and let the spring loaded weather hood move into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage. The PROTEGO® BE/HK-E end-of-line deflagration flame arrester is available for alcohols and other substances with MESG ≥ 0,85mm.

The standard design can be used for operating temperatures up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other internationally accepted standards.

Special Features and Advantages

- endurance burning protection for alcohols and hydrocarbons with MESG ≥ 0,85mm.
- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood will open and signal the impact of a flame
- fusible link is resistant against chemicals
- modular design allows replacement of single FLAMEFILTER®
- modular design results in low spare part costs
- protection against atmospheric deflagration and endurance burning

Design Types and Specifications

There are two different designs:

End-of-line deflagration flame arrester, basic design	**BE/HK-E -** $\boxed{–}$
End-of-line deflagration flame arrester with heating jacket	**BE/HK-E -** $\boxed{H}$

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	20 / ¾"	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"
a	163 / 6.42	163 / 6.42	163 / 6.42	183 / 7.20	183 / 7.20	218 / 8.58	218 / 8.58
b	180 / 7.09	180 / 7.09	180 / 7.09	190 / 7.48	190 / 7.48	200 / 7.87	200 / 7.87

Dimensions for deflagration flame arrester with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,85 mm	IIB1	–	

Table 3: Material selection for housing

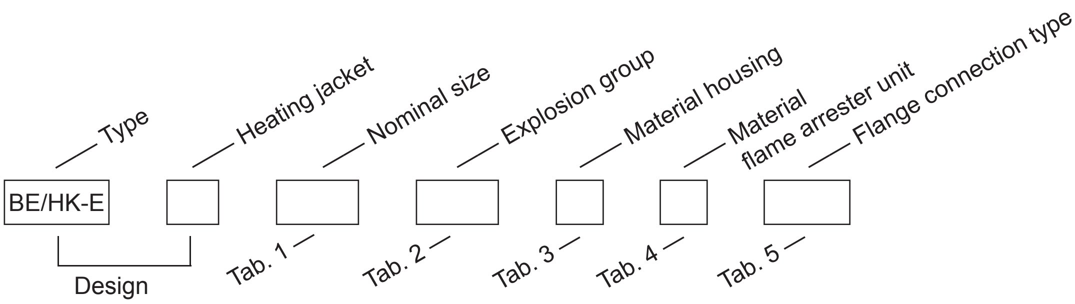
Design	B	C	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Steel	Stainless steel	
Flame arrester unit	A	A, B	

Table 4: Material combinations of flame arrester unit

Design	A	B	Special materials upon request
FLAMEFILTER® cage	Stainless steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Hastelloy	
Spacer	Stainless steel	Hastelloy	

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

BE/HK-E	–	H	–	80	–	IIB1	–	B	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

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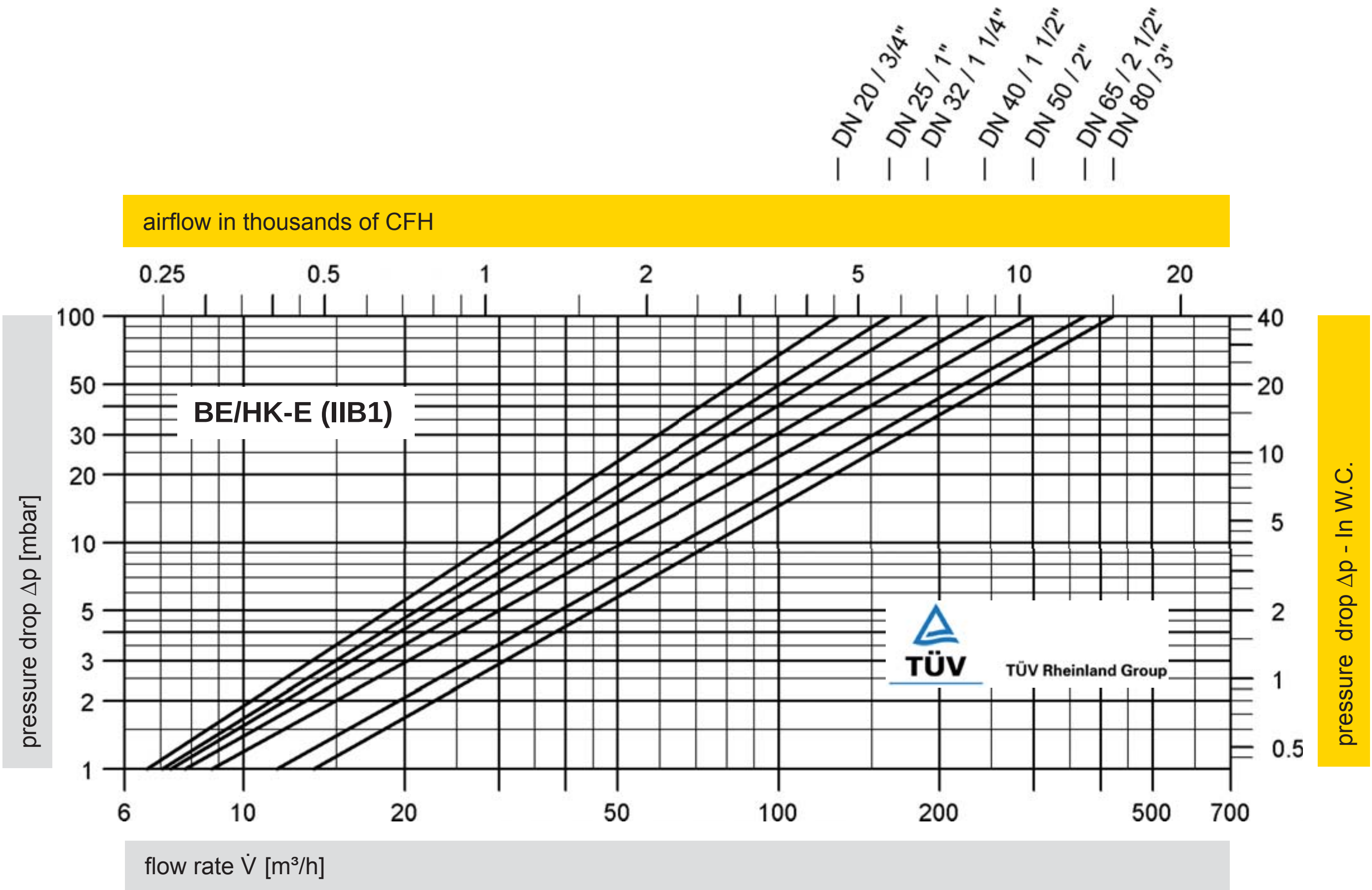
Deflagration Flame Arrester, endurance burning proof, End-of-Line

Flow Capacity Charts

PROTEGO® BE/HK-E



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

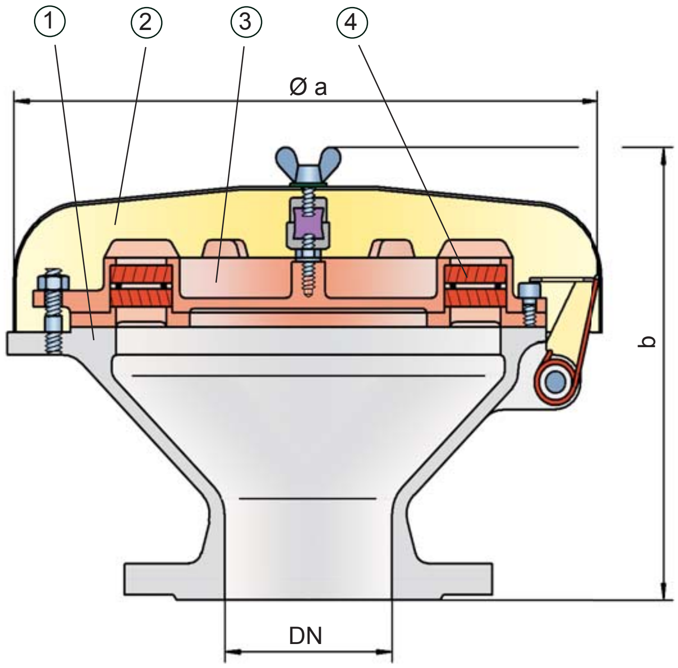
Notes:

Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HR

FM APPROVED

FM Approvals
Specification Tested



Function and Description

For many years the PROTEGO® BE/HR end-of-line deflagration flame arrester has been successfully used to protect vessels and plants which are not pressurized. The device provides protection against atmospheric deflagration and stabilized flames which can burn for very long time on the flame arrester element surface, so called endurance burning. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propagating into the vessel or plant.

The PROTEGO® BE/HR consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation the metal weather hood is in a closed position. If a flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and let the spring loaded weather hood move into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage. The FLAMEFILTER® gap size will depend on the devices intended use. Detailing the operating conditions such as the temperature, explosion group and the composition of the fluid, enables PROTEGO® to select the best end-of-line deflagration flame arrester for your application. The PROTEGO® BE/HR series end-of-line deflagration flame arrester is available for substances from explosion groups IIA to IIB3 (NEC groups D to C MESG ≥ 0.65 mm). In a modified design, this device is also available for Ethanol applications.

The standard design can be used with operating temperature of up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- protection against atmospheric deflagration and endurance burning
- endurance burning protection for IIB3 and IIA vapour (NEC groups C and D)
- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood opens and signals the impact of a flame
- fusible link is resistant against chemicals
- modular design allows replacement of single FLAMEFILTER®
- modular design results in low spare part costs

Design Types and Specifications

There are two different designs:

End-of-line deflagration flame arrester, basic design	**BE/HR -** $\boxed{–}$
End-of-line deflagration flame arrester with heating jacket	**BE/HR -** $\boxed{H}$

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

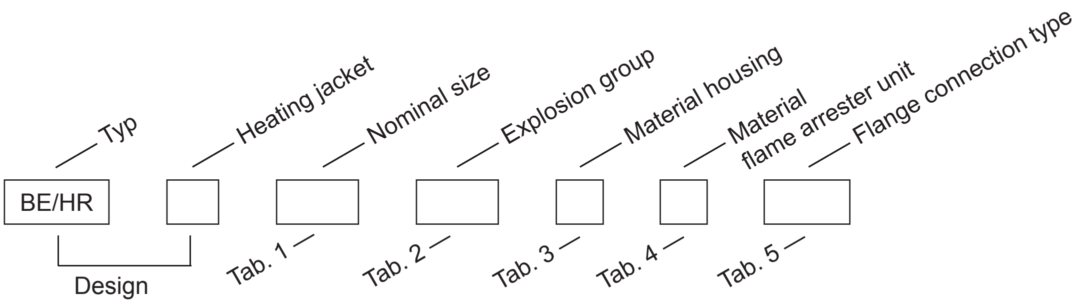
DN	80 / 3"	100 / 4"	Dimensions for deflagration flame arrester with heating jacket upon request
a	353 / 13.90	353 / 13.90	
b	250 / 9.84	250 / 9.84	

Table 2: Selection of explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	
≥ 0,65 mm	IIB3	C	

Table 3: Material selection for housing			
Design	B	C	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Steel	Stainless steel	
Flame arrester unit	A	A, C	

Table 4: Material combinations of flame arrester unit			
Design	A	C	Special materials upon request
FLAMEFILTER® cage	Stainless steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Hastelloy	
Spacer	Stainless steel	Hastelloy	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example												
BE/HR	–	H	–	100	–	IIB3	–	B	–	C	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

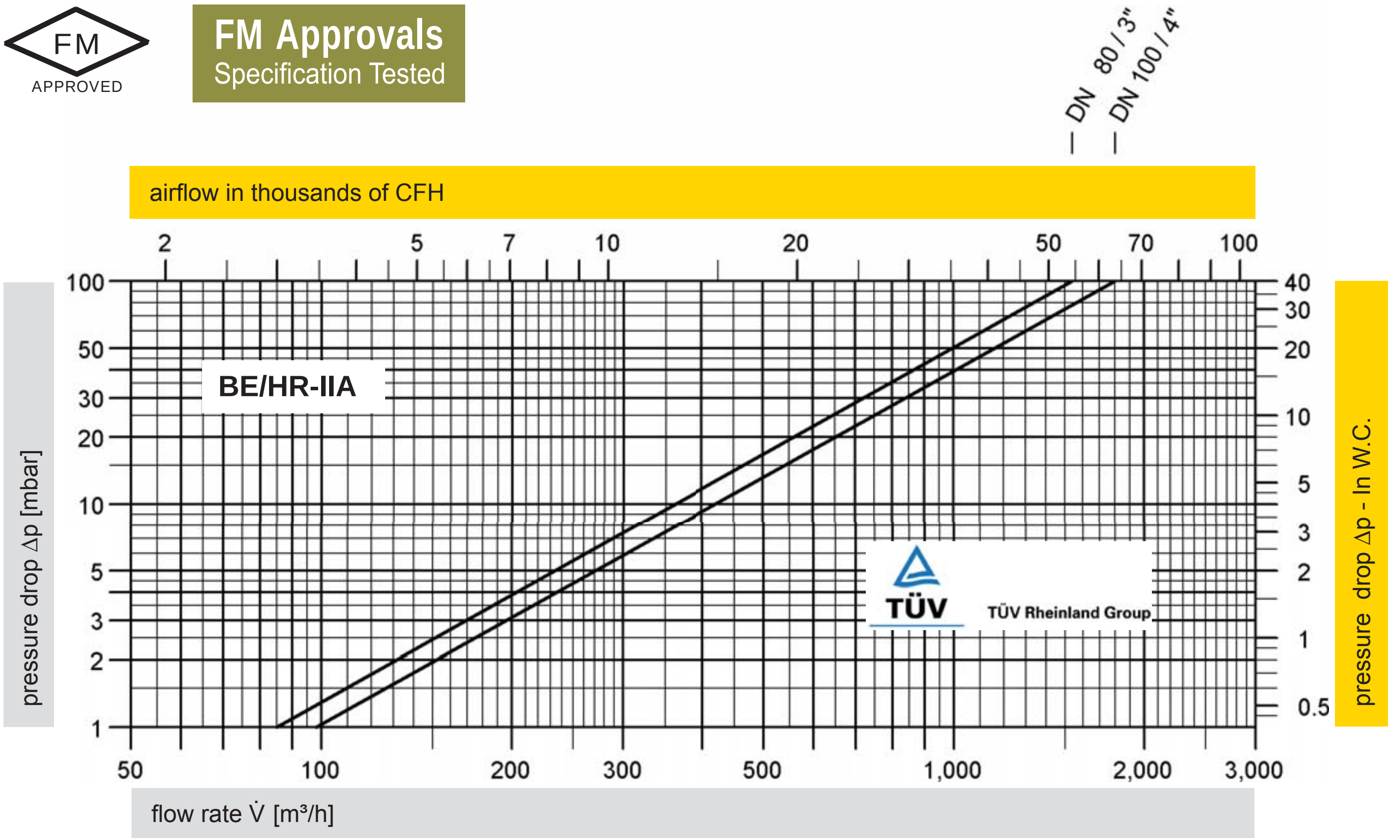
Deflagration Flame Arrester, endurance burning proof, End-of-Line

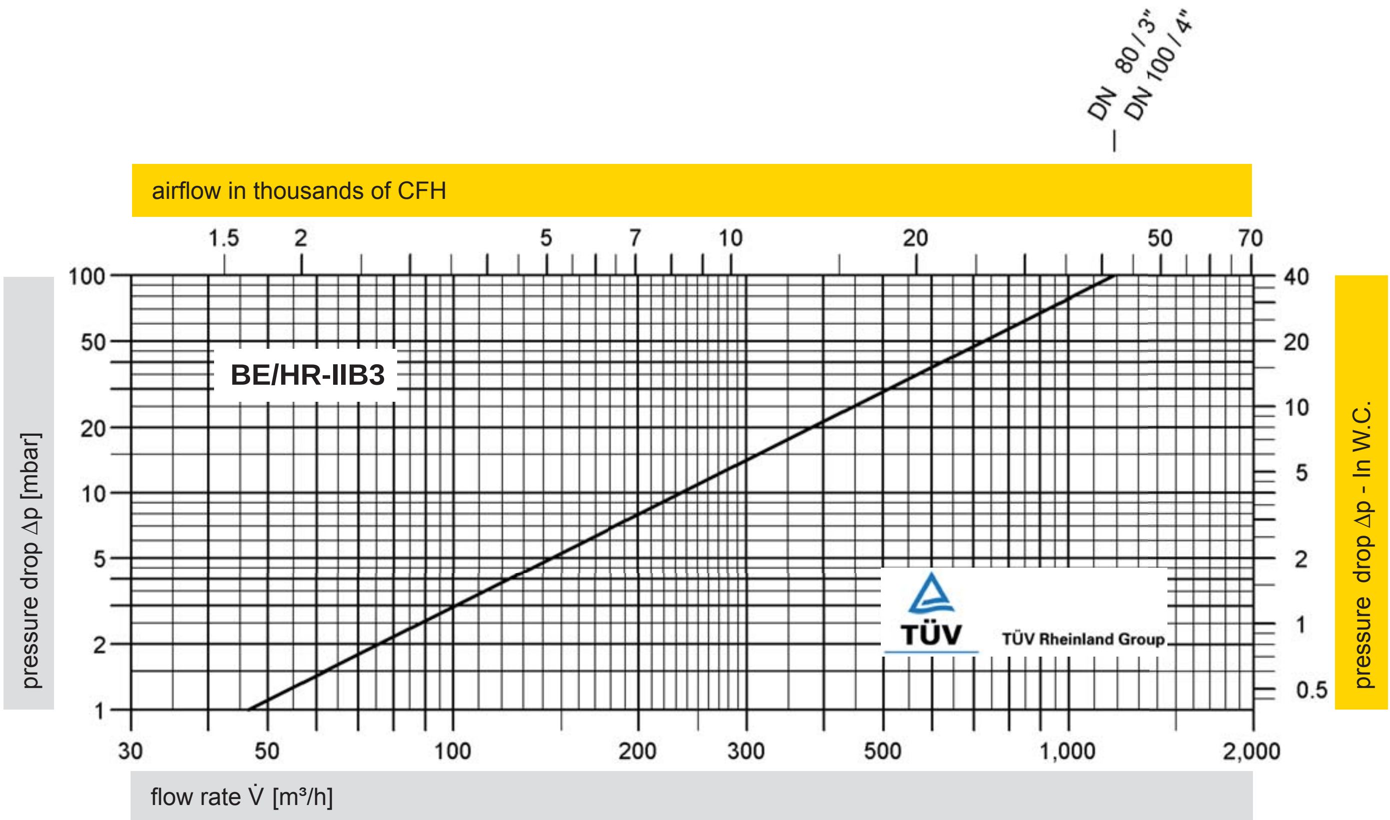
Flow Capacity Charts

PROTEGO® BE/HR

FM APPROVED

FM Approvals
Specification Tested





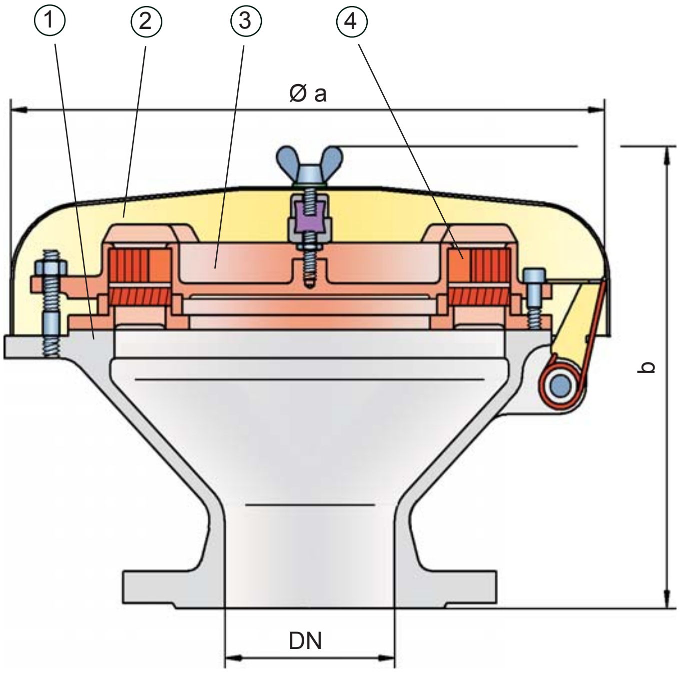
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

Notes:

Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HR-E



Function and Description

The PROTEGO® BE/HR-E end-of-line deflagration flame arrester was specifically developed for vessels which are not pressurized and store Ethanol or other alcohols with a MESG ≥ 0,85 mm. The combustion of alcohol requires a modified flame arrester element design to provide protection against endurance burning. In addition, the device provides protection against atmospheric deflagration. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propagating into the vessel or plant.

The PROTEGO® BE/HR-E consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation, the metal weather hood is in a closed position. If a flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and let the spring loaded weather hood move into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage.

The PROTEGO® BE/HR-E end-of-line deflagration flame arrester is available for alcohols and other substances with a MESG ≥ 0,85 mm.

The standard design can be used for operating temperatures up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other internationally accepted standards.

Special Features and Advantages

- endurance burning protection for alcohols and hydrocarbons with a MESG ≥ 0,85 mm
- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood opens and signals the impact of a flame
- fusible link is resistant against chemicals
- modular design allows replacement of single FLAMEFILTER®
- modular design results in low spare part costs
- protection against atmospheric deflagration and endurance burning

Design Types and Specifications

There are two different designs:

End-of-line deflagration flame arrester, basic design	**BE/HR - E -** $\boxed{-}$
End-of-line deflagration flame arrester with heating jacket	**BE/HR - E -** $\boxed{H}$

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	80 / 3"	100 / 4"	
a	353 / 13.90	353 / 13.90	Dimensions for deflagration flame arrester with heating jacket upon request
b	250 / 9.84	250 / 9.84	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,85 mm	IIB1	–	Special approvals upon request

Table 3: Material selection for housing

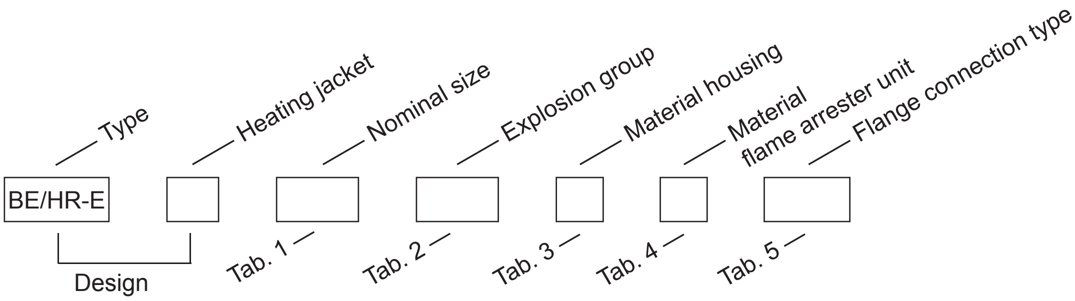
Design	B	C	
Housing	Steel	Stainless steel	Special materials upon request
Weather hood	Steel	Stainless steel	
Flame arrester unit	A	A, B	

Table 4: Material combinations of flame arrester unit

Design	A	B	
FLAMEFILTER® cage	Stainless steel	Stainless steel	Special materials upon request
FLAMEFILTER®	Stainless steel	Hastelloy	
Spacer	Stainless steel	Hastelloy	

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

BE/HR-E	–	H	–	80	–	IIB1	–	B	–	A	–	DIN

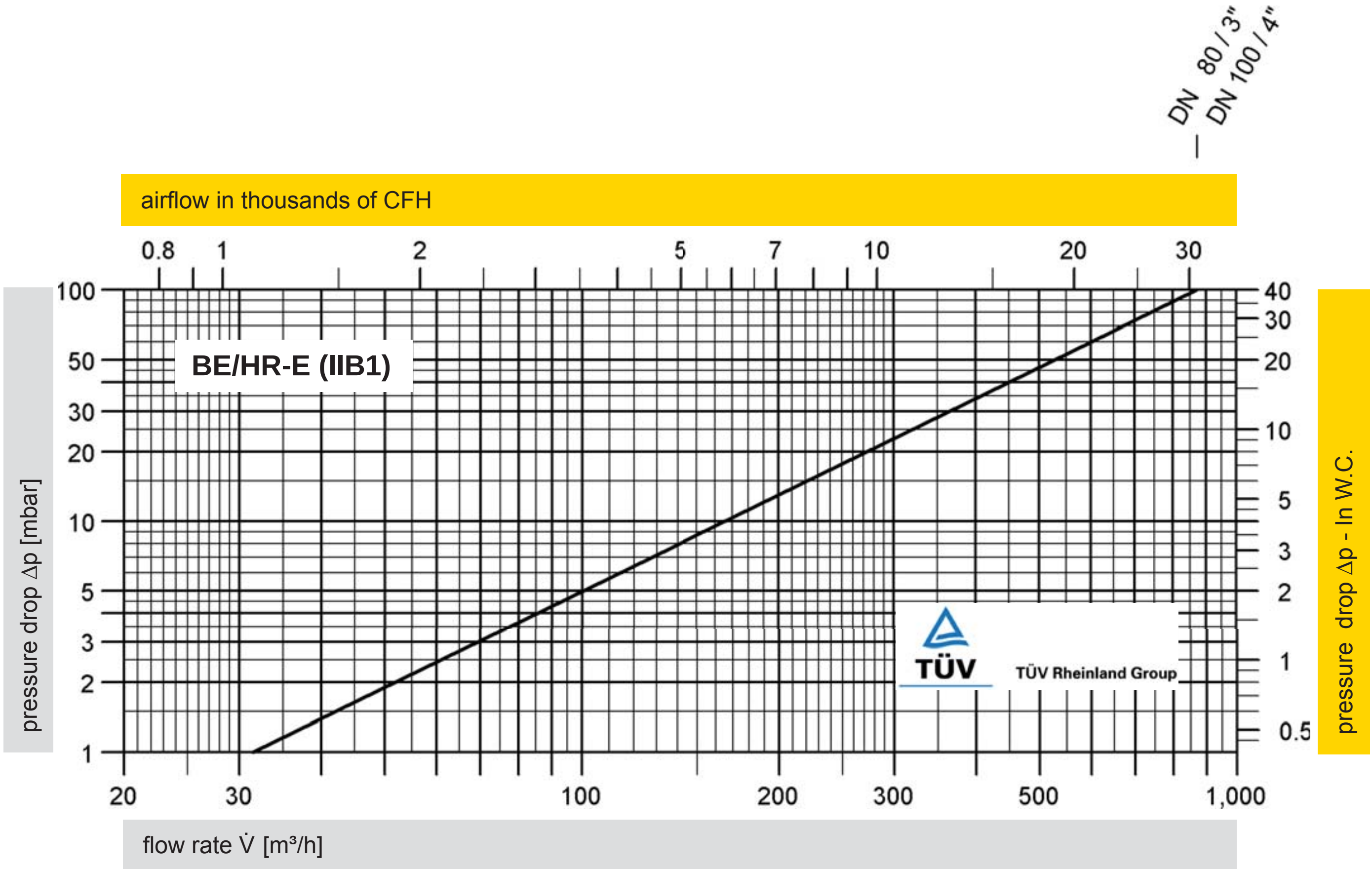
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

for safety and environment

Deflagration Flame Arrester, endurance burning proof, End-of-Line

Flow Capacity Chart

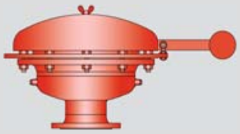
PROTEGO® BE/HR-E



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

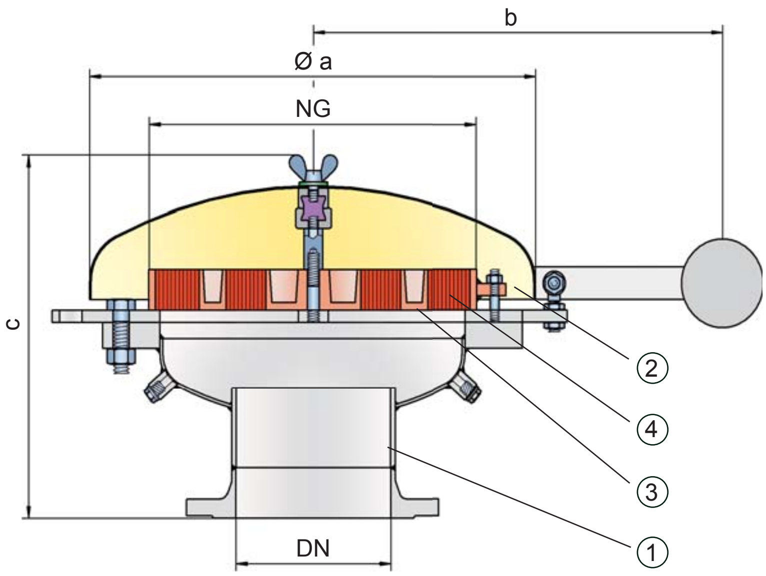
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:



Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® BE/HR-400



Function and Description

The PROTEGO® BE/HR-400 end-of-line deflagration flame arrester is designed to protect large vessels and plants which are not pressurized. The device provides protection against atmospheric deflagration and stabilized flames which can burn for very long time on the flame arrester element surface, so called endurance burning. Main application area is on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration from propagating into the vessel or plant.

The BE/HR-400 consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation, the metal weather hood is in a closed position. If a stabilized flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and an external counterweight will move the weather hood into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage. The FLAMEFILTER® are arranged concentrically and are manufactured in a patented process. The FLAMEFILTER® cage has integrated cooling channels to allow heat to be transferred away from the center of the device. The PROTEGO® BE/HR-400 end-of-line deflagration flame arrester is available for substances from explosion group IIA (NEC group D).

The standard design can be used for operating temperatures up to +60°C / 140°F.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other internationally accepted standards.

Special Features and Advantages

- protection against atmospheric deflagration and endurance burning
- endurance burning protection hydrocarbons of explosion group IIA (NEC group D)
- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood opens and signals the impact of a flame
- fusible link is resistant against chemicals
- maintenance friendly design

Design Types and Specifications

There are two different designs:

End-of-line deflagration flame arrester, basic design	**BE/HR -** $\boxed{-}$
End-of-line deflagration flame arrester with heating coil	**BE/HR -** $\boxed{R}$

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	150 / 6"	200 / 8"	
NG	400 / 16"	400 / 16"	Dimensions for deflagration flame arrester with integrated heating coil upon
a	600 / 23.62	600 / 23.62	
b	545 / 21.46	545 / 21.46	
c	485 / 19.09	485 / 19.09	

Table 2: Selection of explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	

Table 3: Material selection for housing			
Design	A	B	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Steel	Stainless steel	
Flame arrester unit	A, B	B	

Table 4: Material combination of flame arrester unit			
Design	A	B	Special materials upon request
FLAMEFILTER® cage	Steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Stainless steel	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type	Heating coil	Nominal width		Nominal size	Explosion group	Material housing	Material flame arrester unit	Flange connection type
BE/HR			/					
Design		Tab. 1		Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5

Order example

BE/HR – R – 400 / 150 – IIA – B – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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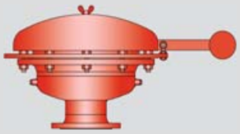
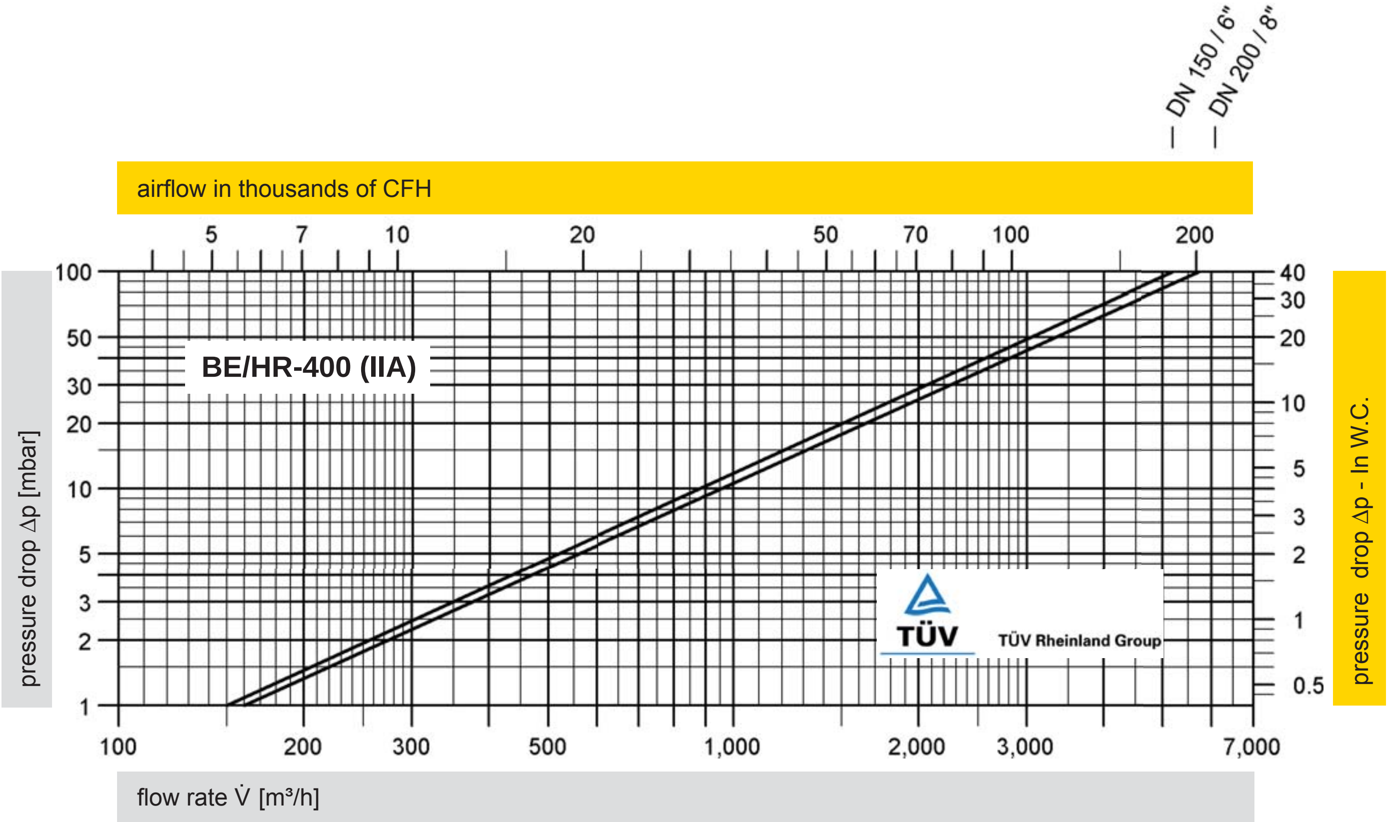


Deflagration Flame Arrester, endurance burning proof, End-of-Line

Flow Capacity Chart

PROTEGO® BE/HR-400



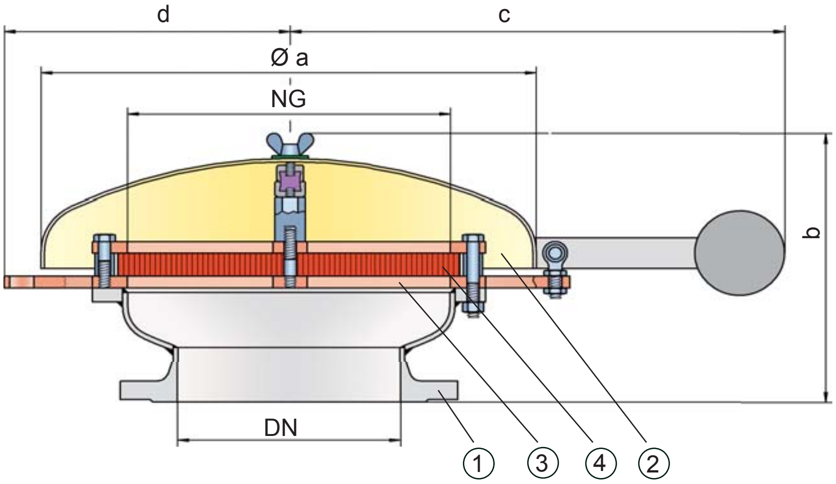
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

Notes:

Deflagration Flame Arrester, endurance burning proof, End-of-Line

PROTEGO® LH/EB 400



The PROTEGO® LH/EB series end-of-line deflagration flame arrester is available for substances from explosion group I (NEC group E).

The standard design can be used with operating temperature of up to +60°C / 140°F.

Special certificates for mining are available and the device is type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- most efficient deflagration flame arrester for methane/air mixtures
- certificates for mining are available
- protection against atmospheric deflagration and endurance burning
- weather hood protects against environmental impact (i.e. weather, bird nests, etc.)
- weather hood will open and signals the impact of a flame
- fusible link is resistant against chemicals
- maintenance friendly design

Function and Description

The PROTEGO® LH/EB 400 end-of-line deflagration flame arrester is used to protect plants and vessels which are not pressurized and process Methane/Air mixtures. The device provides protection against atmospheric deflagration and stabilized flames which can burn for a very long time. This device is specifically applied to vent lines of decommissioned underground mines. Other areas of application are biogas, landfill gas and sewage gas. The device is installed on suction and vent lines, with the goal to prevent flame transmission caused by endurance burning or atmospheric deflagration propagating into the vessel or plant.

The PROTEGO® LH/EB 400 consists of a housing (1), a weather hood (2) and the PROTEGO® flame arrester unit (3). During normal operation, the metal weather hood is in a closed position. If a flame burns on the flame arrester element surface, the fusible link, located in a center position, will melt and an externally located weight will move the weather hood into the open position. The PROTEGO® flame arrester unit consists of two FLAMEFILTER® (4), which are installed in a FLAMEFILTER® cage.

Design Type and Specification

End-of-line deflagration flame arrester, basic design	**LH/EB 400**

Special designs available on request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following pages

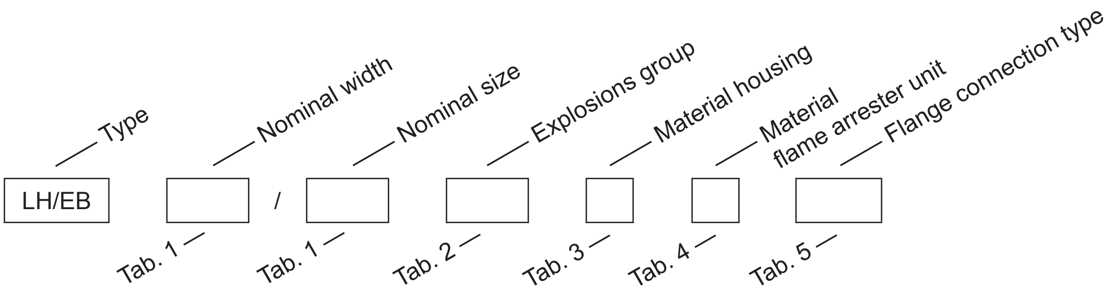
DN	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"
NG	400 / 16"	400 / 16"	400 / 16"	400 / 16"	400 / 16"	400 / 16"
a	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62
b	340 / 13.39	340 /13.39	340 / 13.39	340 / 13.39	340 / 13.39	340 / 13.39
c	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62	600 / 23.62
d	350 / 13.78	350 / 13.78	350 / 13.78	350 / 13.78	350 / 13.78	350 / 13.78

Table 2: Selection of explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 1,14 mm	I	E	

Table 3: Material selection for housing			
Design	A	B	Special materials upon request
Housing	Steel	Stainless steel	
Weather hood	Steel	Stainless steel	
Flame arrester unit	A, B	B	

Table 4: Material combinations of flame arrester unit			
Design	A	B	Special materials upon request
FLAMEFILTER® cage	Steel	Stainless steel	
FLAMEFILTER®	Stainless steel	Stainless steel	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

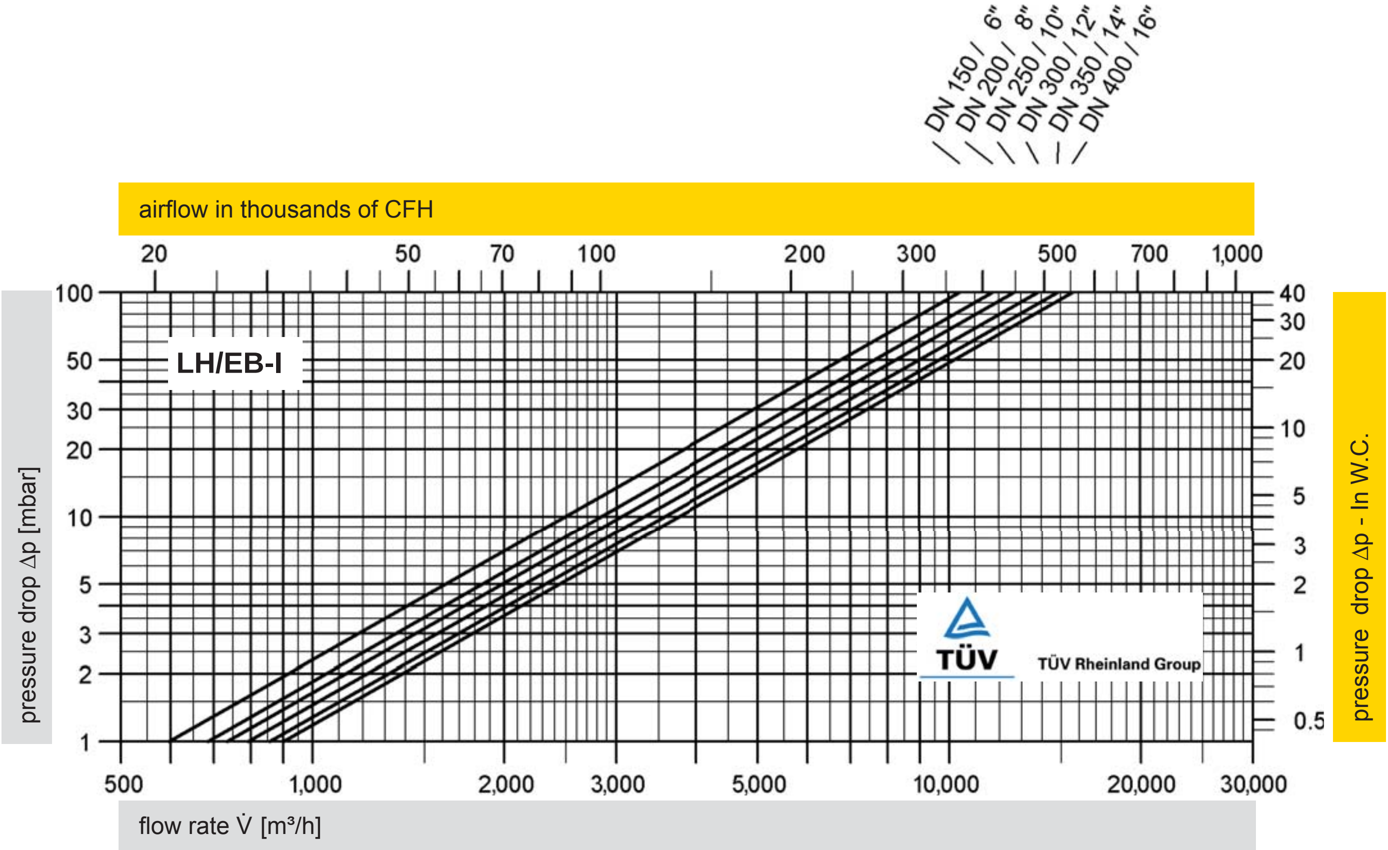
LH/EB	–	400	/	150	–	I	–	B	–	B	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Deflagration Flame Arrester, endurance burning proof, End-of-Line

Flow Capacity Chart

PROTEGO® LH/EB



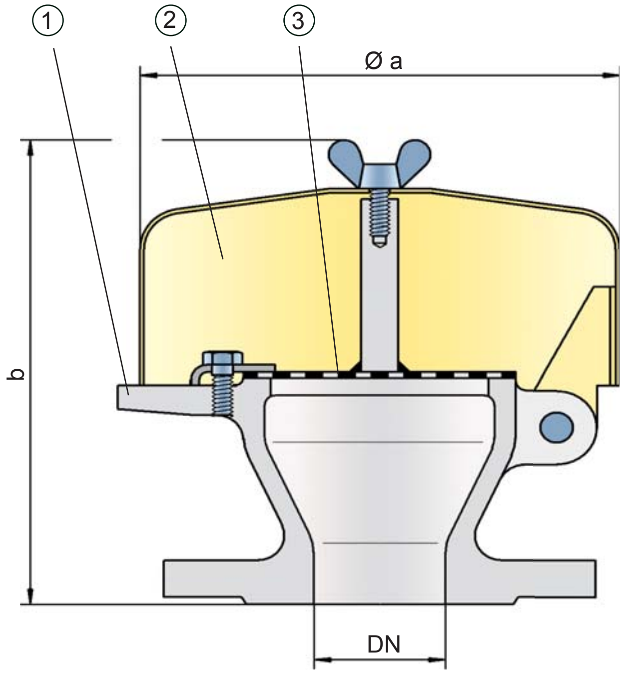
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

Vent Cap, End-of-Line

PROTEGO® EH/0



The vent cap PROTEGO® EH/0 main components are a housing (1), a weather hood (2) and a protection screen (3). The device is equipped with a fixed weather hood out of metal. The protection screen prevents particles or rain from entering the line.

Special Features and Advantages

- vent cap provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- almost maintenance free
- certified flow performance curves

Function and Description

The PROTEGO® E/H0 vent cap allows vessels which are not pressurized to vent. This device prevents rain and dirt from entering the vent line. The EH/0 vent cap is not flame transmission proof. It is often used in combination with detonation flame arresters, when those are used in vent lines, installed at a position which creates a long run up distance from the end of the vent line to prevent endurance burning. The PROTEGO® EH/0 vent cap will then be installed at the end of that vent line to prevent particles or rain from entering the line.

Design Type and Specification

Vent cap, basic design	**EH/0**

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	20 / ¾"	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"
a	163 / 6.42	163 / 6.42	163 / 6.42	183 / 7.20	183 / 7.20	218 / 8.58	218 / 8.58
b	175 / 6.89	175 / 6.89	175 / 6.89	190 / 7.48	190 / 7.48	200 / 7.87	200 / 7.87

Table 2: Material selection

Design	A	B	
Housing	Steel	Stainless steel	Special materials upon request
Weather hood	Steel	Stainless steel	

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type — Nominal size — Material — Flange connection type

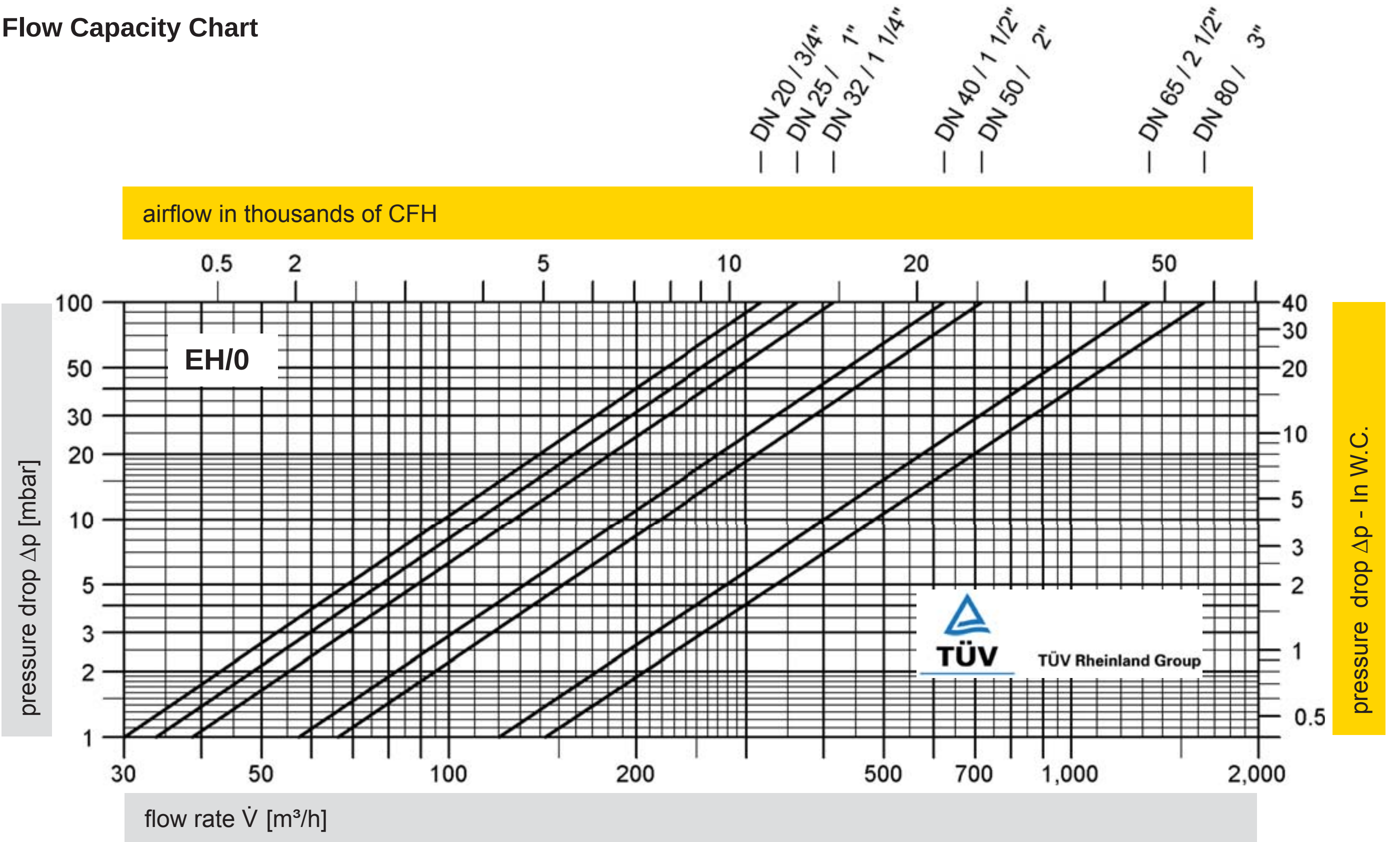
EH/0			
	Tab. 1	Tab. 2	Tab. 3

Order example

EH/0	–	80	–	B	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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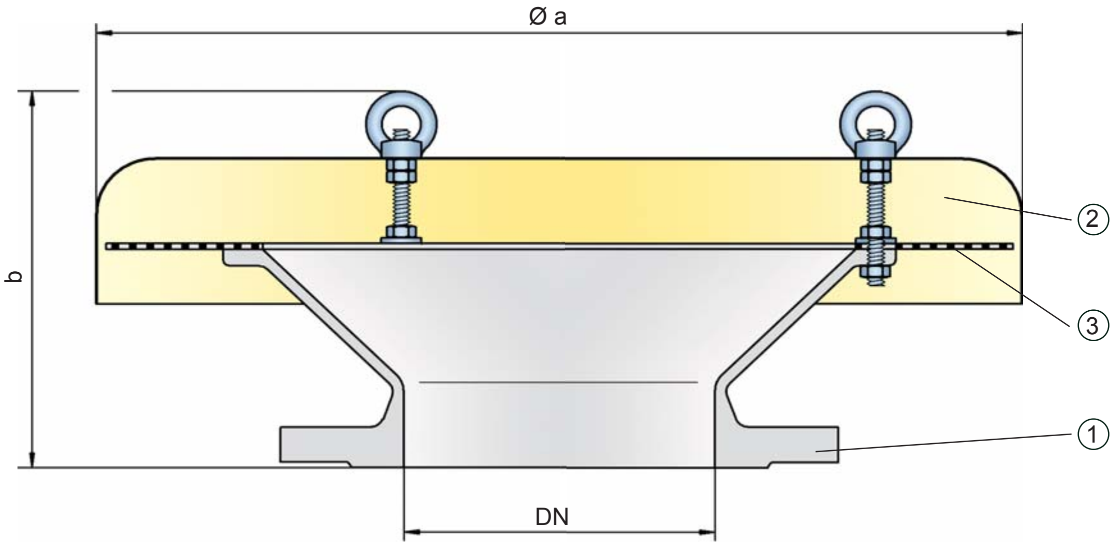
Vent Cap, End-of-Line

PROTEGO® EH/0S



Function and Description

The PROTEGO® EH/0S vent cap allows vessels which are not pressurized to vent. This device prevents rain and dirt entering the vent line. The PROTEGO® EH/0S vent cap is not flame transmission proof. It is often used in combination with detonation flame arresters, when those are used in vent lines, installed at a position which creates a long run up distance from the end of the vent line to prevent endurance burning. The PROTEGO® EH/0S will then be installed at the end of that vent line to prevent particles or rain from entering the line.

The vent cap PROTEGO® EH/0S main components are a housing (1), a weather hood (2) and a protection screen (3). The device is equipped with a fixed weather hood out of metal. The protection screen prevents particles or rain from entering the line.

Special Features and Advantages

- vent cap provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- almost maintenance free
- certified flow performance curves

Design Types and Specification

Vent cap, basic design	**EH/0S**

Special designs available on request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"	500 / 20"	600 / 24"
a	295 / 11.61	550 / 21.65	550 / 21.65	600 / 23.62	600 / 23.62	600 / 23.62	650 / 25.59	800 / 31.50	1000 / 39.37
b	230 / 9.06	240 / 9.45	240 / 9.45	325 / 12.80	320 / 12.60	335 / 13.19	370 / 14.57	385 / 15.16	520 / 20.47

Table 2: Material selection

Design	A	B	
Housing	Steel	Stainless steel	Special materials upon request
Weather hood	Stainless steel	Stainless steel	

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type — Nominal size — Material — Flange connection type

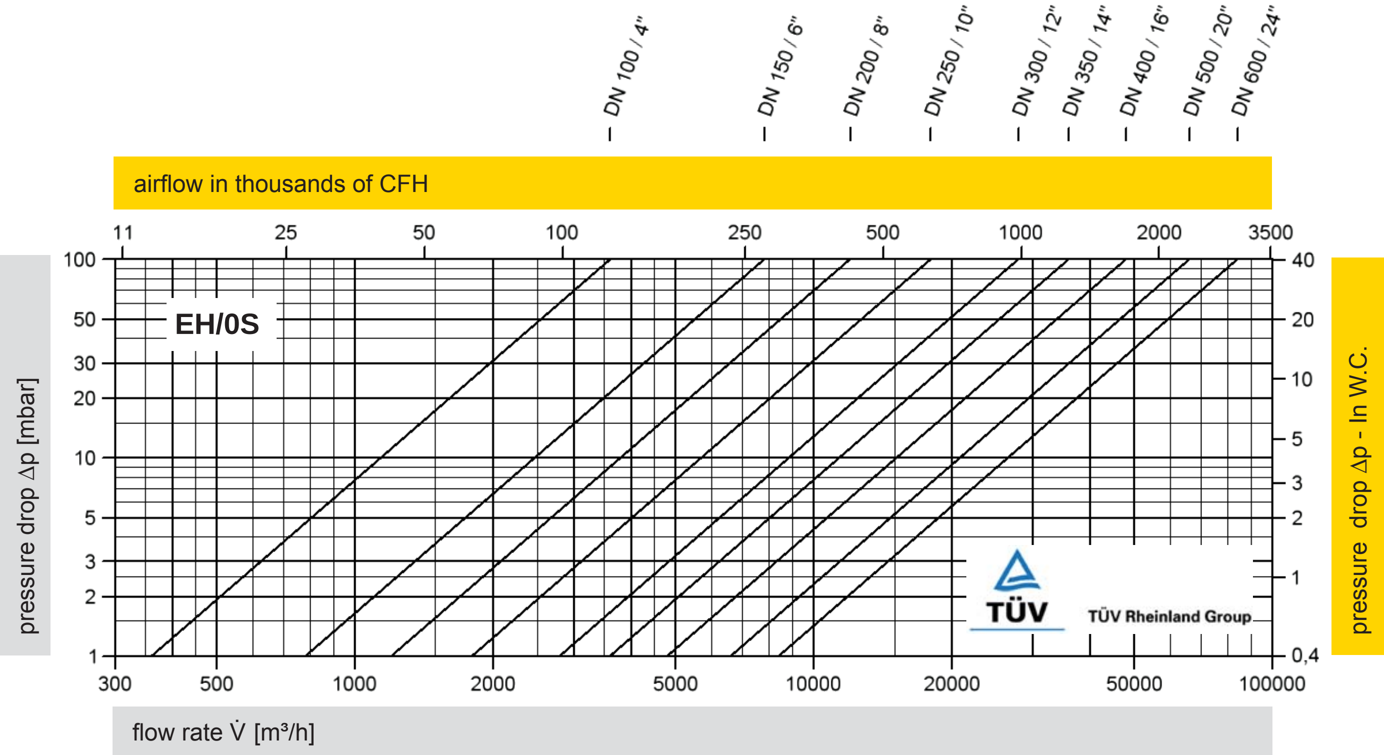
EH/0S			
	Tab. 1	Tab. 2	Tab. 3

Order example

EH/0S – 100 – B – DIN

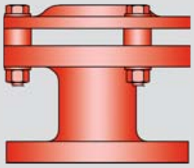
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



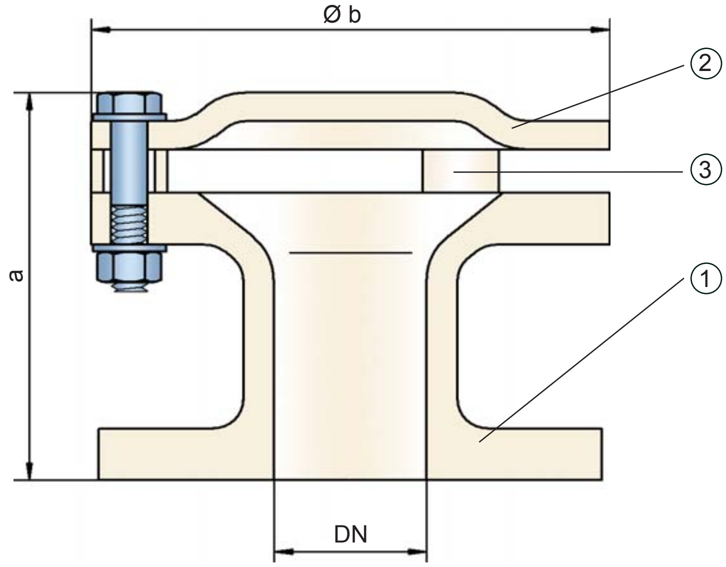
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



Vent Cap, End-of-Line

PROTEGO® E/KS



Function and Description

The E/KS vent cap allows vessels which are not pressurize to vent. The vent cap is made out of plastic and is the best solution in applications with aggressive media. This E/KS vent cap prevents rain and dirt from entering the vent line. The device is not flame transmission proof. It is often used in combination with detonation flame arresters, when those are used in vent lines, installed at a position which creates a long run up distance from the end of the vent line to prevent endurance burning. The E/KS vent cap will then be installed at the end of that vent line to prevent particles or rain from entering the line.

The vent caps main components are a housing (1), a weather hood (2) and spacers (3).

Special Features and Advantages

- vent cap provides protection against environmental impact (harsh weather conditions, bird nests, etc.)
- cost effective device
- almost maintenance free
- certified flow performance curves

Design Types and Specification

Vent cap, basic design	**E/KS**
Special designs available on request	

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

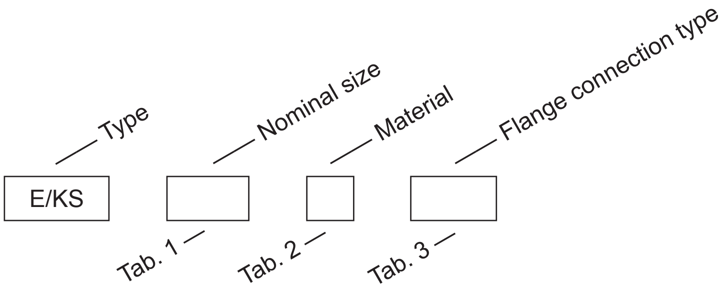
DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	135 / 5.31	140 / 5.51	145 / 5.71	195 / 7.68	200 / 7.87
b	170 / 6.69	230 / 9.06	300 / 11.81	375 / 14.76	450 / 17.72

Table 2: Material selection

Design	A	B	C	
Housing	PE	PP	PVDF	Special materials upon request
Weather hood	PE	PP	PVDF	

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

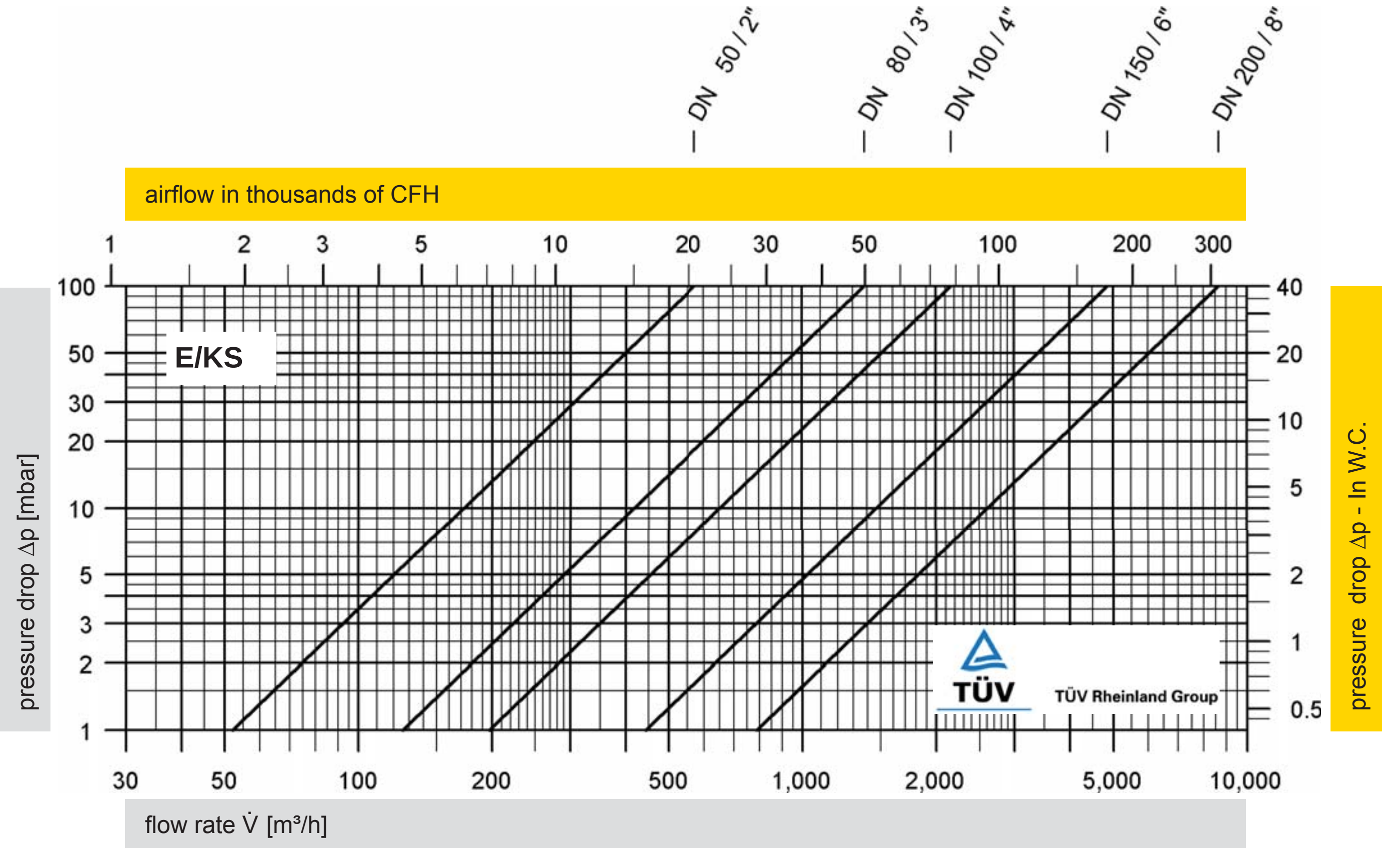


Order example

E/KS – 200 – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

Notes:

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m^2
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	32 + 1,8 T_C
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9$ (T_F - 32)
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means

CS (Carbon steel)	= 1.0619 or 1.0425
SS (Stainless steel)	= 1.4408 or 1.4571
Hastelloy	= 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	= polytetrafluoroethylene
PVDF	= polyvinylidene fluoride
PFA	= perfluoroalkoxy polyme
FPM 70	= fluor carbon rubber
WS 3822	= aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	= ethylene chlorotrifluoro ethylene
FEP	= perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937	inch	1 inch		=	25,4 mm
1 m	= 3.2808	ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936	yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621	miles	1 mile		=	1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	=	6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	=	0,0929 m^2
	= 1.196	sq yards	1 sq yard	=	0,836 m^2
1km^2	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	=	16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	=	0,028317 m^3
	= 6.299	petr. barrels	1 petr. barrel	=	0,15876 m^3

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85	ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214	mph	1 mph	=	1,60934 km/h
1 m^3/h	= 4.403	gal/min (US)	1 gal/min (US)	=	0,227 m^3/h
	= 3.666	gal/min (UK)	1 gal/min (UK)	=	0,273 m^3/h
	= 0.5886	cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367	lb/min	1 lb/min	=	27,216 kg/h
			1 cu ft/h	=	0,028317 m^3/h

Torsion

1 Nm	= 0.723 lbf ft	1 lbf ft	= 1,38 Nm

Density

1 kg/dm^3	= 62.43 lb/cu ft	1 lb/cu ft	= 0,016 kg/dm^3

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

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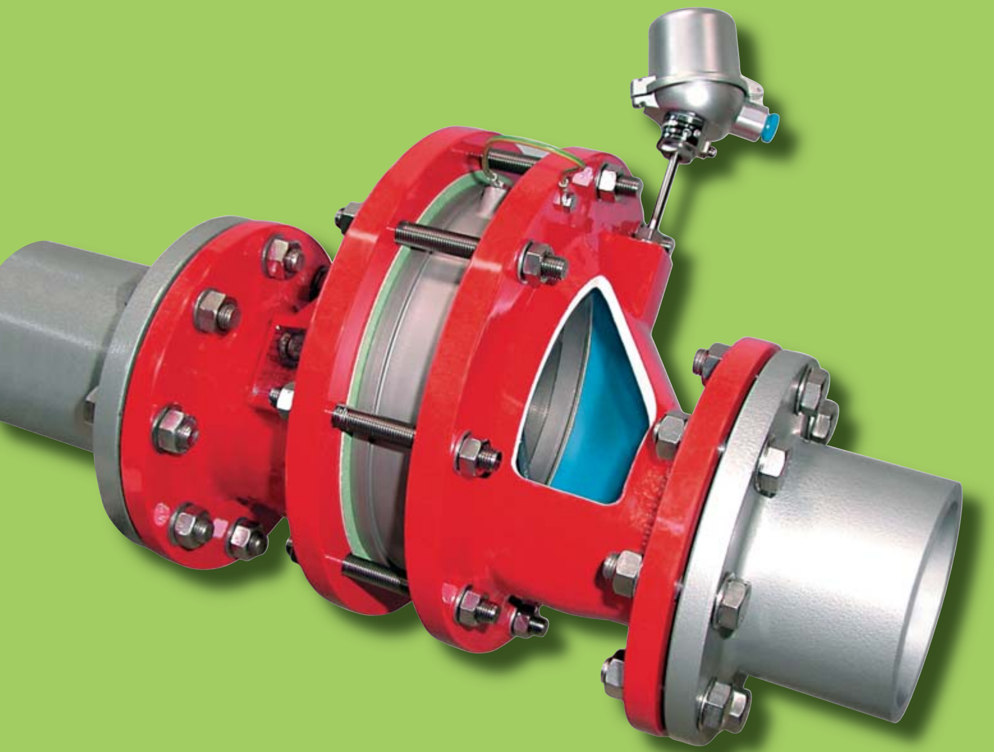
PROTEGO
for safety and environment

PROTEGO® **Deflagration Flame Arresters**



Volume 3

PROTEGO

for safety and environment

Edition 2010

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

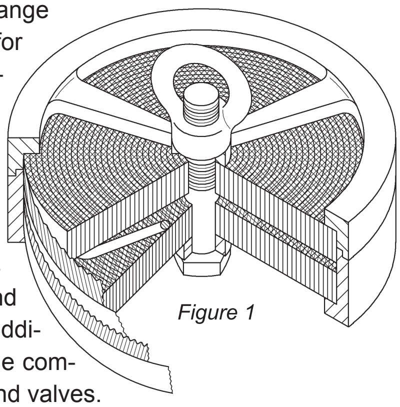
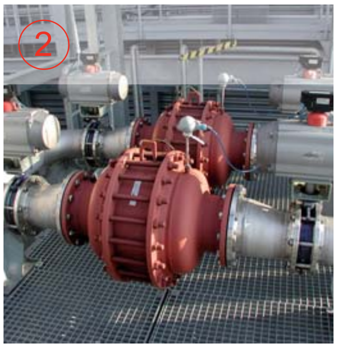
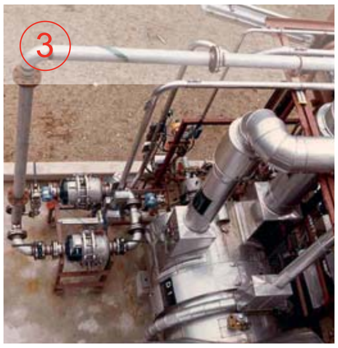


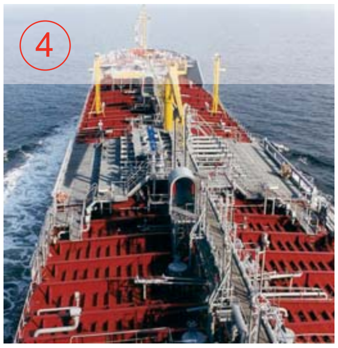
Figure 1

All of our devices are tested by independent national and international third parties in the world‘s largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.





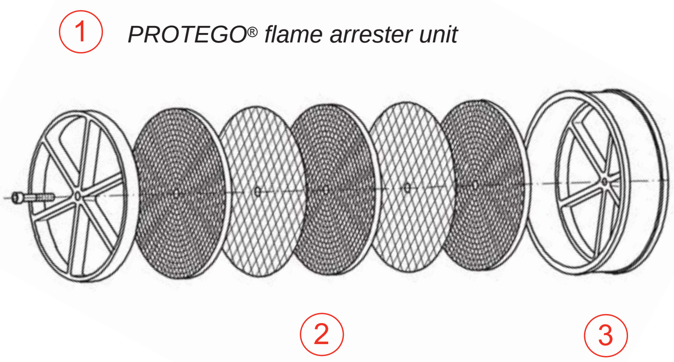


Function and description

The function of flame arresters in the various combustion processes and the location of their installation is discussed in “Technical Fundamentals” (see Vol. 1). In this chapter, we present PROTEGO® in-line **deflagration flame arresters which are installed in pipelines and as components on equipment (i.e. blowers, vacuum pumps)**.

With the goal of protecting process units PROTEGO® deflagration flame arresters are state-of-the-art safety devices that are used in systems handling explosive mixtures to mitigate deflagrations. They reliably suppress the effect of a deflagration in the pipelines near a potential ignition source, extinguish the flame, and protect systems that cannot withstand the pressure of an explosion. In cases where a stable flame can continue on the flame arrester element, in-line deflagration flame arresters only provide protection for a limited time. If this time can be exceeded, an additional measure has to be provided for mixtures that continue to flow continuously.

The main component is the PROTEGO® flame arrester unit (1), which takes the energy from the deflagration and extinguishes the flame in narrow gaps. The flame arrester unit is modular, consisting of several FLAMEFILTER® (2) installed within the FLAMEFILTER® cage (3). The number of FLAMEFILTER® and their gap size depend on the devices intended use and depend on process parameters such as temperature, pressure, vapour group of the handled gases.



Deflagration flame arresters in pipelines for protection of process units can only be used if approved for such application. The distance from the potential ignition source is limited and is expressed by L/D_{max} for the individual device. A fire may result on the flame arrester unit if the mixture continues to flow. As the deflagration flame arrester is only approved for a specific time period, the device should be equipped with a temperature sensor to detect temperature increase caused by a flame. Should the temperature increase over a certain level, a suitable measure such as nitrogen purging should be used.

As a component of equipment, deflagration flame arresters are type-tested and approved along with the equipment (OEM part, i.e. vacuum pumps, blowers). They are not available separately as independent deflagration flame arresters.

A broad variety of types, designs, nominal diameters and materials are available. In addition, we are able to develop customized solutions for our clients at our state-of-the-art test facility, which is the largest privately owned research center in flame arrester business worldwide.

Special features and advantages

The devices can be distinguished and selected based on the following main criteria: **Components for equipment** (i.e. blowers, vacuum pumps) or **devices to be installed in pipelines** handling gas or vapour. Special operating conditions (i.e. **elevated operating pressures or temperatures**) that go beyond classified values of different test standards may have to be considered.

It is important to categorize the products or components into **explosion groups**, depending on their MESG, to select the suitable type of protection from the various designs.

The suitable or required **approved device** must be selected from the great variety of devices that have been tested and approved.

The basic **designs** of the housing are **concentric, eccentric** and with a “easy access cover” for simple disassembly of the flame arrester unit.

The system specification must be considered when choosing the required **nominal diameters** and types of connection.

A **heating jacket** may be necessary for problematic applications.

Special designs offering **unidirectional or bidirectional** protection can be provided as well as versions for **critical fluids (such as products that tend to polymerize or crystallize)** and special product properties.

Deflagration arresters as specific components for OEM equipment (i.e. blowers or vacuum pumps) are specifically optimized and tested along with the equipment.

Preferred applications

Protection of pipelines; containers in chemical, petrochemical, and pharmaceutical processing systems; loading systems; gas collection systems; exhaust combustion systems; flare systems; landfills and biogas systems and sewage treatment plants.

Installation and servicing

PROTEGO® deflagration flame arresters are preferably installed as close as possible to the potential ignition source. Typically any orientation of installation can be chosen, but the direction of flow needs to be taken into account for designs with temperature sensors. No pipes with a nominal diameter greater than the nominal diameter of the device shall be connected to the deflagration flame arrester.

Given the modular design of the PROTEGO® flame arrester unit, any type of deflagration flame arrester is extremely easy to service. For servicing reasons, the location of the flame arrester must be planned to be very accessible; a hoist must be provided if the flame arrester is heavy. Servicing is easy for trained personnel.

PROTEGO® deflagration flame arresters are used in areas subject to explosion hazards. Devices have to be selected that match the intended use. The manufacturer's certificate of conformity provides the boundary conditions for which the device is suitable. The user has to document proper use in accordance with applicable safety guidelines or standards.

Selection

The following main points should be considered for choosing the correct device for your application:

- **In-line flame arrester or component on equipment** (i.e. vacuum pump or blower)
- **Explosion group** of gas mixture
- Standard or special operating conditions **(pressure and temperature)**

Finally, the following criteria are reviewed and considered

- **Nominal diameter** and type of connection
- **Approvals** according to ATEX, FM, Gost-R, GL, etc..
- **Concentric or eccentric design** or designed with an easy access cover
- **Heating jacket or heating coil**
- **Critical fluids**
- **Unidirectional or bidirectional** protection

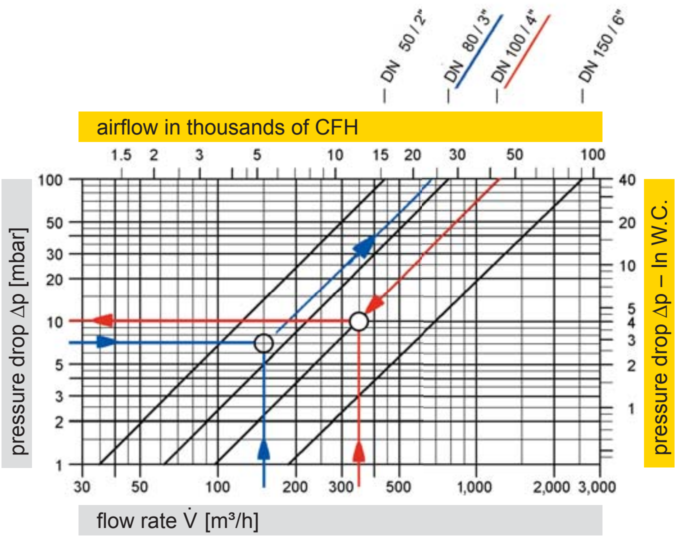
Based on this initial selection, the additional details such as materials, coatings, etc. can be requested or specified.

If no suitable device can be selected, please contact us. Special designs and approvals are available upon request.

Sizing

The nominal diameter of the device is determined or checked in the p/$\dot{V}$ performance diagram. A safety factor must be considered when the fluid has a tendency to clog the flame arrester element.

Given:	Volume flow	m³/h or CFH
Given:	Max. all. pressure drop	Δp mbar or In W.C.
Desired:	Nominal diameter of the deflagration flame arrester	DN
Procedure:	Intersection of the lines with volume flow and maximum allowable pressure drop lies above or on the desired nominal diameter curve of the device	
Given:	Volume flow	m³/h or CFH
Given:	Nominal diameter of pipe	DN
Desired:	Pressure drop	Δp mbar or In W.C.
Procedure:	Intersection of the lines with the volume flow and nominal diameter curve of the device, horizontal straight line leads to the desired flow resistance	

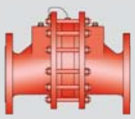
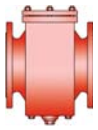
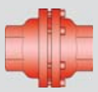
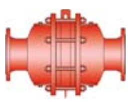
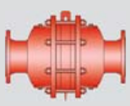


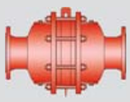
Instructions on calculating the volume flow or influence of density are found in Technical Fundamentals (Vol. 1).

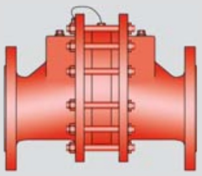
After all the steps are complete, the device can be specified and ordered.

For special cases, please fill out the questionnaire with the process data in Vol. 1, that will serve as information for providing a quote.

PROTEGO® Deflagration Flame Arrester

	Type	Size DN	Design cc = concentric ec = eccentric	Explosion-group ATEX	Explosion-group NEC	Approvals	O = Special designs for higher temperatures and pressures	O = for critical medium (polimerisation, corrosion, crystallisation)	O = unidirectional X = bidirectional	Page
In-line deflagration flame arrester										
	FA-E	25 - 300 1" - 12"	straight through, ec	IIA, IIB3, IIC	D, C, B	ATEX	O	O	X	8 -13
	FA-CN	40 - 300 1½" - 12"	straight through, cc	I	E	ATEX	O		X	14 - 17
	FA-CN	25 - 300 1" - 12"	straight through, cc	IIA, IIB3	D, C	ATEX	O		X	18 - 22
	FA-CN	40 - 300 1½" - 12"	straight through, cc	IIC	B	ATEX			X	24 - 26
	FA-G	G ½" - G 2"	straight through, cc	IIA, IIB3, IIC	D, C, B	ATEX	O		X	28 - 31
	FA-I	50 - 1000 2" - 40"	straight through, cc	IIA, IIB3	D, C	ATEX	O	O	X	32 - 38
	FA-I	150 - 1000 6" - 40"	straight through, cc	IIA, IIB3	D, C	FM	O	O	X	40 - 46
	FA-I-PTFE	50 - 150 2" - 6"	straight through, cc	IIA	D	ATEX		O	X	48 - 50

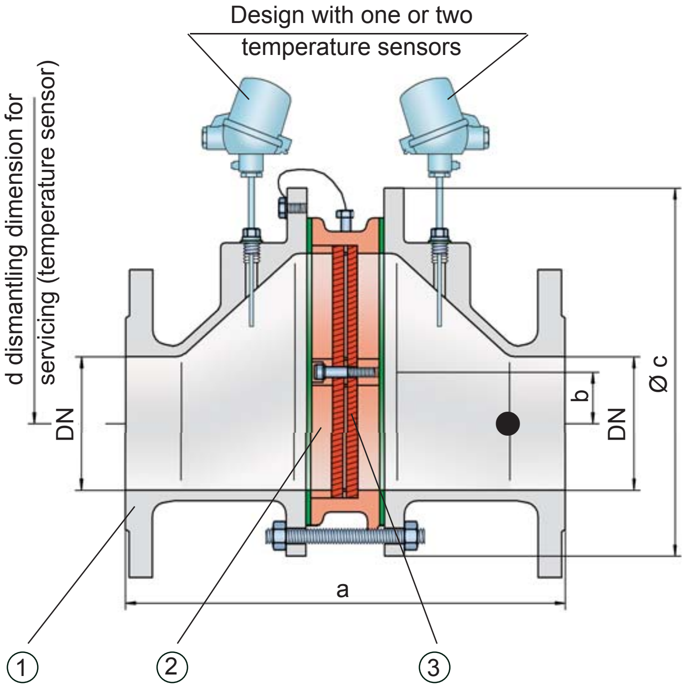
	Type	Size DN	Design cc = concentric ec = eccentric	Explosion-group ATEX	Explosion-group NEC	Approvals	○ = Special designs for higher temperatures and pressures	○ = for critical medium (polimerisation, corrosion, crystallisation)	○ = unidirectional X = bidirectional	Page
Deflagration flame arrester as component on equipment										
	FA-I-V and FA-I-P	50 - 200 2" - 8"	straight through, cc	IIA, IIB3, IIC	D, C, B	Testing and approval only in combination with specific equipment			○ / X	52 - 54
	EV/VS EV/VD	50 - 600 2" - 24"	straight through, cc	IIA, IIB3, IIC	D, C, B				○	56 - 57
	FA-I-FC	80 - 1600 3" - 64"	straight through, cc	IIA, IIB3, IIC	D, C, B				X	58 - 59



In-Line Deflagration Flame Arrester

eccentric design,
bidirectional

PROTEGO® FA-E



● Connection to the protected side (only for type FA-E-T-....)

Function and Description

The PROTEGO® FA-E series of in-line deflagration flame arresters is designed with an eccentric housing to automatically drain condensate build up in the housing. Due to its eccentric design the device can be installed in pipelines that run close to floors or walls and low points, where condensate can collect within the piping system, can be avoided. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was approved. According to EN 12874 the installation limits are $L/D_{max} \le 50$ for deflagration flame arresters of explosion groups IIA and IIB3 (NEC groups D to C) and $L/D_{max} \le 30$ for explosion group IIC (NEC group B).

The devices are symmetrical and offer bidirectional flame transmission protection. The arrester essentially consists of two housing parts (1) and a PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends arrester´s conditions of use.

By indicating the operating parameters such as temperature, pressure, explosion group and the composition of the fluid, the optimum deflagration flame arrester can be selected from a series of approved devices. The PROTEGO® FA-E series of deflagration flame arresters is available for substances from explosion groups IIA to IIC (NEC groups D to B).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Devices with special approval can be obtained for higher pressures (see table 3) and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- eccentric design prevents condensate build up
- special design for elevated operating temperatures and pressures available
- modular design enables individual FLAMEFILTER® to be replaced
- service friendly: FLAMEFILTER® can be cleaned easily
- modular design reduces spare parts cost
- eccentric design eases installation close to floors and walls
- bidirectional flame transmission proof design
- protects against deflagrations for all explosion groups IIA, IIB3 and IIC (NEC groups D, C and B)

Design and Specifications

There are three different designs:

Basic in-line deflagration flame arrester	**FA-E -** $\boxed{–}$
In-line deflagration flame arrester with integrated temperature sensor* as additional protection against short-time burning from one side	**FA-E -** $\boxed{T}$
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-E -** $\boxed{TB}$

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions

Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity charts on the following pages

Expl. Gr.	DN	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
IIA	a	305 / 12.01	305 / 12.01	310 / 12.20	315 / 12.40	360 / 14.17	365 / 14,37	370 / 14.57	435 / 17.13	440 / 17.32	450 / 17.72	480 / 18.90	500 / 19.69
IIB3	a	305 / 12.01	305 / 12.01	310 / 12.20	315 / 12.40	360 / 14.17	365 / 14,37	370 / 14.57	435 / 17.13	440 / 17.32	450 / 17.72	480 / 18.90	500 / 19.69
IIC	a	315 / 12.40	315 / 12.40	320 / 12.60	325 / 12.80	370 / 14.57	375 / 14.76	380 / 14.96	445 / 17.52	450 / 17.72	460 / 18.11	490 / 19.29	510 / 20.08
	b	30 / 1.18	30 / 1.18	30 / 1.18	30 / 1.18	40 / 1.57	40 / 1.57	40 / 1.57	65 / 2.56	65 / 2.56	55 / 2.17	60 / 2.36	60 / 2.36
	c	185 / 7.28	185 / 7.28	210 / 8.27	210 / 8.27	250 / 9.84	250 / 9.84	275 / 10.83	385 / 15.16	385 / 15.16	450 / 17.72	500 / 19.69	575 / 22.64
	d	400 / 15.75	400 / 15.75	410 / 16.14	410 / 16.14	440 / 17.32	440 / 17.32	460 / 18.11	520 / 20.47	520 / 20.47	540 / 21.26	570 / 22.44	600 / 23.62

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0.90 mm	IIA	D	Special approvals upon request
≥ 0.65 mm	IIB3	C	
< 0.50 mm (> 0.50 mm)	IIC (IIB)	B	

Table 3: Selection of max. operating pressure

Expl. Gr.	DN	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
IIA	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2
IIB3	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2
IIC	P_{max}	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi absolute, higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

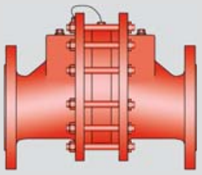
Table 5: Material selection for housing

Design	A	B	C	D
Housing	Ductile iron	Steel	Stainless steel	Hastelloy
Gasket	WS 3822 *	WS 3822 *	PTFE	PTFE
Flame arrester unit	A	A,C	C	D

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

The housing can also be delivered in carbon steel with an ECTFE coating.

Special materials upon request



In-Line Deflagration Flame Arrester

eccentric design, bidirectional

PROTEGO® FA-E

Table 6: Material combinations of the flame arrester unit

Design	A	C	D
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
FLAMEFILTER® *	Stainless steel	Stainless steel	Hastelloy
Spacers	Stainless steel	Stainless steel	Hastelloy

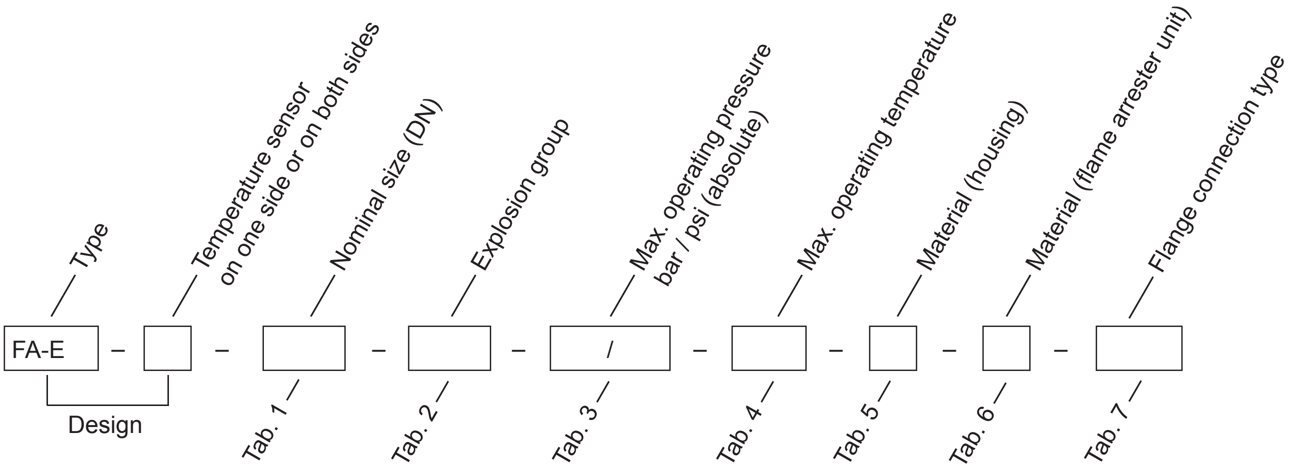
*the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request.

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

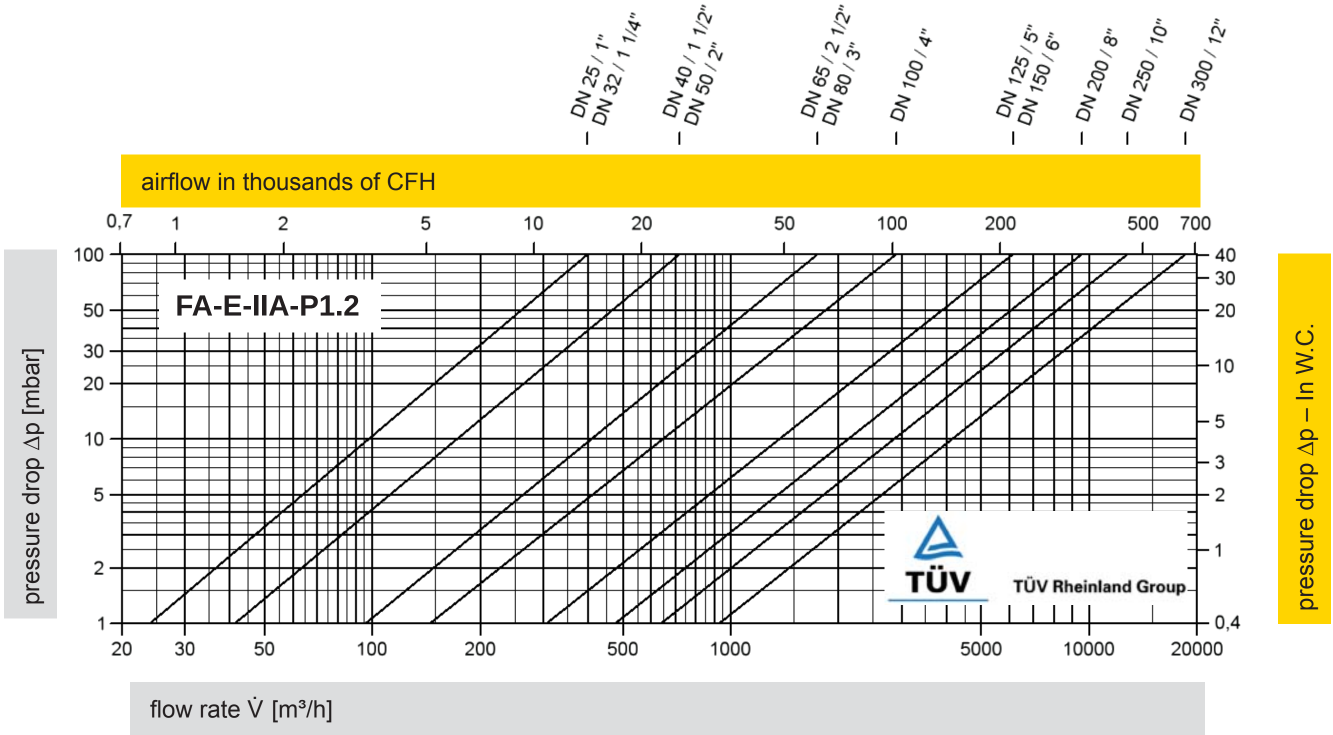
other types upon request

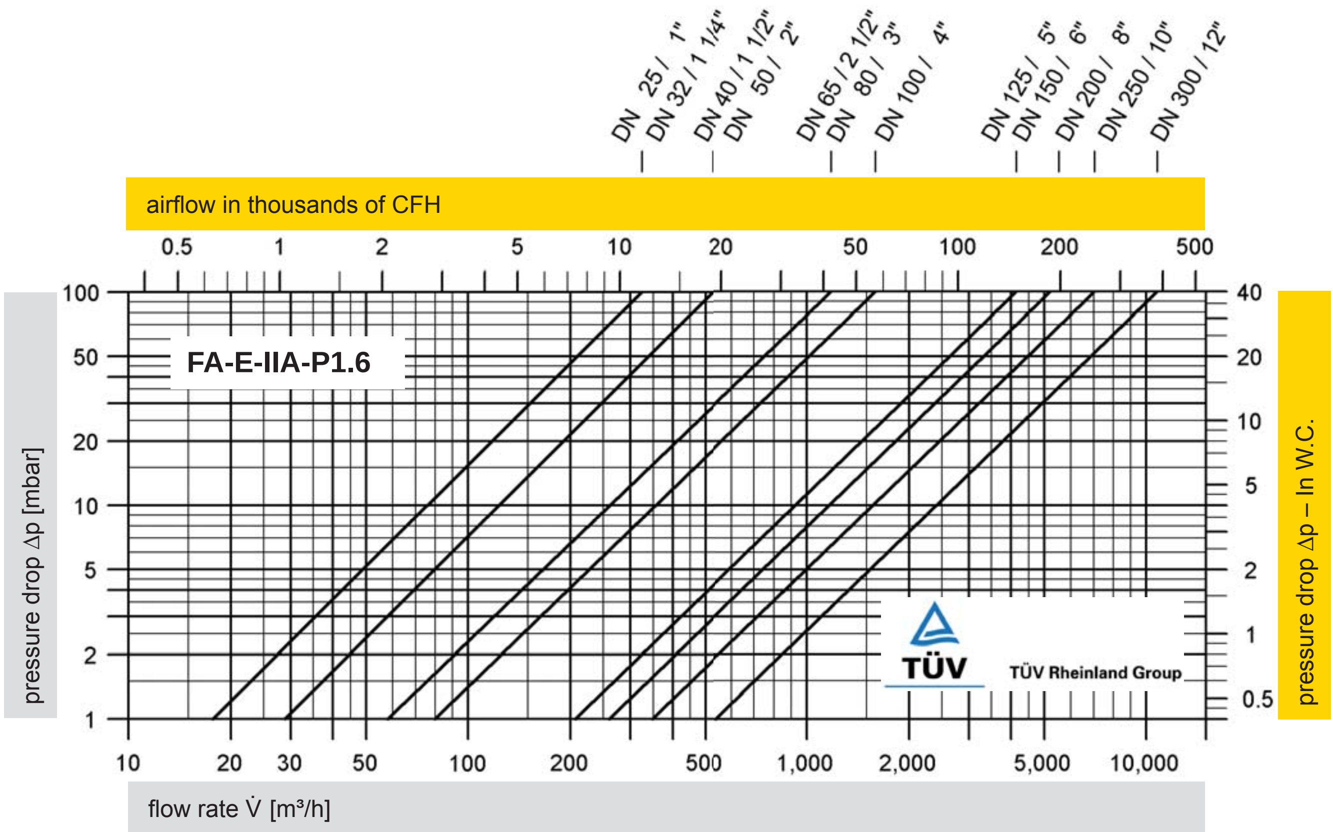


Order example

FA-E	TB	300	IIC	P1.1/	T60	B	C	DIN

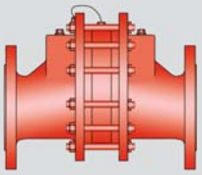
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

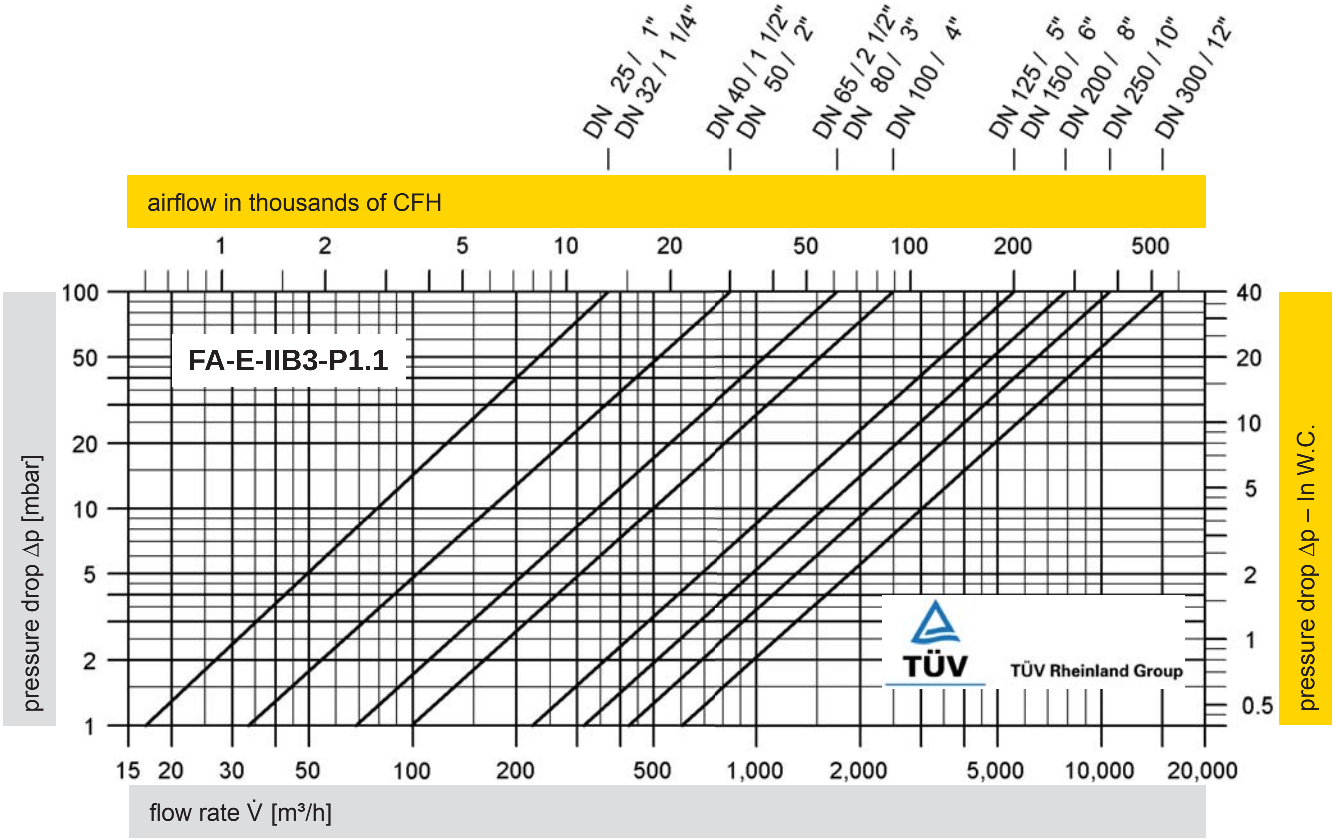
for safety and environment

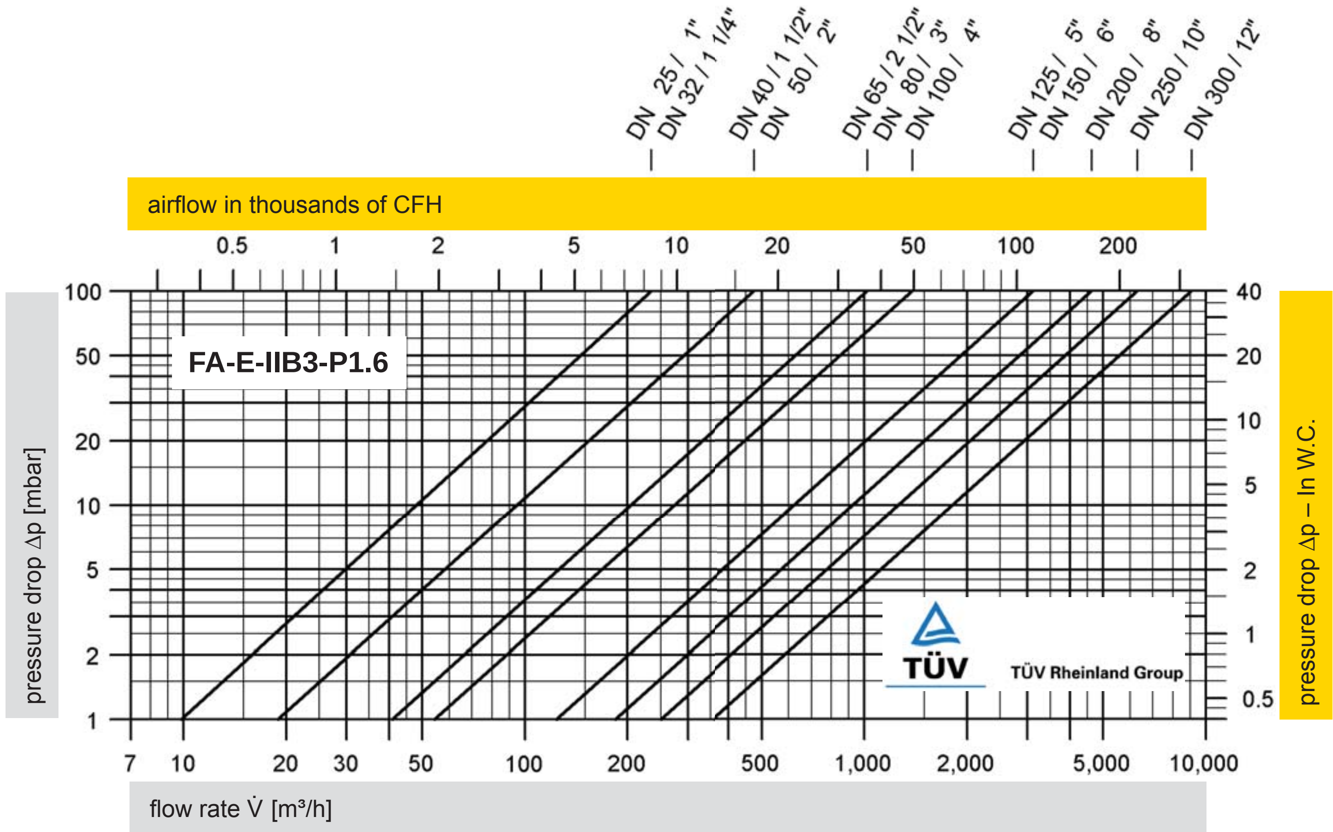


In-Line Deflagration Flame Arrester

Flow Capacity Charts

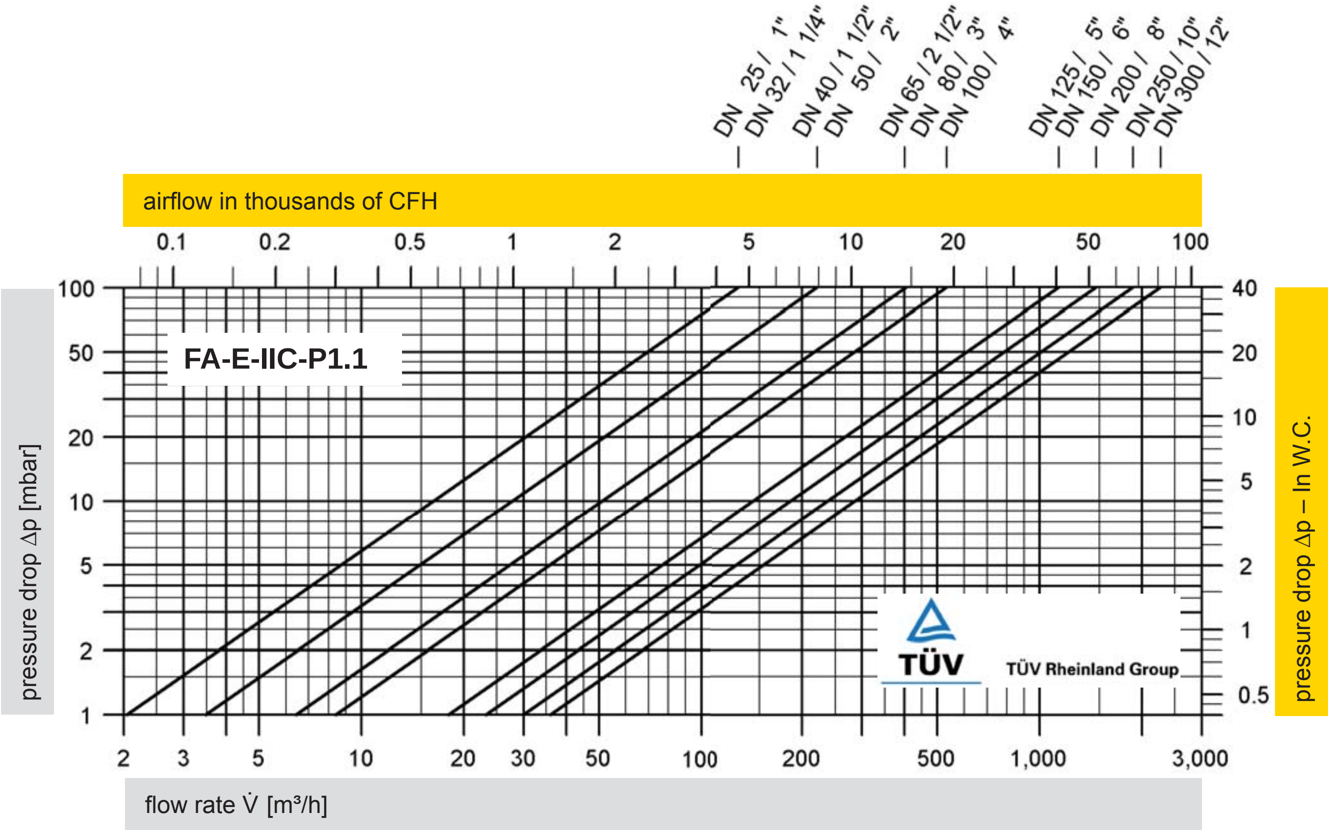
PROTEGO® FA-E



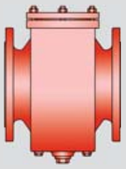


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



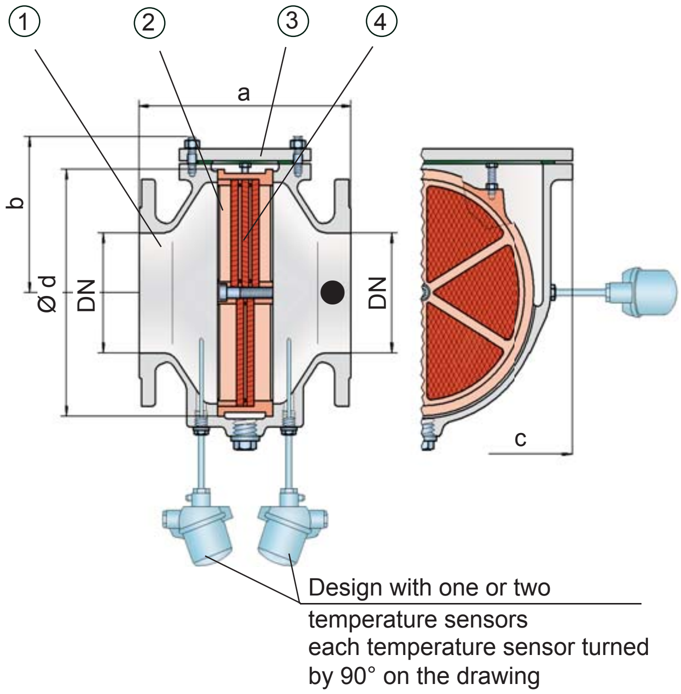
DN 25 / 1"
DN 32 / 1 1/4"
DN 40 / 1 1/2"
DN 50 / 2"
DN 65 / 2 1/2"
DN 80 / 3"
DN 100 / 4"
DN 125 / 5"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
airflow in thousands of CFH
0.1 0.2 0.5 1 2 5 10 20 50 100
FA-E-IIC-P1.1
pressure drop Δp [mbar]
100 50 20 10 5 2 1
pressure drop Δp – In W.C.
40 20 10 5 2 1 0.5
TÜV
TÜV Rheinland Group
2 3 5 10 20 30 50 100 200 500 1,000 3,000
flow rate V̇ [m³/h]



In-Line Deflagration Flame Arrester

for biogas, sewage gas and landfill gas, concentric design, bidirectional

PROTEGO® FA-CN-I



● Connection to the protected side (only for type FA-CN-T-....)

Function and Description

The deflagration and endurance burning-proof PROTEGO® FA-CN-I in-line flame arrester was specially developed for bio-, sewage- and landfill-gas applications. With this device it is possible to protect compressors with high operating pressures and high operating temperatures. It can also be used as an endurance-burning-proof in-line device, without temperature monitoring. The PROTEGO® FA-CN deflagration flame arrester is a compact design utilizing an easy access cover for easy maintainability. The FLAMEFILTER® unit can be removed and cleaned within moments without having to disassemble the pipe. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was tested. For this device the L/D ratio is 50.

The in-line deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device consists of a housing (1) with an easy access cover (3) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester‘s conditions of use.

By indicating the operating parameters such as temperature, pressure, explosion group and the composition of the fluid, the optimum deflagration flame arrester can be selected from a series of approved devices. This version of PROTEGO® FA-CN-I flame arrester protects against deflagrations and endurance burning of explosion group I – methane (NEC group E).

PROTEGO® FA-CN devices for substances of explosion groups IIA, IIB3 and IIC (NEC groups D, C, and B) are shown on separate pages.

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 2.0 bar / 29.0 psi (DN 40/1½" and DN 50/2”) or 1,6 bar / 23.2 (DN 80/3” to DN 300/12”). Devices with special approval can be obtained for higher pressures (see table 3) and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- state of the art design for bio-, sewage- and landfill gas applications
- design available for elevated operating temperatures and pressures
- compact design with easy access cover
- easy maintenance without disassembling of the pipeline
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- bidirectional flame transmission proof design
- provides protection against deflagrations and endurance burning for explosion group I (NEC group E)
- lowest pressure drop results in low operating and lifecycle costs

Design and Specifications

There are three different designs:

Basic in-line deflagration flame arrester	**FA-CN - –**
In-line deflagration flame arrester with integrated temperature sensor* as additional protection against short-time burning from one side	**FA-CN - T**
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-CN - TB**

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity charts on the following pages

DN	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	210 / 8.27	215 / 8.46	235 / 9.25	240 / 9.45	265 / 10.43	305 / 12.01	310 / 12.20	300 / 11.81	320 / 12.60	350 / 13.78
b	100 / 3.94	100 / 3.94	127 / 5.0	127 / 5.0	145 / 5.71	192 / 7.56	192 / 7.56	215 / 8.46	255 / 10.04	290 / 11.42
c	200 / 7.87	200 / 7.87	260 / 10.24	260 / 10.24	308 / 12.13	415 / 16.34	415 / 16.34	446 / 17.56	520 / 20.47	600 / 23.62
d	130 / 5.12	130 / 5.12	185 / 7.28	185 / 7.28	220 / 8.66	310 / 12.20	310 / 12.20	355 / 13.98	420 / 16.54	490 / 19.29

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)
> 1.14 mm	I

Special approvals upon request

Table 3: Selection of max. operating pressure

DN	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
P_{max}	2.0 / 29.0	2.0 / 29.0	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2
P_{max}	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3	2.5 / 36.3		
P_{max}	4.5 / 65.3	4.5 / 65.3	4.5 / 65.3	4.5 / 65.3	4.5 / 65.3	4.5 / 65.3	4.5 / 65.3			
P_{max}			5.0 / 72.5	5.0 / 72.5						

P_{max} = maximum allowable operating pressure in bar / psi absolute, higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection

Design	A	B
Housing	Steel	Stainless steel
Cover	Steel	Stainless steel
Gasket	WS 3822 *	PTFE
Flame arrester unit	Stainless steel	Stainless steel

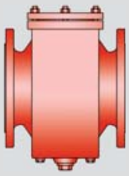
Special materials upon request

* for devices exposed to temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

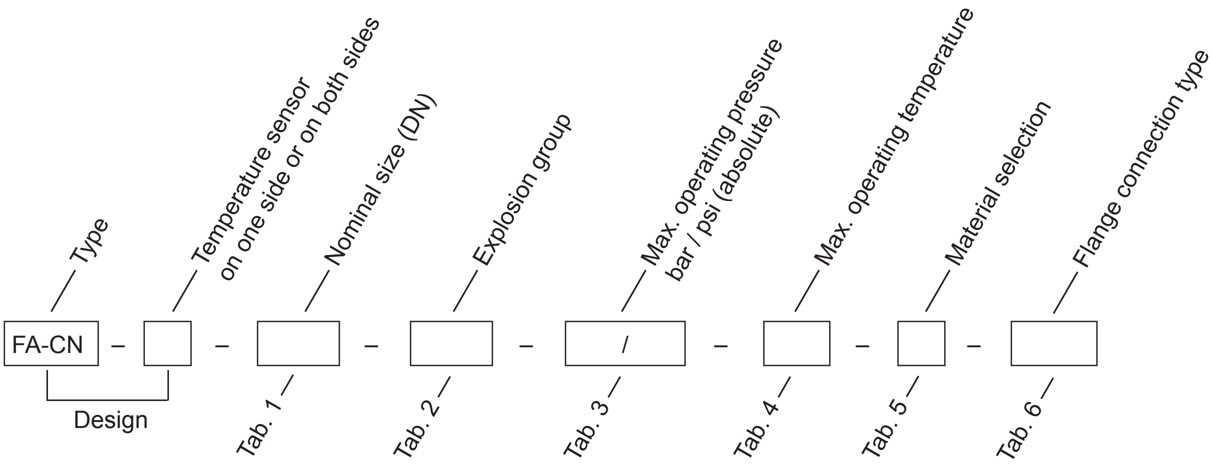
other types upon request



In-Line Deflagration Flame Arrester

for biogas, sewage gas and landfill gas, concentric design, bidirectional

PROTEGO® FA-CN-I



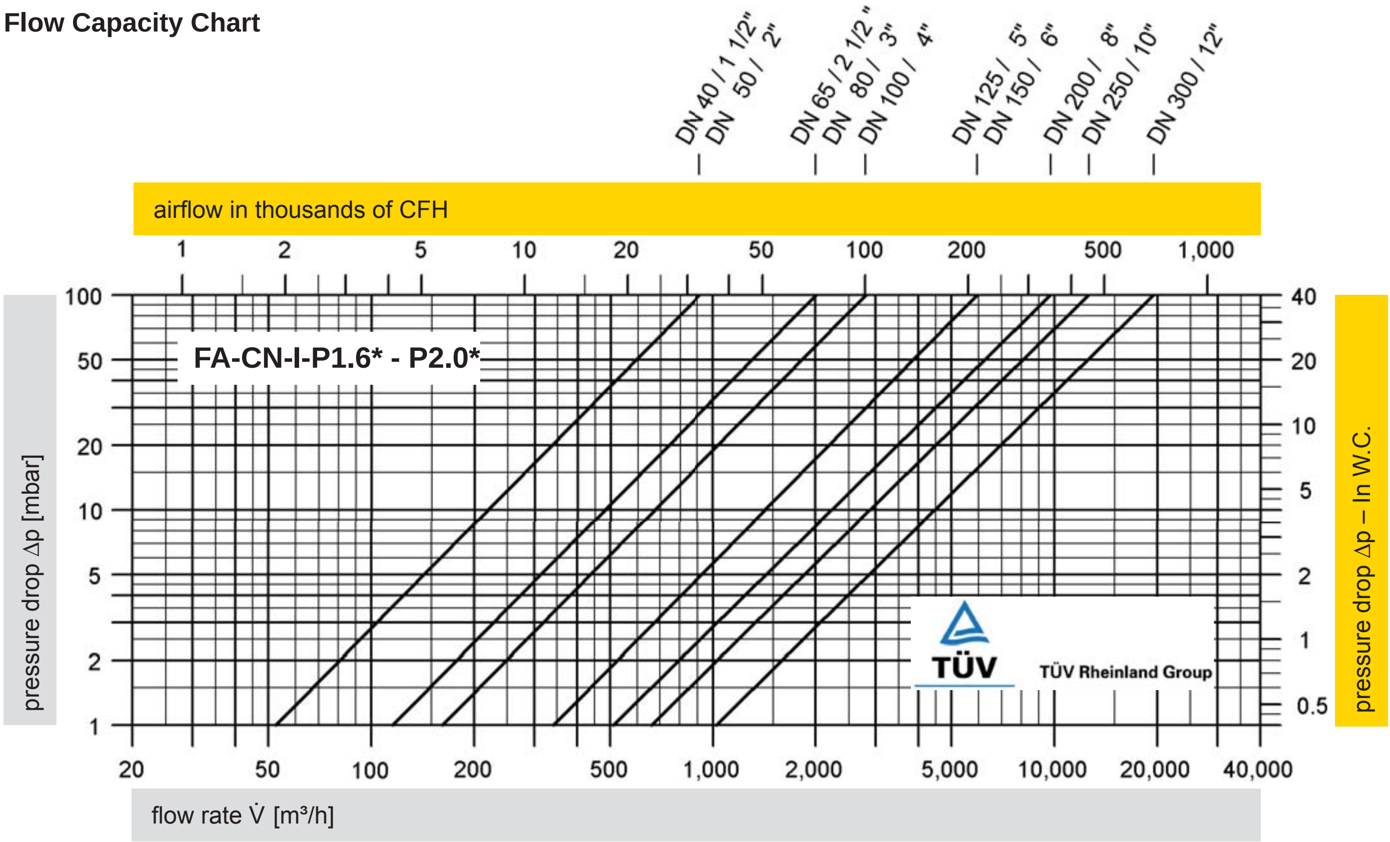
Order example

FA-CN	TB	150	I	P4.5 / –	T60	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

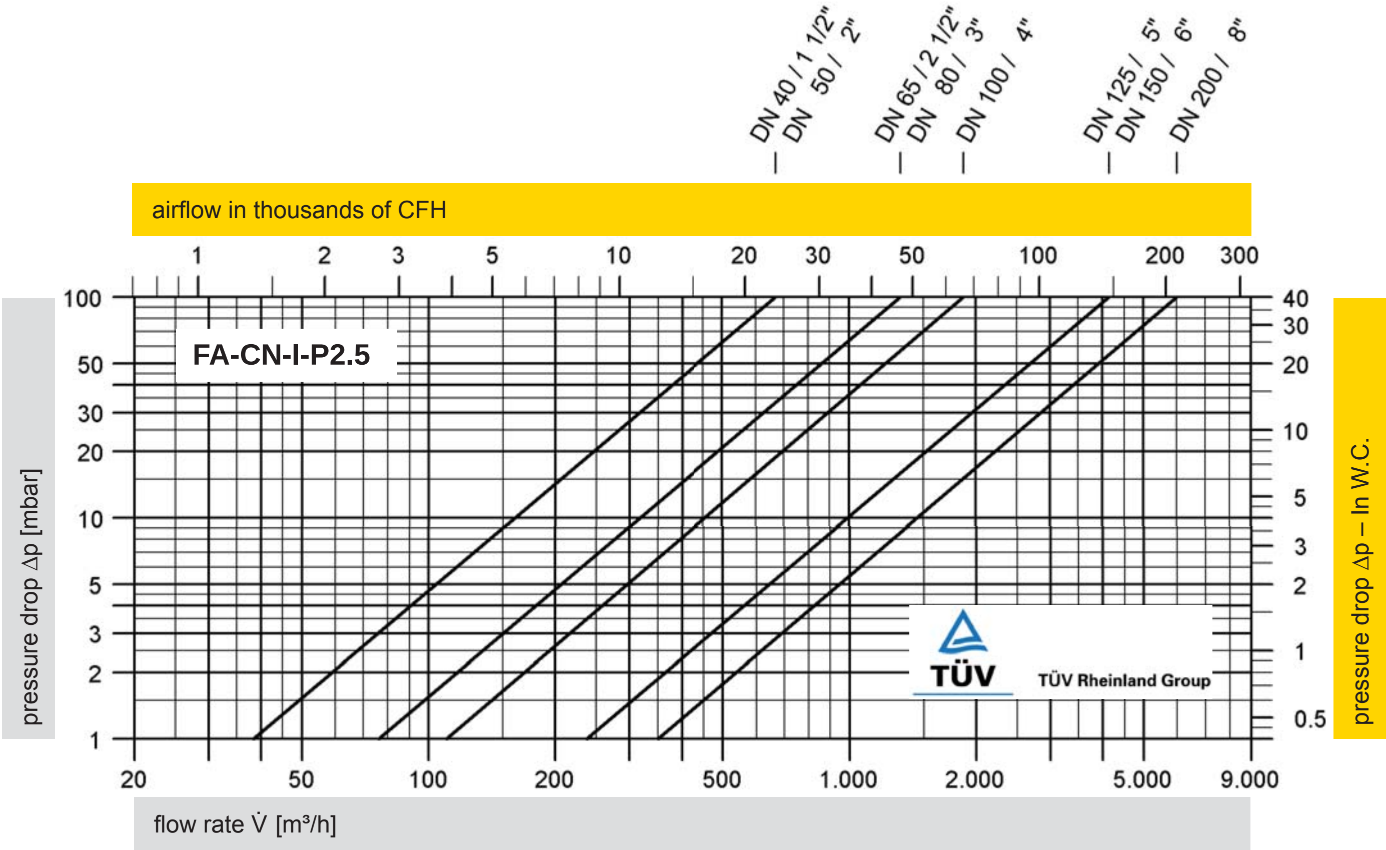
***** see table 3

Flow Capacity Chart

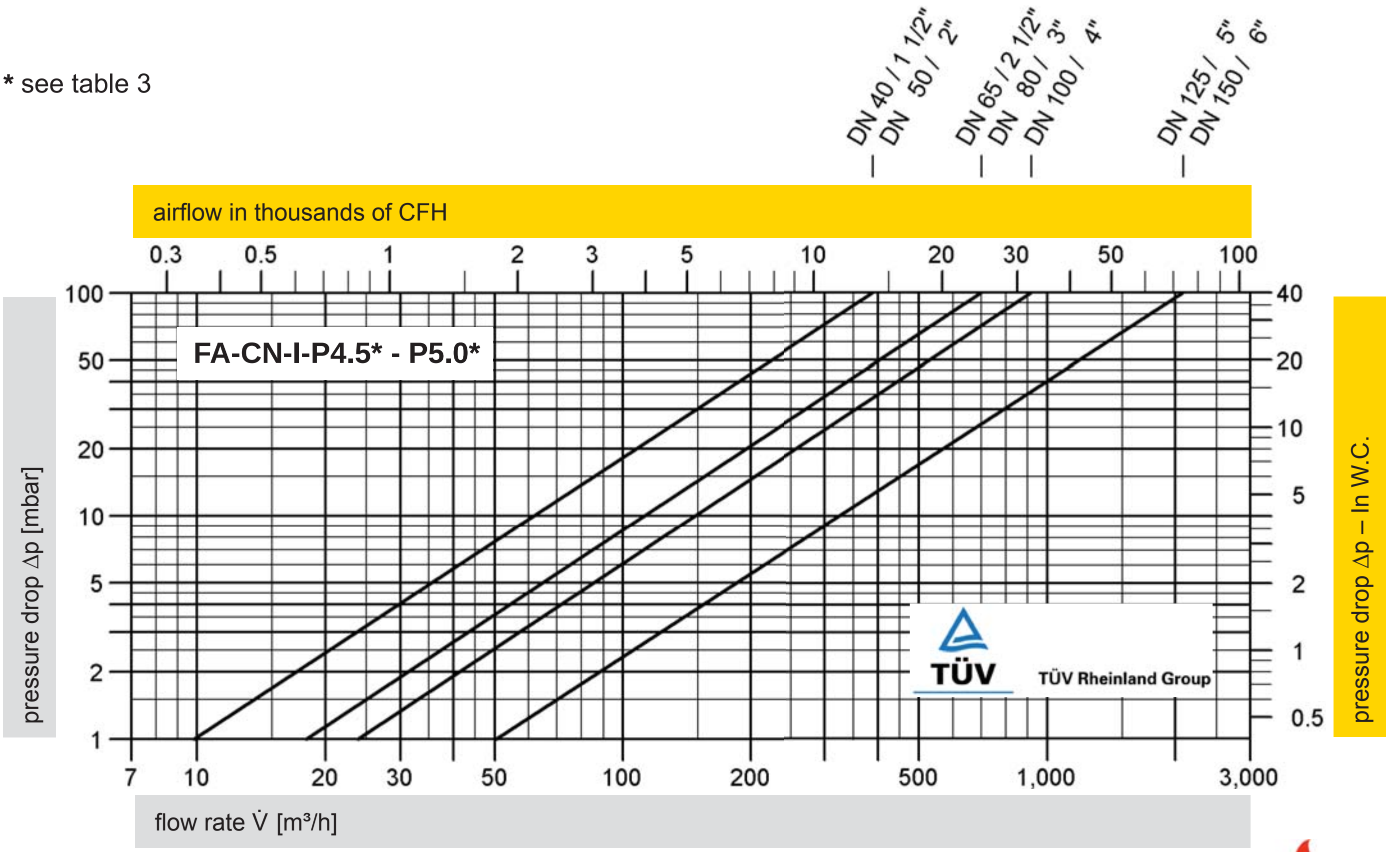


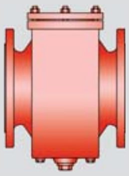
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.


DN 40 / 1 1/2"
DN 50 / 2"
DN 65 / 2 1/2"
DN 80 / 3"
DN 100 / 4"
DN 125 / 5"
DN 150 / 6"
DN 200 / 8"
airflow in thousands of CFH
FA-CN-I-P2.5
pressure drop Δp [mbar]
pressure drop Δp – In W.C.
TÜV
TÜV Rheinland Group
flow rate V̇ [m³/h]

* see table 3

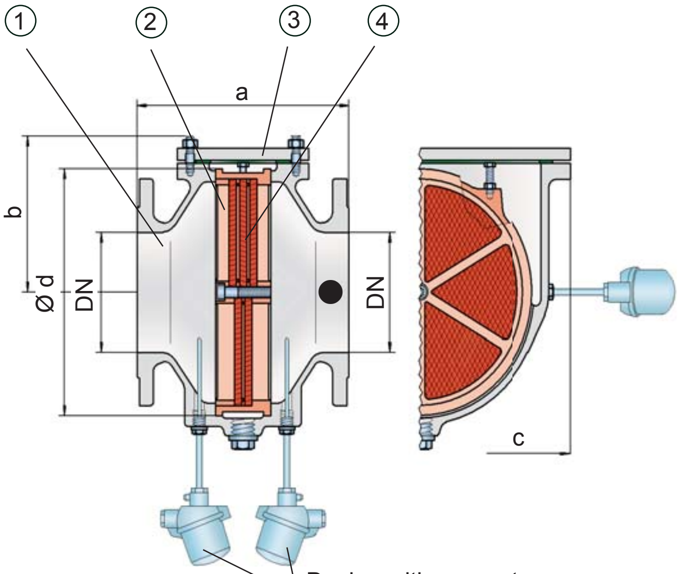

DN 40 / 1 1/2"
DN 50 / 2"
DN 65 / 2 1/2"
DN 80 / 3"
DN 100 / 4"
DN 125 / 5"
DN 150 / 6"
airflow in thousands of CFH
FA-CN-I-P4.5* - P5.0*
pressure drop Δp [mbar]
pressure drop Δp – In W.C.
TÜV
TÜV Rheinland Group
flow rate V̇ [m³/h]



In-Line Deflagration Flame Arrester

concentric design,
bidirectional

PROTEGO® FA-CN-IIA and IIB3



Design with one or two temperature sensors each temperature sensor turned by 90° on the drawing

● Connection to the protected side (only for type FA-CN-T-....)

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Devices with special approval can be obtained for higher pressures (see table 3) and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Function and Description

The PROTEGO® FA-CN in-line deflagration flame arrester is a compact design utilizing an easy access cover for easy maintainability. The PROTEGO® flame arrester unit can be removed and cleaned within moments without having to disassemble the pipe. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was tested. According to EN 12874 this device is approved for a L/D ratio of 50.

The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device consists of a housing (1) with an easy access cover (3) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depend on the devices intended use.

Providing the operating conditions such as the temperature, pressure, explosion group and the composition of the fluid, enables PROTEGO® to select the best deflagration flame arrester for your application. This version of PROTEGO® FA-CN-IIA and IIB3 flame arrester protects against deflagrations of fuel/air mixtures of explosion groups IIA and IIB 3 (NEC D and C (MESG ≥ 0.65 mm)). PROTEGO® FA-CN devices for substances of explosion groups I and IIC (NEC groups E and B) are shown on separate pages.

Special Features and Advantages

- design available for elevated operating temperatures and pressures
- compact design with easy access cover
- easy maintenance without disassembling of the pipeline
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- bidirectional flame transmission proof design
- provides protection against deflagrations for group IIA and IIB3 vapours (NEC group D and C)
- lowest pressure drop results in low operating and lifecycle costs

Design and Specifications

There are three different designs:

Basic in-line deflagration flame arrester	**FA-CN -** $\boxed{–}$
In-line deflagration flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**FA-CN -** $\boxed{T}$
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-CN -** $\boxed{TB}$

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity charts on the following pages

DN	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	200 / 7.87	200 / 7.87	210 / 8.27	215 / 8.46	235 / 9.25	240 / 9.45	265 / 10.43	305 / 12.01	310 / 12.20	300 / 11.81	320 / 12.60	350 / 13.78
b	95 / 3.74	95 / 3.74	110 / 4.33	110 / 4.33	135 / 5.31	135 / 5.31	150 / 5.91	200 / 7.87	200 / 7.87	220 / 8.66	260 / 10.24	295 / 11.61
c	175 / 6.89	175 / 6.89	200 / 7.87	200 / 7.87	260 / 10.24	260 / 10.24	308 / 12.13	415 / 16.34	415 / 16.34	446 / 17.56	520 / 20.47	600 / 23.62
d	105 / 4.13	105 / 4.13	130 / 5.12	130 / 5.12	185 / 7.28	185 / 7.28	220 / 8.66	310 / 12.20	310 / 12.20	355 / 13.98	420 / 16.54	490 / 19.29

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0.90 mm	IIA	D	Special approvals upon request
≥ 0.65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.	DN	25 / 1"	32 / 1¼"	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	n
IIA	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.5 / 21.8	1.5 / 21.8	1.5 / 21.8	1.3 / 18.9	1.3 / 18.9	1.3 / 18.9	3
IIB3	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	3

P_{max} = maximum allowable operating pressure in bar / psi absolute, higher operating pressure upon request
n = number of FLAMEFILTER®

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection

Design	A	B	
Housing	Steel	Stainless steel	Special materials upon request
Cover	Steel	Stainless steel	* for devices exposed to temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
Gasket	WS 3822 *	PTFE	
Flame arrester unit	Stainless steel	Stainless steel	

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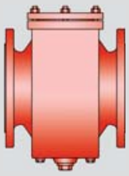
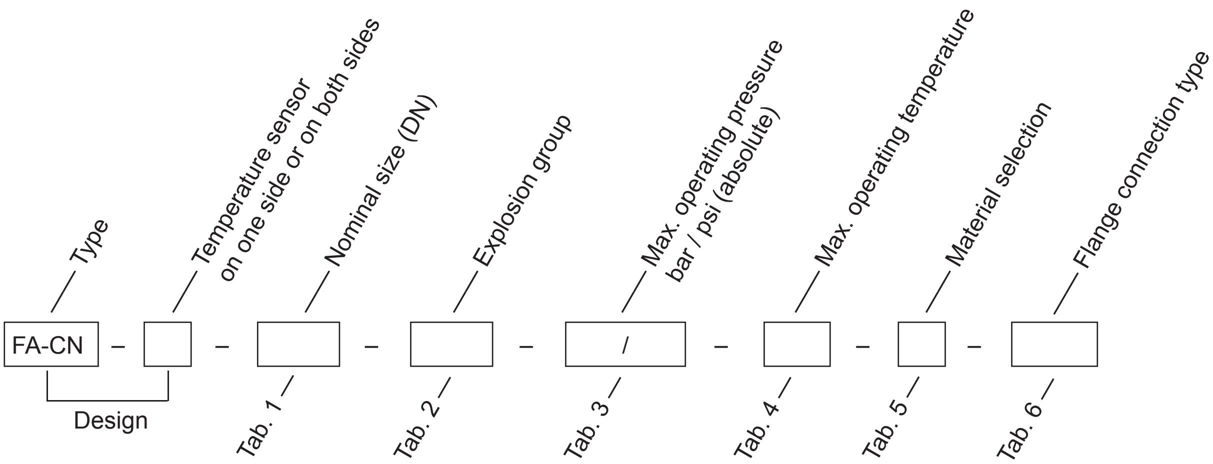


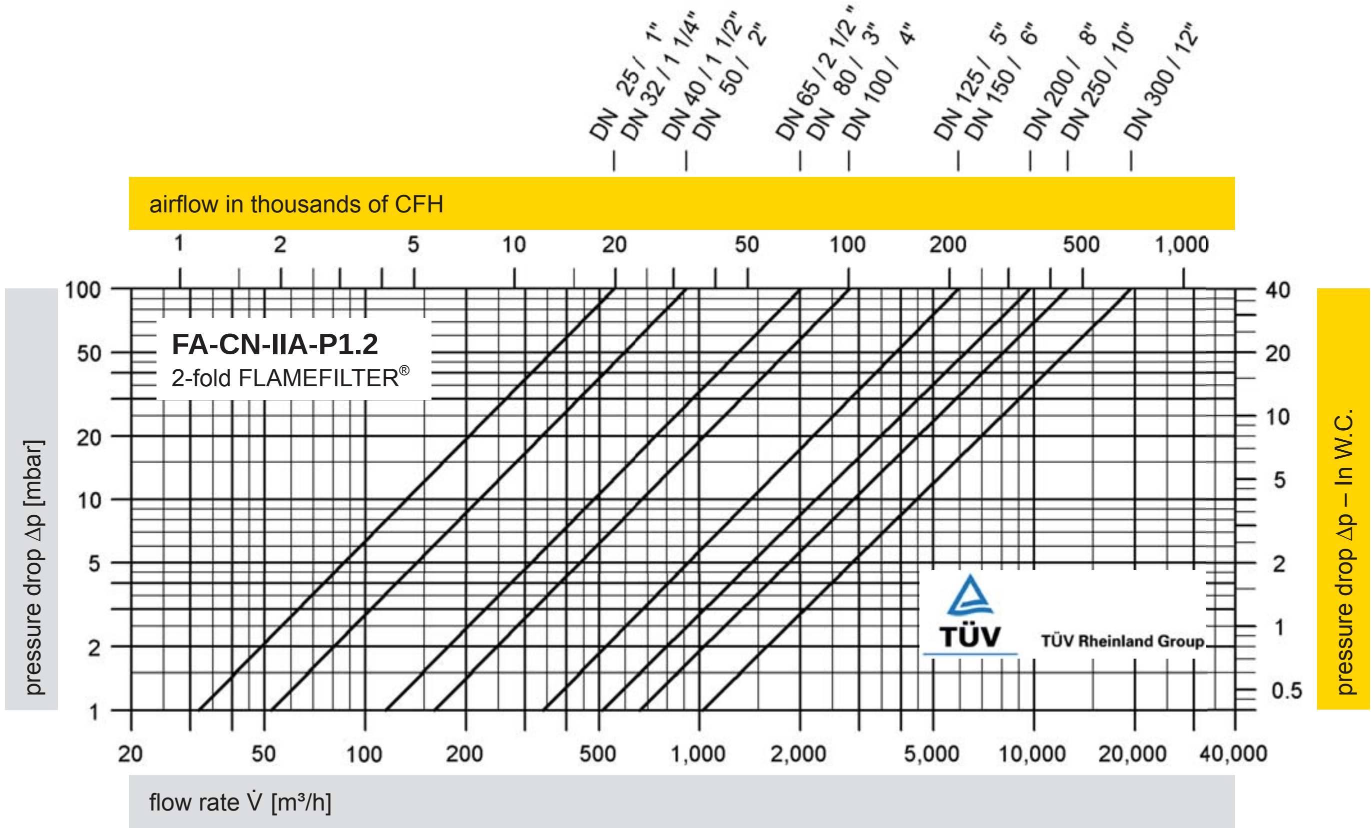
Table 6: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



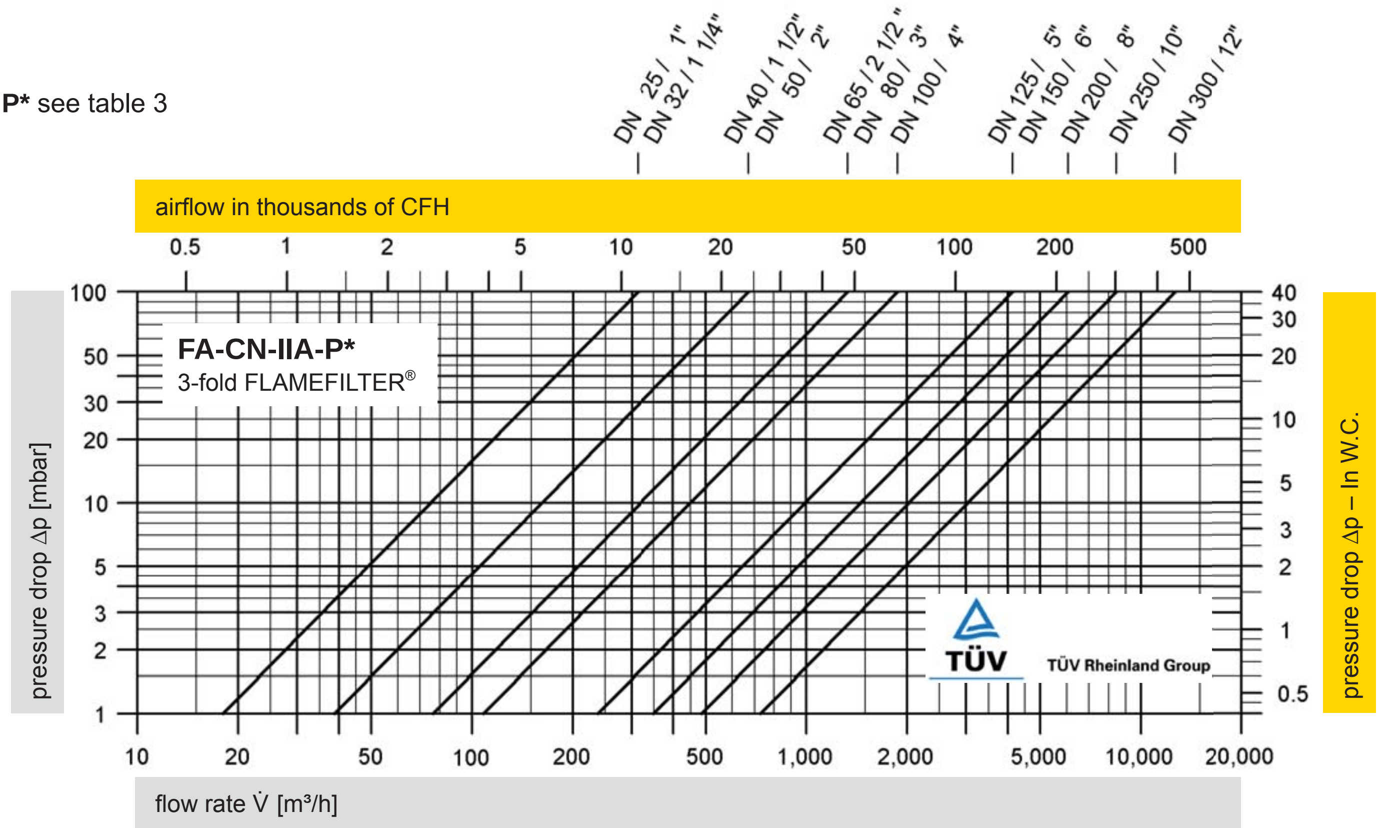
Order example														
FA-CN	–	TB	–	300	–	IIA	–	P1.2 / –	–	T60	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

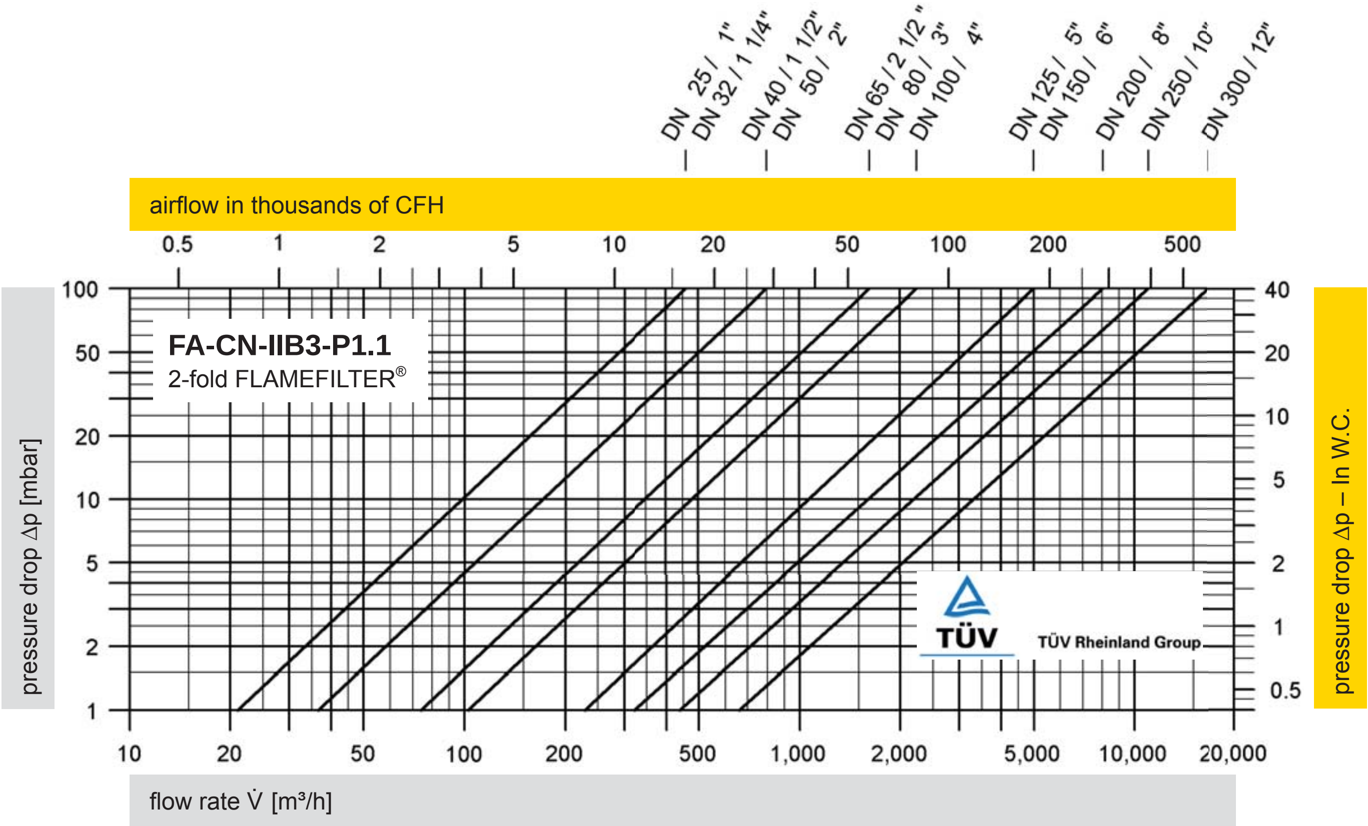
PROTEGO® FA-CN-IIA

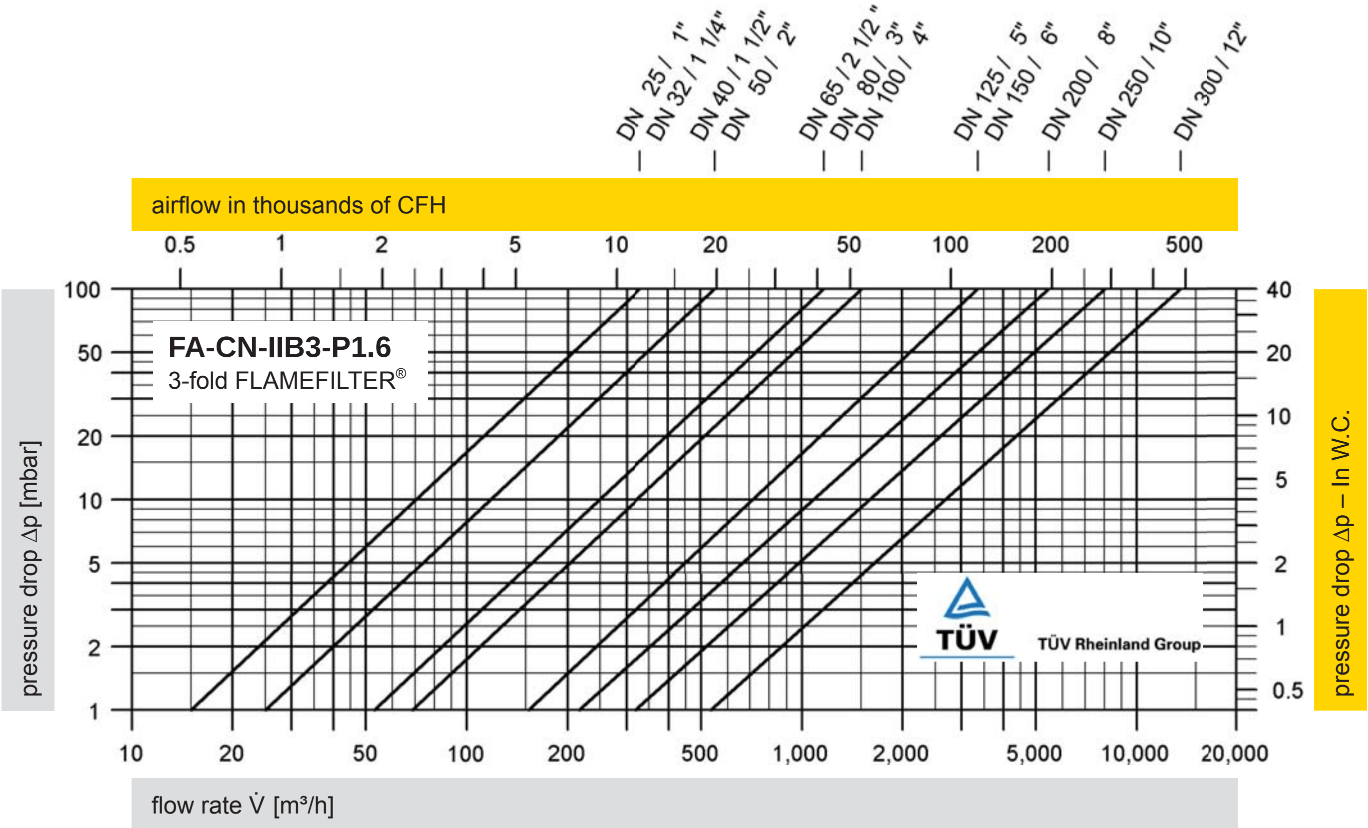


P* see table 3



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

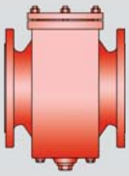




The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

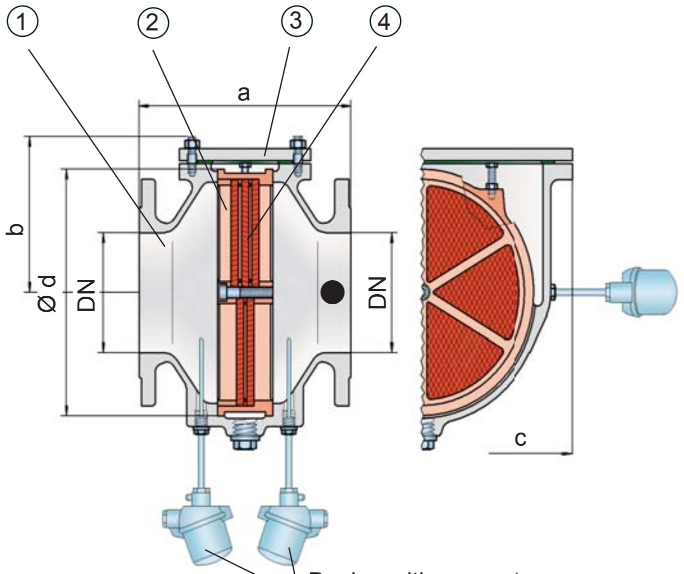
Notes:



In-Line Deflagration Flame Arrester

for hydrogen/air-mixtures, concentric design, bidirectional

PROTEGO® FA-CN-IIC



Design with one or two temperature sensors
each temperature sensor turned by 90° on the drawing

● Connection to the protected side (only for type FA-CN-T-....)

Function and Description

The PROTEGO® FA-CN in-line deflagration flame arrester is a compact design utilizing an easy access cover for easy maintainability. The special PROTEGO® FA-CN-IIC version was developed for hydrogen applications (group IIC vapours – NEC group B). The device is designed to have comparetively large gaps, in relation to other flame arresters for the same explosion group. This allows to apply it to processes having small fluid droplets or particles. The PROTEGO® flame arrester unit can be removed and cleaned within moments without having to disassemble the pipe. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was approved (see table 3).

The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device consists of a housing (1) with an easy access cover (3) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depend on the devices intended use.

Providing the operating conditions such as the temperature, pressure, explosion group and the composition of the fluid, enables PROTEGO® to select the best deflagration flame arrester for your application. The versions of PROTEGO® FA-CN flame arrester protects against deflagrations of fuel/air mixtures of explosion groups IIA, IIB3 and IIC (NEC D, C (MESG ≥ 0.65 mm) and B). FA-CN devices for substances of explosion groups I, IIA and IIB3 (NEC E, D and C) are shown on separate pages.

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- state of the art protection for any hydrogen/air mixture
- can be applied to process flows with small liquid or particle load
- compact design with easy access cover
- easy maintenance without disassembling of the pipeline
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- bidirectional flame transmission proof design
- protects against deflagrations for all explosion groups
- lowest pressure drop results in low operating and lifecycle costs

Design and Specifications

There are three different designs:

Basic in-line deflagration flame arrester	**FA-CN -** –
In-line deflagration flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**FA-CN -** T
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-CN -** TB

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity charts on the following pages

DN	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	210 / 8.27	215 / 8.46	235 / 9.25	240 / 9.45	265 / 10.43	305 / 12.01	310 / 12.20	300 / 11.81	320 / 12.60	350 / 13.78
b	110 / 4.33	110 / 4.33	135 / 5.31	135 / 5.31	150 / 5.91	200/ 7.87	200 / 7.87	220 / 8.66	260 / 10.24	295 / 11.61
c	200 / 7.87	200 / 7.87	260 / 10.24	260 / 10.24	308 / 12.13	415 / 16.34	415 / 16.34	446 / 17.56	520 / 20.47	600 / 23.62
d	130 / 5.12	130 / 5.12	185 / 7.28	185 / 7.28	220 / 8.66	310 / 12.20	310 / 12.20	355 / 13.98	420 / 16.54	490 / 19.29

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
< 0.50 mm	IIC	B	Special approvals upon request

Table 3: Max. allowable L/D-ratio

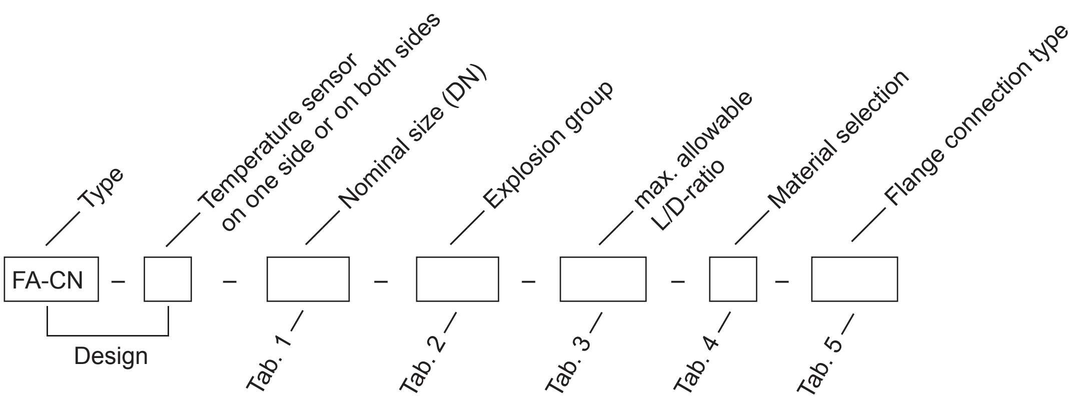
DN	40 / 1½"	50 / 2"	65 / 2½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
L/D max	30	30	10	10	10	30	30	10	10	5
Designa-tion	–	–	X12	X12	X12	–	–	X12	X12	X13

Table 4: Material selection

Design	A	B	
Housing	Steel	Stainless steel	Special materials upon request
Cover	Steel	Stainless steel	
Gasket	WS 3822	PTFE	
Flame arrester unit	Stainless steel	Stainless steel	

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

FA-CN	TB	100	IIC	X12	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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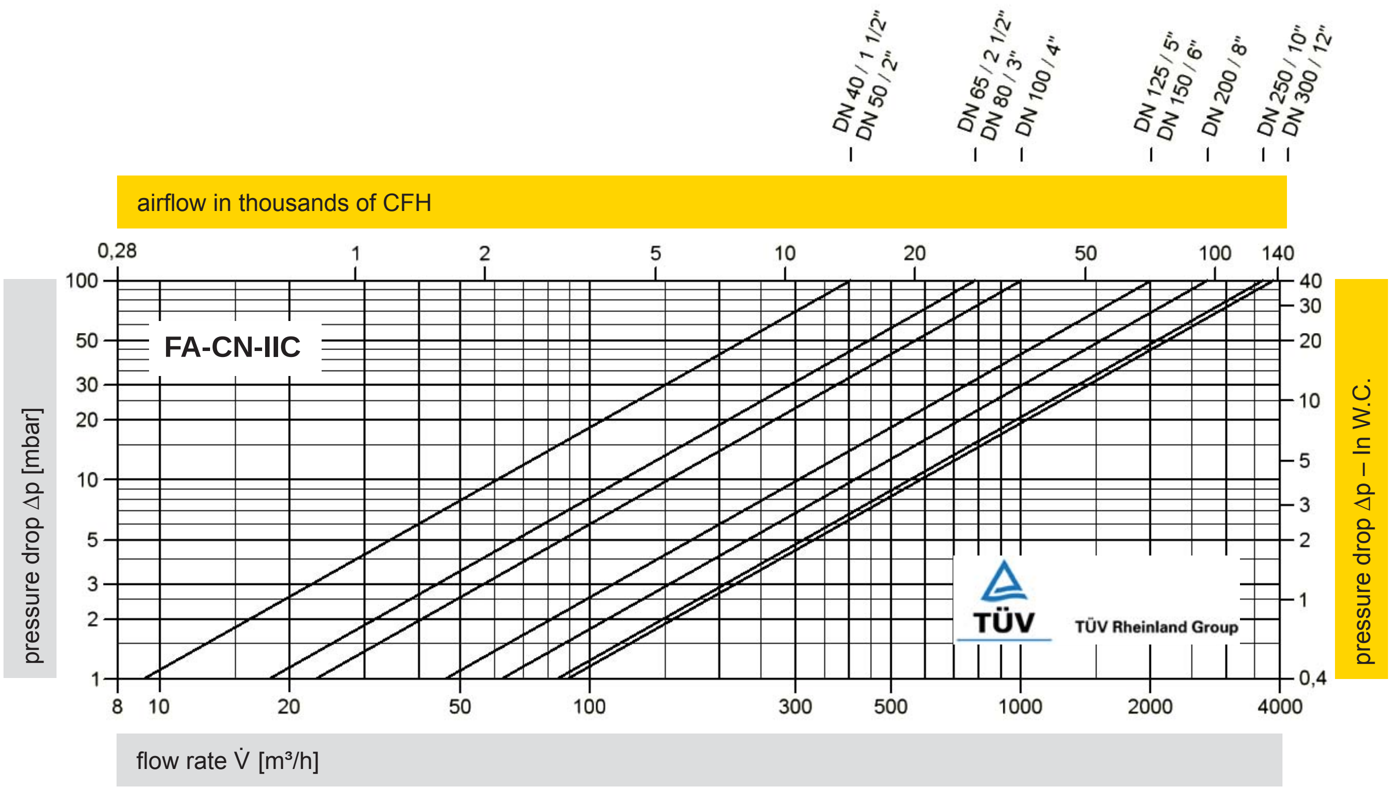
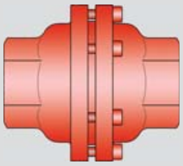
PROTEGO® FA-CN-IIC



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

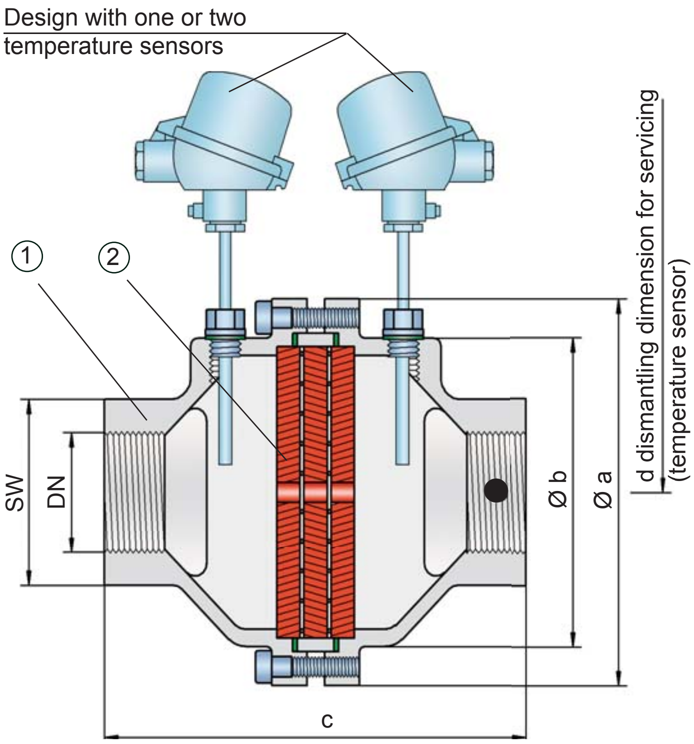
Notes:



In-Line Deflagration Flame Arrester

concentric design, bidirectional

PROTEGO® FA-G



● Connection to the protected side (only for type FA-G-T-...)

Function and Description

The compact design of the PROTEGO® FA-G in-line deflagration flame arrester makes it the state of the art technology for installation in pipes with diameters of up to 2”. The devices are installed with minimal distance to the burner to protect fuel feed lines. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was approved. As per EN 12874 the L/D ratio is limited to $L/D_{max} \leq 50$ for deflagration flame arresters of explosion groups IIA and IIB3 (NEC groups D and C (MESG ≥ 0.65 mm)) and to $L/D_{max} \leq 30$ for explosion group IIC (NEC group B).

The in-line deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device consists of two housing parts (1) and a PROTEGO® flame arrester unit or a FLAMEFILTER® (2) and spacers in the center. The number of FLAMEFILTER® and their gap size are determined by the operating data and parameters of the mixture flowing in the line (explosion group, pressure, temperature). The PROTEGO® FA-G series in-line deflagration flame arresters is available for explosion groups IIA, IIB3 and IIC (NEC groups D, C (MESG ≥ 0.65 mm) and B).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approval can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- different application possibilities
- modular design
- cost efficient spare parts
- the individual FLAMEFILTER® can be quickly removed and installed
- threaded connection for direct mounting into pipeline
- bidirectional flame transmission proof design
- protects against deflagrations for all explosion groups
- use of temperature sensors for G ½" and 2" is possible

Design and Specifications

There are three different designs:

Basic in-line deflagration flame arrester (G ½" to 2") **FA-G- –**

In-line deflagration flame arrester with integrated temperature sensor* for additional protection against short-time burning from one side (G 1½" to 2") **FA-G- T**

In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides (G 1½" to 2") **FA-G- TB**

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches, SW = width across flats

To select the nominal size (DN), use the flow capacity charts on the following pages

DN	G ½"	G ¾"	G 1"	G 1 ¼"	G 1 ½"	G 2"
a	80 / 3.15	80 / 3.15	100 / 3.94	100 / 3.94	155 / 6.10	155 / 6.10
b	55 / 2.17	55 / 2.17	76 / 2.99	76 / 2.99	124 / 4.88	124 / 4.88
c (IIA up to IIB3)	100 / 3.94	100 / 3.94	110 / 4.33	110 / 4.33	170 / 6.69	170 / 6.69
c (IIB and IIC)	112 / 4.41	112 / 4.41	122 / 4.80	122 / 4.80	170 / 6.69	170 / 6.69
d	—	—	—	—	400 / 15.75	400 / 15.75
SW	32 / 1.26	32 / 1.26	50 / 1.97	50 / 1.97	75 / 2.95	75 / 2.95

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0.90 mm	IIA	D	Special approvals upon request
≥ 0.65 mm	IIB3	C	
< 0.50 mm	IIC	B	

Table 3: Selection of max. operating pressure

		DN	G ½"	G ¾"	G 1"	G 1 ¼"	G 1 ½"	G 2"	
Expl. Gr.	IIA	P_{max}	1.4/20.3	1.4/20.3	1.4/20.3	1.4/20.3	1.5/21.7	1.5/21.7	P_{max} = maximum allowable operating pressure in bar / psi absolute, higher operating pressure upon request
	IIB3	P_{max}	1.2/17.4	1.2/17.4	1.2/17.4	1.2/17.4	1.2/17.4	1.2/17.4	
	IIC	P_{max}	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection

Design	A	B	C
Housing	Steel	Stainless steel	Hastelloy
Gasket	WS 3822 *	PTFE	PTFE
FLAMEFILTER®**	Stainless steel	Stainless steel	Hastelloy

* for devices exposed to temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

** the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing materials are used.

Special materials upon request.

Table 6: Type of connection

Pipe thread DIN ISO 228T1	DIN	other types of thread upon request

Type	Temperature sensor on one side or on both sides	Nominal size	Explosion group	Max. operating pressure bar / psi (absolute)	Max. operating temperature	Material selection	Type of connection
FA-G	–	–	–	/	–	–	–
Design		Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6

Order example

FA-G	TB	2"	IIA	P1.5 / –	T60	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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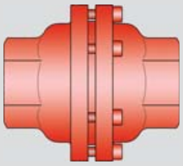
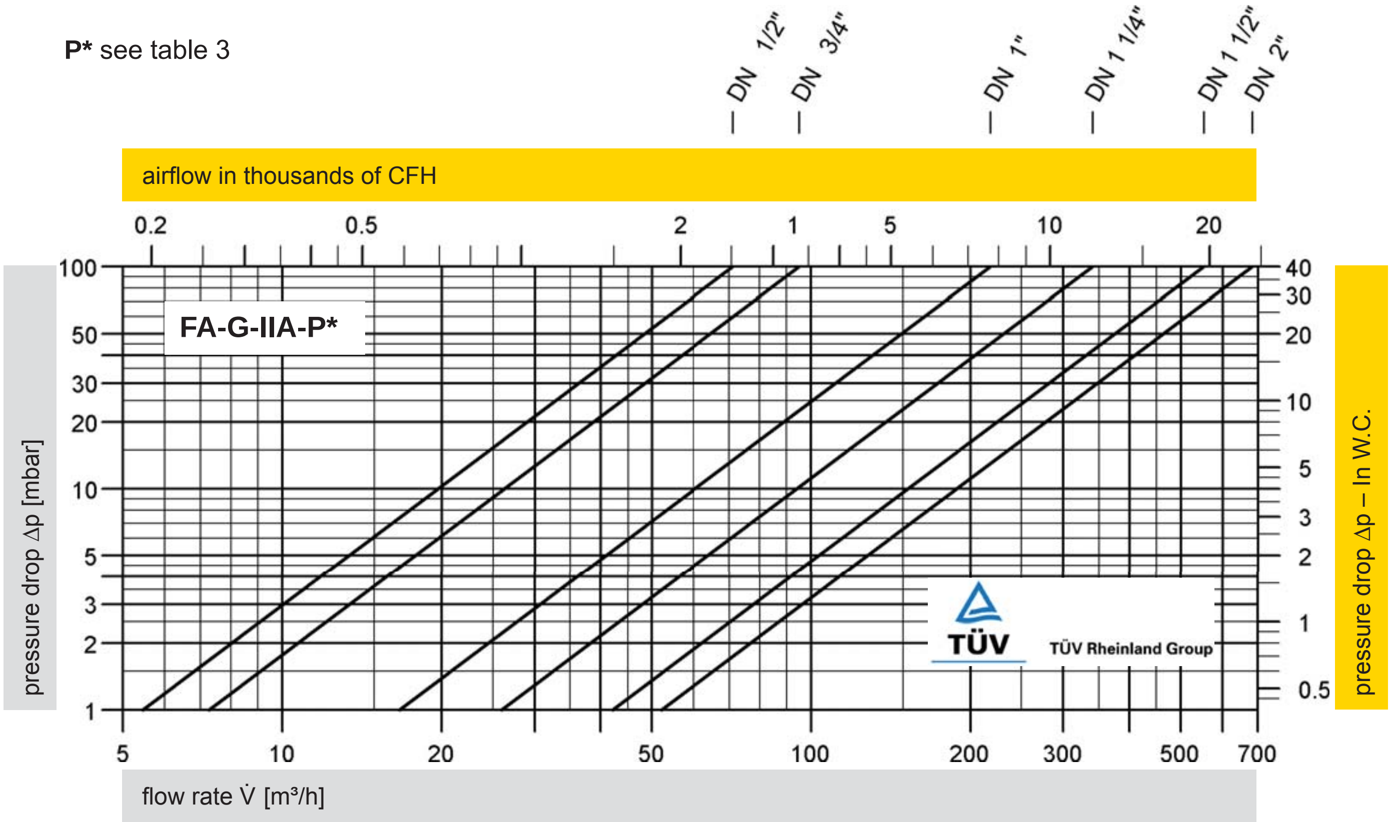


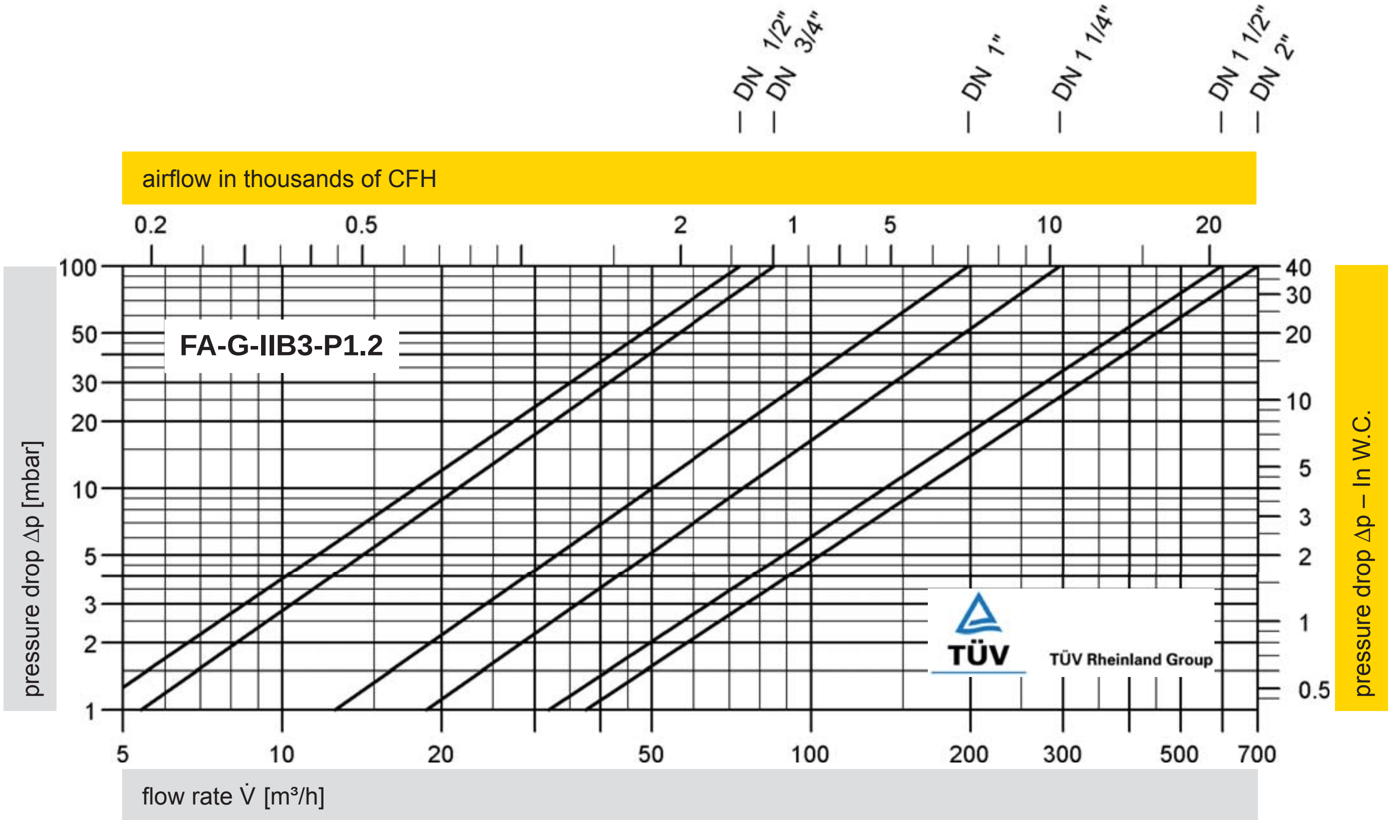
In-Line Deflagration Flame Arrester

Flow Capacity Charts

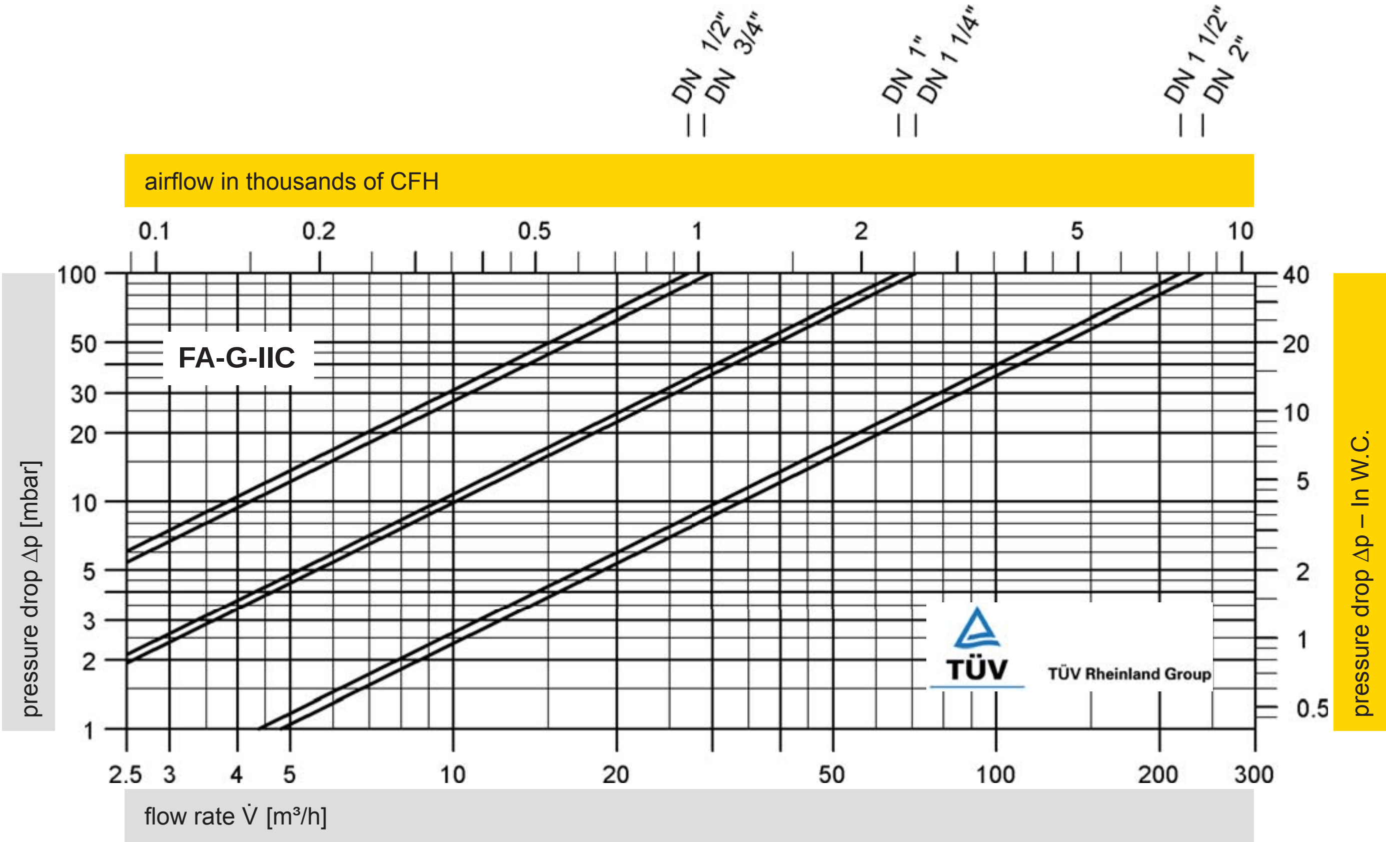
PROTEGO® FA-G-IIA, IIB3 and IIC

P* see table 3





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



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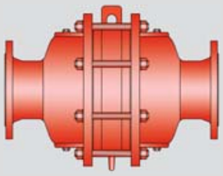
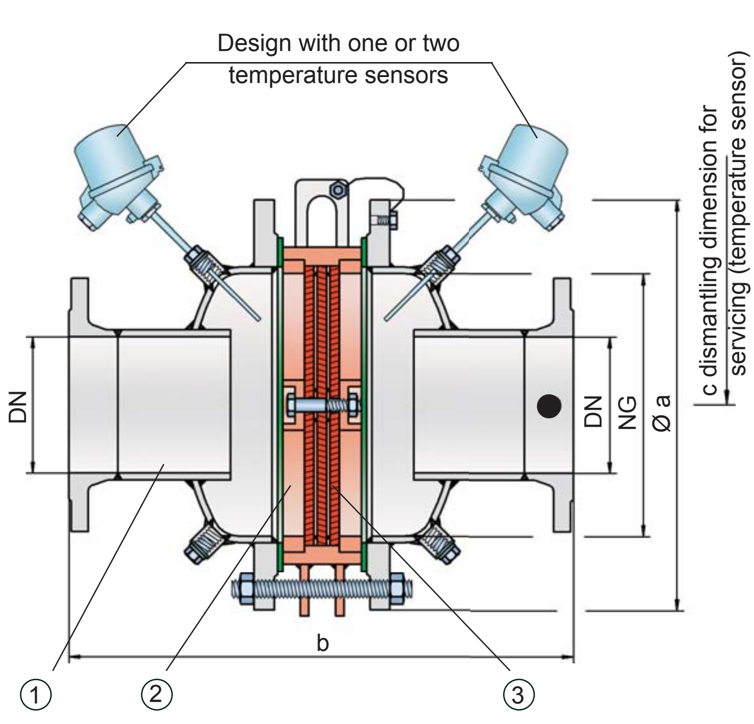


In-Line Deflagration Flame Arrester

concentric design, bidirectional

PROTEGO® FA-I



● Connection to the protected side (only for type FA-I-T-....)

The standard design can be used up to an operating temperature of +60°C/ 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Devices with special approvals can be obtained for higher pressures (see table 3) and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other internationally accepted standards.

Special Features and Advantages

- optimized flow capacity
- different series allow increase of FLAMEFILTER® size for given flange connection resulting in lower pressure drop across the device
- lowest pressure drop results in low operating and lifecycle costs
- option for integrated cleaning nozzles can be provided
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- bidirectional flame transmission proof design
- protects with deflagrations for explosion groups IIA and IIB3 (NEC groups D and C)
- design available for elevated operating temperatures and pressures
- available sizes from DN 50 / 2” to DN 1000 / 40”

Function and Description

In the development of the PROTEGO® FA-I in-line deflagration flame arrester, special effort was made to optimize the fluid dynamic flow characteristics. For a given flange connection size of the flame arrester, the FLAMEFILTER® size can be chosen from series 1, 2 and 3 (see table 1) for the most adequate flow capacity. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was tested (see table 4).

The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device essentially consists of two housing parts (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester´s conditions of use.

Providing the operating conditions such as the temperature, pressure, explosion group and the composition of the fluid, enables PROTEGO® to select the best deflagration flame arrester for your application. The PROTEGO® FA-I series of deflagration flame arresters is available for substances of explosion groups IIA and IIB3 (NEC groups D and C (MESG ≥ 0.65 mm)).

Design and Specifications

There are three different designs:

Basic deflagration flame arrester design	**FA-I-** $\boxed{-}$
In-line deflagration flame arrester with integrated temperature sensor* for additional protection against short-time burning from one side	**FA-I-** $\boxed{\text{T}}$
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-I-** $\boxed{\text{TB}}$

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions Dimensions in mm / inches

To select series and nominal size (DN) - nominal width (NG) combination, use the flow capacity charts on the following pages

Series 1 (standard)													
	DN	50 2"	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
Series 2 (special design for improved flow capacity)													
	DN	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	600 24"
Series 3 (special design for superior flow capacity)													
	DN	-	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	500 20"
	NG	150 6"	150 6"	200 8"	300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
	a	285 / 11.22	285 / 11.22	340 / 13.39	445 / 17.52	565 / 22.24	670 / 26.38	780 / 30.71	975 / 38.39	1175 / 46.26	1405 / 55.31	1630 / 64.17	1830 / 72.05
Expl. Gr.	IIA b*	364 / 14.33	364 / 14.33	452 / 17.79	584 / 22.99	638 / 25.12	688 / 27.09	800 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09
Expl. Gr.	IIB3 b*	364 / 14.33	364 / 14.33	464 / 18.27	596 / 23.46	650 / 25.59	700 / 27.56	800 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09
	c	500 / 19.69	500 / 19.69	520 / 20.47	570 / 22.44	620 / 24.41	670 / 26.38	700 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09

*Dimension b only for P1,2 (IIA) and P1,1 (IIB3).

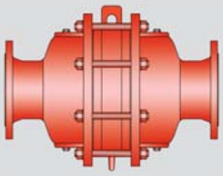
Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0.90 mm	IIA	D	Special approvals upon request
≥ 0.65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

		DN	50 2"	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
		NG	150 6"	150 6"	200 8"	300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
Expl. Gr.	IIA	P_{max}	1.8 / 26.1	1.8 / 26.1	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.4 / 20.3	1.3 / 18.8	1.3 / 18.8	1.2 / 17.4	1.1 / 15.9
Expl. Gr.	IIB3	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi absolut, higher operating pressure upon request



In-Line Deflagration Flame Arrester

concentric design,
bidirectional

PROTEGO® FA-I

Table 4: Table 4: Max. allowable L/D-ratio													
Series 1 (standard)													
DN		50 2"	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
Series 2 (special design for improved flow capacity)													
DN		-	-	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	600 24"
Series 3 (special design for superior flow capacity)													
DN		-	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	500 20"
NG		150 6"	150 6"	200 8"	300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
IIA	L/D_{max}	50	50	50	50	50	50	50	50	50	50	50	50
	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.3 / 18.8	1.3 / 18.8	1.2 / 17.4	1.1 / 15.9
	Designation	-	-	-	-	-	-	-	-	-	-	-	-
IIB3	L/D_{max}	50	50	40	40	35	35	35	30	30	30	25	25
	P_{max}	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9
	Designation	-	-	X6	X6	X7	X7	X7	X8	X8	X8	X9	X9

Table 5: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 6: Material selection for housing			
Design	A	B	C
Housing	Steel	Stainless steel	Hastelloy
Gasket	WS 3822 *	PTFE	PTFE
Flame arrester unit	A, B	C	D

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

The housing can also be delivered in carbon steel with an ECTFE coating.

Special materials upon request.

Table 7: Material combinations of the flame arrester unit			
Design	A	C	D
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
FLAMEFILTER® *	Stainless steel	Stainless steel	Hastelloy
Spacers	Stainless steel	Stainless steel	Hastelloy

* the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used

Special materials upon request.

Table 8: Flange connection type	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

FA-I	–		–		/		–		–		–		–		–		–		–	

Type	
Temperature sensor on one side or on both sides	
Nominal width (NG)	Tab. 1
Nominal size (DN)	Tab. 1
Explosion group	Tab. 2
Max. operating pressure bar / psi (absolute)	Tab. 3
Max. L/D-ratio	Tab. 4
Max. operating temperature	Tab. 5
Material (housing)	Tab. 6
Material (flame arrester unit)	Tab. 7
Flange connection type	Tab. 8

Design (Type and Temperature sensor)

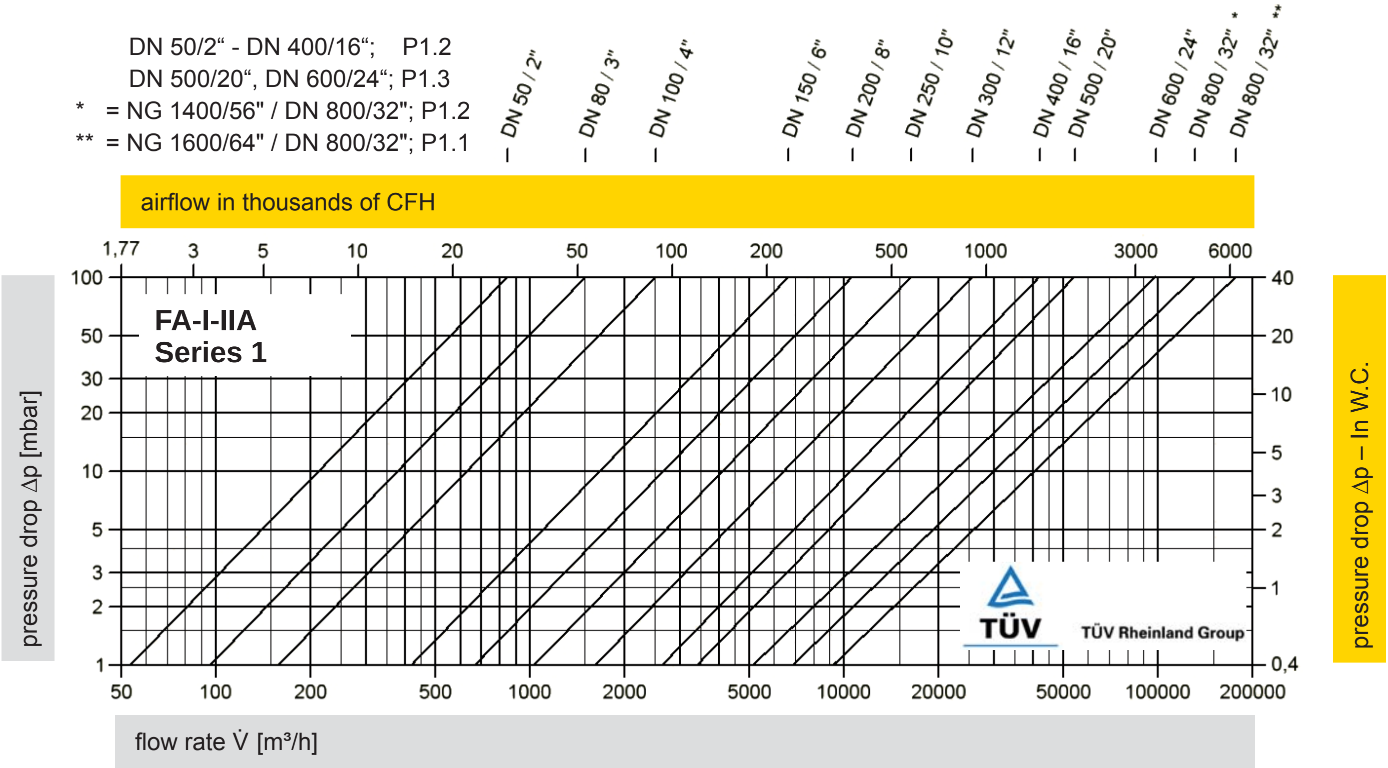
Order example

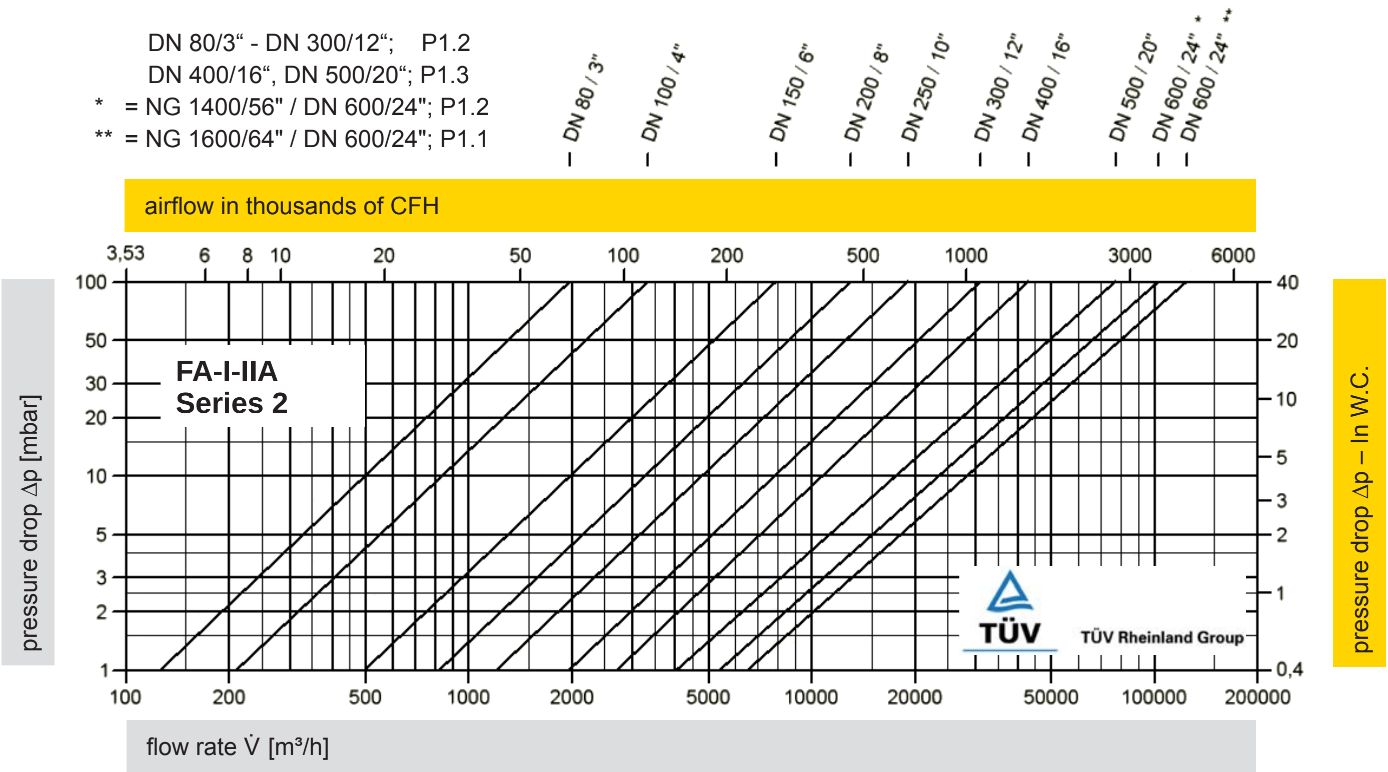
FA-I – TB – 300 / 150 – IIB3 – P1.2 / – – X6 – T60 – B – C – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO

for safety and environment

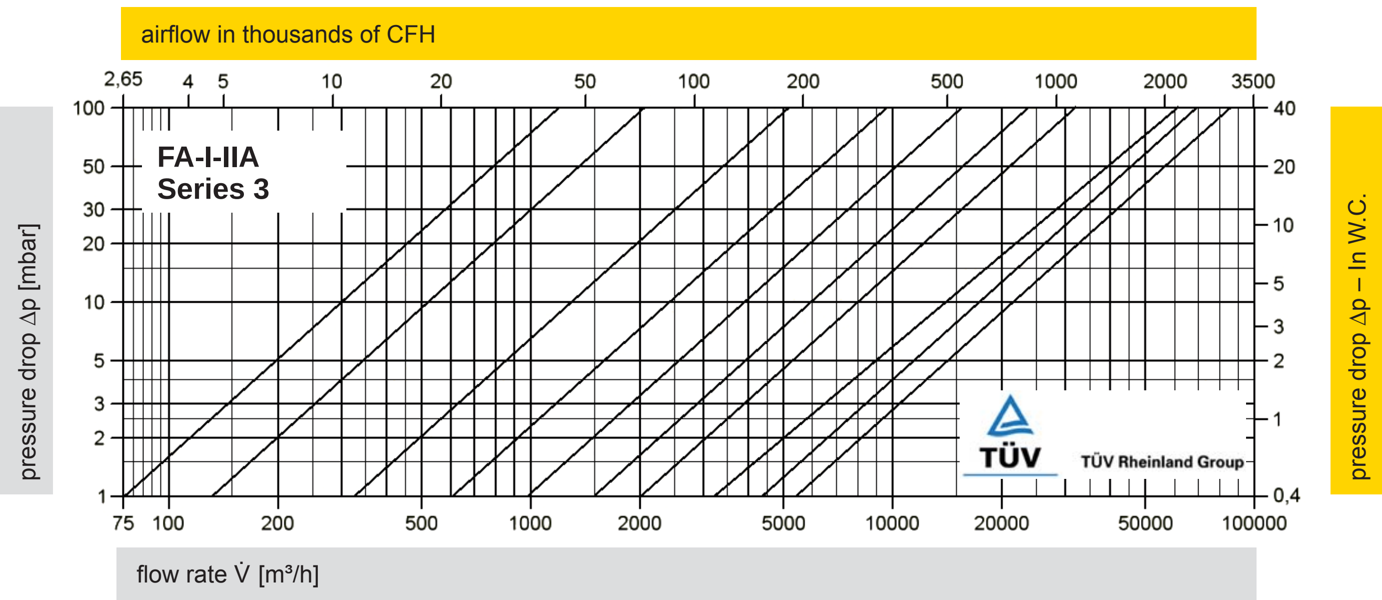




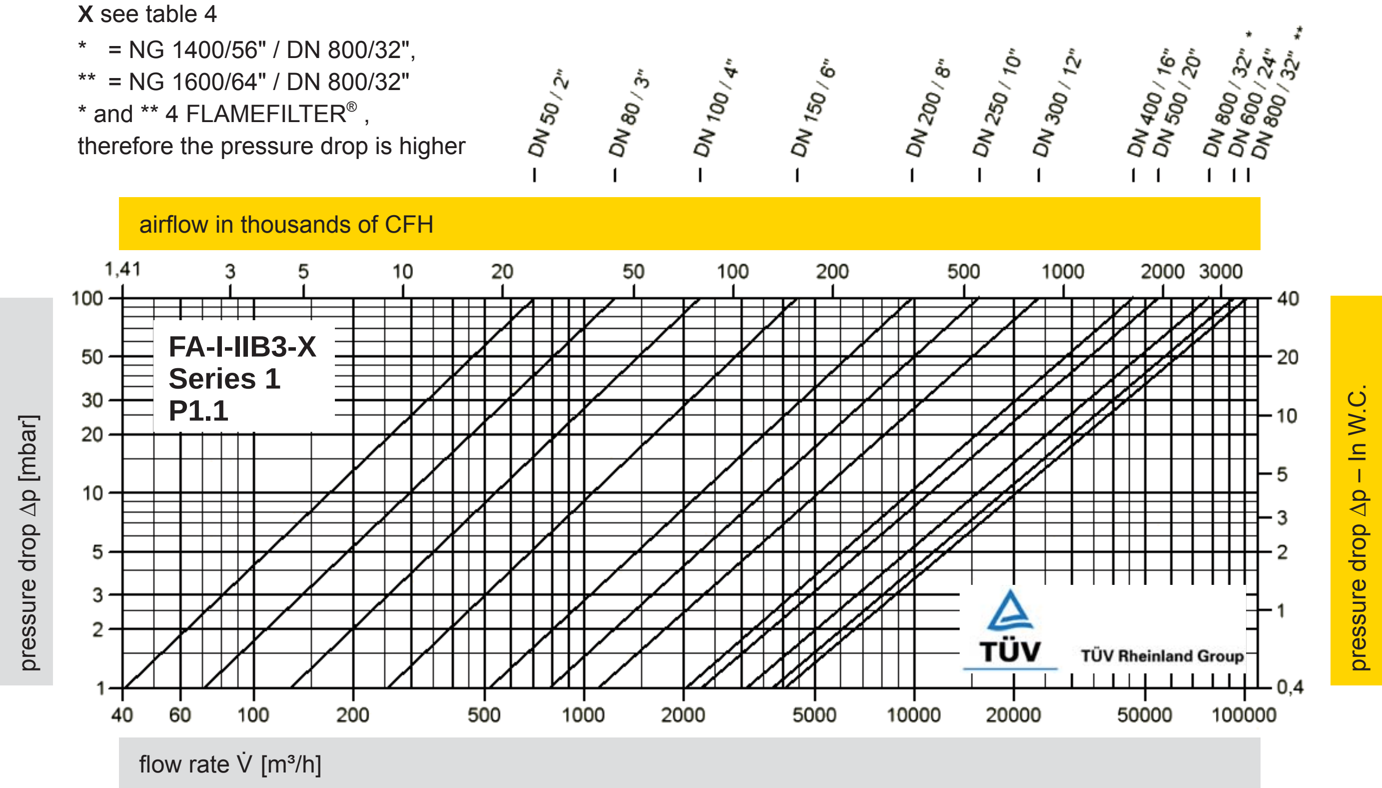
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

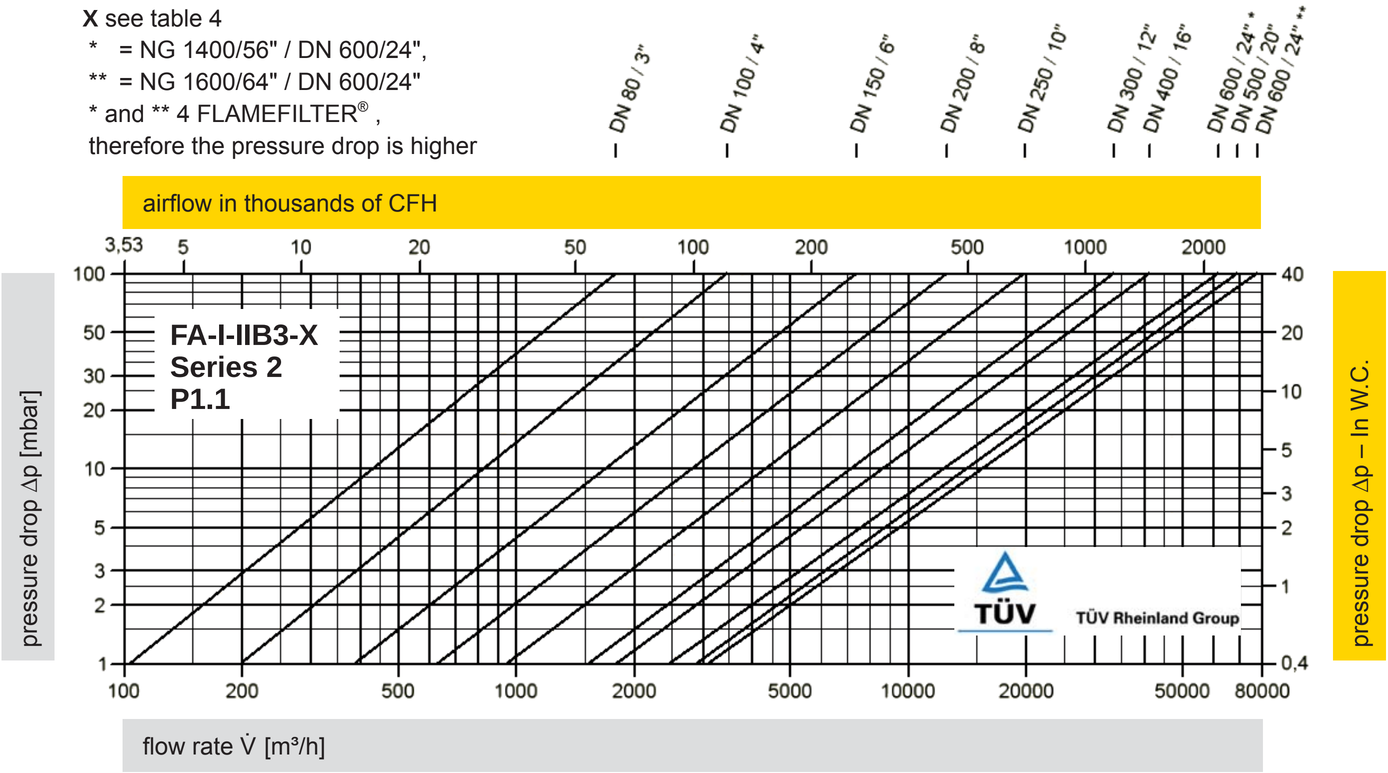
DN 50/2“ - DN 250/10“; P1.2
DN 300/12“, DN 400/16“; P1.3
* = NG 1400/56" / DN 500/20"; P1.2
** = NG 1600/64" / DN 500/20"; P1.1



X see table 4
* = NG 1400/56" / DN 800/32",
** = NG 1600/64" / DN 800/32"
* and ** 4 FLAMEFILTER® ,
therefore the pressure drop is higher

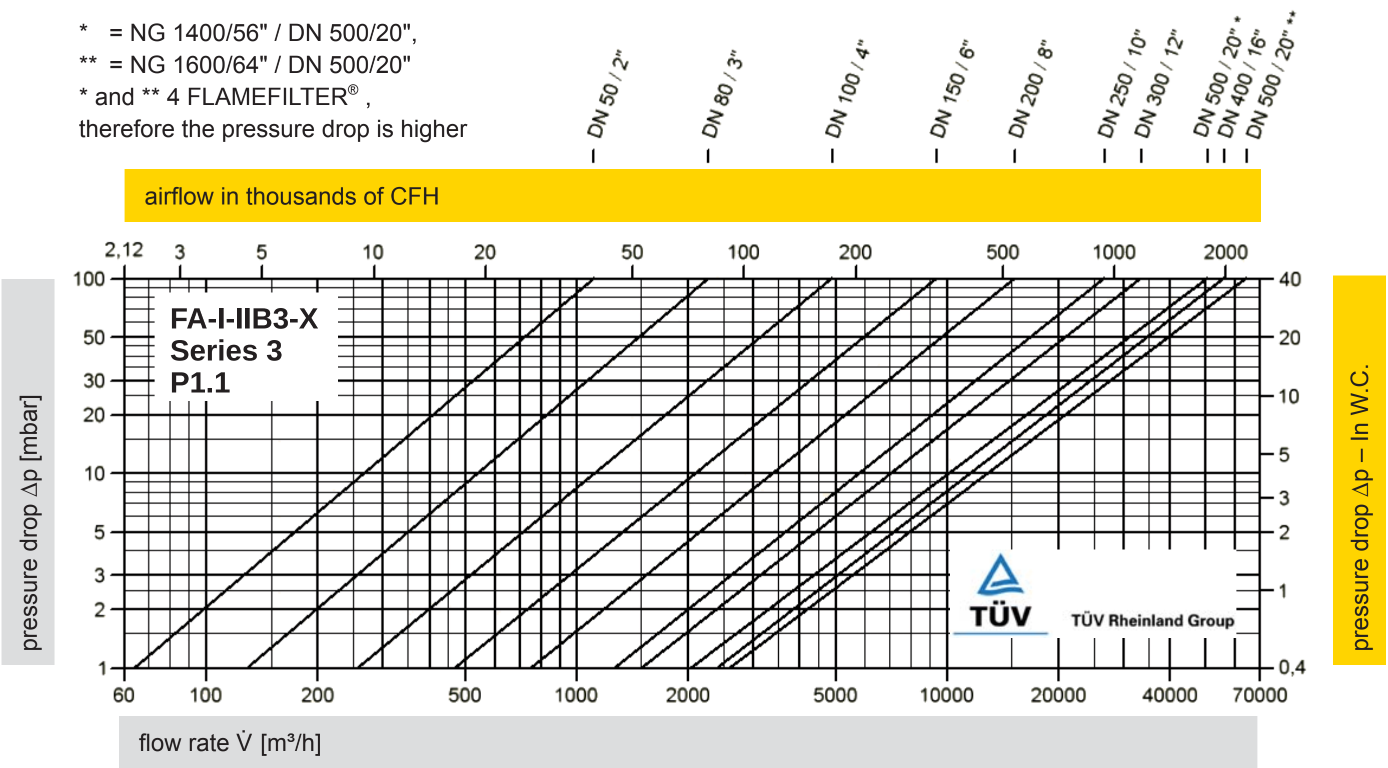


X see table 4
* = NG 1400/56" / DN 600/24",
** = NG 1600/64" / DN 600/24"
* and ** 4 FLAMEFILTER® ,
therefore the pressure drop is higher



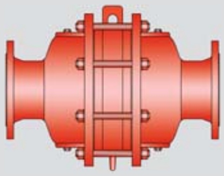
X see table 4

* = NG 1400/56" / DN 500/20",
** = NG 1600/64" / DN 500/20"
* and ** 4 FLAMEFILTER® ,
therefore the pressure drop is higher



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

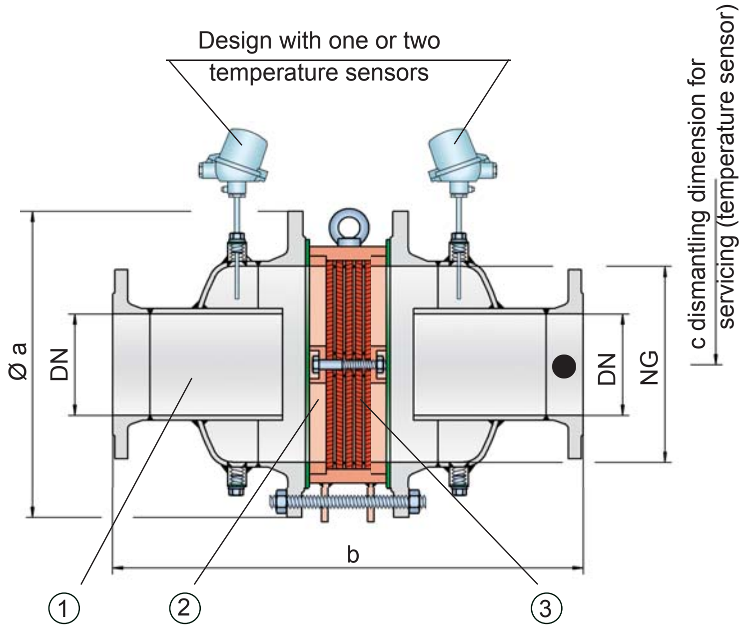


In-Line Deflagration Flame Arrester

concentric design,
bidirectional

PROTEGO® FA-I (FM-Specification-Tested)

FM Approvals
Specification Tested



● Connection to the protected side (only for type FA-I-T-....)

Function and Description

In the development of the FA-I in-line deflagration flame arrester, special effort was made to optimize the fluid dynamic flow characteristics. For a given flange connection size of the flame arrester, the FLAMEFILTER® size can be chosen from series 1, 2 and 3 (see table 1) providing the most adequate flow capacity. When installing the deflagration flame arrester, make sure that the distance between potential ignition sources and the location of the installed device, does not exceed the L/D ratio (pipe length/pipe diameter), for which the device was tested (see table 4). Concerning protection against short time burning, please avoid a horizontal installation.

The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The device consists of two housing parts (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester´s conditions of use.

Providing the operating conditions such as the temperature, pressure, explosion group and the composition of the fluid, enables PROTEGO® to select the best deflagration flame arrester for your application. The PROTEGO® FA-I series of flame arresters is available for explosion groups IIA and IIB 3 (NEC groups D and C MESG ≥ 0.65 mm)).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approval can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and FM specification tested as well as tested to other internationally accepted standards.

Special Features and Advantages

- optimized flow capacity
- different series allow increase of FLAMEFILTER® size for given flange connection resulting in lower pressure drop across the device
- lowest pressure drop results in low operating and lifecycle costs
- option for integrated cleaning nozzles can be provided
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- bidirectional flame transmission proof design
- protects from deflagrations for explosion groups IIA and IIB 3 (NEC groups D and C)
- design available for elevated operating temperatures and pressures
- available in large flange connection sizes

Design and Specifications

There are three different designs:

Basic deflagration flame arrester design	**FA-I-** –
In-line deflagration flame arrester with integrated temperature sensor* for additional protection against short-time burning from one side	**FA-I-** T
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short-time burning from both sides	**FA-I-** TB

Additional special devices available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select series and nominal size (DN) - nominal width (NG) combination, use the flow capacity charts on the following pages

Series 1 (standard)										
DN		150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
Series 2 (special design for improved flow capacity)										
DN		100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	600 24"
Series 3 (special design for superior flow capacity)										
DN		80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	500 20"
NG		300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
a		445 / 17.52	565 / 22.24	670 / 26.38	780 / 30.71	975 / 38.39	1175 / 46.26	1405 / 55.31	1630 / 64.17	1830 / 72.05
Expl. Gr.	IIA (D) b	596 / 23.46	650 / 25.59	700 / 27.56	800 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09
Expl. Gr.	IIB3 (C) b	608 / 23.94	662 / 26.06	712 / 28.03	800 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09
c		570 / 22.44	620 / 24.41	670 / 26.38	800 / 31.50	900 / 35.43	1000 / 39.37	1100 / 43.31	1350 / 53.15	1450 / 57.09

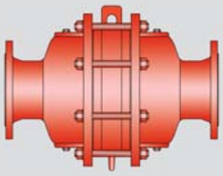
Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0.90 mm	IIA	D	Special approvals upon request
≥ 0.65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

		DN	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
		NG	300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
Expl. Gr.	IIA	P_{max}	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.4 / 20.3	1.3 / 18.8	1.3 / 18.8	1.2 / 17.4	1.1 / 15.9
Expl. Gr.	IIB3	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi absolut, higher operating pressure upon request



In-Line Deflagration Flame Arrester

concentric design,
bidirectional

PROTEGO® FA-I (FM-Specification-Tested)

FM Approvals
Specification Tested

Table 4: Max. allowable L/D-ratio (standard)										
Series 1 (standard)										
DN		150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	800 32"	800 32"
Series 2 (special design for improved flow capacity)										
DN		100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	600 24"	600 24"
Series 3 (special design for superior flow capacity)										
DN		80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	400 16"	500 20"	500 20"
NG		300 12"	400 16"	500 20"	600 24"	800 32"	1000 40"	1200 48"	1400 56"	1600 64"
IIA (D)	L/D max.	50	50	50	50	50	50	50	50	50
	Designa- tion	-	-	-	-	-	-	-	-	-
IIB3 (C)	IIB3 (C)	35	50	50	50	50	50	50	25	25
	Designa- tion	X7	-	-	-	-	-	-	X9	X9

Table 5: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 6: Material selection for housing			
Design	A	B	C
Housing	Steel	Stainless steel	Hastelloy
Gasket	WS 3822 *	PTFE	PTFE
Flame arrester unit	A, B	C	D

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

The housing can also be delivered in carbon steel with an ECTFE coating.

Special materials upon request.

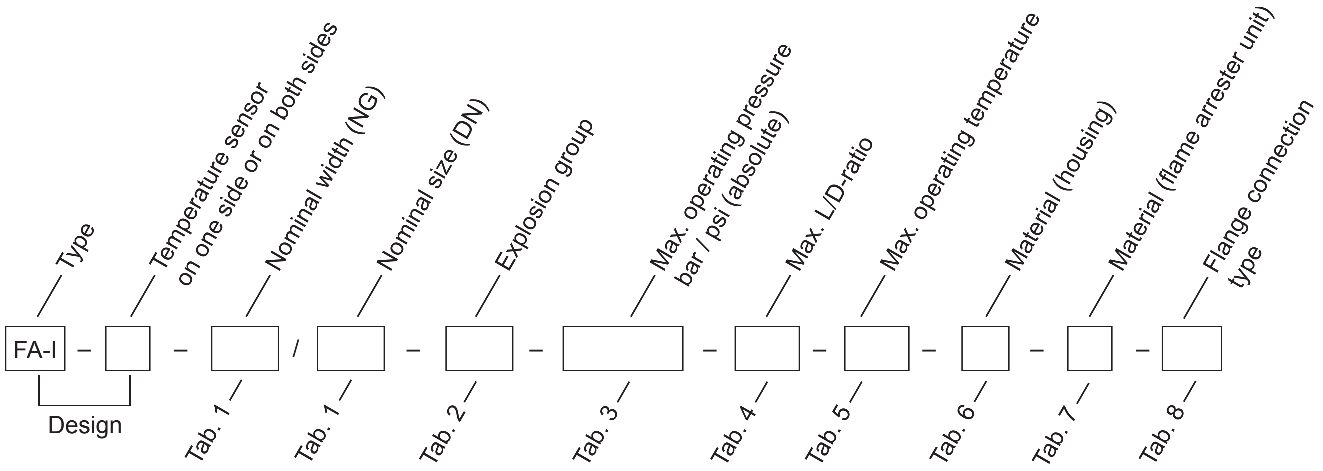
Table 7: Material combinations of the flame arrester unit			
Design	A	C	D
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
FLAMEFILTER® *	Stainless steel	Stainless steel	Hastelloy
Spacers	Stainless steel	Stainless steel	Hastelloy

* the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used

Special materials upon request.

Table 8: Flange connection type	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

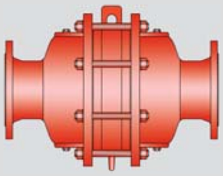
other types upon request



Order example

FA-I – TB – 300 / 150 – IIB3 – P1.2 / – – X7 – T60 – B – C – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



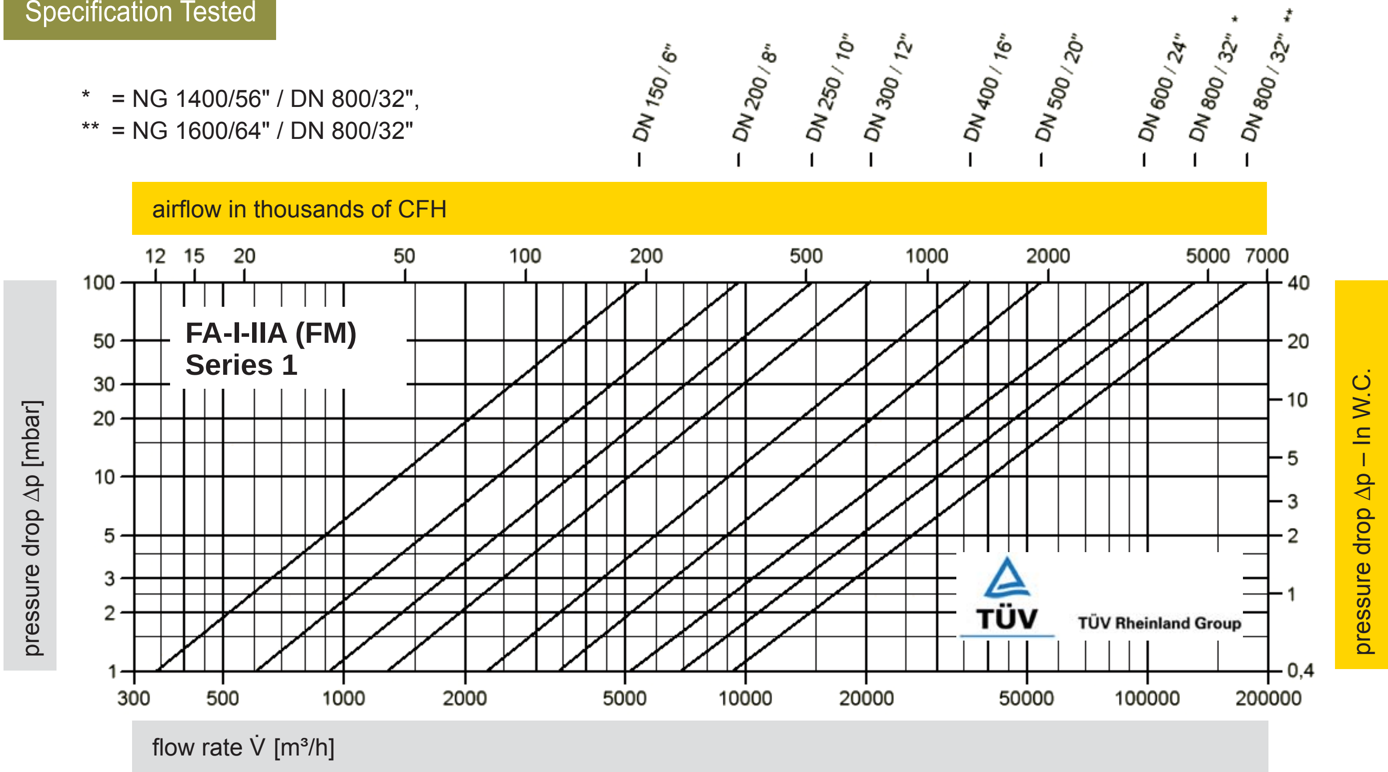
In-Line Deflagration Flame Arrester

Flow Capacity Charts

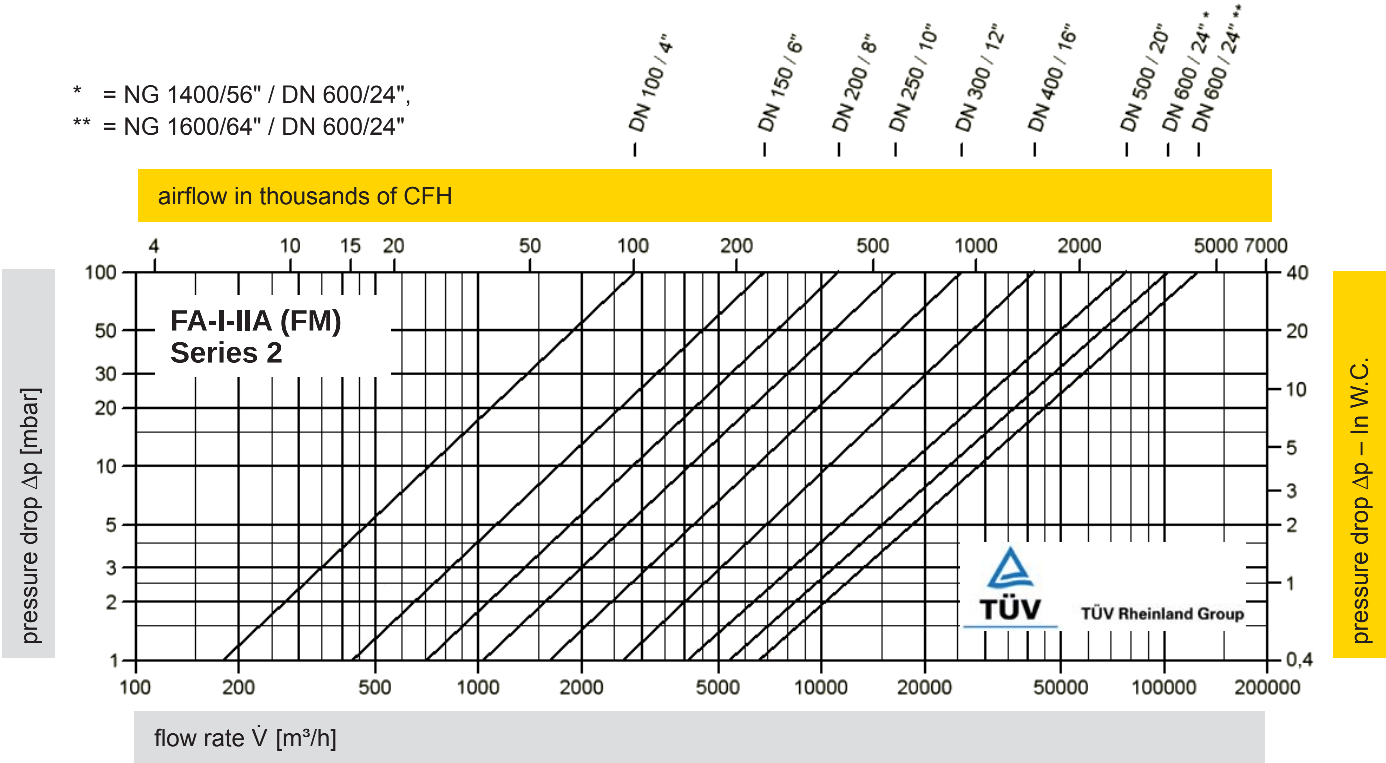
PROTEGO® FA-I (FM-Specification-Tested)

FM Approvals
Specification Tested

* = NG 1400/56" / DN 800/32",
** = NG 1600/64" / DN 800/32"

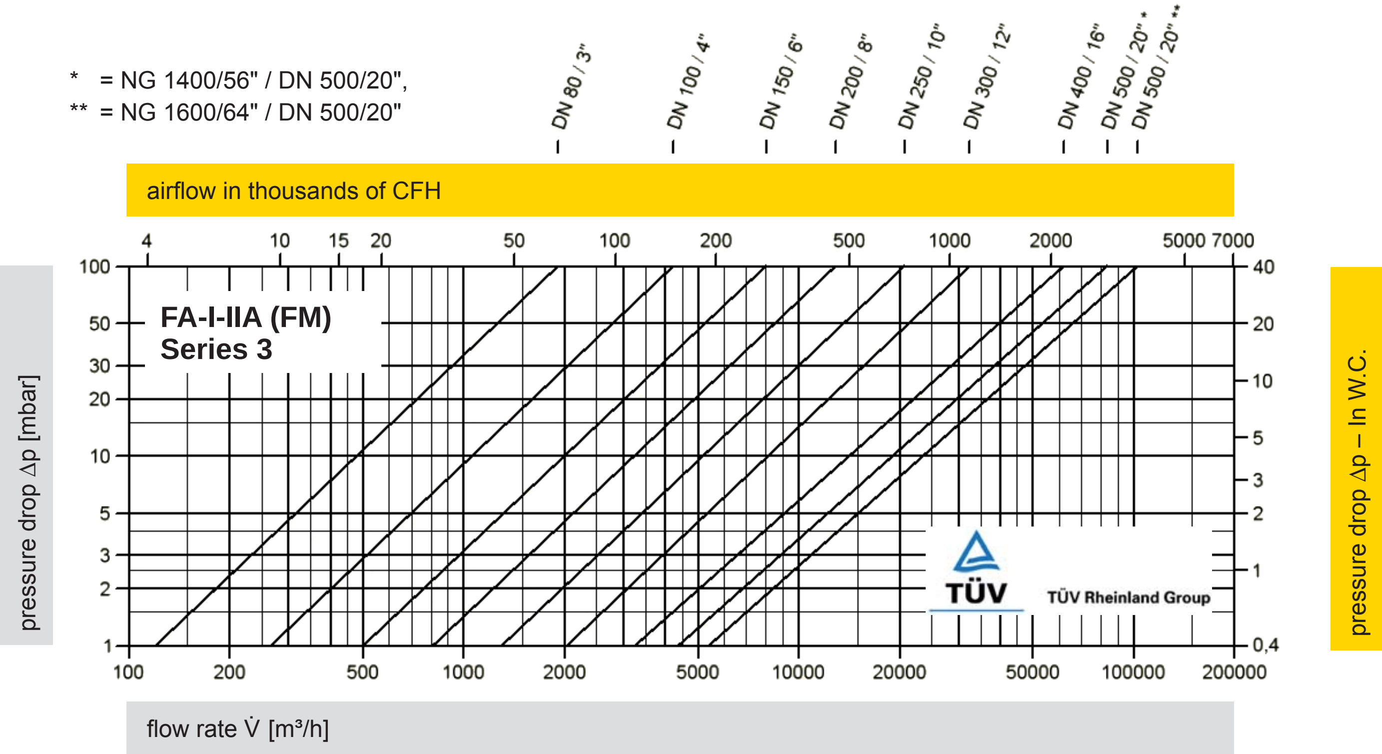


* = NG 1400/56" / DN 600/24",
** = NG 1600/64" / DN 600/24"

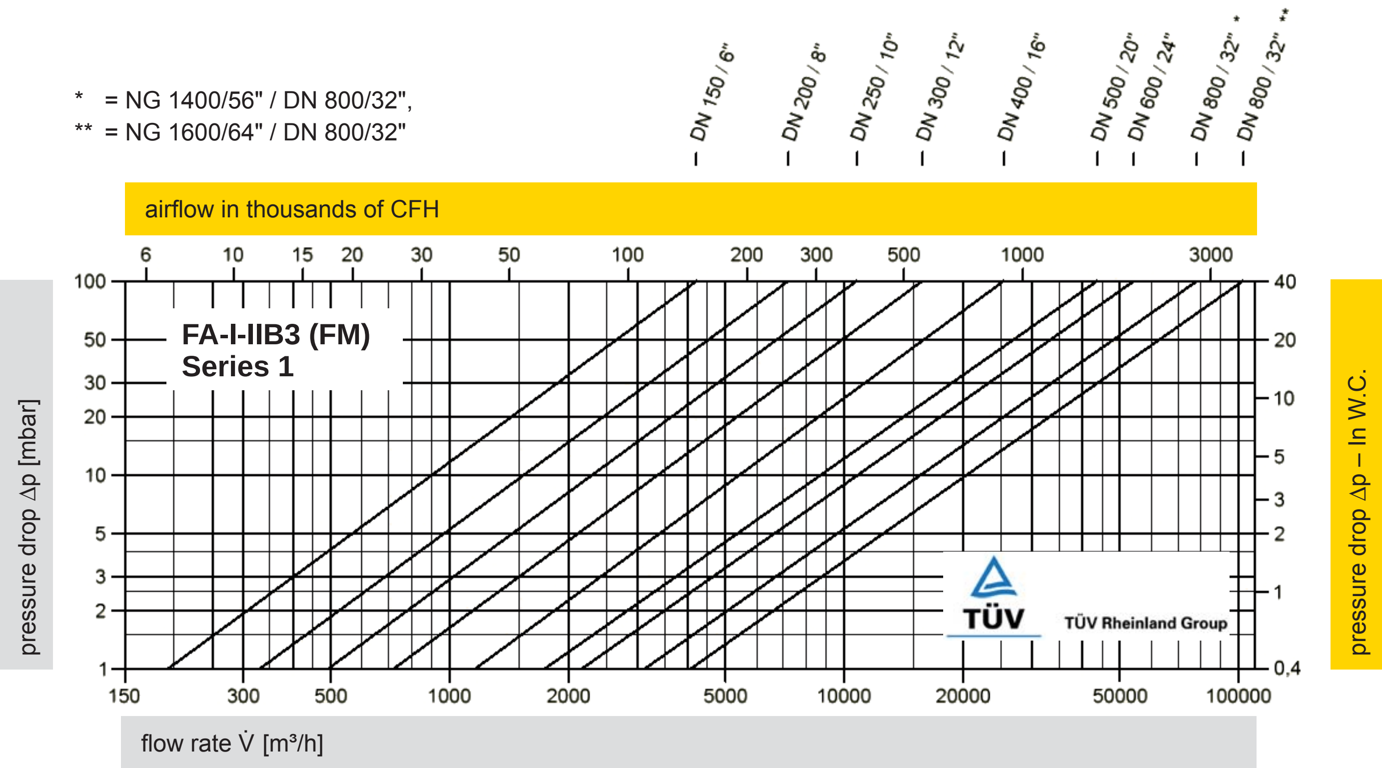


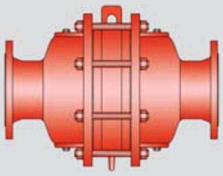
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the Technical Standard ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

*   = NG 1400/56" / DN 500/20",
** = NG 1600/64" / DN 500/20"



*   = NG 1400/56" / DN 800/32",
** = NG 1600/64" / DN 800/32"



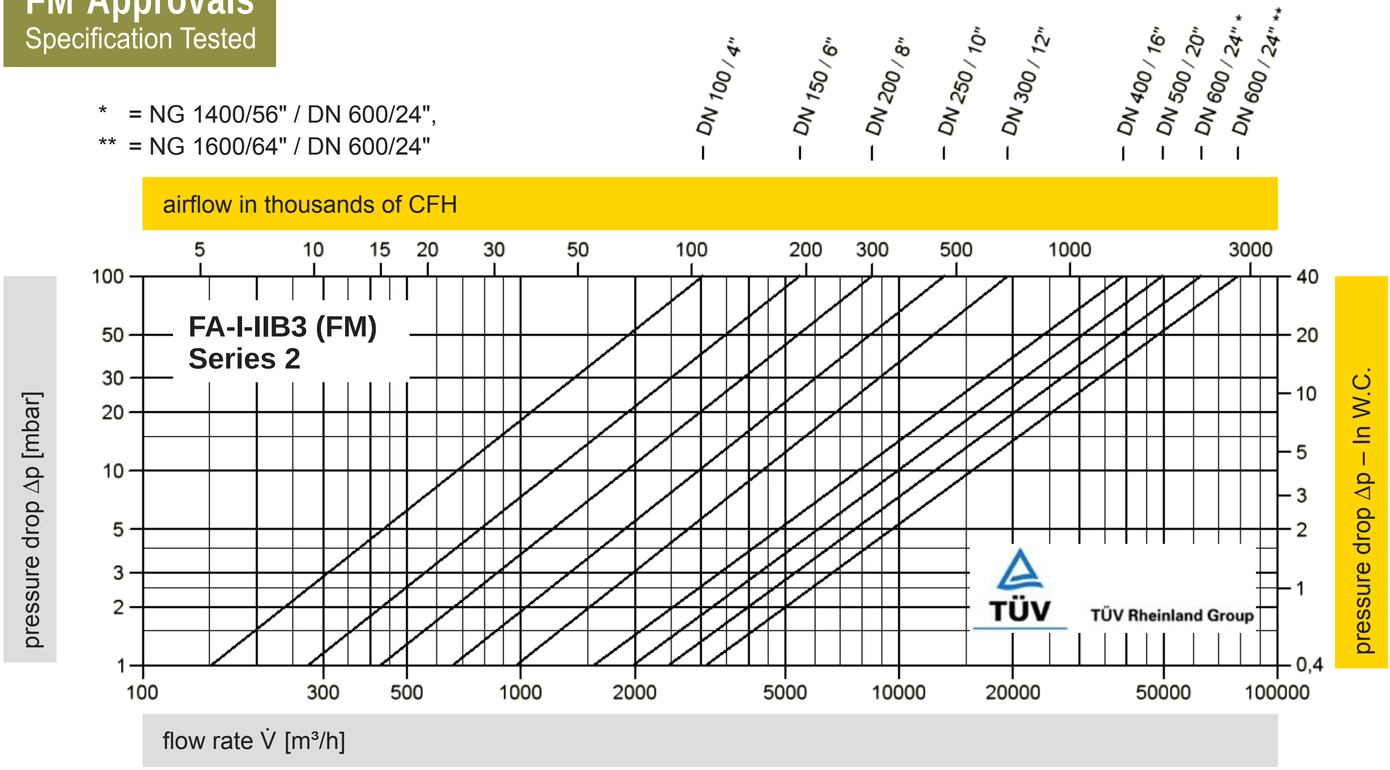


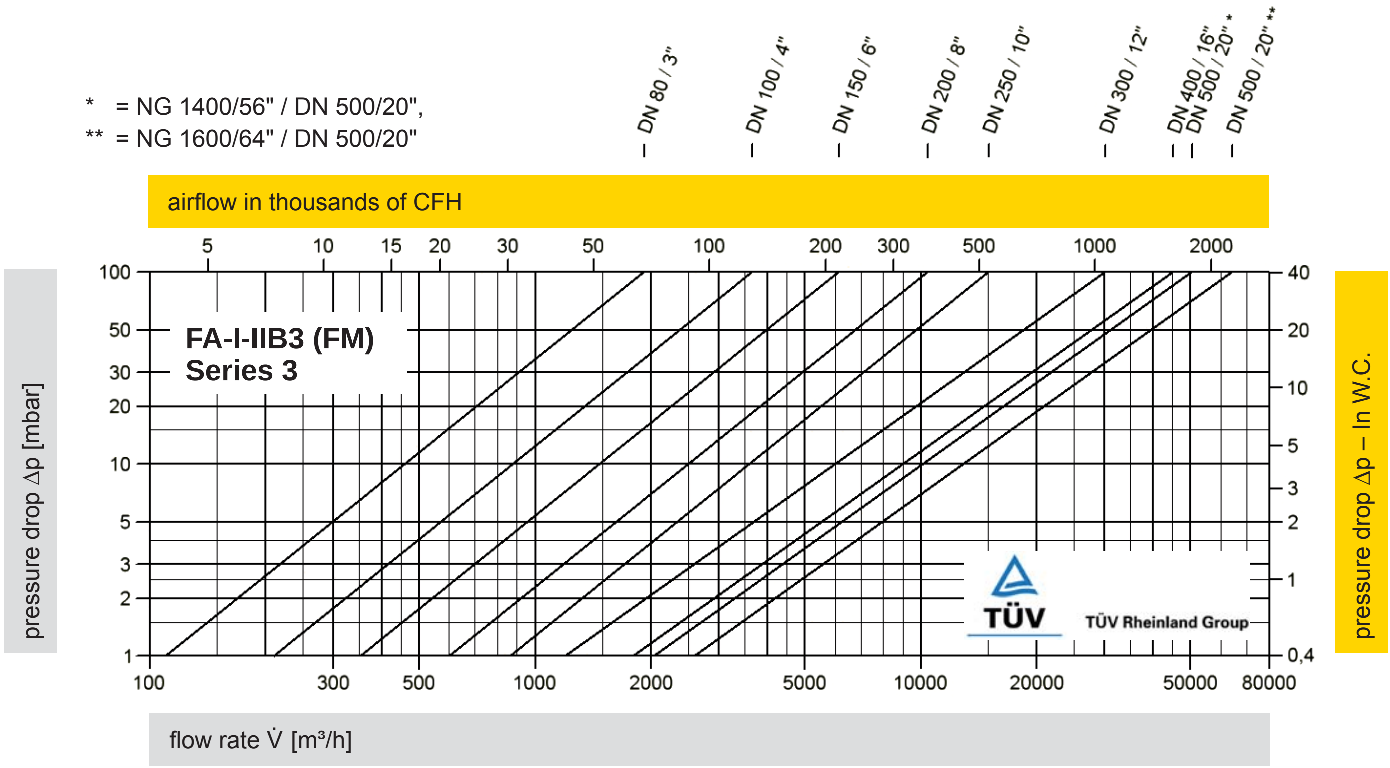
In-Line Deflagration Flame Arrester

Flow Capacity Charts

PROTEGO® FA-I (FM-Specification-Tested)

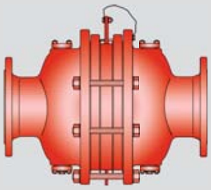
FM Approvals
Specification Tested





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig. Volume flow V̇ in [m³/h] and CFH refer to the Technical Standard ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

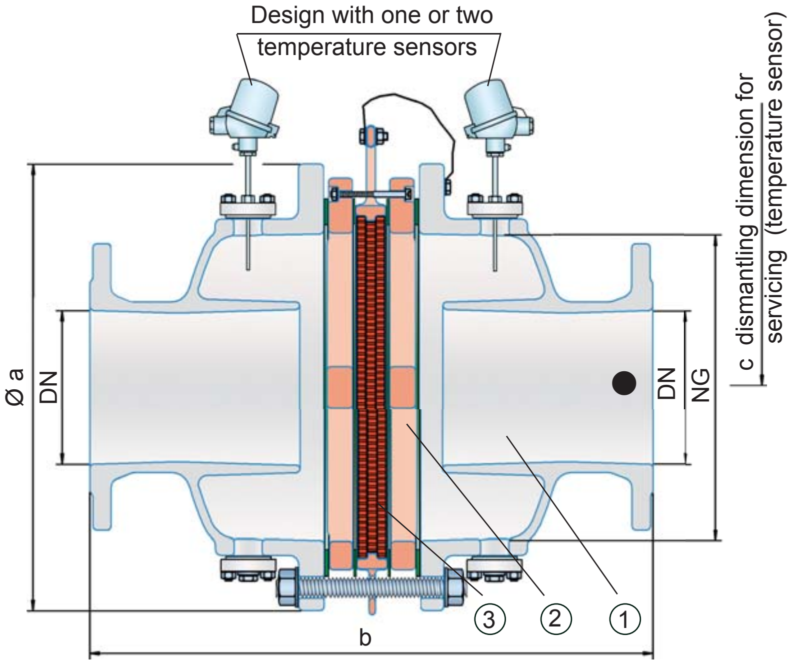
Notes:



In-Line Deflagration Flame Arrester

concentric design, bidirectional

PROTEGO® FA-I-PTFE



● Connection to the protected side (only for type FA-I-PTFE-T-...)

Special Features and Advantages

- Build up of adhesive materials is prevented by the smooth surfaces
- Aplication especially for corrosive and polymerising media
- Less soiling of the device lowers service, operating and life-cycle costs
- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Minimum pressure loss and associated low operating and life-cycle costs
- Service-friendly design
- The modular design enables individual FLAMEFILTER® to be replaced
- Bidirectional operation as well as any direction of flow
- Installation of temperature sensors is possible

Function and Description

The in-line deflagration flame arresters type PROTEGO® FA-I-PTFE are the latest generation of flame arresters and are distinguished by its unique resistance to adhesive and corrosive media. The use of fluoroplastics as a high-tech housing coating and as solid material for the flame arrester element is unique throughout the world.

When installing the deflagration flame arrester make sure that the distance between potential ignition sources and the location of the installed device, the L/D ratio (pipe length/pipe diameter), does not exceed the value of 50.

The deflagration flame arrester is symmetrical and offers bidirectional flame transmission protection. The arrester essentially consists of two coated housing parts (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of PTFE-FLAMEFILTER® and their gap size depends on the arrester‘s conditions of use.

The deflagration flame arrester PROTEGO® FA-I-PTFE can be used for explosion group IIA (NFPA group D). The standard design is approved at an operating temperature up to +60°C / 140°F. The maximum allowable operating pressure depends on nominal diameter (DN) and nominal size (NG) and amounts to a maximum of 1.6 bar / 23.2 psi absolute (for DN 100 / 4” and DN 150 / 6” see table 3).

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Design Types and Specifications

There are three different designs available:

Basic in-line deflagration flame arrester	**FA-I-PTFE - [–]**
In-line deflagration flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**FA-I-PTFE - [T]**
In-line deflagration flame arrester with two integrated temperature sensors* for additional protection against short time burning from both sides	**FA-I-PTFE - [TB]**

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions				Dimensions in mm / inches
To select series and nominal size (DN) - nominal width (NG) combination, please use the flow capacity chart on the following page				
DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"
NG	150 / 6"	150 / 6"	200 / 8"	300 / 12"
a	287 / 11.30	287 / 11.30	342 / 13.46	447 / 17.60
b	380 / 14.96	380 / 14.96	468 / 18.43	612 / 24.09
c	430 / 16.93	430 / 16.93	480 / 18.90	530 / 20.87

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0.90 mm	IIA	D	

Table 3: Selection of max. operating pressure

DN	50 / 2“	80 / 3“	100 / 4"	150 / 6"
NG	150 / 6“	150 / 6“	200 / 8“	300 / 12“
P_{max}	1.6 / 23.2	1.6 / 23.2	1.2 / 17.4	1.2 / 17.4

P_{max} = in bar / psi absolut, higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material for housing

Design	A
Housing	Steel with an ECTFE coating
Gasket	PTFE
Flame arrester unit	A, B, C

Special materials upon request

Table 6: Material combinations of the flame arrester unit

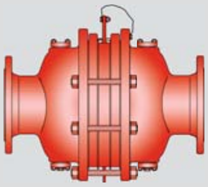
Design	A	B	C
FLAMEFILTER® cage	Steel with an ECTFE coating	Hastelloy	Stainless Steel
Spider rings	Steel with an ECTFE coating	Hastelloy	Stainless Steel
FLAMEFILTER® *	PTFE*	PTFE*	PTFE*
Spacer	PEEK / ETFE / FEP	PEEK / ETFE / FEP	PEEK / ETFE / FEP

Special materials upon request

* electrically conductive

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



In-Line Deflagration Flame Arrester

concentric design,
bidirectional

PROTEGO® FA-I-PTFE

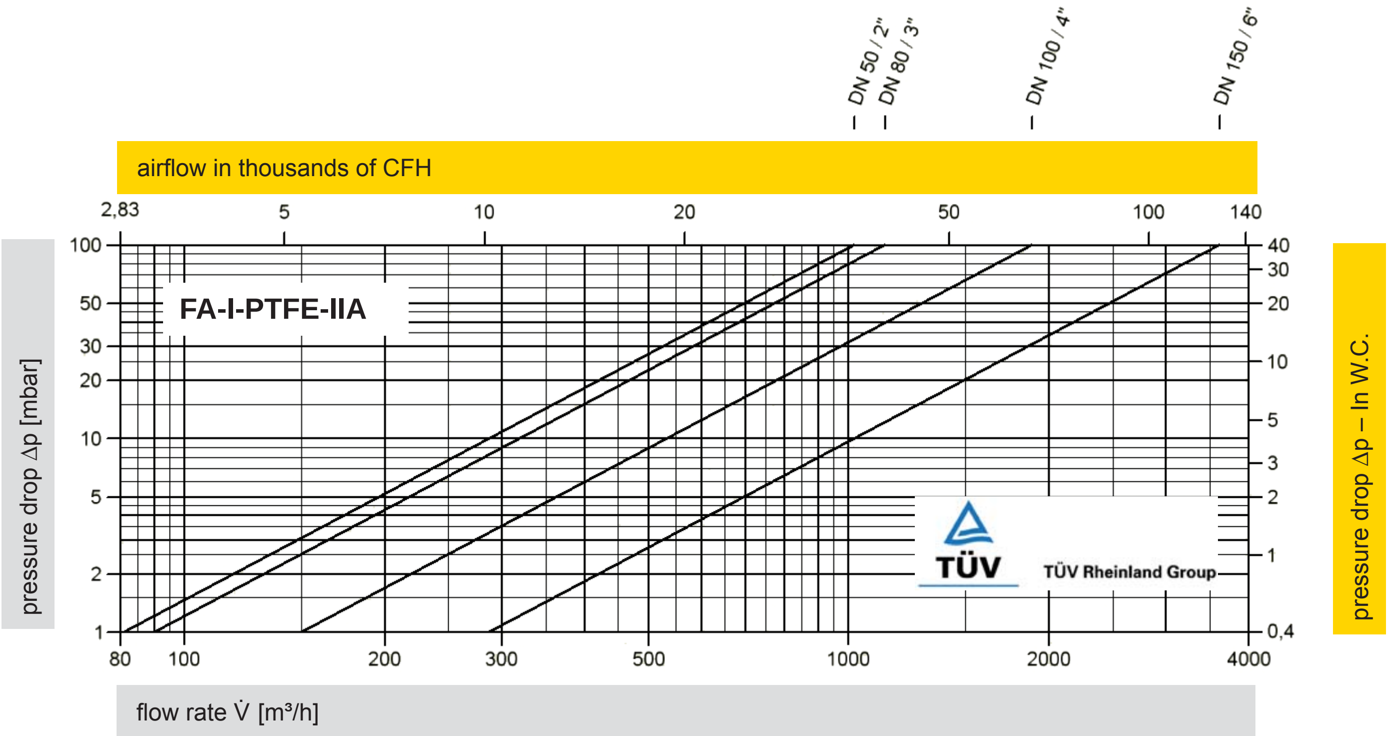
Type	Temperature sensor on one side or on both sides	Nominal width (NG)	Nominal size (DN)	Explosion group	Max. operating pressure bar /psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
FA-I-PTFE –	–	/	–	–	/ –	–	–	–	
Design		Tab. 1	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

FA-I-PTFE –	TB –	300 /	150 –	IIA –	P1.2/ – –	T60 –	A –	A –	DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

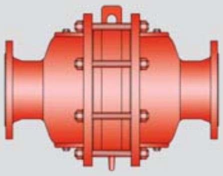
Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

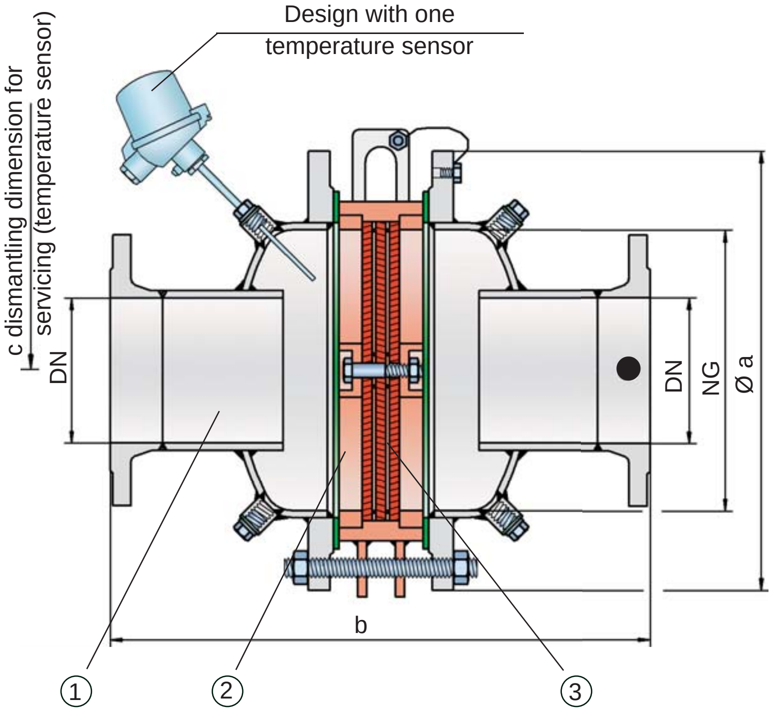
Notes:



Flame Arrester

for vacuum pumps, compressors and blowers

PROTEGO® FA-I-V and FA-I-P



Special Features and Advantages

- customized protection for vacuum pumps, blowers and compressors
- modular design provides every user with the optimal flame arrester
- flexible design parameters result in lowest pressure drops
- modular flame arrester unit enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- worldwide, long-term availability of spare parts

● Connection to the protected side (only for type FA-I-V-T-....)

Function and Description

PROTEGO® FA-I-V and FA-I-P flame arresters are specifically designed for vacuum pumps, blowers, and compressors. The high flow velocity in the small gaps of these machines can lead to undesirable ignitions within the housing. One of the safest measures against explosion propagation are flame arrester units that are installed on the vacuum and pressure side of the equipment. PROTEGO® FA-I-V devices for the vacuum side and PROTEGO® FA-I-P devices for the pressure side provide a unique modular design that gives every manufacturer of vacuum pumps or comparable devices the option of using optimized and adapted flame arresters. Our expert technical staff will assist you with the proper selection of the devices as well as execution of type testing.

PROTEGO® FA-I-V and FA-I-P devices are symmetrical in design. The arrester essentially consists of two housing parts (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester´s conditions of use. PROTEGO® FA-I-V and FA-I-P flame arresters are available for explosion groups IIA to IIC (NEC groups D to B) and special gases such as ethylene oxide.

Design and Specifications

There are five different designs:

Flame arrester for low pressure side in the basic design	**FA-I-V** $\boxed{-}$
Flame arrester for the low pressure side with integrated temperature sensor* for additional protection against short-time burning on one side	**FA-I-V-** $\boxed{T}$
Flame arrester for the pressure side in the basic design	**FA-I-P** $\boxed{-}$
Flame arrester for the pressure side with integrated temperature sensor* for additional protection against short-time burning on one side (recommended)	**FA-I-P-** $\boxed{T}$

Additional special devices are available upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Flow capacity curves are provided for each individual application.

Table 1: Dimensions — Dimensions in mm / inches

Series 1								
DN			50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"
Series 2								
DN			-	-	80 / 3"	100 / 4"	150 / 6"	200 / 8"
Series 3								
DN			-	-	-	80 / 3"	100 / 4"	150 / 6"
Series 4								
DN			-	-	-	-	80 / 3“	-
NG			150 / 6"	150 / 6"	200 / 8"	300 / 12"	400 / 16"	500 / 20"
a			285 / 11.22	285 / 11.22	340 13.39	445 / 17.52	565 / 22.24	670 / 26.38
Number of FLAMEFILTER®	2	b	364 / 14.33	364 / 14.33	452 / 17.80	584 / 22.99	638 / 25.12	688 / 27.09
	3	b	376 / 14.80	376 / 14.80	464 / 18.27	596 / 23.46	650 / 25.59	700 / 27.56
	4	b	388 / 15.28	388 / 15.28	476 / 18.74	608 / 23.94	662 / 26.06	712 / 28.03
	5	b	400 / 15.75	400 / 15.75	488 / 19.21	628 / 24.72	690 / 27.17	752 / 29.61
	6	b	412 / 16.22	412 / 16.22	500 / 19.69	640 / 25.20	702 / 27.17	764 / 30.08
	7	b	-	-	500 / 19.69	650 / 25.59	-	-
	8	b	-	-	-	662 26.06	-	-
c			500 / 19.69	500 / 19.69	520 / 20.47	570 / 22.44	620 / 24.41	570 / 26.38

Table 2: Selection of FLAMEFILTER® gap / Explosion group

FLAMEFILTER® gap	MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
0.7 mm	> 0.90 mm	IIA	D
0.5 mm	≥ 0.65 mm	IIB3	C
0.3 mm	≥ 0.50 mm	IIB	C
0.2 mm	< 0.50 mm	IIC	B

Table 3: Material selection for housing

Design	A	B	C
Housing	Steel	Stainless steel	Hastelloy
Gasket	WS 3822	PTFE	PTFE
Flame arrester unit	A, B	B	C

The housing can also be delivered in steel with an ECTFE coating.

Special materials upon request

Table 4: Material combinations of the flame arrester unit

Design	A	B	C
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
FLAMEFILTER® *	Stainless steel	Stainless steel	Hastelloy
Spacers	Stainless steel	Stainless steel	Hastelloy

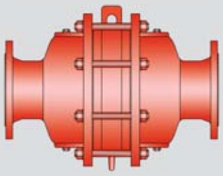
* the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request



Flame Arrester

for vacuum pumps, compressors and blowers

PROTEGO® FA-I-V and FA-I-P

Type (for suction side)		Type (for pressure side)		Temperature sensor		Number of FLAMEFILTER®		FLAMEFILTER® gap		Nominal width (NG)		Nominal size (DN)		Material (housing)		Material (flame arrester unit)		Flange connection type
FA-I-V	or	FA-I-P	–		–		–		–		/		–		–		–	
Design						Tab. 1		Tab. 2		Tab. 1		Tab. 1		Tab. 3		Tab. 4		Tab. 5

Order example

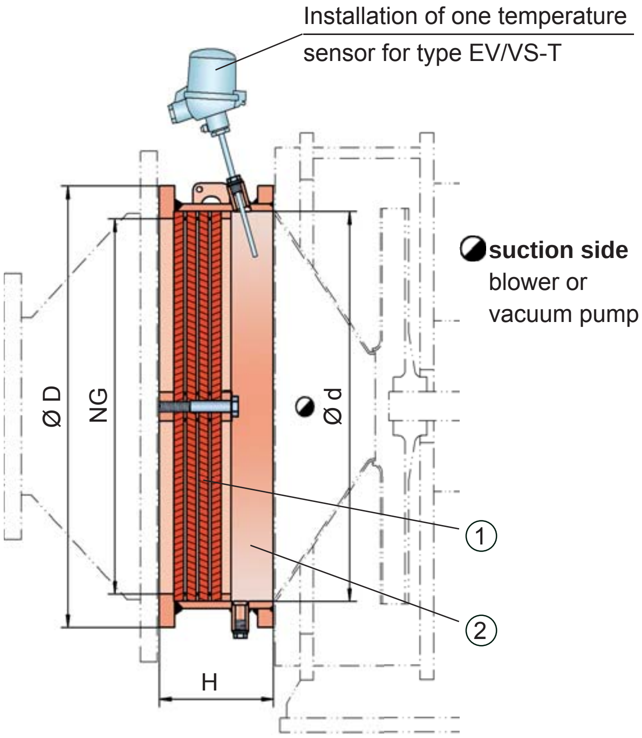
FA-I-V	—	–	T	–	*	–	0.5	–	300	/	150	–	B	–	B	–	DIN

* according to type-approval
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Notes:

PROTEGO® EV/VS and EV/VD

Type EV/VS

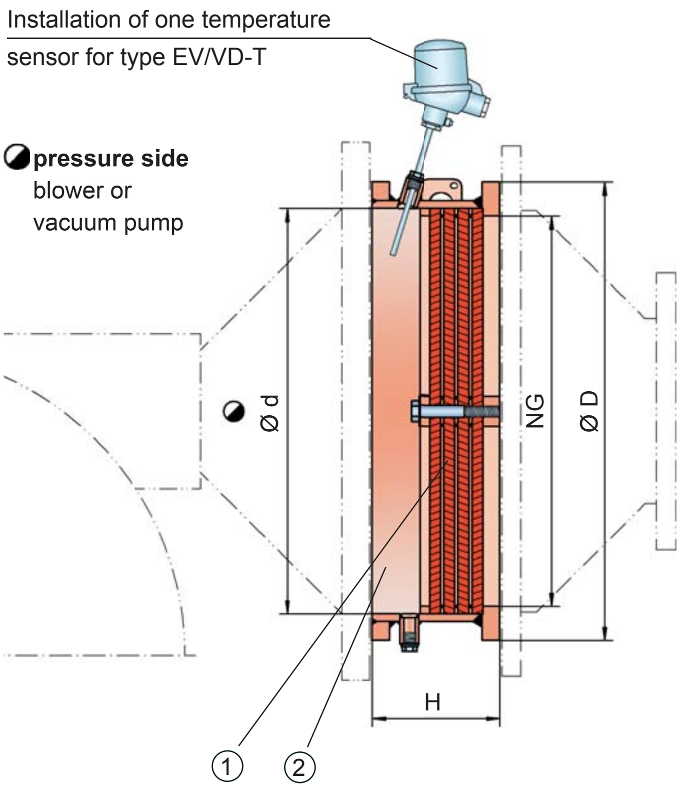


Function and Description

PROTEGO® EV/VS and PROTEGO® EV/VD flame arrester units provide manufacturers of vacuum pumps, blowers and compressors with a cost-effective protection for their machines. The high flow velocities in the small gaps of these machines can lead to undesirable ignitions within the housing. One of the safest measures against explosion propagation are flame arrester units that are installed on the inlet and outlet side of the machines. PROTEGO® EV/VS for inlet (vacuum side) and PROTEGO® EV/VD for outlet (pressure side) are flame arrester units without housing. They are designed modular providing each manufacturer of blowers, vacuum pumps or similar devices the option of using optimized, adapted, and cost-effective flame arrester units. Our expert technical staff will assist you with the proper selection of the devices as well as execution of type testing.

PROTEGO® EV/VS and PROTEGO® EV/VD flame arrester units are modular in design and consist of several FLAMEFILTER® (1) and spacers firmly held in a FLAMEFILTER® cage (2). The number of FLAMEFILTER® and the gap size depend on the intended use. Both types have a threaded nozzle for temperature sensors. PROTEGO® EV/VS and PROTEGO® EV/VD flame arrester units are available for explosion groups from IIC to IIA (NEC groups B to D) and special gases such as ethylene oxide.

Type EV/VD



Special Features and Advantages

- cost-effective alternative to complete flame arresters with flange connection
- customized protection for vacuum pumps, blowers and compressors
- modular design provides every user with the optimal PROTEGO® flame arrester unit
- flexible design parameters result in lowest pressure drops
- the modular design enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- worldwide, long-term availability of spare parts in different materials

Design and Specifications

There are four different designs:

Flame arrester unit for the inlet side, basic design **EV/VS** –

Flame arrester unit for the inlet side with integrated temperature sensor* for additional protection against short-time burning on one side **EV/VS - T**

Flame arrester unit for the pressure side, basic design **EV/VD** –

Flame arrester unit for the pressure side with integrated temperature sensor* for additional protection against short-time burning on one side **EV/VD - T**

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

NG	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	400 / 16"	500 / 20"	600 / 24"
D	102 / 4.02	138 / 5.43	158 / 6.22	212 / 8.35	268 / 10.55	320 / 12.60	370 / 14.57	482 / 18.98	585 / 23.03	685 / 26.97
d	69 / 2.72	93 / 3.66	117 / 4.61	172 / 6.77	218 / 8.58	275 / 10.83	325 / 12.80	415 / 16.34	515 / 20.28	615 / 24.21
H	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69	170 / 6.69

Table 2: Selection of FLAMEFILTER® gap / Explosion group

FLAMEFILTER® gap	MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
0.7 mm	> 0.90 mm	IIA	D
0.5 mm	≥ 0.65 mm	IIB3	C
0.3 mm	≥ 0.50 mm	IIB	C
0.2 mm	< 0.50 mm	IIC	B

Table 3: Material selection of Flame arrester unit

Design	A	B	C
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
Gasket	WS 3822	PTFE	PTFE
FLAMEFILTER® Set	A, B	B	C

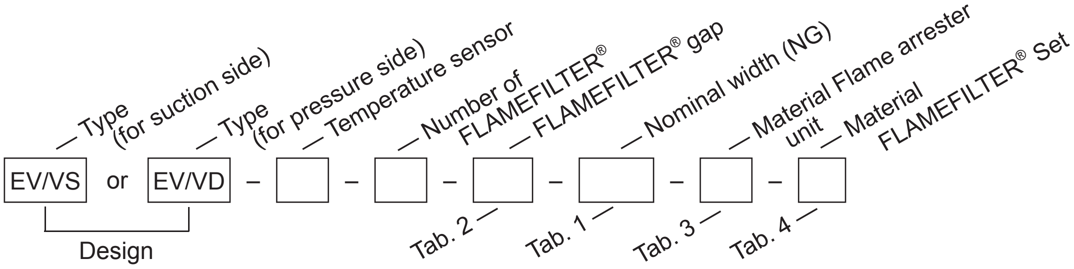
Special materials upon request

Table 4: Material selection of FLAMEFILTER® Set

Design	A	B	C
FLAMEFILTER® *	Stainless steel	Stainless steel	Hastelloy
Spacers	Stainless steel	Stainless steel	Hastelloy

* the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed cage materials are used.

Special materials upon request



Order example

EV/VS	—	T	*	0.5	600	B	B

* according to type-approval

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

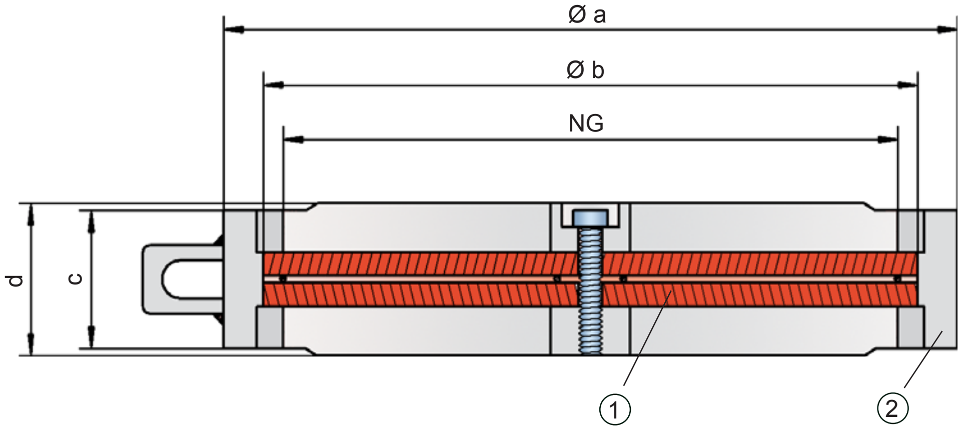
Flow capacity curves are provided for each individual application

PROTEGO
for safety and environment

Flame Arrester Unit

for installation in devices

PROTEGO® FA-I-FC



Function and Description

The PROTEGO® FA-I-FC flame arrester unit is type tested and approved as an integral part of equipment. It consists of a FLAMEFILTER® cage (2) filled with FLAMEFILTER® (1). The FLAMEFILTER® cages are sized so that they can be installed between flange connections. The component provides equipment manufacturers protection against deflagrations, volume deflagrations or protection of engines. Each PROTEGO® flame arrester unit is selected from a modular system that provides each manufacturer the option of using optimized, adapted, and cost-effective protection. Our expert technical staff will assist you with the proper selection of the devices as well as execution of type testing.

The PROTEGO® FA-I-FC flame arrester unit consists of two FLAMEFILTER® installed within the FLAMEFILTER® cage. The FLAMEFILTER® diameter and gap size depend on the intended use. PROTEGO® FA-I-FC components can be arranged for all explosion groups and special gases such as ethylene oxide.

Special Features and Advantages

- cost-effective alternative to complete flame arresters with flange connection
- customized protection for machines and engines
- available sizes from DN 50 / 2” to DN 2000 / 80”
- modular design provides optimal flame arrester unit for every application
- flexible design parameters result in lowest pressure drops
- modular design enables individual FLAMEFILTER® to be replaced and cleaned
- modular design reduces spare parts cost
- worldwide, long-term availability of spare parts
- needs to be type tested for specific application together with equipment

Design and Specifications

Basic flame arrester unit design **FA-I-FC**

Table 1: Dimensions — Dimensions in mm / inches

NG	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"
a		135 / 5.31	155 / 6.10	194 / 7.64	248 / 9.76	310 / 12.20	363 / 14.29	420 / 16.54	465 / 18.31
b		90 / 3.54	110 / 4.33	172 / 6.77	225 / 8.86	285 / 11.22	331 / 13.03	380 / 14.96	430 / 16.93
c		50 / 1.97	50 / 1.97	55 / 2.17	65 / 2.56	–	70 / 2.76	–	70 / 2.76
d		–	–	–	–	76 / 2.99	–	86 / 3.39	–

NG	500 / 20"	600 / 24"	800 / 32"	1000 / 40"	1200 / 48"	1400 / 56"	1600 / 64"	2000 / 80"	
a	555 / 21.85	655 / 25.79	855 / 33.66	1070 / 42.13	1280 / 50.39	1500 / 59.06	1700 / 66.93		
b	515 / 20.28	615 / 24.21	815 / 32.09	1015 / 39.96	1215 / 47.83	1415 / 55.71	1615 / 63.58		
c	70 / 2.76	70 / 2.76	80 / 3.15	90 / 3.54	90 / 3.54	110 / 4.33	110 / 4.33		
d	–	75 / 2.95	85 / 3.35	95 / 3.74	95 / 3.74	115 / 4.53	115 / 4.35		

Table 2: Selection of FLAMEFILTER® gap / Explosion group

FLAMEFILTER® gap	MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
0.9 mm	> 0.90 mm	IIA	D
0.7 mm			
0.5 mm	≥ 0.65 mm	IIB3	C
0.3 mm	≥ 0.50 mm	IIB	
0.2 mm	< 0.50 mm	IIC	B

Table 3: Material selection of Flame arrester unit

Design	A	B	C
FLAMEFILTER® cage	Steel	Stainless steel	Hastelloy
Gasket	WS 3822	PTFE	PTFE
FLAMEFILTER® Set	A	A	C

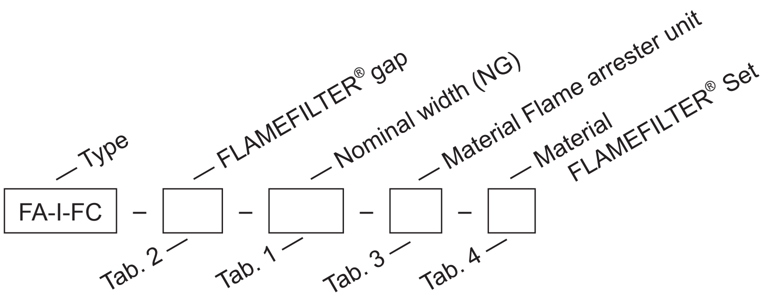
Special materials upon request

Table 3: Material selection of FLAMEFILTER® Set

Design	A	C
FLAMEFILTER® *	Stainless steel	Hastelloy
Spacers	Stainless steel	Hastelloy

* the FLAMEFILTER® is also available in the materials Tantalum, Inconel, Copper, etc. when the listed cage materials are used.

Special materials upon request



Order example

FA-I-FC	–	0.5	–	600	–	B	–	A

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow capacity curves are provided for each individual application.

Notes:

Notes:

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m^2
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	32 + 1,8 T_C
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9$ (T_F - 32)
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means

CS (Carbon steel)	= 1.0619 or 1.0425
SS (Stainless steel)	= 1.4408 or 1.4571
Hastelloy	= 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	=	polytetrafluoroethylene
PVDF	=	polyvinylidene fluoride
PFA	=	perfluoroalkoxy polyme
FPM 70	=	fluor carbon rubber
WS 3822	=	aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	=	ethylene chlorotrifluoro ethylene
FEP	=	perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937	inch	1 inch		= 25,4 mm
1 m	= 3.2808	ft	1 ft	= 12 inch	= 0,3048 m
	= 1.0936	yards	1 yard	= 3 ft	= 0,9144 m
1 km	= 0.621	miles	1 mile		= 1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	= 6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	= 0,0929 m^2
	= 1.196	sq yards	1 sq yard	= 0,836 m^2
1km^2	= 100	hectares		
	= 0.3861	sq miles		
	= 247	acres		

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	= 16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	= 28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	= 4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	= 3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	= 0,028317 m^3
	= 6.299	petr. barrels	1 petr. barrel	= 0,15876 m^3

Mass

1 g	= 0.03527 oz	1 oz	= 28,35 g
1 kg	= 2.2046 lb	1 lb	= 16 oz
			= 0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85 ft/min	1 ft/min	= 0,508 cm/s
1 km/h	= 0.6214 mph	1 mph	= 1,60934 km/h
1 m^3/h	= 4.403 gal/min (US)	1 gal/min (US)	= 0,227 m^3/h
	= 3.666 gal/min (UK)	1 gal/min (UK)	= 0,273 m^3/h
	= 0.5886 cu ft/min	1 cu ft/min	= 28,317 liter/min
1 kg/h	= 0.0367 lb/min	1 lb/min	= 27,216 kg/h
		1 cu ft/h	= 0,028317 m^3/h

Torsion

1 Nm	= 0.723 lbf ft	1 lbf ft	= 1,38 Nm

Density

1 kg/dm^3	= 62.43 lb/cu ft	1 lb/cu ft	= 0,016 kg/dm^3

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

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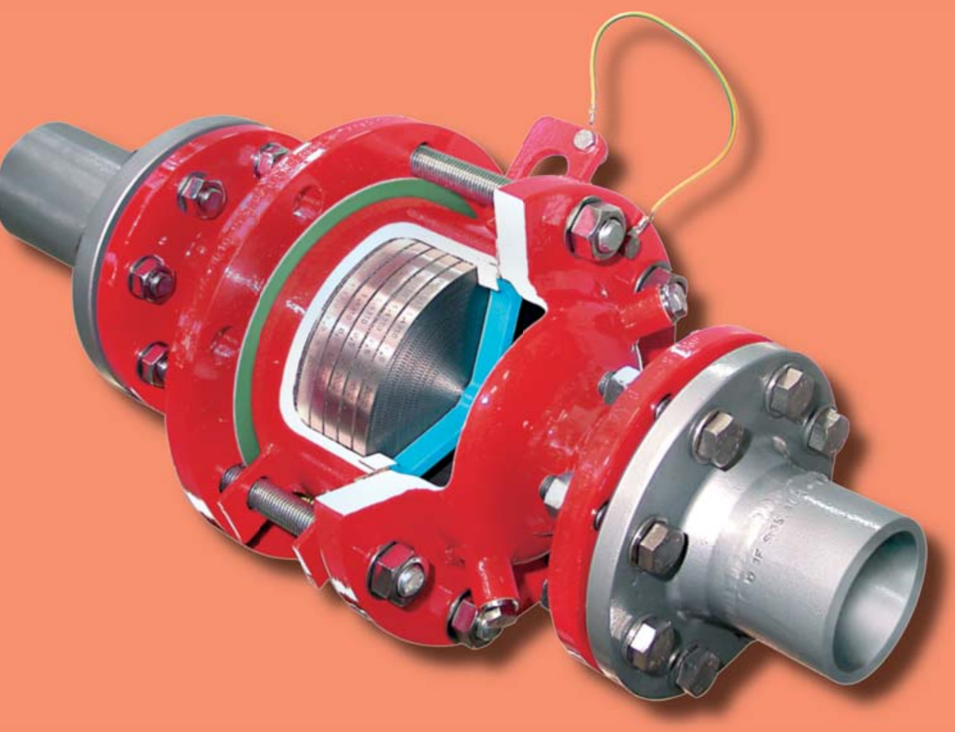
PROTEGO
for safety and environment

PROTEGO® **Detonation Flame Arresters**



Volume 4

Edition 2010

for safety and environment

More than 50 years ago, PROTEGO® started developing special devices to protect systems against explosions as well as pressure and vacuum relief valves that met the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents but also to imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

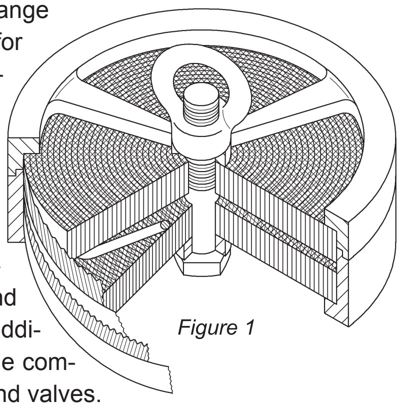
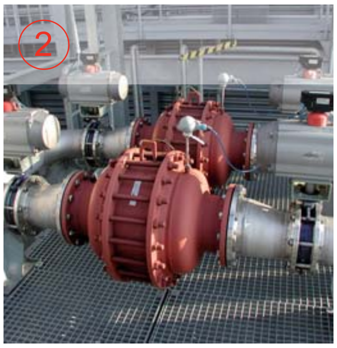
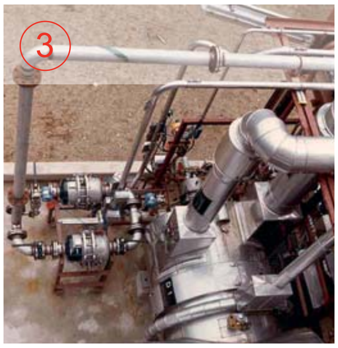


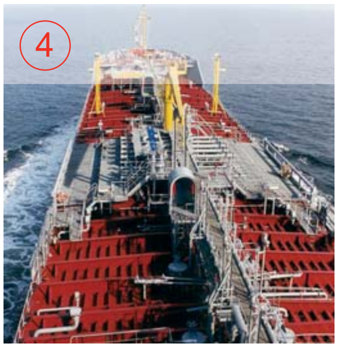
Figure 1

All of our devices are tested by independent national and international third parties in the world‘s largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.





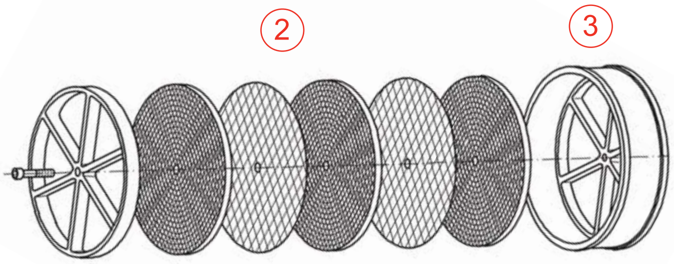


Function and description

The function of flame arresters in the various combustion processes and applications is discussed in „Technical Fundamentals" (→ Vol. 1). In this chapter, PROTEGO®'s product line of **detonation arresters** for **stable** and **unstable detonations** is presented.

PROTEGO® detonation flame arresters are highly developed safety devices that are used in pipe systems in which detonations can occur. They reliably suppress the effect of a detonation, extinguish the flame, and protect non-explosionproof components and vessels.

The main component generally is the original PROTEGO® flame arrester unit (1), which takes the energy from the detonation and extinguish the flame in narrow gaps. The PROTEGO® flame arrester unit consists of several FLAMEFILTER® (2) and spacers, firmly held in the FLAMEFILTER® cage (3). The number of FLAMEFILTER® and their gap size depend on the devices intended use and on process parameters such as temperature, pressure, vapour group of the handled gases.



1 *PROTEGO® flame arrester unit*

All dry detonation flame arrester types have a modular design. For larger nominal diameters, energy is withdrawn from the detonation shock wave upon entering the patented shock absorber, the SWGTE (Shock Wave Guide Tube Effect), and other innovative technical solutions, before the detonation reaches the FLAMEFILTER®.

Dry PROTEGO® detonation flame arresters are also tested and safe with respect to deflagrations. Equipped with an additional temperature sensor, they are also protected from short-time stabilized burning on the FLAMEFILTER®.

In close collaboration with scientific institutions, PROTEGO® has developed safety devices that can be used in any area subject to an explosion hazard and protects against stable and unstable detonations, unidirectional or bidirectional. Corresponding statements of conformity (CE, FM, etc.) have been awarded based on type tests according to ATEX, PED, and other international standards.

A wide range of types, designs, nominal diameters and materials are available. In addition, we are able to develop tailored solutions at our worldwide unique testing facility.

Special features and advantages

The most important distinctive features are the selection criteria: **Stable or unstable** detonations, **dry detonation arresters** for installation in gas- or vapour-conducting pipes, or **liquid detonation arresters**, i.e. flame arresters with a liquid barrier for pipes in which liquids are transported. For the parameters of pressure and temperature, **special operating conditions** beyond standard values may have to be considered.

It is important to categorize the products or the components of the mixture into **explosion groups** according to their MESG to select the suitable flame arrester from the various designs for all the explosion groups.

The designs differ according to their **concentric, eccentric, and 90-degree design.**

The respective system specification must be considered when choosing the required **nominal diameters and types of connection.**

A **heating jacket** may be necessary, but not every device can be provided with a heating jacket.

There are designs for **critical media**, special **product properties** (such as viscosity, density, crystallization, and polymerization), and for **unidirectional or bidirectional protection.**

Preferred applications

Protection of

- Piping systems
- Tanks and vessels in chemical, petrochemical, and pharmaceutical processing plants
- Loading systems
- Gas collection systems
- Exhaust gas combustion systems
- Flare systems
- Landfills and biogas systems
- Waste-water treatment plants

Installation and maintenance

PROTEGO® detonation flame arresters are also tested and protect against deflagrations so that they can be used at any distance from a potential ignition source. However, they are preferably installed as close as possible to the part of the system to be protected. No pipes with a nominal diameter greater than the nominal diameter of the devices can be connected to detonation arresters.

Given the modular design of the PROTEGO® flame arrester unit, any type of detonation flame arrester is extremely easy to service. For servicing reasons, the location of the flame arrester must be planned to be very accessible; a hoist must be provided if the flame arrester is heavy. Servicing is easy for trained personnel.

PROTEGO® detonation flame arresters are used in areas subject to explosion hazards. Select devices that match the intended use. The manufacturer's certificate of conformity provides the boundary conditions for which the device is suitable. The user has to document proper use in accordance with applicable safety guidelines or standards.

Selection

The possible types are pre-selected from the product line based on the most important process data:

- **Stable** detonations or **unstable detonations**
- Lines that conduct **dry gas/vapours** or **liquids**
- Standard or **non-standard operating conditions** (pressure and temperature)
- **Explosion group** of the transported mixture

Finally, the following criteria are reviewed and selected:

- Approvals according to ATEX, FM, USCG, CSA, GOST-R, GL, IMO, etc.
- Concentric, excentric, or 90-degree design
- Nominal diameter and type of connection
- Heating jacket or customer-supplied electrical heat tracing
- Critical media
- Unidirectional or bidirectional

If no suitable device can be found, please contact us. Special designs and approvals are available.

Based on this initial selection, the additional details such as materials, coatings, etc. can be requested or defined in the type sheet.

Sizing

The nominal diameter of the device is determined or checked in the p/V flow chart. A safety margin must be provided when the processed fluid is highly contaminated.

Given: Volume flow — m^3/h or CFH

Given: Max. all. pressure drop — Δp mbar or In W.C.

Desired: Nominal diameter of the detonation flame arrester — DN

Procedure: Intersection of the lines with the volume flow and maximum allowable pressure drop lies above or on the desired nominal diameter curve

or

Given: Volume flow — m^3/h or CFH

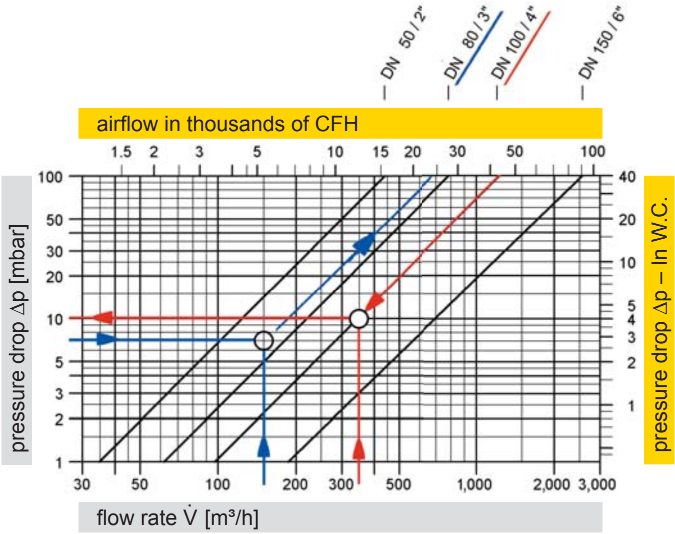
Given: Nominal diameter of pipe — DN

Desired: Pressure drop — Δp mbar or In W.C.

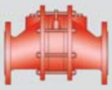
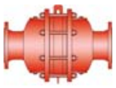
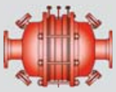
Procedure: Intersection of the lines with the volume flow and nominal diameter curve, horizontal straight line leads to the desired pressure drop

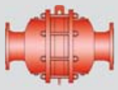
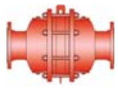
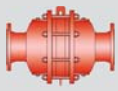
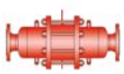
Instructions on how to calculate the volumetric flow or influence of density are found in Vol. 1 „Technical Fundamentals".

After all steps are complete, the device can be completely specified and requested or ordered.



PROTEGO® Detonation Flame Arrester

	Type	Size	Design cc = concentric ec = eccentric	Explosion Group ATEX	Explosion Group NEC	Approvals	O = dry type × = liquid type	O = for non-standartd operating parameter	O = for critical medium (polimerisation, corrosion, crystallisation)	O = Heating jacket, Heating coil	O = unidirectional, × = bidirectional	Page
for stable detonation												
	DA-G	G ½" - G 2"	straigth through, cc	IIA, IIB3, IIC	D, C, B	ATEX	O	O			×	8 - 11
	DR/SV	G ½" - G ¾"	straight through, cc	IIA	D	ATEX	O				O	12 - 13
	DA-E	25-300 1" - 12"	straight through, ec	IIA, IIB3	D, C	ATEX	O	O			×	14 - 16
	DA-SB	50-600 2" - 24"	straight through, cc	IIA, IIB3, IIC	D, C, B	ATEX	O	O		O	×	18 - 25
	DA-SB-PTFE	50-100 2" - 4"	straight through, cc	IIA	D	ATEX	O		O		×	26 - 29
	DR/ES	G ¼" - G ¾"	90-degree	IIA, IIB3, IIC	D, C, B	ATEX	O	O			O	30 - 32
	DR/ES	25-200 1" - 8"	90-degree	IIA, IIB3	D, C	ATEX	O/×	O		O	O	34 - 38
	DR/ES-V	40-200 1 ½" - 8"	90-degree	IIA, IIB3	D, C	ATEX	O	O		O	O	40 - 44
	DR/ES-PTFE	40-150 1 ½" - 6"	90-degree	IIA	D	ATEX	O		O		O	46 - 48
	DR/SBW	50-400 2" - 16"	straight through, cc	IIA, IIB3	D, C	ATEX	O	O		O	×	50 - 53
	LDA-W	25-300 1" - 12"	straight through	IIA, IIB3	D, C	ATEX	×		O		O	54 - 56
	LDA-WF(W)	25-250 1" - 10"	straight through	IIA, IIB3	D, C	ATEX	×		O		O	58 - 60

	Type	Size	Design cc = concentric ec = eccentric	Explosion Group ATEX	 NEC	Approvals	O = dry type × = liquid type	O = for non-standardt operating parameter	O = for critical medium (polimerisation, corrosion, crystallisation)	O = Heating jacket, Heating coil	O = unidirectional, × = bidirectional	Page
for stable detonation												
	LDA	25-250 1" - 10"	vertical	IIA, IIB3	D, C	ATEX	×				O	62 - 64
	LDA-F	25-250 1" - 10"	vertical	IIA, IIB3	D, C	ATEX	×				O	66 - 68
	EF/V	25-250 1" - 10"	vertical	IIA, IIB3	D, C	ATEX	×				O	70 - 71
	BR/TS	80 3"	90-degree	IIB3	C	CE	O				O	72 - 73
for unstable detonation												
	DA-UB	50-600 2" - 24"	straight through, cc	IIA, IIB3	D, C	ATEX	O	O		O	×	74 - 79
	DA-CG	50-600 2" - 24"	straight through, cc	IIA, IIB3	D, C	USCG	O	O		O	×	80 - 85
	DA-FM	50-250 2" - 10"	straight through, cc	IIB3	C	FM	O			O	×	86 - 90
	DA-CSA	50-400 2" - 16"	straight through, cc	IIA, IIB3	D, C	CSA	O	O			×	92 - 94
	DR/EU	25-150 1" - 6"	90-degree	IIA, IIB2, IIB3	D, D, C	ATEX	O	O		O	O	96 - 99
	DR/FM	40-150 1 ½" - 6"	90-degree	IIA, IIB3	D, C	FM	O	O		O	O	100 - 103

Larger sizes upon request

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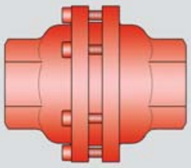
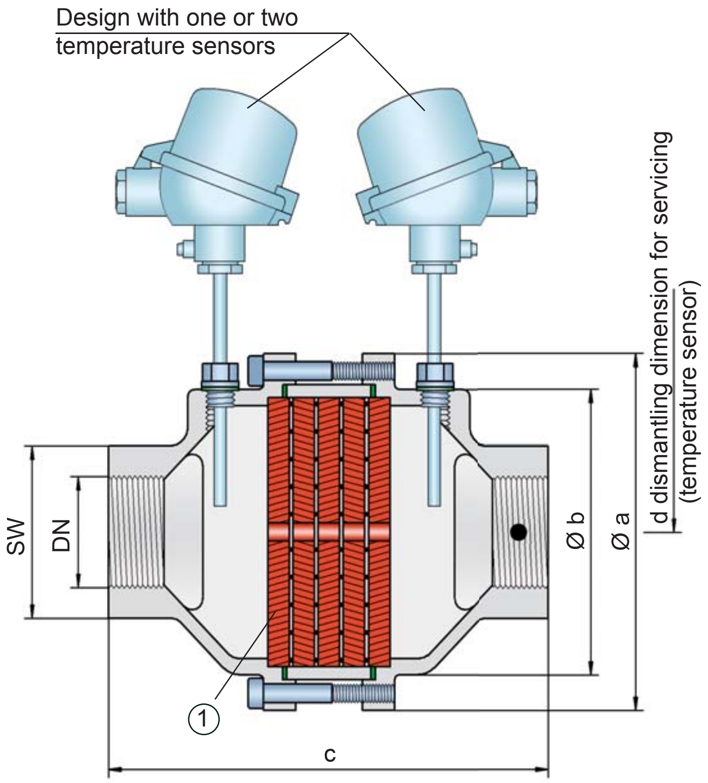


In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design, bidirectional

PROTEGO® DA-G



● Connection to the protected side (only for type DA-G-T-...)

Function and Description

The PROTEGO® DA-G series is a compact in-line detonation flame arrester for installation in pipes with diameters up to 2“, and is used, for example, in industrial applications such as gas analysis lines.

Once a detonation enters the flame arrester, energy is absorbed from the shock wave, and the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (1).

The PROTEGO® flame arrester unit consists of several FLAMEFILTER® firmly held in a housing. The gap size and number of FLAMEFILTER® are determined by the operating data and parameters of the mixture flowing in the line (explosion group, pressure, temperature).

To provide an optimum result between the housing size, number of FLAMEFILTER® and their gap size, a device was developed that can be used for all explosion groups, IIA, IIB3 and IIC (NEC Group D, C MESG ≥ 0.65 mm and B). The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Devices with special approvals can be obtained for higher pressures (see table 4) and higher temperatures upon request.

The device is bidirectional and equipped with a threaded connection. The thread can be executed to international standards. The detonation arrester can be used at any location in the pipe, independently from the location of the ignition source.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Bidirectional
- Modular design
- The individual FLAMEFILTER® can be quickly removed and installed
- The individual FLAMEFILTER® are easy to service and replace
- Different application possibilities
- Cost efficient spare parts
- Possible installation of temperature sensors

Design Types and Specifications

There are three different designs available:

Basic design of the DA-G in-line detonation flame arrester, size ½“ to 2“ — **DA-G- $\boxed{–}$**

In-line detonation flame arrester with integrated temperature sensor* as additional protection against short burning from one side, size 1½“ to 2“ — **DA-G- $\boxed{T}$**

In-line detonation flame arrester with two integrated temperature sensors* as additional protection against short time burning from both sides, size 1½“ to 2“ — **DA-G- $\boxed{TB}$**

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches, SW = width across flats

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	G ½"	G ¾"	G 1"	G 1 ¼"	G 1 ½"	G 2"
a	80 / 3.15	80 / 3.15	100 / 3.94	100 / 3.94	155 / 6.10	155 / 6.10
b	55 / 2.17	55 / 2.17	76 / 2.99	76 / 2.99	124 / 4.88	124 / 4.88
c (IIA)	112 / 4.41	112 / 4.41	122 / 4.80	122 / 4.80	205 / 8.07	205 / 8.07
c (IIB3 and IIC)	135 / 5.31	135 / 5.31	145 / 5.71	145 / 5.71	205 / 8.07	205 / 8.07
d	—	—	—	—	400 / 15.75	400 / 15.75
SW	32 / 1.26	32 / 1.26	50 / 1.97	50 / 1.97	75 / 2.95	75 / 2.95

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	
< 0,50 mm	IIC	B	

Table 3: Selection of max. operating pressure

		DN	G ½"	G ¾"	G 1"	G 1 ¼"	G 1 ½"	G 2"	
Expl. Gr.	IIA	P_{max}	1.2/17.4	1.2/17.4	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request
	IIB3	P_{max}	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	1.4/20.3	1.4/20.3	
	IIC	P_{max}	1.1/15.9	1.1/15.9	1.1/15.9	1.1/15.9	1.6/23.2	1.6/23.2	

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

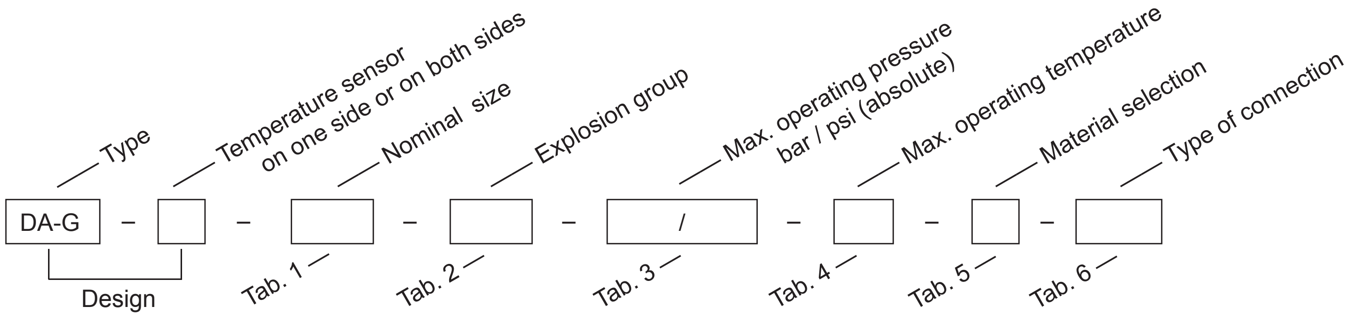
Design	A	B	C
Housing	Steel	Stainless Steel	Hastelloy
Gasket	WS 3822 *	PTFE	PTFE
FLAMEFILTER® **	Stainless Steel	Stainless Steel	Hastelloy

* for devices exposed to temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
** the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing materials are used.

Special materials upon request

Table 6: Type of connection

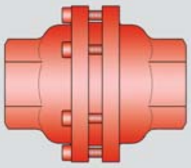
Pipe thread DIN ISO 228T1	DIN	other types of thread upon request



Order example

DA-G	TB	2"	IIB3	P1.4 / –	T60	A	DIN

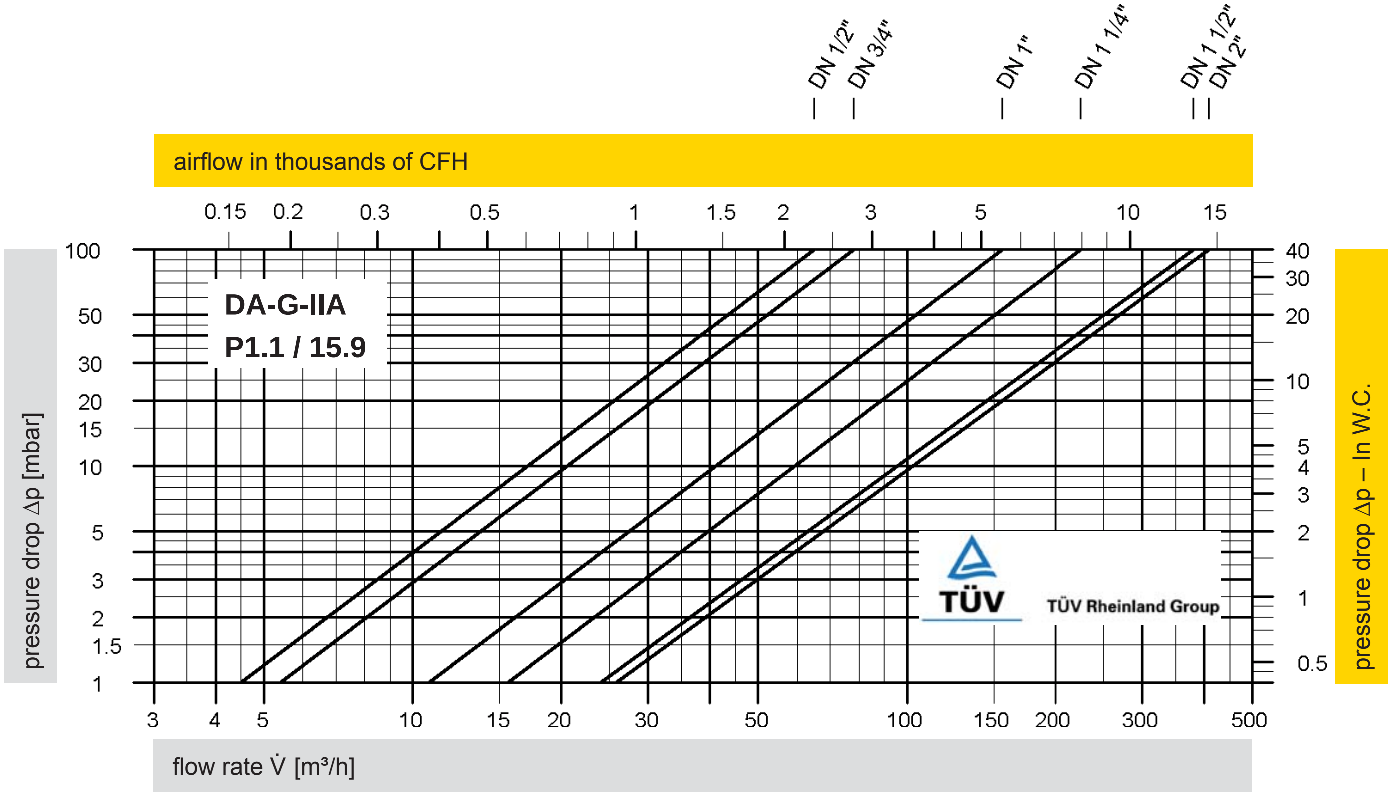
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

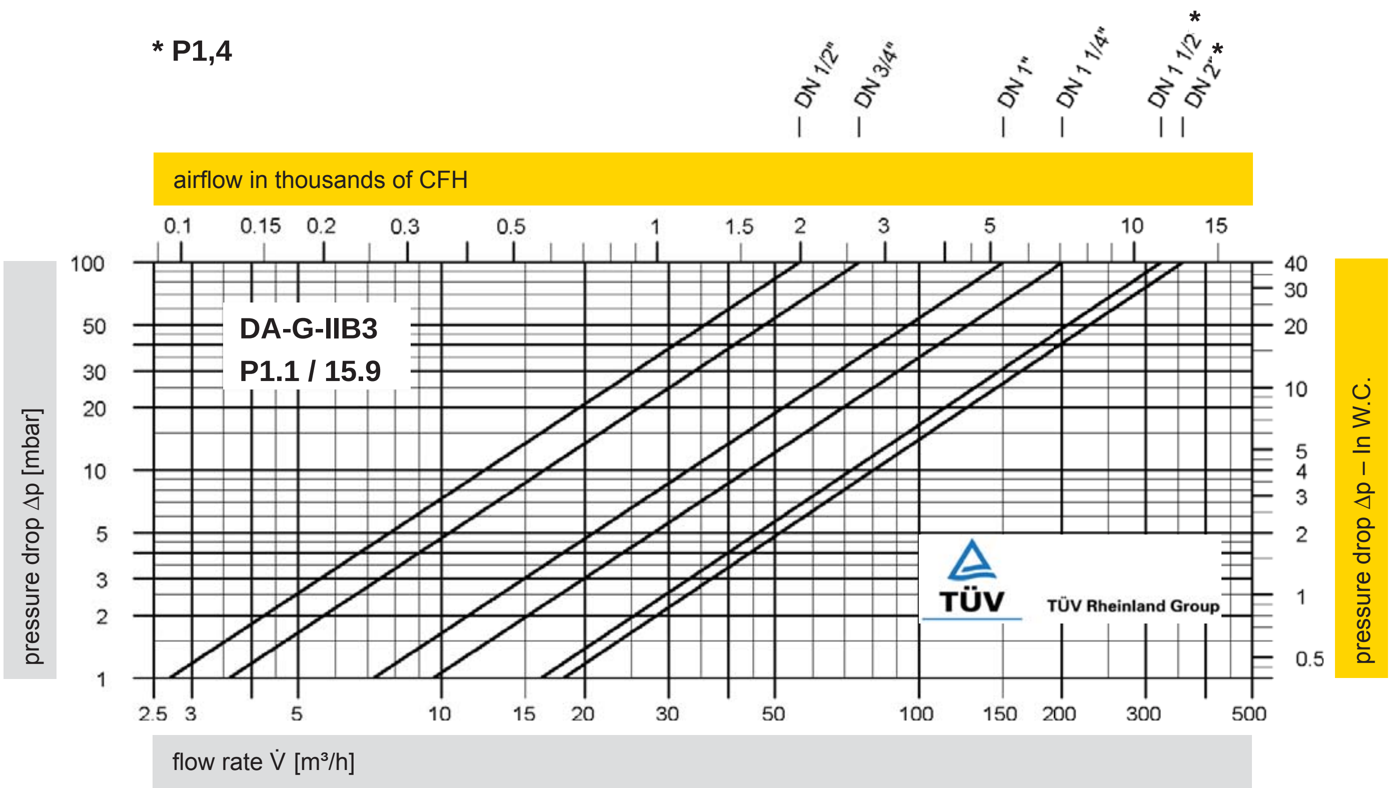


In-Line Detonation Flame Arrester

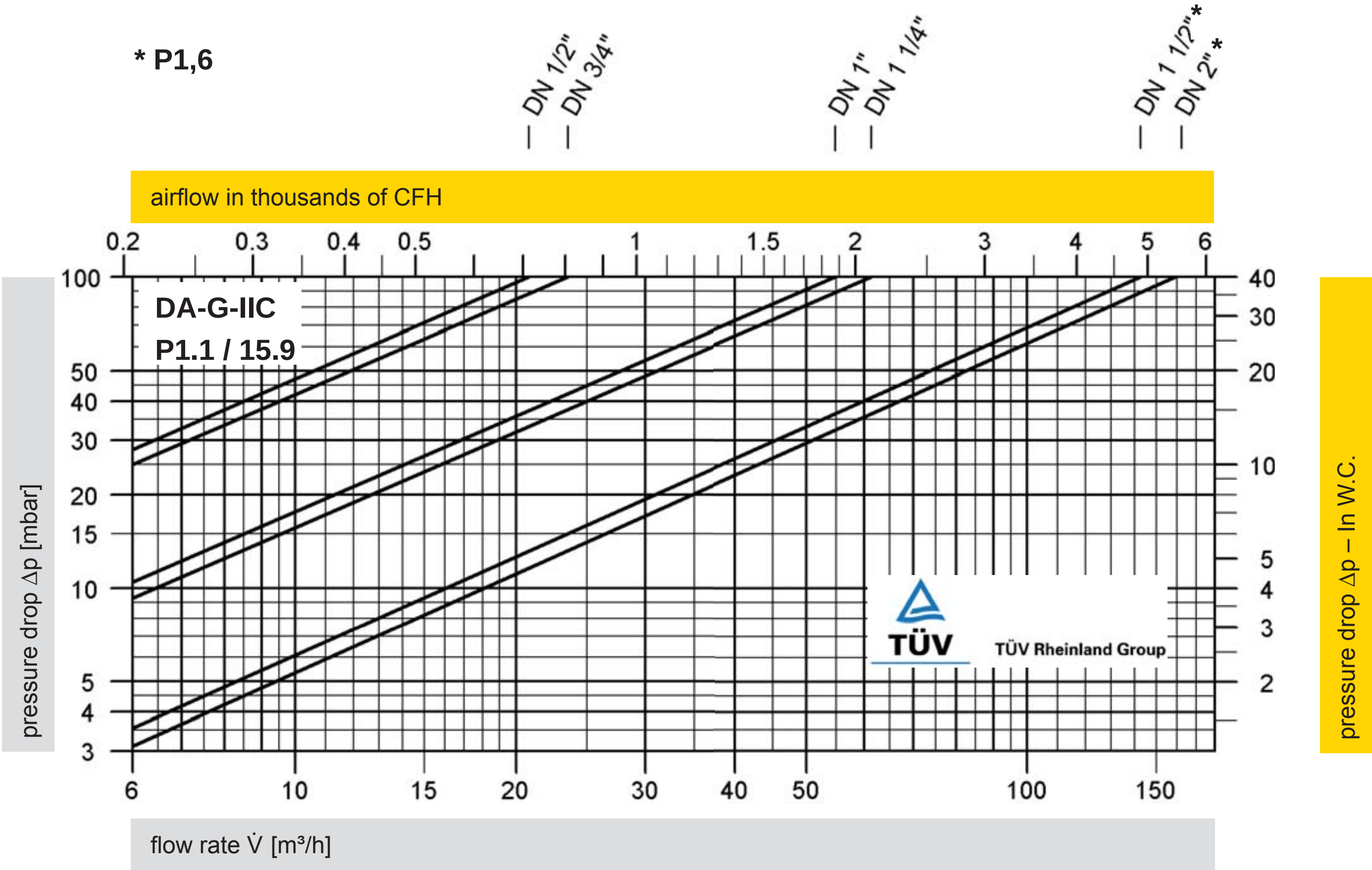
Flow Capacity Charts

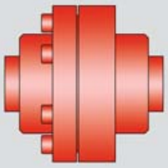
PROTEGO® DA-G





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

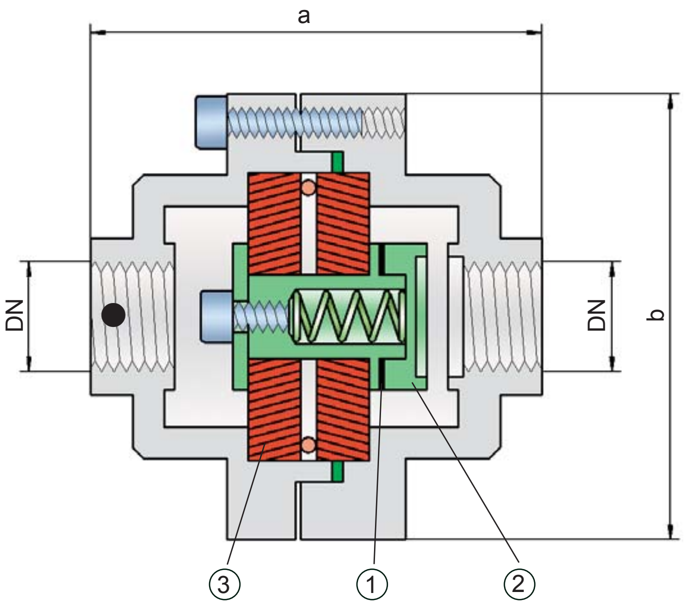

* P1,6
DN 1/2"
DN 3/4"
DN 1"
DN 1 1/4"
DN 1 1/2"*
DN 2"*
airflow in thousands of CFH
0.2
0.3
0.4
0.5
1
1.5
2
3
4
5
6
DA-G-IIC
P1.1 / 15.9
100
50
40
30
20
15
10
5
4
3
pressure drop Δp [mbar]
40
30
20
10
5
4
3
2
pressure drop Δp – In W.C.
TÜV
TÜV Rheinland Group
6
10
15
20
30
40
50
100
150
flow rate V̇ [m³/h]



In-Line Detonation Flame Arrester

with cut-off valve,
for stable detonations and deflagrations in a straight through design, unidirectional

PROTEGO® DR/SV



● Connection to the protected side

Function and Description

The PROTEGO® DR/SV flame arrester series ideally combines the function of a detonation arrester with the advantages of a cut-off valve. In case of ignition, the fire can be stabilized within the flame arrester when the flammable gas continues to flow. Inside the detonation arrester, is a valve (1) that closes in case of fire, stops the additional supply of fuel and extinguishes the flames. Temperature sensors in combination with an emergency switch off do not have to be installed when a type PROTEGO® DR/SV device is used. This device is particularly useful for the intake-side protection of compressors and pumps.

The flame arrester protects against deflagrations and stable detonations. It can be installed anywhere in the pipe independently from the distance of the potential ignition source.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by the central plate disc (2) before the flame is extinguished in the narrow gaps of the two original FLAMEFILTER® (3). This device can be used for fluids of explosion group IIA (NEC group D).

The in-line detonation flame arresters are unidirectional and equipped with a threaded connection. The thread can be executed to international standards. The standard design can be used up to an operating temperature of +60°C / 140°F and an (absolute) operating pressure up to 1.1 bar / 15,9 psi.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Protects against stabilized burning
- No expensive emergency switch-offs are required
- Temperature monitoring is not necessary
- Minimum number of FLAMEFILTER®
- Easy to maintain
- The individual FLAMEFILTER® can be quickly removed and installed
- The FLAMEFILTER® can be individually replaced
- Cost efficient spare parts
- Provides protection from deflagrations and stable detonations
- Ideal protective system for vacuum pumps

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	G ½"	G ¾"
a	115 / 4.53	115 / 4.53
b	100 / 3.94	100 / 3.94

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request

Table 3: Selection of max. operating pressure

DN	G ½"	G ¾"
P_{max}	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing		
Design	A	B
Housing	Brass	Stainless Steel
Gasket	WS 3822	WS 3822
Flame arrester unit	A	A, B

Table 6: Material combinations of the flame arrester unit		
Design	A	B
FLAMEFILTER® *	Stainless Steel	Stainless Steel
Spacer	Stainless Steel	Stainless Steel
Support for FLAMEFILTER®	Brass	Stainless Steel
Washer	Brass	Stainless Steel

Special materials upon request
* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing materials are used.

Table 7: Type of connection		
Pipe thread DIN ISO 228T1	DIN	other types of thread upon request

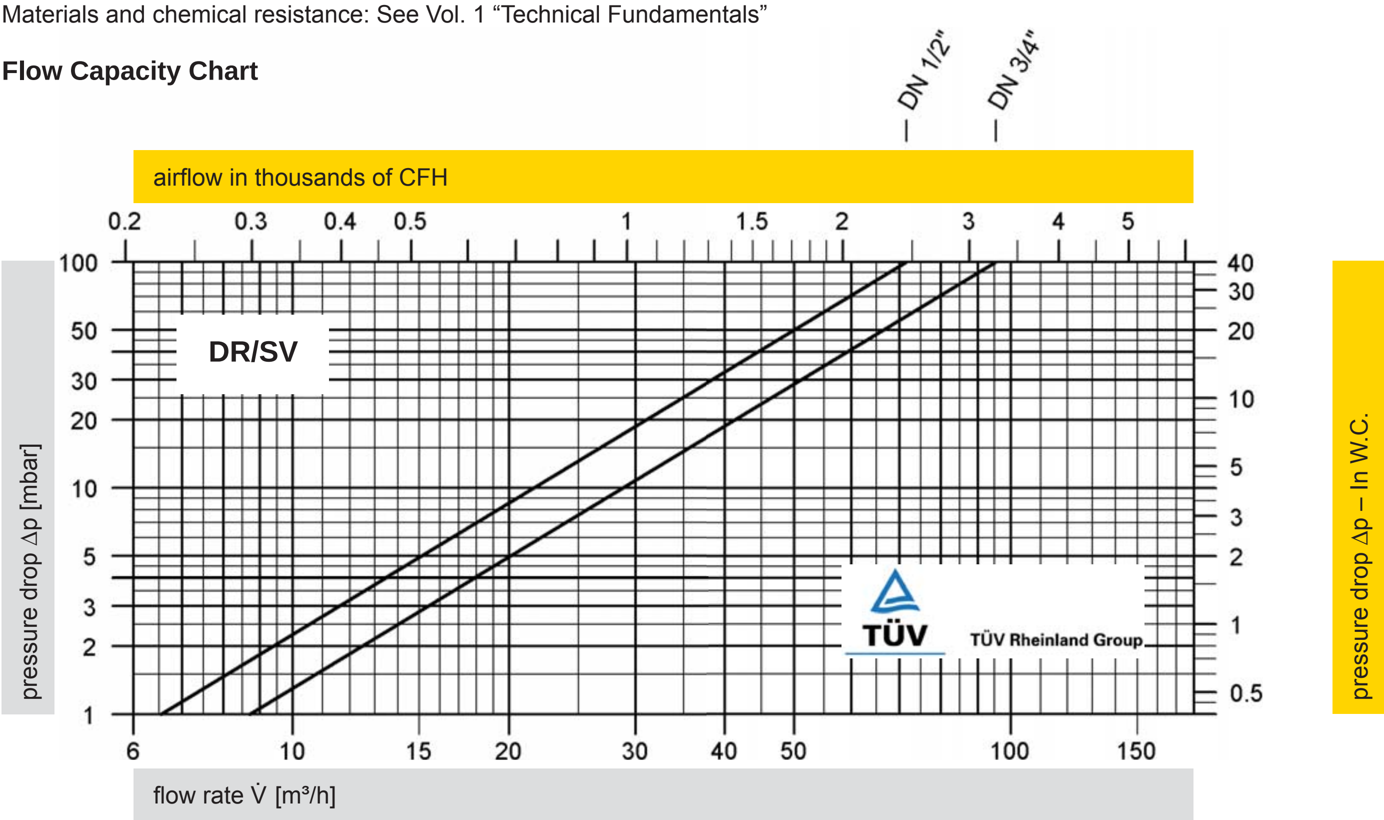
Type	Nominal size	Explosion group	Max. operating pressure bar / psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Type of connection
DR/SV			/				
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

DR/SV	½"	IIA	P1.1/ –	T60	A	A	DIN

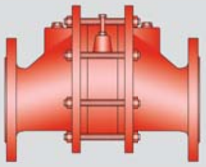
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

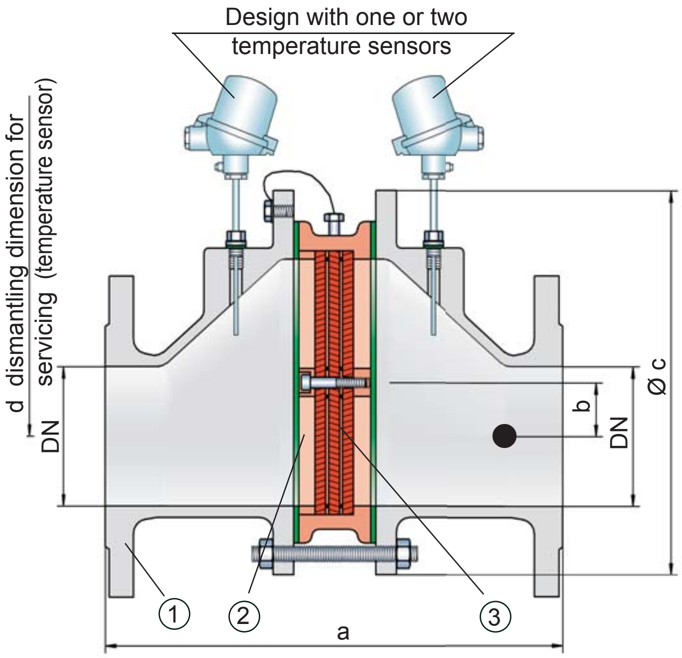
for safety and environment



Eccentric In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design, bidirectional

PROTEGO® DA-E



● Connection to the protected side
(only for type DA-E-T-...)

Function and Description

The PROTEGO® DA-E series of detonation arresters is distinguished by its eccentric housing shape. When condensate accumulates within the PROTEGO® flame arrester unit, the design enables the liquid to drain without collecting large amounts in the housing. The eccentricity of the device has decisive advantages in comparison to the classic flame arresters when pipes are installed close to the wall.

The detonation arrester is symmetrical and offers bidirectional flame arresting. The arrester essentially consists of two housing parts (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use. By indicating the operating parameters such as temperature, pressure and explosion group and the composition of the fluid, the optimum detonation arrester can be selected. The PROTEGO® DA-E series of flame arresters is available for explosion groups IIA to IIB3 (NEC Group D to C MESG ≥ 0.65 mm).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approval can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Eccentric design prevents the collection of condensate
- The modular design enables individual FLAMEFILTER® to be replaced
- Easy maintenance with quick removal and installation of FLAMEFILTER®
- Cost efficient spare parts
- Eccentric design allows installation in close to wall pipes
- Bidirectional operation as well as any flow direction and installation position
- Protects from deflagrations and stable detonations
- Possible installation of temperature sensors

Design Types and Specifications

There are three different designs available:

Basic design of the detonation arrester	**DA-E-** –
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning of one side	**DA-E-** T
Detonation arrester with two integrated temperature sensors* as additional protection against short time burning from both sides	**DA-E-** TB

Additional special arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

		DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"	300 12"
Expl. Gr.	IIA	a	304/ 11.97	304/ 11.97	320/ 12.60	325/ 12.80	370/ 14.57	375/ 14.76	380/ 14.96	481/ 18.94	487/ 19.17	510/ 20.08	540/ 21.26	560/ 22.05
	IIB3	a	304/ 11.97	304/ 11.97	357/ 14.06	361/ 14.21	408/ 16.06	412/ 16.22	428/ 16.85	493/ 19.41	499/ 19.65	522/ 20.55	552/ 21.73	572/ 22.52
		b	29/ 1.14	29/ 1.14	29/ 1.14	29/ 1.14	38/ 1.50	38/ 1.50	39/ 1.53	65/ 2.56	65/ 2.56	55/ 2.17	58/ 2.28	60/ 2.36
		c	185/ 7.28	185/ 7.28	210/ 8.27	210/ 8.27	250/ 9.84	250/ 9.84	275/ 10.83	385/ 15.16	385/ 15.16	450/ 17.72	500/ 19.69	575/ 22.64
		d	400/ 15.75	400/ 15.75	410/ 16.14	410/ 16.14	440/ 17.32	440/ 17.32	460/ 18.11	520/ 20.47	520/ 20.47	540/ 21.26	570/ 22.44	600/ 23.62

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.		DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"	300 12"
	IIA	P_{max}	1.3 / 18.8	1.3 / 18.8	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4
	IIB3	P_{max}	1.1 / 15.9	1.1 / 15.9	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	B	C	D	
Housing	Ductile Iron	Steel	Stainless Steel	Hastelloy	** for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
Gasket	WS 3822 *	WS 3822 *	PTFE	PTFE	The housing is also available in carbon steel with an ECTFE coating.
Flame arrester unit	A	A, C	C	D	

Special materials upon request

Table 6: Material combinations of the flame arrester unit

Design	A	C	D
FLAMEFILTER® cage	Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy

*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type	Temperature sensor on one side or on both sides	Nominal size	Explosion group	Max. operating pressure bar / psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
DA-E –	–	–	–	/ –	–	–	–	
Design		Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

DA-E – TB – 32 – IIA – P1.3 / – – T60 – C – C – DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

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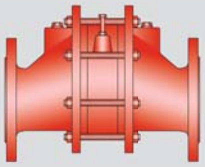
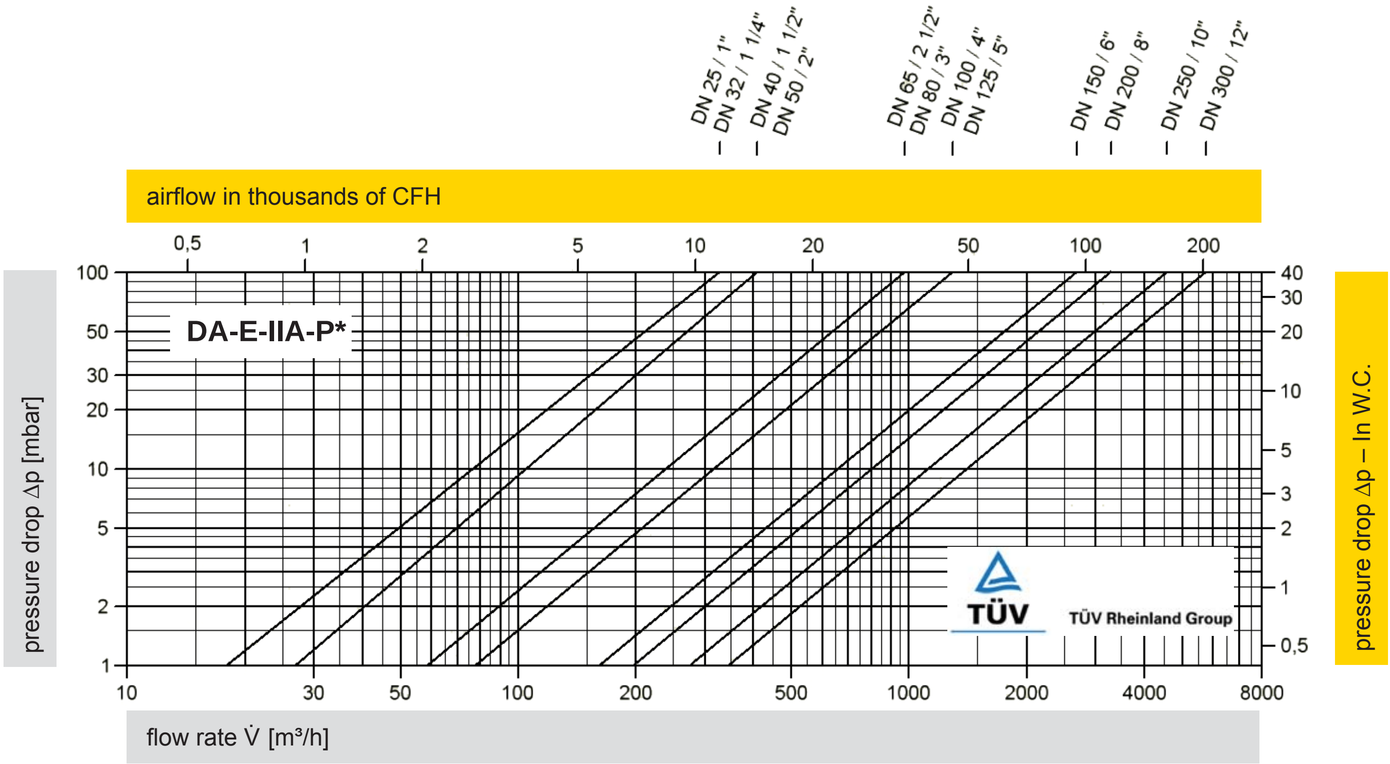


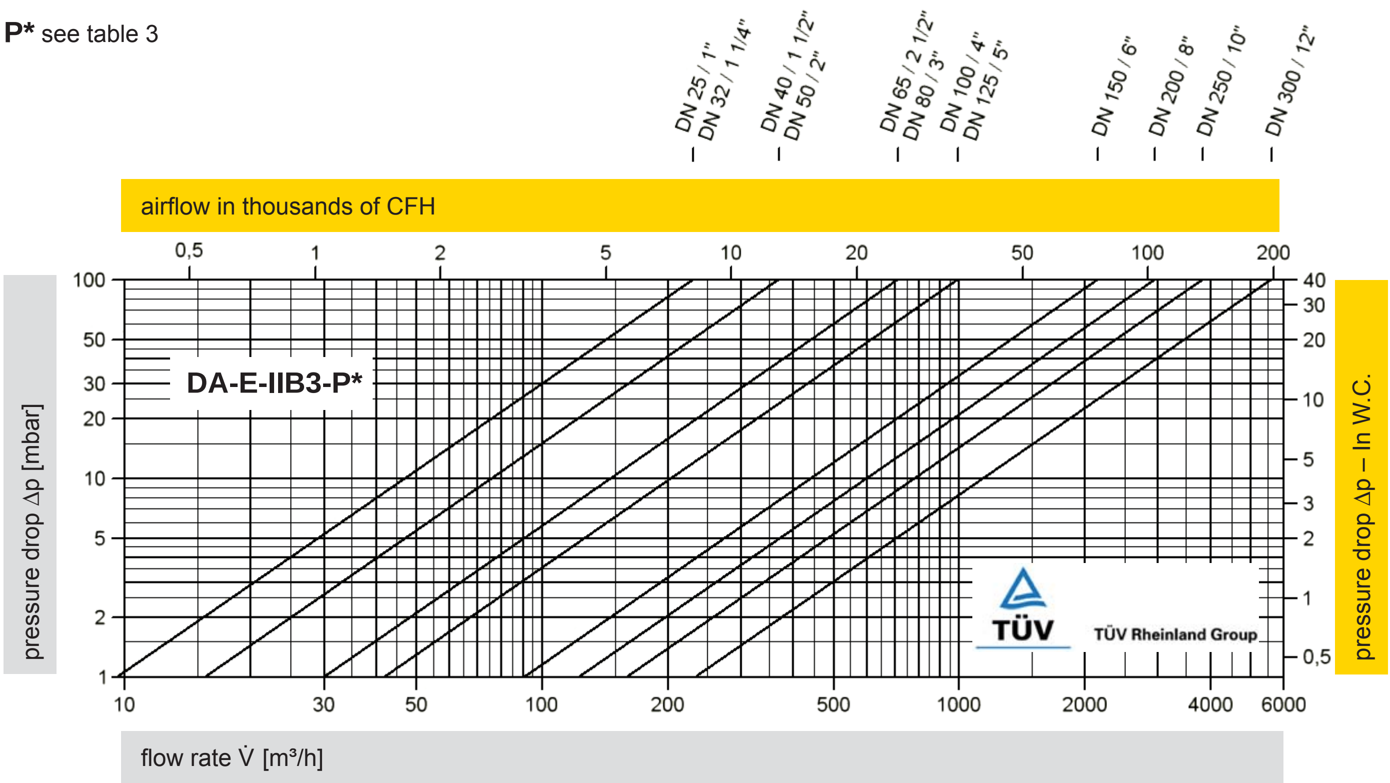
Eccentric In-Line Detonation Flame Arrester

Flow Capacity Charts

PROTEGO® DA-E



P* see table 3



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Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
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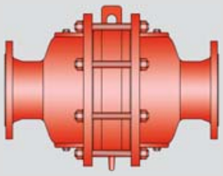
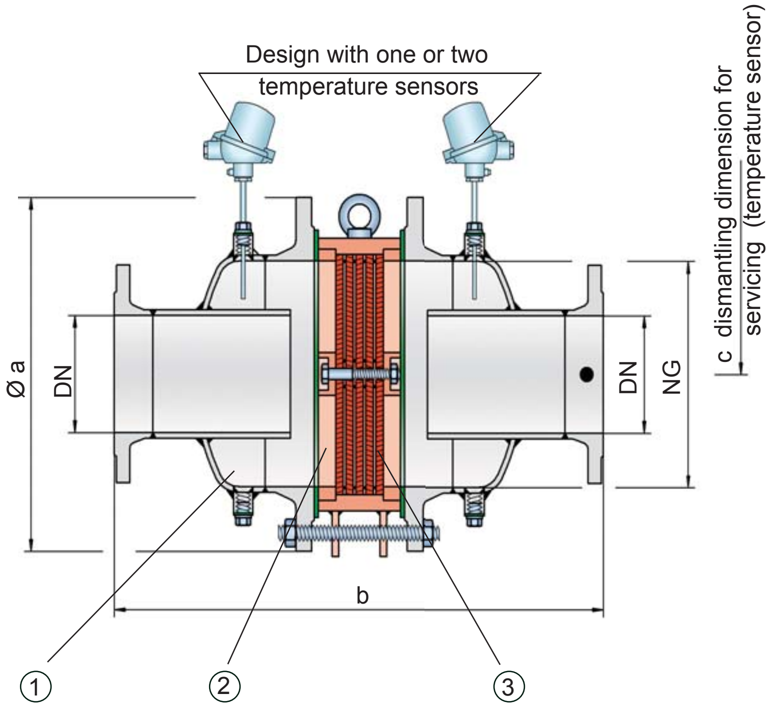
Notes:



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock tube, bidirectional

PROTEGO® DA-SB



● Connection to the protected side (only for type DA-SB-T-...)

Function and Description

The in-line detonation flame arresters type PROTEGO® DA-SB are the newest generation of flame arresters. On the basis of fluid dynamic, explosion dynamics calculation and decades of experience from field tests, a product line was developed that offers minimum pressure loss and maximum safety. The flame arrester uses the *Shock Wave Guide Tube Effect (SWGTE)* to optimally decouple the flame front and shock wave. The result is an in-line detonation arrester without a classic shock absorber; in addition the use of FLAMEFILTER® is minimized.

The devices are symmetrical and offer bidirectional flame arresting for deflagrations and stable detonations. The arrester essentially consists of two housing parts with an integrated shock tube (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use.

By indicating the operating parameters such as temperature, pressure and explosion group, and the composition of the fluid, the optimum detonation arrester can be selected from a series of approved devices. The PROTEGO® DA-SB flame arresters are available for all explosion groups.

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Numerous devices with special approval can be obtained for higher presssures (see table 3) and higher temperatures.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Optimized performance from the patented *Shock Wave Guide Tube Effect (SWGTE)*
- Less number of FLAMEFILTER® from the use of the patented shock tube *(SWGTE)*
- The modular design enables individual FLAMEFILTER® to be replaced
- Different series allow scalable pressure loss across the surface of the FLAMEFILTER®
- Minimum pressure loss and associated low operating and life-cycle costs
- Cost efficient spare parts
- Service-friendly design
- Expanded application range for higher operating temperatures and pressures
- Bidirectional operation as well as any direction of flow and installation position
- Installation of temperature sensors are possible

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DA-SB - – - –**
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DA-SB - T - –**
In-line detonation flame arrester with two integrated temperature sensors* for additional protection against short time burning from both sides	**DA-SB- TB - –**
In-line detonation flame arrester with heating jacket	**DA-SB - H -**

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select series and nominal size (DN) - nominal width (NG) combination, please use the flow capacity charts on the following pages

Series 1 (standard) **													
	DN	50 2"	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	350 14"	400 16"	500 20"	600 24"	800 32"
Series 2 (special design for improved flow capacity) **													
	DN	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	350 14"	400 16"	500 20"	-
Series 3 (special design for superior flow capacity) **													
	DN	-	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	350 14"	400 16"	-
	NG	150 6"	150 6"	200 8"	300 12"	400 16"	500 20"	600 24"	700 28"	800 32"	1000 40"	1200 48"	1600 64"
	a	285 / 11.22	285 / 11.22	340 / 13.39	445 / 17.52	565 / 22.24	670 / 26.38	780 / 30.71	895 / 35.24	1015 / 39.96	1230 / 48.43	1455 / 57.28	1915 / 75.39
Expl. Gr.	IIA b*	388 / 15.28	388 / 15.28	476 / 18.74	626 / 24.65	712 / 28.03	800 / 31.50	1000 / 39.37	1200 / 47.24	1400 / 55.12	1600 / 62.99	1800 / 70.87	
Expl. Gr.	IIB3 b*	400 / 15.75	412 / 16.22	500 / 19.69	650 / 25.59	724 / 28.50	824 / 32.44	1000 / 39.37	1200 / 47.24	1400 / 55.12	1600 / 62.99	1800 / 70.87	
Expl. Gr.	IIC b*	400 / 15.75	400 / 15.75	500 / 19.69	638 / 25.12	700 / 27.56	800 / 31.50	1000 / 39.37	1200 / 47.24	1400 / 55.12			
	c	500 / 19.69	500 / 19.69	520 / 20.47	570 / 22.44	620 / 24.41	670 / 26.38	720 / 28.35	770 / 30.31	820 / 32.28	950 / 37.40	1050 / 41.34	1250 / 49.21

* dimension b only for P1.1 / 15.9

** special sizes up to DN 1000/40“, NG 2000/80“ available

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	
< 0,50 mm	IIC	B	

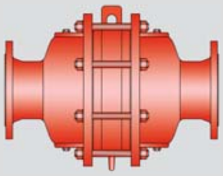
Table 3: Selection of max. operating pressure

		DN	50 2“	80 3“	100 4“	150 6“	200 8“	250 10“	300 12“	350 14“	400 6“	500 20“	600 24“	800 32“
		NG	150 6“	150 6“	200 8“	300 12“	400 16“	500 20“	600 24“	700 28“	800 32“	1000 40“	1200 48“	1600 64“
Expl. Gr.	IIA	P_{max}	2.1 / 30.5	2.1 / 30.5	2.1 / 30.5	2.1 / 30.5	2.1 / 30.5	2.1 / 30.5	1.4 / 20.3	1.4 / 20.3	1.4 / 20.3	1.1 / 15.9	1.1 / 15.9	1.2 / 17.4
Expl. Gr.	IIB3	P_{max}	1.4 / 20.3	1.4 / 20.3	1.4 / 20.3	1.8 / 26.1	1.8 / 26.1	1.8 / 26.1	1.8 / 26.1	1.4 / 20.3	1.4 / 20.3	1.1 / 15.9	1.1 / 15.9	
Expl. Gr.	IIC	P_{max}	2.2 / 31.9	2.2 / 31.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / * 15.9	1.1 / * 15.9	1.1 / * 15.9			

P_{max} = maximum allowable operating pressure in bar / psi absolut, higher operating pressure upon request

in-between size up to P_{max} upon request

* capacity charts upon request



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock tube, bidirectional

PROTEGO® DA-SB

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing				
Design	A	B	C	* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made out of PTFE. The housing is also available in Steel with ECTFE coating.
Housing Heating jacket (DA-SB-H-(T)-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel	
Gasket	WS 3822 *	PTFE	PTFE	
Flame arrester unit	A, B	B, C, D	D	

Special materials upon request

Table 6: Material combinations of the flame arrester unit					
Design	A	B	C	D	*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy	
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy	
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy	

Special materials upon request

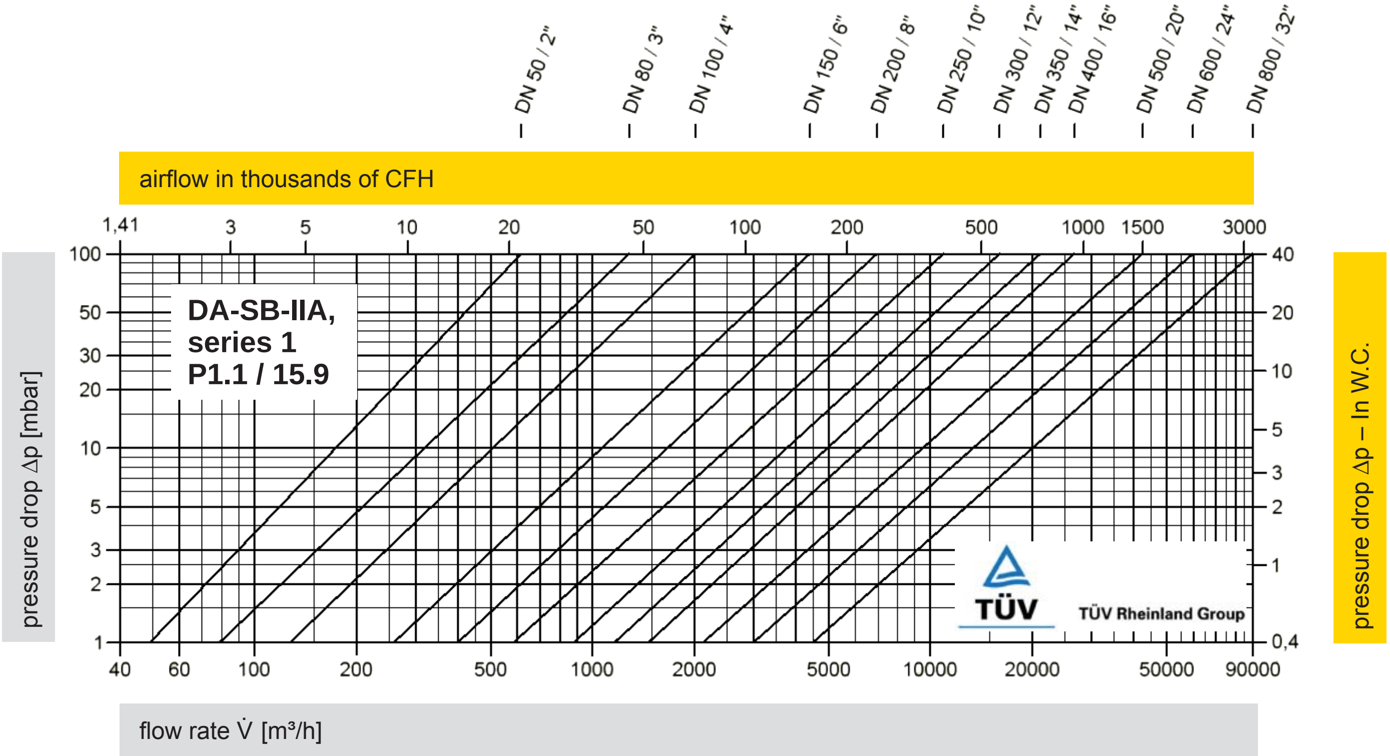
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

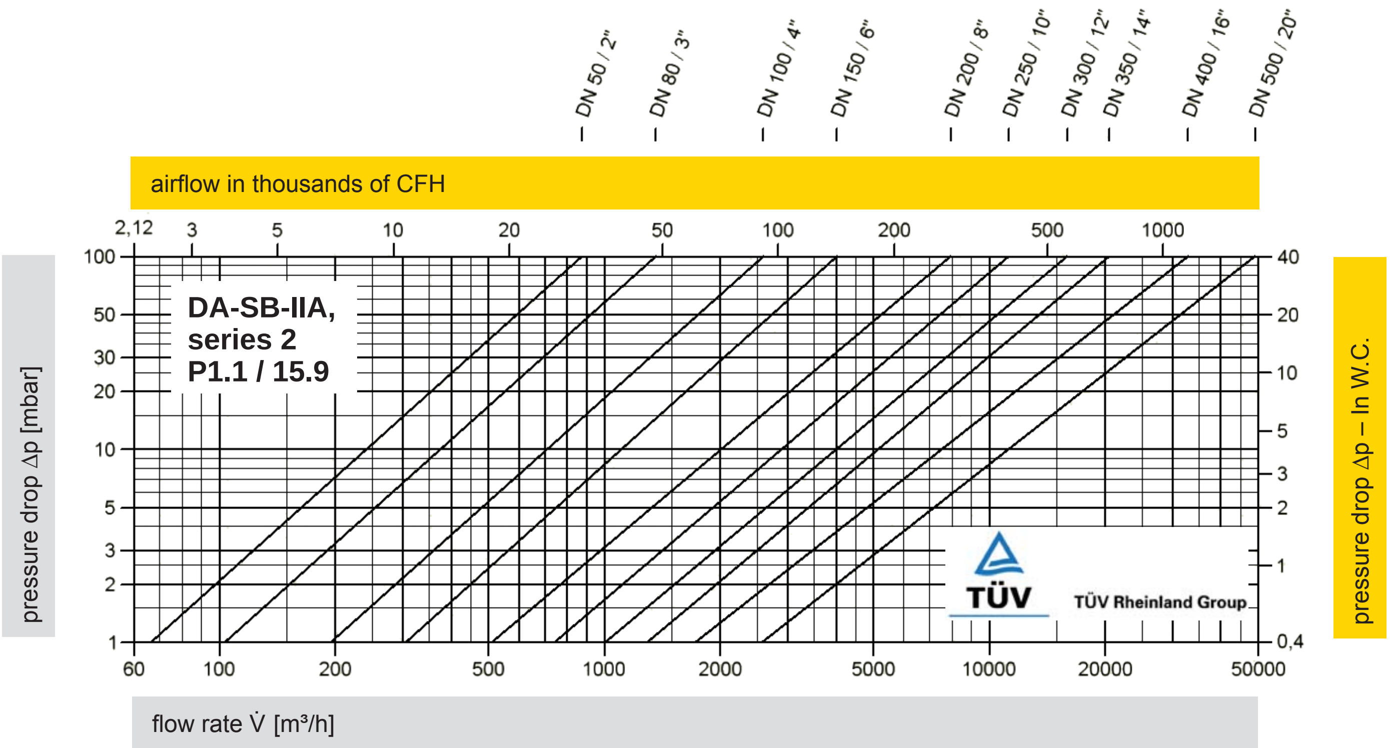
Type	Heating jacket	Temperature sensor on one side or on both sides	Nominal width (NG)	Nominal size (DN)	Explosion group	Max. operating pressure bar /psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
DA-SB –	–	–	/	–	–	/	–	–	–	
Design	Design	Design	Tab. 1	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

DA-SB –	H –	TB –	800 /	400 –	IIB3 –	P1.1/ – –	T60 –	B –	B –	DIN

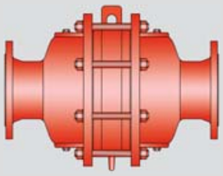
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

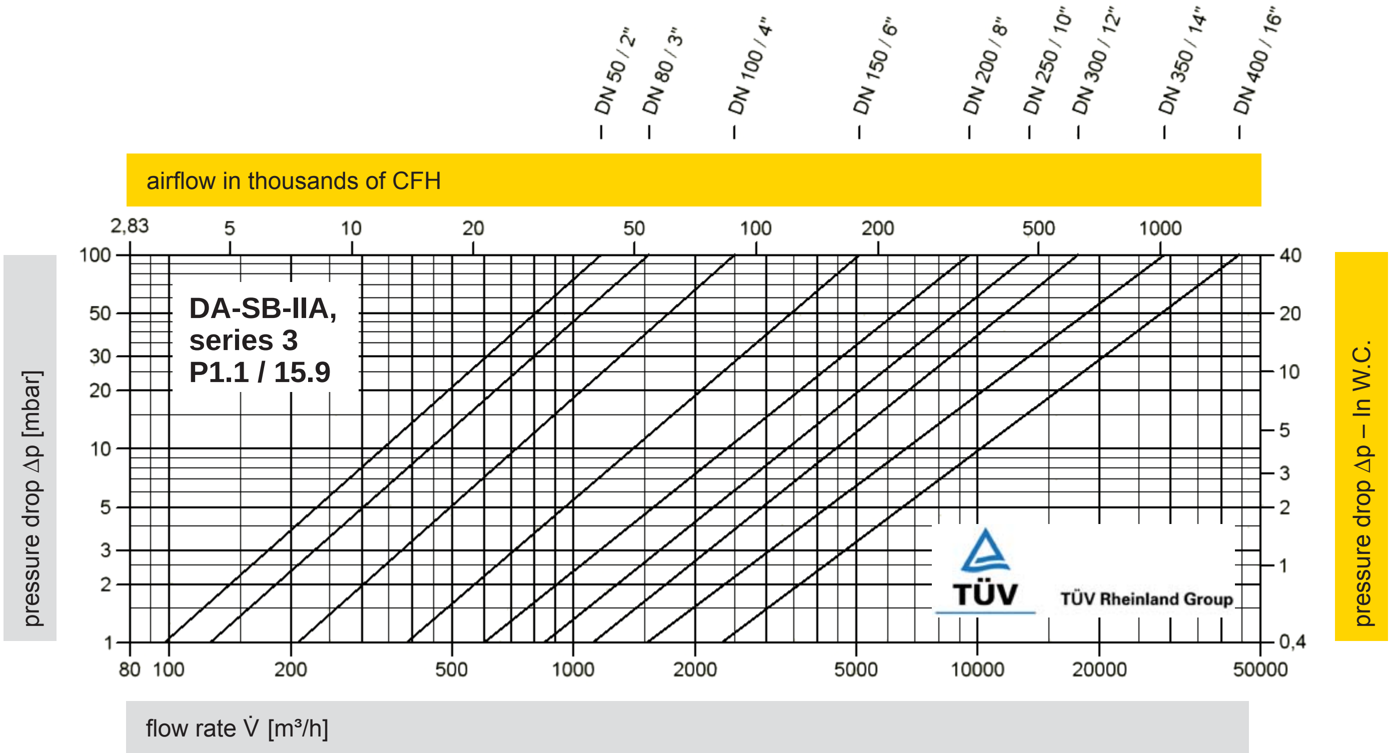
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

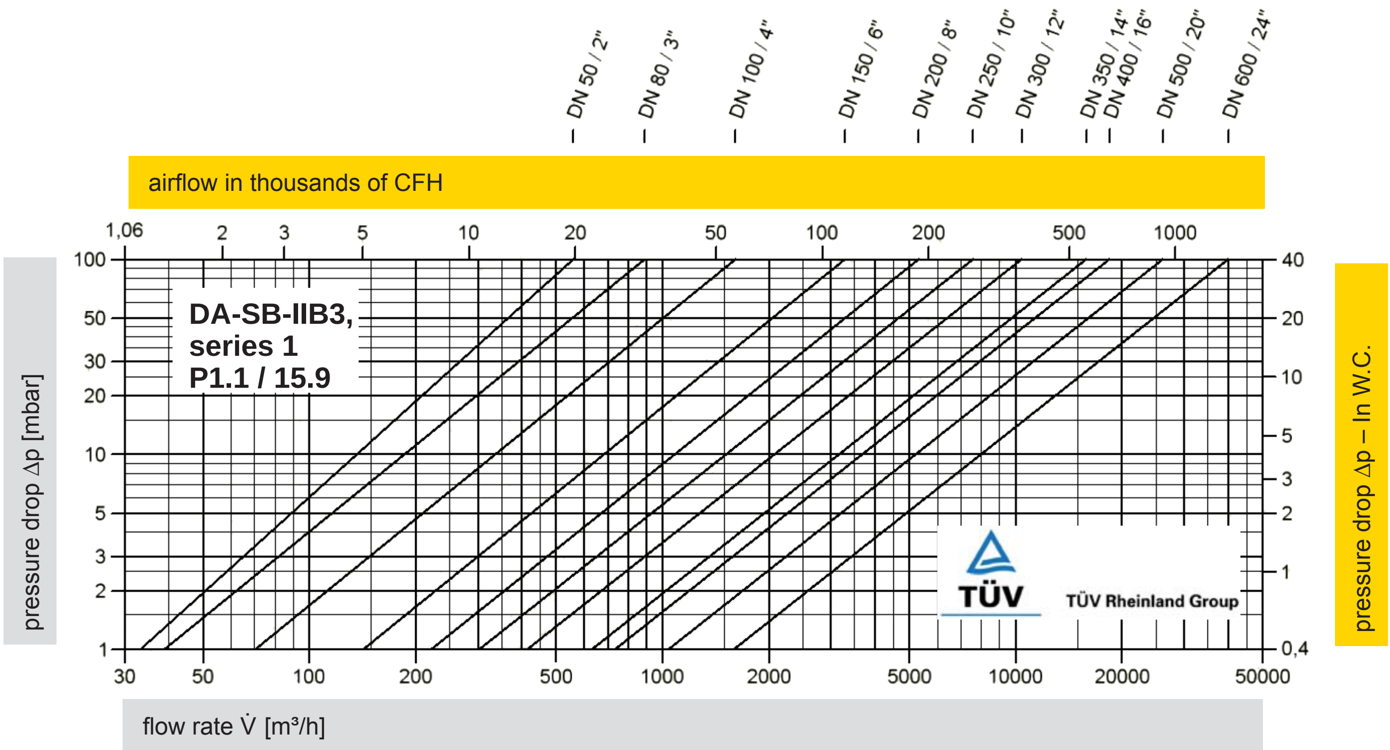


In-Line Detonation Flame Arrester

Flow Capacity Charts

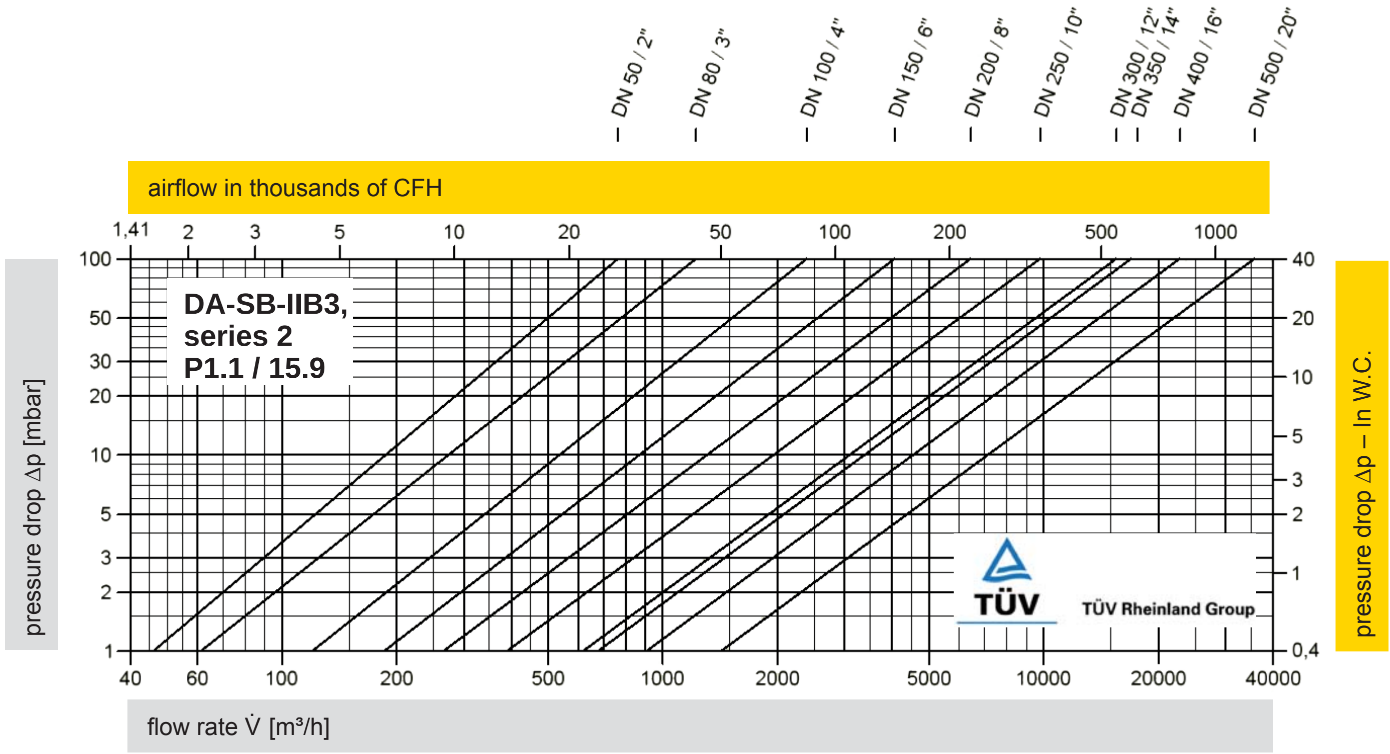
PROTEGO® DA-SB

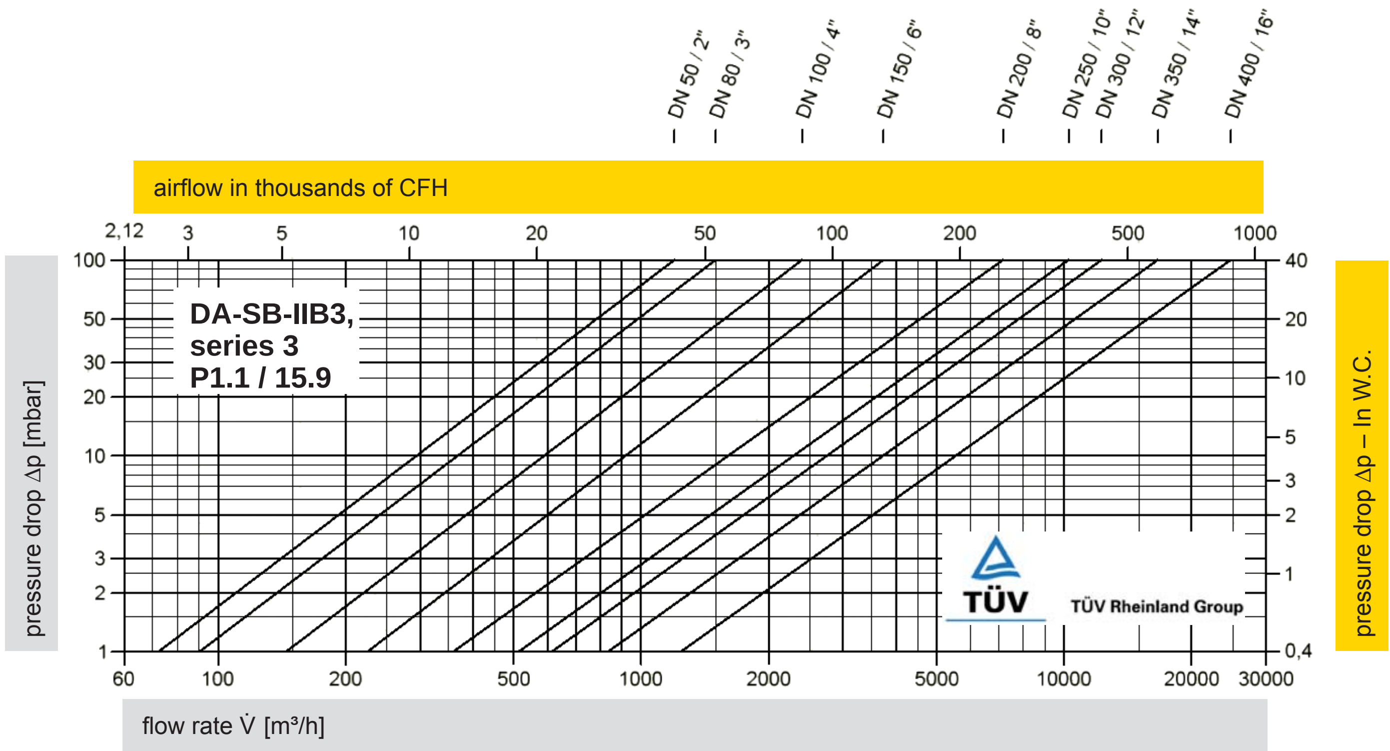


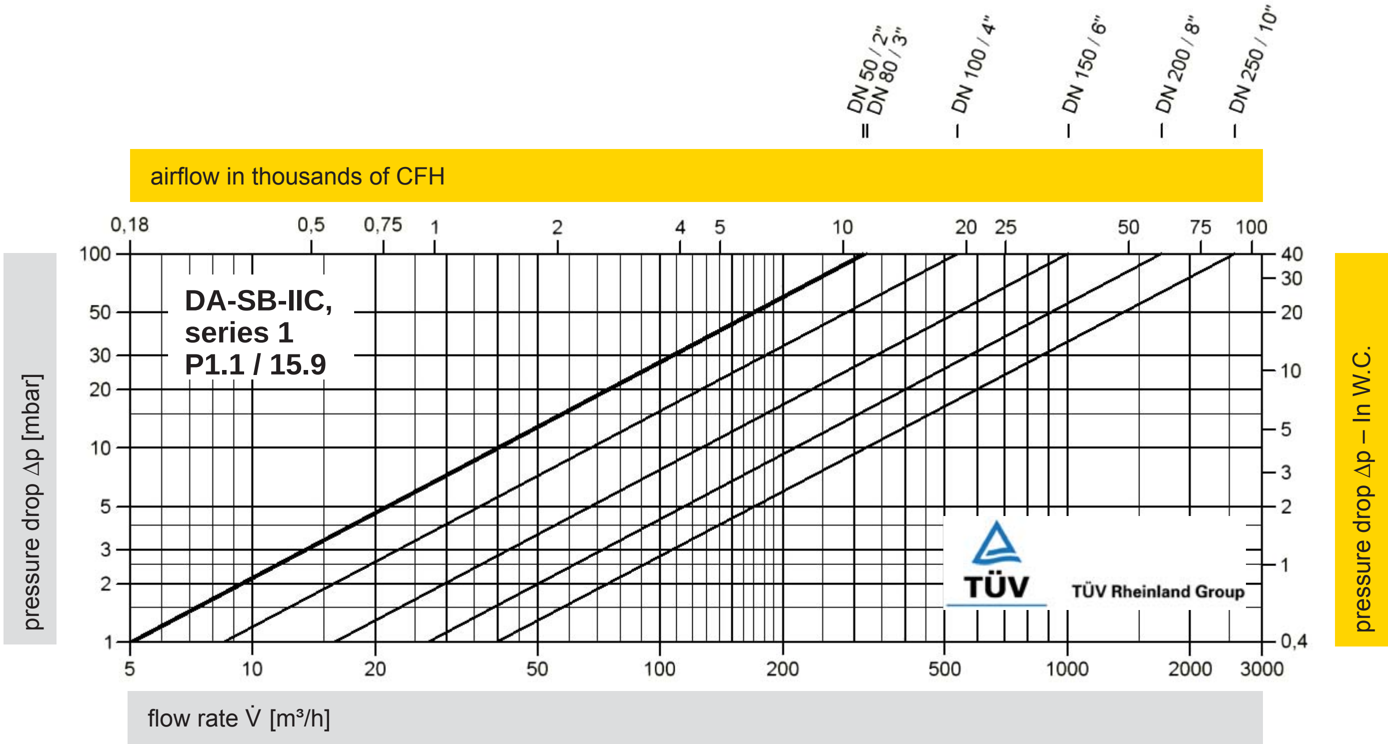


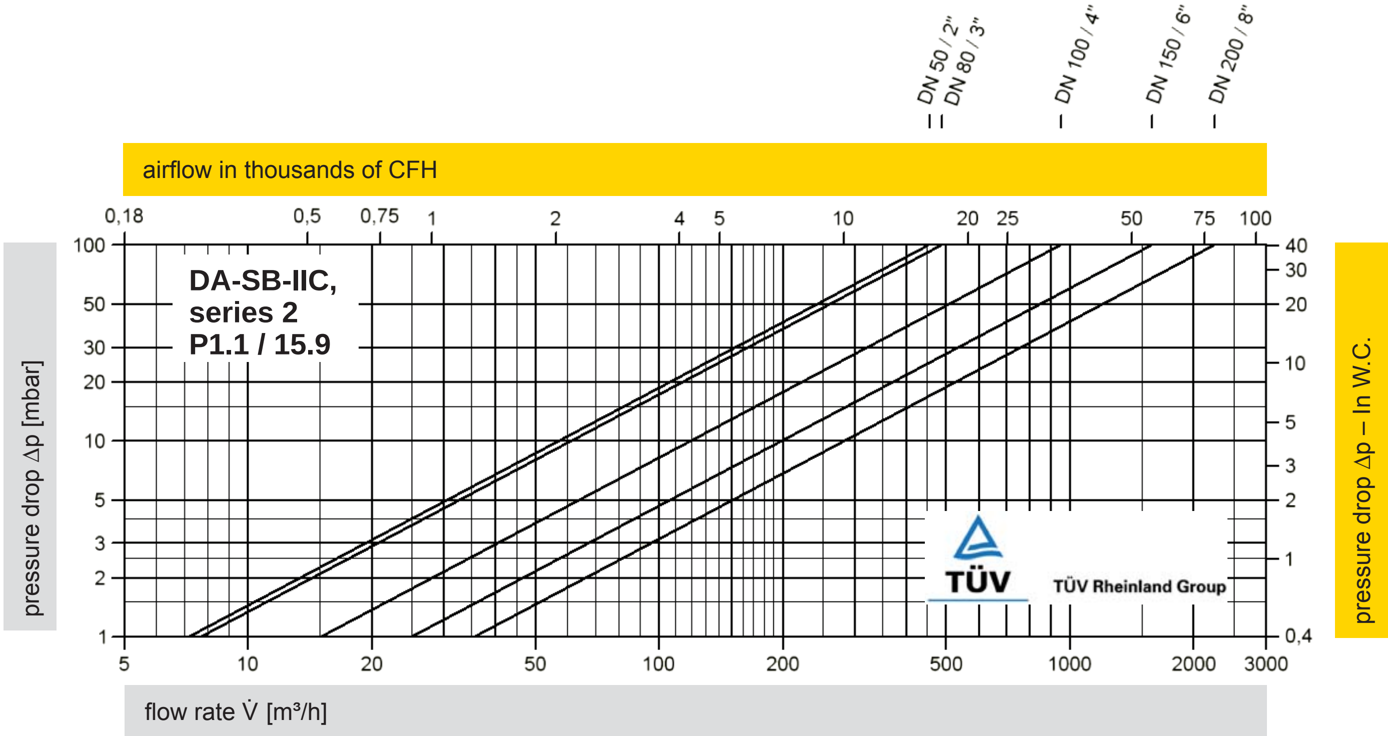
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.


DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
DN 350 / 14"
DN 400 / 16"
DN 500 / 20"
airflow in thousands of CFH
1,41
2
3
5
10
20
50
100
200
500
1000
DA-SB-IIB3,
series 2
P1.1 / 15.9
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
pressure drop Δp – In W.C.
40
20
10
5
3
2
1
0,4
TÜV
TÜV Rheinland Group
40
60
100
200
500
1000
2000
5000
10000
20000
40000
flow rate V̇ [m³/h]

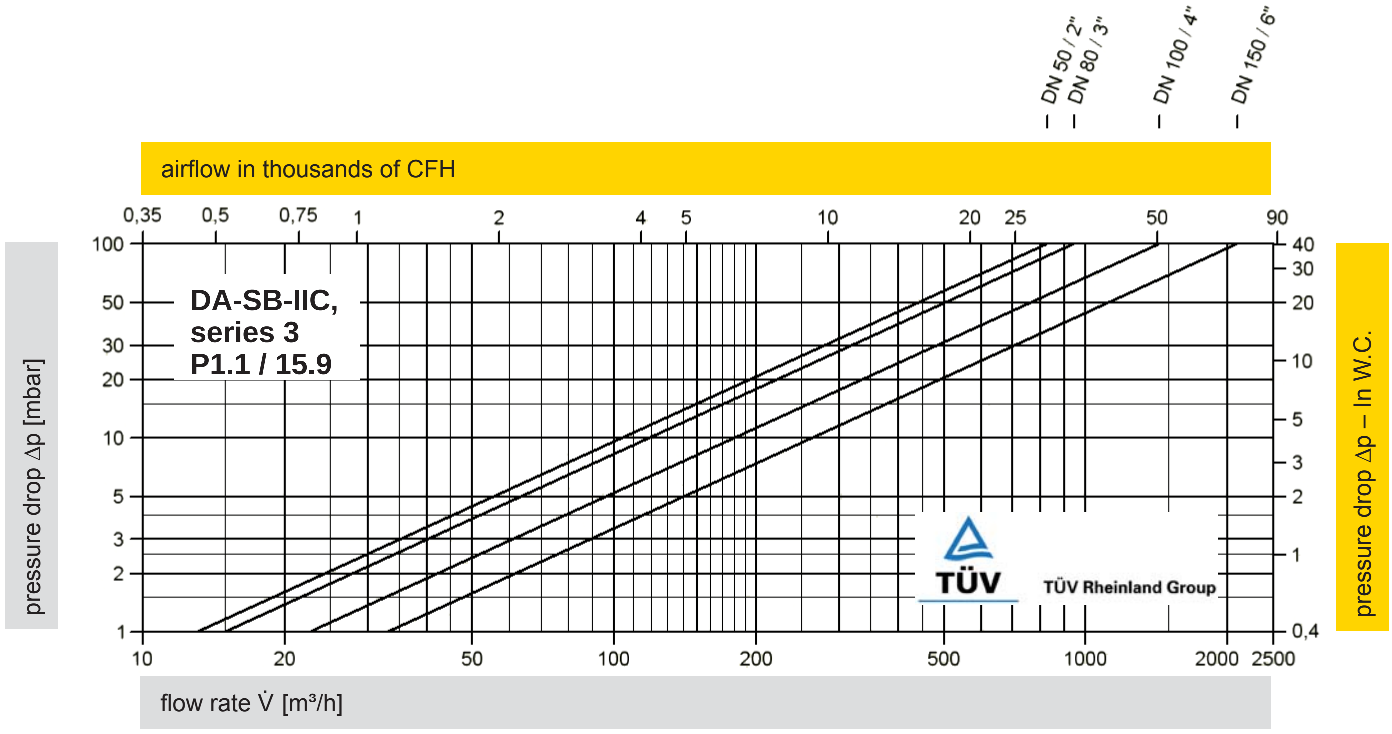

DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
DN 350 / 14"
DN 400 / 16"
airflow in thousands of CFH
2,12
3
5
10
20
50
100
200
500
1000
DA-SB-IIB3,
series 3
P1.1 / 15.9
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
pressure drop Δp – In W.C.
40
20
10
5
3
2
1
0,4
TÜV
TÜV Rheinland Group
60
100
200
500
1000
2000
5000
10000
20000
30000
flow rate V̇ [m³/h]



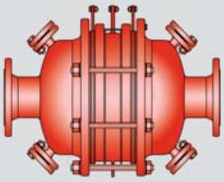


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".



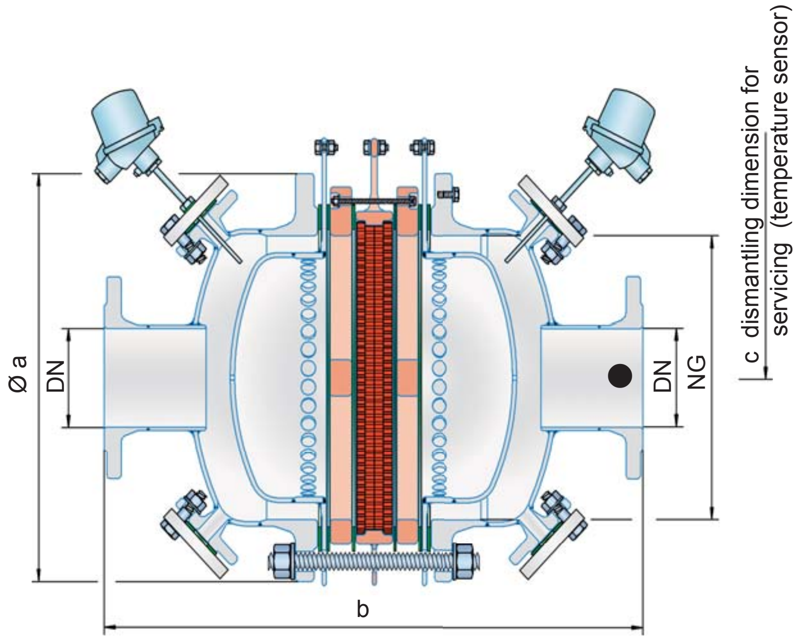
DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
airflow in thousands of CFH
0,35 0,5 0,75 1 2 4 5 10 20 25 50 90
pressure drop Δp [mbar]
100 50 30 20 10 5 3 2 1
DA-SB-IIC,
series 3
P1.1 / 15.9
TÜV
TÜV Rheinland Group
40 30 20 10 5 3 2 1 0,4
pressure drop Δp – In W.C.
10 20 50 100 200 500 1000 2000 2500
flow rate V̇ [m³/h]



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DA-SB-PTFE



● Connection to the protected side (only for type DA-SB-PTFE-T-...)

Special Features and Advantages

- Build up of adhesive materials is prevented by the smooth surfaces
- Aplication especially for corrosive and polymerising media
- Less soiling of the device lowers service, operating and life-cycle costs
- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Different series allow scalable pressure loss across the surface of the FLAMEFILTER®
- Minimum pressure loss and associated low operating and life-cycle costs
- Service-friendly design
- The modular design enables individual FLAMEFILTER® to be replaced
- Bidirectional operation as well as any direction of flow and installation position
- Installation of temperature sensors is possible

Function and Description

The in-line detonation flame arresters type PROTEGO® DA-SB-PTFE are the latest generation of flame arresters and are distinguished by its unique resistance to adhesive and corrosive media. The use of fluoroplastics as a high-tech housing coating and as solid material for the flame arrester element is unique throughout the world.

The speed of incoming detonations is highly reduced by the effective shock absorber (1) and result in an equal pressure distribution across the FLAMEFILTER® surface. This improves the flame extinction in the narrow gaps of the original PTFE-FLAMEFILTER® (3).

The devices are symmetrical and offers bidirectional flame arresting for deflagrations and stable detonations. The arrester essentially consists of two coated housing parts (4), two coated shock absorbers and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use.

The detonation arrester PROTEGO® DA-SB-PTFE can be used for explosion group IIA (NFPA group D). The standard design is approved at an operating temperature up to +60°C / 140°F. The maximum allowable operating pressure depends on nominal diameter (DN) and nominal size (NG) and amounts to a maximum of 2.4 bar / 34.8 psi absolute (for DN50 / 2" see table 3).

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Design Types and Specifications

There are three different designs available:

Basic in-line detonation flame arrester	**DA-SB-PTFE -** $\boxed{–}$
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DA-SB-PTFE -** $\boxed{T}$
In-line detonation flame arrester with two integrated temperature sensors* for additional protection against short time burning from both sides	**DA-SB-PTFE -** $\boxed{TB}$

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

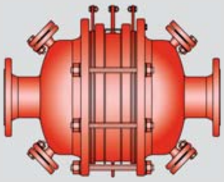
Table 1: Dimensions				Dimensions in mm / inches
To select series and nominal size (DN) - nominal width (NG) combination, please use the flow capacity charts on the following pages				
Series 1 (standard)				
DN	50 / 2"	80 / 3"	-	-
Series 2 (special design for improved flow capacity)				
DN	-	-	80 / 3"	100 / 4"
NG	150 / 6"	150 / 6"	200 / 8"	300 / 12"
a	287 / 11.30	287 / 11.30	342 / 13.46	447 / 17.60
b	407 / 15.75	407 / 15.75	497 / 19.57	645 / 25.39
c	400 / 15.75	400 / 15.75	530 / 20.87	530 / 20.87

Table 2: Selection of the explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	

Table 3: Selection of max. operating pressure				
DN	50 / 2“	80 / 3“	80 / 3“	100 / 4“
NG	150 / 6“	150 / 6“	200 / 8“	300 / 12“
P_{max}	2.4 / 34.8	1.1 / 15.9	1.2 / 17.4	1.2 / 17.4

P_{max} = allowable operating pressure in bar / psi absolut, higher operating pressure upon request

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DA-SB-PTFE

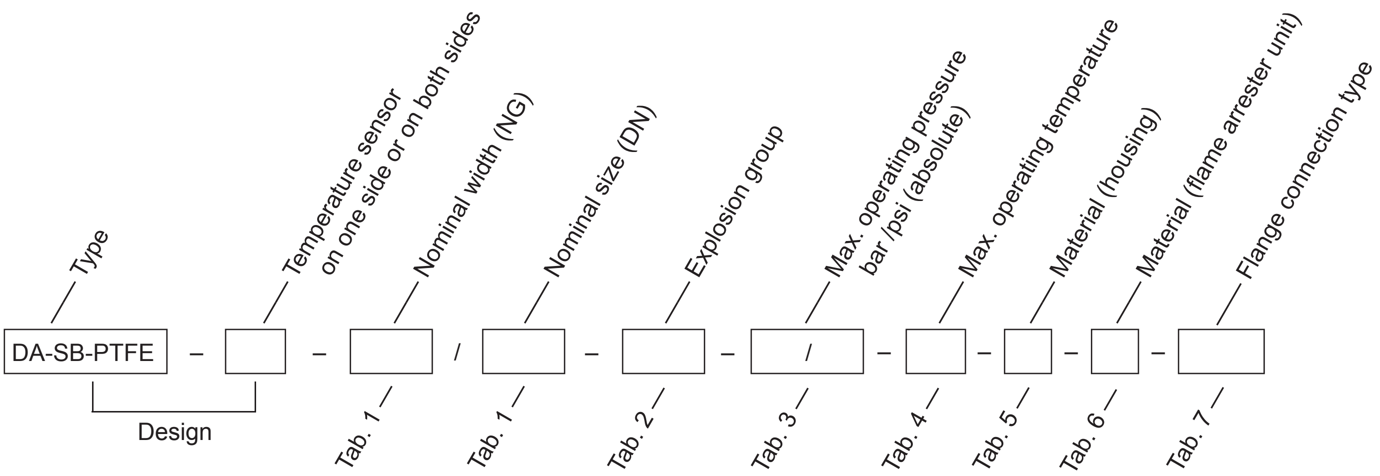
Table 5: Material for housing		
Design	A	
Housing	Steel with an ECTFE coating	
Shock absorber	Steel with an ECTFE coating	Special materials upon request
Gasket	PTFE	
Flame arrester unit	A, B, C	

Table 6: Material combinations of the flame arrester unit			
Design	A	B	C
FLAMEFILTER® cage	Steel with an ECTFE coating	Hastelloy	Stainless Steel
Spider rings	Steel with an ECTFE coating	Hastelloy	Stainless Steel
FLAMEFILTER® *	PTFE*	PTFE*	PTFE*
Spacer	PEEK / ETFE / FEP	PEEK / ETFE / FEP	PEEK / ETFE / FEP

Special materials upon request

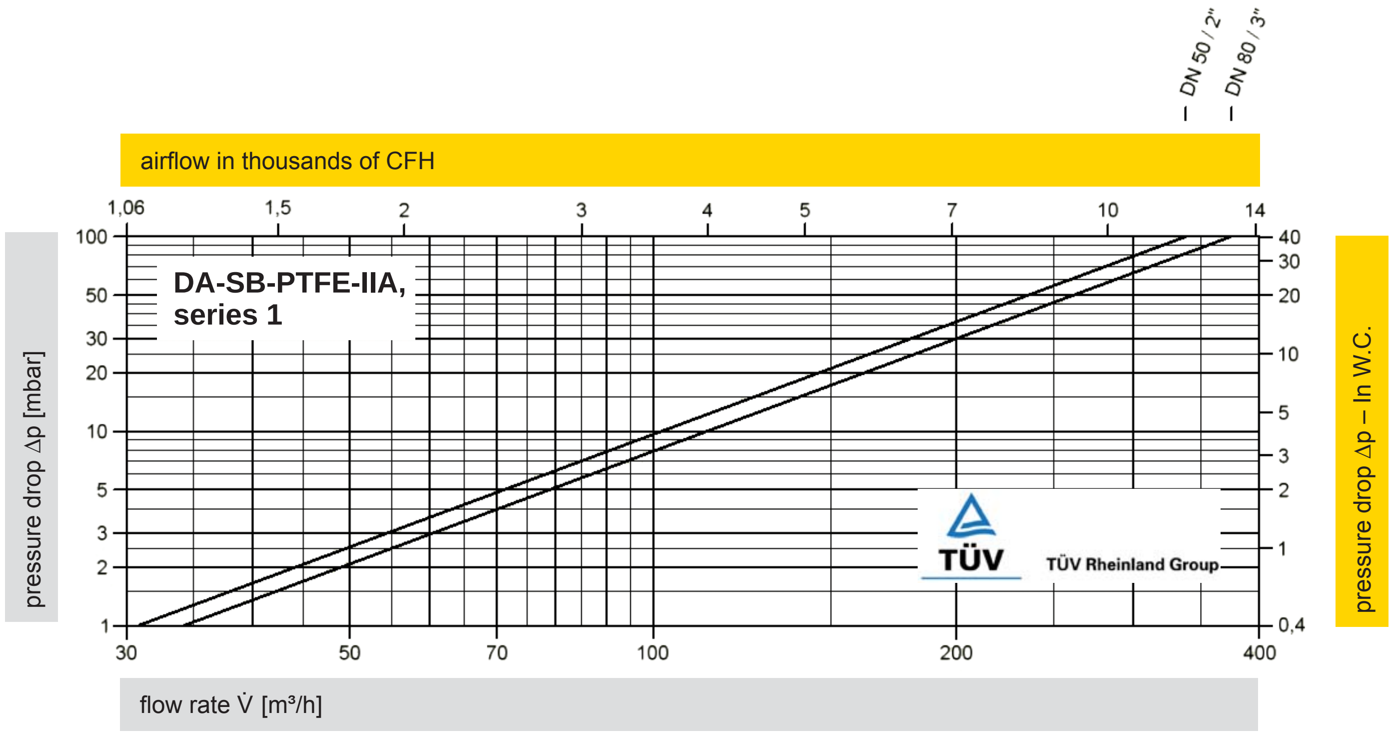
* electrically conductive

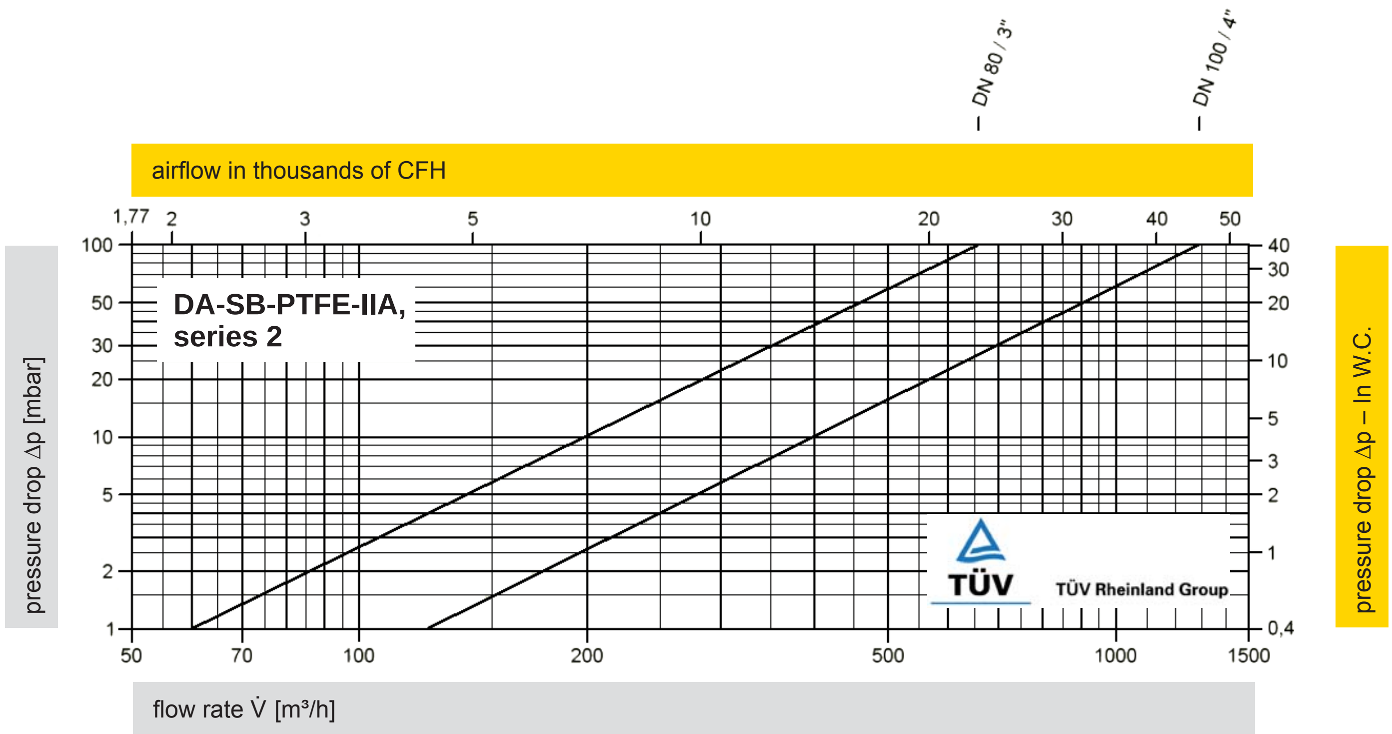
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



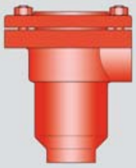
Order example																		
DA-SB-PTFE	–	TB	–	300	/	100	–	IIA	–	P1.2/ –	–	T60	–	A	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





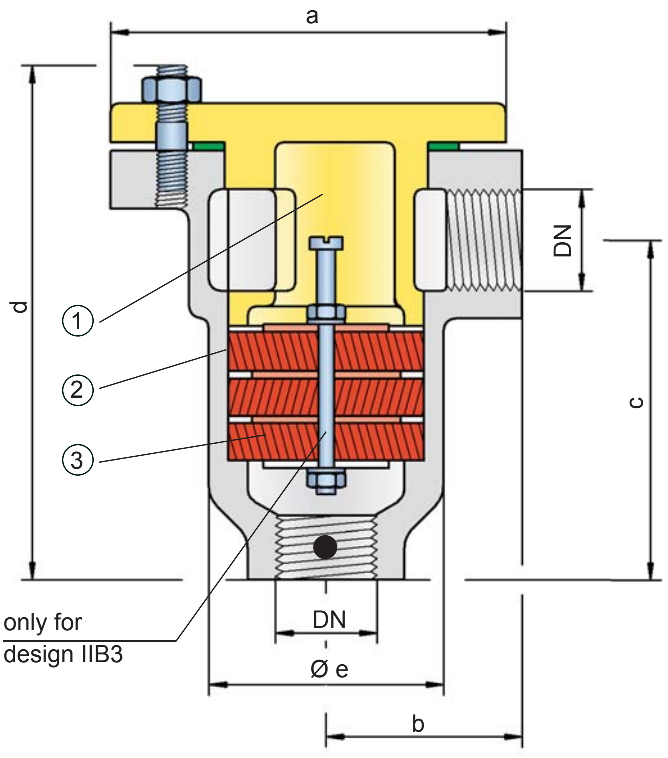
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in right angle design, unidirectional

PROTEGO® DR/ES



● Connection to the protected side

Function and Description

The PROTEGO® DR/ES series in-line detonation flame arrester with connection size up to ¾“ is ideal for installation in small pipes and to protect equipment such as gas analyzers. The device protects against deflagrations and stable detonations. It can be installed anywhere in the pipe no matter what the distance is from the potential ignition source. The small and compact flame arrester has a right angle design.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by diversion mainly through the shock absorber (1) before the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (3).

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers (for explosion group IIC - NEC group B) whose gap size and number is determined by the operating parameters of the processed fluid (explosion group, pressure, temperature). This device is available for explosion groups IIB3 and IIC (NEC group C MESG ≥ 0.65 mm and B).

This in-line detonation flame arrester functions unidirectional and is equipped with a threaded connection. The thread can be adapted to international standards. The standard design is approved at an operating temperature up to +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approvals can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Compact design
- Minimum number of FLAMEFILTER® due to shock absorber technology or optimal geometry

Design for IIB3:
- The device can be serviced without disconnecting the pipe
- The individual FLAMEFILTER® can be quickly removed and installed

- Cost efficient spare parts
- Provides protection from deflagrations and stable detonations
- Through right angle design no pipe elbows are needed
- Works for nearly any flammable gas and gas mixture
- Low life-cycle costs

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	G ¼"	G ½"	G¾"
a	48 / 1.89	70 / 2.76	80 / 3.15
b	35 / 1.38	40 / 1.57	47 / 1.85
c	70 / 2.76	75 / 2.95	87 / 3.43
d	108 / 4.25	115 / 4.53	135 / 5.31
e	34 / 1.34	50 / 1.97	60 / 2.36

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request
< 0,50 mm	IIC	B	

Table 3: Selection of max. operating pressure

Expl. Gr.		DN	G¼"	G ½"	G ¾"
	IIB3	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4
	IIC	P_{max}	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request
Expl. Gr. IIB3 covers Expl. Gr. IIA

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	B	C	D
Housing	Ductile Iron	Steel	Stainless Steel	Hastelloy
Cover with shock absorber*	Ductile Iron	Steel	Stainless Steel	Hastelloy
Gasket	WS 3822 **	WS 3822 **	PTFE	PTFE
Flame arrester unit	A	A	A	B

G ¼" only comes in design C and D

* G ¼" without shock absorber

** for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

Special materials upon request

Table 6: Material combinations of the flame arrester unit

Design	A	B
FLAMEFILTER® *	Stainless Steel	Hastelloy
Spacer	Stainless Steel	Hastelloy

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 7: Type of connection

Pipe thread DIN ISO 228T1	DIN	other types of thread upon request

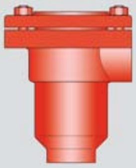
Type	Nominal size	Explosion group	Max. operating pressure bar /psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Type of connection
DR/ES			/				
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

DR/ES	10	IIB3	P1.2 / –	T60	A	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

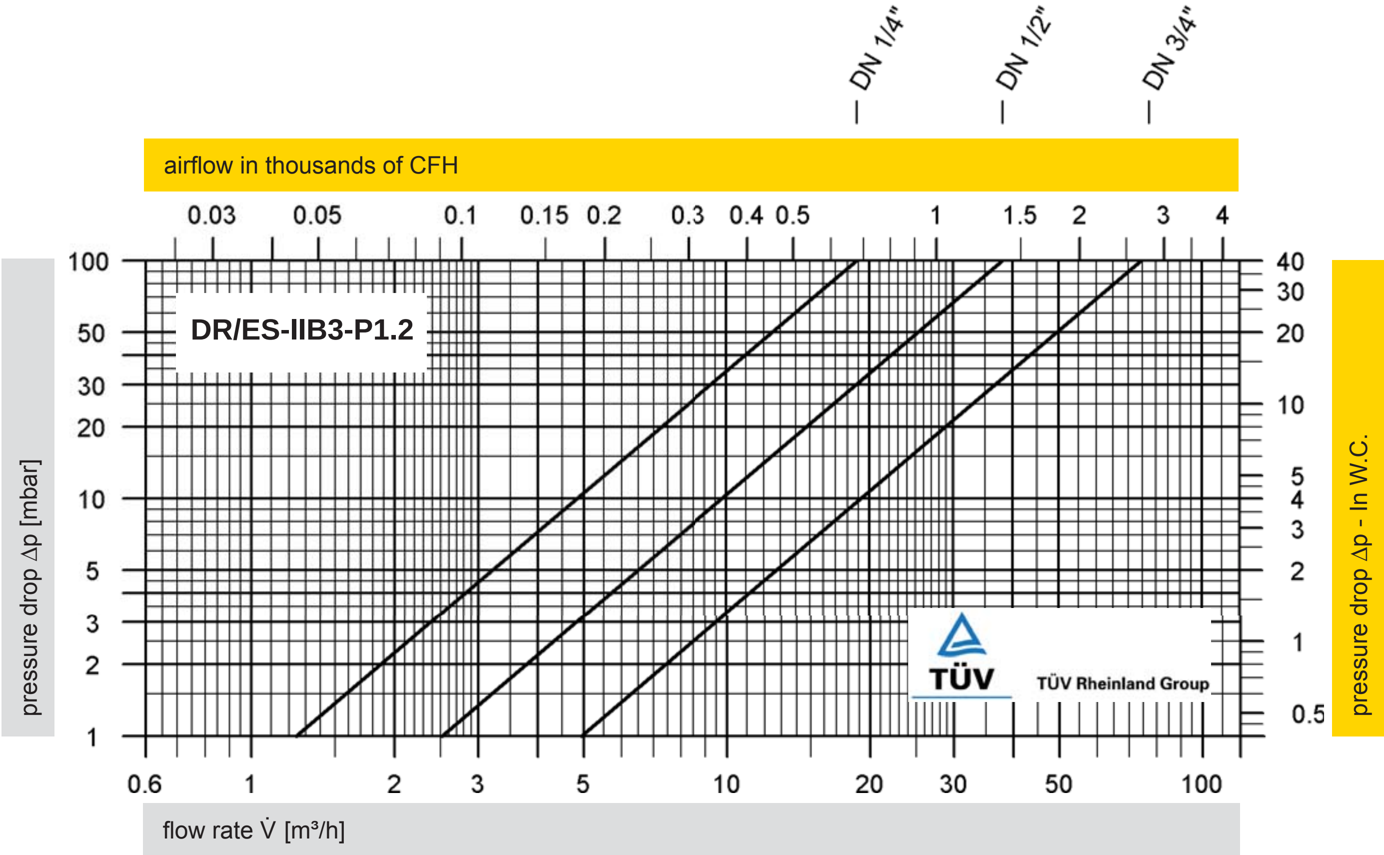
PROTEGO

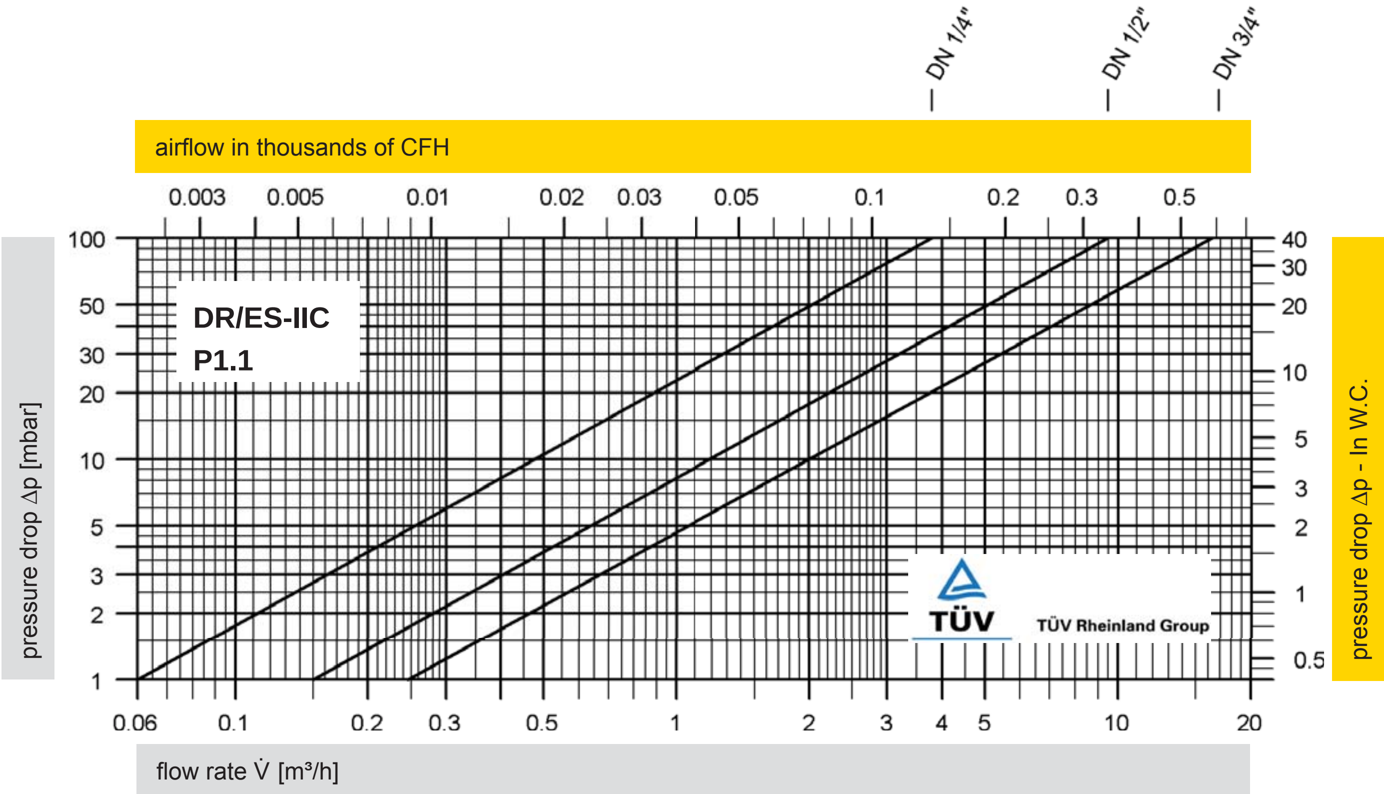


In-Line Detonation Flame Arrester

Flow Capacity Charts

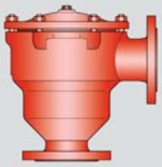
PROTEGO® DR/ES





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

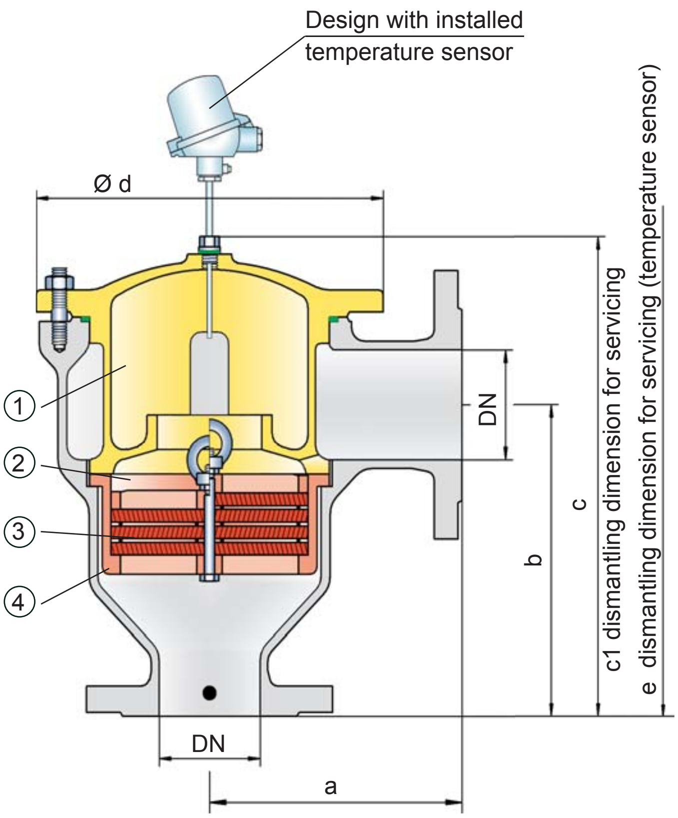
Notes:



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in right angle design with shock absorber, unidirectional

PROTEGO® DR/ES



● Connection to the protected side

Function and Description

The PROTEGO® DR/ES in-line detonation flame arrester has been used for decades in industrial plant construction because its right angle design offers advantages towards maintenance and costs in comparison to most straight designs.

Once a detonation enters the device, energy is absorbed from the detonation shock wave by the integrated shock absorber (1) before the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (3).

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers firmly held in the FLAMEFILTER® cage (4). The gap size and number of FLAMEFILTER® are determined by the operating data of the mixture flowing in the line (explosion group, pressure, temperature). This device is approved for explosion groups from IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design is approved at an operating temperature up to +60°C / 140°F and an absolute operating pressure up to 1.2 bar / 17.4 psi. Devices with special approvals can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Quick removal and installation of the complete PROTEGO® flame arrester unit and FLAMEFILTER® in the cage
- Due to modular design the FLAMEFILTER® can be individually replaced
- Cost efficient spare parts
- The right angle design saves pipe elbows
- Minimum pressure loss and hence low operating and life-cycle costs
- Extended application range for higher operating temperatures and pressures

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DR/ES-** $\boxed{-}$ **-** $\boxed{-}$
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning	**DR/ES-** $\boxed{T}$ **-** $\boxed{-}$
In-line detonation flame arrester with heating jacket	**DR/ES-** $\boxed{H}$ **-** $\boxed{-}$
In-line detonation flame arrester with integrated temperature sensor* against short time burning and heating jacket	**DR/ES-** $\boxed{H}$ **-** $\boxed{T}$

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"
a	125/4.92	125/4.92	153/6.02	155/6.10	198/7.80	200/7.87	250/9.84	332/13.07	335/13.19	425/16.73
b	140/5.51	140/5.51	183/7.20	185/7.28	223/8.78	225/8.86	290/11.42	357/14.06	360/14.07	505/19.88
c	210/8.27	210/8.27	290/11.42	290/11.42	365/14.37	365/14.37	440/17.32	535/21.06	535/21.06	800/31.50
c1	285/11.22	285/11.22	395/15.55	395/15.55	500/19.69	500/19.69	595/23.43	750/29.53	750/29.53	1230/48.43
d	150/5.91	150/5.91	210/8.27	210/8.27	275/10.83	275/10.83	325/12.80	460/18.11	460/18.11	620/24.41
e	495/19.49	495/19.49	600/23.62	600/23.62	705/27.76	705/27.76	795/31.30	950/37.40	950/37.40	1435/56.50

Table 2: Selection of the explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure												
		DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"
Expl. Gr.	IIA	P_{max}	4.0/58.0	4.0/58.0	4.0/58.0	4.0/58.0	2.9/42.1	2.9/42.1	2.0/29.0	2.0/29.0	2.0/29.0	1.2/17.4
	IIB3	P_{max}	3.0/43.5	3.0/43.5	2.0/29.0	2.0/29.0	2.0/29.0	2.0/29.0	1.5/21.7	1.4/20.3	1.4/20.3	1.1/15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing				
Design	A	B	C	D
Housing Heating jacket (DR/ES-H-(T)-...)	Ductile Iron	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Cover with shock absorber	Ductile Iron	Steel	Stainless Steel	Hastelloy
O-Ring	FPM **	FPM **	PTFE	PTFE
Flame arrester unit	A	A	C, D	E

** for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
The housing and cover with the shock absorber can also be delivered in steel with an ECTFE coating.
Special materials upon request

Table 6: Material combinations of the flame arrester unit					
Design	A	C	D	E	* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy	
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy	
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy	

Special materials upon request

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

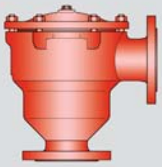
Type – Heating jacket – Temperature sensor – Nominal size – Explosion group – Max. operating pressure bar /psi (absolute) – Max. operating temperature – Material (housing) – Material (flame arrester unit) – Flange connection type

DR/ES	–		–		–		–		–	/	–		–		–		–	
Design						Tab. 1		Tab. 2		Tab. 3		Tab. 4		Tab. 5		Tab. 6		Tab. 7

Order example

DR/ES	–	H	–	T	–	150	–	IIB3	–	P1.4/ –	–	T60	–	A	–	A	–	DIN

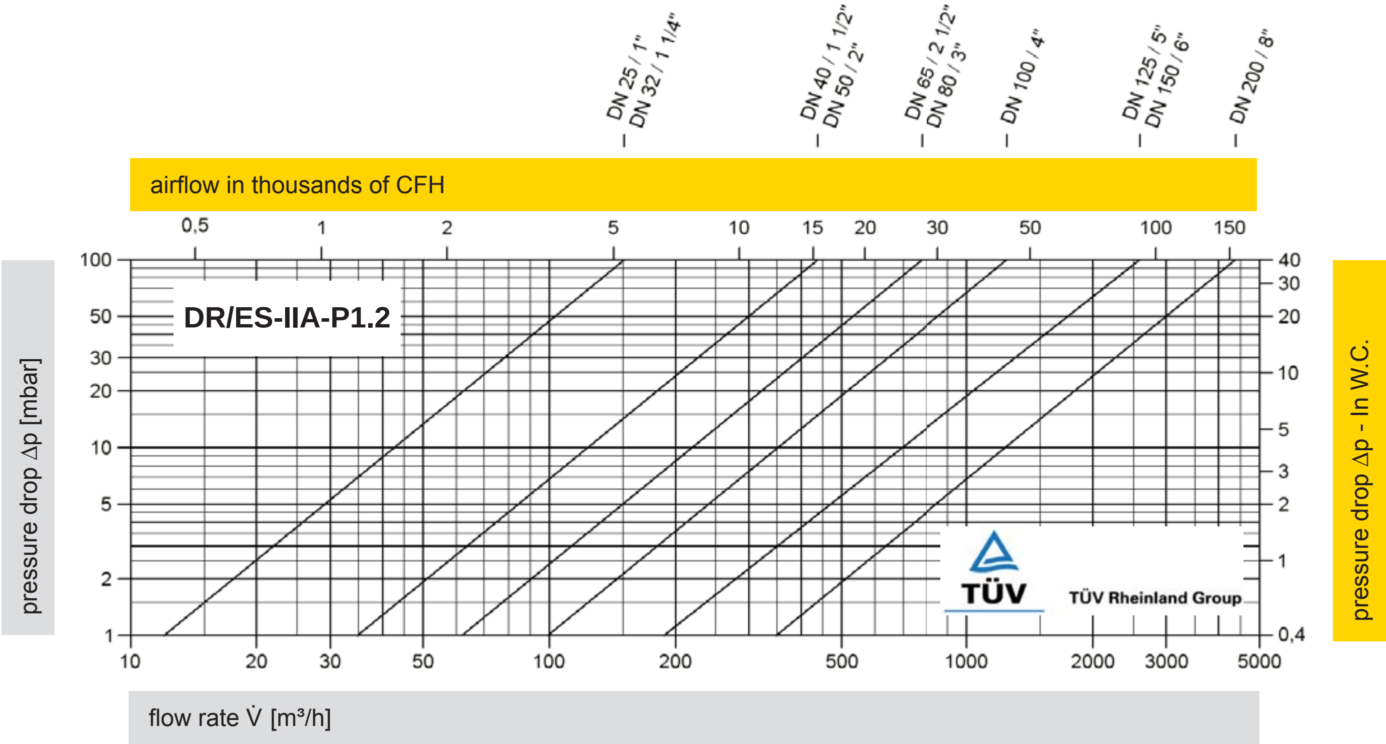
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

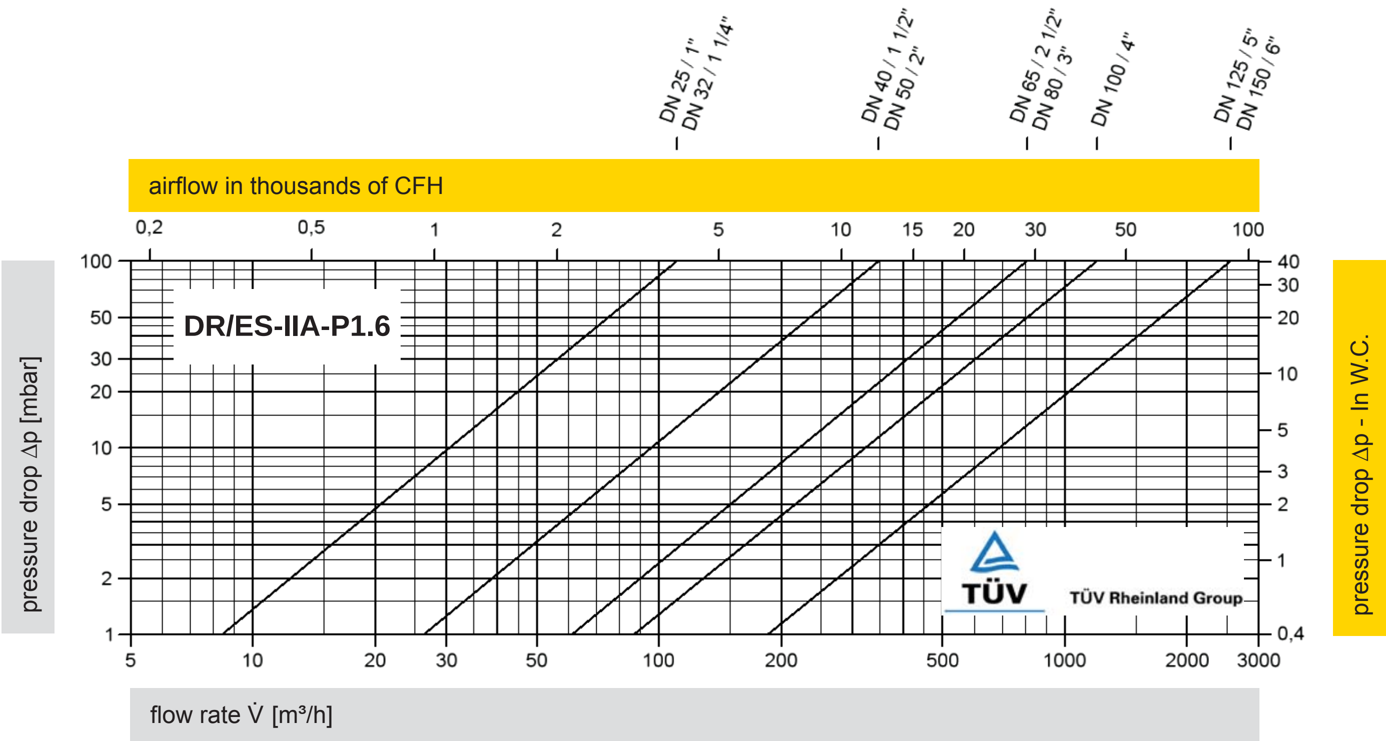


In-Line Detonation Flame Arrester

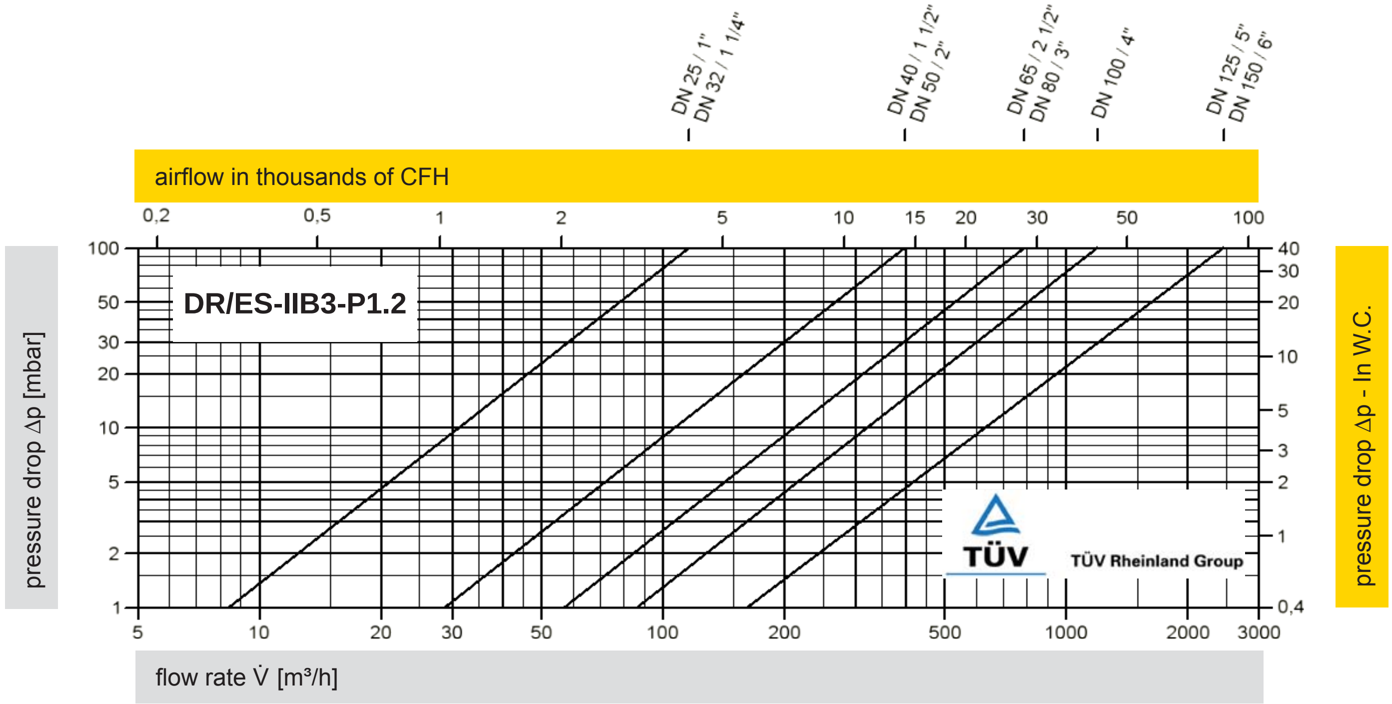
Flow Capacity Charts

PROTEGO® DR/ES

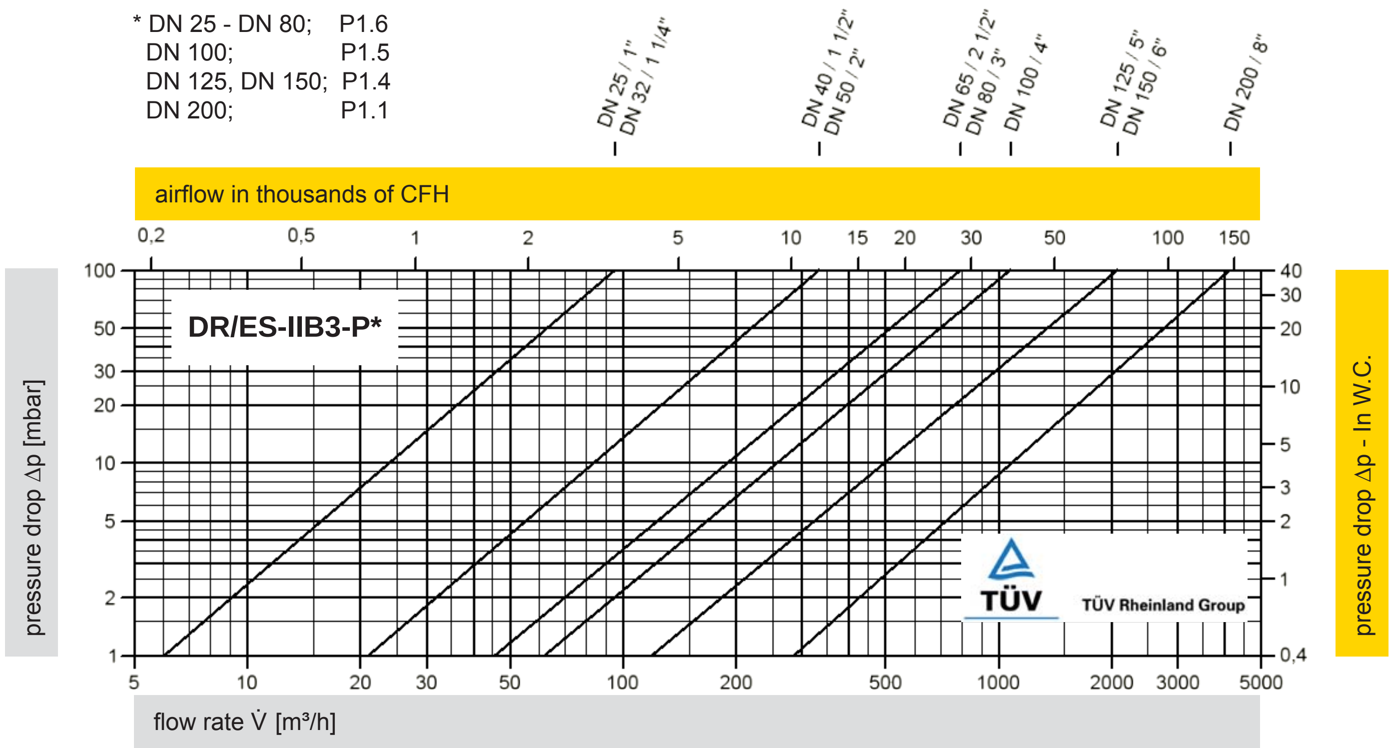


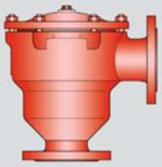


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



* DN 25 - DN 80; P1.6
DN 100; P1.5
DN 125, DN 150; P1.4
DN 200; P1.1

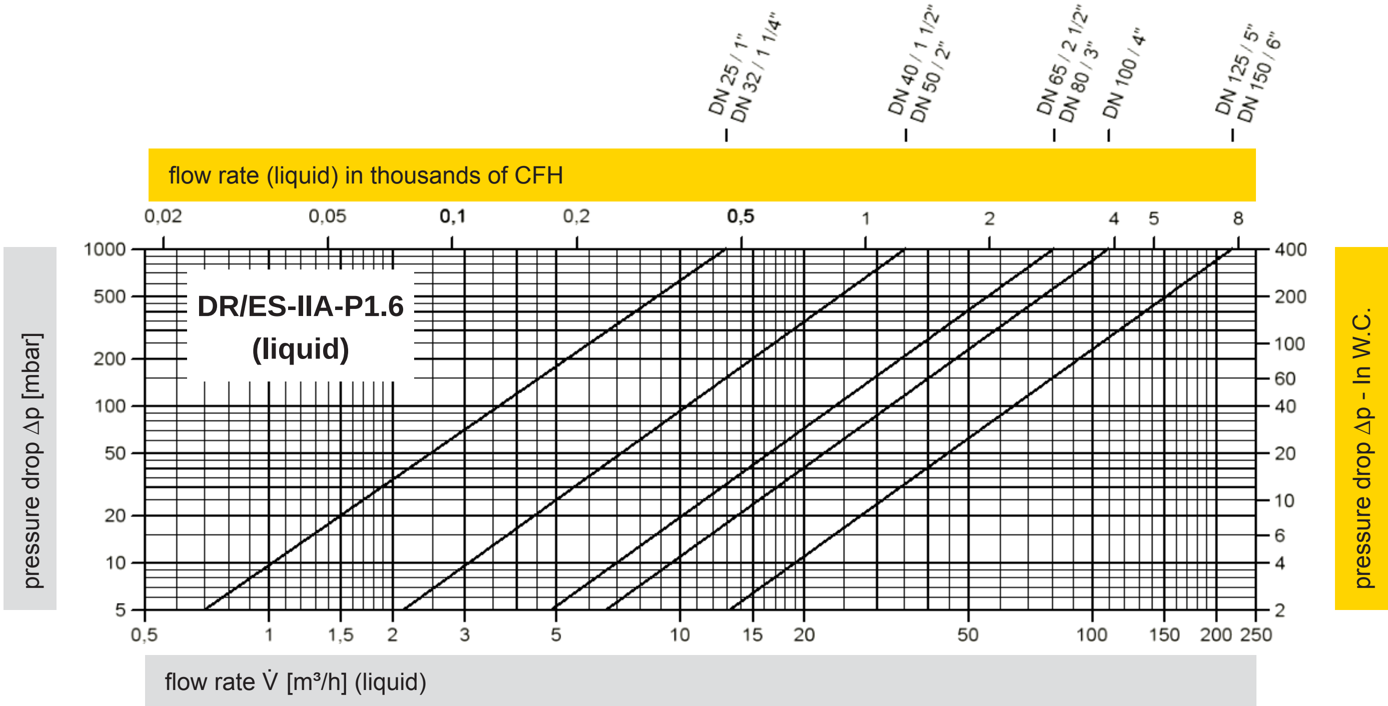


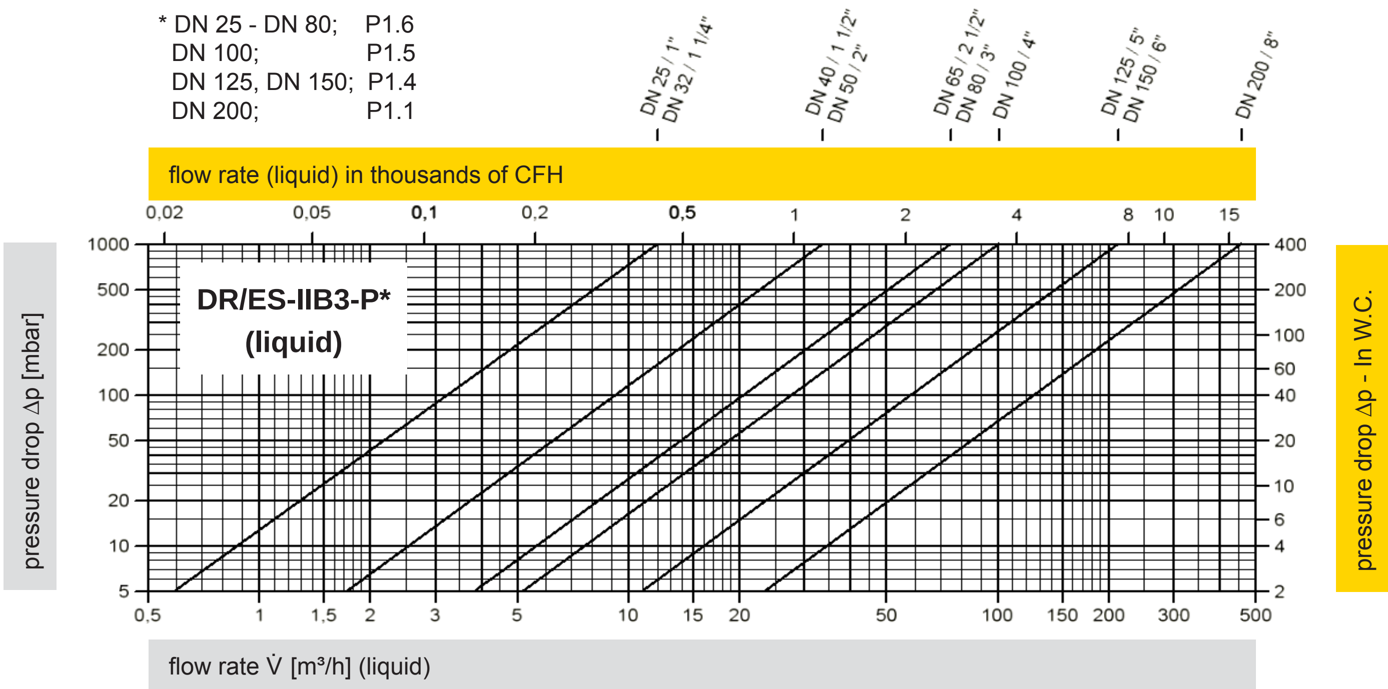


In-Line Detonation Flame Arrester

Flow Capacity Charts (liquid)

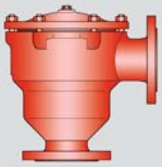
PROTEGO® DR/ES





The volume flow $\dot{V}$ in m³/h was determined with water according to DIN EN 60534 at a temperature $T_n = 15^{\circ}$C and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity $v = 10^{-6}$ m²/s

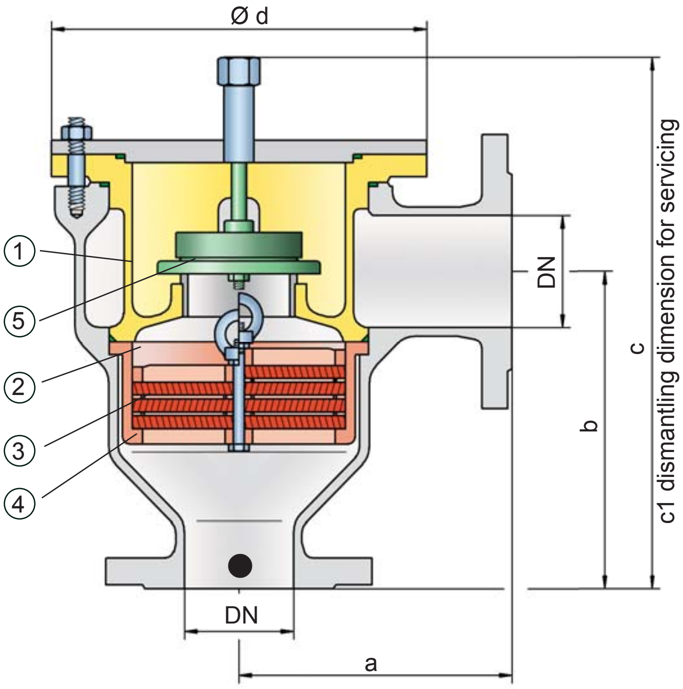
Notes:



In-Line Detonation Flame Arrester

with integrated pressure relief valve, for stable detonations and deflagrations in right angle design with shock absorber, unidirectional

PROTEGO® DR/ES-V



● Connection to the protected side

Set pressure: from +2.0 mbar up to +35 mbar
from +0.8 In W.C. up to +14 In W.C.

Higher or lower settings upon request

Function and Description

PROTEGO® DR/ES-V series uniquely combines the function of in-line detonation flame arrester with the function of a pressure relief valve in one device. The device protects against deflagrations and stable detonations. The weight-loaded pallet type valve (5) integrated in the shock absorber (1) of the in-line detonation flame arrester is designed as pressure relief valve. The set pressure of the valve is adjusted in the factory and can range from 2 to 35 mbar (0.8 to 14 In W.C.). After the pressure increases 40% from its set pressure, the valve completely opens to yield the maximum volumetric flow. If installed in suction lines of storage tanks, the valve pallet works at the same time as check valve. This means that the product can not flow back from the suction line into the tank. Although several functions are integrated in a single housing, the device is extremely easy to service, which is primarily due to the classic right angle design.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by the integrated shock absorber, before the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (3). The flame suppression is guaranteed independent of the valve pallet position.

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers firmly held in the FLAMEFILTER® cage (4). The gap size and number of FLAMEFILTER® are determined by the operating data parameters of the mixture flowing in the line (explosion group, pressure, temperature). This device is available for explosion groups from IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design is approved at an operating temperature up to +60°C / 140°F and absolute operating pressure up to 1.2 bar / 17.4 psi. Devices with special approvals can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Integration of in-line detonation flame arrester and pressure relief valve in one device
- Excellent tightness of the valve
- Applicable as a detonation-proof check valve in suction lines of storage tanks
- Optimum for use as an overflow valve in venting and recovering vapour lines
- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Quick removal and installation of the complete PROTEGO® flame arrester unit and the individual FLAMEFILTER® in the cage
- Cost efficient spare parts
- Provides protection from deflagration and stable detonations
- Extended application range for higher operating temperatures and pressures

Design Types and Specifications

There are two different designs available:

Basic version of the detonation arrester with check valve	**DR/ES- V - –**
Detonation arrester with check valve and heating jacket	**DR/ES- V - H**

Remark

$$\text{set pressure} = \frac{\text{opening pressure resp. tank design pressure}}{1{,}4}$$

Set pressure = the valve starts to open

Opening pressure = set pressure plus overpressure

Overpressure = pressure increase over the set pressure

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"
a	153 / 6.02	155 / 6.10	198 / 7.80	200 / 7.87	250 / 9.84	332 / 13.07	335 / 13.19	425 / 16.73
b	183 / 7.20	185 / 7.28	223 / 8.78	225 / 8.86	290 / 11.42	357 / 14.06	360 / 14.17	505 / 19.88
c	305 / 12.01	305 / 12.01	395 / 15.55	395 / 15.55	460 / 18.11	575 / 22.64	575 / 22.64	863 / 33.98
c1	410 / 16.14	410 / 16.14	530 / 20.87	530 / 20.87	615 / 24.21	790 / 31.10	790 / 31.10	1295 / 50.98
d	210 / 8.27	210 / 8.27	275 / 10.83	275 / 10.83	325 / 12.80	460 / 18.11	460 / 18.11	620 / 24.41

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.		DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8“
	IIA	P_{max}	4.0/58.0	4.0/58.0	2.9/42.1	2.9/42.1	2.0/29.0	2.0/29.0	2.0/29.0	1.2/17.4
	IIB3	P_{max}	2.0/29.0	2.0/29.0	2.0/29.0	2.0/29.0	1.5/21.7	1.4/20.3	1.4/20.3	1.1/15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	B	C	D
Design Heating jacket (DR/ES-V-H-...)	Ductile Iron	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Cover with shock absorber	Ductile Iron	Steel	Stainless Steel	Hastelloy
Gaskets	FPM *	FPM *	PTFE	PTFE
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Flame arrester unit	A	A	C, D	E

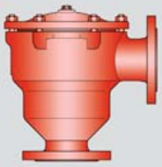
* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
The housing and the cover with shock absorber can also be delivered in steel with an ECTFE coating.
Special materials upon request

Table 6: Material combinations of the flame arrester unit

Design	A	C	D	E
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
Special materials upon request

PROTEGO
for safety and environment



In-Line Detonation Flame Arrester

with integrated pressure relief valve, for stable detonations and deflagrations in right angle design with shock absorber, unidirectional

PROTEGO® DR/ES-V

Table 7: Material selection for valve pallet

Design	A	B	C
Pressure range	I	II	III
Set pressure [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to 35 >+5.6 up to 14
Valve pallet	Aluminium	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal

Table 8: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type / Heating jacket / Nominal size / Explosion group / Max. operating pressure bar /psi (absolute) / Max. operating temperature / Material (housing) / Material (flame arrester unit) / Set pressure / Material (valve pallet) / Flange connection type

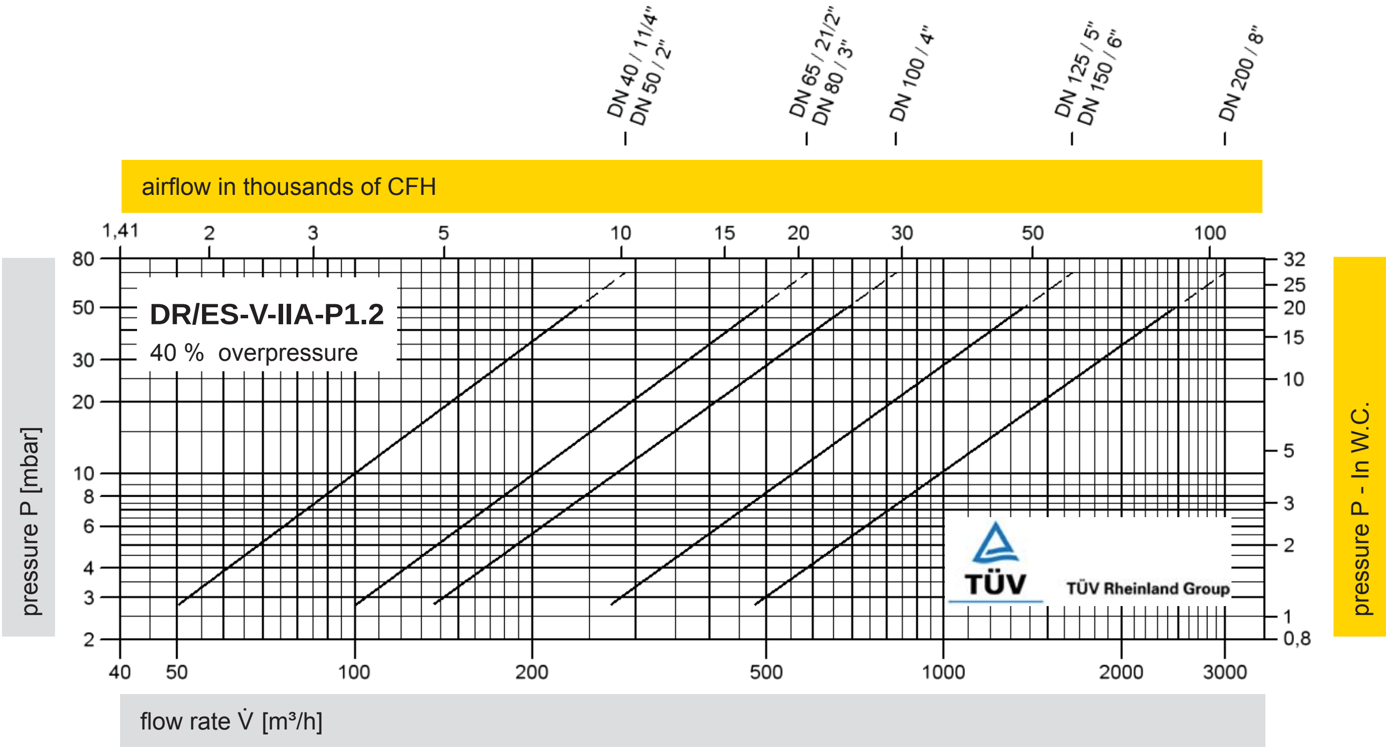
DR/ES-V – H – [ ] – [ ] – [/] – [ ] – [ ] – [ ] – [/] – [ ] – [ ]

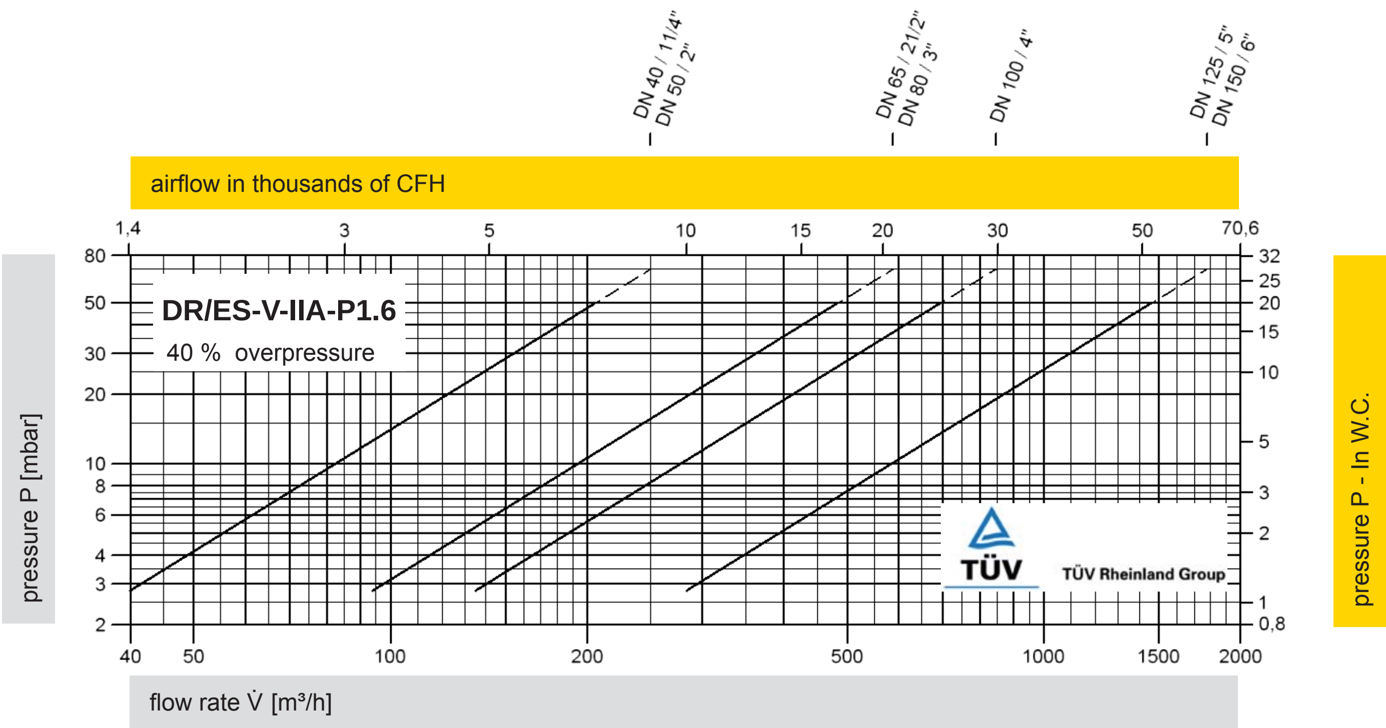
Design / Tab. 1 / Tab. 2 / Tab. 3 / Tab. 4 / Tab. 5 / Tab. 6 / Setting [mbar] / Setting [In W.C.] / Tab. 7 / Tab. 8

Order example

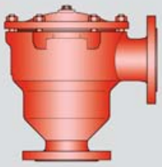
DR/ES-V – H – 50 – IIB3 – P1.6 / – – T60 – A – A – 5 / – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





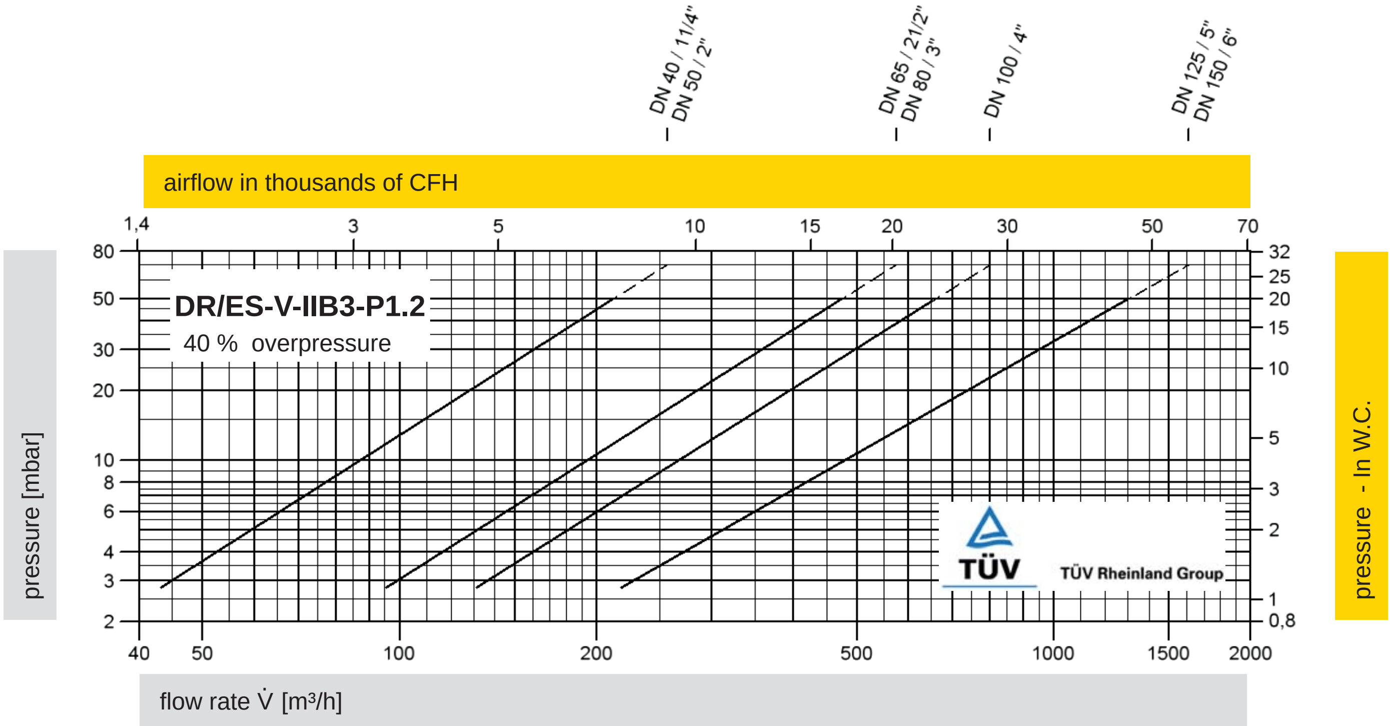
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

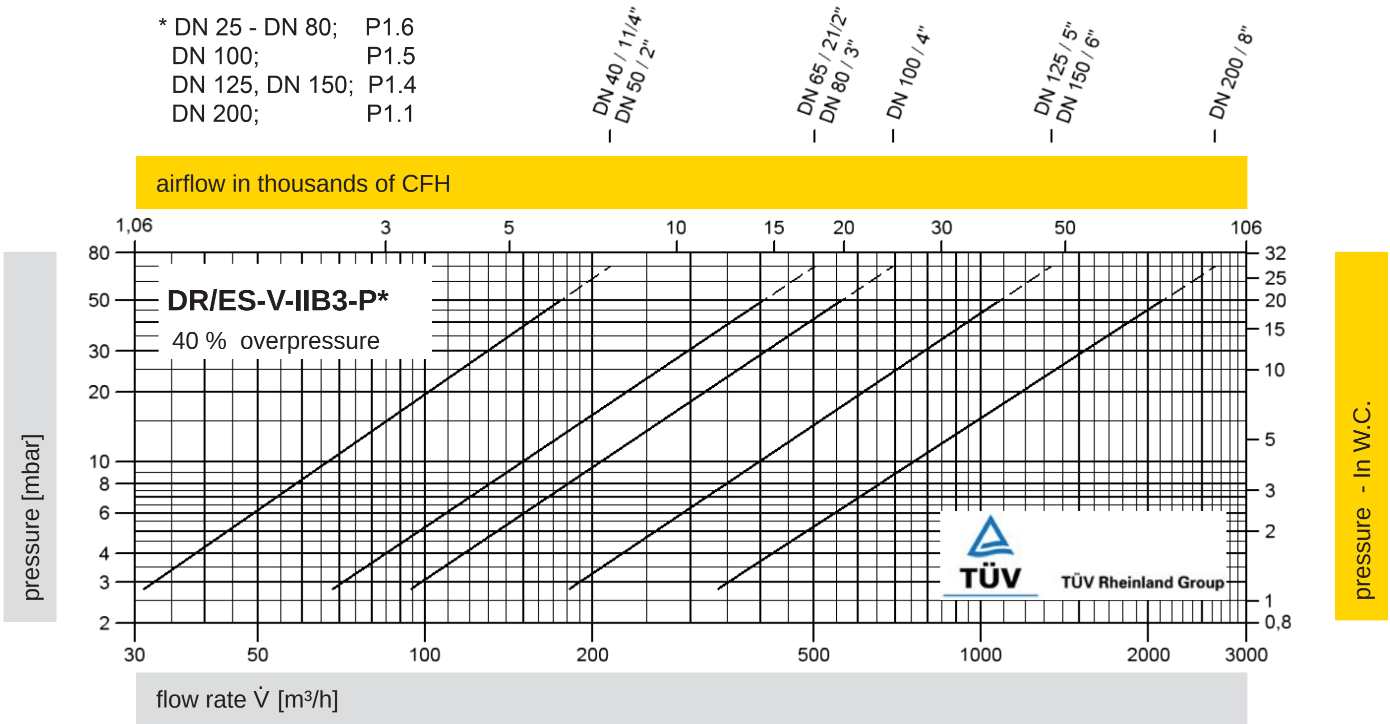


In-Line Detonation Flame Arrester

Flow Capacity Charts

PROTEGO® DR/ES-V





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

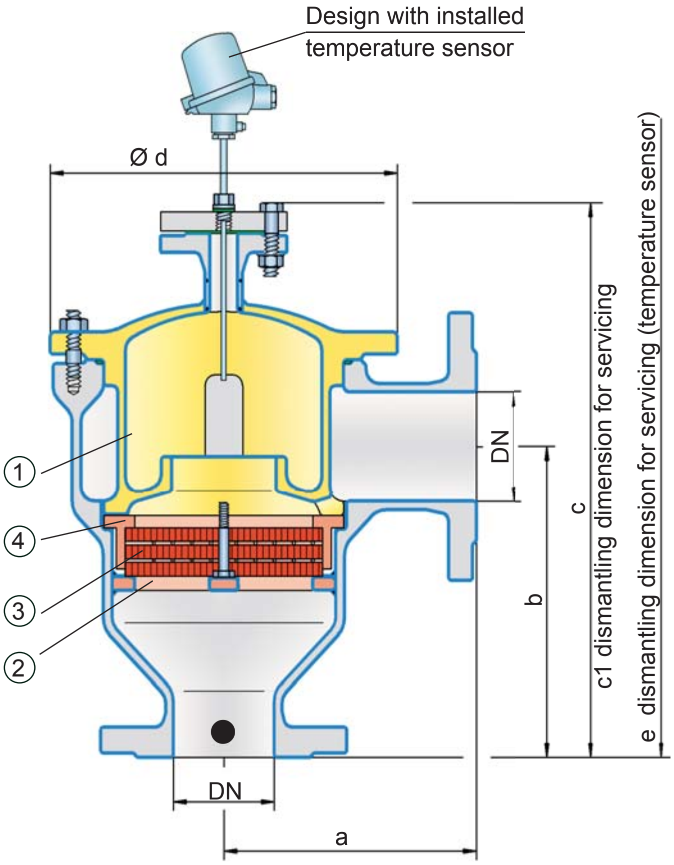
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

In-Line Detonation Flame Arrester

for stable detonations and deflagrations in right angle design with shock absorber, unidirectional

PROTEGO® DR/ES-PTFE



● Connection to the protected side

Function and Description

The PROTEGO® DR/ES-PTFE series in-line detonation flame arrester is distinguished by its unique resistance to adhesive and corrosive media. The use of fluoroplastics as a high-tech housing coating and as safety flame arrester element is unique throughout the world. The device represents a further development of PROTEGO® flame arresters DR/ES in a right angle design that have been used and proven for decades in industry. The device protects against deflagrations and stable detonations.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by the integrated shock absorber (1) before the flame is extinguished in the narrow channel of the original PTFE FLAMEFILTER® (3).

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers firmly held in the FLAMEFILTER® cage (4). The gap size and number of FLAMEFILTER® are determined by the operating data parameters of the mixture flowing in the line (pressure, temperature). The detonation arrester can be used for explosion group IIA (NEC group D). The standard design is approved at an operating temperature up to +60°C / 140°F and an absolute operating pressure acc. to table 3.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Build up of adhesive materials is prevented by the smooth surfaces
- Less soiling of the device lowers service, operating and life-cycle costs
- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Quick removal and installation of the complete PROTEGO® flame arrester unit and the individual FLAMEFILTER® in the cage
- The modular design enables individual FLAMEFILTER® to be replaced
- Offers protection against deflagrations and stable detonations
- The right angle design saves pipe elbows
- Best for corrosive media

Design Types and Specifications

There are two different designs available:

Basic in-line detonation flame arrester	**DR/ES - PTFE** –
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning	**DR/ES - PTFE - T**

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
a	153 / 6.02	155 / 6.10	198 / 7.80	200 / 7.87	250 / 9.84	332 / 13.07	335 / 13.19
b	183 / 7.20	185 / 7.28	223 / 8.78	225 / 8.86	290 / 11.42	357 / 14.06	360 / 14.17
c	345 / 13.58	345 / 13.58	430 / 16.93	430 / 16.93	500 / 19.69	605 / 23.82	605 / 23.82
c1	455 / 17.91	455 / 17.91	585 / 23.03	585 / 23.03	680 / 26.77	835 / 32.87	835 / 32.87
d	210 / 8.27	210 / 8.27	275 / 10.83	275 / 10.83	325 / 12.80	460 / 18.11	460 / 18.11
e	685 / 26.97	685 / 26.97	770 / 30.31	770 / 30.31	840 / 33.07	940 / 37.01	940 / 37.01

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	

Table 3: Selection of max. operating pressure

Expl. Gr.	DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
IIA	P_{max}	1.1 / 15.9	1.1 / 15.9	1.2 / 17.4	1.2 / 17.4	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	Special materials upon request
Housing	Steel with an ECTFE coating	
Cover with shock absorber	Steel with an ECTFE coating	
Gasket	PTFE	
Flame arrester unit	A, B, C	

Table 6: Material combinations of the flame arrester unit

Design	A	B	C
FLAMEFILTER® cage	PTFE *	Hastelloy	Stainless Steel
FLAMEFILTER® *	PTFE *	PTFE *	PTFE *
Spacer	PEEK / ETFE / FEP	PEEK / ETFE / FEP	PEEK / ETFE / FEP

* electrically conductive

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type	Temperature sensor	Nominal size	Explosion group	Max. operating pressure bar /psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
DR/ES-PTFE –	–	–	–	/ –	–	–	–	
Design		Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

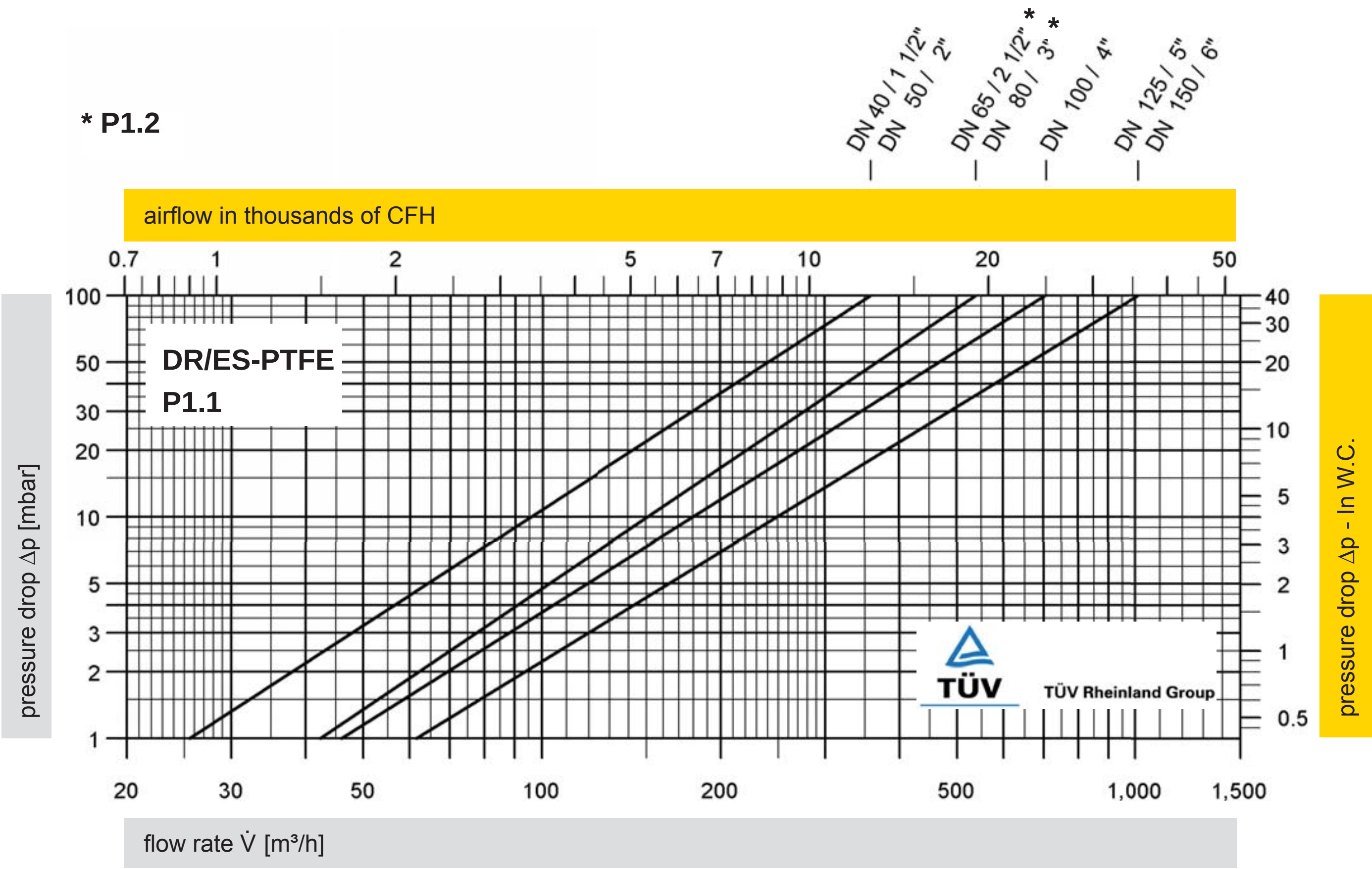
DR/ES-PTFE – T – 80 – IIA – P1.2 / – – T60 – A – A – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

In-Line Detonation Flame Arrester

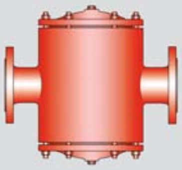
Flow Capacity Chart

PROTEGO® DR/ES-PTFE



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

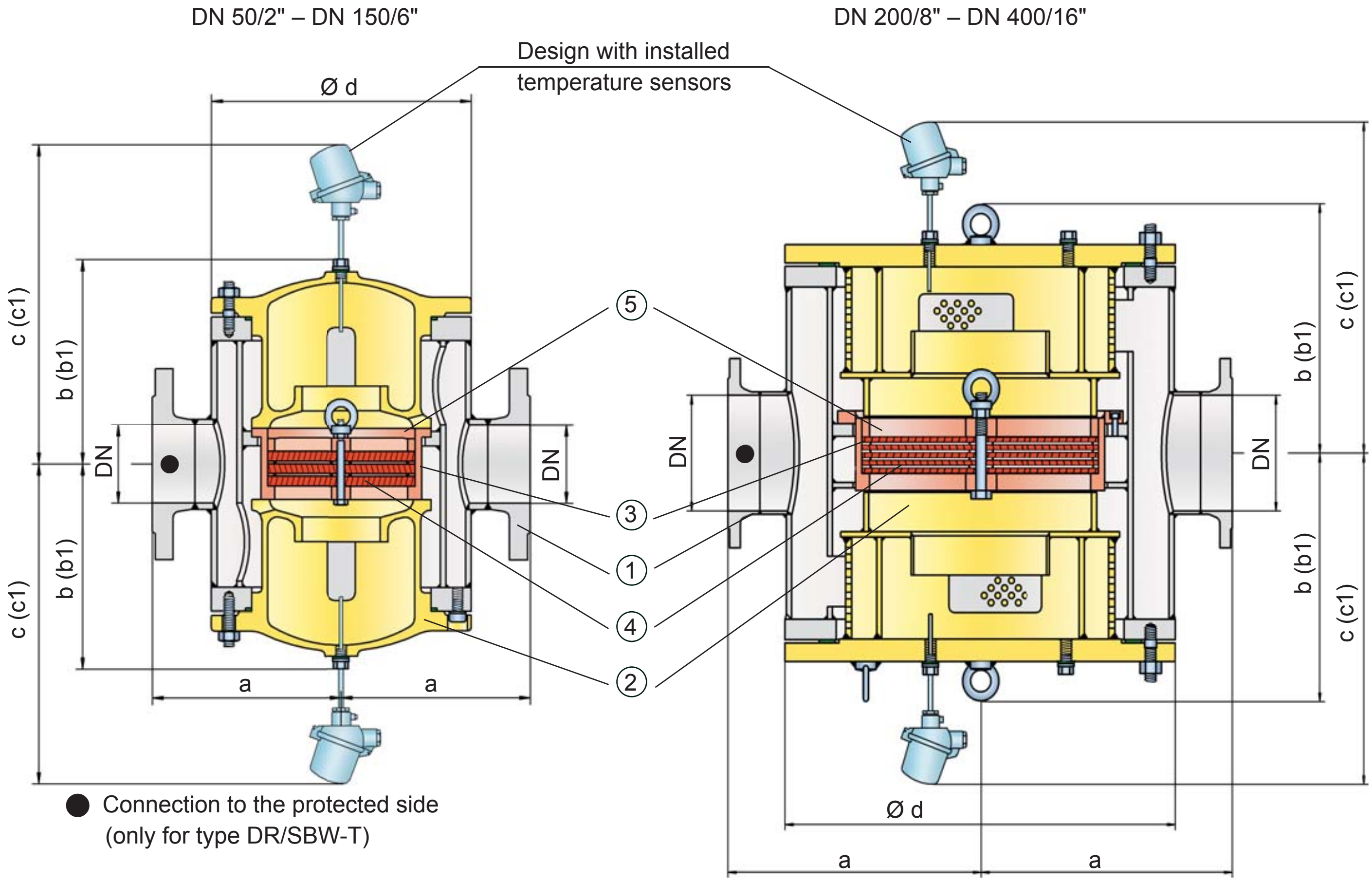
Notes:



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DR/SBW



Function and Description

In the development of the PROTEGO® DR/SBW in-line detonation flame arrester, special effort was made to ease future maintenance of the flame arresters. The PROTEGO® flame arrester unit (5) can be removed and cleaned within moments without having to disassemble the piping. The effective shock absorber of the device and elaborate housing geometry reduces the number of flame arrester elements to a minimum.

The device is symmetrical and offers bidirectional flame arresting protecting from stable detonations and deflagrations.The flame arrester essentially consists of a double-jacket housing (1) with two integrated shock absorbers (2) with the PROTEGO® flame arrester unit in the center. The PROTEGO® flame arrester unit consists of several FLAMEFILTER® (4) and spacers firmly held in a FLAMEFILTER® cage (3). The number of FLAMEFILTER® and their gap size depends on the arrester‘s conditions of use. By indicating the operating parameters such as the temperature, pressure and explosion group and the composition of the fluid, the optimum in-line detonation flame arrester can be selected. The PROTEGO® DR/SBW series of flame arresters is available for explosion groups IIA to IIB3 (NFPA group D to C MESG ≥ 0.65 mm).

The standard design is approved at an operating temperature up to +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approvals can be obtained for higher pressures and higher temperatures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Particularly service-friendly design
- Minimum number of FLAMEFILTER® due to use of effective shock absorber
- Minimum pressure loss and hence low operating and lifecycle costs
- The modular design enables individual FLAMEFILTER® to be exchanged
- Cost efficient spare parts
- Bidirectional operation as well as any flow direction and installation position
- Expanded application range for higher operating temperatures and pressures
- Installation of temperature sensors possible

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DR/SBW-** $\boxed{-}$ **-** $\boxed{-}$
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DR/SBW-** $\boxed{\mathbf{T}}$ **-** $\boxed{-}$
In-line detonation flame arrester with two integrated temperature sensors* as additional protection against short time burning from both sides	**DR/SBW-** $\boxed{\mathbf{TB}}$ **-** $\boxed{-}$
In-line detonation flame arrester with heating jacket	**DR/SBW-** $\boxed{\mathbf{H}}$ **-** $\boxed{}$

Additional special flame arresters upon request

*Resistance thermometer for device group II,
category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN) and nominal width (NG), please use the flow capacity charts on the following pages

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8“	250 / 10"	300 / 12"	350 / 14"	400 / 16"
NG	150 / 6"	150 / 6"	200 / 8"	300 / 12"	500 / 20"	500 / 20"	600 / 24"	700 / 28"	800 / 32"
a	225/8.86	225/8.86	275/10.83	350/13.78	550/21.65	550/21.65	725/28.54	800/31.50	825/32.48
b	210/8.27	210/8.27	220/8.66	290/11.42	525/20.67	525/20.67	590/23.23	655/25.78	725/28.54
b1 *	325/12.80	325/12.80	360/14.17	475/18.70	835/32.87	835/32.87	960/37.80	1075/42.32	1215/47.83
c	395/15.55	395/15.55	410/16.14	475/18.70	630/24.80	630/24.80	700/27.56	765/30.12	835/32.87
c1 *	450/17.72	450/17.72	465/18.31	530/20.87	730/28.74	730/28.74	800/31.50	865/34.06	935/36.81
d	275/10.83	275/10.83	325/12.80	460/18.11	840/33.07	840/33.07	1000/39.37	1150/45.28	1250/49.21

* b1 dismantling dimension for servicing
c1 dismantling dimension for servicing (temperature sensor)

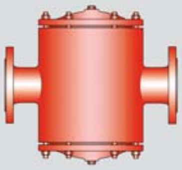
Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.		DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"
		NG	150 / 6"	150 / 6"	200 / 8"	300 / 12"	500 / 20"	500 / 20"	600 / 24"	700 / 28"	800 / 32"
	IIA	P_{max}	4 / 58	4 / 58	3 / 43.5	3 / 43.5	1.6 / 23.2	1.6 / 23.2	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9
	IIB3	P_{max}	1.7 / 24.6	1.7 / 24.6	1.7 / 24.6	1.7 / 24.6	1.2 / 17.4	1.2 / 17.4	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request



In-Line Detonation Flame Arrester

for stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DR/SBW

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing			
Design	A	B	C
Housing Heating jacket (DR/SBW-H-(T)-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Cover with shock absorber	Steel	Stainless Steel	Hastelloy
Gasket	FPM *	PTFE	PTFE
Flame arrester unit	A	C, D	E

* for devices exposed to elevated temperatures above 150°C / 302 °F (T150), gaskets made of PTFE.

Special materials upon request

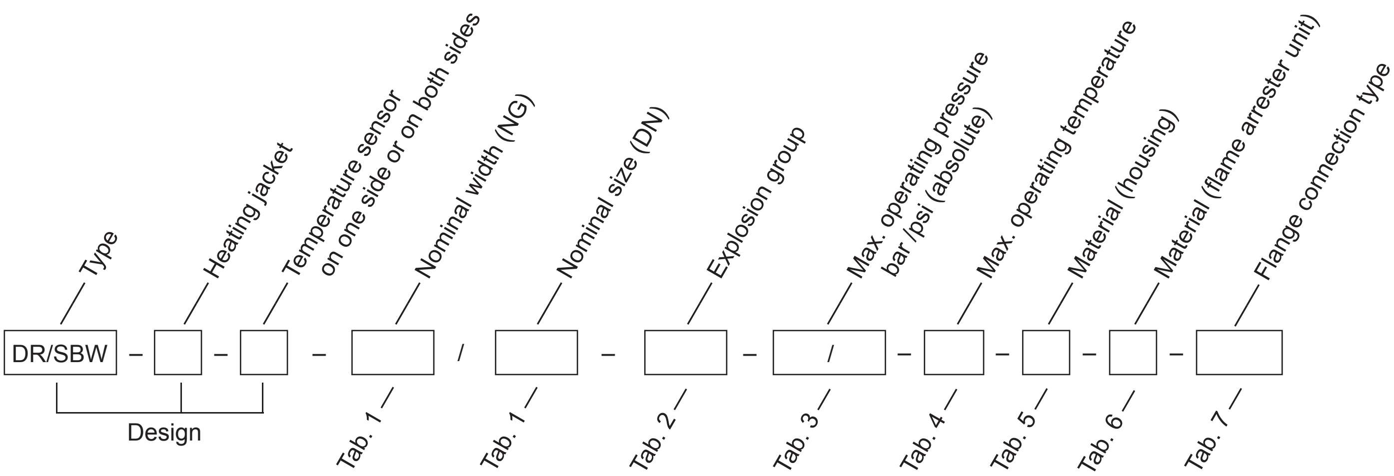
Special device with unidirectional shock absorber DR/SW-... from DN 50 resp. NG 150 available.

Table 6: Material combinations of the flame arrester unit				
Design	A	C	D	E
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

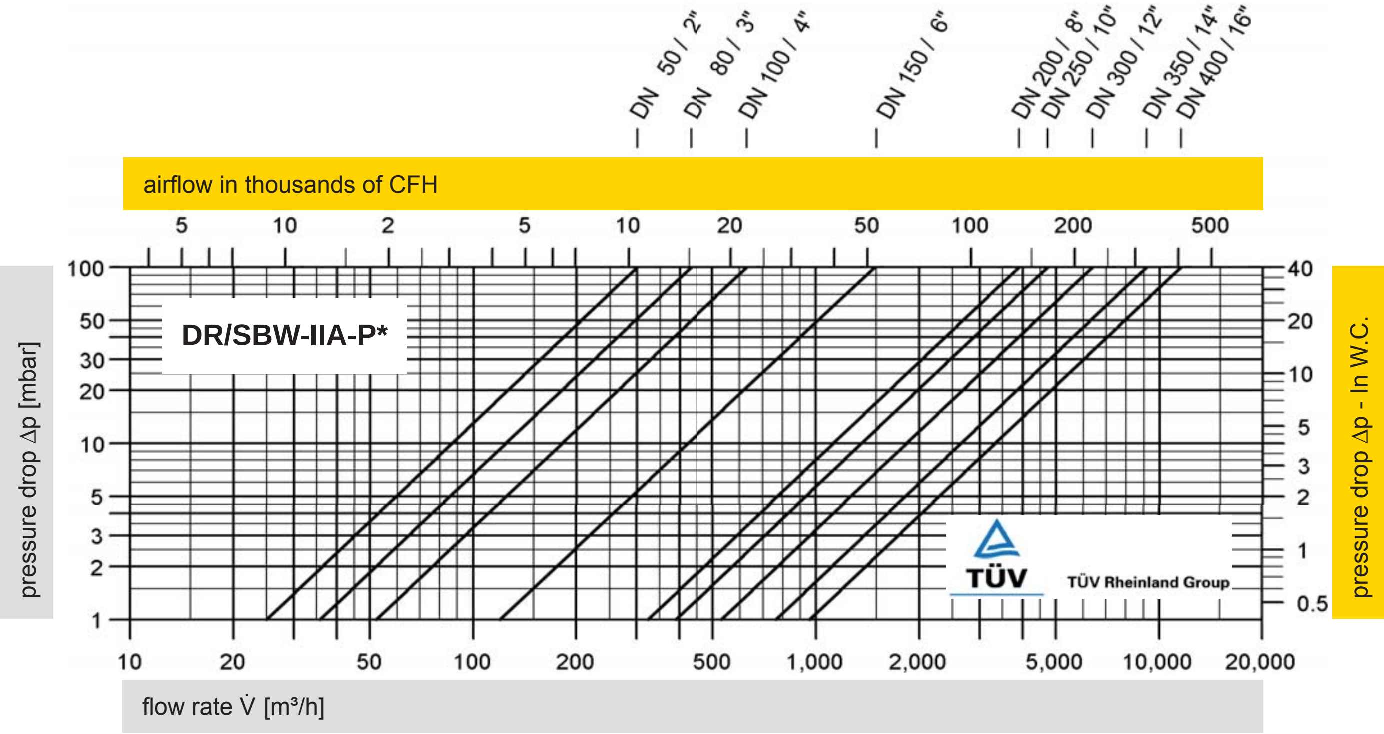
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



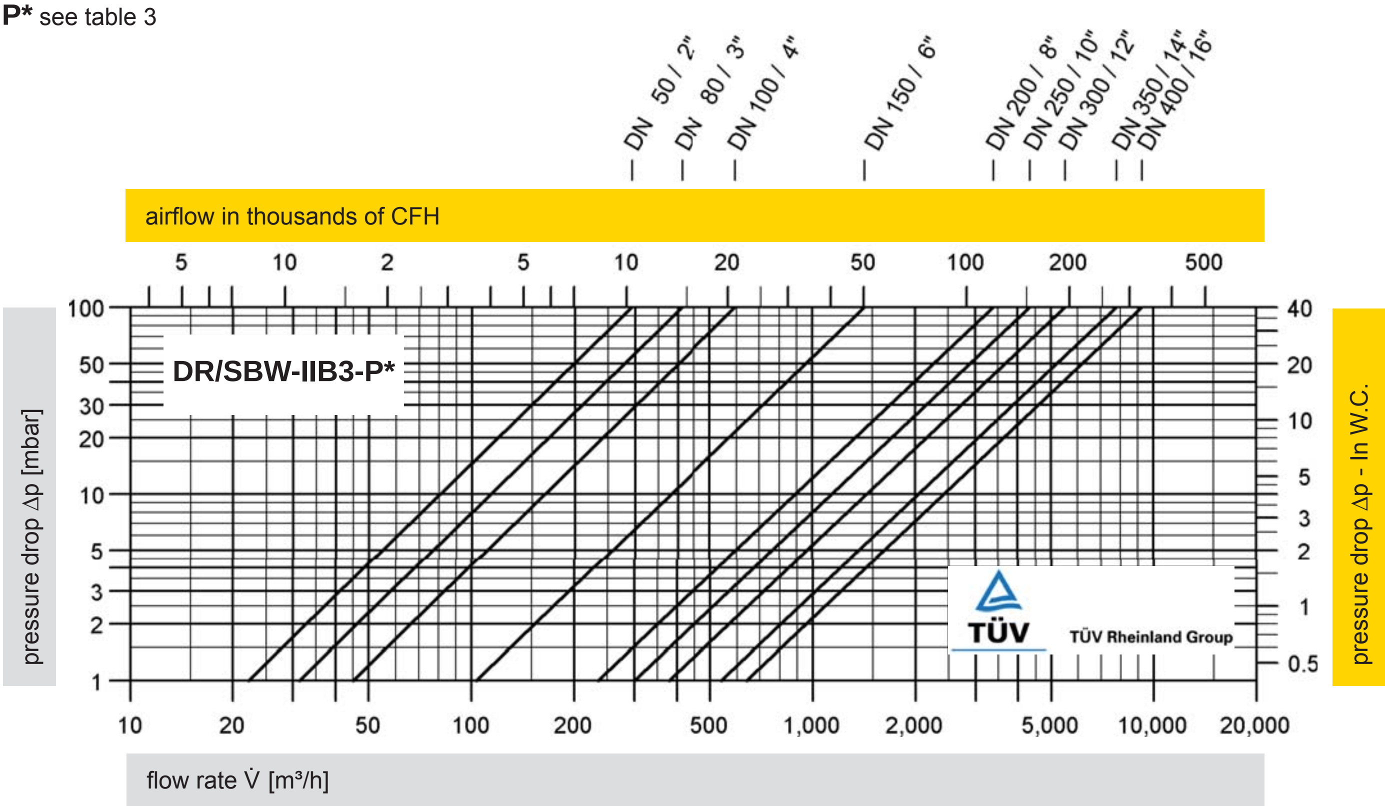
Order example

DR/SBW	–	H	–	TB	–	800	/	400	–	IIB3	–	P1.1/ –	–	T60	–	C	–	C	–	DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"



P* see table 3

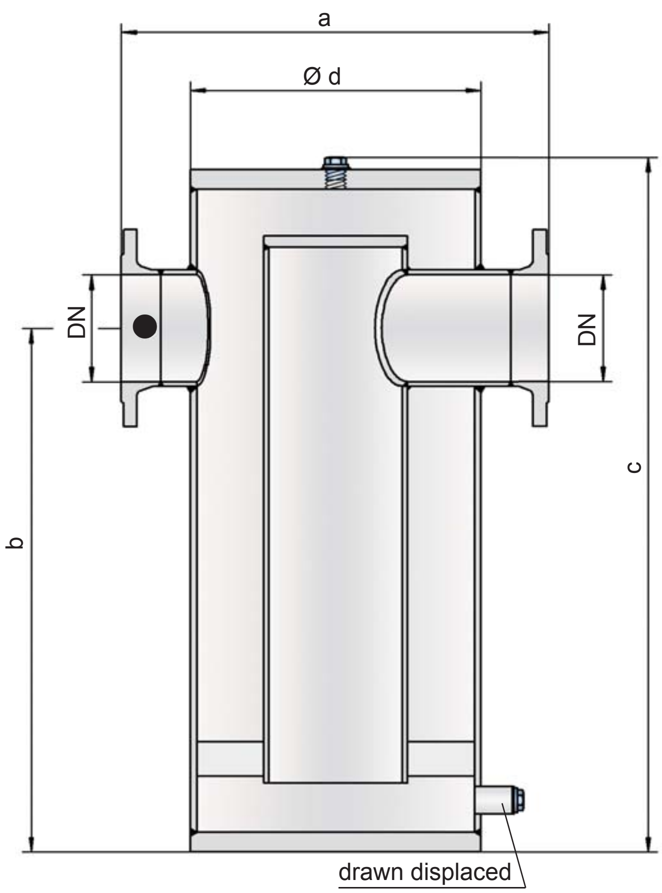


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

In-Line Liquid Detonation Flame Arrester

for filling lines - external installation

PROTEGO® LDA-W



● Tank connection / protected side

When a highly accelerated pipe deflagration or detonation occurs, the combustion pressure and flame propagation speed is first substantially reduced by the construction and converted into a low-energy deflagration that is then stopped by the remaining immersion liquid.

The application range for the device are a product vapour/air mixture temperature up to +60°C / 140°F and an absolute pressure up to 1.1 bar / 15.9 psi. This covers all of the possible operating conditions of empty lines for flammable liquids. The liquid detonation arrester is designed for pressures up to 10 bar / 145 psi and therefore resists explosion pressure offering protection for almost all flammable liquids. The device is approved for explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm). Special designs with a cleaning cover for highly viscous and contaminated liquids can be provided.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Function and Description

The type PROTEGO® LDA-W liquid detonation flame arrester was developed for storage container filling lines that are not continuously filled with product and sometimes contain a combustible mixture. The device is installed outside of the container in the filling line. If the explosive atmosphere is ignited, the device prevents the combustion from traveling into the tank. The PROTEGO® LDA-W series of liquid detonation flame arresters functions according to the siphon principle in which the liquid product serves as a barrier against flame propagation.

Special Features and Advantages

- The device is easily accessible since it is mounted on the containers outside
- Minimum risk of soiling
- Low pressure loss
- Provides protection from deflagrations and stable detonations
- Useful for nearly all flammable liquids
- Meets TRbF* requirements
- Maintenance friendly design also useable as strainer

*TRbF = technical regulations for flammable liquids

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following pages

DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"	300 12"
a	250 / 9.84	275 / 10.83	350 / 13.78	350 / 13.78	450 / 17.72	450 / 17.72	500 / 19.69	600 / 23.62	600 / 23.62	700 / 27.56	850 / 33.46	1000 / 39.37
b	325 / 12.80	360 / 14.17	420 / 16.54	420 / 16.54	540 / 21.26	540 / 21.26	595 / 23.43	915 / 36.02	915 / 36.02	1100 / 43.31	1325 / 52.17	1480 / 58.27
c	445 / 17.52	480 / 18.90	565 / 22.24	565 / 22.24	720 / 28.35	720 / 28.35	800 / 31.50	1265 / 49.80	1265 / 49.80	1520 / 59.84	1830 / 72.05	2050 / 80.71
d	140 / 5.51	140 / 5.51	195 / 7.68	195 / 7.68	275 / 10.83	275 / 10.83	325 / 12.80	460 / 18.11	460 / 18.11	510 / 20.08	610 / 24.02	700 / 27.56

Table 2: Selection of the explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing				
Design	A	B	C	Special materials upon request
Housing	Steel	Stainless Steel	Hastelloy	
Gasket	WS 3822	PTFE	PTFE	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other connections upon request
ANSI 150 lbs RFSF	ANSI	

Type	Nominal size	Explosion group	Max. operating temperature	Material (housing)	Flange connection type
LDA-W	–	–	–	–	–
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5

Order example

LDA-W – 300 – IIB3 – T60 – A – DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

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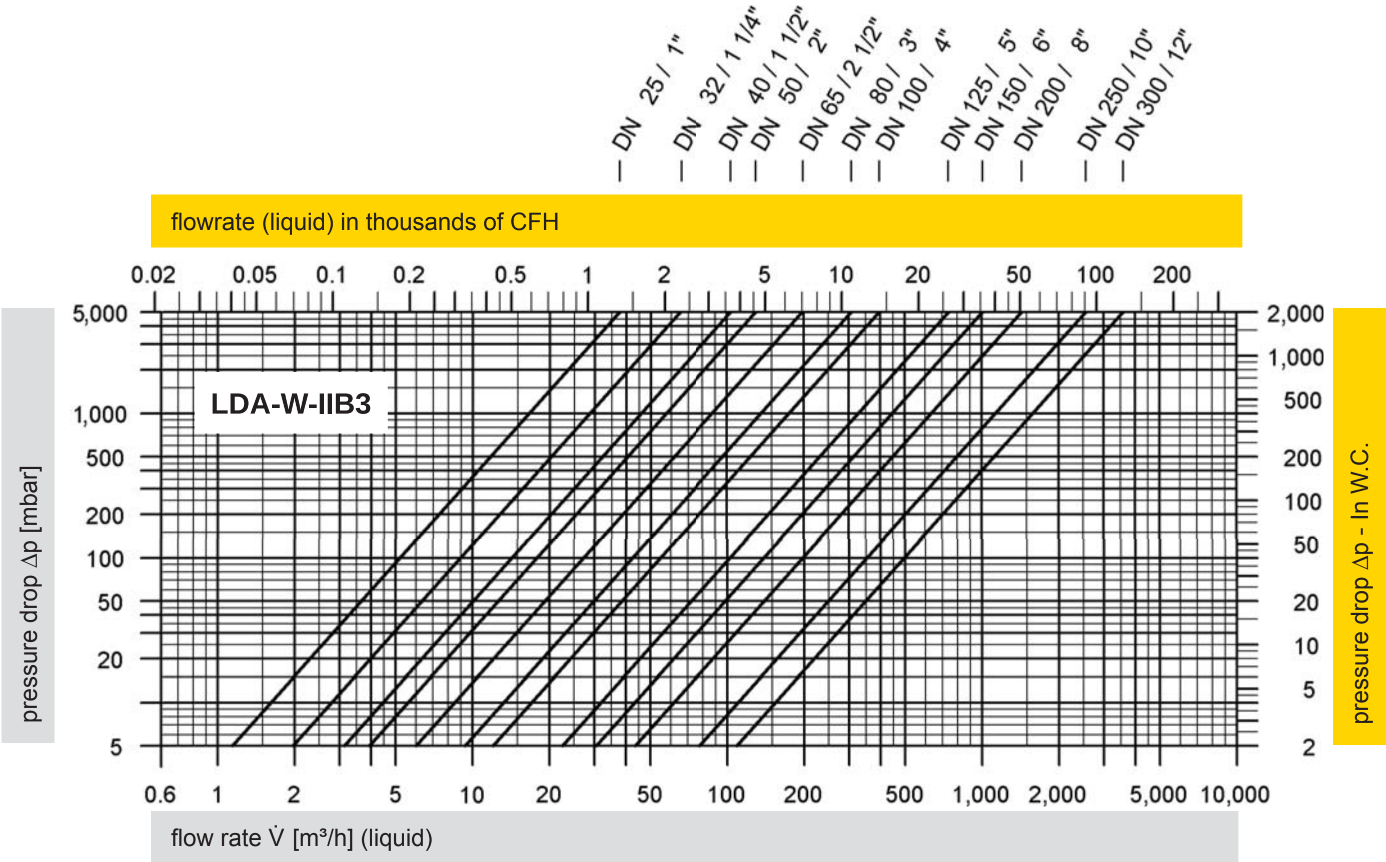
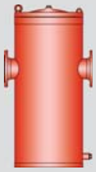
PROTEGO® LDA-W



The volume flow V̇ in m³/h was determined with water according to DIN EN 60534 at a temperature T_n = 15°C and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity v = 10^{-6} m^2/s.

To avoid electrostatic charge of flammable liquids the maximum flow is limited (refer to BG-Regulation 132, CENELEC-Report CLC/TR 50404).

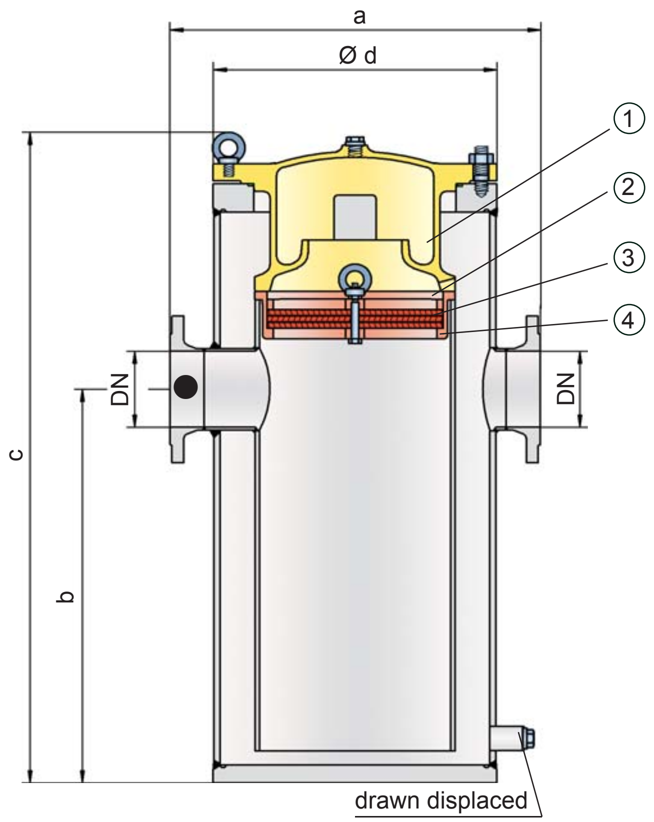
Notes:



In-Line Liquid Detonation Flame Arrester

for filling and drain lines - external installation

PROTEGO® LDA-WF(W)



● Tank connection / protected side

Function and Description

The PROTEGO® LDA-WF(W) series of liquid detonation flame arresters was developed for storage container filling lines that are not continuously filled with product and sometimes contain a combustible mixture. The integrated siphon protection (1) with PROTEGO® flame arrester unit (2) additionally prevents the liquid in which the lines are immersed from being siphoned off while the container is being drained. PROTEGO® flame arrester consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage (4). The number of FLAMEFILTER® and their gap size depends on the arresters conditions of use. The device is installed outside of the container in the filling and drain lines. If the explosive atmosphere is ignited, the device prevents the combustion from traveling into the tank. The PROTEGO® LDA-WF(W) series of liquid detonation flame arresters combines the classic PROTEGO® flame arrester design with the siphon principle in which the liquid product serves as a barrier to flame propagation.

When a highly accelerated pipe deflagration or detonation occurs, the combustion pressure and flame propagation speed is first substantially reduced by the design and converted into a low-energy deflagration that is then stopped by the remaining immersion liquid and the PROTEGO® flame arrester.

The application range for the device are a product vapour/air mixture temperature up to +60°C / 140°F and an absolute pressure up to 1.1 bar / 15.9 psi. This covers all of the possible operating conditions of empty lines for flammable liquids. The liquid detonation arrester is designed for pressures up to 10 bar / 145 psi and therefore resists explosion pressure and offers protection for almost all flammable liquids. The device is approved for explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm). Special designs with a cleaning cover for highly viscous liquids can be provided.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- The device is easily accessible since it is mounted on the containers outside
- Siphon protection offers a high degree of safety
- Minimum risk of soiling
- Low pressure loss
- Provides protection from deflagrations and stable detonations
- Useful for nearly all flammable liquids
- Meets TRbF* requirements

*TRbF = technical regulations for flammable liquids

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following pages

DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"
a	250 / 9.84	250 / 9.84	346 / 13.62	350 / 13.78	446 / 17.56	450 / 17.72	500 / 19.69	600 / 23.62	600 / 23.62	700 / 27.56	900 / 35.43
b	325 / 12.80	325 / 12.80	415 / 16.34	415 / 16.34	535 / 21.06	535 / 21.06	600 / 23.62	915 / 36.02	915 / 36.02	1090 / 42.91	1300 / 51.18
c	475 / 18.70	475 / 18.70	605 / 23.82	605 / 23.82	831 / 32.72	831 / 32.72	936 / 36.58	1340 / 52.76	1340 / 52.76	1520 / 59.84	1750 / 68.90
d	150 / 5.91	150 / 5.91	210 / 8.27	210 / 8.27	275 / 10.83	275 / 10.83	325 / 12.80	460 / 18.11	460 / 18.11	510 / 20.08	610 / 24.02

Table 2: Selection of the explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing			
Design	A	B	Special materials upon request
Housing	Steel	Stainless Steel	
Shock absorber	Steel	Stainless Steel	
Gasket (shock absorber)	FPM	PTFE	
Gasket (locking screw)	WS 3822	PTFE	
Flame arrester unit	A	A	

Table 5: Material for flame arrester unit	
Design	A
FLAMEFILTER® cage	Stainless Steel
FLAMEFILTER® *	Stainless Steel
Spacer	Stainless Steel

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request.

Table 6: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other connections upon request
ANSI 150 lbs RFSF	ANSI	

Type	Nominal size	Explosion group	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
LDA-WF(W)	–	–	–	–	–	–
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6

Order example

LDA-WF(W) – 250 – IIB3 – T60 – A – A – DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

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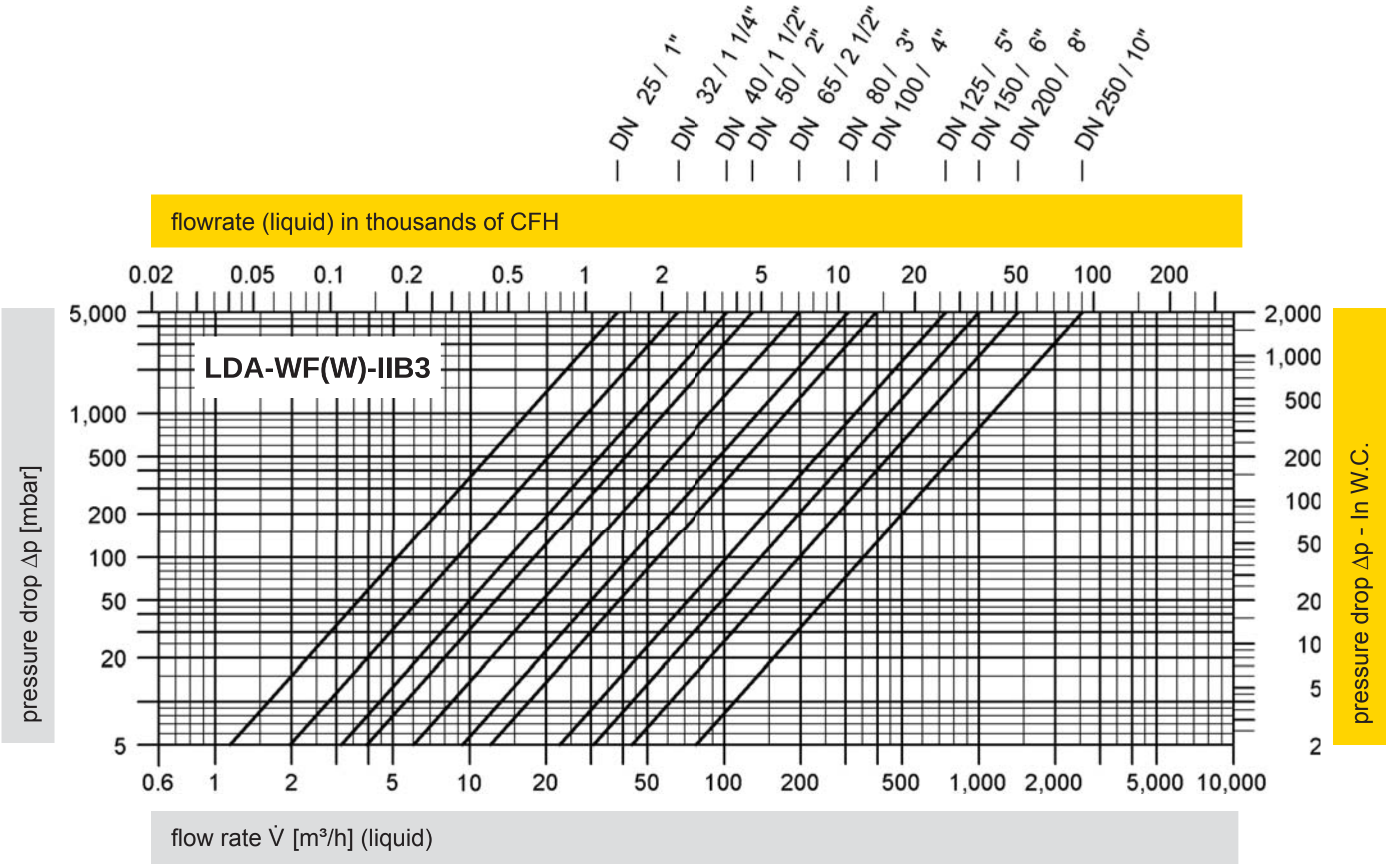
PROTEGO® LDA-WF(W)



The volume flow $\dot{V}$ in m³/h was determined with water according to DIN EN 60534 at a temperature T_n = 15°C and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity $v = 10^{-6}$ m²/s.

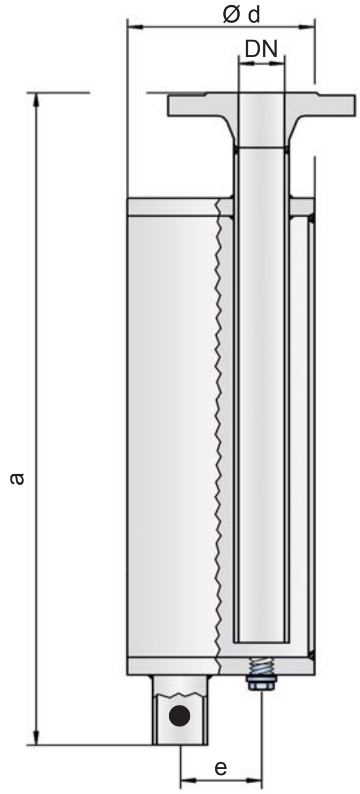
To avoid electrostatic charge of flammable liquids the maximum flow is limited (refer to BG-Regulation 132, CENELEC-Report CLC/TR 50404).

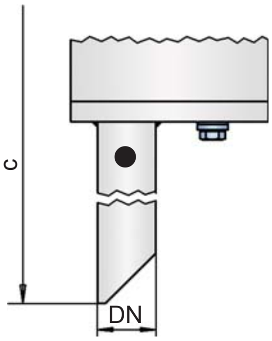
Notes:

Liquid Detonation Flame Arrester

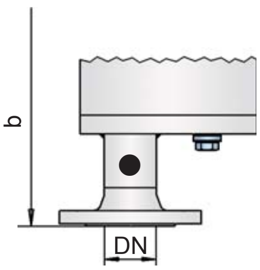
for filling lines - internal installation

PROTEGO® LDA





Outlet type II



Outlet type III

Outlet type I

● Tank connection / protected side

Function and Description

The PROTEGO® LDA series of liquid detonation arresters was developed for storage tank filling lines that are not continuously filled with product and sometimes contain a combustible mixture.

The device is installed inside the tank at the end of the line and prevents the combustion from being transferred into the tank if the explosive atmosphere ignites. The liquid detonation arresters function according to the siphon principle in which the liquid product serves as a liquid barrier to flame propagation.

When a highly accelerated pipe deflagration or detonation occurs, the combustion pressure and flame propagation speed is first substantially reduced by the design and converted into a low-energy deflagration that is then stopped by the remaining immersion liquid.

The application range for the device are a product vapour/air mixture temperature up to + 60°C / 140°F and an absolute pressure up to 1.1 bar / 15.9 psi. This covers all of the possible operating conditions of empty lines for flammable liquids. The liquid detonation arrester is pressure-resistant up to 10 bar / 145 psi. The device protects against nearly all flammable liquids, and is approved for explosion groups IIA to IIB3 (NFPA group D to C MESG ≥ 0.65 mm). Special designs with a cleaning cover for highly viscous liquids can be provided.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Simple construction that helps prevent soiling
- Low pressure loss
- Provides protection from deflagrations and stable detonations
- Useful for nearly all flammable liquids
- Meets TRbF* requirements
- Deliverable with different outlets

*TRbF = technical regulations for flammable liquids

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following pages

DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"
a	500 / 19.69	580 / 22.83	700 / 27.56	700 / 27.56	825 / 32.48	925 / 36.42	1050 / 41.34	1150 / 45.28	1350 / 53.15	1650 / 64.96	2000 / 78.74
b	538 / 21.18	620 / 24.41	745 / 29.33	745 / 29.33	870 / 34.25	975 / 38.39	1102 / 43.39	1205 / 47.44	1405 / 55.31	1712 / 67.40	2068 / 81.42
c	725 / 28.54	805 / 31.69	925 / 36.42	925 / 36.42	1050 / 41.34	1145 / 45.08	1270 / 50.00	1380 / 54.33	1580 / 62.20	1880 / 74.02	2300 / 90.55
d	115 / 4.53	140 / 5.51	168 / 6.61	168 / 6.61	220 / 8.66	245 / 9.65	325 / 12.80	356 / 14.02	500 / 19.69	600 / 23.62	700 / 27.56
e	50 / 1.97	58 / 2.28	65 / 2.56	65 / 2.56	95 / 3.74	105 / 4.13	135 / 5.31	155 / 6.10	200 / 7.87	250 / 9.84	300 / 11.81

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	Special materials upon request
Gasket	WS 3822	PTFE	

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other connections upon request
ANSI 150 lbs RFSF	ANSI	

Table 6: Outlet type

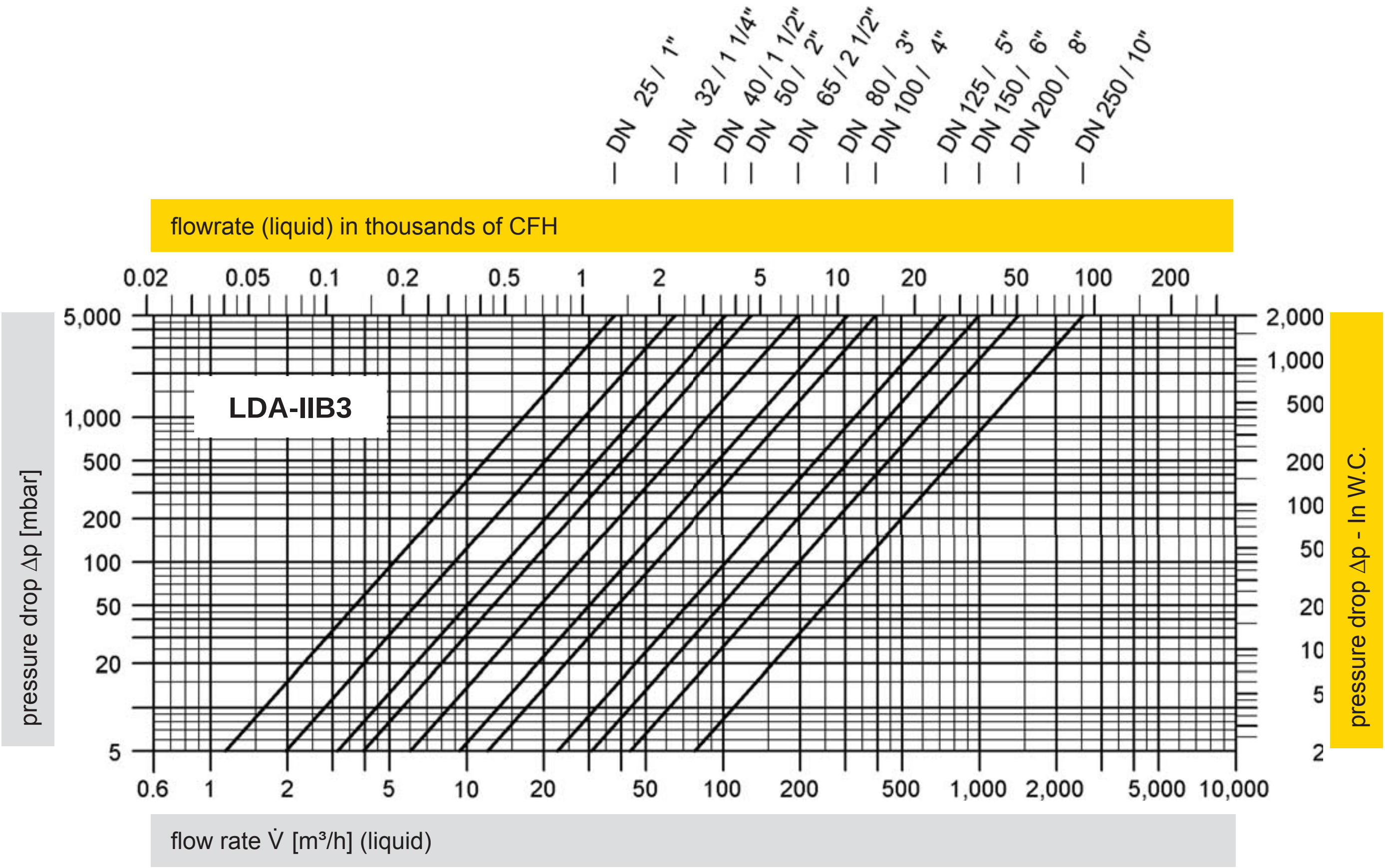
Straight pipe	I	other types upon request
Beveled pipe	II	
EN 1092-1, Form B1 or DIN 2501, Form C	III (EN or DIN)	
ANSI 150 lbs RFSF	III (ANSI)	

Type		Nominal size		Explosion group		Max. operating temperature		Material (housing)		Flange connection type		Outlet type
LDA	–		–		–		–		–		–	
		Tab. 1		Tab. 2		Tab. 3		Tab. 4		Tab. 5		Tab. 6

Order example

LDA	–	150	–	IIB3	–	T60	–	B	–	DIN	–	III (DIN)

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



The volume flow $\dot{V}$ in m³/h was determined with water according to DIN EN 60534 at a temperature T_n = 15°C and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity $v = 10^{-6}$ m²/s.

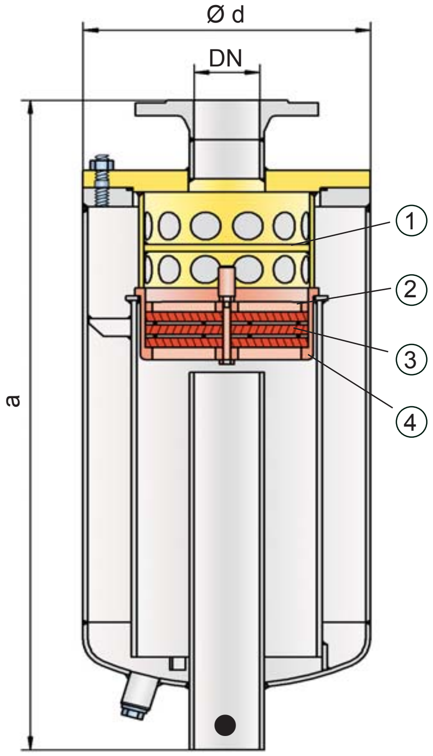
To avoid electrostatic charge of flammable liquids the maximum flow is limited (refer to BG-Regulation 132, CENELEC-Report CLC/TR 50404).

Notes:

Liquid Detonation Flame Arrester

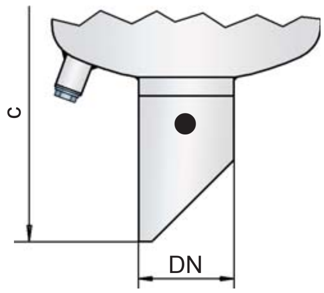
for filling and drain lines - internal installation

PROTEGO® LDA-F

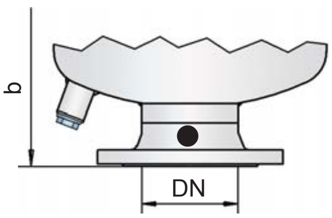


Outlet type I

● Tank connection / protected side



Outlet type II



Outlet type III

The PROTEGO® LDA-F series of liquid detonation arresters combines the classic PROTEGO® flame arrester design with the siphon principle in which the liquid product serves as a barrier to flame propagation.

When a highly accelerated pipe deflagration or detonation occurs, the combustion pressure and flame propagation speed is first substantially reduced by the design and converted into a low-energy deflagration that is then stopped by the remaining immersion liquid and the PROTEGO® flame arrester.

The application limits for the device are product vapour/air mixture temperatures up to +60°C / 140°F and an absolute pressure up to 1.1 bar / 15.9 psi. This covers all of the possible operating conditions of empty lines for flammable liquids. The liquid detonation arrester in standard design is pressure-resistant up to 10 bar / 145 psi. The device protects against nearly all flammable liquids and is approved for explosion groups IIA to IIB3 (NEC group D and C MESG ≥ 0.65 mm).

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Function and Description

The PROTEGO® LDA-F series of liquid detonation arresters was developed for storage tanks filling and drain lines that are not continuously filled with product and sometimes contain a combustible mixture. The integrated siphon protection (1) with PROTEGO® flame arrester unit (2) additionally prevents the liquid in which the lines are immersed from being siphoned off while the container is being drained. PROTEGO® flame arrester consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage (4). The number of FLAMEFILTER® and their gap size depends on the arresters conditions of use. The device is installed inside the container at the end of the line and prevents the combustion from being transferred into the tank if the explosive atmosphere ignites.

Special Features and Advantages

- Siphon protection offers a high degree of safety
- Minimum risk of soiling
- Low pressure loss
- Provides protection from deflagrations and stable detonations
- Useful for nearly all flammable liquids
- Meets TRbF* requirements
- Deliverable with different outlets

*TRbF = technical regulations for flammable liquids

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following pages

DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"
a	550 / 21.65	550 / 21.65	650 / 25.59	650 / 25.59	850 / 33.46	875 / 34.45	1050 / 41.34	1250 / 49.21	1450 / 57.09	1600 / 62.99	1975 / 77.76
b	588 / 23.15	590 / 23.23	692 / 27.24	695 / 27.36	895 / 35.24	925 / 36.42	1102 / 43.39	1305 / 51.38	1505 / 59.25	1662 / 65.43	2043 / 80.43
c	775 / 30.51	775 / 30.51	875 / 34.45	875 / 34.45	1075 / 42.32	1095 / 43.11	1270 / 50.00	1480 / 58.27	1680 / 66.14	1830 / 72.05	2275 / 89.57
d	140 / 5.51	140 / 5.51	220 / 8.66	220 / 8.66	275 / 10.83	275 / 10.83	356 / 14.07	457 / 17.99	508 / 20.00	600 / 23.62	711 / 27.99

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	Special materials upon request
Shock absorber	Steel	Stainless Steel	
Gasket	FPM	PTFE	
Flame arrester unit	A	A	

Table 5: Material for flame arrester unit

Design	A
FLAMEFILTER® cage	Stainless Steel
FLAMEFILTER® *	Stainless Steel
Spacer	Stainless Steel

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other connections upon request
ANSI 150 lbs RFSF	ANSI	

Table 7: Outlet type

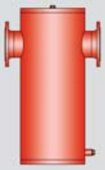
Straight pipe	I	other types upon request
Beveled pipe	II	
EN 1092-1, Form B1 or DIN 2501, Form C	III (EN or DIN)	
ANSI 150 lbs RFSF	III (ANSI)	

Type	Nominal size	Explosion group	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type	Outlet type
LDA-F	–	–	–	–	–	–	–
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Tab. 6	Tab. 7

Order example

LDA-F	250	IIB3	T60	A	A	DIN	III (DIN)

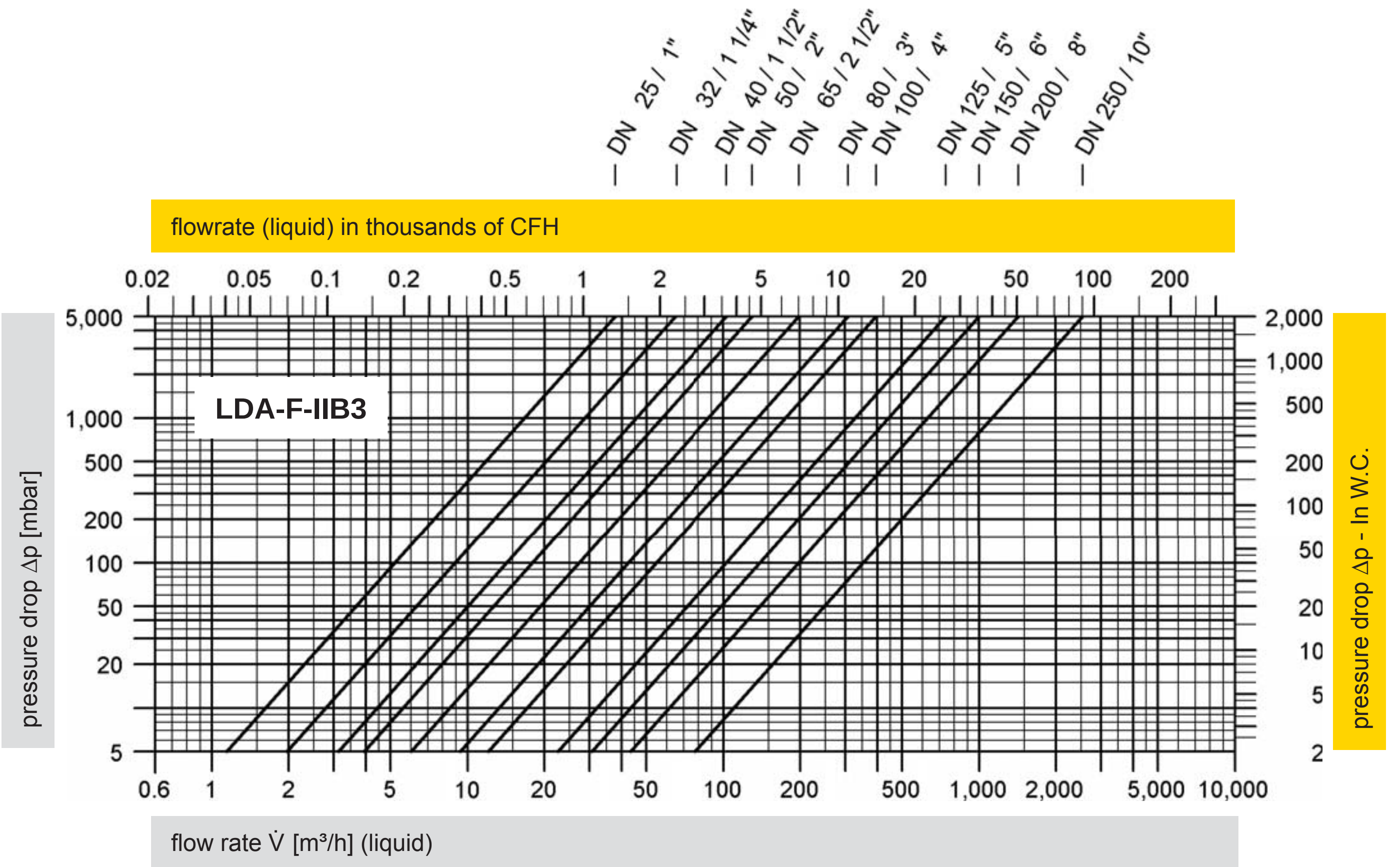
Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"



Liquid Detonation Flame Arrester

Flow Capacity Chart

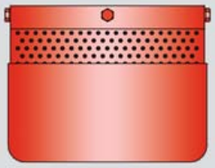
PROTEGO® LDA-F



The volume flow $\dot{V}$ in m³/h was determined with water according to DIN EN 60534 at a temperature $T_n = 15^{\circ}C$ and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity $v = 10^{-6}$ m²/s.

To avoid electrostatic charge of flammable liquids the maximum flow is limited (refer to BG-Regulation 132, CENELEC-Report CLC/TR 50404).

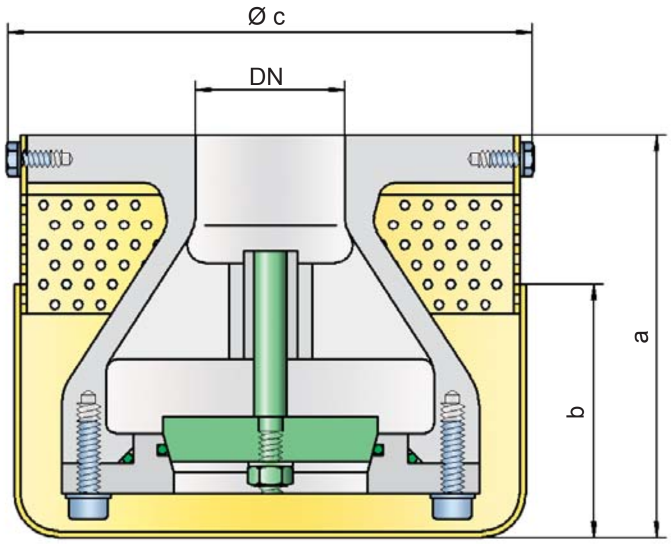
Notes:



Detonation Flame Arrester

Detonation-proof foot valve for suction lines

PROTEGO® EF/V



Combustible mixtures can arise in filling and drain lines of storage containers that are not always filled with product. With the ignition of the explosive atmosphere, highly accelerated pipe deflagration or detonations can arise. The detonation-proof foot valve prevents the combustion from being transmitted into the tank and destroying it. The design of the foot valve ensures that the strainer is always filled with residual product. Together with the special valve design, this combination prevents flame flash back from the inside out.

The application limits for the device are a product vapour/air mixture temperature up to +60°C / 140°F and an absolute pressure up to 1.1 bar / 15.9 psi. This covers all of the possible operating conditions of empty lines for flammable liquids.

The device protects against nearly all flammable liquids, and is permitted for explosion group IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

Type-tested according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Function and Description

The PROTEGO® EF/V detonation-safe foot valve protects the suction line in a storage tank. The nearly service-free device is installed at the end of the emptying line within the tank. When a pump draws, the valve opens at an approximate underpressure of 30 mbar / 12 In W.C. . When the pump is turned off, the device functions as a check valve and prevents the line from emptying. This is very helpful when the pump is restarted.

Special Features and Advantages

- Almost service-free
- The check valve makes it easier to start the pump
- Provides protection from deflagrations and stable detonations
- Applicable to nearly all flammable liquids
- Meets TRbF* 20 requirements
- The special strainer prevents solid particles from entering

*TRbF = technical regulations for flammable liquids

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	25 1"	32 1 ¼"	40 1 ½"	50 2"	65 2 ½"	80 3"	100 4"	125 5"	150 6"	200 8"	250 10"
a	125 / 4.92	125 / 4.92	135 / 5.31	135 / 5.31	160 / 6.29	160 / 6.29	200 / 7.87	235 / 9.25	260 / 10.24	400 / 15.75	450 / 17.72
b	85 / 3.35	85 / 3.35	85 / 3.35	85 / 3.35	95 / 3.74	95 / 3.74	125 / 4.92	130 / 5.12	135 / 5.31	175 / 6.89	200 / 7.81
c	150 / 5.91	150 / 5.91	180 / 7.09	180 / 7.09	210 / 8.27	210 / 8.27	250 / 9.84	305 / 12.01	360 / 14.17	475 / 18.70	560 / 22.05

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing					
Design	A	B	C	D	Special materials upon request
Housing	Steel	Stainless Steel	Steel	Stainless Steel	
Valve	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	
Gasket (Valve)	PTFE	PTFE	PTFE	PTFE	
Gasket (housing)	FPM	FPM	PTFE	PTFE	
Strainer	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other connections upon request
ANSI 150 lbs RFSF	ANSI	

Type — Nominal size — Explosion group — Max. operating temperature — Material (housing) — Flange connection type

EF/V – [ ] – [ ] – [ ] – [ ] – [ ]

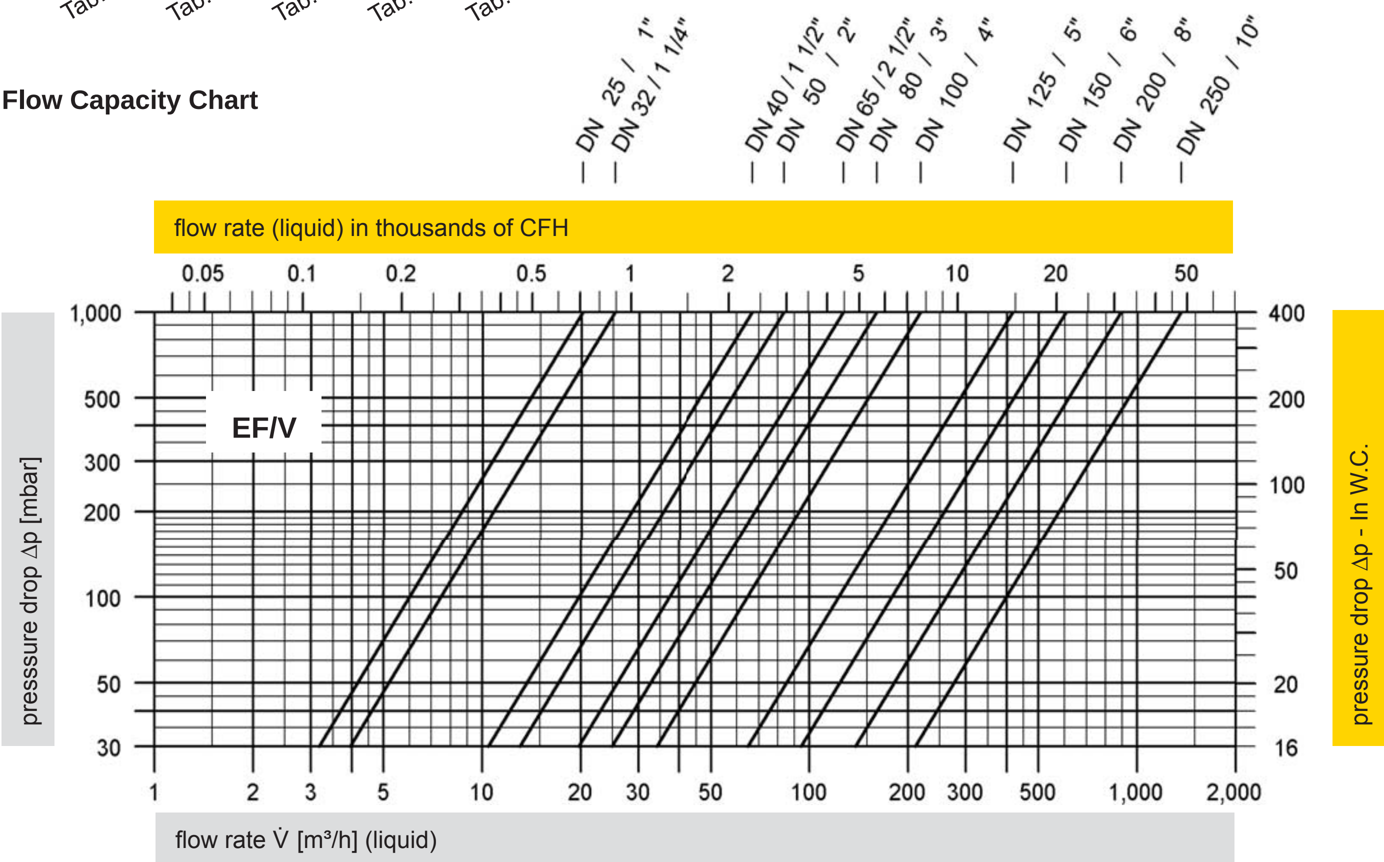
Tab. 1 — Tab. 2 — Tab. 3 — Tab. 4 — Tab. 5

Order example

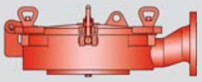
EF/V – 250 – IIB3 – T60 – B – DIN

Materials and chemical resistance:
See Vol. 1 "Technical Fundamentals"

Flow Capacity Chart



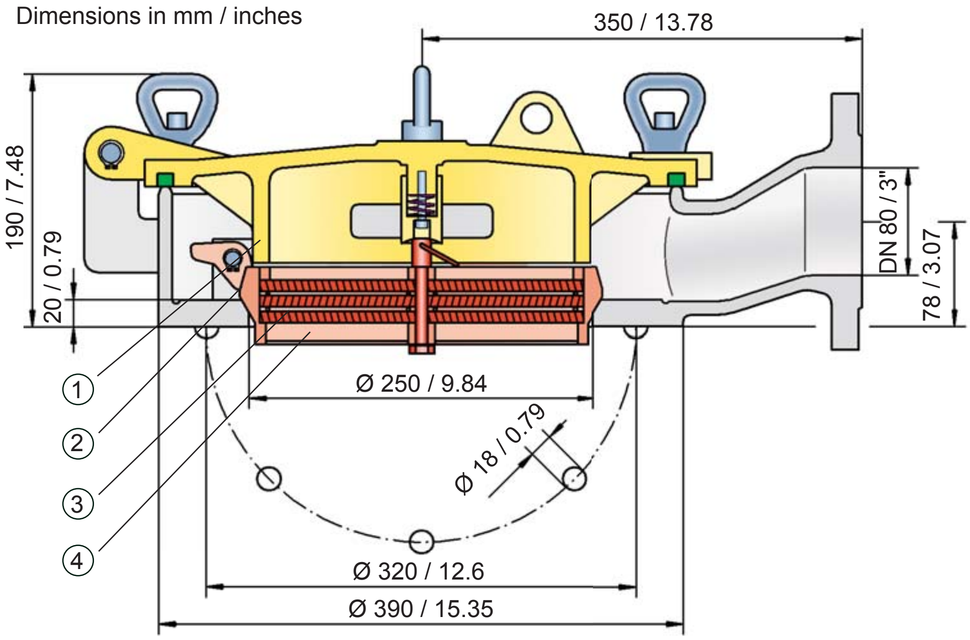
The volume flow $\dot{V}$ in m³/h was determined with water according to DIN EN 60534 at a temperature $T_n = 15^\circ C$ and an atmospheric pressure p_n = 1,013 bar, kinetic viscosity $v = 10^{-6}$ m²/s.
To avoid electrostatic charge of flammable liquids the maximum flow is limited (refer to BG-Regulation 132, CENELEC-Report CLC/TR 50404).



Detonation Flame Arrester

for tank ships and containers

PROTEGO® BR/TS-250



The standard design is approved up to an operating temperature of +60°C / 140°F and an operating pressure up to 1.1 bar / 15.9 psi (absolute), and it meets all the conditions of the ADNR* for hazardous goods transport on European inland waterways.

Type-tests according to EN 12874 and classification societies are available

Function and Description

The type PROTEGO® BR/TS-250-IIB3 detonation flame arrester was specially developed for protecting tankships and can also be used for containers. These devices are especially used on tank ships for inland navigation or coastal shipping. The device is installed on the tank or a pipe section connected to the tank with a nominal size of 250 mm / 10" and connected to the gas balancing line (DN 80 / 3"). The individual tanks connected via the gas balancing line are technically decoupled by the detonation arresters and protected.

The device protects against unidirectional detonation. In particular, the arrester consists of a shock absorber (1) and the PROTEGO® flame arrester unit (2). The PROTEGO® flame arrester unit consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage (4). It is moveable and can be folded to the side for maintenance. The primary goal of this design is to enable the tank to be vented or supplied with air in an emergency when ice or crystallizing products clog the FLAMEFILTER®. The PROTEGO® BR/TS flame arrester can be used for explosion groups IIA to IIB3 (NEC group D and C MESG ≥ 0.65 mm).

Special Features and Advantages

- Meets all ADNR* requirements
- Flat design
- The emergency venting with the flexibly mounted flame arrester enables use even in bad weather conditions as well as with contaminated products
- Extraordinarily easy to service
- The design of the PROTEGO® flame arrester unit enables individual FLAMEFILTER® to be replaced
- Cost efficient spare parts
- We offer support in calculating loading and unloading rates
- Applicable for nearly all flammable liquids
- May be used as maintenance and cleaning hatch

* PRESCRIPTION OF THE TRANSPORT OF DANGEROUS GOODS ON THE RHINE

Table 1: Material selection for housing

Design	A	B
Housing	Steel	Stainless Steel
Cover	Steel	Stainless Steel
Gasket	Tankatite	Tankatite
Flame arrester unit	A	A

Table 2: Material for flame arrester unit

Design	A
FLAMEFILTER® cage	Stainless Steel
FLAMEFILTER®	Stainless Steel
Spacer	Stainless Steel

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other tconnections upon request
ANSI 150 lbs RFSF	ANSI	

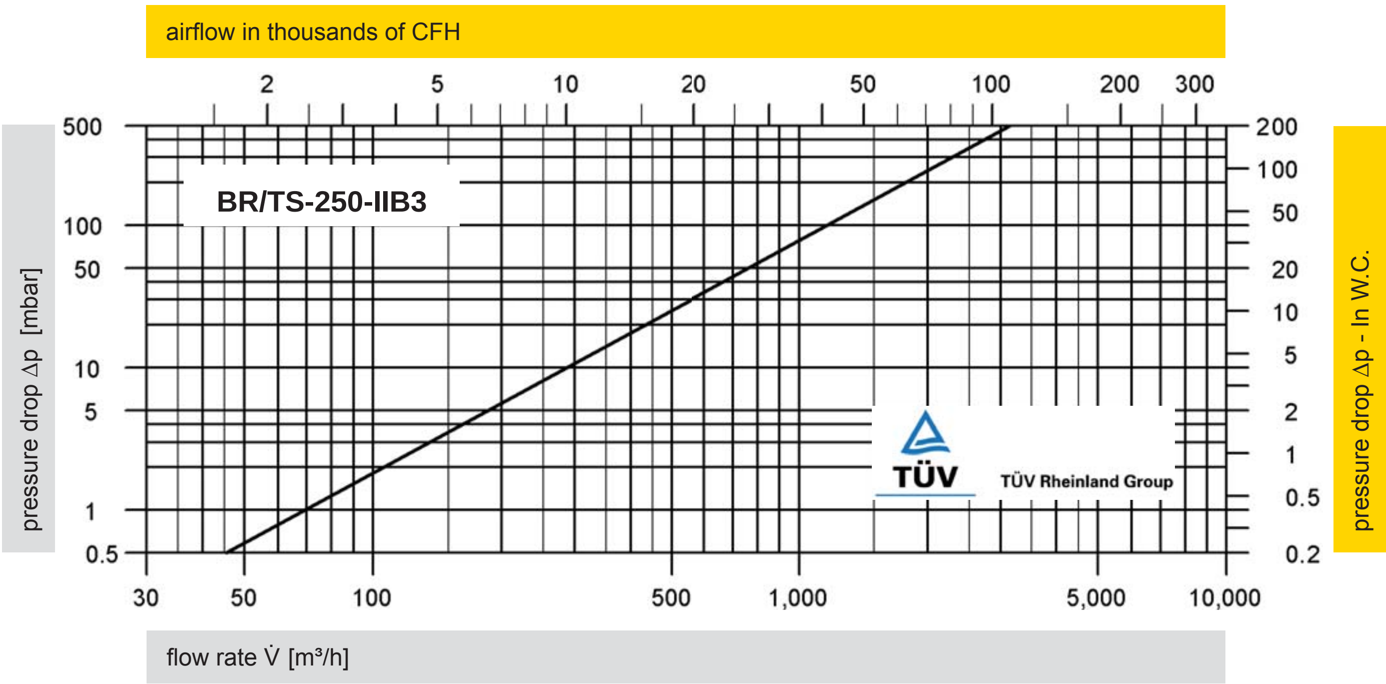
Type		Material (housing)		Material (flame arrester unit)		Flange connection type
BR/TS-250-IIB3	–		–		–	
		Tab. 1		Tab. 2		Tab. 3

Order example

BR/TS-250-IIB3	–	A	–	A	–	DIN

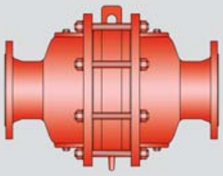
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

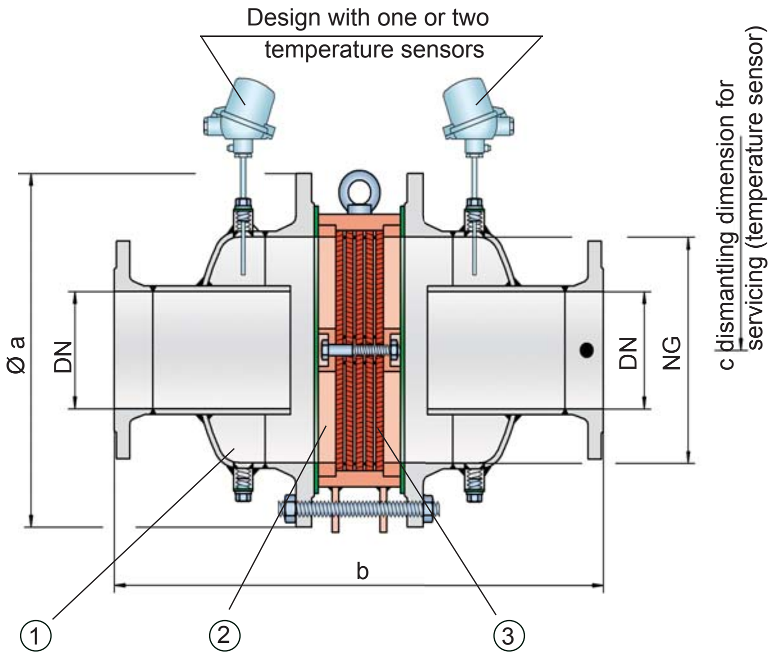
PROTEGO
for safety and environment



In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in a straight through design with a shock tube, bidirectional

PROTEGO® DA-UB



● Connection to the protected side (only for type DA-UB-T-....)

Function and Description

The in-line detonation flame arresters type PROTEGO® DA-UB are the newest generation of flame arresters. On the basis of fluid dynamic and explosion-dynamic calculations and decades of experience from field tests, a line was developed that offers minimum pressure loss and maximum safety. The device uses the *Shock Wave Guide Tube Effect (SWGTE)* to optimally decouple the flame front and shock wave. The result is an in-line detonation flame arrester without a classic shock absorber, and the use of flame-extinguishing elements is minimized.

The devices are symmetrical and offer bidirectional flame arresting for deflagrations, stable and unstable detonations. The arrester essentially consists of two housing parts with an integrated shock tube (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use.

By indicating the operating parameters such as temperature, pressure and explosion group and the composition of the fluid, the optimum detonation arrester can be selected from a series of approved devices. PROTEGO® DA-UB flame arresters are available for explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Numerous devices with special approval can be supplied for higher pressures (see table 3) and higher temperatures.

Type-approved according to ATEX Directive 94/9/EC und EN 12874 as well as other international standards.

Special Features and Advantages

- Optimized performance from the patented *Shock Wave Guide Tube Effect (SWGTE)*
- Less number of FLAMEFILTER® from the use of the patented shock tube *(SWGTE)*
- The modular design enables individual FLAMEFILTER® to be exchanged
- Different series allow scalable pressure loss across the surface of the FLAMEFILTER®
- Minimum pressure loss and associated low operating and life-cycle costs
- Cost efficient spare parts
- Service-friendly design
- Expanded application range for higher operating temperatures and pressures
- Bidirectional operation as well as any direction of flow and installation position
- Possible installation of temperature sensors

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DA-UB - – - –**
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning	**DA-UB - T - –**
In-line detonation flame arrester with two integrated temperature sensors* for additional protection against short time burning from both sides	**DA-UB-TB - –**
In-line detonation flame arrester with heating jacket	**DA-UB - H -**

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions										Dimensions in mm / inches
To select series and nominal size (DN) - nominal width (NG) combination, please use the flow capacity charts on the following pages										
Series 1 (standard)										
DN	50 2"	80 3"	100 4"	150 6"	200 8"	250 10"	300 12"	350 14"	400 16"	
Series 2 (special design for improved flow capacity)										
DN	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	350 14"	600 24"
Series 3 (special design for superior flow capacity)										
DN	-	-	-	50 / 80 2" / 3"	100 4"	150 6"	200 8"	250 10"	300 12"	500 20"
NG	150 6"	150 6"	200 8"	300 12"	400 16"	500 20"	600 24"	700 28"	800 32"	1400 56"
a	285 / 11.22	285 / 11.22	340 / 13.39	445 / 17.52	565 / 22.24	670 / 26.38	780 / 30.71	895 / 35.24	1015 / 39.96	1675 / 65.94
Expl. Gr. IIA b*	388 / ** 15.28	388 / ** 15.28	488 / ** 19.21	626 / ** 24.65	700 / 27.56	800 / 31.50	1000 / 39.37	1200 / 47.24	1400 / 55.12	2200 / 86.61
Expl. Gr. IIB3 b*	388 / ** 15.28	388 / ** 15.28	500 / 19.69	638 / 25.12	724 / 28.50	824 / 32.44	1000 / 39.37	1200 / 47.24	1400 / 55.12	
c	500 / 19.69	500 / 19.69	520 / 20.47	570 / 22.44	620 / 24.41	670 / 26.38	720 / 28.35	770 / 30.31	820 / 32.28	1060 / 41.73

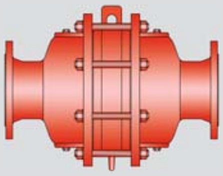
* dimension b only for P1.1 / 15.9
** only for P1.2 / 17.4

Table 2: Selection of the explosion group			
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure											
	DN	50 2“	80 3“	100 4“	150 6“	200 8“	250 10“	300 12“	350 14“	400 6“	600 24“
	NG	150 6“	150 6“	200 8“	300 12“	400 16“	500 20“	600 24“	700 28“	800 32“	1400 56“
Expl. Gr. IIA	P_{max}	1.8 / 26.1	1.8 / 26.1	1.6 / 23.2	1.6 / 23.2	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.6/ 23.2
Expl. Gr. IIB3	P_{max}	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request
in-between size up to P_{max} upon request

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature



In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in a straight through design with a shock tube, bidirectional

PROTEGO® DA-UB

Table 5: Material selection for housing

Design	A	B	C
Housing Heating jacket (DA-UB-H-(T)-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Gasket	WS 3822 *	PTFE	PTFE
Flame arrester unit	A	B, C	D

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

The housing is also available in Steel with an ECTFE coating.

Special materials upon request

Table 6: Material combinations of the flame arrester unit

Design	A	B	C	D
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

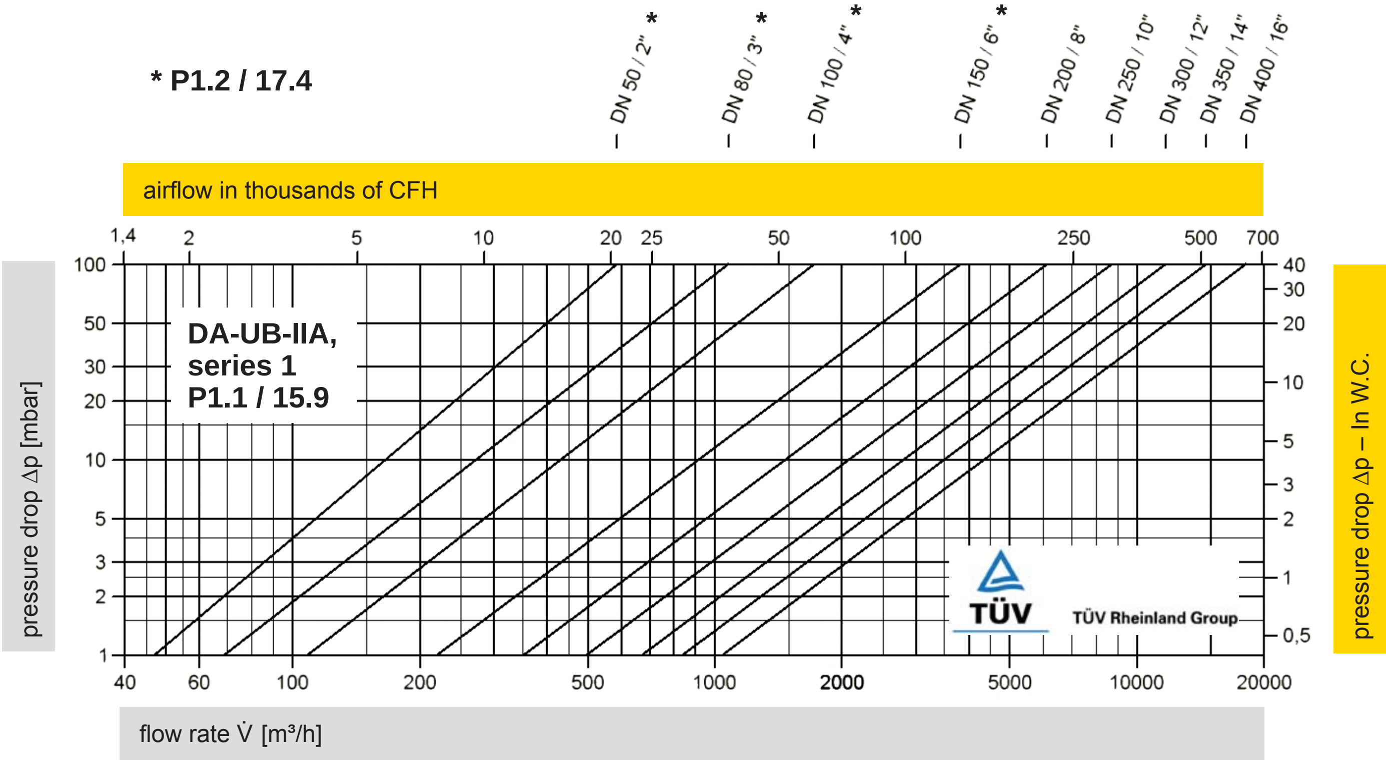
Type	Heating jacket	Temperature sensor on one side or on both sides	Nominal width (NG)	Nominal size (DN)	Explosion group	Max. operating pressure bar /psi (absolute)	Max. operating temperature	Material (housing)	Material (flame arrester unit)	Flange connection type
DA-UB –	–	–	Tab. 1 /	Tab. 1 –	Tab. 2 –	Tab. 3 –	Tab. 4 –	Tab. 5 –	Tab. 6 –	Tab. 7

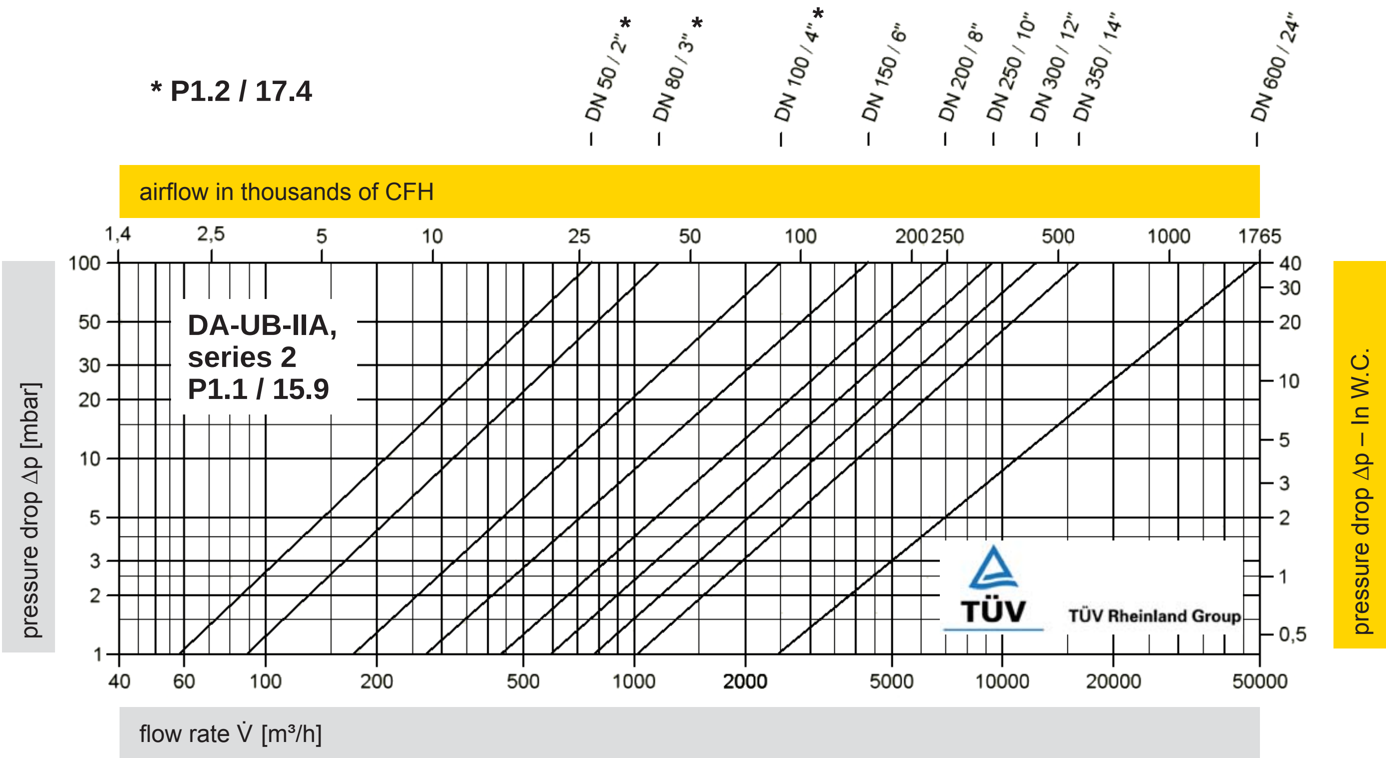
Design (Type, Heating jacket, Temperature sensor)

Order example

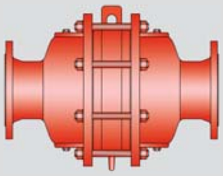
DA-UB – H – TB – 300 / 150 – IIB3 – P1.5 / – – T60 – B – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





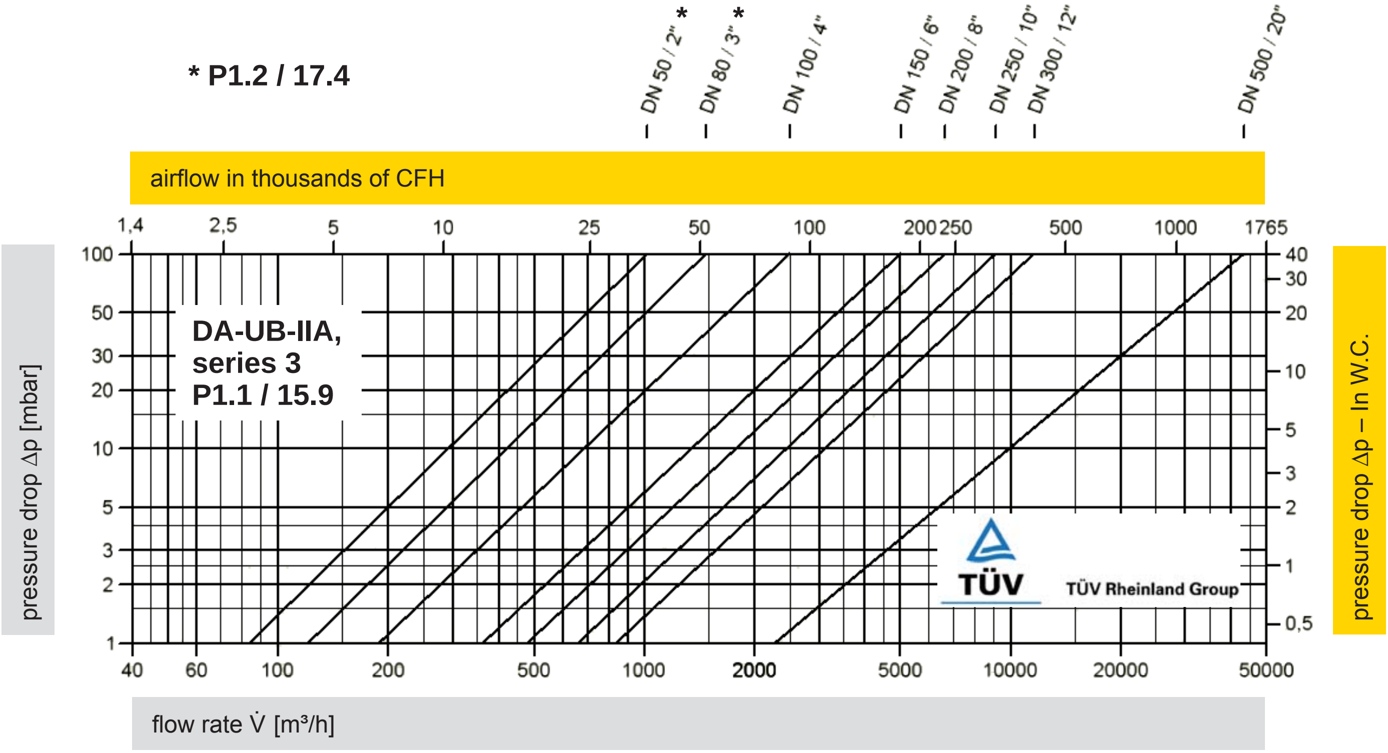
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

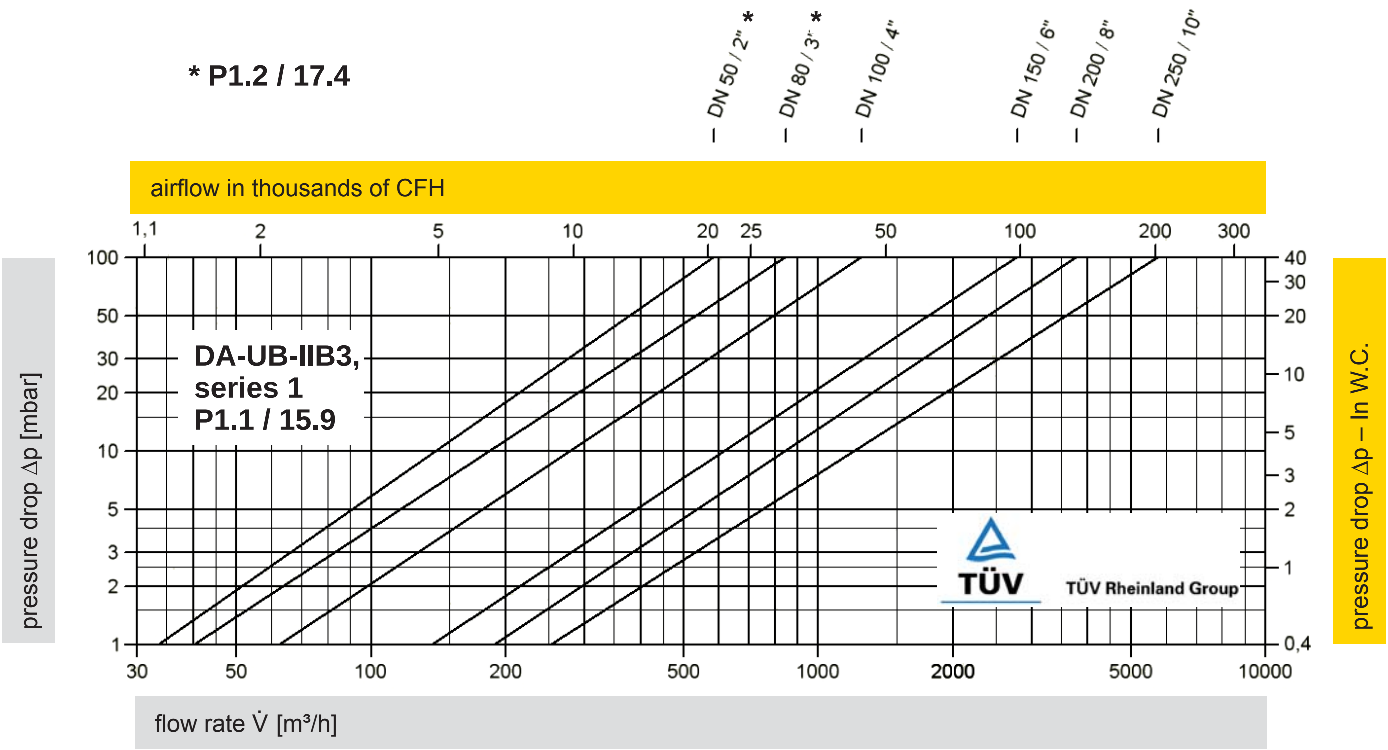


In-Line Detonation Flame Arrester

Flow Capacity Charts

PROTEGO® DA-UB





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
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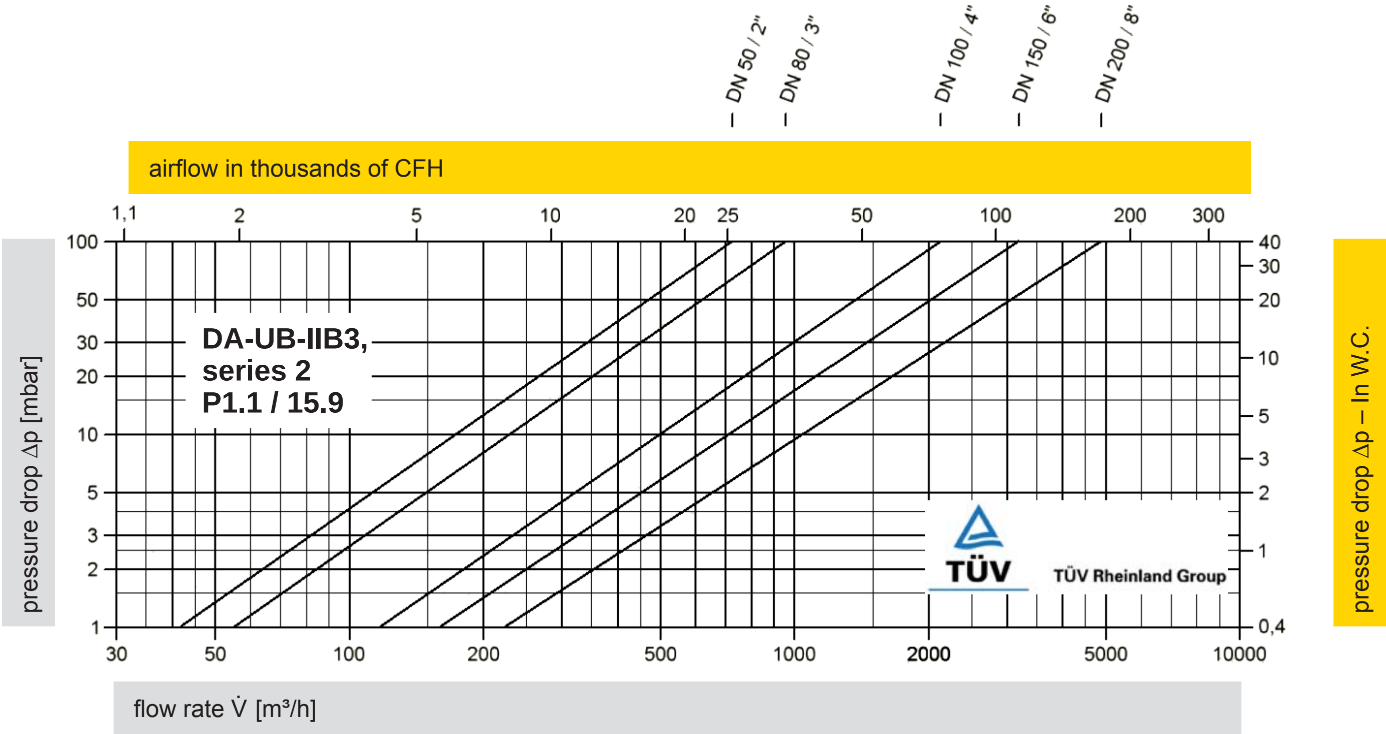
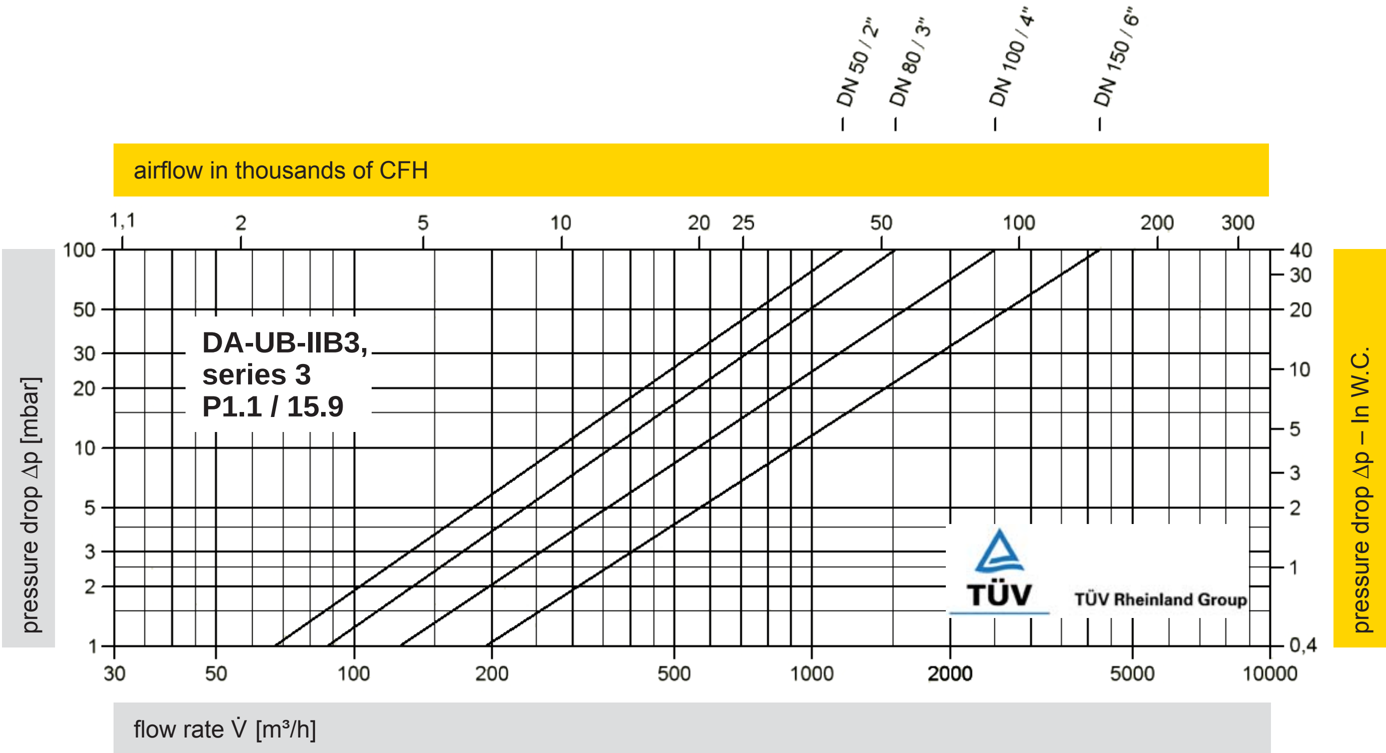
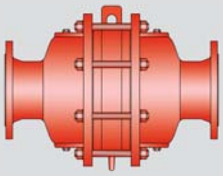

DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
airflow in thousands of CFH
1,1
2
5
10
20
25
50
100
200
300
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
DA-UB-IIB3,
series 2
P1.1 / 15.9
TÜV
TÜV Rheinland Group
40
30
20
10
5
3
2
1
0,4
pressure drop Δp – In W.C.
30
50
100
200
500
1000
2000
5000
10000
flow rate V̇ [m³/h]

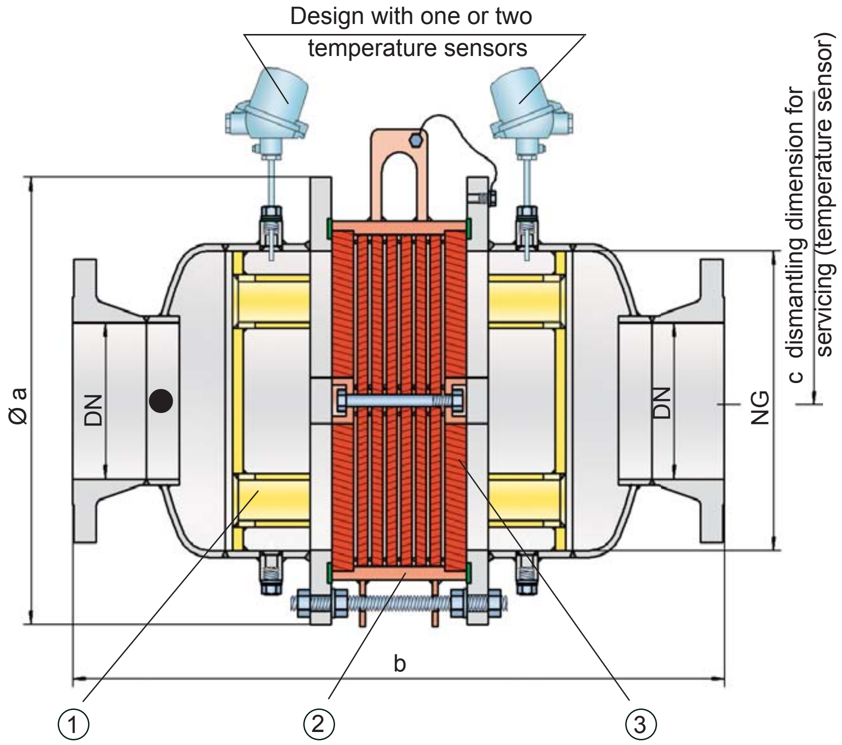

DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
airflow in thousands of CFH
1,1
2
5
10
20
25
50
100
200
300
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
DA-UB-IIB3,
series 3
P1.1 / 15.9
TÜV
TÜV Rheinland Group
40
30
20
10
5
3
2
1
0,4
pressure drop Δp – In W.C.
30
50
100
200
500
1000
2000
5000
10000
flow rate V̇ [m³/h]



In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DA-CG



● Connection to the protected side (only for type DA-CG-T-....)

Function and Description

The PROTEGO® DA-CG series of detonation arresters was developed especially for the North American market and optimized to meet the demands of the US Coast Guard. The devices are symmetrical and offer bidirectional flame arresting for deflagrations, stable and unstable detonations.

The speed of incoming detonations is greatly reduced by the effective shock absorber (1). This improves the flame extinction in the narrow gaps of the original FLAMEFILTER® (3).

The flame arrester essentially consists of two housing parts with an integrated shock absorber and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use.

By indicating the operating parameters such as the temperature, pressure and explosion group and the composition of the fluid, the optimum in-line detonation flame arrester can be selected. Type PROTEGO® DA-CG flame arresters are available for explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure acc. to table 3. Devices with special approvals can be obtained for higher pressures and higher temperatures upon request.

The flame arresters have been approved according to the American Standard 33 CFR part 154 and are accepted by the US Coast Guard.

Special Features and Advantages

- Offers protection against deflagrations, stable and unstable detonations
- Less number of FLAMEFILTER® from the use of the effective shock absorber
- The modular design enables individual FLAMEFILTER® to be exchanged
- Different series allow scalable pressure loss across the surface of the FLAMEFILTER®
- Minimum pressure loss and associated low operating and life-cycle costs
- Cost efficient spare parts
- Service-friendly design
- Also available for large nominal sizes
- Expanded application range for higher operating temperatures and pressures
- Bidirectional operation as well as any direction of flow and installation position
- Possible installation of temperature sensors

Design Types and Specifications

There are three different designs available:

Basic in-line detonation flame arrester	**DA-CG- –**
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DA-CG- T**
Detonation arrester with two integrated temperature sensors* as additional protection against short time burning from both sides	**DA-CG- TB**

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions											Dimensions in mm / inches
To select series and nominal size (DN) - nominal width (NG) combination,use the flow capacity charts on the following pages											
Series 1 (standard)											
DN	50/2"	80/3"	100/4"	150/6"	200/8"	250/10"	300/12"	350/14"	400/16"	500/20"	600/24"
NG	150/6"	150/6"	200/8"	300/12"	400/16"	500/20"	600/24"	700/28"	800/32"	1000/40"	1200/48"
a	285 / 11.22	285 / 11.22	340 / 13.39	460 / 11.18	580 / 22.83	715 / 28.15	840 / 33.07	1025 / 40.35	1025 / 40.35	1255 / 49.41	1485 / 58.46
b	650 / 25.59	650 / 25.59	700 / 27.56	800 / 31.50	900 / 35.43	1100 / 43.31	1250 / 49.21	1500 / 59.06	1500 / 59.06	1700 / 66.93	2000 / 78.74
c	300 / 11.81	300 / 11.81	330 / 12.99	380 / 14.96	490 / 19.29	540 / 21.26	590 / 23.23	690 / 27.17	690 / 27.17	790 / 31.10	880 / 34.65
Series 2 (special design for improved flow)											
DN	50/2"	80/3"	100/4"	150/6"	200/8"	250/10"	300/12"	350/14"	400/16"	500/20"	600/20"
NG	200/8"	200/8"	300/12"	400/16"	500/20"	600/24"	800/32"	800/32"	1000/40"	1200/48"	1400/52"
a	340 / 13.39	340 / 13.39	460 / 11.18	580 / 22.83	715 / 28.15	840 / 33.07	1025 / 40.35	1025 / 40.35	1255 / 49.41	1485 / 58.46	1675 / 65.94
b	700 / 27.56	700 / 27.56	800 / 31.50	900 / 35.43	1100 / 43.31	1250 / 49.21	1500 / 59.06	1500 / 59.06	1700 / 66.93	2000 / 78.74	2050 / 80.71
c	330 / 12.99	330 / 12.99	380 / 14.96	490 / 19.29	540 / 21.26	590 / 23.23	690 / 27.17	690 / 27.17	790 / 31.10	880 / 34.65	980 / 38.58
Series 3 (special design for superior flow)											
DN	50/2"	80/3"	100/4"	150/6"	200/8"	250/10"	300/12"	350/14"	400/16"	500/20"	600/20"
NG	300/12"	300/12"	400/16"	500/20"	600/24"	800/32"	1000/40"	1000/40"	1200/48"	1400/52"	1600/56"
a	460 / 18.11	460 / 18.11	580 / 22.83	715 / 28.15	840 / 33.07	1025 / 40.35	1025 / 40.35	1255 / 49.41	1485 / 58.46	1685 / 66.34	1930 / 75.34
b	800 / 31.50	800 / 31.50	900 / 35.43	1100 / 43.31	1250 / 49.21	1500 / 59.06	1500 / 59.06	1700 / 66.93	2000 / 78.74	2050 / 80.71	2100 / 82.68
c	380 / 14.96	380 / 14.96	490 / 19.29	540 / 21.26	590 / 23.23	690 / 27.17	690 / 27.17	790 / 31.10	880 / 34.65	980 / 38.58	1080 / 42.52

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

		DN	50/2“	80/3“	100/4“	150/6“	200/8“	250/10“	300/12“	350/14“	400/ 6“	500/20“	600/24“
		NG	150/6“	150/6“	200/8“	300/12“	400/16“	500/20“	600/24“	700/28“	800/32“	1000/40“	1200/48“
Expl. Gr.	IIA	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4
	IIB3	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.26	1.6 / 23.2	1.6 / 23.2

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

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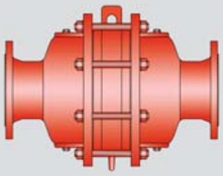
for safety and environment



In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DA-CG

Table 4: Specification of max. operating temperature	
≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

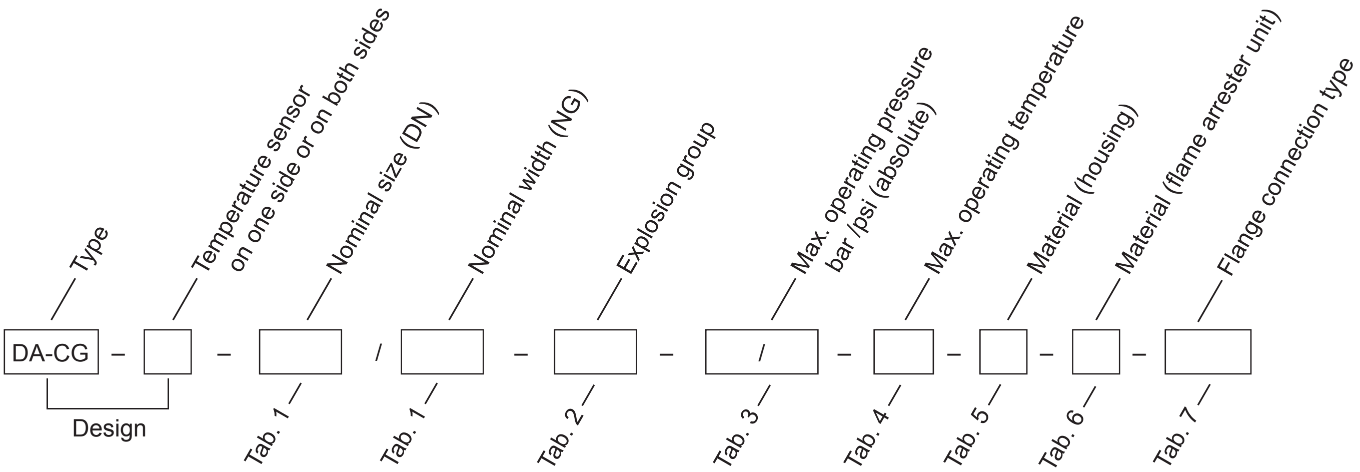
Table 5: Material selection for housing			
Design	A	B	* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
Housing	Steel	Stainless Steel	
Gasket	WS 3822 *	PTFE	
Flame arrester unit	A	B	

Special materials upon request

Table 6: Material combinations of the flame arrester unit			
Design	A	B	*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
FLAMEFILTER® cage	Steel	Stainless Steel	
FLAMEFILTER® *	Stainless Steel	Stainless Steel	
Spacer	Stainless Steel	Stainless Steel	

Special materials upon request

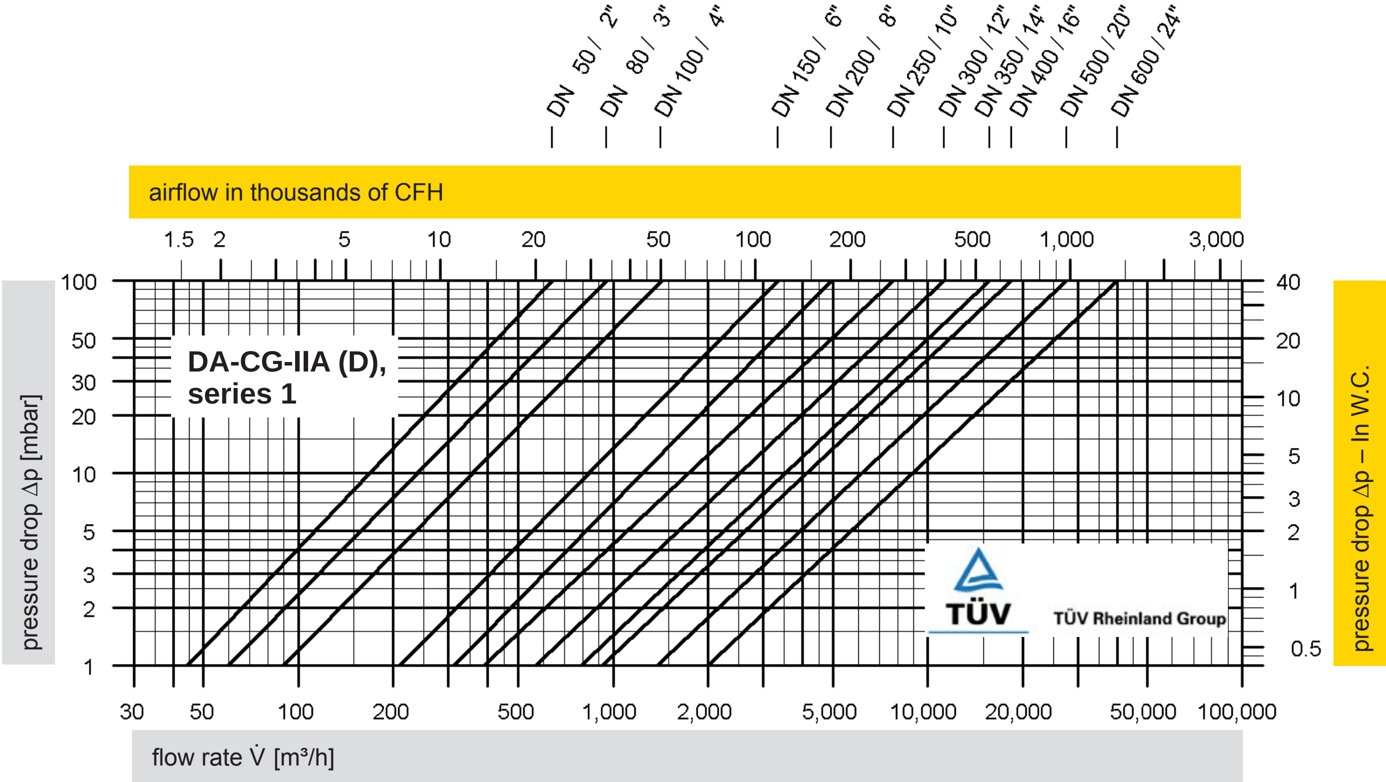
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

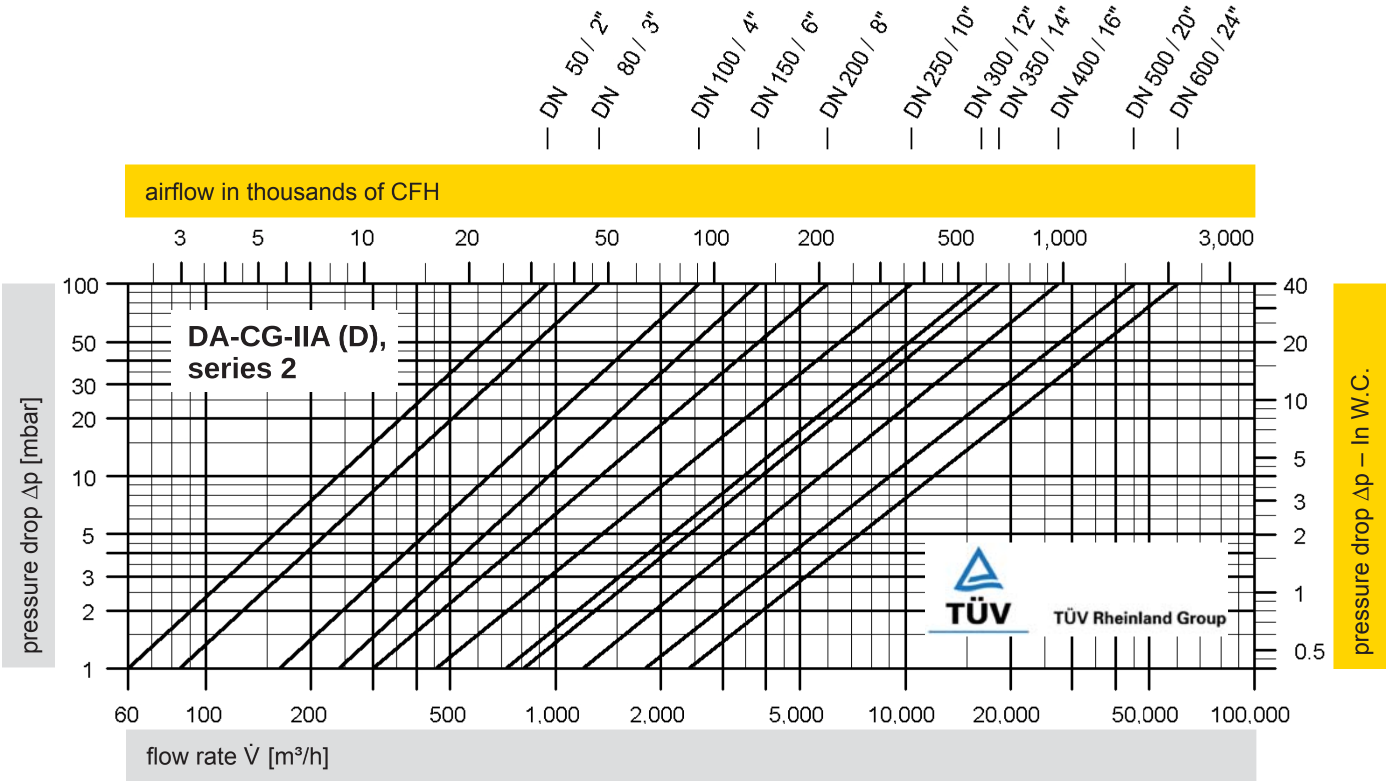


Order example

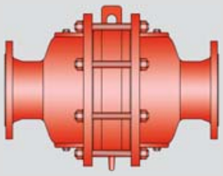
DA-CG – TB – 1200 / 600 – IIB3 – P1.6/ – – T60 – B – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





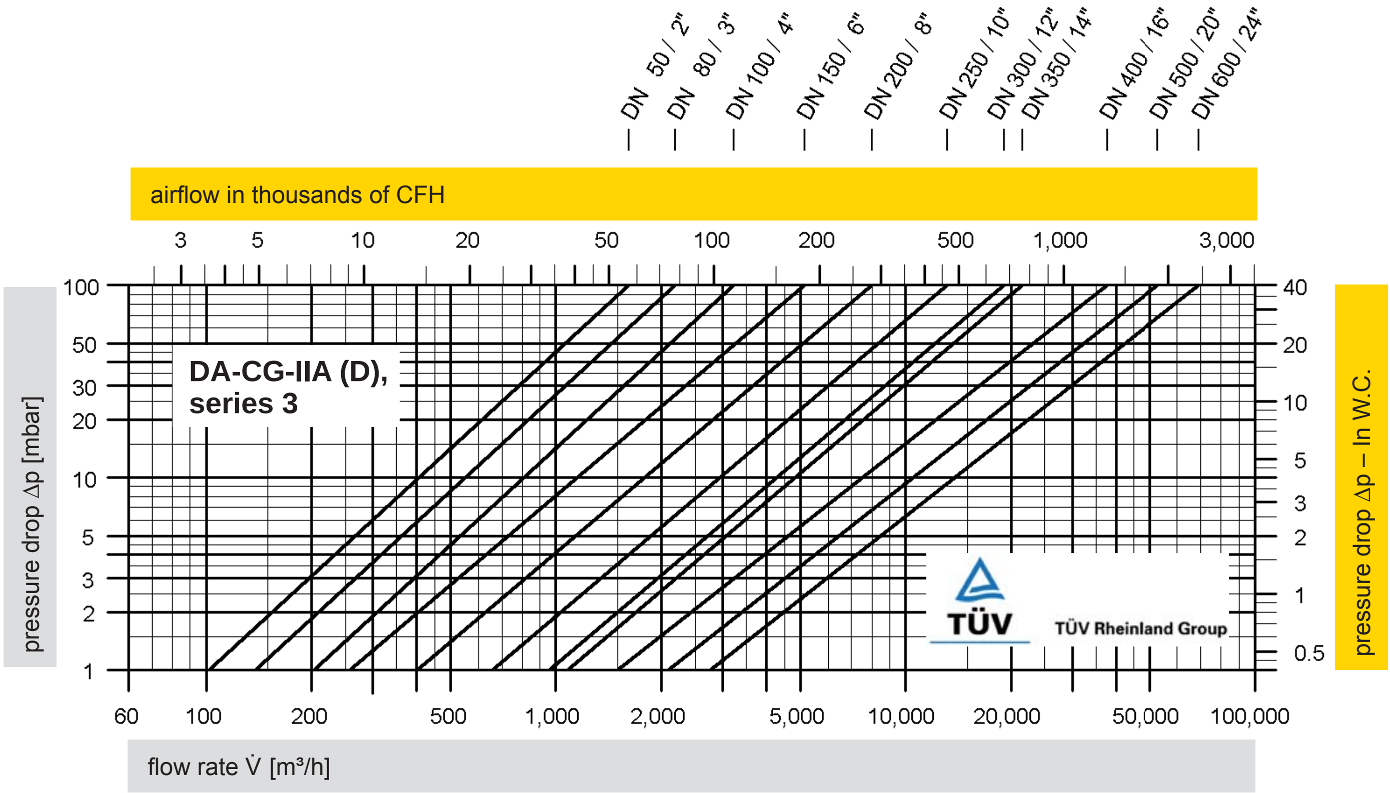
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

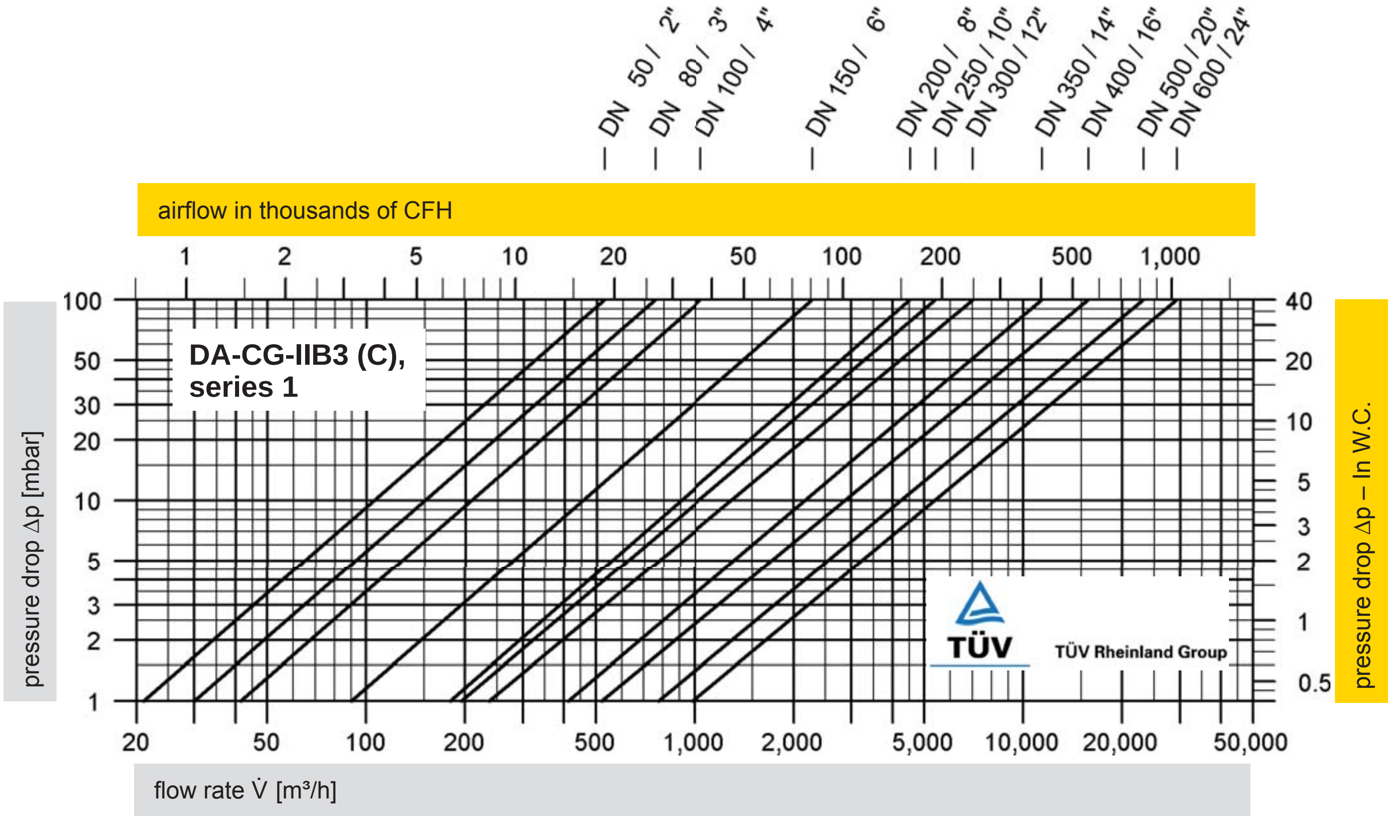


In-Line Detonation Flame Arrester

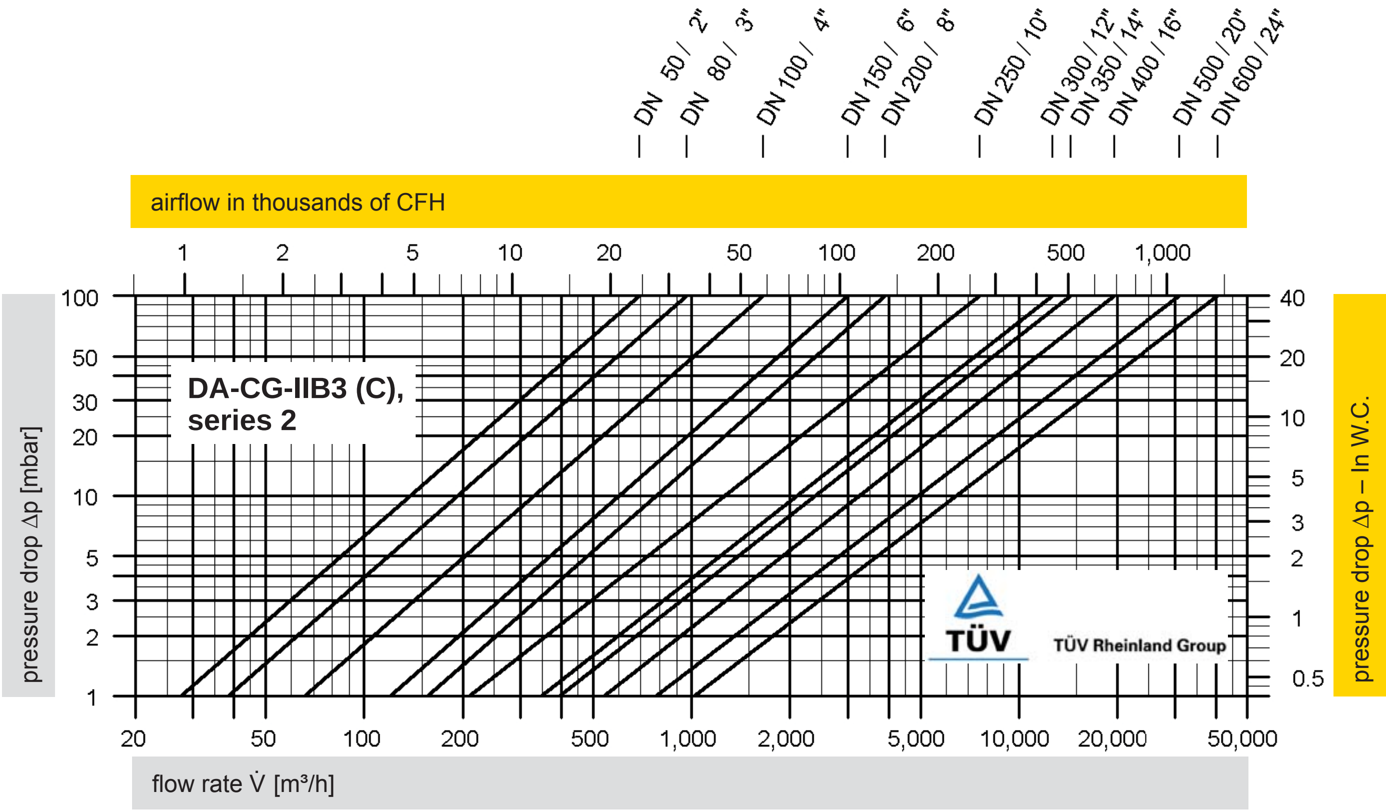
Flow Capacity Charts

PROTEGO® DA-CG

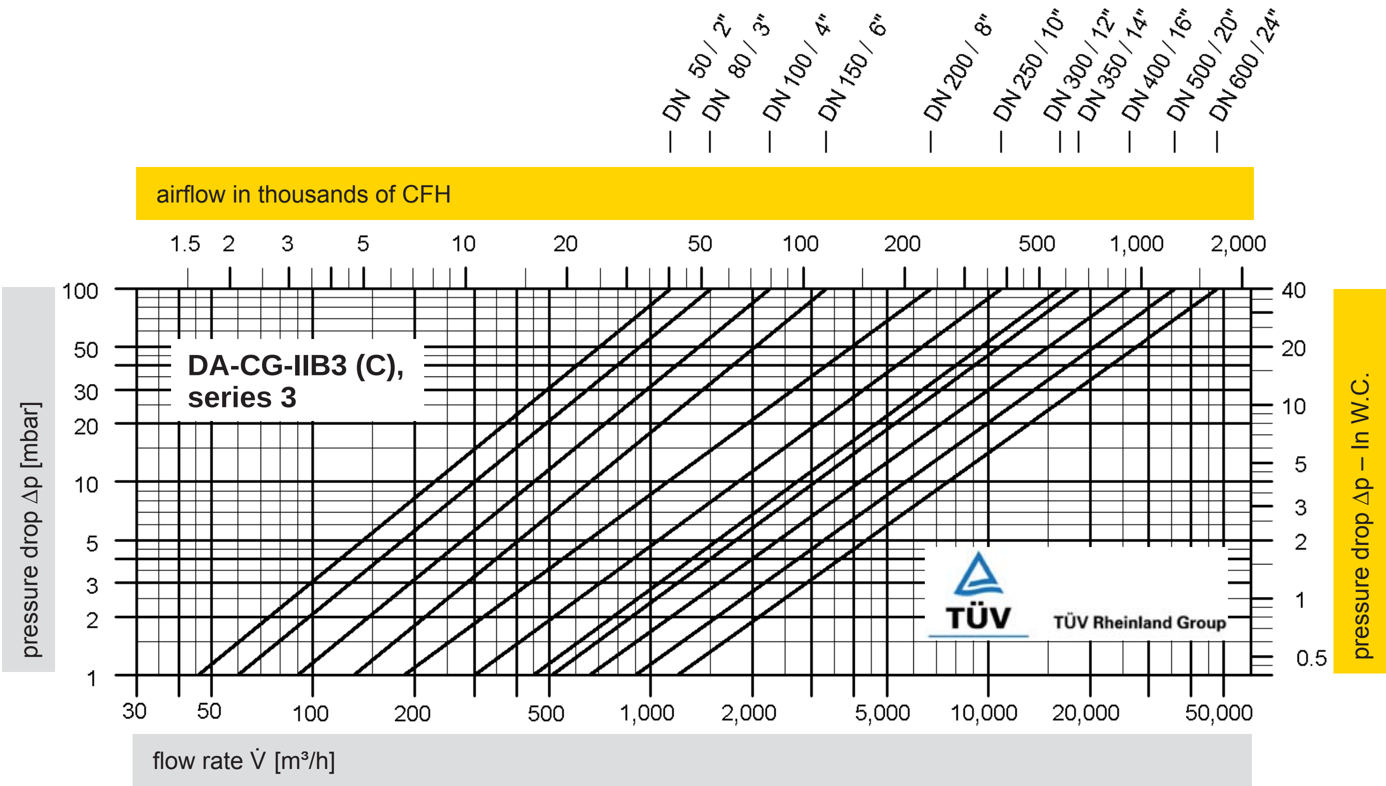




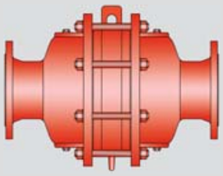
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".



DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
DN 350 / 14"
DN 400 / 16"
DN 500 / 20"
DN 600 / 24"
airflow in thousands of CFH
1
2
5
10
20
50
100
200
500
1,000
DA-CG-IIB3 (C), series 2
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
pressure drop Δp – In W.C.
40
20
10
5
3
2
1
0.5
TÜV
TÜV Rheinland Group
20
50
100
200
500
1,000
2,000
5,000
10,000
20,000
50,000
flow rate V̇ [m³/h]



DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
DN 350 / 14"
DN 400 / 16"
DN 500 / 20"
DN 600 / 24"
airflow in thousands of CFH
1.5
2
3
5
10
20
50
100
200
500
1,000
2,000
DA-CG-IIB3 (C), series 3
pressure drop Δp [mbar]
100
50
30
20
10
5
3
2
1
pressure drop Δp – In W.C.
40
20
10
5
3
2
1
0.5
TÜV
TÜV Rheinland Group
30
50
100
200
500
1,000
2,000
5,000
10,000
20,000
50,000
flow rate V̇ [m³/h]

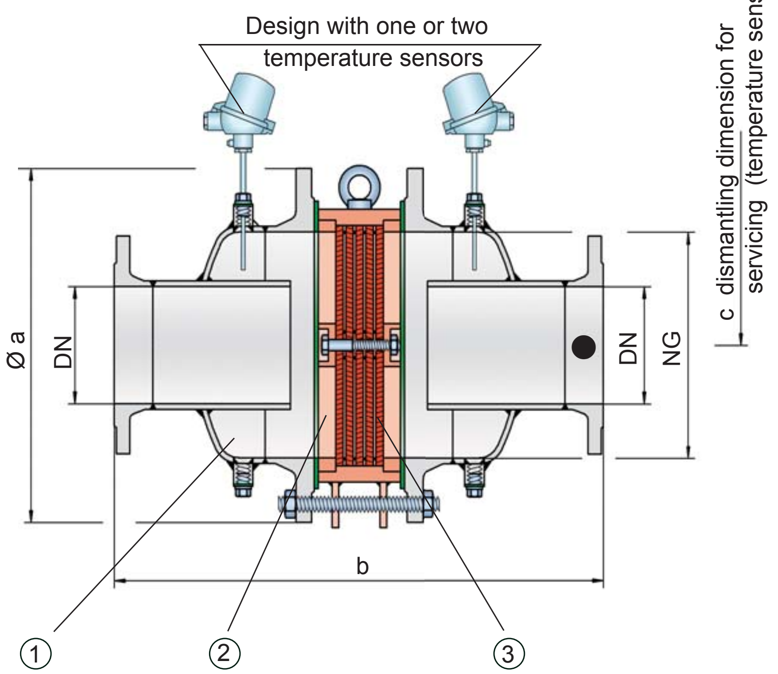


In-Line Detonation Flame Arrester

for unstable and stable detonations as well as deflagrations in a straight through design with a shock tube, bidirectional

PROTEGO® DA-FM

FM Approvals
Specification Tested



● Connection to the protected side (only for type DA-FM-T-....)

Function and Description

The PROTEGO® DA-FM series of in-line detonation flame arresters is the newest generation of flame arresters. On the basis of fluid dynamic and explosion-dynamic calculations as well as decades of experience from field tests, a line was developed that offers minimum pressure loss and maximum safety. The device uses the *Shock Wave Guide Tube Effect (SWGTE)* to optimally decouple the flame front and shock wave. The result is an in-line detonation flame arrester without a classic shock absorber, and the use of flame-extinguishing elements is minimized.

The devices are symmetrical and offer bidirectional flame arresting for deflagrations, stable and unstable detonations. The arrester essentially consists of two housing parts with an integrated shock tube (1) and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® (3) and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester‘s conditions of use. By indicating the operating parameters such as the temperature, pressure and explosion group as well as the composition of the fluid, the optimum in-line detonation flame arrester can be selected from a series of approved devices. Type PROTEGO® DA-FM flame arresters are available for explosion group IIB3 (NEC group C MESG ≥ 0.65 mm).

The standard design can be used up to an operating temperature up to +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi.

This series was tested and approved by FM Approvals (Factory Mutual), additional international standards are available upon request.

Special Features and Advantages

- Optimized performance from the patented *Shock Wave Guide Tube Effect (SWGTE)*
- Less number of FLAMEFILTER® from the use of the patented shock tube *(SWGTE)*
- The modular design enables individual FLAMEFILTER® to be replaced
- Different series allow scalable pressure loss across the surface of the FLAMEFILTER®
- Minimum pressure loss and associated low operating and life-cycle costs
- Cost efficient spare parts
- Service-friendly design
- Bidirectional operation as well as any direction of flow and installation position
- Possible installation of temperature sensors

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DA-FM-** – - –
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DA-FM-** T - –
In-line detonation flame arrester with two integrated temperature sensors* as additional protection against short time burning from both sides	**DA-FM-** TB - –
In-line detonation flame arrester with heating jacket	**DA-FM-** H -

Additional special flame arresters upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions						Dimensions in mm / inches
To select series and nominal size (DN) - nominal width (NG) combination, please use the flow capacity charts on the following pages						
Series 1 (standard)						
DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"
Series 2 (special design for improved flow)						
DN	-	-	50 / 2" 80 / 3"	100 / 4"	150 / 6"	200 / 8"
Series 3 (special design for superior flow)						
DN	-	-	-	50 / 2" 80 / 3"	100 / 4"	150 / 6"
NG	150 / 6"	150 / 6"	200 / 8"	300 / 12"	400 / 16"	500 / 20"
a	285 / 11.22	285 / 11.22	340 / 13.38	445 / 17.52	565 / 22.24	670 / 26.38
b	412 / 16.22	412 / 16.22	512 / 20.16	650 / 25.59	724 / 28.50	824 / 32.44
c	500 / 19.69	500 / 19.69	520 / 20.47	570 / 22.44	620 / 24.41	670 / 26.38

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	

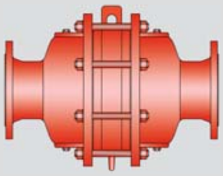
Table 3: Selection of max. operating pressure

Expl. Gr.		DN	50 2“	80 3“	100 4“	150 6“	200 8“	250 10“
		NG	150 6“	150 6“	200 8“	300 12“	400 16“	500 20“
	IIB3 (C)	P_{max}	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9	1.1 / 15.9

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature



In-Line Detonation Flame Arrester

for unstable and stable detonations as well as deflagrations in a straight through design with a shock tube, bidirectional

PROTEGO® DA-FM

FM Approvals
Specification Tested

Table 5: Material selection for housing

Design	A	B	C
Housing Heating jacket (DA-FM-H-(T)-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Gasket	WS 3822 *	PTFE	PTFE
Flame arrester unit	A	B, C	D

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.

The housing is also available in Steel with an ECTFE coating.

Special materials upon request

Table 6: Material combinations of the flame arrester unit

Design	A	B	C	D
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.

Special materials upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

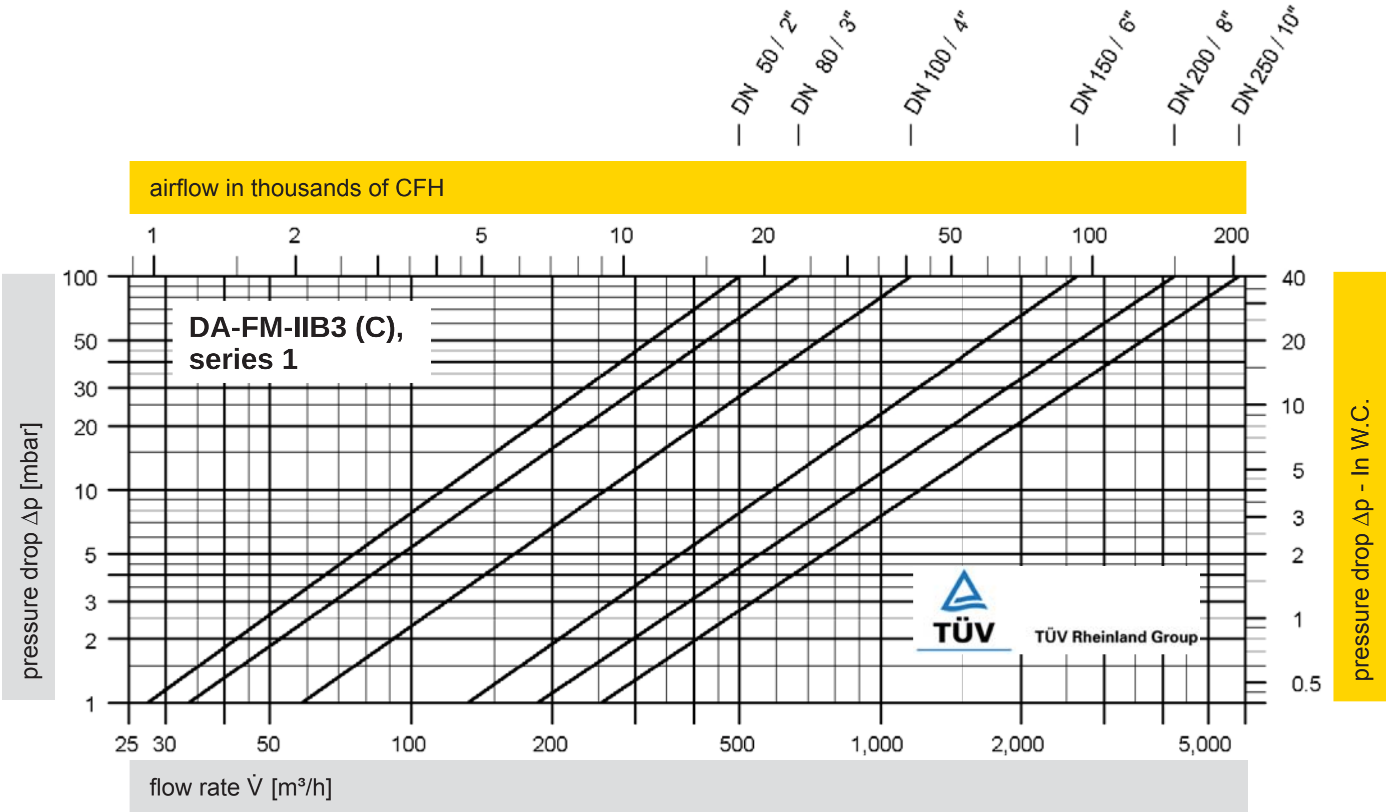
other types upon request

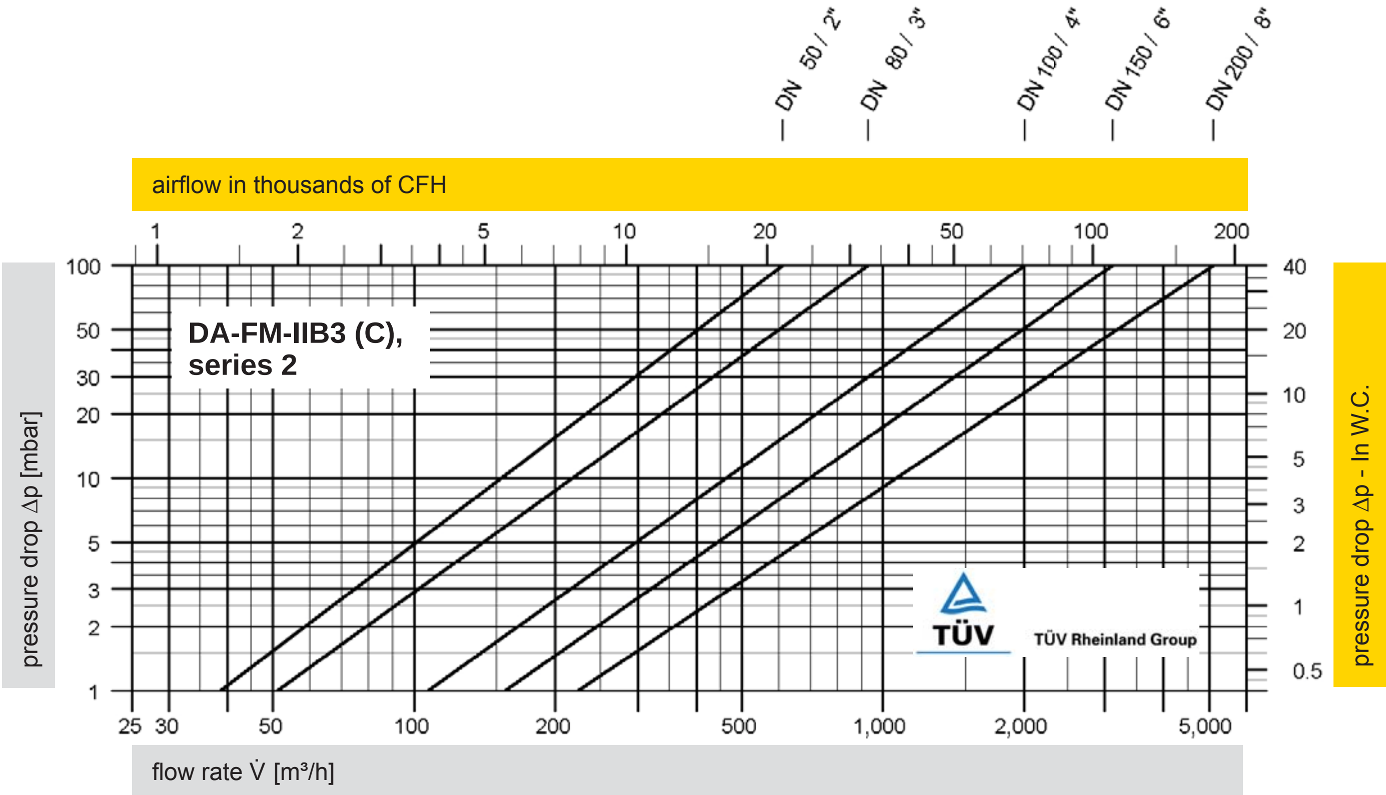
Type	Heating jacket	Temperature sensor on one side or on both sides		Nominal width (NG)		Nominal size (DN)		Explosion group		Max. operating pressure bar /psi (absolute)		Max. operating temperature		Material (housing)		Material (flame arrester unit)		Flange connection type
DA-FM	–		–		/		–		–	/	–		–		–		–	
Design				Tab. 1		Tab. 1		Tab. 2		Tab. 3		Tab. 4		Tab. 5		Tab. 6		Tab. 7

Order example

DA-FM – H – TB – 300 / 150 – IIB3 – P1.1/ – – T60 – B – B – DIN

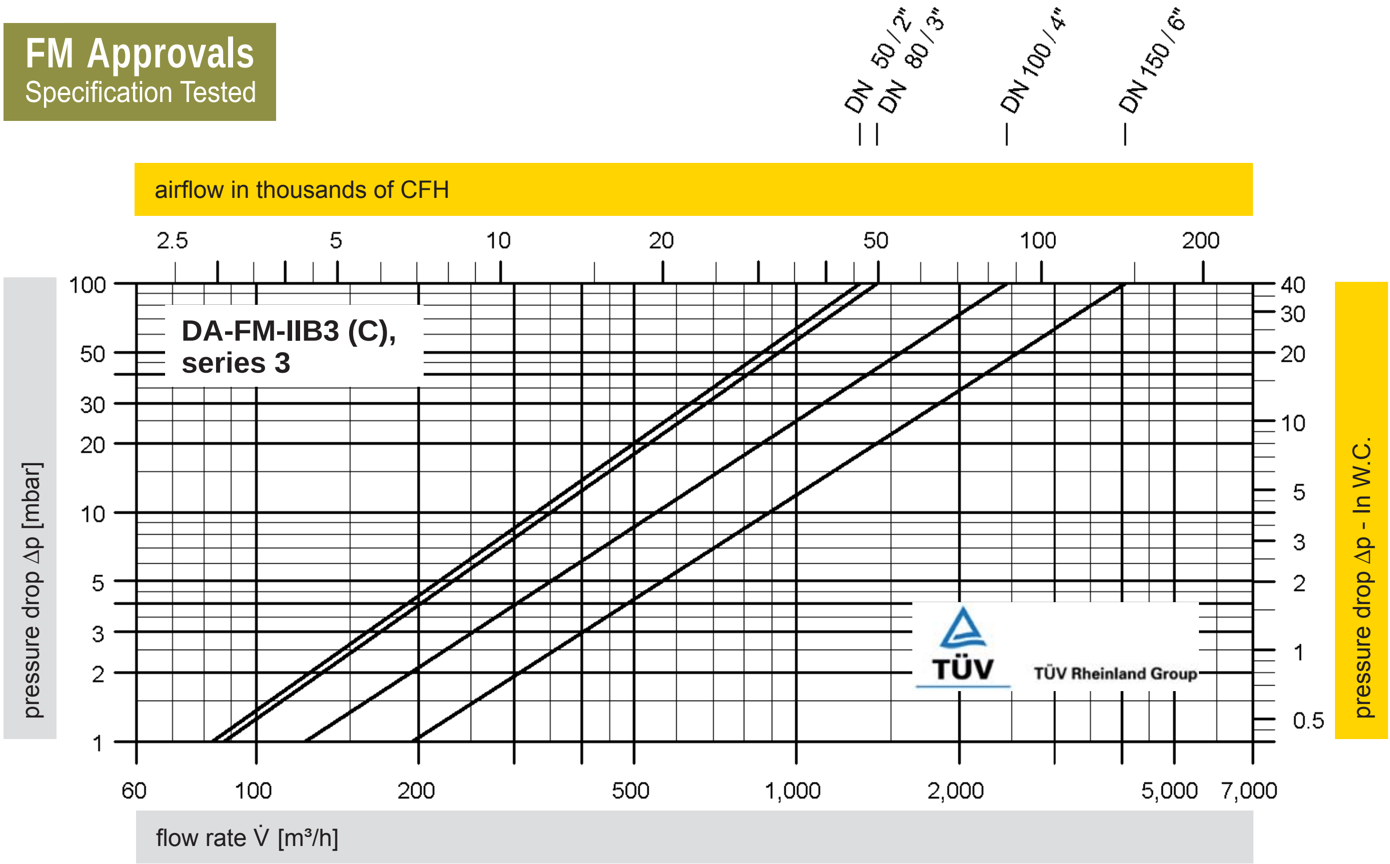
Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"





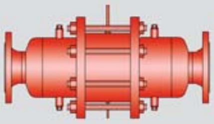
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

FM Approvals
Specification Tested



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

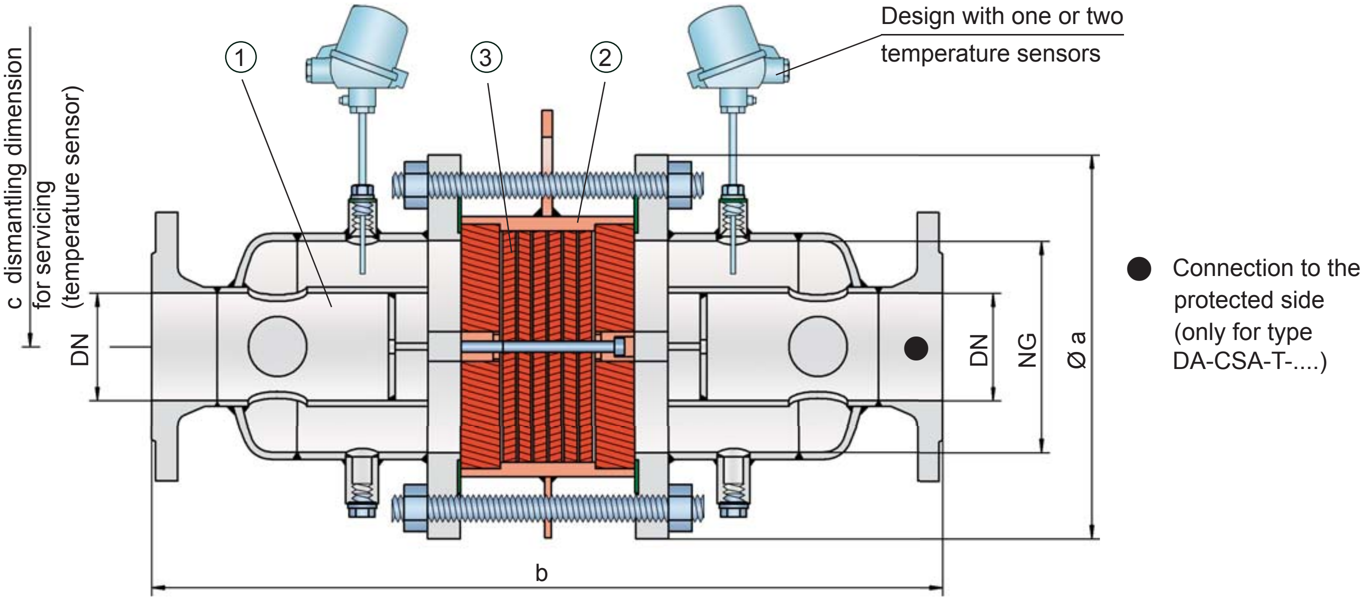
Notes:



In-Line Detonation Flame Arrester

for unstable and stable detonations as well as deflagrations in a straight through design with shock absorber, bidirectional

PROTEGO® DA-CSA



Function and Description

The PROTEGO® DA-CSA series of in-line detonation flame arresters was developed especially for the North American market and optimized to meet the demands of the US Coast Guard and **Canadian Standards Association** (CSA). The devices are symmetrical and offer bidirectional flame arresting for deflagrations, stable and unstable detonations.

The speed of incoming detonations is greatly reduced by the effective shock absorber (1). This improves the flame extinction in the narrow gaps of the original FLAMEFILTER® (3).

The flame arrester essentially consists of two housing parts with an integrated shock absorber and the PROTEGO® flame arrester unit (2) in the center. The PROTEGO® flame arrester unit is modular and consists of several FLAMEFILTER® and spacers firmly held in a FLAMEFILTER® cage. The number of FLAMEFILTER® and their gap size depends on the arrester's conditions of use. By indicating the operating parameters such as the temperature, pressure and explosion group and the composition of the fluid, the optimum in-line detonation flame arrester can be selected from a series of approved devices. The PROTEGO® DA-CSA series of flame arresters is available for explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design is approved at an operating temperature up to +60°C / 140°F and an absolute operating pressure up to 1.2 bar / 17.4 psi.

The flame arresters have been tested together with FM Approvals according American Standard 33 CFR part 154 and the conditions of the CSA.

Special Features and Advantages

- Offers protection against deflagrations, stable and unstable detonations
- Less number of FLAMEFILTER® from the use of the effective shock tube
- The modular design enables individual FLAMEFILTER® to be replaced
- Minimum pressure loss and associated low operating and life-cycle costs
- Cost efficient spare parts
- Service-friendly design
- Also available for large nominal sizes
- Bidirectional operation as well as any direction of flow and installation position
- Possible installation of temperature sensors

Design Types and Specifications

There are three different designs available:

Basic in-line detonation flame arrester	**DA-CSA -** –
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning from one side	**DA-CSA -** T
Detonation arrester with two integrated temperature sensors* as additional protection against short time burning from both sides	**DA-CSA -** TB

Additional special fittings upon request

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN) and nominal width (NG), please use the flow capacity charts on the following pages

for explosion group IIA (D)

DN	50/2"	80/3"	100/4"	150/6"	200/8"	250/10"	300/12"	400/16"
NG	150/6"	150/6"	200/8"	300/12"	400/16"	500/20"	600/24"	800/32"
a	285 / 11.22	285 / 11.22	340 / 13.39	460 / 18.11	580 / 22.84	715 / 28.15	840 / 33.07	1025 / 40.35
b	700 / 27.56	700 / 27.56	840 / 33.07	1090 / 42.91	1318 / 51.89	1500 / 59.06	1970 / 77.56	2232 / 87.87
c	370 / 14.57	370 / 14.57	390 / 15.35	450 / 17.72	540 / 21.26	590 / 23.23	640 / 25.20	740 / 29.14

for explosion group IIB3 (C)

DN	50/2"	80/3"	100/4"	150/6"	200/8"	250/10"	300/12"	400/16"
NG	150/6"	150/6"	200/8"	300/12"	400/16"	500/20"	600/24"	800/32"
a	285 / 11.22	285 / 11.22	340 / 13.39	460 / 18.11	580 / 22.84	715 / 28.15	840 / 33.07	1025 / 40.35
b	700 / 27.56	700 / 27.56	850 / 33.47	1100 / 43.31	1318 / 51.89	1537 / 60.51	2007 / 79.02	2307 / 90.83
c	370 / 14.57	370 / 14.57	390 / 15.35	450 / 17.72	540 / 21.26	590 / 23.23	640 / 25.20	740 / 29.14

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.	DN	50/2“	80/3“	100/4“	150/6“	200/8“	250/10“	300/12"	400/16"
	NG	150/6“	150/6“	200/8“	300/12“	400/16“	500/20“	600/24"	800/32"
IIA	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4
IIB3	P_{max}	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4	1.2 / 17.4

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
Gasket	WS 3822 *	PTFE	Special materials upon request
Flame arrester unit	A	B	

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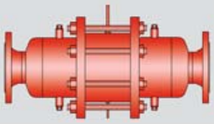


In-Line Detonation Flame Arrester

for unstable and stable detonations as well as deflagrations in a straight through design with shock absorber, bidirectional

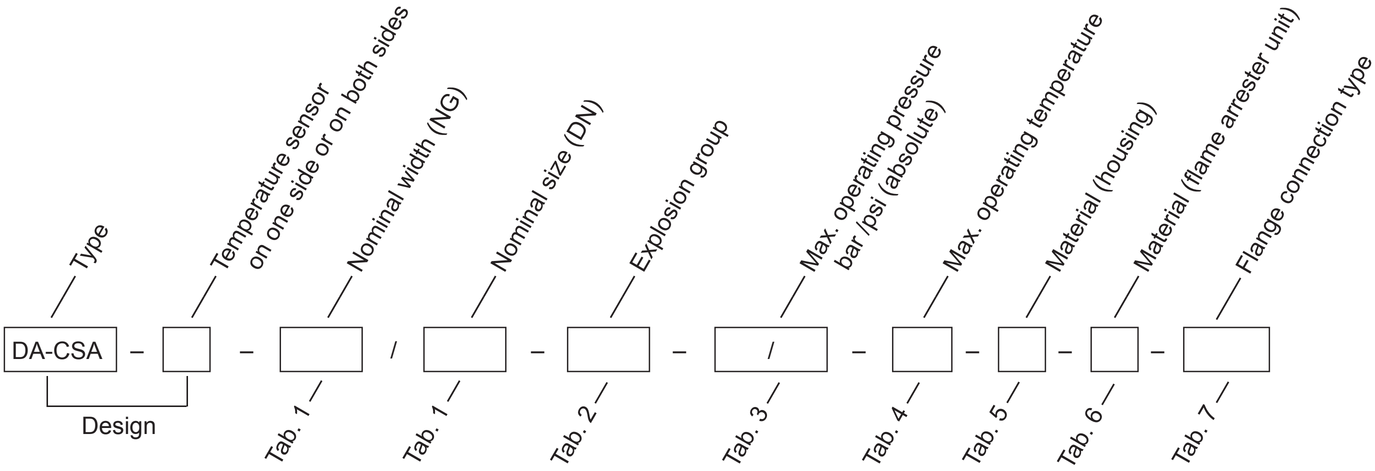
PROTEGO® DA-CSA

Table 6: Material combinations of the flame arrester unit

Design	A	B	*the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
FLAMEFILTER® cage	Steel	Stainless Steel	
FLAMEFILTER® *	Stainless Steel	Stainless Steel	
Spacer	Stainless Steel	Stainless Steel	Special materials upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

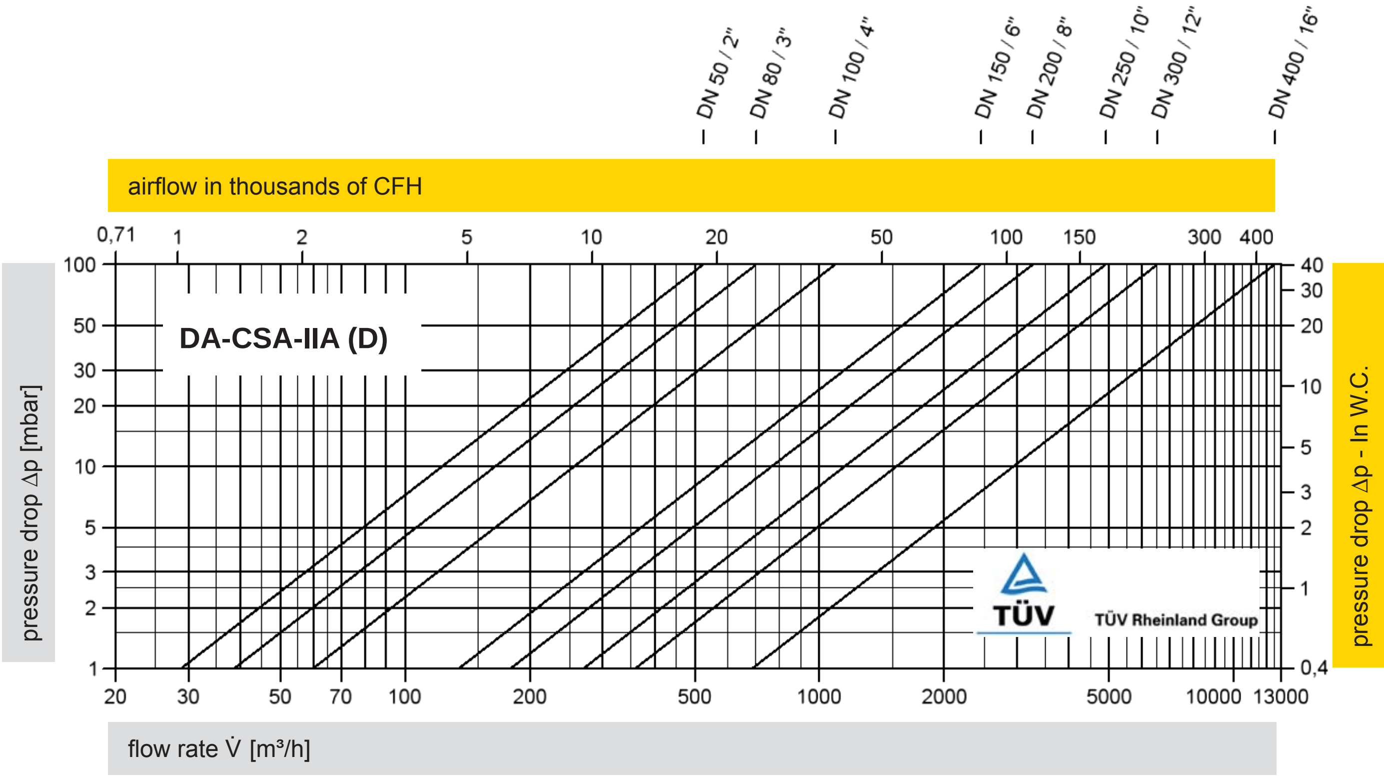


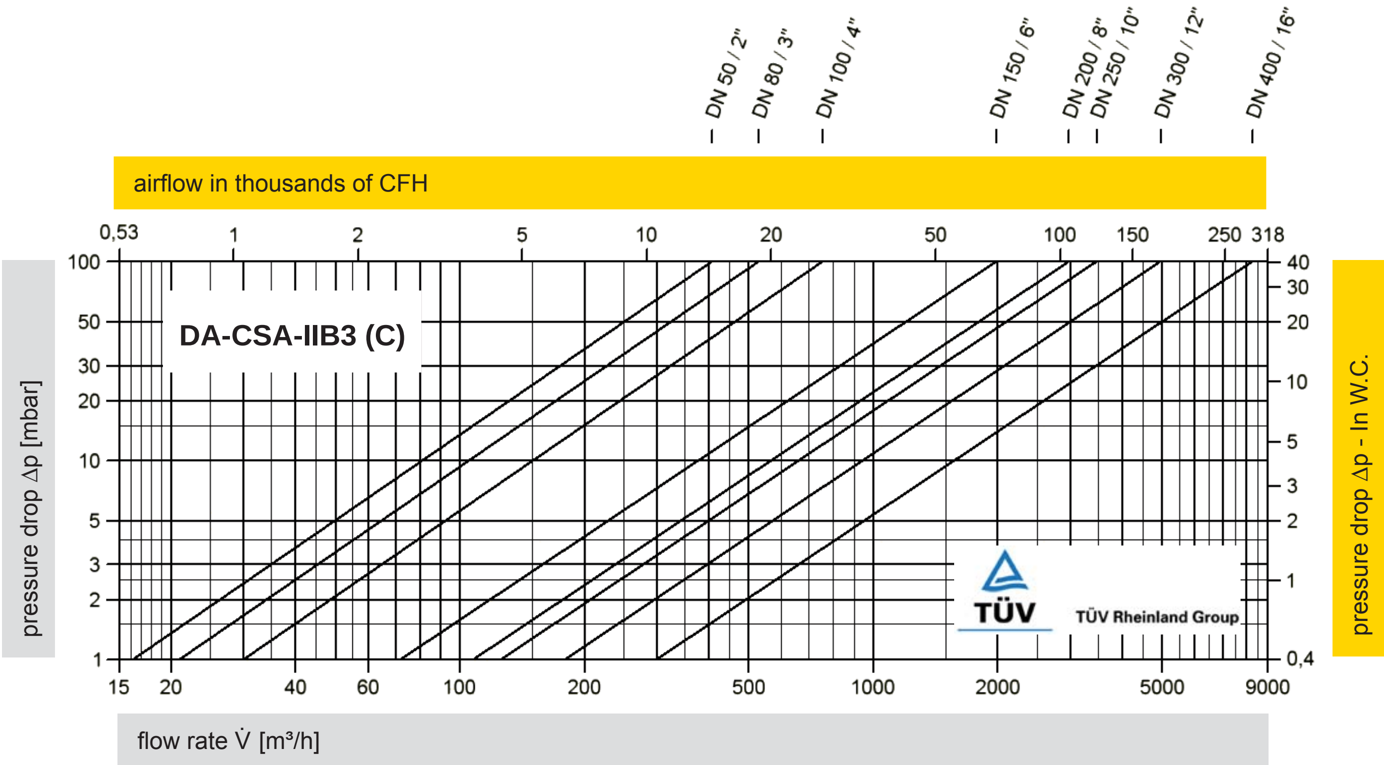
Order example

DA-CSA	–	TB	–	1200	/	600	–	IIB3	–	P1.2 / –	–	T60	–	B	–	B	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® DA-CSA





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

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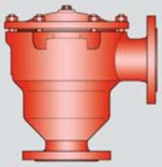
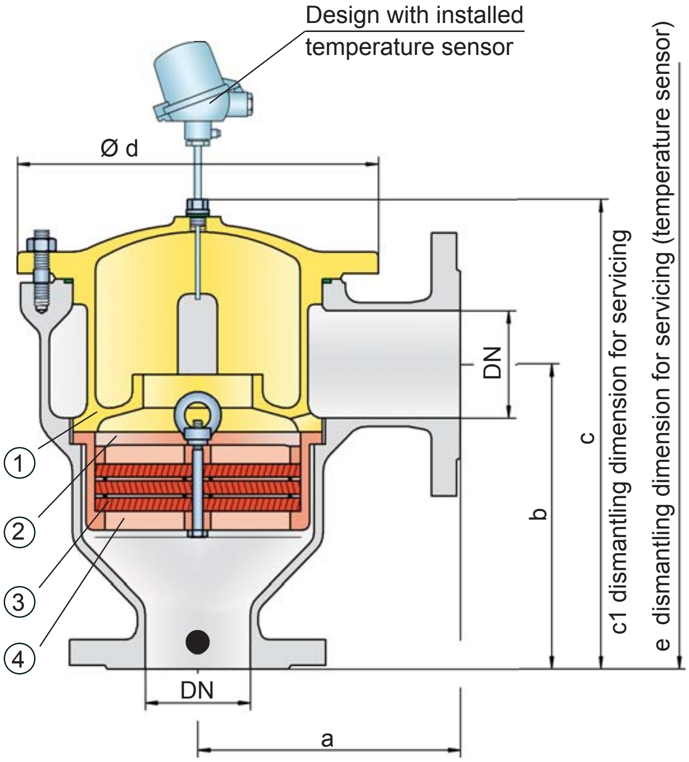


In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in right angle design with a shock absorber, unidirectional

PROTEGO® DR/EU



● Connection to the protected side

Function and Description

The PROTEGO® DR/EU series of in-line detonation flame arresters represents a further development of PROTEGO® flame arresters DR/ES used successfully for decades in industry. The device protects against deflagrations, stable and unstable detonations. The classic right angle design offers considerable cost and maintenance advantages in comparison to a straight through design.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by the integrated shock absorber (1) before the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (3).

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers firmly held in the FLAMEFILTER® cage (4). The gap size and number of FLAMEFILTER® are determined by the operating data parameters of the mixture flowing in the line (explosion group, pressure, temperature). This device is available explosion groups from IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design can be used up to an operating temperature of +60°C / 140°F and an absolute operating pressure acc. to table 3. Numerous special approvals can be obtained for higher temperatures and pressures upon request.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- Minimum number of FLAMEFILTER® due to the effective shock absorber
- Quick removal and installation of the complete PROTEGO® flame arrester unit and of the FLAMEFILTER® in the cage
- The modular design enables individual FLAMEFILTER® to be replaced
- Cost efficient spare parts
- Provides protection from deflagration as well as from stable and unstable detonation
- The right angle design saves pipe elbows
- Minimum pressure loss and hence low operating and lifecycle costs
- Extended application range for higher operating temperatures and pressures

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DR/EU-** $\boxed{–}$ $\boxed{–}$
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning	**DR/EU-** $\boxed{T}$ $\boxed{–}$
In-line detonation flame arrester with heating jacket	**DR/EU-** $\boxed{H}$ $\boxed{–}$
in-line detonation flame arrester with integrated temperature sensor* and heating jacket	**DR/EU-** $\boxed{H}$ - $\boxed{T}$

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
a	125/4.92	125/4.92	153/6.02	155/6.10	198/7.80	200/7.87	250/9.84	332/13.07	335/13.19
b	140/5.51	140/5.51	183/7.20	185/7.28	223/8.78	225/8.86	290/11.42	357/14.06	360/14.17
c	210/8.27	210/8.27	290/11.42	290/11.42	365/14.37	365/14.37	440/17.32	535/21.06	535/21.06
c1	285/11.22	285/11.22	395/15.55	395/15.55	500/19.69	500/19.69	595/23.43	750/29.53	750/29.53
d	150/5.91	150/5.91	210/8.27	210/8.27	275/10.83	275/10.83	325/12.80	460/18.11	460/18.11
e	495/19.49	495/19.49	600/23.62	600/23.62	705/27.76	705/27.76	795/31.30	950/37.40	950/37.40

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,75 mm	IIB2	D	
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

		DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
Expl. Gr.	IIA	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.5 / 21.7	1.2 / 17.4	1.2 / 17.4
	IIB2	P_{max}								1.4 / 20.3	1.4 / 20.3
	IIB3	P_{max}	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.6 / 23.2	1.4 / 20.3	1.2 / 17.4*	1.2 / 17.4*

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request
* special flame arrester unit

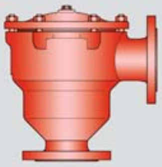
Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	$T_{max.}$ operating temperature

Table 5: Material selection for housing

Design	A	B	C	D
Housing Heating jacket (DR/EU-H-(T)-...)	Ductile Iron	Carbon Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Cover with shock absorber	Ductile Iron	Steel	Stainless Steel	Hastelloy
O-Ring	FPM *	FPM *	PTFE	PTFE
Flame arrester unit	A	A	C, D	E

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
The housing and cover with the shock absorber can also be delivered in steel with an ECTFE coating.
Special materials upon request



In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in right angle design with a shock absorber, unidirectional

PROTEGO® DR/EU

Table 6: Material combinations of the flame arrester unit				
Design	A	C	D	E
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used.
Special materials upon request

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

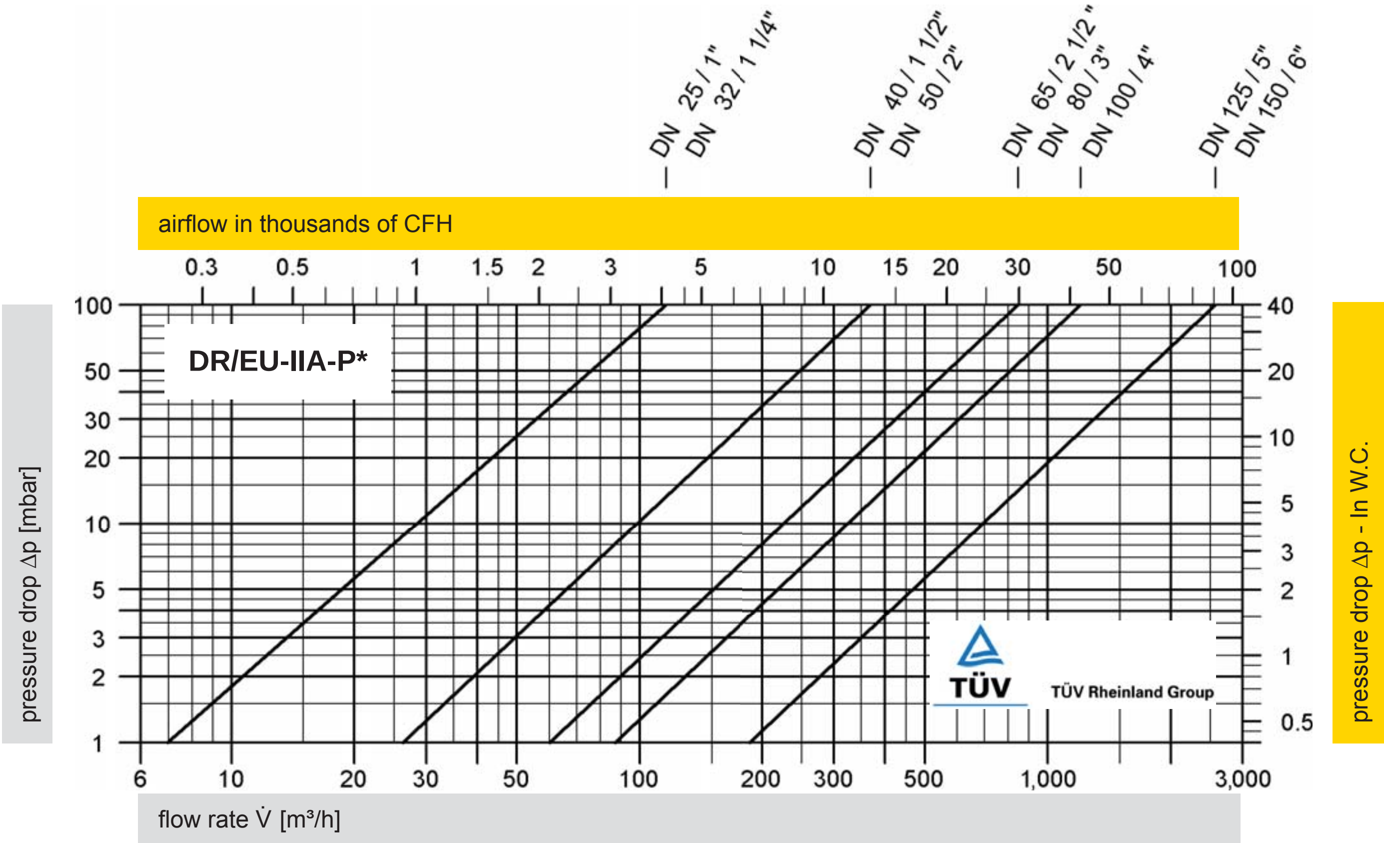
Type – Heating jacket – Temperature sensor – Nominal size – Explosion group – Max. operating pressure bar /psi (absolute) – Max. operating temperature – Material (housing) – Material (flame arrester unit) – Flange connection type

DR/EU	–		–		–		–		–	/	–		–		–		–	
Design						Tab. 1		Tab. 2		Tab. 3		Tab. 4		Tab. 5		Tab. 6		Tab. 7

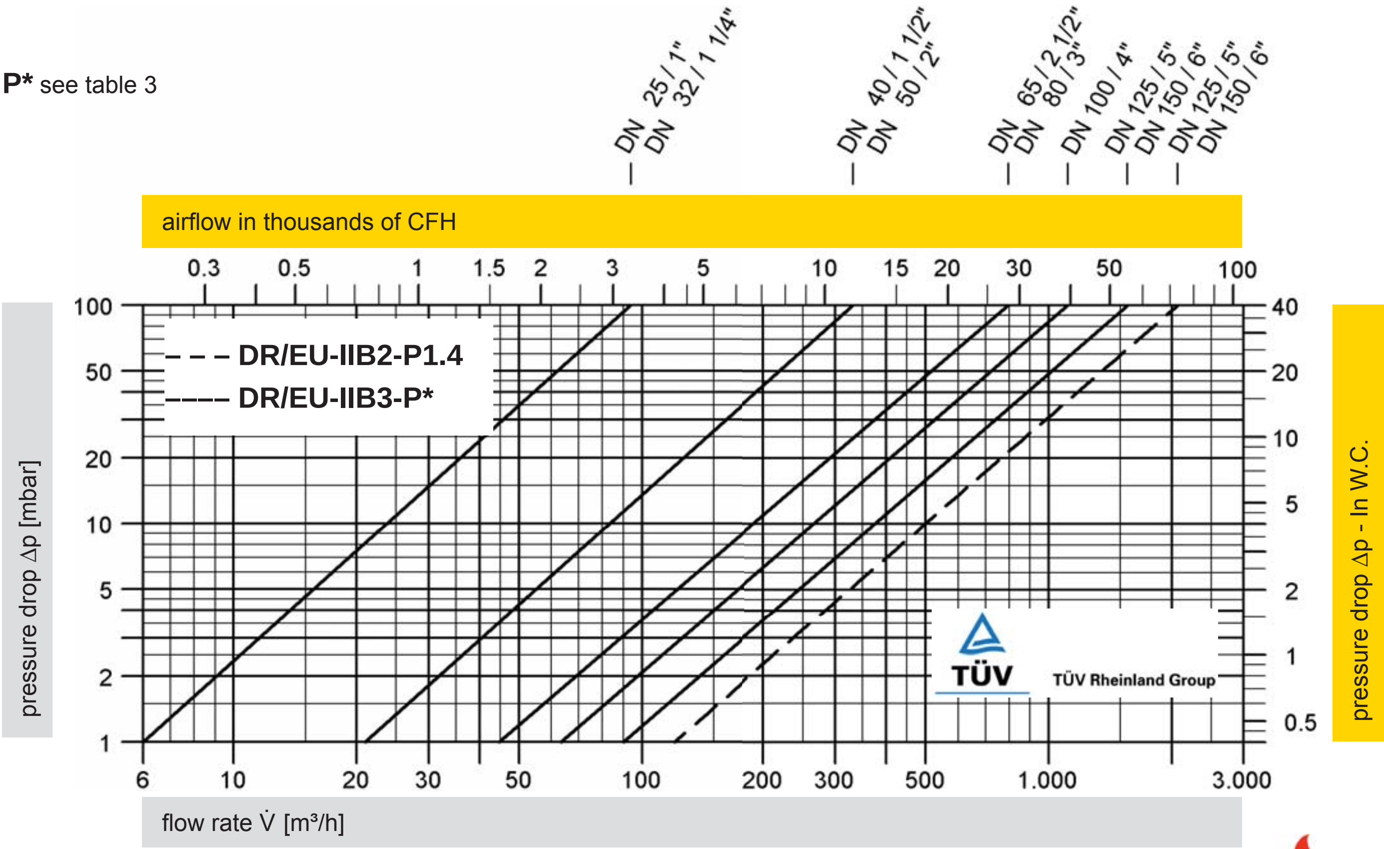
Order example

DR/EU	–	H	–	T	–	50	–	IIB3	–	P1.6/ –	–	T60	–	B	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



P* see table 3



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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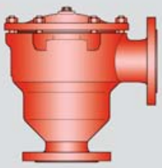
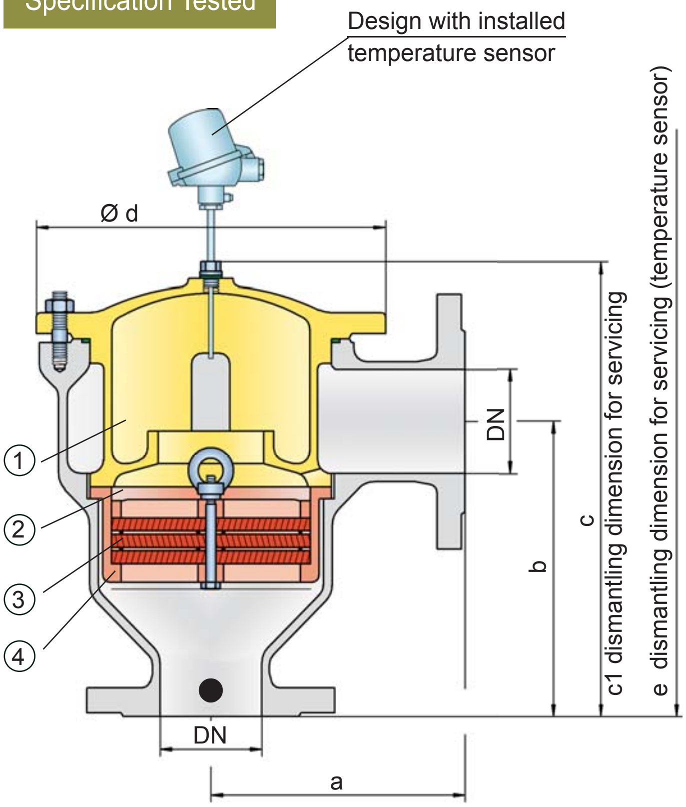


In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in right angle design with shock absorber, unidirectional

PROTEGO® DR/FM

FM Approvals
Specification Tested



● Connection to the protected side

Function and Description

The PROTEGO® DR/FM series of in-line detonation flame arresters represents a further development of PROTEGO® flame arresters DR/ES used successfully for decades in industry. The device protects against deflagrations, stable and unstable detonations. The classic right angle design offers considerable cost and maintenance advantages in comparison to a straight through design.

Once a detonation enters the flame arrester, energy is absorbed from the detonation shock wave by the integrated shock absorber (1) before the flame is extinguished in the narrow gaps of the original FLAMEFILTER® (3).

The PROTEGO® flame arrester unit (2) consists of several FLAMEFILTER® and spacers firmly held in the FLAMEFILTER® cage (4). The gap size and number of FLAMEFILTER® are determined by the operating data of the mixture flowing in the line (explosion group, pressure, temperature).

This device is available for explosion groups from IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The standard design is approved for an operating temperature up to +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi. Devices with special approvals are available for higher temperatures and pressures upon request.

This series was tested and approved by FM Approvals (Factory Mutual); additional international standards are available upon request.

Special Features and Advantages

- Minimum number of FLAMEFILTER® due to the patented shock absorber
- Quick removal of and installation of the complete PROTEGO® flame arrester unit and of the FLAMEFILTER®
- The modular design enables individual FLAMEFILTER® to be replaced
- Cost efficient spare parts
- Offers protection against deflagrations, stable and unstable detonations
- The right angle design saves pipe elbows
- Minimum pressure loss and hence low operating and lifecycle costs
- Extended application range of use for higher operating pressures

Design Types and Specifications

There are four different designs available:

Basic in-line detonation flame arrester	**DR/FM- [–] - [–]**
In-line detonation flame arrester with integrated temperature sensor* as additional protection against short time burning	**DR/FM- [T] - [–]**
In-line detonation flame arrester with heating jacket	**DR/FM- [H] - [–]**
In-line detonation flame arrester with integrated temperature sensor* and heating jacket	**DR/FM- [H] - [T]**

*Resistance thermometer for device group II, category (1) 2 (GII cat. (1) 2)

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
a	153 / 6.02	155 / 6.10	198 / 7.80	200 / 7.87	250 / 9.84	332 / 13.07	335 / 13.19
b	183 / 7.20	185 / 7.28	223 / 8.78	225 / 8.86	290 / 11.42	357 / 14.06	360 / 14.17
c	290 / 11.42	290 / 11.42	365 / 14.37	365 / 14.37	440 / 17.32	535 / 21.06	535 / 21.06
c1	395 / 15.55	395 / 15.55	500 / 19.69	500 / 19.69	595 / 23.43	750 / 29.53	750 / 29.53
d	210 / 8.27	210 / 8.27	275 / 10.83	275 / 10.83	325 / 12.80	460 / 18.11	460 / 18.11
e	600 / 23.62	600 / 23.62	705 / 27.76	705 / 27.76	795 / 31.30	950 / 37.40	950 / 37.40

Table 2: Selection of the explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating pressure

Expl. Gr.	DN	40 / 1 ½"	50 / 2"	65 / 2 ½"	80 / 3"	100 / 4"	125 / 5"	150 / 6"
IIA (D)	P_{max}	1.6 / 23.2	1.6 / 23.2	1.5 / 21.7	1.5 / 21.7	1.5 / 21.7	1.2 / 17.4	1.2 / 17.4
IIB3 (C)	P_{max}	1.5 / 21.7	1.5 / 21.7	1.4 / 20.3	1.4 / 20.3	1.3 / 18.8	1.2 / 17.4	1.2 / 17.4 *

P_{max} = maximum allowable operating pressure in bar / psi (absolute), higher operating pressure upon request
* special flame arrester unit

Table 4: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 5: Material selection for housing

Design	A	B	C	D
Housing Heating jacket (DR/FM-H-(T)-...)	Ductile Iron —	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless steel
Cover with shock absorber	Ductile Iron	Steel	Stainless Steel	Hastelloy
O-Ring	FPM *	FPM *	PTFE	PTFE
Flame arrester unit	A	A	C, D	E

* for devices exposed to elevated temperatures above 150°C / 302°F (T150), gaskets made of PTFE.
The housing and cover with the shock absorber can also be delivered in steel with an ECTFE coating.
Special materials upon request

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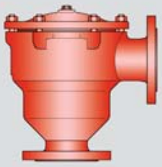


In-Line Detonation Flame Arrester

for unstable and stable detonations and deflagrations in right angle design with shock absorber, unidirectional

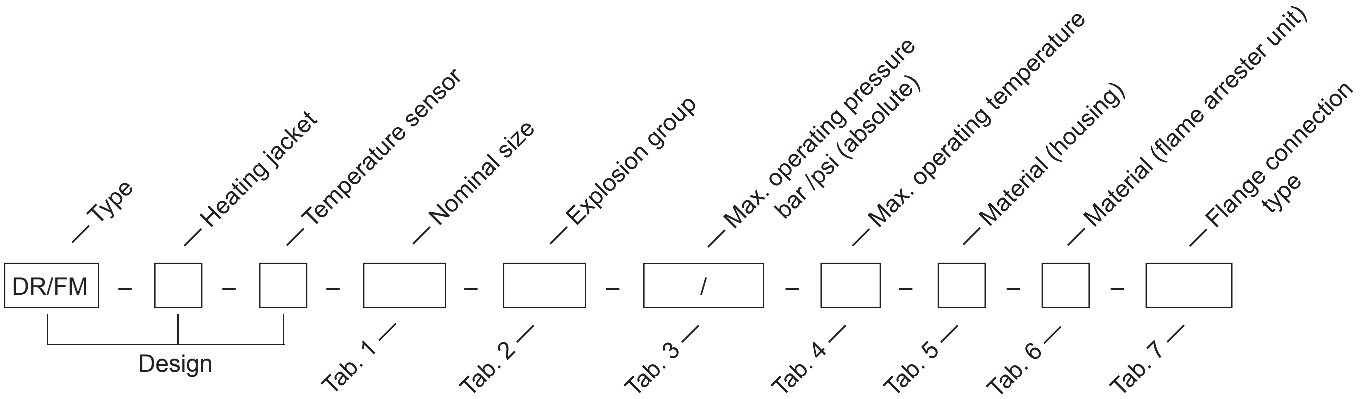
PROTEGO® DR/FM

FM Approvals
Specification Tested

Table 6: Material combinations of the flame arrester unit				
Design	A	C	D	E
FLAMEFILTER® cage	Steel	Stainless Steel	Stainless Steel	Hastelloy
FLAMEFILTER® *	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy
Spacer	Stainless Steel	Stainless Steel	Hastelloy	Hastelloy

* the FLAMEFILTER® are also available in the materials Tantalum, Inconel, Copper, etc. when the listed housing and cage materials are used. Special materials upon request

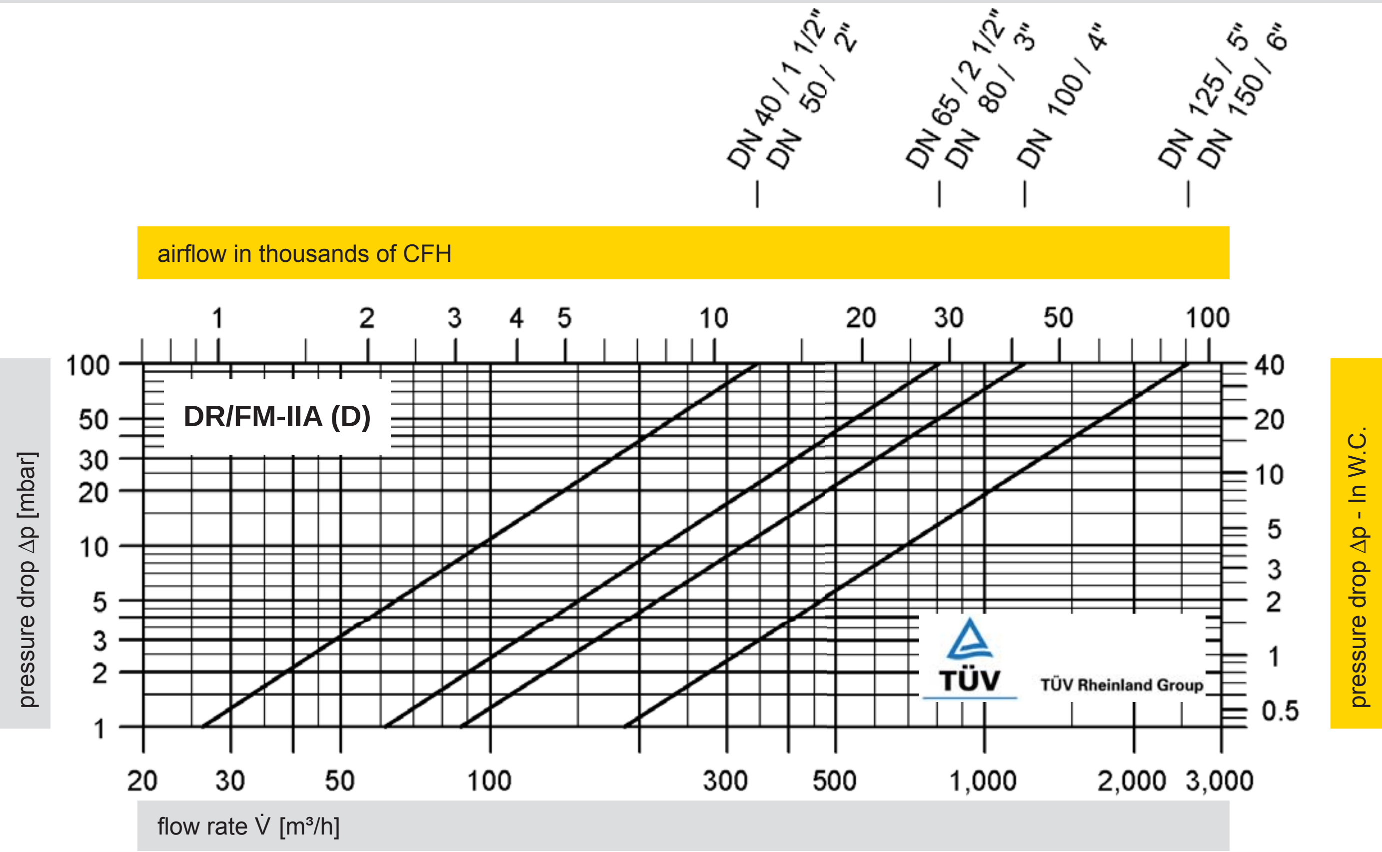
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

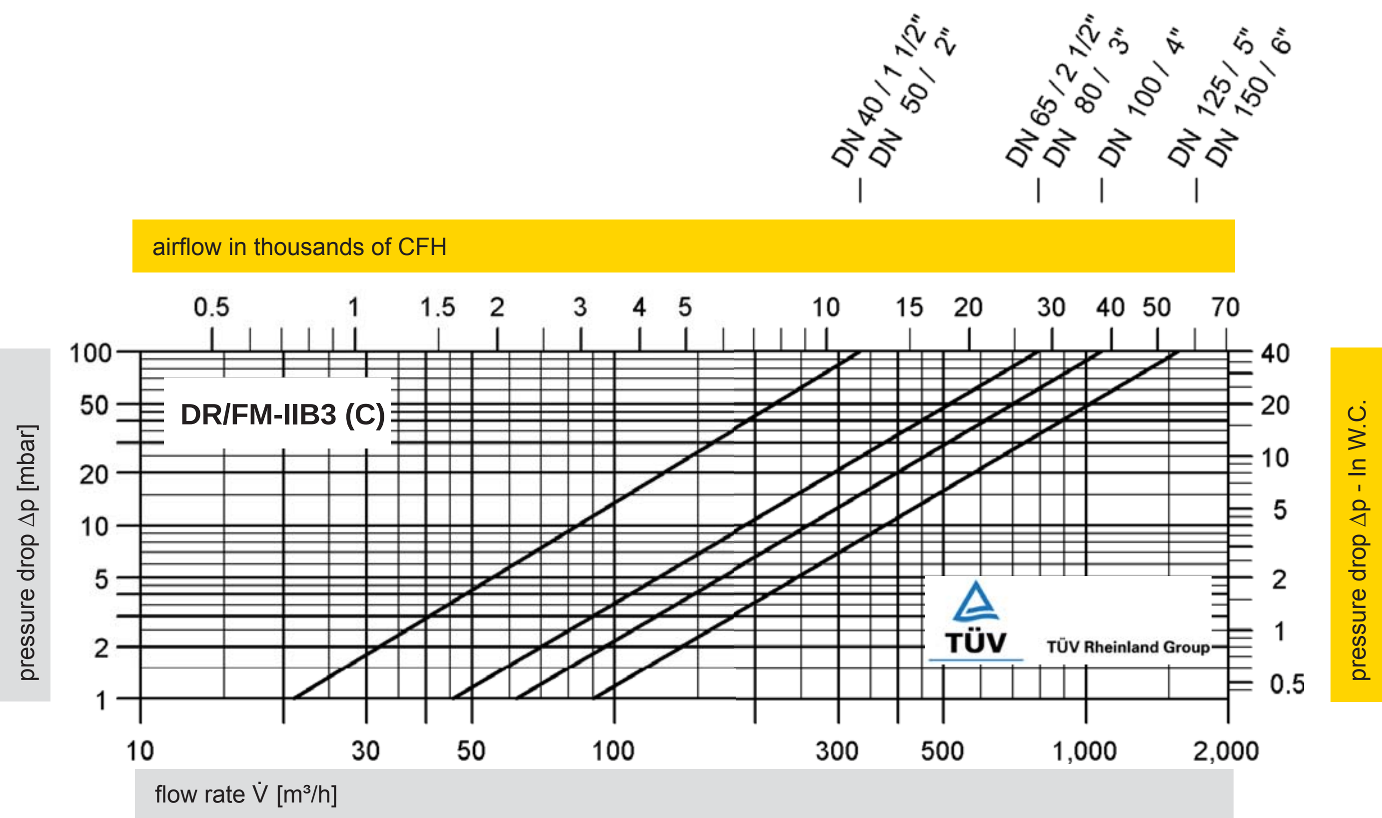


Order example

DR/FM	H	T	50	IIB3	P1.5/ –	T60	B	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





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Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

Notes:

Notes:

Materials and Conversion Tables

Pressure

1 bar	= 14.504 psi	$1\ lb/ft^2$	=	$47,88\ N/m^2$
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	$249,08\ N/m^2$
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= $2.089\ lb/ft^2$	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= $1\ N/m^2$	1 psi	=	$1\ lb/in^2$

Temperature

To convert ºC in ºF use	T_F	=	$32 + 1,8\ T_C$
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9\ (T_F - 32)$
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means

CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	= polytetrafluoroethylene
PVDF	= polyvinylidene fluoride
PFA	= perfluoroalkoxy polyme
FPM 70	= fluor carbon rubber
WS 3822	= aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	= ethylene chlorotrifluoro ethylene
FEP	= perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937 inch	1 inch		=	25,4 mm
1 m	= 3.2808 ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936 yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621 miles	1 mile		=	1,609 km

Area

$1cm^2$	= 0.1550	sq inch	1 sq inch	=	$6,4516\ cm^2$
$1\ m^2$	= 10.7639	sq ft	1 sq ft	=	$0,0929\ m^2$
	= 1.196	sq yards	1 sq yard	=	$0,836\ m^2$
$1km^2$	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

$1\ cm^3$	= 0.06102	cu inch	1 cu inch	=	$16,3870\ cm^3$
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
$1\ m^3$	= 35.315	cu ft	1 cu ft	=	$0,028317\ m^3$
	= 6.299	petr. barrels	1 petr. barrel	=	$0,15876\ m^3$

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85	ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214	mph	1 mph	=	1,60934 km/h
$1\ m^3/h$	= 4.403	gal/min (US)	1 gal/min (US)	=	$0,227\ m^3/h$
	= 3.666	gal/min (UK)	1 gal/min (UK)	=	$0,273\ m^3/h$
	= 0.5886	cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367	lb/min	1 lb/min	=	27,216 kg/h
			1 cu ft/h	=	$0,028317\ m^3/h$

Torsion

1 Nm	= 0.723 lbf ft	1 lbf ft	= 1,38 Nm

Density

$1\ kg/dm^3$	= 62.43 lb/cu ft	1 lb/cu ft	= $0,016\ kg/dm^3$

Safety devices are installed to prevent damage. The requirements need to be defined as early as in the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region upon request.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts available for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

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PROTEGO

for safety and environment

PROTEGO® **Pressure/Vacuum Relief Valves**

end-of-line

Volume 5

PROTEGO

for safety and environment

Edition 2010

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

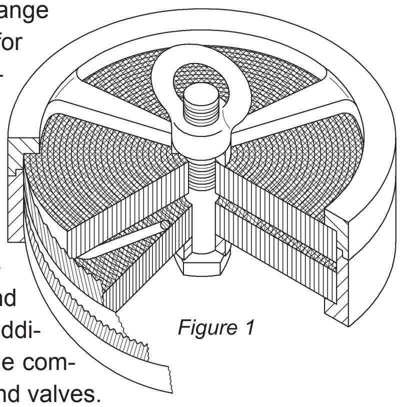
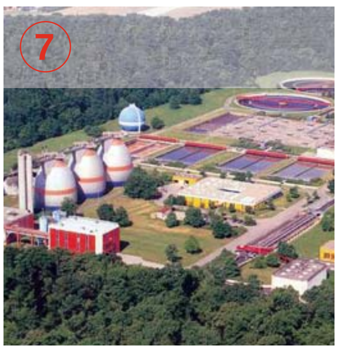


Figure 1

All of our devices are tested by independent national and international third parties in the world's largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

FM Approvals
Specification Tested

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.



Pressure/Vacuum Relief Valves – end-of-line

Function and Description

The function of pressure/vacuum valves for relief and conservation and the corresponding applications is discussed in „Technical Fundamentals“ (→ Vol. 1). In this chapter PROTEGO®´s product line of pressure/vacuum relief valves in end-of-line application is presented.

These are special devices that function as an **end-of-line valve** to protect against pressure and vacuum. The valves may be designed as pipe away version which can be connected to a vent header to process vapors.

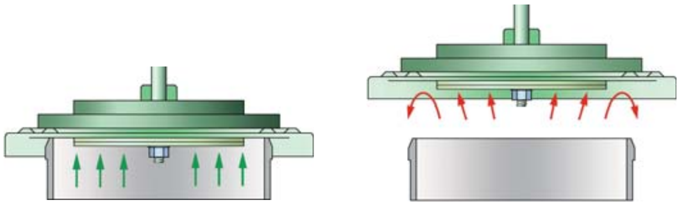
Pressure relief valves prevent vapor loss up to the adjusted set pressure and offer reliable protection against excess pressure.

Vacuum relief valves prevent the unallowable entrance of air up to the adjusted set pressure and offer reliable protection against vacuum.

Pressure/vacuum relief valves perform all of the above tasks.

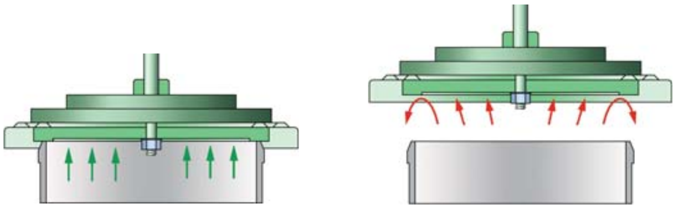
PROTEGO® pressure/vacuum disc relief valves have weight-loaded or spring-loaded valve pallets.

PROTEGO® pressure/vacuum relief valves with a full-lift disc discharge the volumetric flow within 10% overpressure from the set pressure up to full lift. After the response, the valve pallet immediately transitions to a full lift (Figs. 1 and 2).



closed *outflow with full lift*

Fig. 1: Outflow with a full-lift disc and air cushion seal



closed *outflow with full lift*

Fig. 2: Outflow with a full-lift disc and metal seal

This is attained by precisely harmonizing the diameter and height of the valve pallet rim with the adapted, lapped valve seat. In addition, a flow-enhancing design reinforces the overall effect on the outflow side. These valve pallets are used in end-of-line valves and in-line valves. The arrangement of valve pallet guidance and seal is combined in the term valve pallet.

Given the right size, the unique **10% technology** of the valves enables a set pressure that is just 10% below the maximum allowable tank pressure. For tanks with emergency relief vents the openingpressure of the relief valve needs to be below the set pressure of the emergency relief vent. The valve immediately opens to a full lift under a full load like a classic safety valve but in response to minimum changes in pressure. The full-lift discs are the result of years of development. The ingenious engineering enables reliable valve pallet operation at a full load. The highly developed PROTEGO® manufacturing technology has produced a seal that is far superior to the conventional standard. This feature is supported by valve seats made of high-quality stainless steel and individually lapped valve pallets or valve seats with an air cushion seal, among other things.

Diaphragm valves are pressure/vacuum relief valves with a flexible diaphragm. Their special design is to satisfactorily handle problem products, even at extremely low temperatures below freezing, a thousand times over.

Special features and advantages

- Large flows with only a slight pressure drop
- Pressure setting close to the opening pressure (PROTEGO® 10% technology) for optimum retention of pressure in the system
- Seal superior to the normal standard values, which minimizes product loss
- The valve pallet is guided within the housing to protect against the weather

Preferred Applications

PROTEGO® pressure/vacuum relief valves are used as inbreathing and outbreathing valves, pressure relief valves, conservation valves, for simple control, and for venting tanks and equipment when an unallowable vacuum or pressure is exceeded. They are used for low pressures, i.e. in pressure ranges in which classic safety valves cannot be used due to their limited performance characteristics. PROTEGO® valves are available as pressure relief valves, vacuum relief valves, or as combined pressure/vacuum relief valves.

PROTEGO® **diaphragm valves** are used for problem products and low temperatures.

Pilot valves are advantageous for special control responses or when a tight seal is required up to the point at which the valve starts to open.

High-velocity-vent valves are used **on tanker ships and for special land uses.**

Installation and servicing

The valves come with detailed installation and servicing instructions.
Shipping braces are installed for safe transportation. Make sure that the transportation locks are removed before installing the valves. Startup checklists help to properly set up the valves for use.

Selection and sizing

To operate the system properly, the right valve is to be selected.

The criteria for selecting the right device are:

Function – a pressure relief valve, a vacuum relief valve, or a combined pressure/vacuum relief valve, with a pipe-away connection if needed.

Design – a combined end-of-line valve or separate pressure relief and vacuum relief valves with a perpendicular connection or horizontal connection. The devices are weight-loaded; therefore the valves are to be installed vertically.

The adjusted set pressure – the standard maximum allowable (tank) pressure minus 10% overpressure; it determines the combination of materials for the disc.

Type of seal – for disc valves according to the pressure level, either with an air cushion seal, or with a metal seal to provide an extremely tight seal.

Special operating conditions – for viscous and adhesive media, for frost-protected operation, or for use with polymerizing products.

The **nominal diameter** of the valve is generally determined by the connecting flange of the pipe, tank, or system part, or by the design specified in the performance diagram. To size a valve, the flow must be known for the overpressure output (outbreathing) and vacuum output (inbreathing). The nominal diameter or number of valves may have to be adjusted. Take into account potential system counterpressure when connecting a pipe.

Sizing

The **valve size** results from the volume flow which has to be vented to avoid an increase above the maximum allowable pressure or vacuum. Certified volume flow diagrams are used for sizing. For correct sizing the operating conditions and the pressure drops of the piping system (including other installed devices) and superimposed backpressures have to be taken into account.

Detailed procedures and examples for sizing are described in “Technical Fundamentals” (see Volume 1).

Example 1

Given: Volume flow $\dot{V}_{max}$ in m³/h / CFH (i.e. for in- or out breathing of a storage tank this is the sum of the pump capacity and the thermal breathing requirement) and maximum allowable opening pressure (i.e. tank pressure) p_T in mbar / In W.C.

Requested: Valve size DN

Procedure: The intersection point of $\dot{V}_{max}$ and p_T determines the required valve size. Opening pressure = the maximum allowable tank pressure. The volume flow diagrams show the volume flow as function of the opening pressure for a fully open valve.

The set pressure of the valve has to be determined so that the calculated volume flow can safely be discharged. For a valve which needs 10% overpressure to reach full lift the set pressure may be chosen 10% below the fully open pressure (i.e. maximum allowable tank pressure). Attention: pressure drop of piping systems and other installed devices have to be considered!

Many conventional valves need 100% overpressure to reach full lift. In these cases the set pressure may be just half of the maximum allowable tank pressure. Consequently these valves open earlier and avoidable product losses occur.

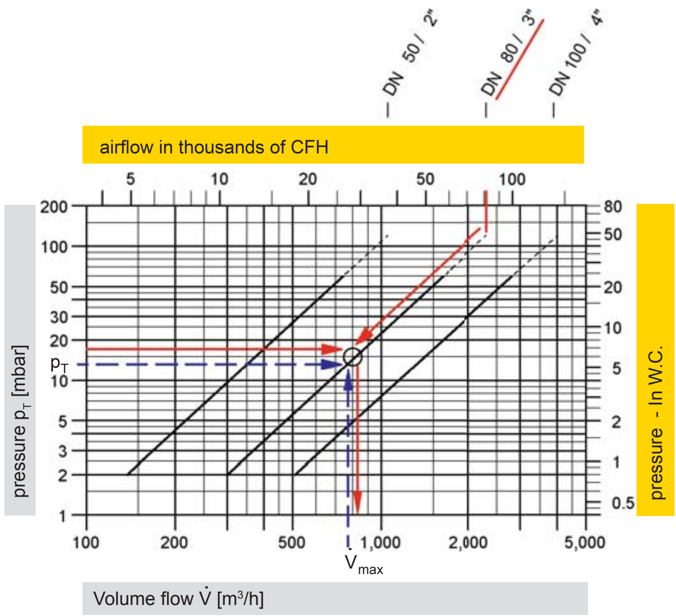
Example 2

Alternatively the valve performance has to be checked if the size and maximum allowable pressure are provided.

Given: Connection nozzle size and maximum allowable opening pressure (i.e. tank pressure) p in mbar / In W.C.

Required: Volume flow in m³/h / CFH, set pressure p_A in mbar / In W.C.

Procedure: From the intersection point of the straight line of p and the valve performance curve of the specific valve size the volume flow $\dot{V}_{max}$ is determined. The volume flow of the set pressure p_A may be 10%, (PROTEGO® technology) or 40% or 100% below the opening pressure p_T. Attention: pressure drop of piping systems and other installed devices have to be considered!



The required set pressure (= start of opening) will be the opening pressure (valve fully open) minus the characteristic overpressure.

For PROTEGO® valves and end of line devices the overpressure characteristic is 10% unless otherwise stated. Within 10% overpressure the valve pallet will reach full lift. A further increase in flow performance will follow the pressure volume flow diagram.

Material selection is based on plant and engineering specifications.

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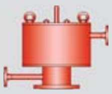
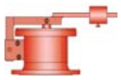
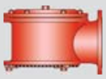
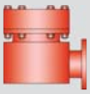
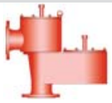
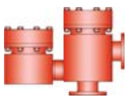
PROTEGO® Pressure/Vacuum-Relief-Valves - end-of-line

	Type	Size	pressure setting positive setting range mbar / In W.C.	pressure setting negative setting range mbar / In W.C.	Design O = horizontal connection X = vertical connection	O = soft sealing X = metallic sealing	O = for non-standard operating parameters	O = for critical Medium (Polymerisation, Corrosion, Cristallisation)	O = Heating jacket, Heating coil	Page
Pressure Relief Valves, weight pallet type										
	P/EL	50 - 80 2" - 3"	+3.5 up to +210/ +1.4 up to +84		X	O / X			O	8 - 9
	P/ELR	80 - 100 3" - 4"	+3.5 up to +210/ +1.4 up to +84		X	O / X			O	10 - 11
	SD/BS-H	80-200 3" - 8"	+5 up to +210/ +2 up to +84		X	X	O		O	12 - 13
	D/SVL	50-300 2" - 12"	+2.0 up to +60/ +0.8 up to +24		X	O / X				14 - 15
	ER/V	200-700 8" - 28"	DN 200-350: +5 up to +40/ +2 up to +16 DN 400-700: +5 up to +25/ +2 up to +10		X	O			O	16 - 17
	ER/VH	200-700 8" - 28"	DN 200-350: >+40 up to +60/ >+16 up to +24 DN 400-700: >+25 up to +60/ >+10 up to +24		X	O				18 - 19
	ER/V-F	200-700 8" - 28"	>+60 up to +500/ >+24 up to +200		X	O				20 - 21
	D/KSM	50-200 2" - 8"	+5.0 up to +100/ +2.0 up to +40		X	O	O	O		22 - 24
Vacuum Relief Valves, weight pallet type										
	SV/E-1-0	50 - 300 2" - 12"		-2.0 up to -60 / -0.8 up to -24	O	O / X			O	26 - 27
	SV/T-0-H	80 - 250 3" - 10"		-7.0 up to -50 / -2.8 up to -20	X	X	O		O	28 - 30
	V/KSM	50-200 2" - 8"		-5.0 up to -100 / -2.0 up to -40	O	O	O	O		32 - 34

	Type	Size	pressure setting positive setting range mbar / In W.C.	 negative setting range mbar / In W.C.	Design O = horizontal connection X = vertical connection	O = soft sealing X = metallic sealing	O = for non-standard operating parameters	O = for critical Medium (Polymerisation, Corrosion, Cristallisation)	O = Heating jacket, Heating coil	Page
Pressure and Vacuum Relief Valves, weight pallet type										
	PV/EL	50 - 80 2" - 3"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -35 / -1.4 up to -14	O	O / X			O	36 - 39
	PV/ELR	80 - 100 3" - 4"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -50 / -1.4 up to -20	O	O / X			O	40 - 43
	VD/SV	50 - 80 2" - 3"	+2.0 up to +60 / +0.8 up to +24	-2.0 up to -60 / -0.8 up to -24	X	O / X			O	44 - 46
	VD/SV-PA(L)	50 - 300 2" - 12"	+2.0 up to +60 / +0.8 up to +24	-2.0 up to -60 / -0.8 up to -24	X	O / X			O	48 - 51
	VD/KSM	50 - 200 2" - 8"	+5.0 up to +100 / +2.0 up to +40	-5.0 up to -100 / -2.0 up to -40	X	O	O	O		52 - 54
	VD/KSM-PA	50 - 200 2" - 8"	+5.0 up to +100 / +2.0 up to +40	-5.0 up to -100 / -2.0 up to -40	X	O	O	O		56 - 58
Pressure and Vacuum Relief Valves, pilot-operated										
	PM/(D)S	80 - 300 3" - 12"	+10 up to +300 / +4.0 up to +120	-3.0 up to -7 / -1.2 up to -2.8	X	X	O			60 - 63
	PM/F	80 - 300 3" - 12"	+10 up to +350 / +4.0 up to +140	-3.0 up to -10 / -1.2 up to -4.0	X	X	O			64 - 67

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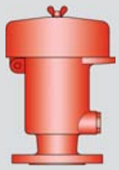
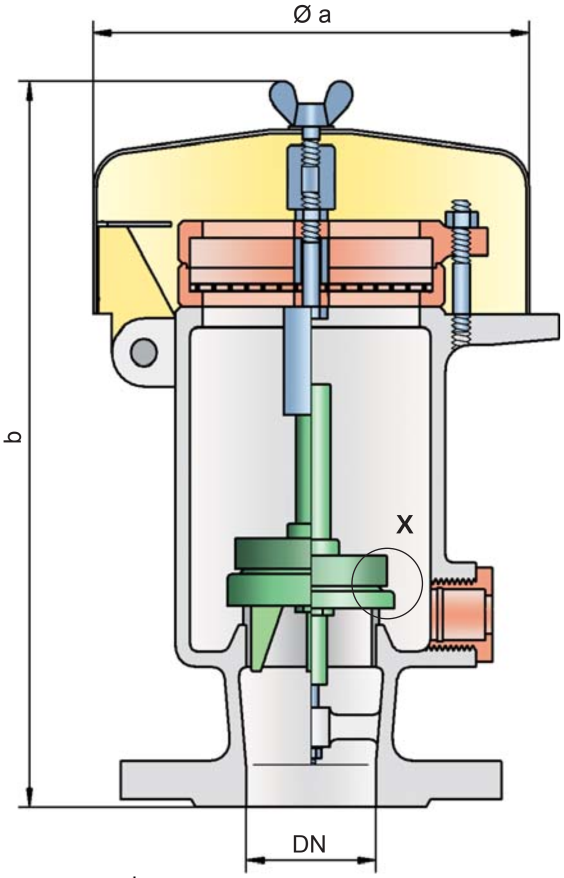
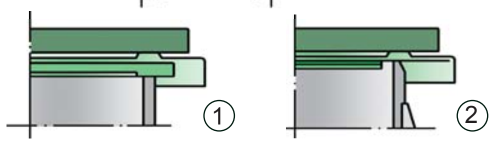


Pressure Relief Valve

PROTEGO® P/EL



Detail **X**



Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The P/EL type PROTEGO® valve is a highly developed pressure relief valve. It is primarily used as a safety device for relieving pressure in tanks, containers and process engineering equipment. The valve protect against unallowable overpressure and prevents the unacceptable loss of product vapors close to the set pressure.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used, and they enable the use of corrosive media. After the excess pressure is discharged, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to an explosion hazard
- self-actuated condensate drain

Design Types and Specifications

The valve pallet is weight-loaded. At set pressures greater than 80 mbar (32.1 In W.C.), an elongated construction is used.

There are two different designs:

Pressure valve in basic design **P/EL - $\boxed{-}$**

Pressure valve with heating jacket **P/EL - $\boxed{H}$**

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

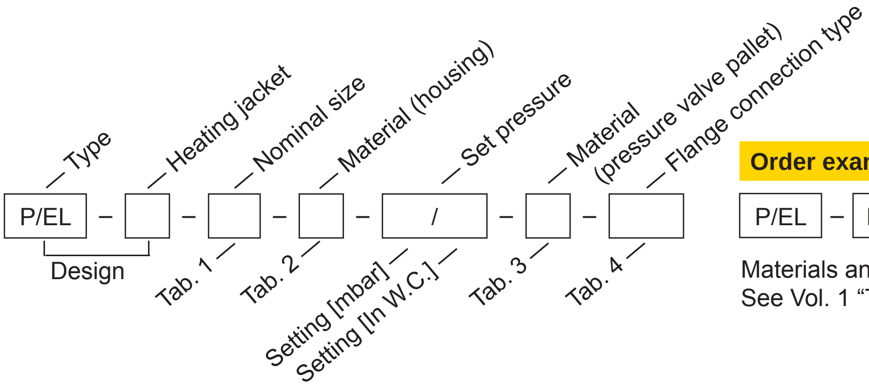
DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58
b	287 / 11.30	452 / 17.80	289 / 11.38	454 / 17.87

Dimensions for pressure valves with heating jacket upon request

Table 2: Material selection for housing			
Design	B	C	Special materials upon request
Housing Heating jacket (P/EL-H-...)	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	
Protective mesh screen	Stainless Steel	Stainless Steel	

Table 3: Material selection for pressure valve pallet					
Design	A	B	C	D	Special materials (Aluminum-coated, Titanium, Hastelloy) and higher pressure settings upon request
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 4: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

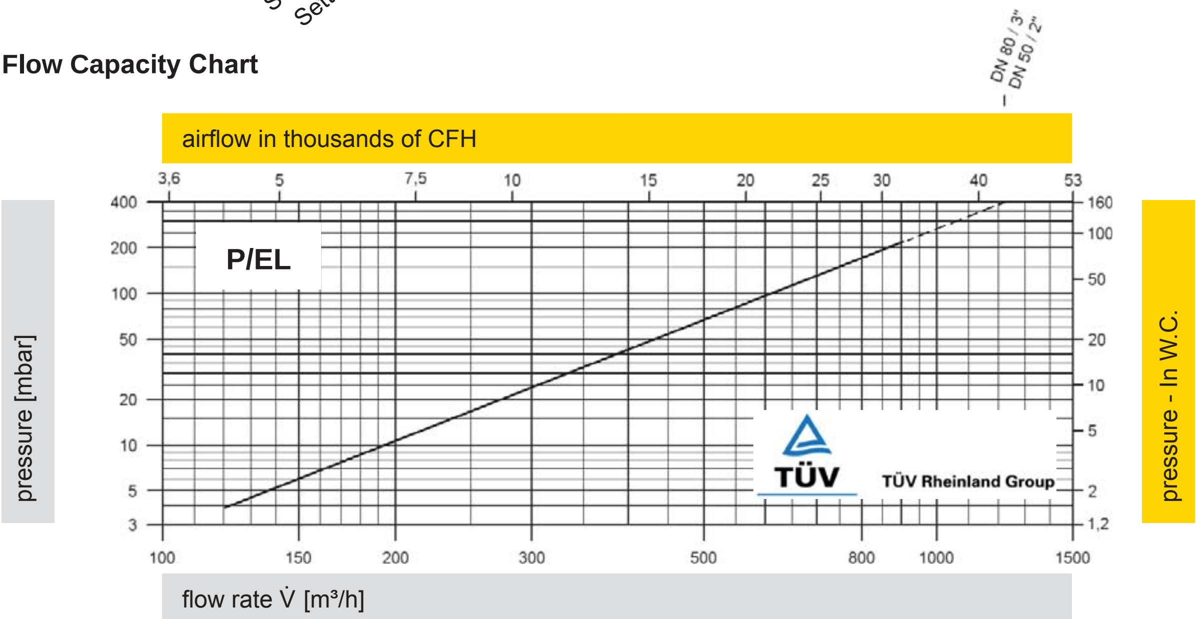


Order example

P/EL – H – 50 – B – 50 / - – D – DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity curve has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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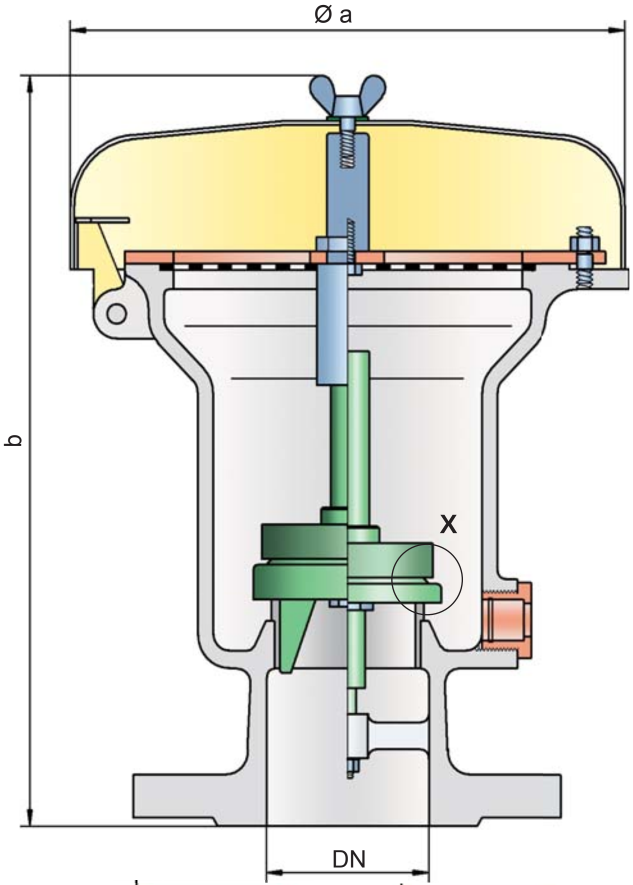
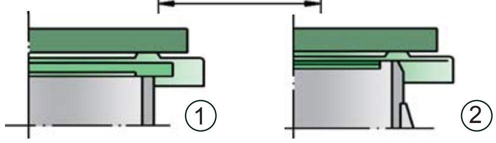
Pressure Relief Valve

PROTEGO® P/ELR



Detail **X**



Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The P/ELR type PROTEGO® valve is a highly developed pressure relief valve with excellent flow performance. It is primarily used as a safety device for relieving pressure in tanks, containers, and process engineering equipment. The valve offers reliable protection against overpressure and prevents the unacceptable loss of product vapors close to the set pressure.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- Can be used in areas subject to an explosion hazard
- self-actuated condensate drain

Design Types and Specifications

The valve pallet is weight-loaded. At set pressures greater than 80 mbar (32.1 In W.C.), an elongated construction is used.

There are two different designs:

Pressure valve in basic design **P/ELR -** $\boxed{-}$

Pressure valve with heating jacket **P/ELR -** $\boxed{\text{H}}$

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

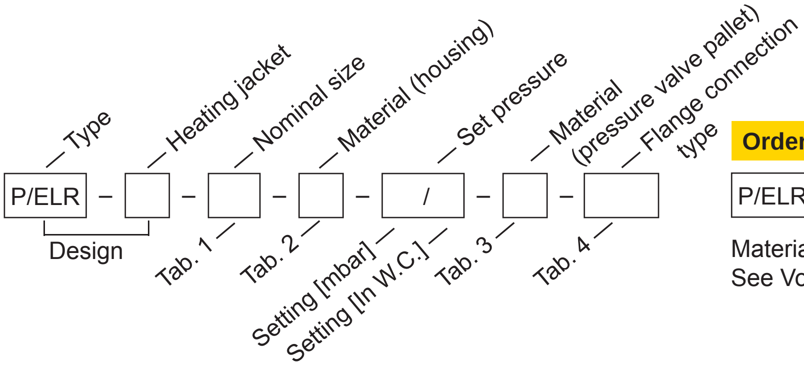
DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90
b	345 / 13.58	505 / 19.88	345 / 13.58	505 / 19.88

Dimensions for pressure valves with heating jacket upon request

Table 2: Material selection for housing			
Design	B	C	Special materials upon request
Housing Heating jacket (P/ELR-H-...)	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	
Protective mesh screen	Stainless Steel	Stainless Steel	

Table 3: Material selection for pressure valve pallet					
Design	A	B	C	D	Special materials (Aluminum-coated, Titanium, Hastelloy) and higher pressure settings upon request
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	
Valve pallet	Aluminium	Stainless steel	Stainless steel	Stainless steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 4: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

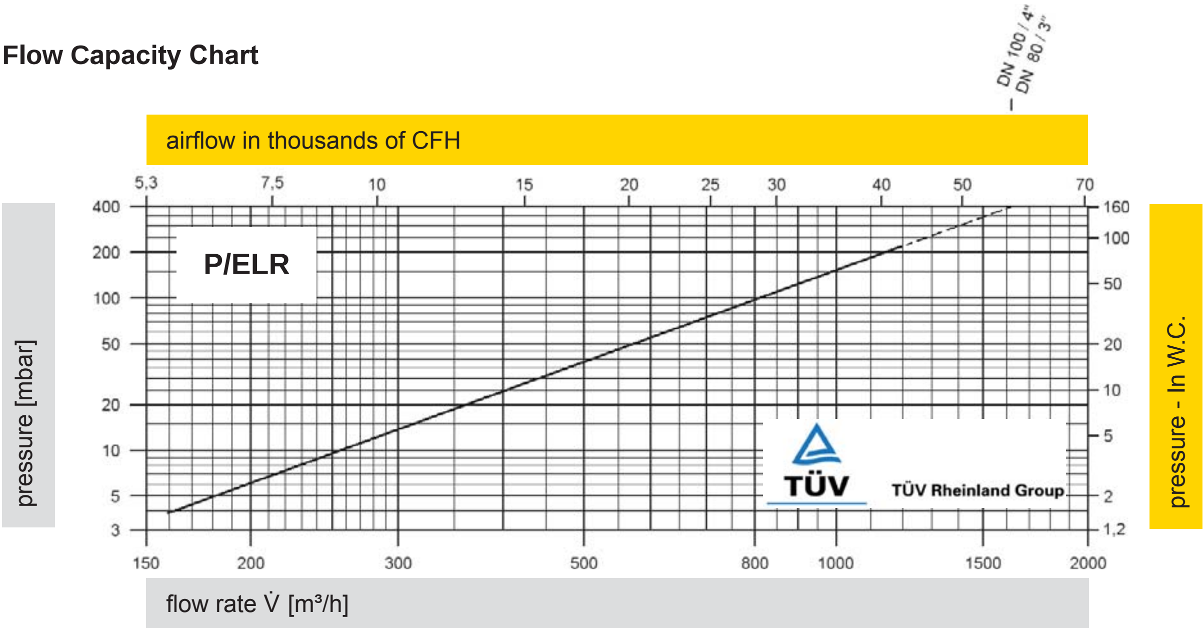


Order example

P/ELR	–	H	–	100	–	B	–	100 / -	–	D	–	DIN

Materials and chemical resistance:
See Vol. 1 "Technical Fundamentals"

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

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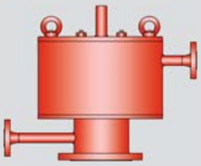
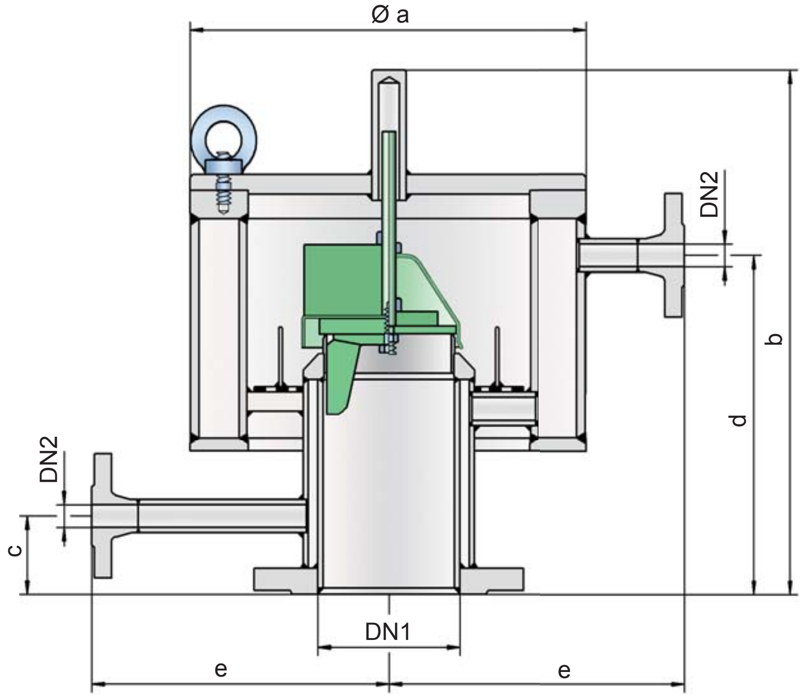


Pressure Relief Valve

in heat jacketed design

PROTEGO® SD/BS-H



Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high-grade stainless steel with precisely lapped valve pallets and a reinforced housing design. After the excess pressure is discharged, the valve reseats and provides a tight seal again.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to an explosion hazard
- heating jacketed design down to the flange to avoid cold bridges
- maximum permissible heating medium temperature of 320°C / 608°F (at 6 bar / 87 psi)
- a special design with a heatable valve cover is available
- at low pressure settings, an optimized valve pallet cover prevents the set pressure from being distorted by dust or condensate
- reinforced housing design
- a special design with a mechanical vent pallet lift device is available

Pressure Settings:

+5.0 mbar up to +210 mbar
+2.0 in W.C. up to +84 in W.C.
Higher pressure settings upon request.

Function and Description

The SD/BS-H type PROTEGO® valve is a highly developed pressure relief valve with a heating jacket down to the flange. It is primarily used as pressure relief device for vessels and process engineering equipment under difficult operating conditions. This includes extreme weather conditions or products that tend to form polymers at certain temperatures, adhere, or form deposits that negatively influence function (such as bitumen, tar, dust). The valve offers reliable protection against overpressure and prevents the unacceptable loss of product vapors close to the set pressure.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Design Types and Specifications

The valve pallet is weight-loaded. Starting at a set pressure of 30 mbar, a vane guide is also used.

Pressure valve in basic design with heating jacket **SD/BS - H**

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN1	DN2	a	b	b	c	d	d	e
			≤ 30 mbar ≤ 12 in W.C.	> 30 mbar > 12 in W.C.		≤ 30 mbar ≤ 12 in W.C.	> 30 mbar > 12 in W.C.	
80 / 3" *	15 / ½"	325 / 12.80	400 / 15.75	515 / 20.28	70 / 2.76	250 / 9.84	390 / 15.35	250 / 9.84
100 / 4"	15 / ½"	325 / 12.80	400 / 15.75	505 / 19.88	60 / 2.36	250 / 9.84	380 / 14.96	250 / 9.84
150 / 6"	15 / ½"	405 / 15.94	460 / 18.11	595 / 23.43	60 / 2.36	315 / 12.40	470 / 18.50	290 / 11.42
200 / 8"	15 / ½"	510 / 20.08	470 / 18.50	575 / 22.64	65 / 2.56	305 / 12.01	445 / 17.52	340 / 13.39

* also available with special flange DN 50 / 2"

Table 2: Material selection for housing

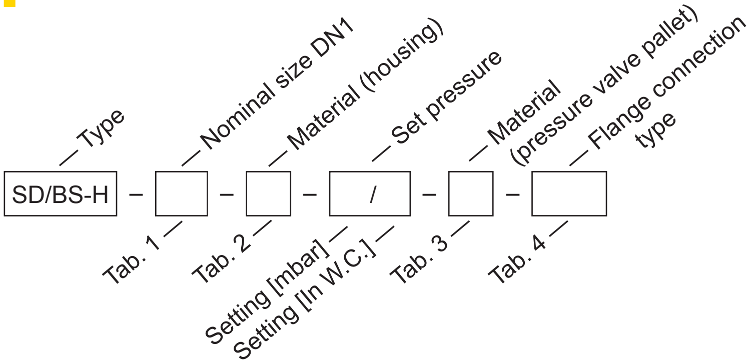
Design	A	B	
Housing Heating Jacket	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve Seat	Stainless Steel	Stainless Steel	

Table 3: Material selection for pressure valve pallet

Design	A	B	C	
Pressure range [mbar] [In W.C.]	+5 up to +25 +2 up to +10	>+10 up to +30 >+4 up to +12	>+30 up to +210 >+12 up to +84	Special materials and higher pressure settings upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	
Valve pallet hood	Stainless Steel	Stainless Steel	-	
Sealing	Metal to Metal	Metal to Metal	Metal to Metal	

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

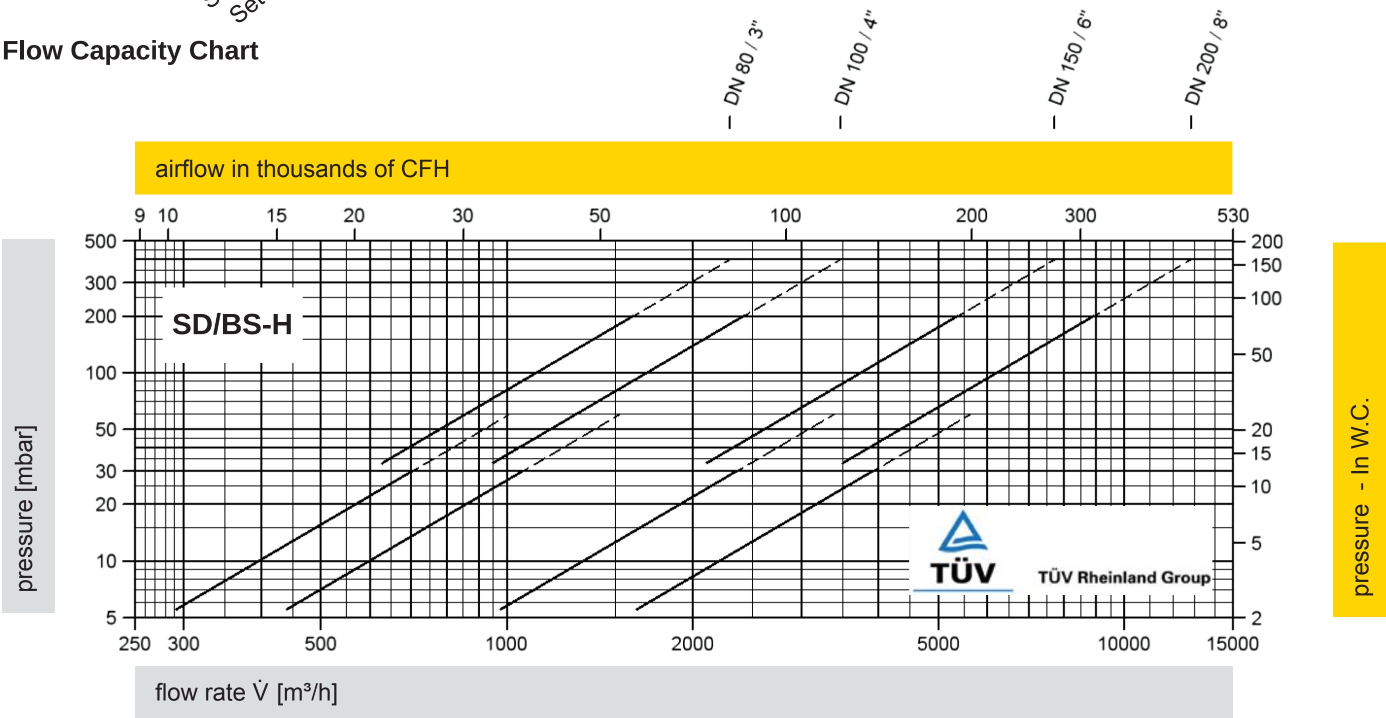


Order example

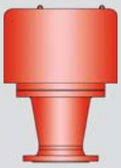
SD/BS-H – 200 – B – 25/ - – B – DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart

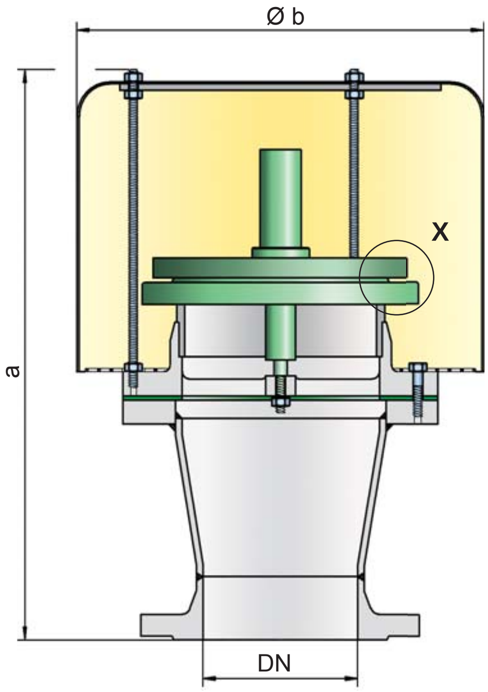


The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

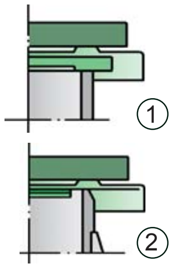


Pressure Relief Valve

PROTEGO® D/SVL



Detail **X**



Pressure settings:

+2.0 mbar up to +60 mbar
+0.8 in W.C. up to +24 in W.C.
Higher pressure settings upon request.

Function and Description

The D/SVL type PROTEGO® valve is a high performance pressure relief valve. It is primarily used as a safety device for relieving pressure in tanks, containers, and process engineering equipment. The valve offers reliable protection against overpressure and prevents the unacceptable loss of product vapors close to the set pressure.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallet from sticking when sticky products are used, and they enable the use of corrosive media. After the excess pressure is discharged, the valve reseats and provides a tight seal again.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- extremely high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to an explosion hazard

Design Types and Specifications

The valve pallet is weight-loaded. Higher pressures can be achieved upon request with a special spring-loaded design.

Pressure valve in basic design **D/SVL -**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	336 / 13.23	412 / 16.22	444 / 17.48	564 / 22.20	664 / 26.20	687 / 27.05	687 / 27.05
b	200 / 7.87	295 / 11.61	295 / 11.61	465 / 18.31	550 / 21.65	650 / 25.59	650 / 25.59

Table 2: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	Special Materials upon request
Sealing	WS 3822	PTFE	
Weather hood	Stainless Steel	Stainless Steel	

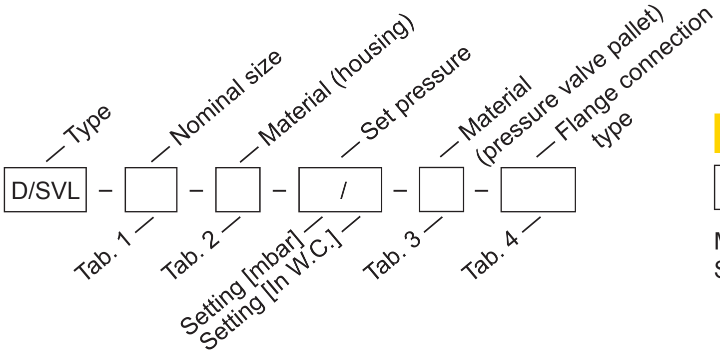
Table 3: Material selection for pressure valve pallet

Design	A	B	C	D	E	F
Pressure [mbar] range [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24
Valve	Aluminium	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special Materials and higher pressure settings upon request

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

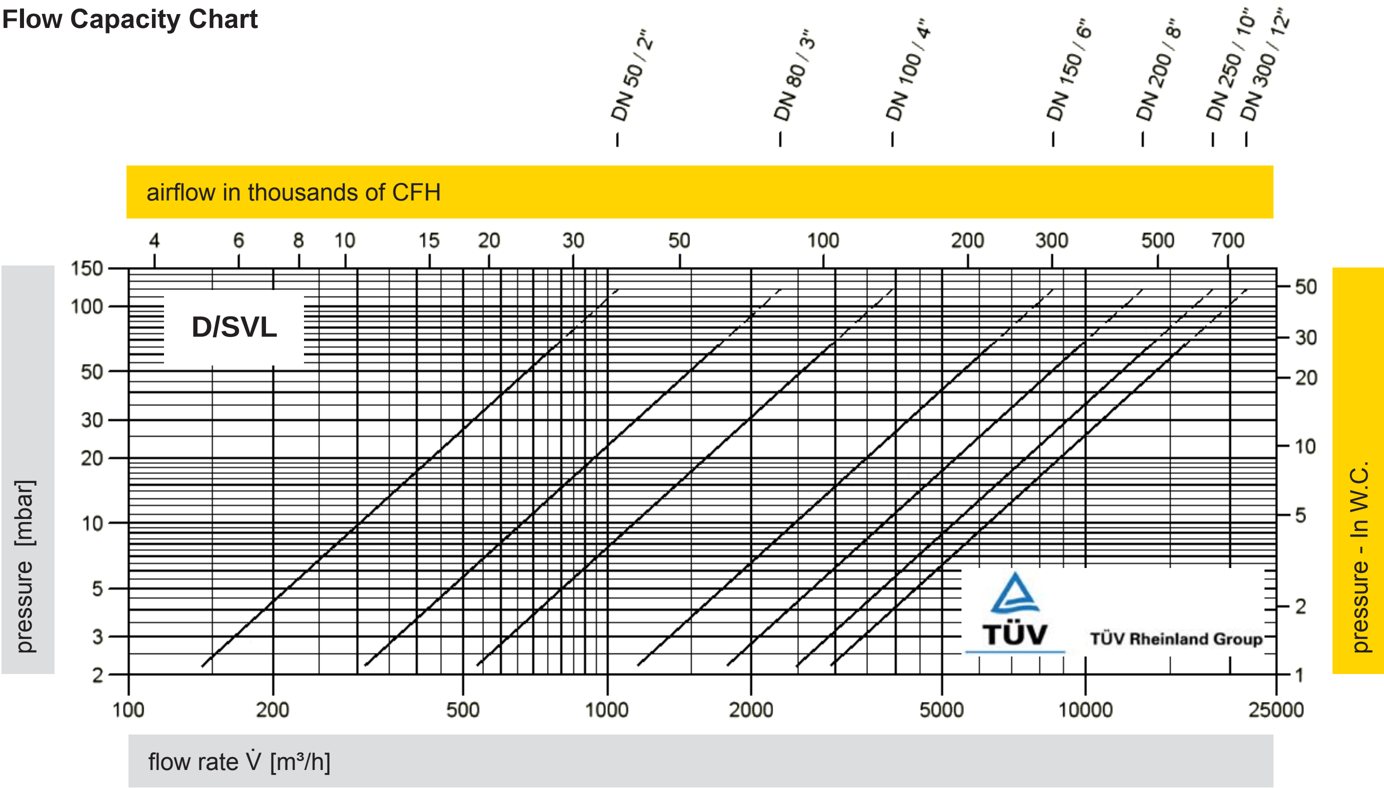


Order example

D/SVL – 200 – B – 50/ – F – DIN

Materials and chemical resistance:
See Vol. 1 "Technical Fundamentals"

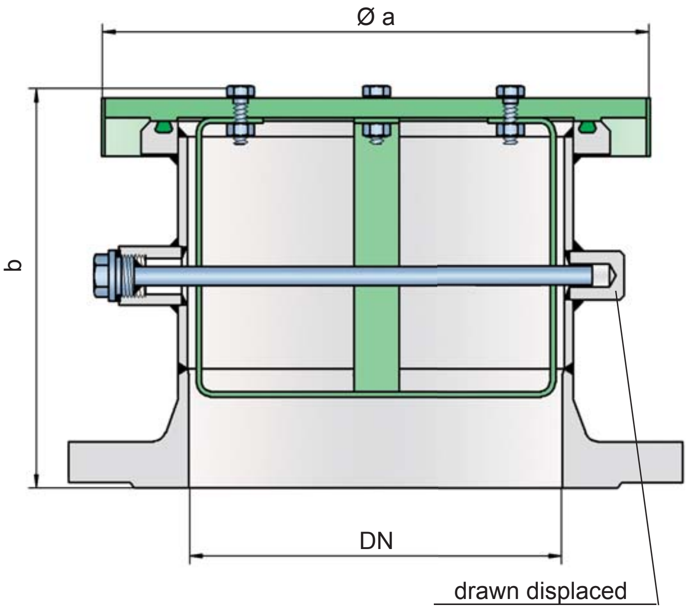
Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".

Emergency pressure relief valve

PROTEGO® ER/V



Pressure settings:

DN 200 to DN 350:	+5 mbar	up to	+40 mbar
	+2 In W.C.	up to	+16 In W.C.
DN 400 to DN 700:	+5 mbar	up to	+25 mbar
	+2 In W.C.	up to	+10 In W.C

For higher pressure settings, see types ER/VH and ER/V-F.

Function and Description

The ER/V type PROTEGO® valve is a highly developed emergency pressure relief valve with high flow capacity. It is primarily used as a safety device for emergency pressure relief for storage tanks, containers, silos, and process engineering equipment; it offers reliable protection against overpressure and prevents impermissible product vapor loss close to the set pressure. It is designed to relief particularly large amounts to prevent the vessel from rupturing in an emergency case.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of stainless steel with an inserted O-ring seal, a precisely lapped valve pallet, as well as a reinforced housing design. After the excess pressure is relieved, the valve reseats and provides a tight seal again.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- excellent tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to explosion hazards
- reinforced design
- safely secured housing cover
- best technology for API-tanks

Design Types and Specifications

The valve pallet is weight-loaded. Higher pressures are achieved with levers (see ER/VH) or with spring-loading (see ER/V-F).

Pressure valve in basic design **ER/V**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

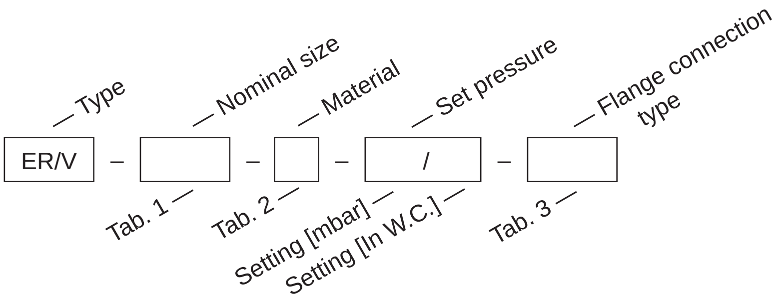
To select the nominal size (DN), use the flow capacity chart on the following page

DN	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"	450 / 18"	500 / 20"	600 / 24"	700 / 28"
a	305 / 12.01	375 / 14.76	425 / 16.73	445 / 17.52	495 / 19.49	545 / 21.46	615 / 24.21	715 / 28.15	795 / 31.30
b	depending on pressure setting								

Table 2: Material selection

Design	A	B	C	D	
Housing	Steel	Steel	Stainless Steel	Stainless Steel	* depending on pressure setting
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	
Valve pallet	Aluminium*	Steel-Stainless Steel*	Aluminium*	Stainless Steel*	Special Materials upon reqest
Sealing	FPM	FPM	FPM	FPM	

Table 3: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

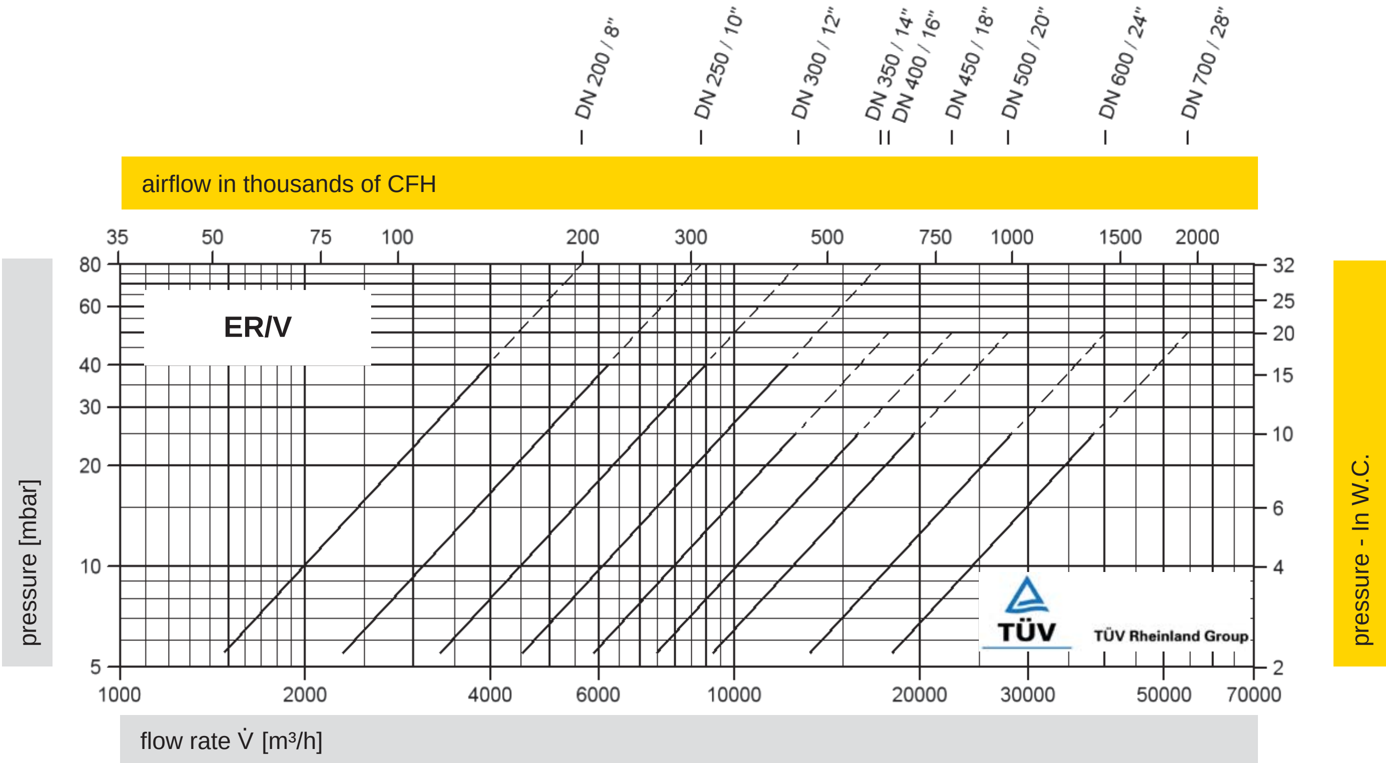


Order example

ER/V	–	500	–	C	–	20/ -	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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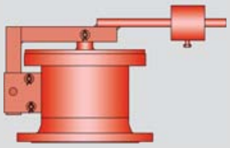
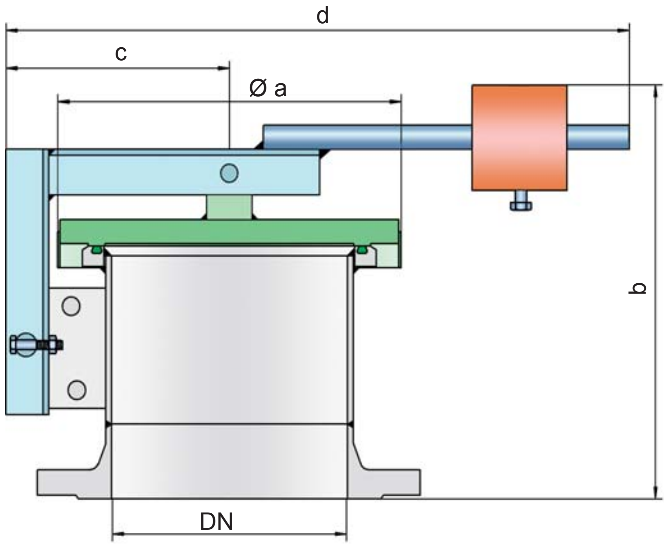


Pressure Relief Valve

PROTEGO® ER/VH



Pressure settings:

DN 200 to DN 350: >+40 mbar up to +60 mbar
>+16 In W.C. up to +24 In W.C.
DN 400 to DN 700: >+25 mbar up to +60 mbar
>+10 In W.C. up to +24 In W.C.
Higher and lower pressure settings, upon request.

Function and Description

The ER/VH type PROTEGO® valve is a highly developed emergency pressure relief valve with high flow capacity. It is primarily used as a safety device for emergency pressure relief for storage tanks, containers, silos, and process engineering equipment; it offers reliable protection against overpressure and prevents impermissible product vapor loss close to the set pressure. It is designed to discharge particularly large amounts to prevent the vessel from rupturing in an emergency case. Higher set pressures are achieved by a lever with lockable weight loading. The position of the weight is factory-marked. Starting at DN 500, the devices can also be used as manhole covers.

When the set pressure is reached, the valve starts to open and is fully open within 10% overpressure. This unique 10% "full lift type technology" enables a pressure setting that is only 10% below the maximum allowable working pressure or design pressure of the tank. Even in the low pressure range the vent has the opening characteristic comparable to a typical high pressure safety relief valve. The full lift type pallets are a result of many years of development. The valve pallet is mounted on one side.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of stainless steel with an inserted O-ring seal, a precisely lapped valve pallet, as well as a reinforced housing design. After the excess pressure is discharged, the valve reseats and provides a tight seal again.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- excellent tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- can be used in areas subject to explosion hazards
- reinforced housing design
- safely secured housing cover
- best technology for API-tanks

Design Types and Specifications

The valve pallet is weight-loaded. Lower pressures are generally achieved without a lever design (see ER/V), and higher pressures are realized with spring-loading (see ER/V-F).

Pressure valve in basic design **ER/VH**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

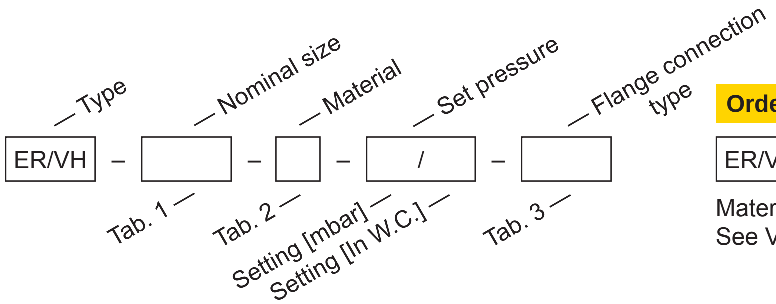
DN	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"	450 / 18"	500 / 20"	600 / 24"	700 / 28"
a	305 / 12.01	375 / 14.76	425 / 16.73	445 / 17.52	495 / 19.49	545 / 21.46	615 / 24.21	715 / 28.15	795 / 31.30
b	350 / 13.78	365 / 14.37	385 / 15.16	390 / 15.35	390 / 15.35	415 / 16.34	420 / 16.53	450 / 17.72	465 / 18.31
c	200 / 7.87	240 / 9.45	265 / 10.43	285 / 11.22	310 / 12.20	330 / 12.99	360 / 14.17	410 / 16.14	450 / 17.72
d	590 / 23.23	735 / 28.94	780 / 30.71	845 / 33.27	890 / 35.04	1070 / 42.13	1090 / 42.91	1140 / 44.88	1380 / 54.33

Table 2: Material selection		
Design	A	B
Housing	Steel	Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Valve pallet	Stainless Steel or Steel-Stainless Steel	Stainless Steel
Sealing	FPM	FPM
Weight	Steel	Stainless Steel

Special materials upon request

Table 3: Flange connection type	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

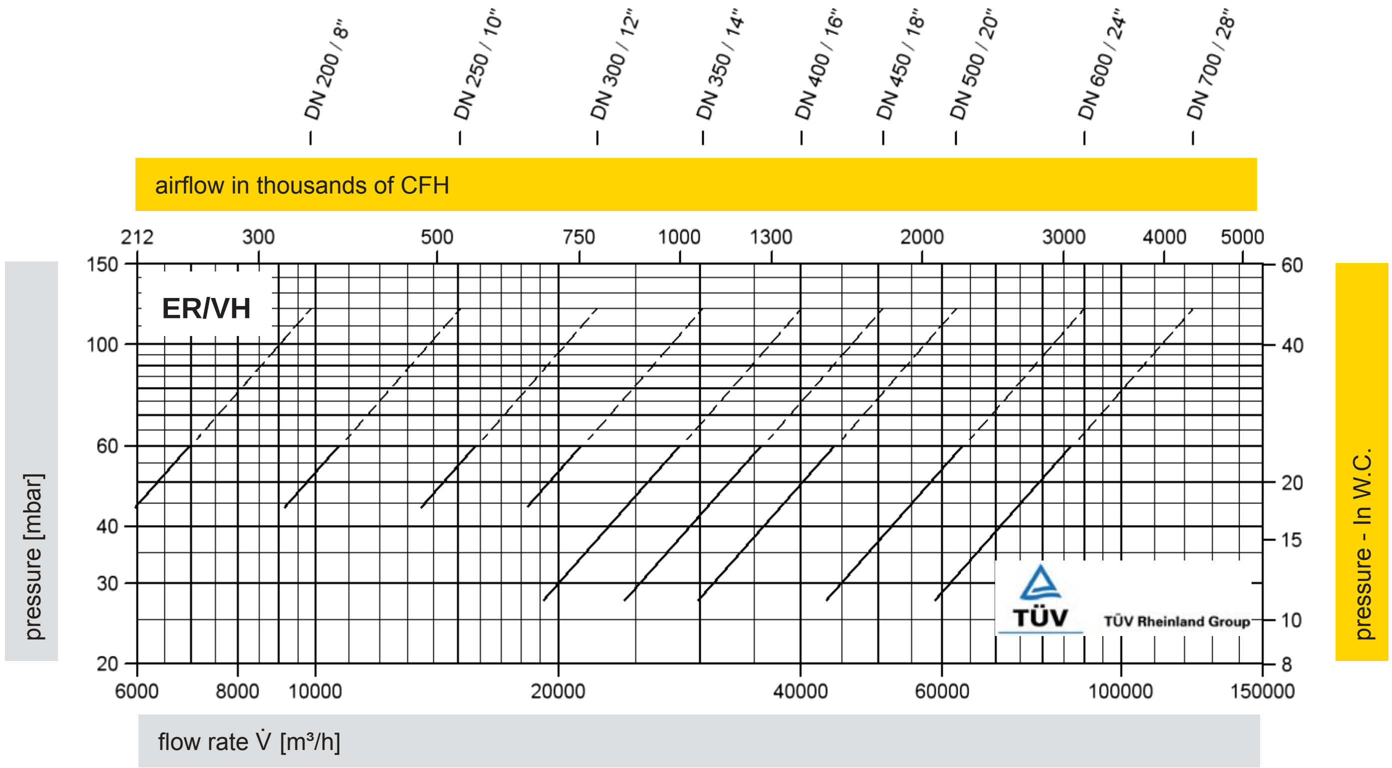


Order example

ER/VH	–	500	–	B	–	50 / -	–	DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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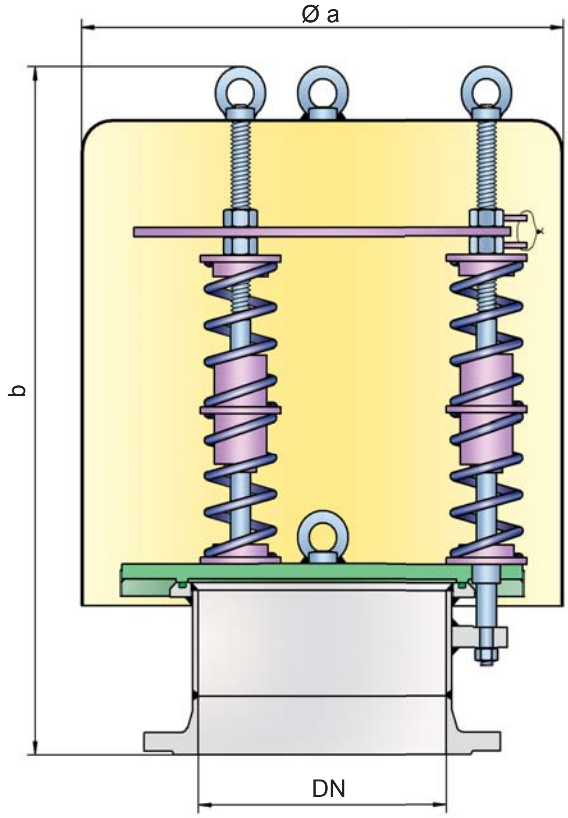
Pressure Relief Valve

PROTEGO® ER/V-F



Pressure settings:

>+60 mbar up to +500 mbar
>+24 In W.C. up to +200 In W.C.
Higher pressure settings, upon request.
Lower pressure settings, see types ER/V and ER/VH.

Function and Description

The ER/V-F type PROTEGO® valve is a highly developed emergency pressure relief valve with high flow capacity. It is primarily used as a safety device for emergency pressure relief for storage tanks, containers, silos, and process engineering equipment; it offers reliable protection against overpressure and prevents impermissible product vapor loss close to the set pressure. It is designed to discharge particularly large amounts to prevent the vessel from rupturing in a emergency case. The spring-loading allows for higher set pressures than those with the ER/V or ER/VH.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high-grade steel with an inserted O-ring seal, a precisely lapped valve pallet, as well as a reinforced housing design. After the excess pressure is relieved, the valve reseats and provides a tight seal again.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- excellent tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to explosion hazards
- reinforced housing design
- spring-loading for high set pressures
- best technology for API-tanks

Design Types and Specifications

The valve pallet is spring-loaded. Lower pressures are achieved with the ER/V and ER/VH designs.

Pressure valve in basic design **ER/V-F**

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN	200 / 8"	250 / 10"	300 / 12"	350 / 14"	400 / 16"	450 / 18"	500 / 20"	600 / 24"	700 / 28"
a	465 / 18.31	550 / 21.65	650 / 25.59	650 / 25.59	800 / 31.50	800 / 31.50	1000 / 39.37	1000 / 39.37	1200 / 47.24
b	860 / 33.86 (≤370 mbar ≤148 InW.C.)	860 / 33.86 (≤240 mbar ≤96 InW.C.)	1170 / 46.06 (≤240 mbar ≤96 InW.C.)	1170 / 46.06 (≤270 mbar ≤108 InW.C.)	1150 / 45.28 (≤220 mbar ≤88 InW.C.)	1175 / 46.26 (≤170 mbar ≤68 InW.C.)	1430 / 56.30 (≤130 mbar ≤52 InW.C.)	1425 / 56.10 (≤140 mbar ≤56 InW.C.)	1690 / 66.54 (≤140 mbar ≤56 InW.C.)
b	980 / 38.58 (>370 mbar >148 InW.C.)	980 / 38.58 (>240 mbar >96 InW.C.)	1490 / 58.66 (>240 mbar >96 InW.C.)	1490 / 58.66 (>270 mbar ≤108 InW.C.)	1490 / 58.66 (>220 mbar ≤88 InW.C.)	1515 / 59.65 (>170 mbar >68 inW.C.)	1660 / 65.35 (>130 mbar >52 InW.C.)	1655 / 65.16 (>140 mbar >56 InW.C.)	1910 / 75.20 (>140 mbar >56 InW.C.)

Table 2: Material selection

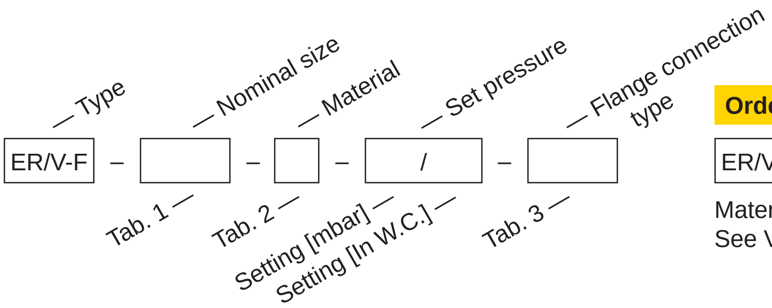
Design	A	B
Housing	Steel	Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Valve pallet	Stainless Steel or Steel-Stainless Steel	Stainless Steel
Sealing	FPM	FPM
Pressure spring	Stainless Steel	Stainless Steel
Weather hood	Steel	Stainless Steel

Special materials upon request

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

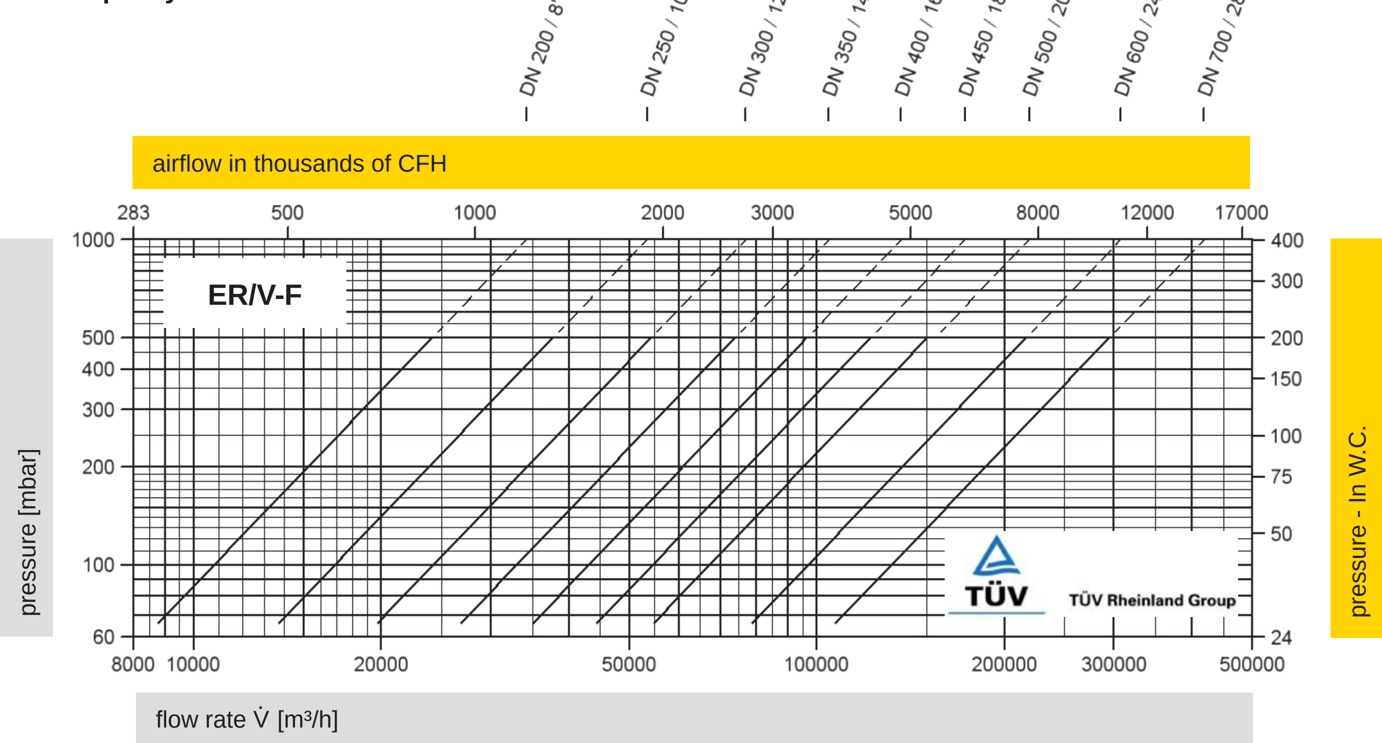


Order example

ER/V-F	–	500	–	B	–	300/ -	–	DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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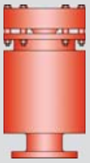
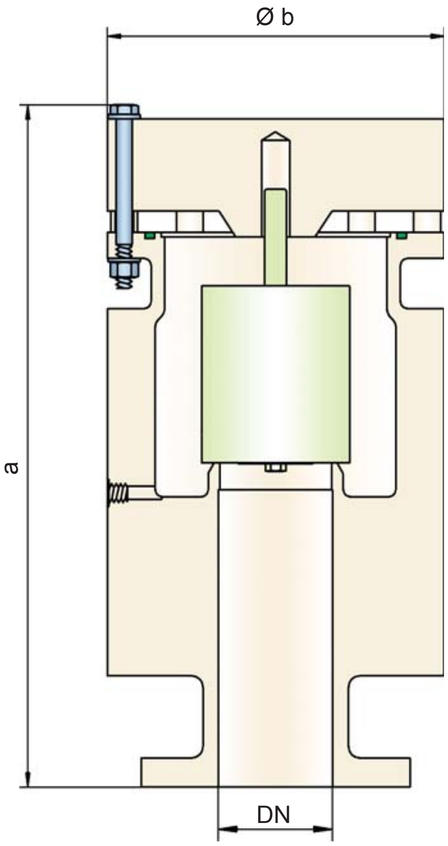


Pressure Relief Valve

made of plastic

PROTEGO® D/KSM



Due to our highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is facilitated by special valve seats made of high quality synthetic material or PTFE. After the excess pressure is discharged, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Pressure settings:

+5 mbar up to +100 mbar (DN 80/3" - DN 200/8")
+2 In W.C. up to +40 In W.C.

+6 mbar up to +100 mbar (DN 50/2")
+2.4 In W.C. up to +40 In W.C.

Higher pressure settings upon request.

Function and Description

The PROTEGO® valve D/KSM is a state-of-the-art pressure relief valve with excellent flow performance made out of highgrade synthetic material. It is primarily used as a safety fitting for relieving pressure in tanks, containers, and process engineering equipment. The valve prevents emission losses almost up to the set pressure. The valve is a perfect solution for corrosive, polymerizing or sticky media.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure (MAWP) of the tank and still safely vent the required mass flow.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- the valve pallet is guided within the housing to protect against harsh weather conditions
- corrosion resistant valve
- perfect solution for corrosive, polymerizing and sticky media
- weight reduction in comparsion to steel/stainless steel
- smooth surface
- condensate drain
- different plastics can be combined
- maintenance friendly design

Design Types and Specifications

The valve pallet is weight-loaded, and the highest pressure levels are only attained with metal disks.

Pressure valve in basic design **D/KSM-**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN) use the flow capacity charts on the following pages

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	376 / 14.80	521 / 20.51	563 / 22.17 (543 / 21.38)*	687 / 27.05 (681 / 26.81)*	952 / 37.48
b	180 / 7.09	250 / 9.84	300 / 11.81	350 / 13.78 (405 / 15.94)*	560 / 22.05 (500 / 19.68)*

* Dimensions in brackets only for PVDF

Tabelle 2: Material selection for housing

Design	A	B	C	
Housing	PE	PP	PVDF	
Valve seats	PE	PP	PVDF	Special materials upon request
Sealing	FPM	FPM	FPM	
Valve pallet	A, C, D	B, C, D	C, D	

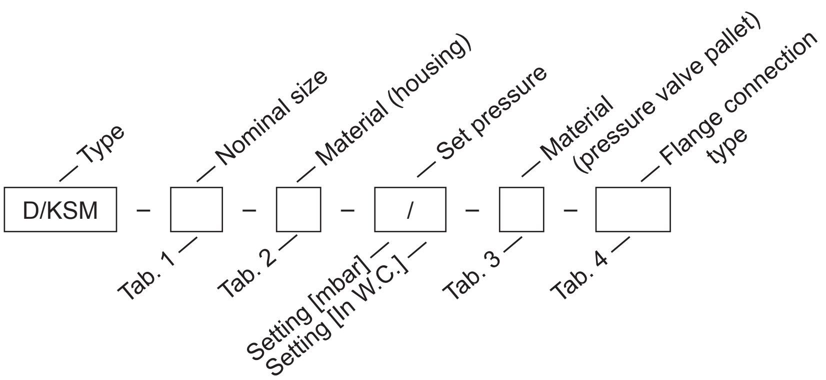
Table 3: Material selection for pressure valve pallet

Design	A	B	C	D
Pressure range [mbar] [In W.C.]	+5.0 up to +17 +2.0 up to +6.8	+5.0 up to +17 +2.0 up to +6.8	+10 up to +32 +4.0 up to +12.8	+30 up to +100 +12 up to +40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weights	PE	PP	PVDF	Hastelloy

Special materials and other pressure settings are available upon request

Table 4: Flange connection type

EN 1092-1, Form A or DIN 2501, Form B, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

D/KSM	200	A	25 / -	C	DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

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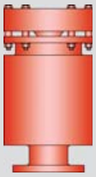
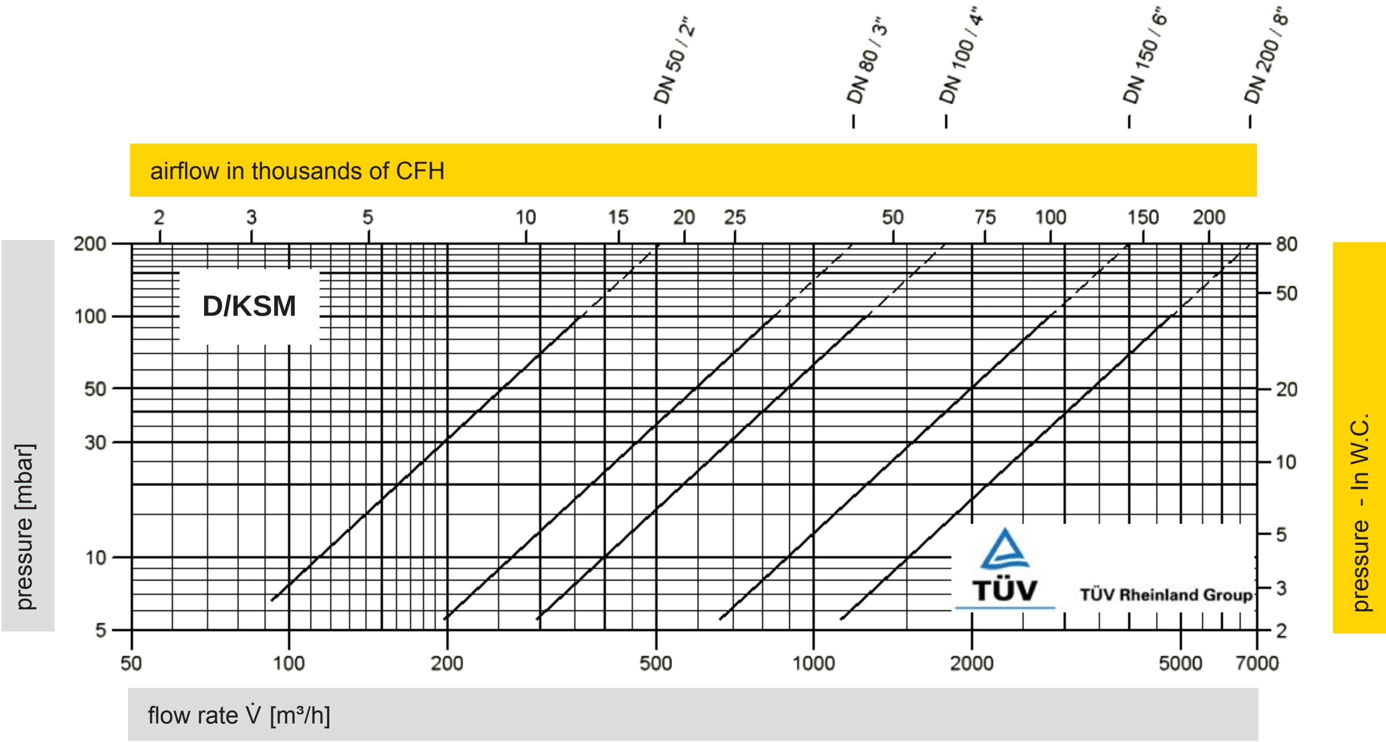


Pressure Relief Valve

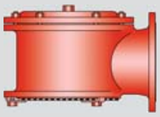
Flow Capacity Chart

PROTEGO® D/KSM



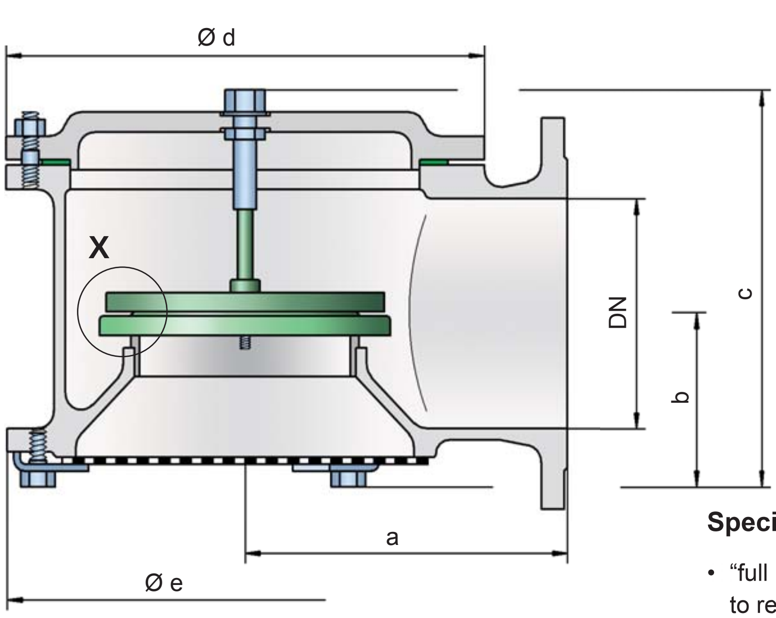
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

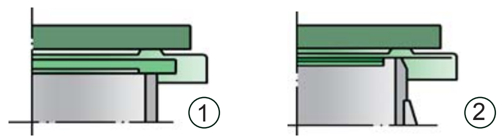


Vacuum Relief Valve

PROTEGO® SV/E-1-0



Detail **X**



Vacuum settings:
-2.0 mbar up to -60 mbar
-0.8 In W.C. up to -24 In W.C.
Higher vacuum settings upon request.

Function and Description

The SV/E-1-0 type PROTEGO® valve is a highly developed vacuum relief valve with excellent flow performance. It is primarily used as a safety device for relieving vacuum in tanks, containers and process engineering equipment. The valve offers reliable protection against vacuum, and prevents inbreathing of air close to the set pressure.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure of the tank and still safely vent the required mass flow.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used, and they enable the use of corrosive media. After the vacuum is relieved, the valve reseats and provides a tight seal again.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to an explosion hazard
- self-actuated condensate drain
- best technology for API-tanks

Design Types and Specifications

The valve pallet is weight-loaded. Higher vacuum can be achieved upon request with a special spring-loaded design.

There are two different designs:

Vacuum valve in basic design **SV/E-1-0 - –**

Vacuum valve with heating jacket **SV/E-1-0 - H**

Additional special devices available upon request.

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN) use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	140 / 5.51	170 / 6.69	190 / 7.48	230 / 9.06	300 / 11.81	325 / 12.80	425 / 16.73
b	75 / 2.95	85 / 3.35	95 / 3.74	120 / 4.72	140 / 5.51	165 / 6.50	205 / 8.07
c	205 / 8.07	205 / 8.07	285 / 11.22	355 / 13.98	405 / 15.94	460 / 18.11	500 / 19.69
d	170 / 6.69	235 / 9.25	280 / 11.02	335 /13.19	445 / 17.52	505 / 19.88	505 / 19.88
e	215 / 8.46	215 / 8.46	255 / 10.04	335 / 13.19	425 / 16.73	460 / 18.11	625 / 24.61

Dimensions for vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	C	D	The housings is also available with an ECTFE-Coating
Housing Heating jacket (SV/E-1-0-H-...)	Ductail Iron –	Steel Steel	Stainless Steel Stainless Steel	Aluminium –	
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Special materials upon request
Sealing	WS 3822	WS 3822	PTFE	WS 3822	

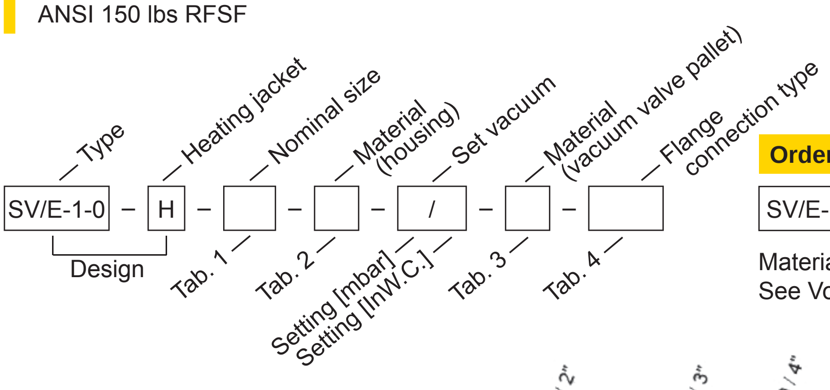
Table 3: Material selection for vacuum valve pallet

Design	A	B	C	D	E	F
vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to 5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special materials (Alu-coated, Titanium, Hastelloy) and higher vacuum settings are available upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

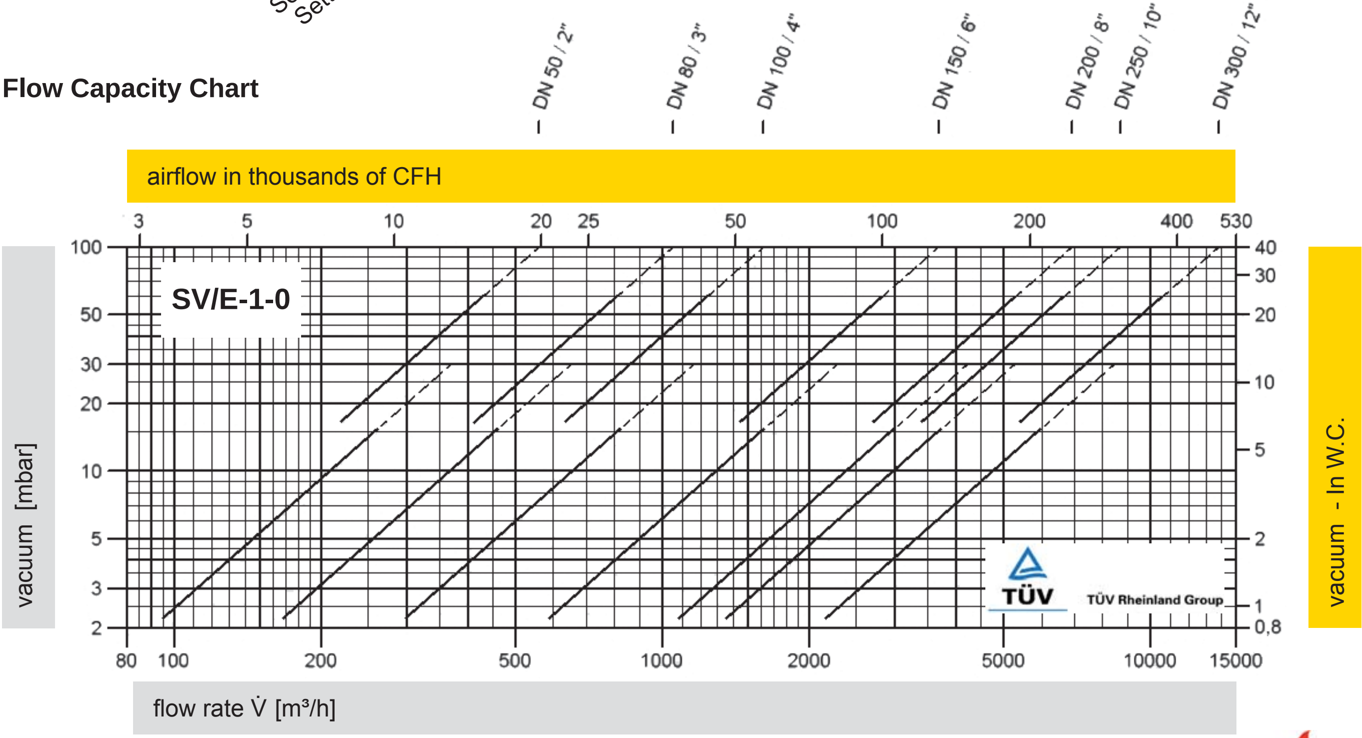


Order Exmaple

SV/E-1-0 – H – 200 – B – -5.0 / - – B – DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

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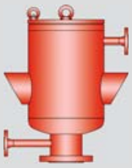
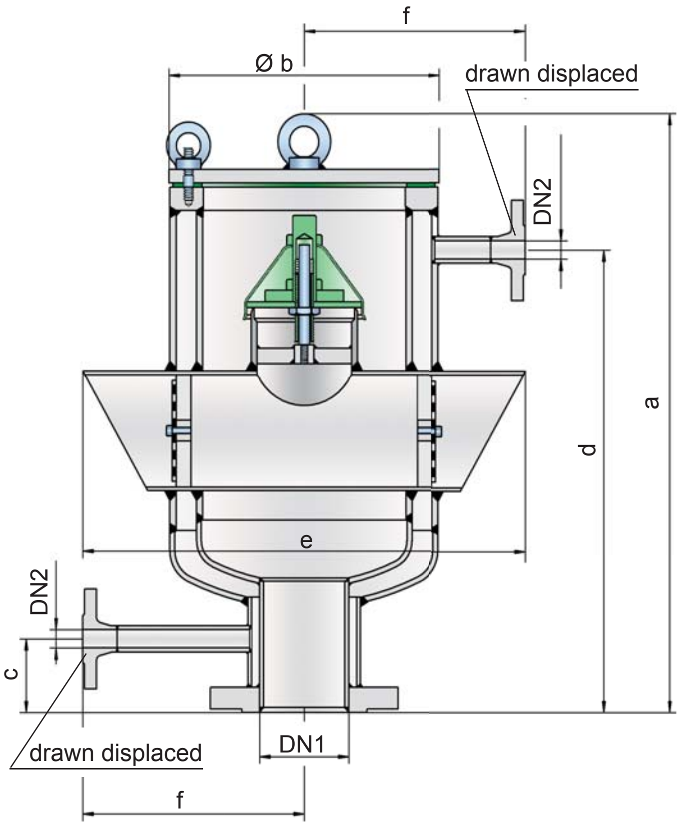


Vacuum Relief Valve

in a special heat jacketed design

PROTEGO® SV/T-0-H



Vacuum settings:
-7 mbar up to -50 mbar
-2.8 In W.C. up to -20 In W.C.
Higher and lower vacuum settings upon request.

Function and Description

The SV/T-0-H type PROTEGO® valve is a highly developed vacuum relief valve with a valve housing that comes with a heating jacket down to the flange. It is primarily used as a safety device for inbreathing to tanks, containers, and process engineering equipment under difficult operating conditions. This includes extreme weather conditions or products that tend to form polymers at certain temperatures, adhere, or form deposits that negatively influence function (such as bitumen, tar, dust). The valve offers reliable protection against vacuum and prevents the intake of air close to the set vacuum.

When the set vacuum is reached, the valve starts to open and reaches full lift within a 40% vacuum increase. Up to the set vacuum, the tank vacuum is maintained with a seal that is far superior to the conventional standard due to the highly developed manufacturing technology. This feature is achieved by valve seats made of high quality stainless steel with precisely lapped valve pallets and a reinforced housing design. After the vacuum is relieved, the valve reseats and again provides a tight seal.

Special Features and Advantages

- excellent tightness and hence least possible product losses and reduced environmental pollution
- high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to an explosion hazard
- complete heat jacketed design down to the flange to avoid cold bridges
- maximum permissible heating medium temperature of 320°C / 608°F (at 6 bar / 87 psi)
- a special design that preheats incoming air is also available
- a special design with a heatable valve cover is also available
- the valve pallet cover prevents the set pressure from being distorted by dust or condensate
- reinforced housing design
- a special design with a mechanical vent pallet lift device is available

Design Types and Specifications

The valve pallet is weight-loaded.

Vacuum valve in basic design with heating jacket **SV/T - 0 - H**

Additional special devices available upon request.

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN) use the capacity chart on the following page

DN1	80 / 3" *	100 / 4"	150 / 6"	200 / 8"	250 / 10"
DN2	15 / ½"	15 / ½"	15 / ½"	15 / ½"	15 / ½"
a	570 / 22.44	570 / 22.44	720 / 28.35	920 / 36.22	1050 / 41.34
b	275 / 10.83	275 / 10.83	355 / 13.98	405 / 15.94	508 / 20.00
c	70 / 2.76	70 / 2.76	60 / 2.36	70 / 2.76	70 / 2.76
d	440 / 17.32	440 / 17.32	590 / 23.23	790 / 31.10	920 / 36.22
e	450 / 17.72	450 / 17.72	650 / 25.59	750 / 29.53	950 / 37.40
f	225 / 8.86	225 / 8.86	260 / 10.24	300 / 11.91	350 / 13.78

* also available with special flange DN 50 / 2"

Table 2: Material selection for housing

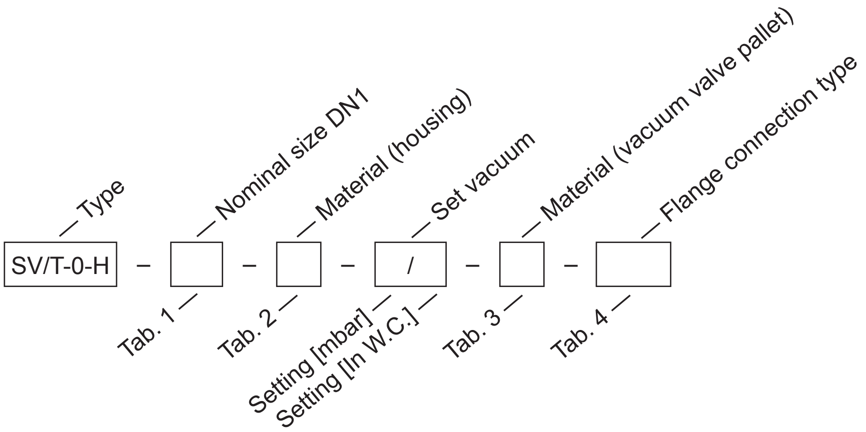
Design	A	B	
Housing Heating jacket	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Sealing	WS 3822	WS 3822	

Table 3: Material selection for vacuum valve pallet

Design	A	B	C	
Vacuum range [mbar] [In W.C.]	-7.0 up to -25 -2.8 up to -10	-10 up to -30 -4.0 up to -12	-30 up to -50 -12 up to -20	Special materials and other vacuum settings are available upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	
Valve pallet hood	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	Metal to Metal	Metal to Metal	Metal to Metal	

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Order example

SV/T-0-H	–	200	–	B	–	-20/ -	–	B	–	DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

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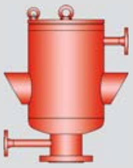
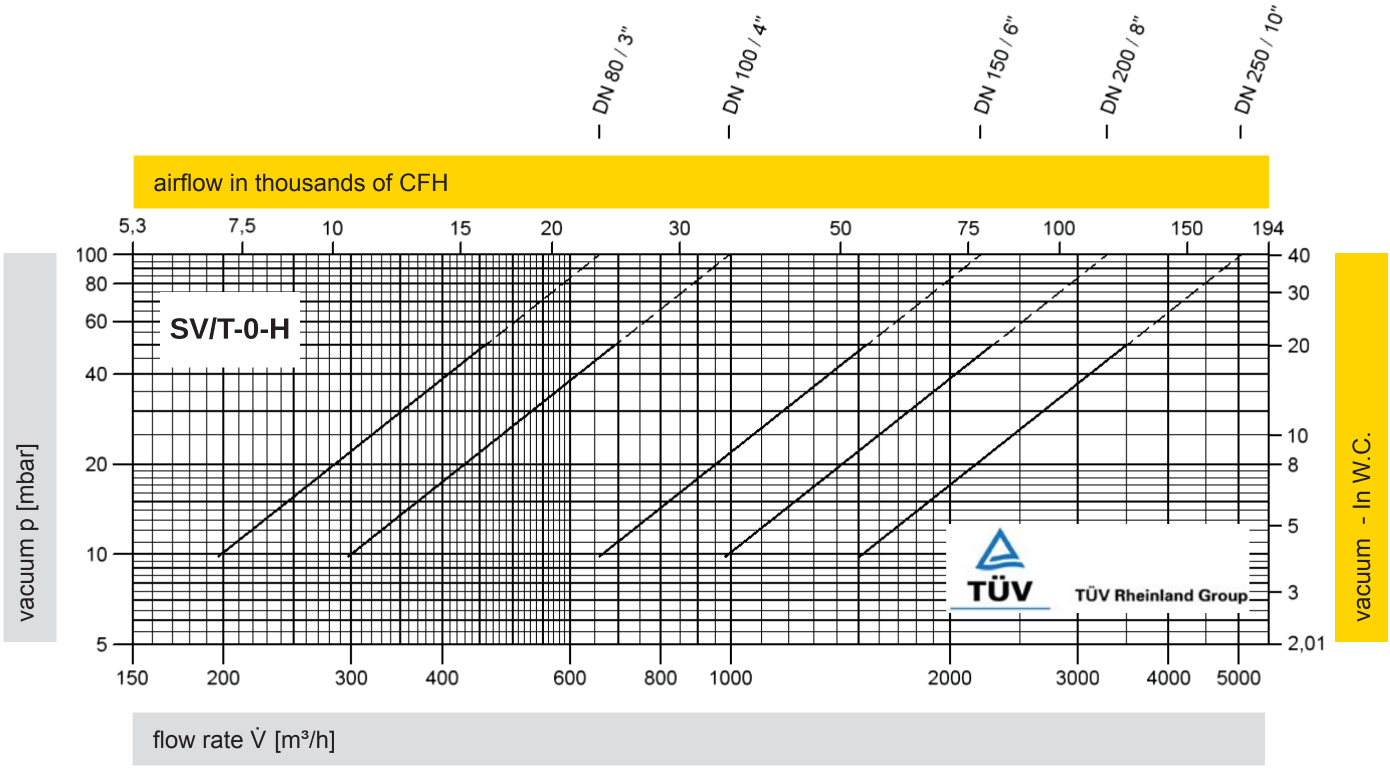


Vacuum Relief Valve

Flow Capacity Chart

PROTEGO® SV/T-0-H



Remark

$$\text{set pressure} = \frac{\text{opening pressure resp. tank design pressure}}{1.4}$$

Set pressure = the valve starts to open

Opening pressure = set pressure plus overpressure

Overpressure = pressure increase over the set pressure

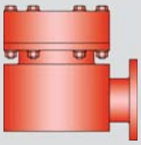
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

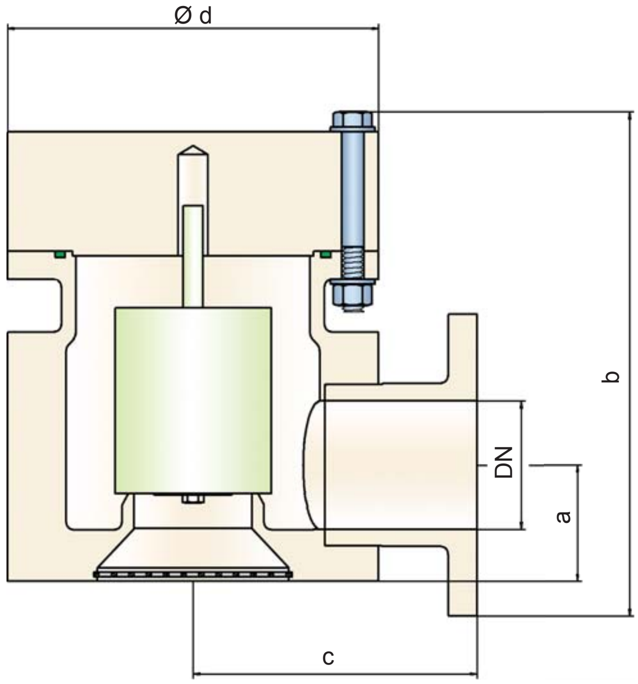
Notes:

Vacuum Relief Valve

made of plastic

PROTEGO® V/KSM





Due to our highly developed manufacturing technology, the tank pressure is maintained up to the set vacuum, with a seal that is far superior to the conventional standard. This feature is achieved by valve seats made of high-performance plastics and a high grade PTFE seal. After the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- the valve pallet is guided within the housing to protect against harsh weather conditions
- corrosion resistant valve
- perfect solution for corrosive, polymerizing and sticky media
- weight reduction in comparsion to steel/stainless steel
- smooth surface
- automatic condensate drain
- different plastics can be combined
- maintenance friendly design

Vacuum settings:

-5 mbar	up to	-100 mbar	(DN 80/3” - DN 200/8”)
-2 In W.C.	up to	-40 In W.C.	
-6 mbar	up to	-100 mbar	(DN 50/2”)
-2.4 In W.C.	up to	-40 In W.C.	

Higher pressure settings upon request.

Function and Description

The PROTEGO® valve V/KSM is a state-of-the-art vacuum relief valve with excellent flow performance made of highgrade synthetic material. It is used as a safety device to relieve vacuum in tanks, containers, and process engineering equipment; it prevents the inbreathing of air until reaching the set vacuum. The valve is a perfect solution for corrosive, polymerizing or sticky media.

The device will start to open as soon as the set vacuum is reached and is fully open within 10% vacuum increase. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working vacuum (MAWV) of the tank and still safely vent the required mass flow.

Design Types and Specifications

The valve pallet is weight-loaded, and the highest pressure levels are only attained with metal discs.

Vacuum valve in basic design **V/KSM-**

Additional special devices available upon request.

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	57 / 2.24	77 / 3.03	87 / 3.43 (115 / 4.53)*	126 / 4.96 (146 / 5.75)*	180 / 7.09 (175 / 6.89)*
b	259 / 10.20	376 / 14.80	373 / 14.69 (338 / 13.31)*	460 / 18.11 (427 / 16.81)*	469 / 18.46 (437 / 17.20)*
c	150 / 5.91	200 / 7.87	225 / 8.86	280 / 11.02	350 / 13.78
d	180 / 7.09	250 / 9.84	300 / 11.81	350 / 13.78 (405 / 15.94)*	560 / 22.05 (500 / 19.68)*

* Dimensions in brackets only for PVDF

Table 2: Material selection for housing

Design	A	B	C	
Housing	PE	PP	PVDF	
Valve seat	PE	PP	PVDF	Special Materials upon request
Sealing	FPM	FPM	FPM	
Valve pallet	A, C, D	B, C, D	C, D	

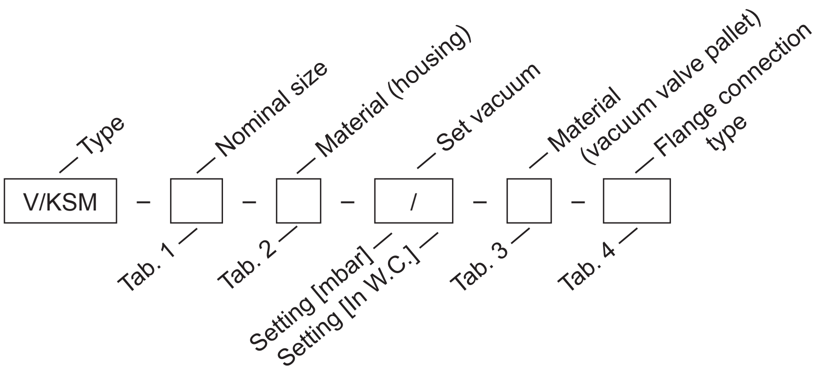
Table 3: Material selection for vacuum valve pallet

Design	A	B	C	D
Vacuum range [mbar] [In W.C.]	-5.0 up to -17 -2.0 up to -6.8	-5.0 up to -17 -2.0 up to -6.8	-10 up to -32 -4.0 up to -12.8	-30 up to -100 -12 up to -40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weight	PE	PP	PVDF	Hastelloy

Special materials and other vacuum settings are available upon request

Table 4: Flange connection type

EN 1092-1, Form A or DIN 2501, Form B, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

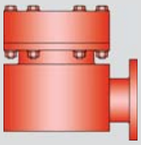


Order example

V/KSM	–	200	–	A	–	-8.0 / -	–	A	–	DIN

Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

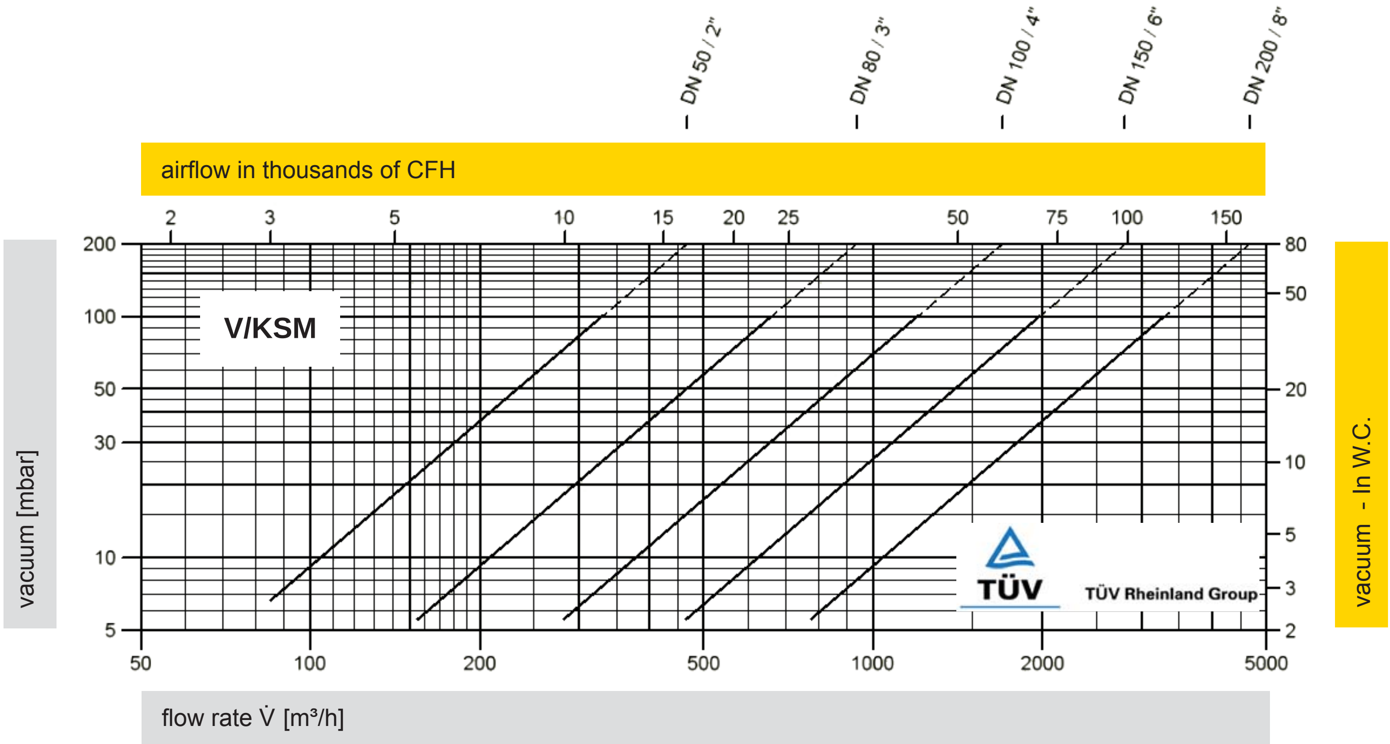
for safety and environment



Vacuum Relief Valve

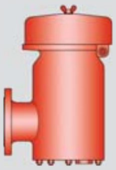
Flow Capacity Chart

PROTEGO® V/KSM



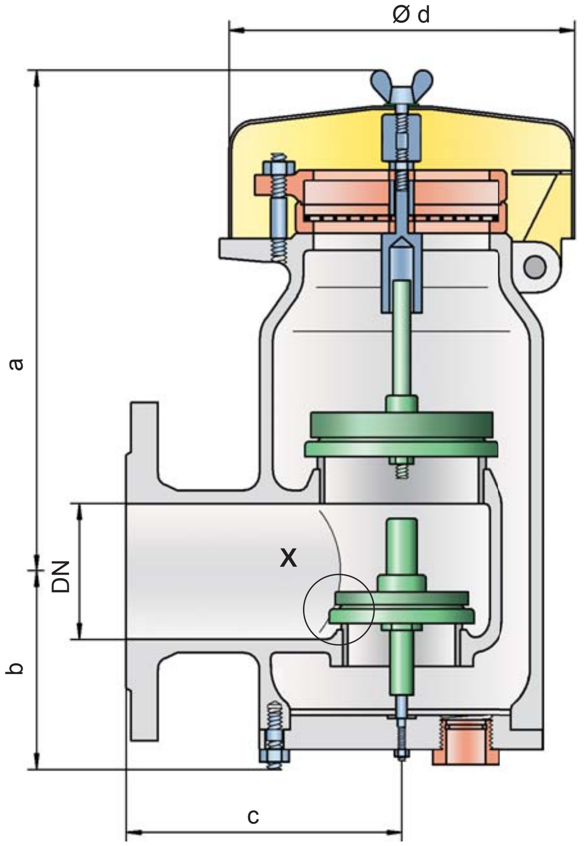
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:



Pressure and Vacuum Relief Valve

PROTEGO® PV/EL



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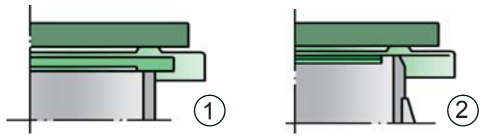


Settings:

Pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 In W.C.	up to	+84 In W.C.
Vacuum:	-14 mbar	up to	-35 mbar
	-5.6 In W.C.	up to	-14 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.
Higher and lower settings upon request.

Function and Description

The PV/EL type PROTEGO® valve is a highly developed combined pressure and vacuum relief valve. It is primarily used as a safety device for relieving pressure and vacuum in tanks, containers and process engineering equipment. The valve offers reliable protection against overpressure and excessive vacuum. It prevents also the impermissible loss of product vapors close to the set pressure as well as the intake of air on the vacuum side close to set vacuum.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for presssure and vacuum relief.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallet from sticking when sticky products are used, and they enable the use of corrosive media. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against freezing in cold weather
- can be used in areas subject to an explosion hazard
- self-actuated condensate drain
- special design with lifting gear can be purchased

Design Types and Specifications

The valve pallets are weight-loaded. At set pressures greate than 60 mbar (24.1 In W.C.), an elongated construction is used.

There are two different designs

Pressure/vacuum relief valve in basic design	**PV/EL -** $\boxed{-}$
Pressure/vacuum relief valve with heating jacket	**PV/EL -** $\boxed{H}$

Additional special devices available upon request.
Any combination of vacuum and pressure levels can be set for the valve. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve pallets are used.

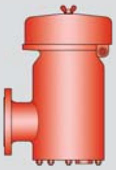
Table 1: Dimensions					Dimensions in mm / inches
To select the nominal size (DN), please use the flow capacity charts on the following pages					
DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"	Dimensions for pressure/ vacuum relief valve with heating jacket upon request
Set pressure	≤ +60 mbar ≤ +24.1 in W.C.	> +60 mbar > +24.1 in W.C.	≤ +60 mbar ≤ +24.1 in W.C.	> +60 mbar > +24.1 in W.C.	
a	308 / 12.13	443 / 17.44	308 / 12.13	443 / 17.44	
b	108 / 4.25	108 / 4.25	108 / 4.25	108 / 4.25	
c	165 / 6.50	165 / 6.50	167 / 6.57	167 / 6.57	
d	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	

Table 2: Material selection for housing			
Design	B	C	Special materials upon request
Housing Heating jacket (PV/EL-H-...)	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	
Protective mesh screen	Stainless Steel	Stainless Steel	

Table 3: Material selection for pressure valve pallet					
Design	A	B	C	D	Special material as well as higher set pressure upon request
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

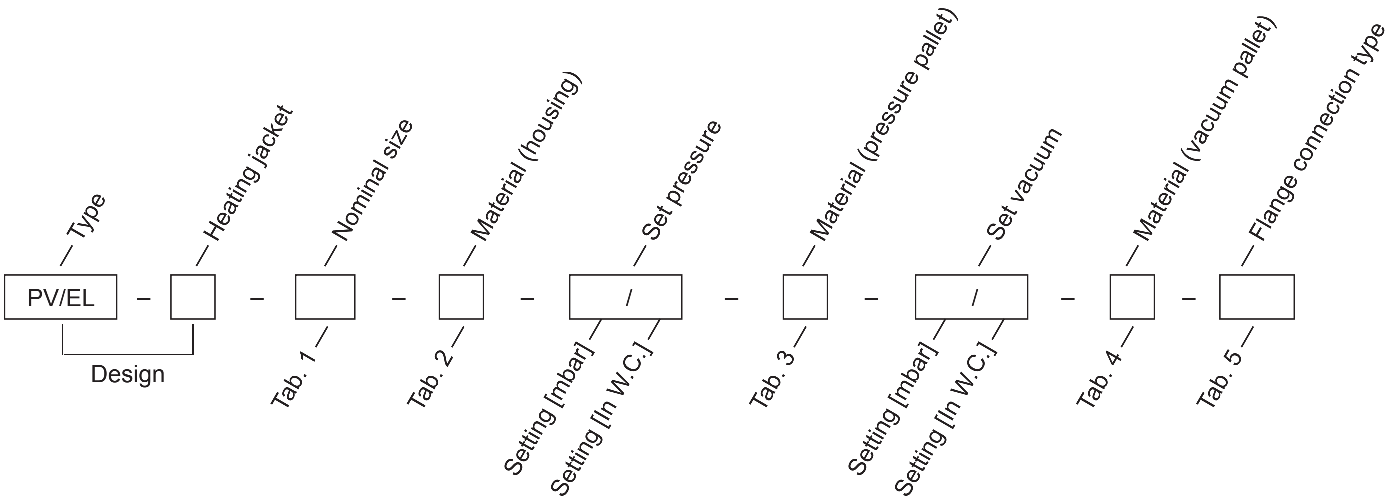
Table 4: Material selection for vacuum valve pallet					
Design	A	B	C	D	Special material as well as higher set vacuum upon request
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Pressure and Vacuum Relief Valve

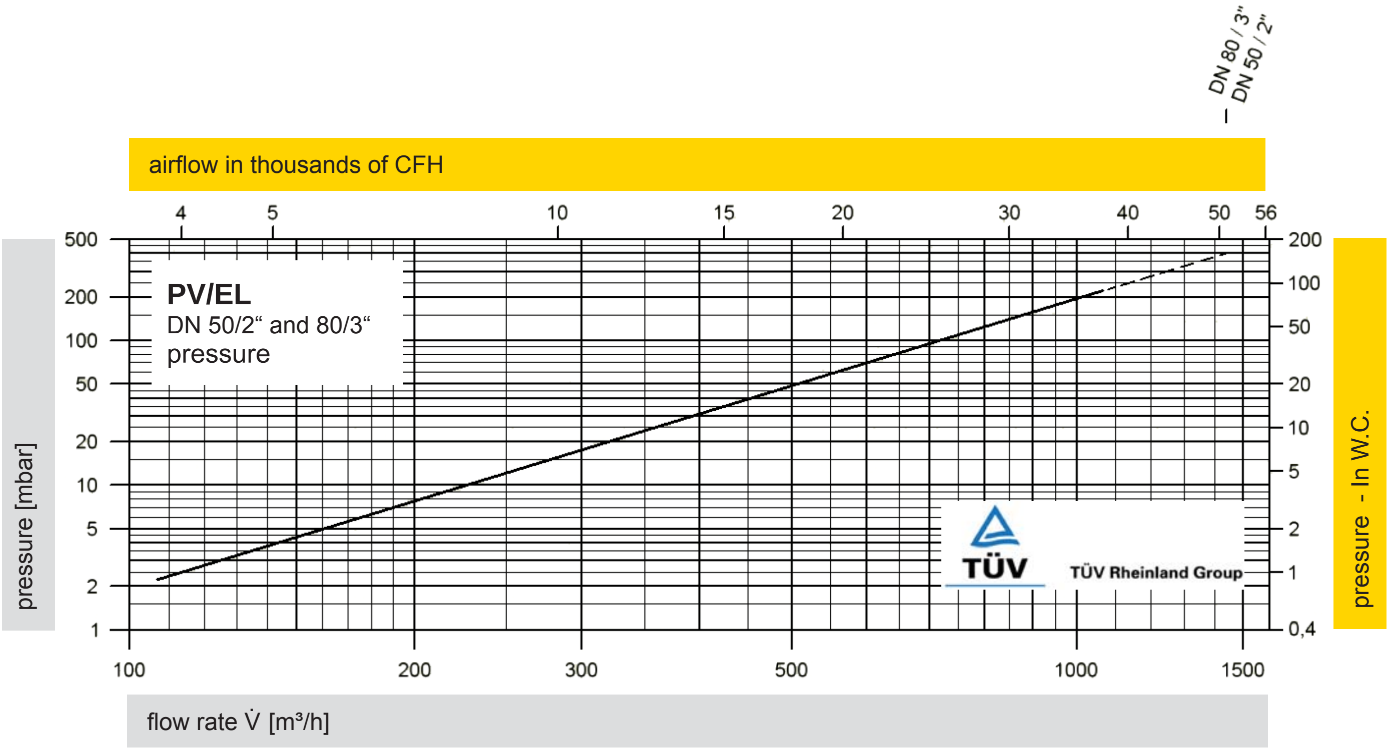
PROTEGO® PV/EL

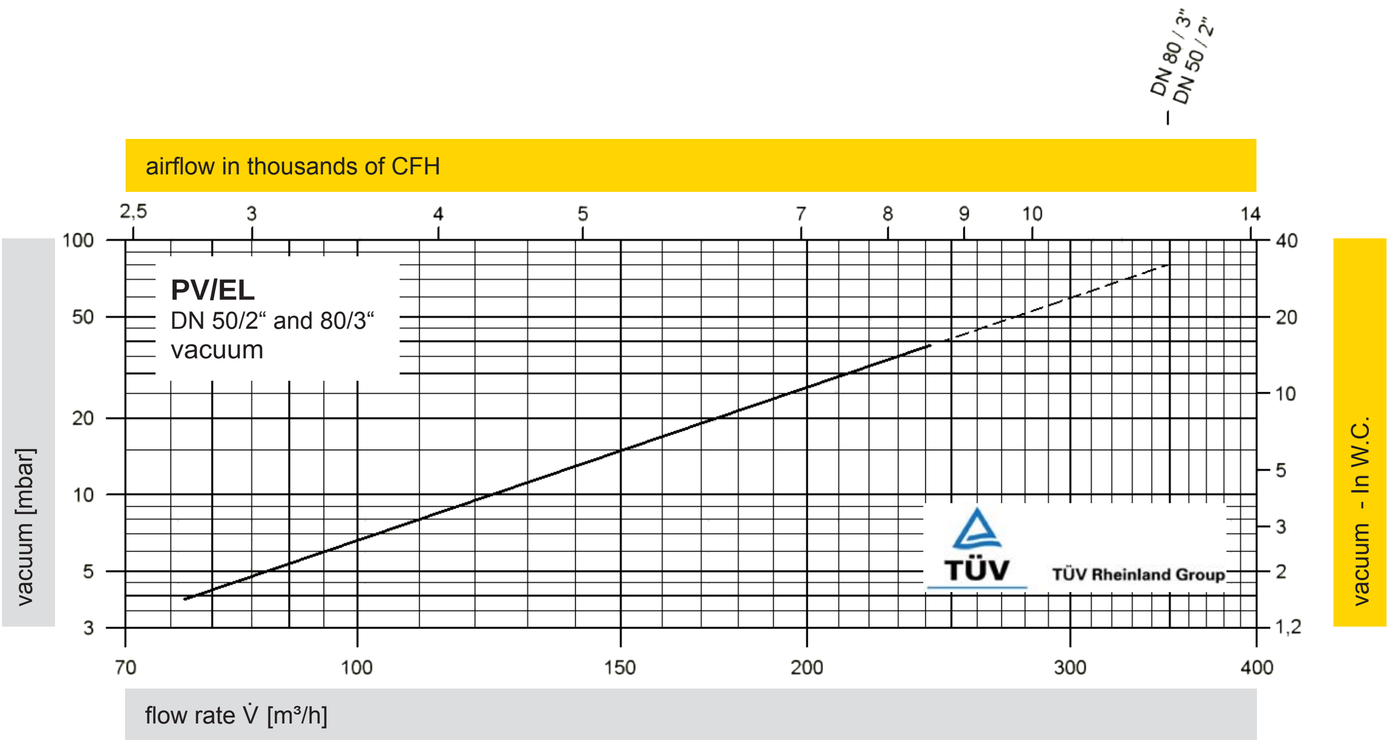


Order example

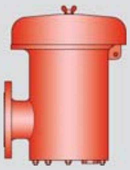
PV/EL	–	H	–	50	–	B	–	50 / –	–	D	–	-10 / –	–	B	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



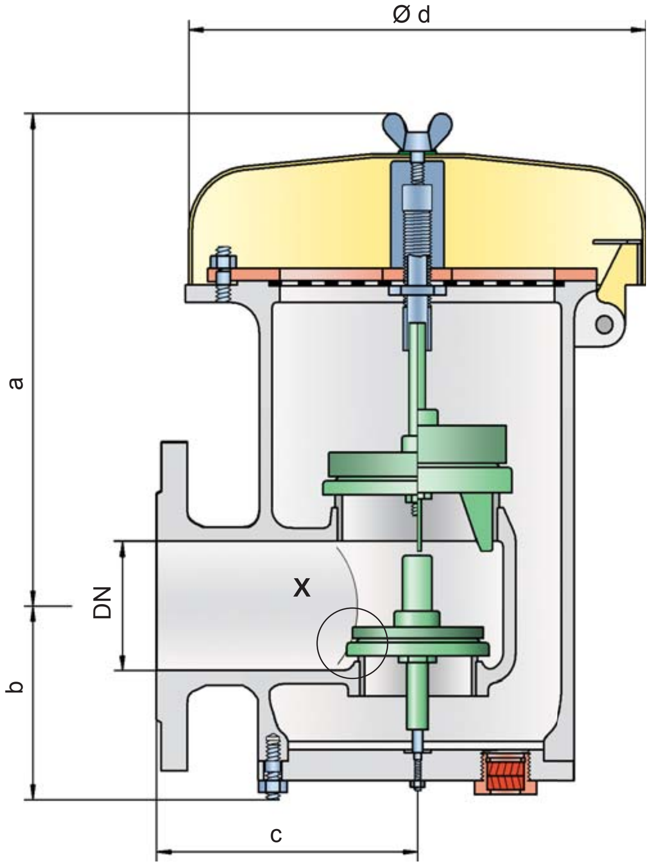


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



Pressure and Vacuum Relief Valve

PROTEGO® PV/ELR



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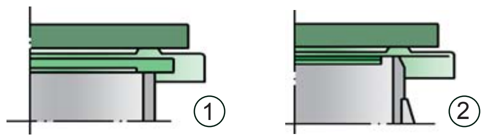


Settings:

Pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 In W.C.	up to	+84 In W.C.
Vacuum:	-14 mbar	up to	-50 mbar
	-5.6 In W.C.	up to	-20 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.
Higher and lower settings upon request

Function and Description

The PV/ELR type PROTEGO® valve is a highly developed combined pressure and vacuum relief valve with excellent flow performance. Typically the valve is installed in the in- and outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for presssure and vacuum relief.

Due to the highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallet from sticking when sticky products are used, and they enable the use of corrosive media. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- high flow capacity
- the valve pallet is guided within the housing to protect against freezing in cold weather
- can be installed in explosion hazardous areas
- self-actuated condensate drain
- compact design saves space
- special design with lifting gear can be purchased
- maintenance friendly design

Design Types and Specifications

The valve pallets are weight-loaded. At set pressures greate than 35 mbar (14 In W.C.), an elongated construction is used.

There are two different designs:

Pressure/vacuum relief valve in basic design	**PV/ELR -** –
Pressure/vacuum relief valve with heating jacket	**PV/ELR -** **H**

Additional special devices available upon request.

Any combination of vacuum and pressure levels can be set for the valve. When the difference between the pressure and vacuum exceeds 150 mbar/60.2 In W.C., special valve pallets are used.

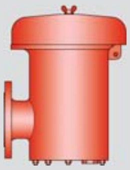
Table 1: Dimensions					Dimensions in mm / inches
To select the nominal size (DN), please use the flow capacity charts on the following pages					
DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"	Dimensions for pressure/ vacuum relief valve with heating jacket upon request
Set pressure	≤ +35 mbar ≤ +14 in W.C.	> +35 mbar > +14 in W.C.	≤ +35 mbar ≤ +14 in W.C.	> +35 mbar > +14 in W.C.	
a	345 / 13.58	475 / 18.70	345 / 13.58	475 / 18.70	
b	141 / 5.55	141 / 5.55	141 / 5.55	141 / 5.55	
c	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	
d	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90	

Table 2: Material selection for housing			
Design	B	C	Special materials upon request
Housing Heating jacket (PV/ELR-H-...)	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	
Protective mesh screen	Stainless Steel	Stainless Steel	

Table 3: Material selection for pressure valve pallet					
Design	A	B	C	D	Special material as well as higher set pressure upon request
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

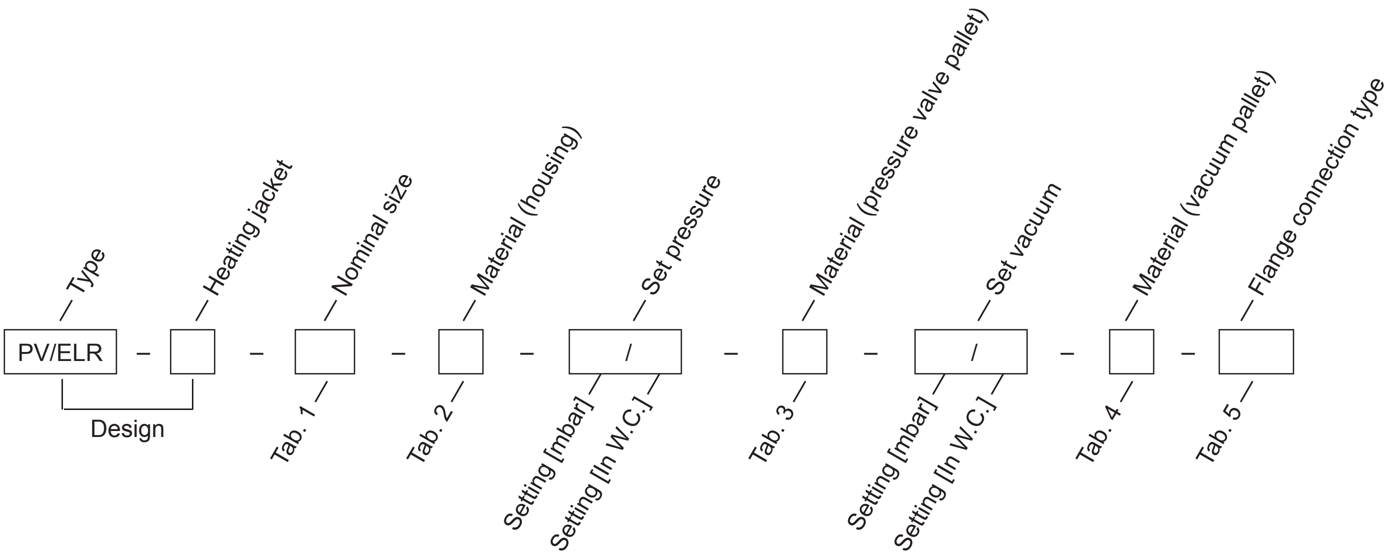
Table 4: Material selection for vacuum valve pallet					
Design	A	B	C	D	Special material as well as higher set vacuum upon request
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -50 <-5.6 up to -20	<-14 up to -50 <-5.6 up to -20	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Pressure and Vacuum Relief Valve

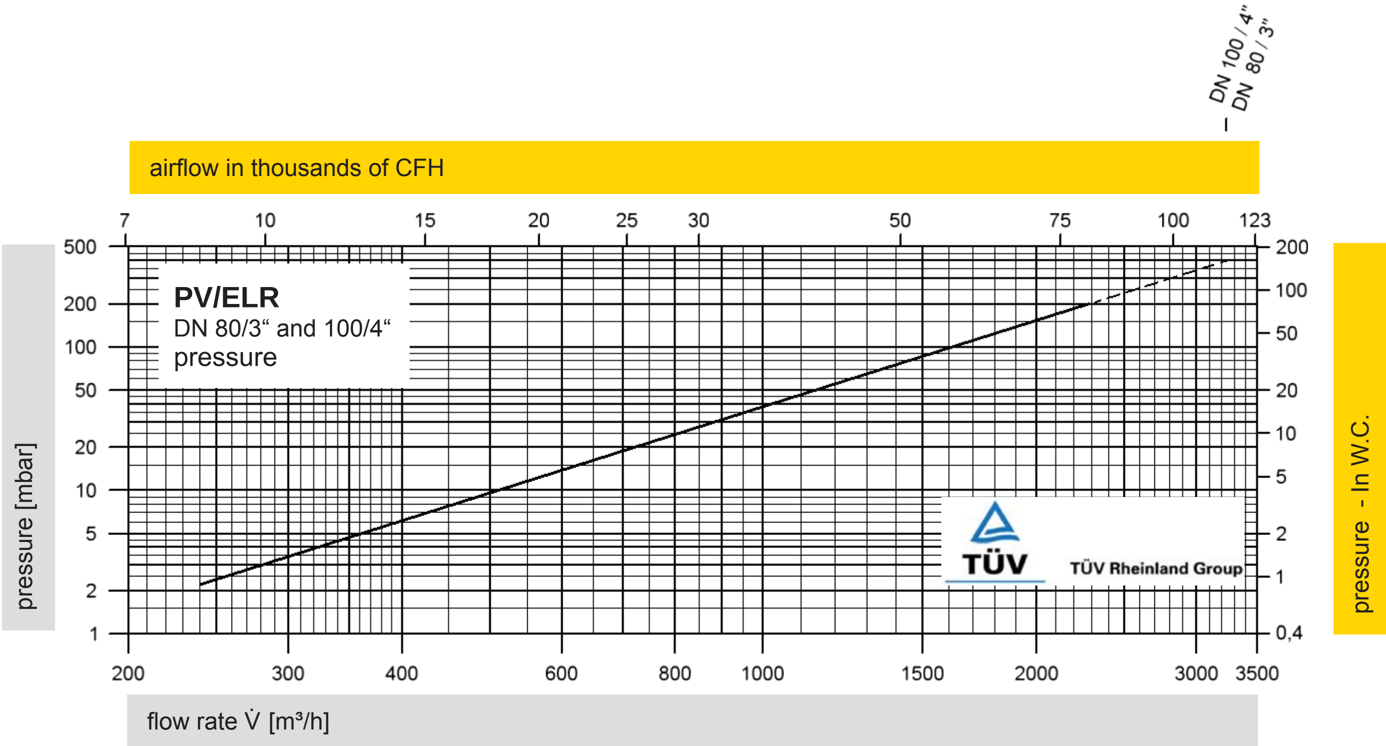
PROTEGO® PV/ELR

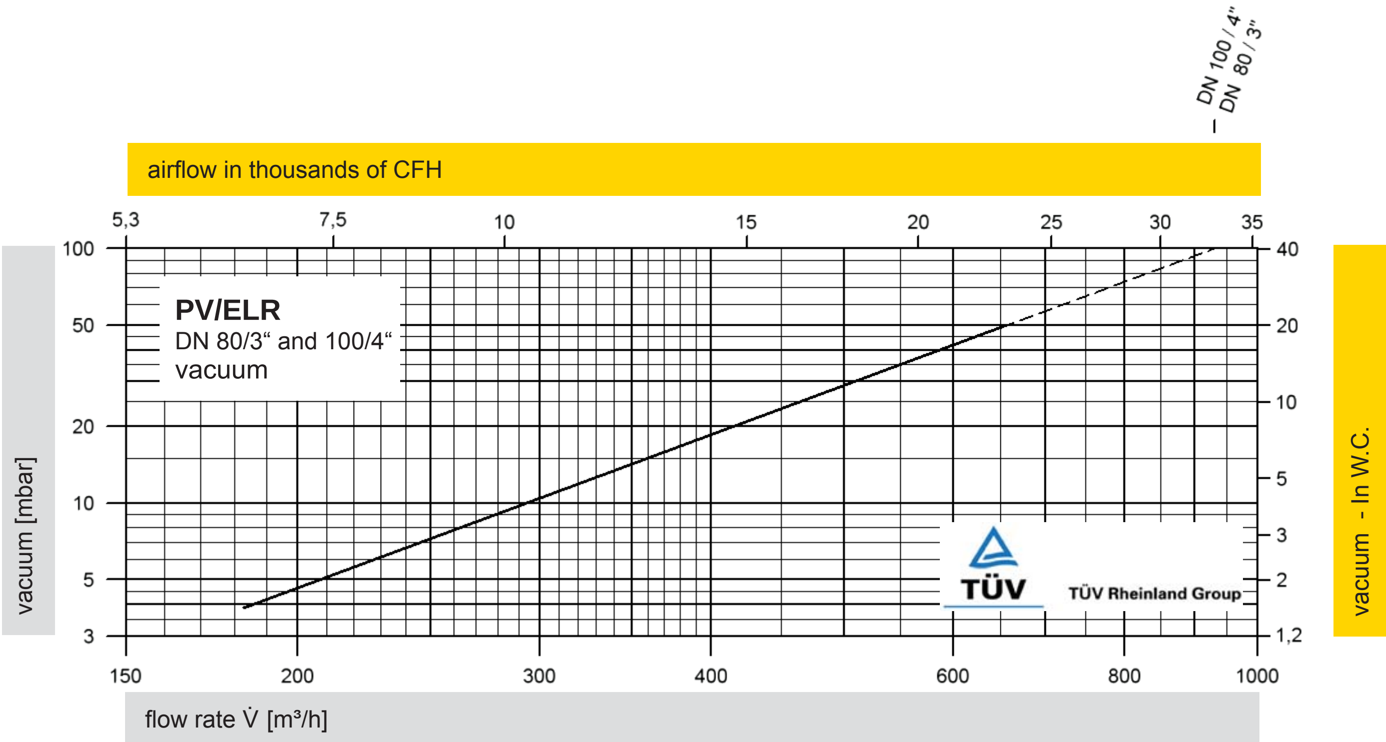


Order example

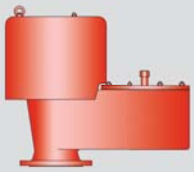
PV/ELR	H	80	B	50 / –	D	-10 / –	B	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



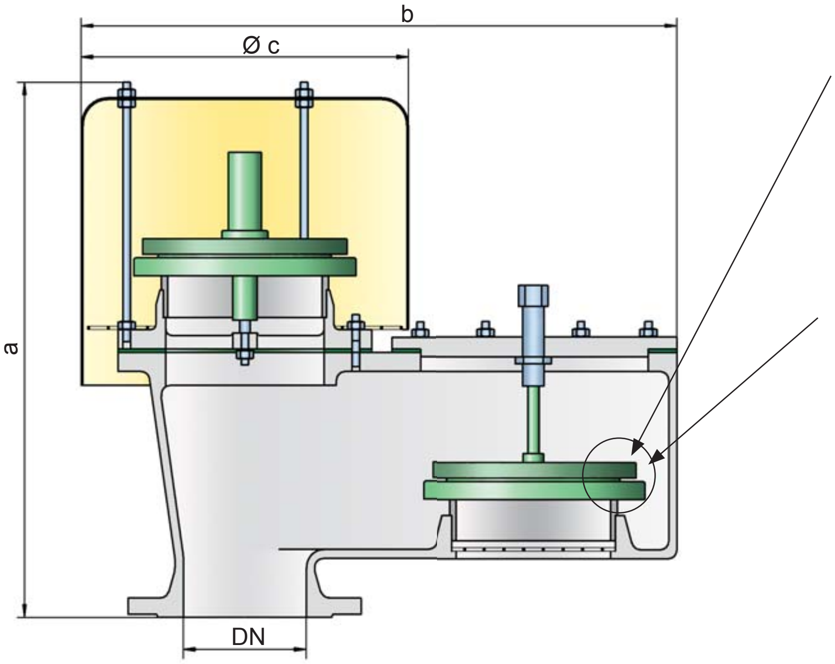


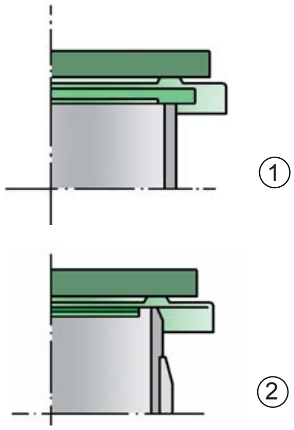
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.



Pressure and Vacuum Relief Valve

PROTEGO® VD/SV





Settings:

Pressure:	+2.0 mbar	up to	+60 mbar
	+0.8 In W.C.	up to	+24 In W.C.
Vacuum:	-2.0 mbar	up to	-60 mbar
	-0.8 In W.C.	up to	-24 In W.C.

Higher or lower settings upon request.

Function and Description

The VD/SV type PROTEGO® valve is a highly developed pressure and vacuum relief valve with excellent flow performance. Typically the valve is installed in the in- and outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for presssure and vacuum relief.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- very high flow capacity
- the valve pallet is guided within the housing to protect against harsh weather conditions
- can be used in areas subject to explosion hazards
- self draining
- maintenance friendly design
- best technology for API-tanks

Design Types and Specifications

The valve pallets are weight-loaded. Higher pressures can be achieved upon request with a special spring-loaded design.

There are two different designs:

Pressure/vacuum valve in basic design	**VD/SV-** –
Pressure/vacuum relief valve with heating jacket	**VD/SV-** H

Additional special devices available upon request.

Any combination of vacuum and pressure levels can be set for the valve. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve pallets are used.

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	396 / 15.59	497 / 19.57	519 / 20.43	654 / 25.75	757 / 29.80	802 / 31.57	802 / 31.57
b	355 / 13.98	448 / 17.64	548 / 21.57	788 / 31.02	900 / 35.43	1030 / 40.55	1030 / 40.55
c	200 / 7.87	295 / 11.61	295 / 11.61	465 / 18.31	550 / 21.65	650 / 25.59	650 / 25.59

Dimensions of pressure and vacuum relief valves with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	C
Housing Heating jacket (VD/SV-H-...)	Aluminium –	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	WS 3822	WS 3822	PTFE
Weather hood	Stainless Steel	Stainless Steel	Stainless Steel

Option: Housing ECTFE-coated

Special materials upon request

Table 3: Material selection for pressure valve pallet

Design	A	B	C	D	E	F
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to metal	Metal to metal	PTFE	PTFE

Special material as well as higher set pressure upon request

Table 4: Material selection for vacuum valve pallet

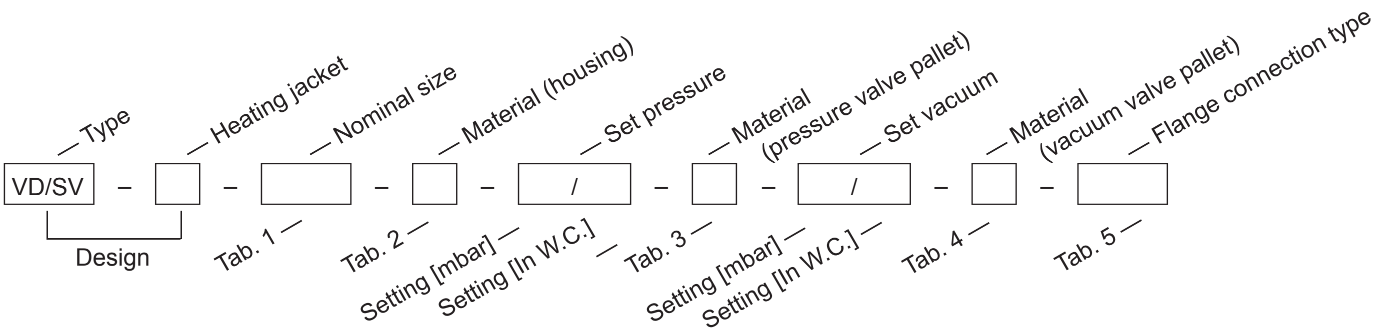
Design	A	B	C	D	E	F
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24	<-35 up to -60 <-14 up to -24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	PTFE	Metal to Metal	PTFE

Special material as well as higher vacuum upon request

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

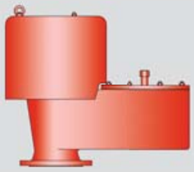


Order example

VD/SV – H – 200 – B – 30 / – C – -4.0 / – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

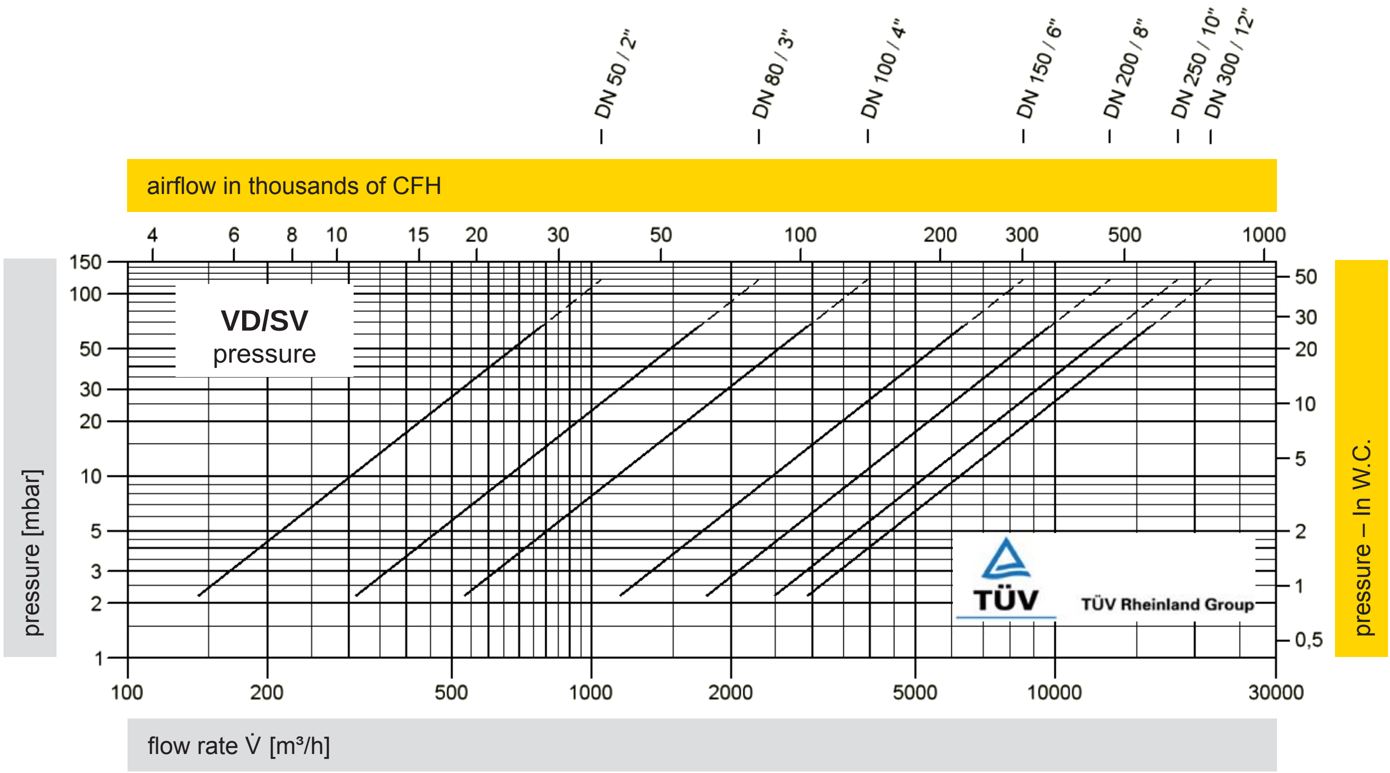
for safety and environment

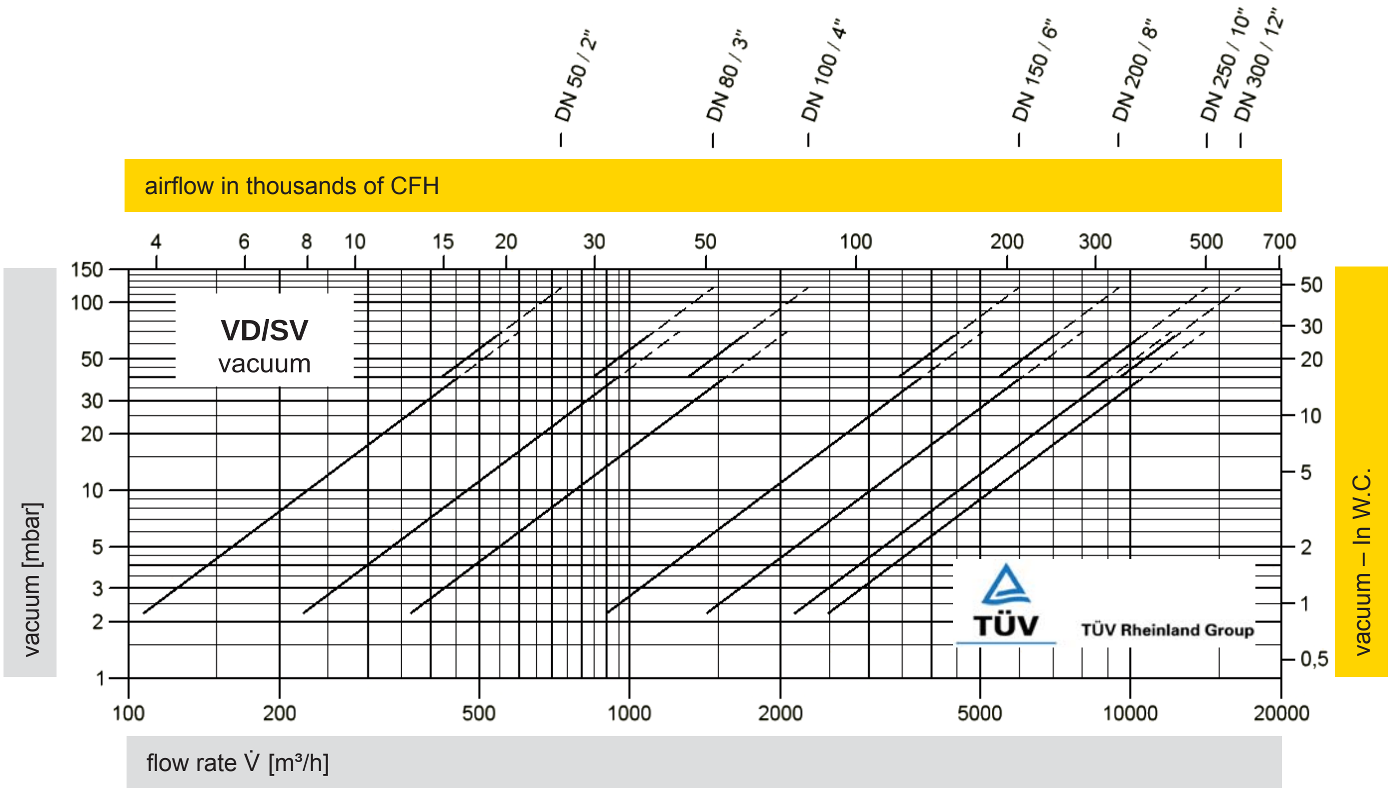


Pressure and Vacuum Relief Valve

Flow Capacity Charts

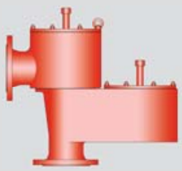
PROTEGO® VD/SV





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

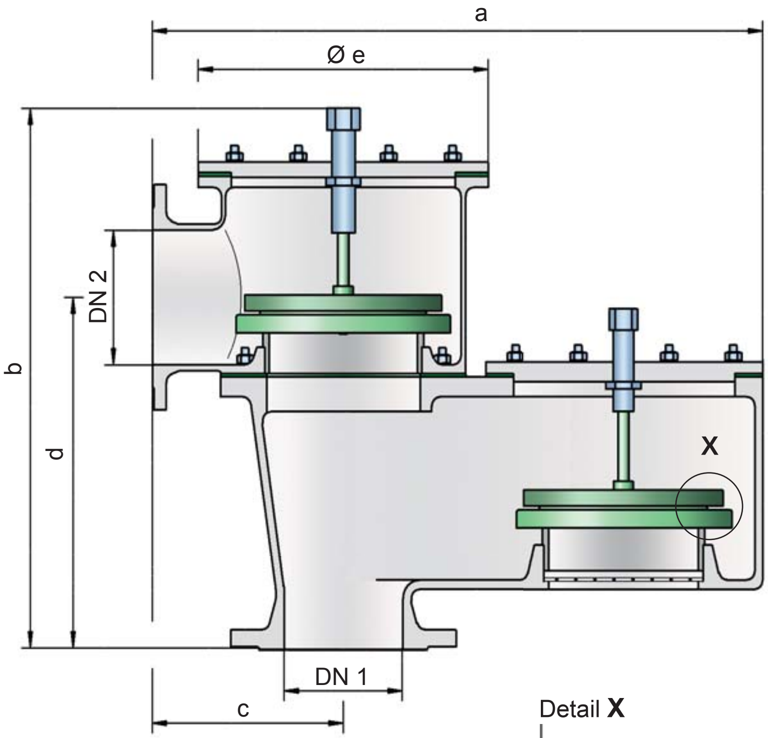
Notes:



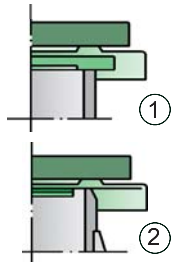
Pressure and Vacuum Relief Valve

with pipe-away connection

PROTEGO® VD/SV-PA(L)



Detail **X**



Settings:

Pressure:	+2.0 mbar	up to	+60 mbar
	+0.8 In W.C.	up to	+24 In W.C.
Vacuum:	-2.0 mbar	up to	-60 mbar
	-0.8 In W.C.	up to	-24 In W.C.

Higher or lower settings upon request.

Function and Description

The VD/SV-PA(L) type PROTEGO® valve is a highly developed pressure and vacuum relief valve with excellent flow performance. Typically the valve is installed in the in- and outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum. The product vapors can be discharged through a collective line connected to the line flange on the pressure side. If the vapors are explosive connect a detonation flame arrester.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for presssure and vacuum relief.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is achieved by valve seats made of high quality stainless steel and with precisely lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- set pressure is close to the opening pressure which results in best possible pressure management of the system
- very high flow capacity
- can be used in areas subject to explosion hazards
- self draining
- maintenance friendly design
- best technology for API-tanks

Design Types and Specifications

The valve pallets are weight-loaded. Higher pressures can be achieved upon request with a special spring-loaded design. Choose the model (L) if the discharge nozzle has a nominal diameter that is greater than the nominal diameter of the tank filler neck.

There are four different designs:

Pressure/vacuum valve in basic design	**VD/SV-PA -** $\boxed{-}$
Pressure/vacuum valve with heating jacket	**VD/SV-PA -** $\boxed{H}$
Pressure/vacuum relief valve with DN2 > DN1	**VD/SV-PAL-** $\boxed{-}$
Pressure/vacuum relief valve with DN2 > DN1 with heating jacket	**VD/SV-PAL-** $\boxed{H}$

Additional special devices available upon request.

Any combination of vacuum and pressure setting can be achieved for the valve. When the difference between the pressure and vacuum exceeds 150 mbar (60.2 In W.C.), special valve pallets are used.

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity charts on the following pages

VD/SV-PA

DN 1	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
DN 2	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	405 / 15.95	480 / 18.90	600 / 23.62	805 / 31.69	925 / 36.42	1010 / 39.76	1010 / 39.76
b	390 / 15.35	485 / 19.09	550 / 21.65	660 / 25.98	780 / 30.71	875 / 34.45	875 / 34.45
c	150 / 5.91	180 / 7.09	200 / 7.87	250 / 9.84	300 / 11.81	305 / 12.01	305 / 12.01
d	240 / 9.45	300 / 11.81	330 / 12.99	390 / 15.35	480 / 18.90	555 / 21.85	582 / 22.91
e	165 / 6.50	192 / 7.56	240 / 9.45	350 / 13.78	390 / 15.35	460 / 18.11	460 / 18.11

VD/SV-PAL

DN 1	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
DN 2	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"
a	395 / 15.55	445 / 17.52	565 / 22.24	770 / 30.31	895 / 35.24	1010 / 39.76	1010 / 39.76
b	400 / 15.74	485 / 19.09	550 / 21.65	655 / 25.79	775 / 30.51	875 / 34.45	885 / 34.45
c	140 / 5.51	143 / 5.63	165 / 6.50	216 / 8.50	267 / 10.51	305 / 12.01	305 /12.01
d	255 / 10.04	308 / 12.13	355 / 13.98	417 / 16.42	505 / 19.88	582 / 22.91	603 / 23.74
e	165 / 6.50	192 / 7.56	240 / 9.45	350 / 13.78	390 /15.35	460 / 18.11	460 / 18.11

Dimensions of pressure and vacuum relief valves with heating jacket upon request

Table 2: Material selection for housing

Desing	A	B	C
Housing Heating jacket (VD/SV-PA(L)-H-...)	Aluminium –	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	WS 3822	WS 3822	PTFE

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material selection for pressure valve pallet

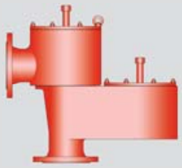
Design	A	B	C	D	E	F
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24	>+14 up to +35 >+5.6 up to +14	>+35 up to +60 >+14 up to +24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special material (alu-coated, titan, hastelloy) as well as higher set pressure upon request

Table 4: Material selection for vacuum valve pallet

Design	A	B	C	D	E	F
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24	<-14 up to +35 <-5.6 up to +14	<-35 up to -60 <-14 up to -24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special material (alu-coated, titan, hastelloy) as well as higher set vacuum upon request

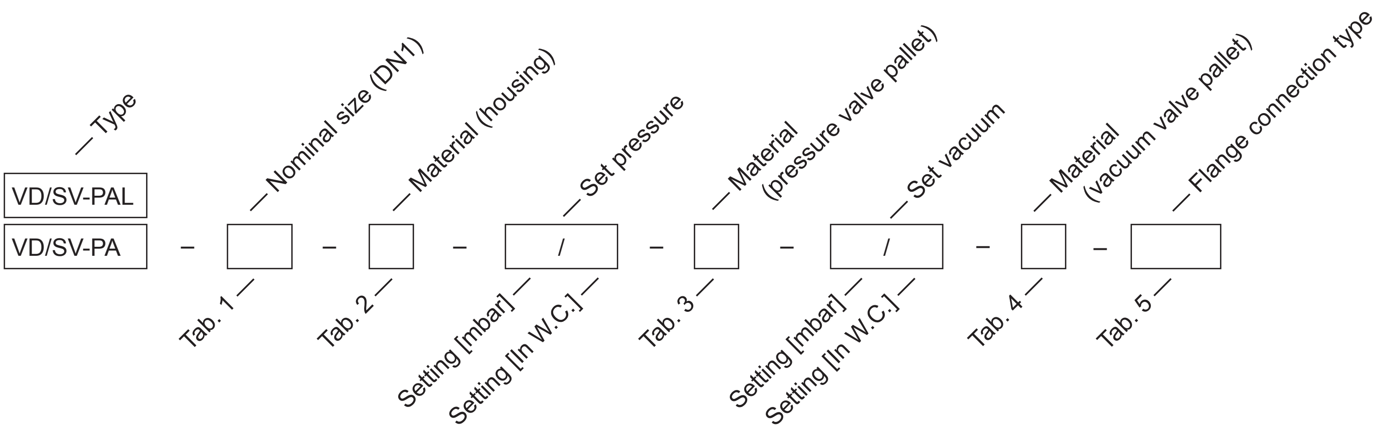


Pressure and Vacuum Relief Valve

with pipe-away connection

PROTEGO® VD/SV-PA(L)

Table 5: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

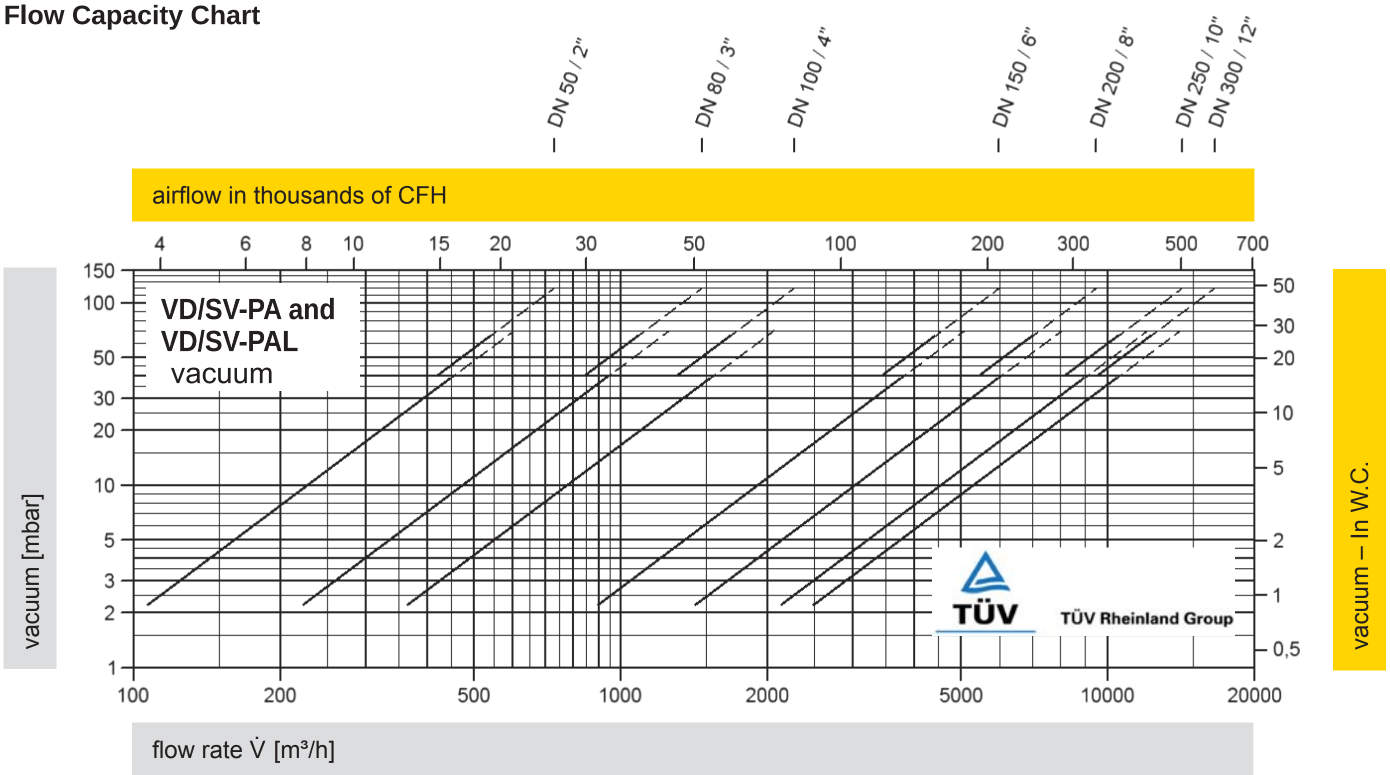


Order example

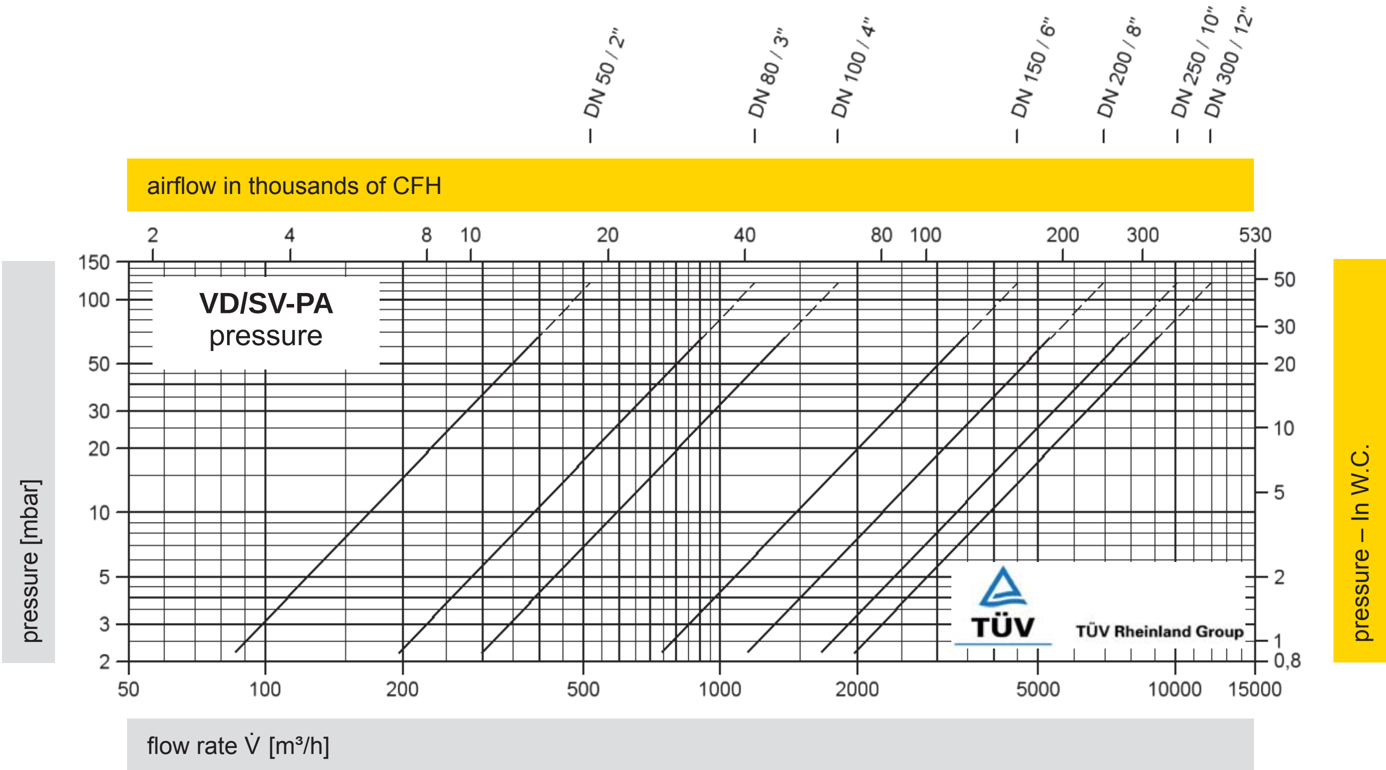
VD/SV-PA	–	200	–	B	–	30 / -	–	C	–	-4.0 / -	–	B	–	DIN

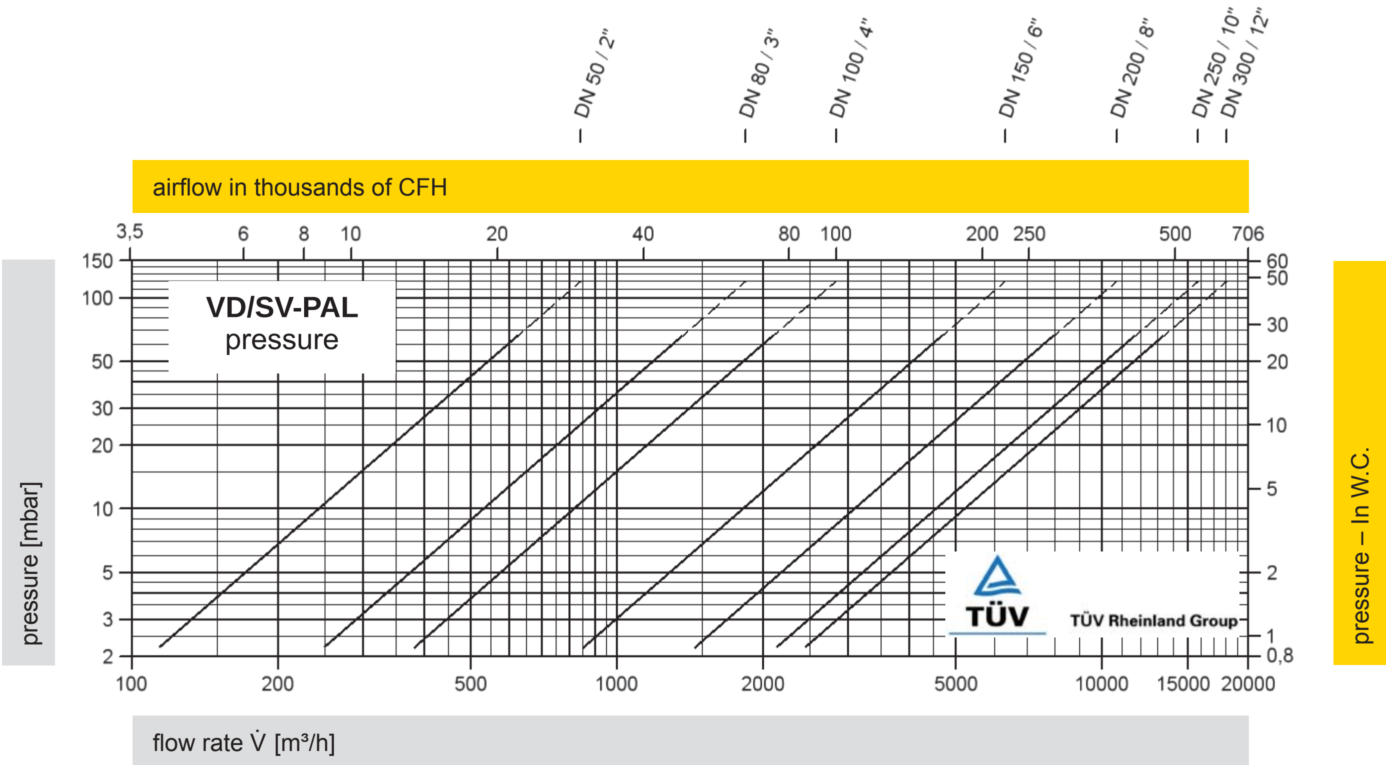
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

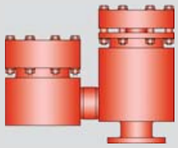
Flow Capacity Chart



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.


DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
airflow in thousands of CFH
2
4
8
10
20
40
80
100
200
300
530
VD/SV-PA
pressure
pressure [mbar]
150
100
50
30
20
10
5
3
2
pressure – In W.C.
50
30
20
10
5
2
1
0,8
TÜV
TÜV Rheinland Group
50
100
200
500
1000
2000
5000
10000
15000
flow rate V̇ [m³/h]

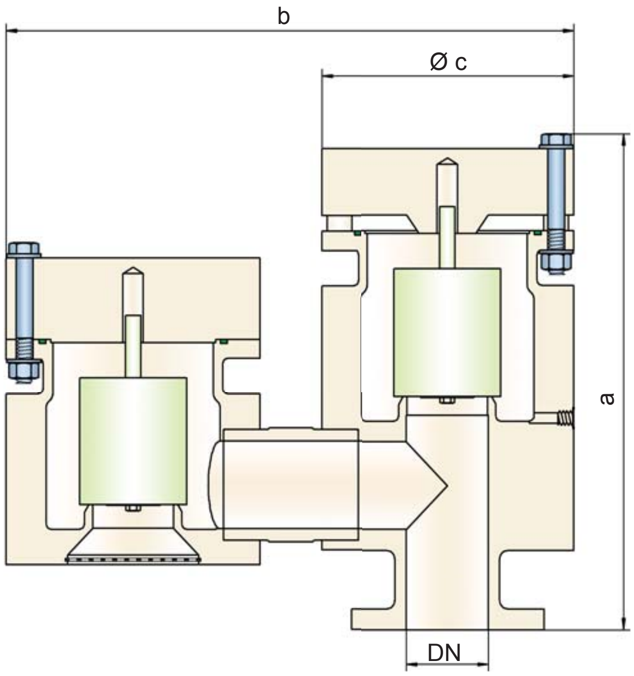

DN 50 / 2"
DN 80 / 3"
DN 100 / 4"
DN 150 / 6"
DN 200 / 8"
DN 250 / 10"
DN 300 / 12"
airflow in thousands of CFH
3,5
6
8
10
20
40
80
100
200
250
500
706
VD/SV-PAL
pressure
pressure [mbar]
150
100
50
30
20
10
5
3
2
pressure – In W.C.
60
50
30
20
10
5
2
1
0,8
TÜV
TÜV Rheinland Group
100
200
500
1000
2000
5000
10000
15000
20000
flow rate V̇ [m³/h]



Pressure and Vacuum Relief Valve

made of plastic

PROTEGO® VD/KSM



Settings:

Pressure:

+5 mbar	up to	+100 mbar (DN 80/3" - DN 200/8")
+2 In W.C.	up to	+40 In W.C.
+6 mbar	up to	+100 mbar (DN 50/2")
+2.4 In W.C.	up to	+40 In W.C.

Vacuum:

-5 mbar	up to	-100 mbar (DN 80/3" - DN 200/8")
-2 In W.C.	up to	-40 In W.C.
-6 mbar	up to	-100 mbar (DN 50/2")
-2.4 In W.C.	up to	-40 In W.C.

Higher and lower settings upon request

Function and Description

The PROTEGO® valve VD/KSM is a state-of-the-art pressure and vacuum relief valve with excellent flow performance made of highgrade synthetic material. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure. The valve is a perfect solution for corrosive, polymerizing or sticky media.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure and vacuum (MAWP and MAWV) of the tank and still safely vent the required mass flow. The opening characteristic for pressure and vacuum side is the same.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is achieved by special valve seats made of high quality synthetic material or PTFE. After the excess pressure is discharged or vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- the valve pallet is guided within the housing to protect against harsh weather conditions
- corrosion resistant valve
- perfect solution for corrosive, polymerizing and sticky media
- weight reduction in comparison to steel/stainless steel
- vacuum side self draining and pressure side condensate drain
- smooth surface
- different plastics can be combined
- maintenance friendly design

Design Types and Specifications

The valve pallets are weight-loaded, and the highest pressure levels are only attained with metal discs.

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	376 / 14.80	521 / 20.51	563 / 22.17 (542 / 21.34)*	670 / 26.38 (681 / 26.81)*	917 / 36.10 (952 / 37.48)*
b	430 / 16.93	575 / 22.64	700 / 27.56 (675 / 26.57)*	825 / 32.48 (880 / 34.65)*	1190 / 46.85 (1100 / 43.31)*
c	180 / 7.09	250 / 9.84	300 / 11.81	350 / 13.78 (405 / 15.94)*	560 / 22.05 (500 / 19.68)*

* Dimensions in brackets only for PVDF

Table 2: Material selection for the housing

Design	A	B	C
Housing	PE	PP	PVDF
Valve seat	PE	PP	PVDF
Sealing	FPM	FPM	FPM
Pressure valve pallet	A, C, D	B, C, D	C, D
Vacuum valve pallet	A, C, D	B, C, D	C, D

Special Materials upon request

Table 3: Material selection for pressure valve pallet

Design	A	B	C	D
Pressure range [mbar] [In W.C.]	+5.0 up to +17 +2.0 up to +6.8	+5.0 up to +17 +2.0 up to +6.8	+10 up to +32 +4.0 up to +12.8	+30 up to +100 +12 up to +40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weight	PE	PP	PVDF	Hastelloy

Special materials and other pressure settings are available upon request

Table 4: Material selection for vacuum valve pallet

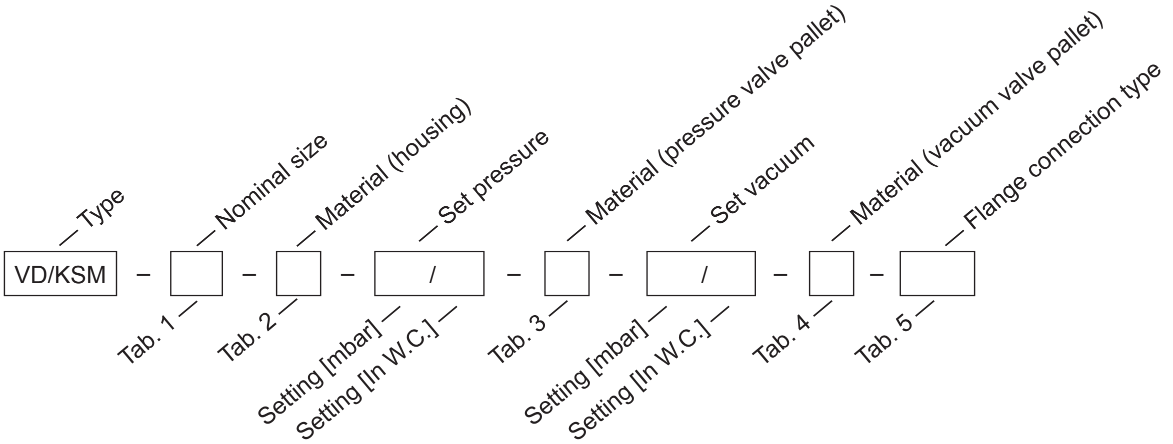
Design	A	B	C	D
Vacuum range [mbar] [In W.C.]	-5.0 up to -17 -2.0 up to -6.8	-5.0 up to -17 -2.0 up to -6.8	-10 up to -32 -4.0 up to -12.8	-30 up to -100 -12 up to -40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weight	PE	PP	PVDF	Hastelloy

Special materials and other vacuum settings are available upon request

Table 5: Flange connection type

EN 1092-1, Form A or DIN 2501, Form B, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

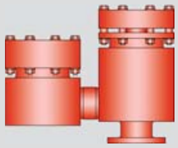
other types upon request



Order example

VD/KSM – 200 – A – +15 / – A – -8.0 / – A – DIN

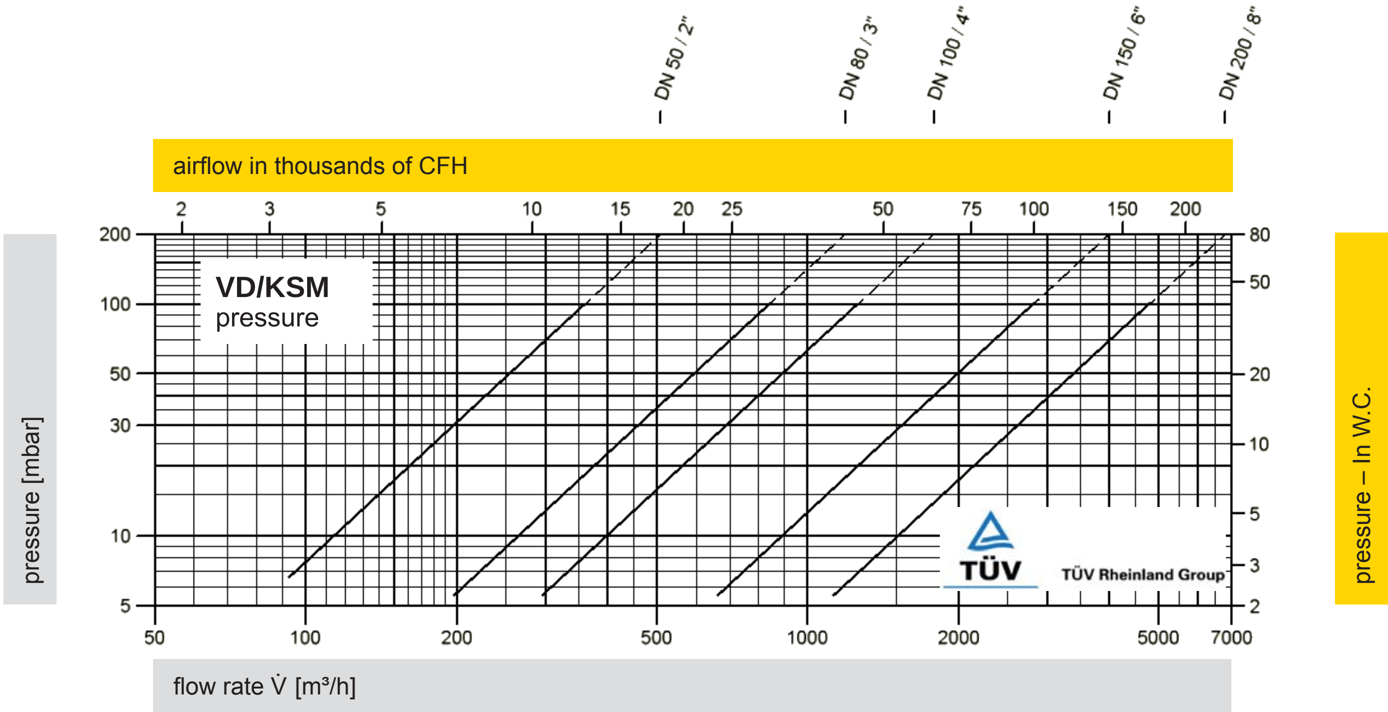
Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

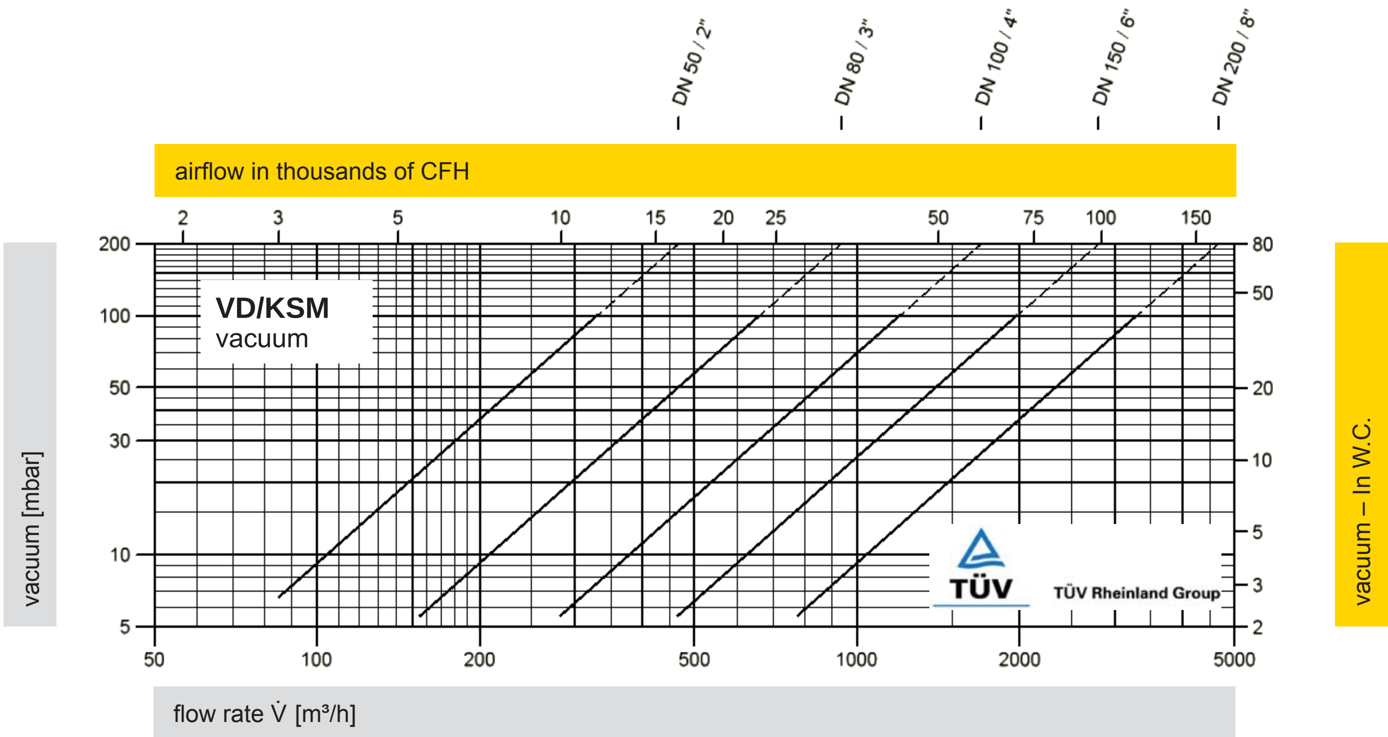


Pressure and Vacuum Relief Valve

Flow Capacity Charts

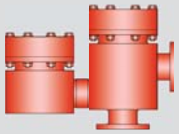
PROTEGO® VD/KSM





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

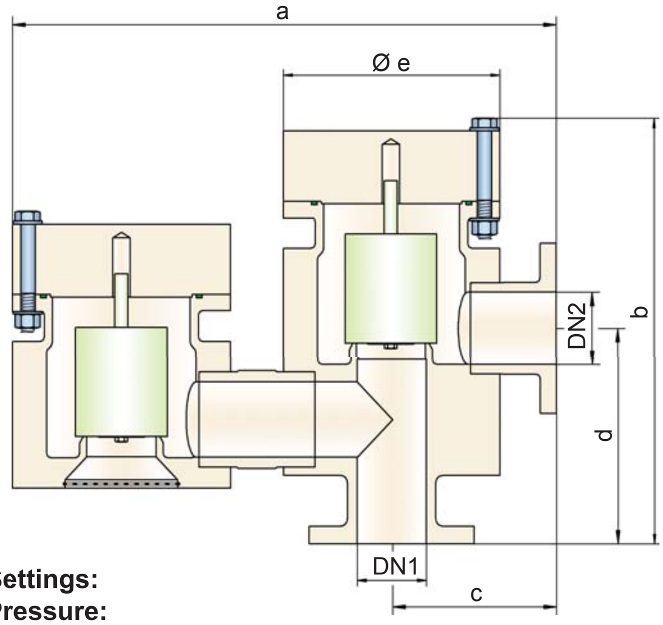
Notes:



Pressure and Vacuum Relief Valve

made of plastic

PROTEGO® VD/KSM-PA



Settings:

Pressure:

+5 mbar	up to	+100 mbar (DN 80/3” - DN 200/8”)
+2 In W.C.	up to	+40 In W.C.
+6 mbar	up to	+100 mbar (DN 50/2”)
+2.4 In W.C.	up to	+40 In W.C.

Vacuum:

-5 mbar	up to	-100 mbar (DN 80/3” - DN 200/8”)
-2 In W.C.	up to	-40 In W.C.
-6 mbar	up to	-100 mbar (DN 50/2”)
-2.4 In W.C.	up to	-40 In W.C.

Higher and lower settings upon request

Function and Description

The PROTEGO® valve VD/KSM-PA is a state-of-the-art pressure and vacuum relief valve with excellent flow performance made of highgrade synthetic material. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure. The valve is a perfect solution for corrosive, polymerizing or sticky media.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure and vacuum (MAWP and MAWV) of the tank and still safely vent the required mass flow. The opening characteristic for pressure and vacuum side is the same.

Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is achieved by special valve seats made of high quality synthetic material or PTFE. After the excess pressure is discharged or vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- the set pressure is close to the opening pressure which results in best possible pressure management of the system
- the valve pallet is guided within the housing to protect against harsh weather conditions
- corrosion resistant valve
- perfect solution for corrosive, polymerizing and sticky media
- weight reduction in comparison to steel/stainless steel
- vacuum side self draining and pressure side condensate drain
- smooth surface
- different plastics can be combined
- maintenance friendly design

Design Types and Specifications

The valve pallets are weight-loaded, and the highest pressure levels are only attained with metal discs.

Pressure/vacuum valve in basic design **VD/KSM-PA-**

Additional special devices available upon

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), use the flow capacity chart on the following page

DN1	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
DN2	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	490 / 19.29	650 / 25.59	775 / 30.51 (750 / 29.53)*	930 / 36.61 (958 / 37.72)*	1260 / 49.61 (1200 / 47.24)*
b	376 / 14.80	521 / 20.51	563 / 22.17 (523 / 20.59)*	670 / 26.38 (651 / 25.63)*	879 / 34.61 (912 / 35.91)*
c	150 / 5.91	200 / 7.87	225 / 8.86	280 / 11.02	350 / 13.78
d	200 / 7.87	245 / 9.65	300 / 11.81	370 / 14.57	590 / 23.23 (650 / 25.59)*
e	180 / 7.09	250 / 9.84	300 / 11.81	350 / 13.78 (405 / 15.94)*	560 / 22.05 (500 / 19.68)*

* Dimensions in brackets only for PVDF

Table 2: Material selection for the housing			
Design	A	B	C
Housing	PE	PP	PVDF
Valve seat	PE	PP	PVDF
Sealing	FPM	FPM	FPM
Pressure valve pallet	A, C, D	B, C, D	C, D
Vacuum valve pallet	A, C, D	B, C, D	C, D

Special Materials upon request

Table 3: Material selection for pressure valve pallet				
Design	A	B	C	D
Pressure range [mbar] [In W.C.]	+5.0 up to +17 +2.0 up to +6.8	+5.0 up to +17 +2.0 up to +6.8	+10 up to +32 +4.0 up to +12.8	+30 up to +100 +12 up to +40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weight	PE	PP	PVDF	Hastelloy

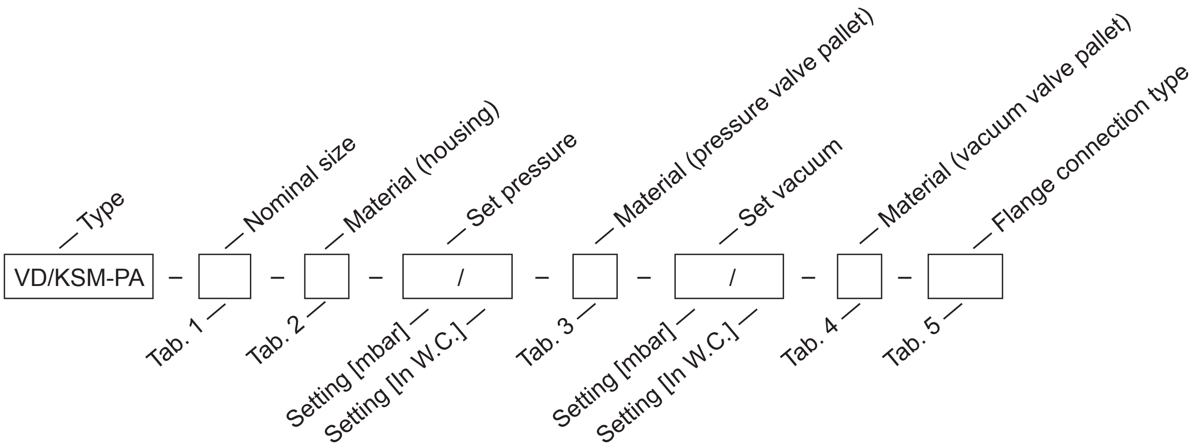
Special materials and other pressure settings are available upon request

Table 4: Material selection for vacuum valve pallet				
Design	A	B	C	D
Vacuum range [mbar] [In W.C.]	-5.0 up to -17 -2.0 up to -6.8	-5.0 up to -17 -2.0 up to -6.8	-10 up to -32 -4.0 up to -12.8	-30 up to -100 -12 up to -40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy
Weight	PE	PP	PVDF	Hastelloy

Special materials and other vacuum settings are available upon request

Table 7: Flange connection type	
EN 1092-1, Form A or DIN 2501, Form B, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

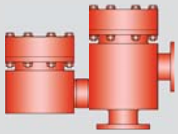
other types upon request



Order example

VD/KSM-PA – 200 – A – +15 / – A – -8.0 / – A – DIN

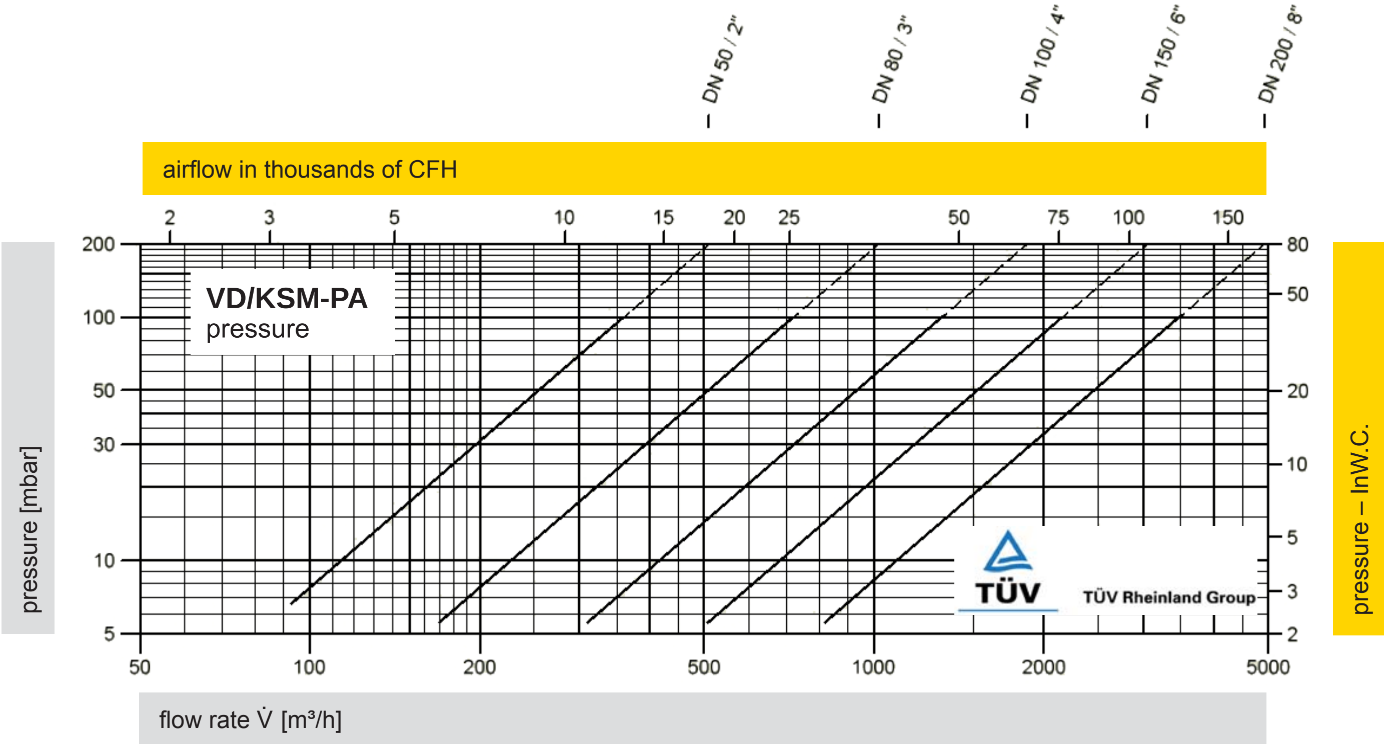
Materials and chemical resistance:
See Vol. 1 “Technical Fundamentals”

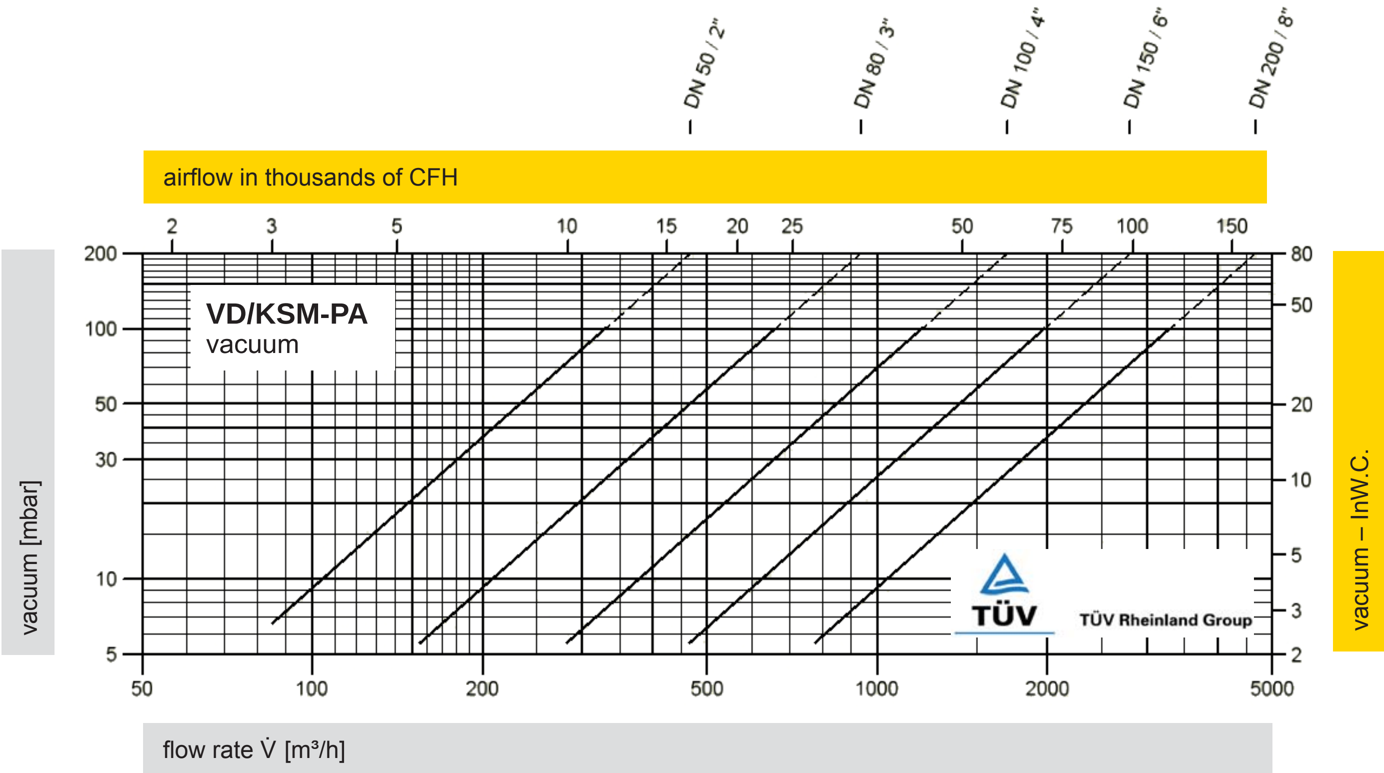


Pressure and Vacuum Relief Valve

Flow Capacity Charts

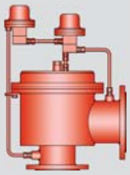
PROTEGO® VD/KSM-PA





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

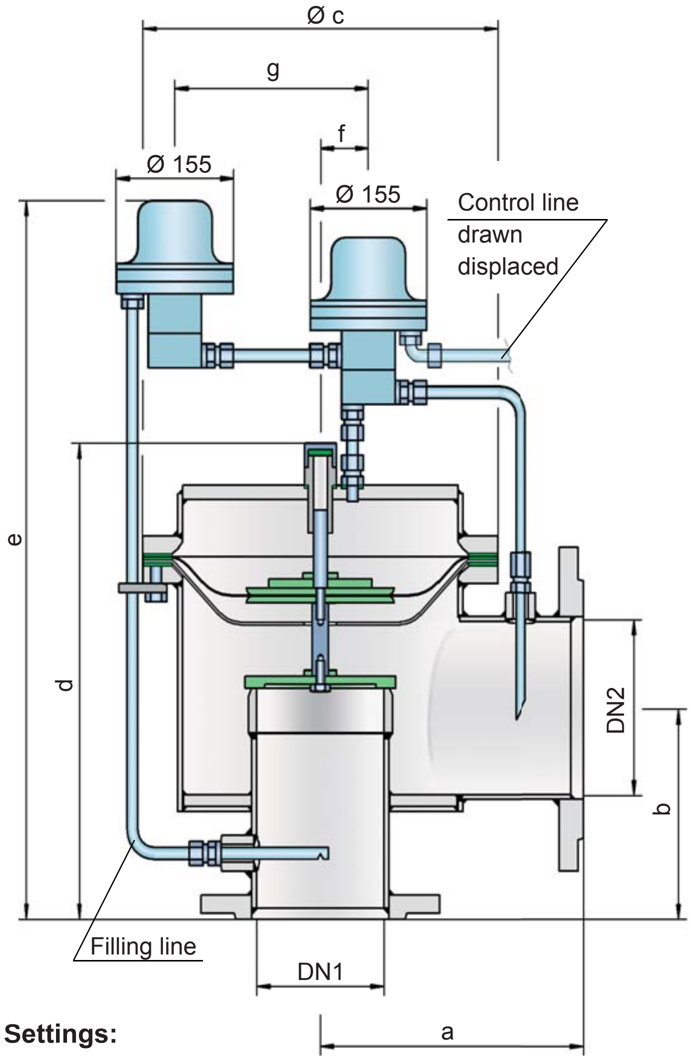
Notes:



Pressure/Vacuum Relief Valve

Pilot-operated diaphragm valve

PROTEGO® PM/(D)S



Settings:

Pressure: +10 mbar up to +300 mbar
+4 In W.C. up to +120 In W.C.

Vacuum: -3.0 mbar up to -7 mbar
-1.2 In W.C. up to -2.8 In W.C.

Higher or lower settings upon request.

Function and Description

The PM/(D)S type pilot-controlled PROTEGO® diaphragm valve is a highly developed valve for pressure and vacuum relief. It is primarily used as a safety device for outbreathing in tanks, containers, and process engineering equipment and it also offers reliable protection from vacuum and overpessure. It prevents the intake of air and unacceptable product vapor loss up to the set point. The valve can also be used as inbreathing valve. The main valve is directly controlled when it is exposed to a vacuum; i.e., it functions as a weight-loaded diaphragm valve. This valve is highly suitable under atmospheric conditions and for use in cryogenic service.

The main valve is controlled by a pilot valve. The pilot valve is controlled by the tank pressure. The tank medium does not continuously flow through the pilot. The set pressure is adjusted at the pilot valve by a corrosion-resistant and low-temperature-resistant permanent magnet.

As the operating pressure increases, the closing force acting on the main valve also rises; i.e. the valve tightness increases to prevent leakage until the set pressure is reached. After the valve responds, it immediately opens completely without any significant increase in pressure (pop open characteristic), and the nominal volumetric flow is discharged through a fully open valve. If this level is exceeded, the pressure increase follows the flow performance curve ($\Delta p/\dot{V}$ curve). Up to the set pressure, the tank pressure is maintained with a tightness that is far superior to the conventional standard due to the superior manufacturing technology. This feature is achieved by valve seats made of high-grade stainless steel with precisely ground valve pallets. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

Special Features and Advantages

- high degree of safety due to double pilot
- controlled by corrosion-resistant, low-temperature-resistant permanent magnet
- the tank medium does not continuously flow through the pilot valve
- pop-open characteristic from a minimum pressure rise to full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- set pressure is close to full lift pressure, which results in high level of design freedom and product savings
- high flow capacity
- the control diaphragm of the main valve is shielded from low temperatures - high-level durability
- can be used in areas subject to an explosion hazard
- designed for use at low temperatures
- self draining

Design Types and Specifications

The valve is equipped with either a control pilot valve or with one control and emergency pilot valve to ensure optimum operating safety in case of malfunctions or damage.

Two different designs are therefore available:

Basic design of pressure/vacuum relief valve with a control pilot valve	**PM/S-**
Basic pressure/vacuum relief valve with a control pilot valve and additional emergency pilot valve	**PM/DS-**

Additional special devices available upon request.

Table 1: Dimensions						Dimensions in mm / inches
To select the nominal size (DN), use the flow capacity charts on the following pages						
DN1	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
DN2	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"
a	225 / 8.86	250 / 9.87	325 / 12.80	375 / 14.76	450 / 17.72	500 / 19.69
b	150 / 5.91	175 / 6.89	225 / 8.86	250 / 9.84	270 / 10.63	300 / 12.81
c	275 / 10.83	330 / 12.99	445 / 17.52	550 / 21.65	665 / 26.18	785 / 30.91
d	370 / 14.57	425 / 16.73	515 / 20.28	590 / 23.23	675 / 26.57	765 / 30.12
e	615 / 24.21	685 / 26.97	770 / 30.31	825 / 32.48	935 / 36.81	1005 / 39.57
f	35 / 1.38	40 / 1.57	40 / 1.57	50 / 1.97	50 /1.97	50 / 1.97
g	160 / 6.30	195 / 7.68	250 / 9.84	315 / 12.40	370 / 14.57	425 / 16.73

Table 2: Material selection for housing			
Design	A	B	Special materials upon request
Housing	Aluminium	Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Sealing	KL-C-4106	KL-C-4106	
Main diaphragm protection	Stainless Steel	Stainless Steel	
Pilot lines	Stainless Steel	Stainless Steel	
Pilot housing	Stainless Steel	Stainless Steel	
Pilot diaphragm	FEP	FEP	

Table 3: Material selection for valve pallet				
Design	A	B	C	Special materials upon request
Pressure range [mbar] [In W.C.]	-3.0 up to -4.0* -1.2 up to -1.6*	-4.0 up to -5.0* -1.6 up to -2.0*	-5.0 up to -7.0* -2.0 up to -2.8*	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	
Diaphragm	FEP	FEP	FEP	
Diaphragm pallet	Aluminium	Aluminium	Stainless Steel	

* The indicated vacuum ranges depend on the nominal sizes and can differ.

The pressure setting can be combined with any vacuum setting

Table 4: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

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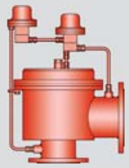


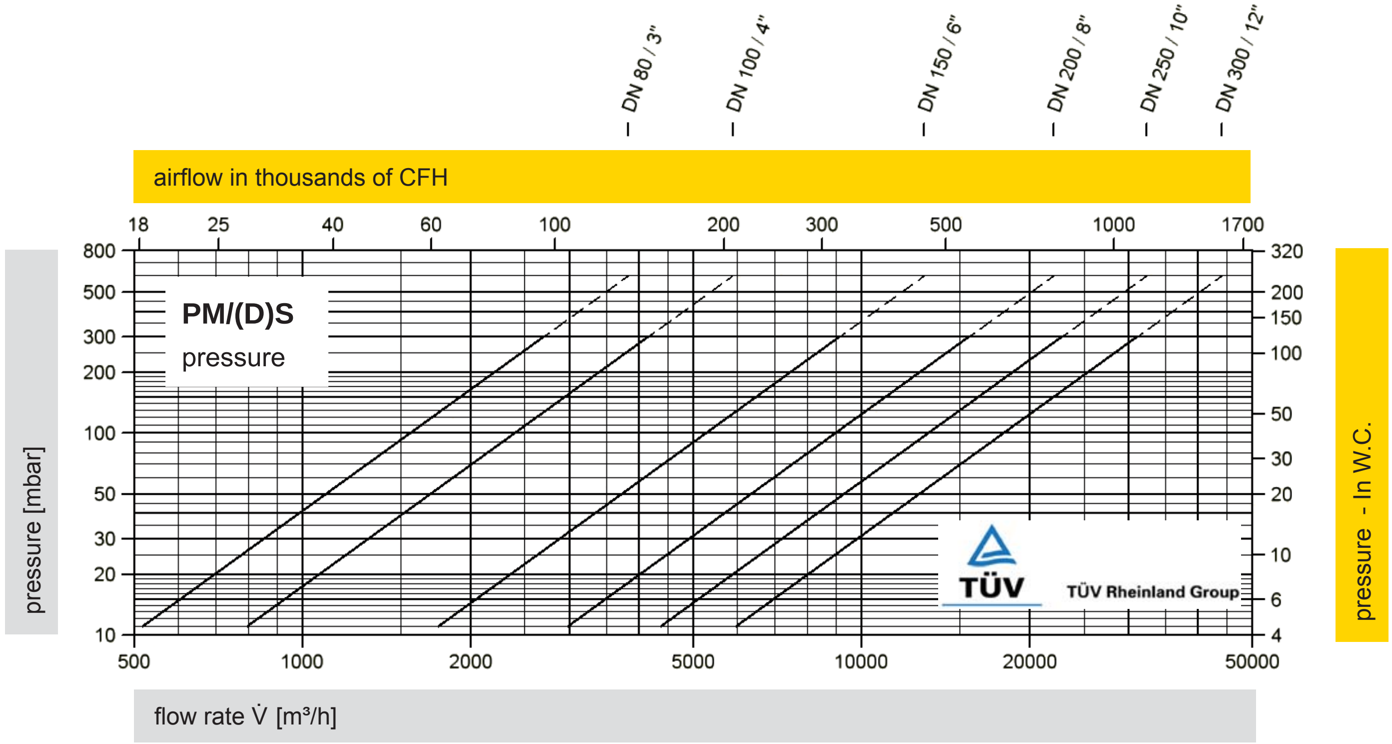
Type	Nominal size DN1	Material (housing)	Set pressure	Set vacuum	Material (valve pallet)	Flange connection type
PM/S- / PM/DS	Tab. 1	Tab. 2	Setting [mbar] / Setting [In W.C.]	Setting [mbar] / Setting [In W.C.]	Tab. 3	Tab. 4

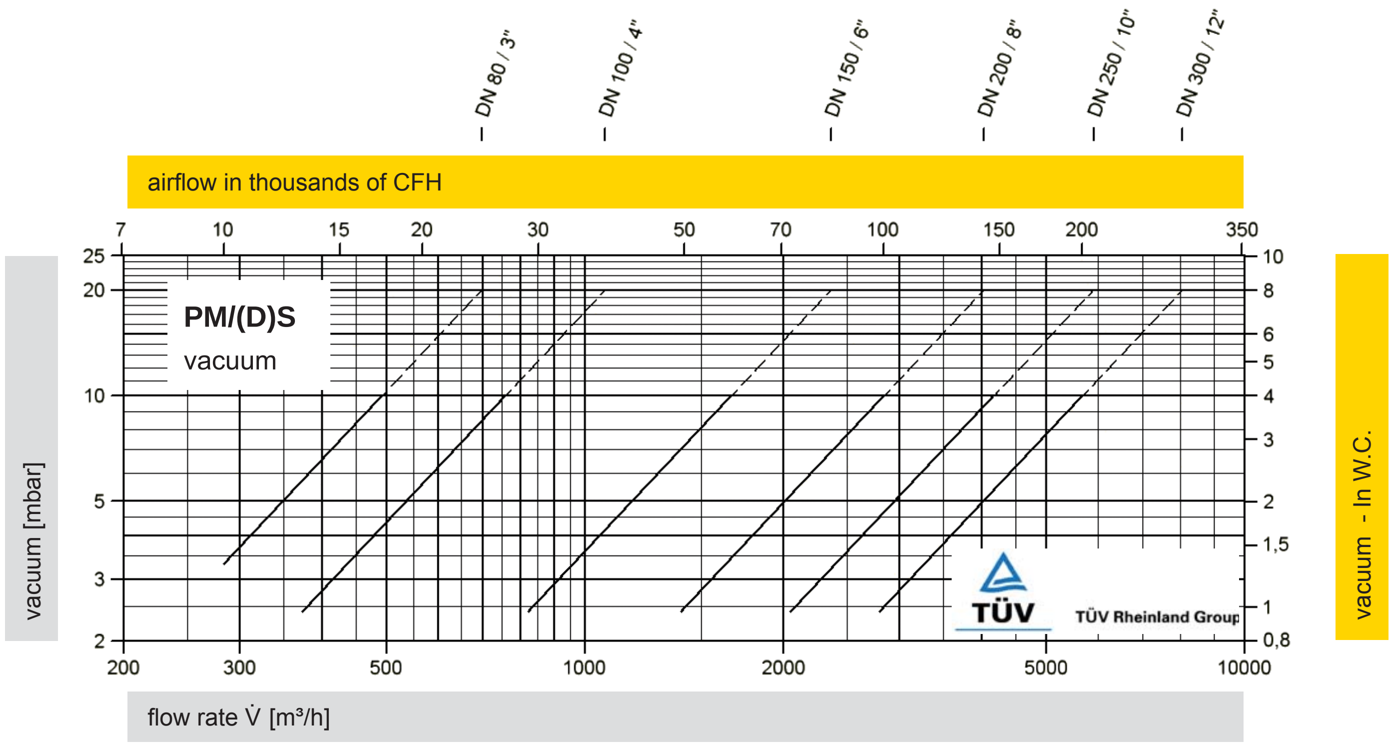
PM/DS – [ ] – [ ] – [/] – [/] – [ ] – [ ]

Order example

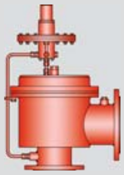
PM/DS	–	200	–	B	–	100/ -	–	-7.0/ -	–	C	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





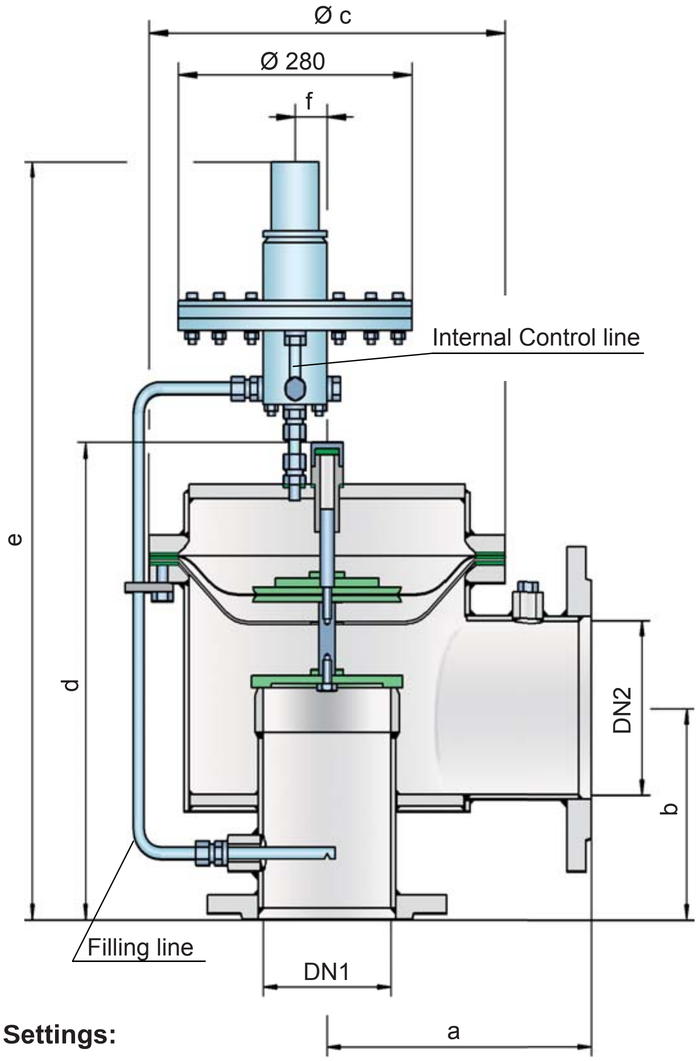
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: "Technical Fundamentals".



Pressure/Vacuum Relief Valve

Pilot-operated diaphragm valve

PROTEGO® PM/F



Settings:

Pressure: +10 mbar up to +350 mbar
+4 In W.C. up to +140 In W.C.

Vacuum: -3.0 mbar up to -10 mbar
-1.2 In W.C. up to -4 In W.C.

Higher or lower settings upon request.

Function and Description

The PM/F type pilot-controlled PROTEGO® diaphragm valve is a highly developed valve for pressure and vacuum relief. It is primarily used as a safety device for outbreathing in tanks, containers, and process engineering equipment and it also offers reliable protection from vacuum and overpessure. It prevents the intake of air and unacceptable product vapor loss up to the set point. The valve can also be used as inbreathing valve. The main valve is directly controlled when it is exposed to a vacuum; i.e., it functions as a weight-loaded diaphragm valve.

The main valve is controlled by a pilot valve. The pilot valve is controlled by the tank pressure. The tank medium does not continuously flow through the pilot. The set pressure is adjusted by stretching or relaxation of a spring.

As the operating pressure increases, the closing force acting on the main valve also rises; i.e. the valve tightness increases to prevent leakage until the set pressure is reached. After the valve responded within 10% pressure rise, it immediately opens completely, and the nominal volumetric flow is discharged through a fully open valve. If this level is exceeded, the pressure increase follows the performance curve ($\Delta p/\dot{V}$ curve). Up to the set pressure, the tank pressure is maintained with a tightness that is far superior to the conventional standard due to the superior manufacturing technology. This feature is achieved by valve seats made of high-grade stainless steel with precisely ground valve pallets. After the excess pressure is discharged, the valve reseats and again provides a tight seal.

Special Features and Advantages

- controlled by corrosion-resistant control valve
- the tank medium does not continuously flow through the pilot valve
- 10% technology for minimum pressure rise up to full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- set pressure is close to full lift pressure, which results in high level of design freedom and product savings
- the control diaphragm of the main valve is shielded from low temperatures - high-level durability
- high flow capacity
- can be used in areas subject to an explosion hazard
- self draining

Design Types and Specifications

The pilot controlled diaphragm valve is equipped with one control valve (pilot valve). For ensuring optimum operation safety in case of any failures or damages, it is recommended to install an emergency pilot valve.

Basic design of pressure/vacuum relief valve with a control pilot valve **PM/F**

Additional special devices available upon request.

Table 1: Dimensions						Dimensions in mm / inches
To select the nominal size (DN), use the flow capacity charts on the following pages						
DN1	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
DN2	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"	350 / 14"
a	225 / 8.86	250 / 9.87	325 / 12.80	375 / 14.76	450 / 17.72	500 / 19.69
b	150 / 5.91	175 / 6.89	225 / 8.86	250 / 9.84	270 / 10.63	300 / 12.81
c	275 / 10.83	330 / 12.99	445 / 17.52	550 / 21.65	665 / 26.18	785 / 30.91
d	370 / 14.57	425 / 16.73	515 / 20.28	590 / 23.23	675 / 26.57	750 / 29.53
e	700 / 27.56	770 / 30.31	860 / 33.86	915 / 36.02	970 / 38.19	1060 / 41.73
f	35 / 1.38	40 / 1.57	40 / 1.57	50 / 1.97	50 / 1.97	50 / 1.97

Table 2: Material selection for housing			
Design	A	B	Special materials upon request
Housing	Aluminium	Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Sealing	KL-C-4106	KL-C-4106	
Main diaphragm protection	Stainless Steel	Stainless Steel	
Pilot lines	Stainless Steel	Stainless Steel	
Pilot housing	Aluminium	Stainless Steel	
Pilot diaphragm	FEP	FEP	

Table 3: Material selection for valve pallet				
Design	A	B	C	Special materials upon request
Pressure range [mbar] [In W.C.]	-3.0 up to -4.0* -1.2 up to -1.6*	-4.0 up to -5.0* -1.6 up to -2.0*	-5.0 up to -10.0* -2.0 up to -4.0*	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	
Diaphragm	FEP	FEP	FEP	
Diaphragm pallet	Aluminium	Aluminium	Stainless Steel	

* The indicated vacuum ranges depend on the nominal sizes and can differ.

The pressure setting can be combined with any vacuum setting

Table 4: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

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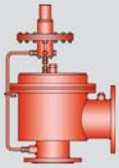


Pressure/Vacuum relief valve

Pilot-operated diaphragm valve

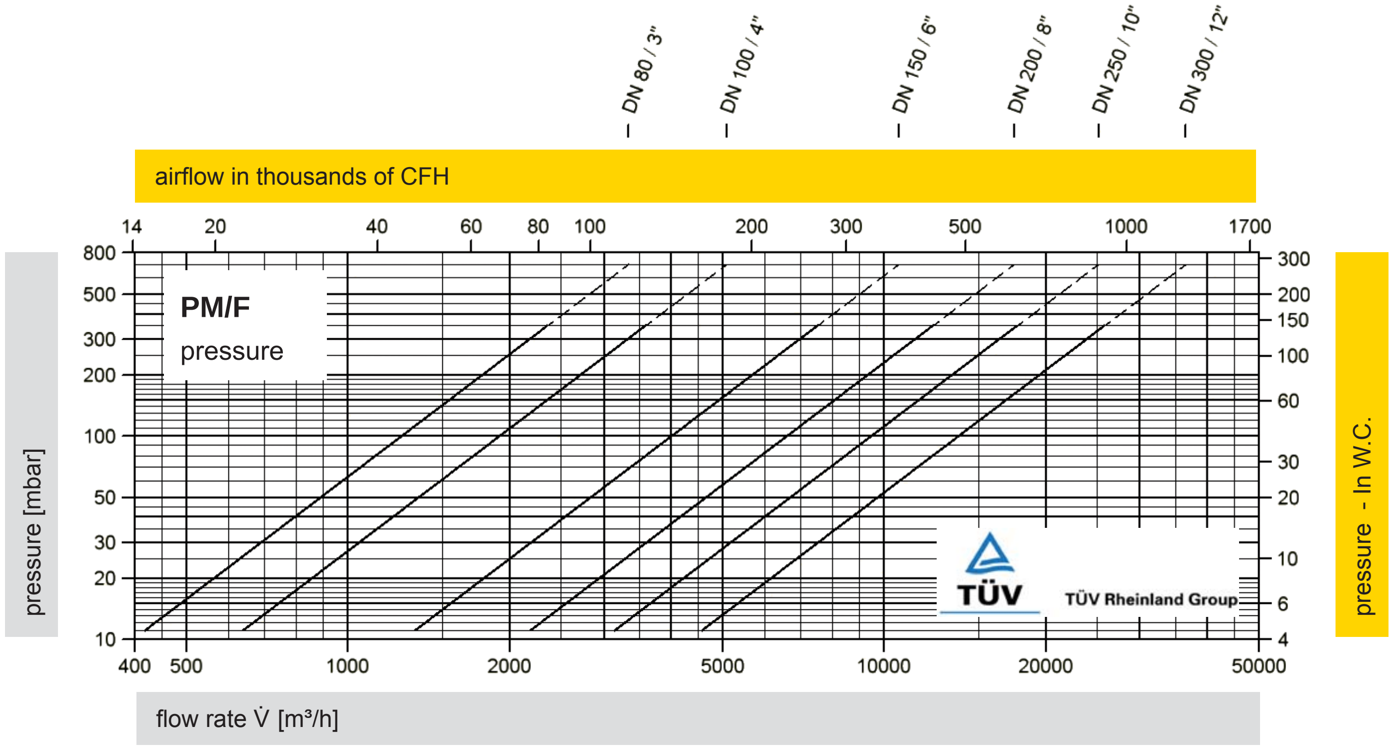
PROTEGO® PM/F

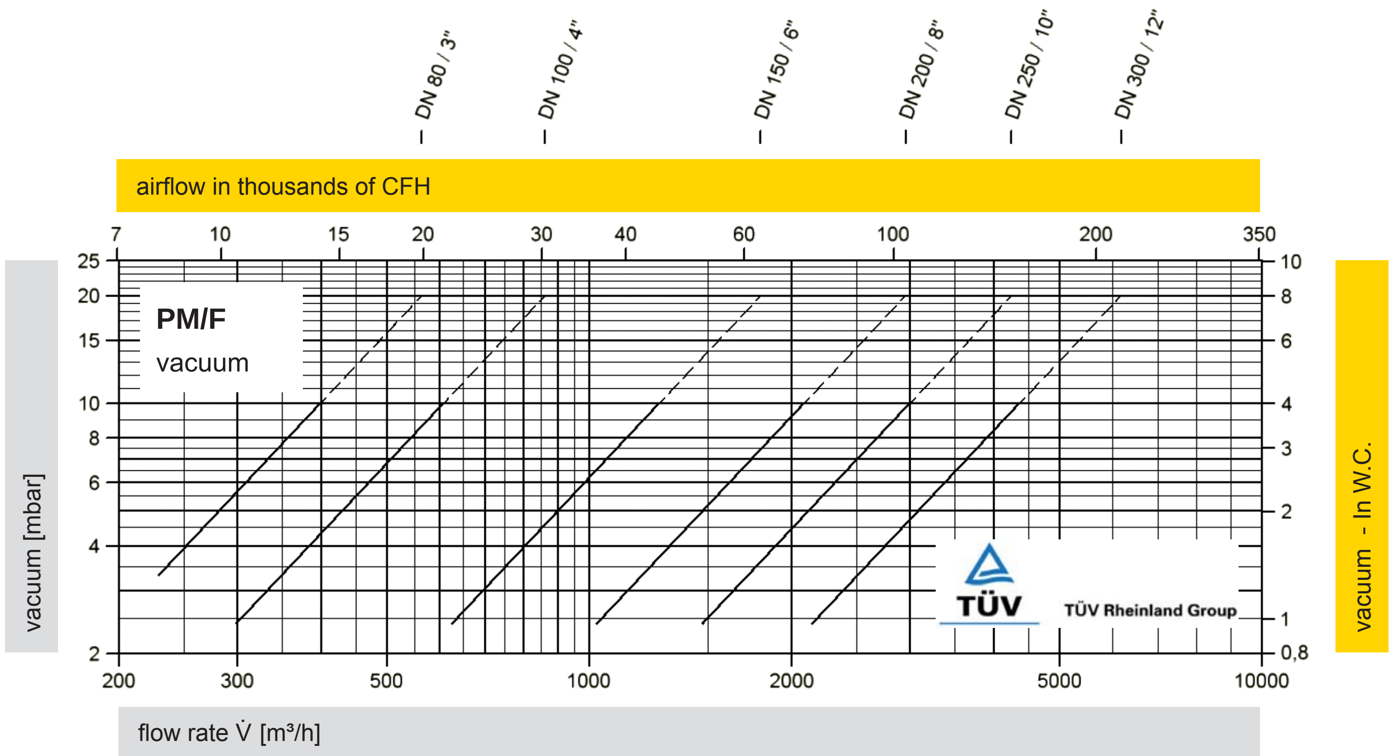
Type	Nominal size DN1	Material (housing)	Set pressure	Set vacuum	Material (valve pallet)	Flange connection type
PM/F			/	/		
	Tab. 1	Tab. 2	Setting [mbar] / Setting In W.C.	Setting [mbar] / Setting [In W.C.]	Tab. 3	Tab. 4

Order example

PM/F	200	B	100/ -	-10 .0/ -	C	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Vol. 1: “Technical Fundamentals”.

Notes:

Notes:

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m^2
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	32 + 1,8 T_C
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9$ (T_F - 32)
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means
CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	=	polytetrafluoroethylene
PVDF	=	polyvinylidene fluoride
PFA	=	perfluoroalkoxy polyme
FPM 70	=	fluor carbon rubber
WS 3822	=	aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	=	ethylene chlorotrifluoro ethylene
FEP	=	perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937	inch	1 inch		=	25,4 mm
1 m	= 3.2808	ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936	yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621	miles	1 mile		=	1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	=	6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	=	0,0929 m^2
	= 1.196	sq yards	1 sq yard	=	0,836 m^2
1km^2	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	=	16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	=	0,028317 m^3
	= 6.299	petr. barrels	1 petr. barrel	=	0,15876 m^3

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85	ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214	mph	1 mph	=	1,60934 km/h
1 m^3/h	= 4.403	gal/min (US)	1 gal/min (US)	=	0,227 m^3/h
	= 3.666	gal/min (UK)	1 gal/min (UK)	=	0,273 m^3/h
	= 0.5886	cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367	lb/min	1 lb/min	=	27,216 kg/h
			1 cu ft/h	=	0,028317 m^3/h

Torsion

1 Nm	= 0.723 lbf ft	1 lbf ft	= 1,38 Nm

Density

1 kg/dm^3	= 62.43 lb/cu ft	1 lb/cu ft	= 0,016 kg/dm^3

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

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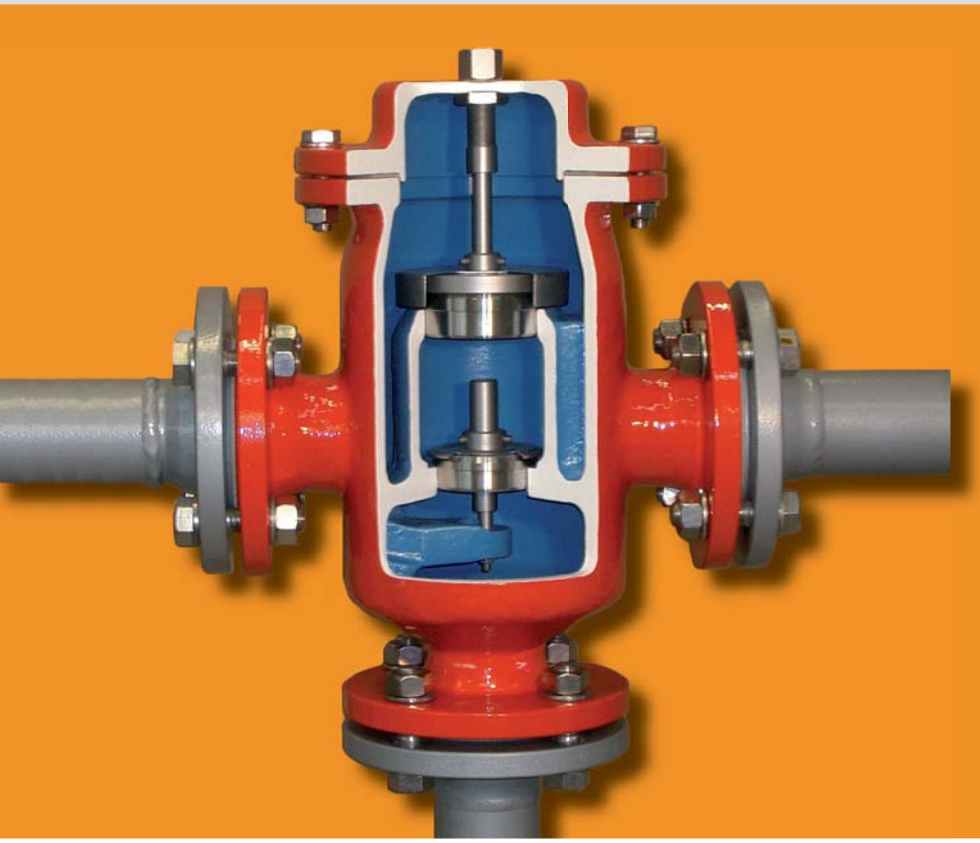
PROTEGO

for safety and environment

PROTEGO® **Pressure and Vacuum Relief Valves**

in-line



Volume 6

Edition 2010

for safety and environment

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

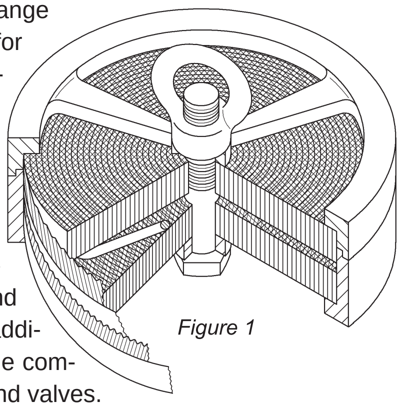
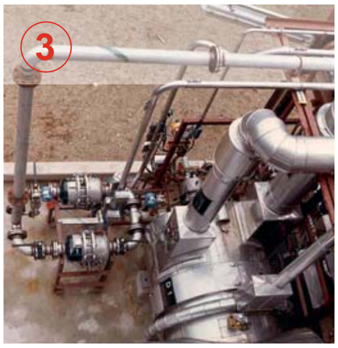
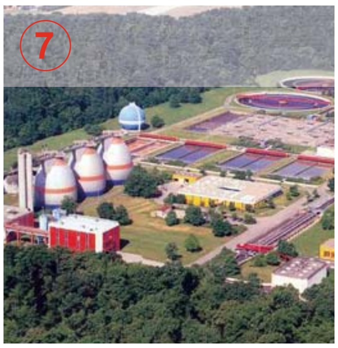


Figure 1

All of our devices are tested by independent national and international third parties in the world's largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.





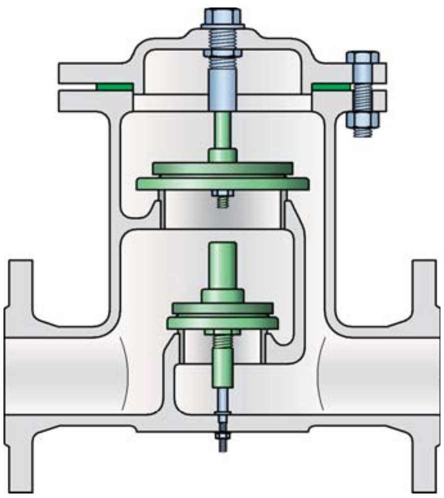
for safety and environment

The working principle and application of pressure and vacuum relief valves on tanks and process equipment is discussed in "Technical Fundamentals" (Volume 1). In this chapter we introduce in-line pressure and vacuum relief valves which can act in a pressure containing, relief or back flow protection function if installed on a tank or other process equipment.

Function and Description

These devices are direct acting weight or spring loaded in-line valves, pallet type, used to protect plant equipment (tanks, vessels, process technical apparatus, piping etc.) against unallowable operational high pressure or vacuum. In-line valves may also be installed as end-of-line valves. In end-of-line applications the open area to atmosphere has to be protected against weather impact, dirt particles or animals (Figure 1).

Figure 1:
Pressure and Vacuum Relief Valve
PROTEGO® DV/ZT



PROTEGO® pressure relief valves provide protection against unallowable high pressure and prevent emission losses almost up to set pressure.

PROTEGO® vacuum relief valves provide safety against unallowable low vacuum and prevent intake of air almost up to set vacuum.

Combined PROTEGO® pressure and vacuum relief valves fulfill both of these functions.

The design of the **PROTEGO®** valve pallets allows full lift to be reached at a maximum of 10% overpressure. This full lift type technology allows the valve to be set just 10% below the allowable fully open pressure (consider MAWP and possible pressure drop of piping and other devices) and still safely discharge the required mass flow. Typical overpressure for conventional valves is 40% to 100% (API 2000). These valves open earlier and reseat later which will result in undesirable product losses.

Special features and advantages

Continuous investment in research and development has allowed PROTEGO® to design valve pallets with the following advantages:

- 10% full lift type technology results in product saving (reduction of breathing losses can be more than 30%)
- PROTEGO® valves open later and reseat earlier, thus providing optimized pressure management and additional saving of inert/blanketing gases
- high flow performance allows cost reduction as smaller sized valves can be installed
- tightness superior to the required national and international standards
- the valve pallet is guided within the housing to protect against harsh weather conditions, i.e. preventing freezing of pallet in cold weather conditions
- can be installed in explosion hazardous areas
- maintenance friendly design

To reduce leak rates to a minimum and fulfill the highest expectation of the industry the valve seats and valve pallets are manufactured from high quality stainless steel and lapped in a highly developed manufacturing process. For low pressure settings valve pallets are equipped with high quality FEP-diaphragm.

Preferred applications

- as pressure containment valve i.e. for blanketing systems
- as pressure reducing valve i.e. to connect to nitrogen blanketing systems
- for controlled venting of plant or storage tanks into a vapour header system
- as back flow protection device in exhaust or inerting systems

Installation and servicing

All PROTEGO® devices are delivered with detailed installation and maintenance manuals. Please take notice of the instructions for the removal of the transport protection, if applicable. The special check lists should be followed to ensure the correct installation of the PROTEGO® devices.

Selection

For safely operating and protecting the plant the correct selection and sizing of the PROTEGO® device is necessary. The valves are mainly characterized by the following criteria:

Function: Pressure relief, vacuum relief or combined pressure and vacuum relief

Working principle: Weight or spring loaded valve pallet, depending on set pressure

Design type: Right angle or straight through design, horizontal or vertical connection to the protected object. The devices are spring or weight loaded and therefore have to be installed with the valve pallets in horizontal position. The maximum and minimum pressure settings depend on the specific design.

Sealing: Depending on the set pressures either metal sealing or soft sealing provide an extremely tight seal.

Operating conditions and critical medium: Polymerisation problems, condensation problems, operating temperature, operating pressure, volume flow are the main criteria for choosing the correct devices.

Depending on the application, it may be important to select a device with a **heating jacket**, but please note that not all devices are available with this feature. Electrical trace heating may be an alternative.

Sizing

The **valve size** results from the volume flow which has to be vented to avoid an increase above the maximum allowable pressure or vacuum. Certified volume flow diagrams are used for sizing. For correct sizing the operating conditions and the pressure drops of the piping system (including other installed devices) and superimposed backpressures have to be taken into account.

Detailed procedures and examples for sizing are described in "Technical Fundamentals" (see Volume 1).

Example 1

Given: Volume flow $\dot{V}_{max}$ in m³/h / CFH (i.e. for in- or out breathing of a storage tank this is the sum of the pump capacity and the thermal breathing require ment) and maximum allowable opening pressure (i.e. tank pressure) p in mbar / In W.C.

Required: Valve size DN

Procedure: The intersection point of $\dot{V}_{max}$ and p_T determines the required valve size. Opening pressure = the maximum allowable tank pressure. The volume flow diagrams show the volume flow as function of the opening pressure for a fully open valve.

The set pressure of the valve has to be determined so that the calculated volume flow can safely be discharged. For a valve which needs 10% overpressure to reach full lift the set pressure may be chosen 10% below the fully open pressure (i.e. maximum allowable tank pressure). Attention: pressure drop of piping systems and other installed devices have to be considered!

Many conventional valves need 100% overpressure to reach full lift. In these cases the set pressure may be just half of the maximum allowable tank pressure. Consequently these valves open earlier and avoidable product losses occur.

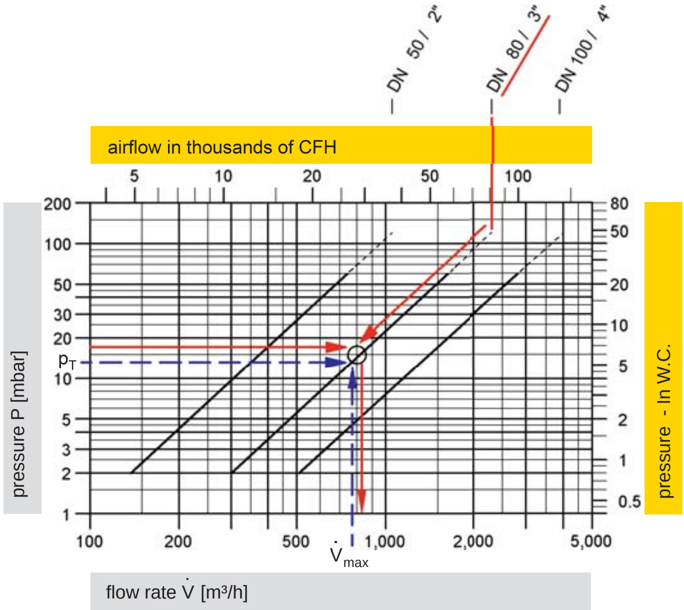
Example 2

Alternatively the valve performance has to be checked if the size and maximum allowable pressure are provided.

Given: Connection nozzle size and maximum allowable opening pressure (i.e. Tank pressure) p in mbar / In W.C.

Required: Volume flow in m³/h / CFH, set pressure p_A in mbar / In W.C.

Procedure: From the intersection point of the straight line of p and the valve performance curve of the specific valve size the volume flow $\dot{V}_{max}$ is determined. The volume flow of the set pressure p_A may be 10%, (PROTEGO®-technology) or 40% or 100% below the opening pressure p_T. Attention: pressure drop of piping systems and other installed devices have to be considered!



The required set pressure (= start of opening) will be the opening pressure (valve fully open) minus the characteristic overpressure.

For PROTEGO® valves and end of line devices the overpressure characteristic is 10% unless otherwise stated. Within 10% overpressure the valve pallet will reach full lift. A further increase in flow performance will follow the pressure volume flow diagram.

Material selection is based on plant and engineering specifications.

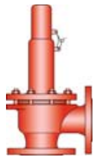
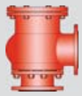
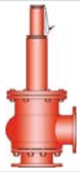
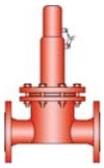
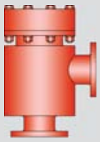
Guidelines for calculating the volume flow and considering the density influence are given in „Technical Fundamentals" (see Volume 1).

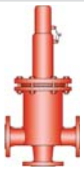
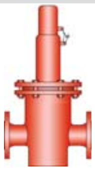
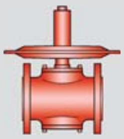
After completing all steps the device can be completely specified and ordered.

To enable us to provide a quotation we recommend completing the data sheet from Vol.1 with the specific process data.

PROTEGO
for safety and environment

PROTEGO® Pressure and Vacuum Relief Valves – in-line

	Type	Size	Pressure setting positive or negative setting range mbar / In W.C.	O = weight loaded X = spring loaded	Design O = straight through design X = right angle design	O = soft sealing X = metallic sealing	O= for critical medium (polymerisation, corrosion, crystallisation)	O = heating jacket	Page
Pressure or Vacuum Relief Valves									
	DZ/E	25 - 300 1" - 12"	±2.0 up to ±60 ±0.8 up to ±24	O	X	O / X		O	8-10
	DZ/E-F	25 - 300 1" - 12"	±60 up to ±500 ±24 up to ±200	X	X	X		O	12-15
	DZ/EA	50 - 150 2" - 6"	±5 up to ±50 ±2 up to ±20	O	X	X	O		16-18
	DZ/EA-F	50 - 150 2" - 6"	±60 up to ±500 ±24 up to ±200	X	X	X	O		20-22
	DZ/T	25 - 300 1" - 12"	±2.0 up to ±60 ±0.8 up to ±24	O	O	O / X		O	24-26
	DZ/T-F	25 - 300 1" - 12"	±60 up to ±500 ±24 up to ±200	X	O	X		O	28-31
	R/KSM	50 - 200 2" - 8"	±5 up to ±100 ±2 up to ±40	O	X	O			32-34

	Type	Size	Pressure setting positive setting range mbar / In W.C.	Pressure setting negative setting range mbar / In W.C.	O = weight loaded X = spring loaded	Design O = straight through design X = right angle design	O = soft sealing X = metallic sealing	O= for critical medium (polymerisation, corrosion, crystallisation)	O = heating jacket	Page
Pressure and Vacuum Relief Valves										
	DV/ZT	40 - 150 1½" - 6"	upper valve pallet ±2.0 up to ±60 ±0.8 up to ±24	lower valve pallet ±3.5 up to ±50 ±1.4 up to ±20	O	O	O / X		O	36-38
	DV/ZT-F	40 - 150 1½" - 6"	+60 up to +500 +24 up to +200	-3.5 up to -50 -1.4 up to -20	X	O	X		O	40-43
	DV/ZU	40 - 150 1½" - 6"	+2.0 up to +60 +0.8 up to +24	-3.5 up to -50 -1.4 up to -20	O	O / X	O / X		O	44-47
	DV/ZU-F	40 - 150 1½" - 6"	+60 up to +500 +24 up to +200	-3.5 up to -50 -1.4 up to -20	X	O / X	X		O	48-51
	DV/ZW	40 - 150 1½" - 6"	+2.0 up to +60 +0.8 up to +24	-3.5 up to -50 -1.4 up to -20	O	O	O / X		O	52-55
	DV/ZW-F	40 - 150 1½" - 6"	+60 up to +500 +24 up to +200	-3.5 up to -50 -1.4 up to -20	X	O	X		O	56-59
Blanketing Valve										
	ZM-R	15 - 100 ½" - 4"	up to +500 up to +200	up to -200 up to -80	X	O	O			60-65

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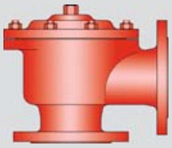
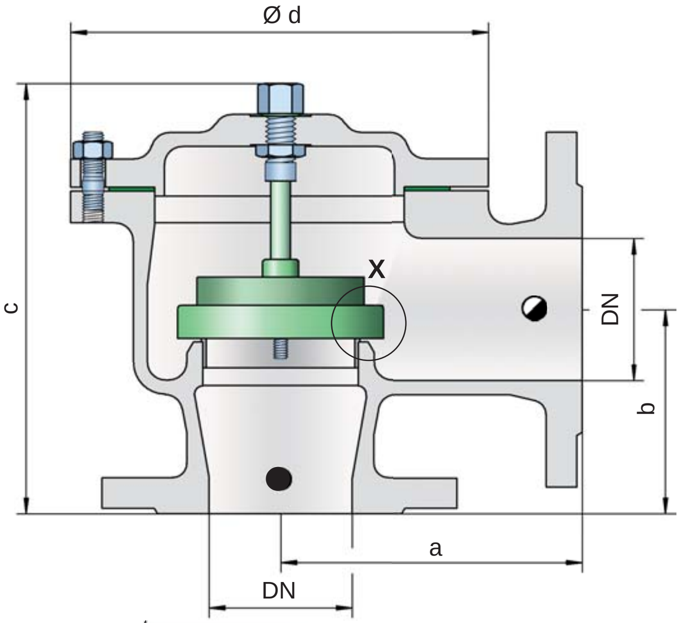


Pressure or Vacuum Relief Valve, In-Line

PROTEGO® DZ/E



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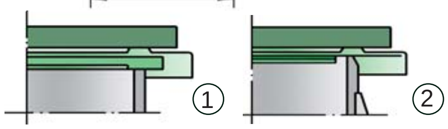


● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Flow direction marked at the housing by →

Pressure or vacuum settings:

DN 25 and 32	±3.5 mbar	up to	±60 mbar
DN 1" and 1¼"	±1.4 In W.C.	up to	±24 In W.C.
DN 40 up to 300	±2.0 mbar	up to	±60 mbar
DN 1½" up to 12"	± 0.8 In W.C.	up to	±24 In W.C.

For higher set pressure or vacuum refer to type DZ/E-F

Function and Description

The PROTEGO® in-line valve DZ/E is a state-of-the-art pressure or vacuum relief valve in right angle design. Typically the valve is installed in the in- or outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for pressure and vacuum relief. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- compact right angle design saves space
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Designs and Specifications

The valve pallet is weight loaded. Higher set pressures for pressure and vacuum are achieved by using spring loaded type DZ/E-F.

Two different right angle designs are available:

In-line pressure or vacuum relief valve, standard design — **DZ/E -** $\boxed{-}$

In-line pressure or vacuum relief valve with heating jacket — **DZ/E -** $\boxed{H}$

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	110 / 4.33	110 / 4.33	125 / 4.92	125 / 4.92	170 / 6.69	190 / 7.48	230 / 9.06	275 / 10.83	325 / 12.80	350 / 13.78
b	75 / 2.95	75 / 2.95	90 / 3.54	90 / 3.54	115 / 4.53	120 / 4.72	160 / 6.30	225 / 8.86	275 / 10.83	300 / 11.81
c	180 / 7.09	180 / 7.09	230 / 9.06	230 / 9.06	245 / 9.65	260 / 10.24	335 / 13.19	505 / 19.88	575 / 22.64	630 / 24.80
d	150 / 5.91	150 / 5.91	170 / 6.69	170 / 6.69	235 / 9.25	280 / 11.02	335 / 13.19	420 / 16.54	505 / 19.88	565 / 22.24

Dimensions for pressure or vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	C
Housing Heating jacket (DZ/E-H-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Valve seat	Stainless Steel	Stainless Steel	Hastelloy
Gasket	WS 3822	PTFE	PTFE
Valve pallet **DN 40 - 300 / 1 ½" - 12"**	A, C, E, F	A, C, E, F	B, D, G
Valve pallet **DN 25 - 32 / 1" - 1 ¼"**	H, I, J	H, I, J	–

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material selection for valve pallet

DN 40 - 300 / 1 ½" - 12"

Design	A	B	C	D	E	F	G
Pressure range [mbar] [In W.C.]	±2.0 up to ±3.5 ±0.8 up to ±1.4	±2.0 up to ±3.5 ±0.8 up to ±1.4	±3.5 up to ±14 ±1.4 up to ±5.6	±3.5 up to ±14 ±1.4 up to ±5.6	±14 up to ±60 ±5.6 up to ±24	±14 up to ±60 ±5.6 up to ±24	±14 up to ±60 ±5.6 up to ±24
Valve pallet	Aluminium	Titanium	Stainless Steel	Titanium	Stainless Steel	Stainless Steel	Hastelloy
Sealing	FEP	FEP	FEP	FEP	Metal to Metal	PTFE	Metal to Metal

DN 25 - 32 / 1" - 1 ¼"

Design	H	I	J
Pressure range [mbar] [In W.C.]	±3,5 up to ±15 ±1.4 up to ±6.0	±15 up to ±60 ±6.0 up to ±24	±15 up to ±60 ±6.0 up to ±24
Valve pallet	PTFE	Stainless Steel	Stainless Steel
Sealing	PTFE	Metal to Metal	PTFE

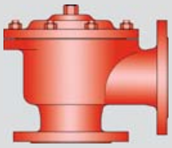
Special materials upon request

For higher set pressure or vacuum refer to type DZ/E-F

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request



Type — Heating jacket — Nominal size — Material (housing) — Set pressure or set vacuum — Material (valve pallet) — Flange connection type

DZ/E	–	H	–		–		–	/	–		–	

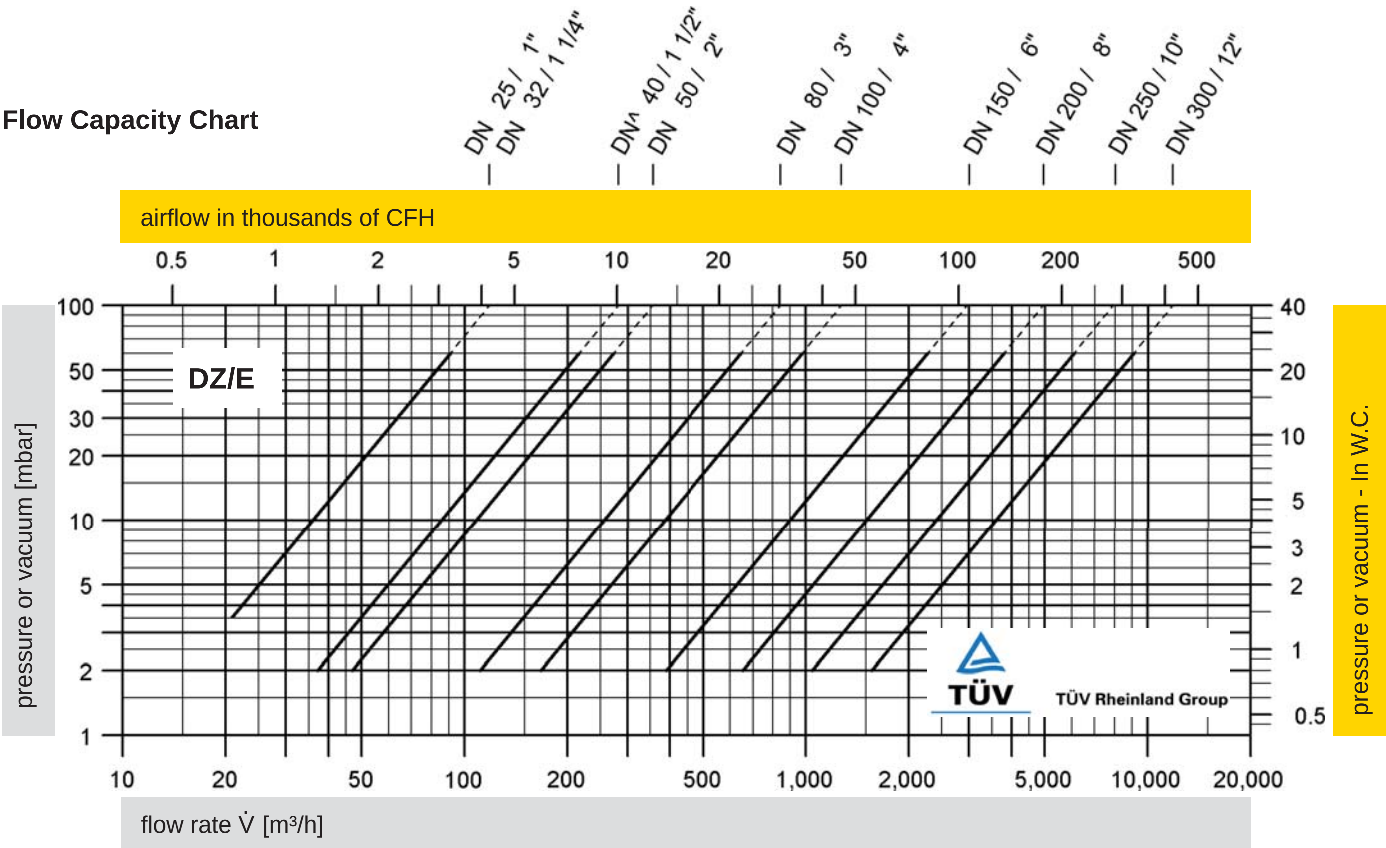
Design: DZ/E – H; Nominal size: Tab. 1; Material (housing): Tab. 2; Set pressure or set vacuum: Setting [mbar] / Setting [In W.C.]; Material (valve pallet): Tab. 3; Flange connection type: Tab. 4

Order example

DZ/E	–		–	80	–	B	–	50 / –	–	E	–	DIN

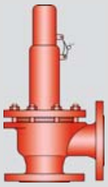
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



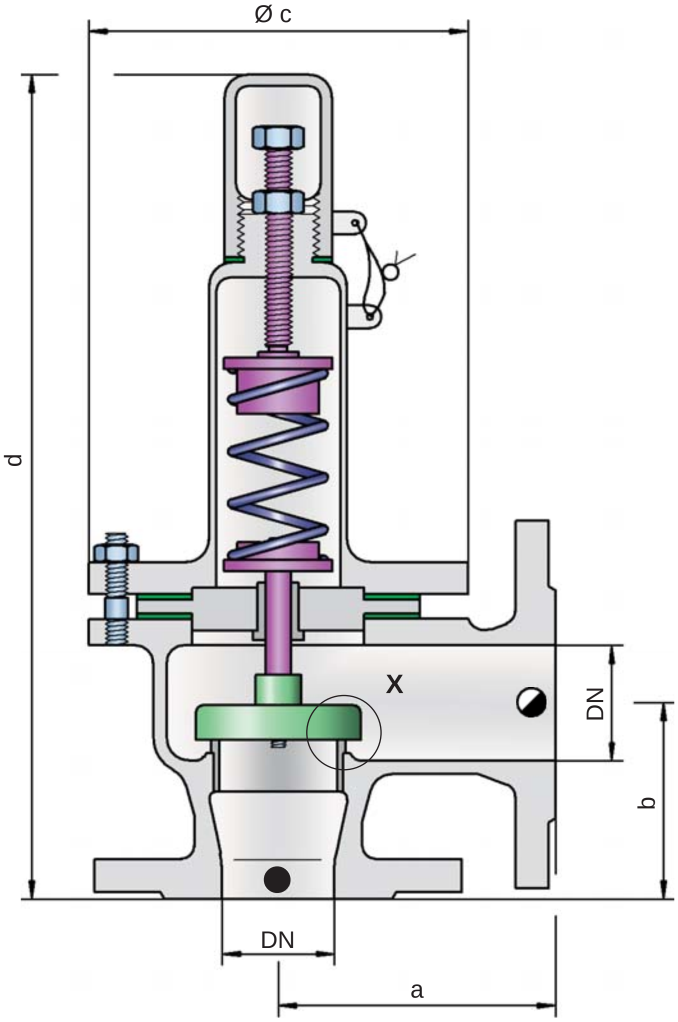
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:



Pressure or Vacuum Relief Valve, In-Line

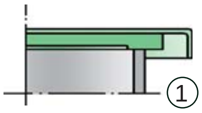
PROTEGO® DZ/E-F



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Detail **X**



Flow direction marked at the housing by ➞

Pressure or vacuum settings:

±60 mbar	up to	±500 mbar	(DN 25/1" up to 200/8")
±24 In W.C.	up to	±200 In W.C.	
±60 mbar	up to	±400 mbar	(DN 250/10")
±24 In W.C.	up to	±160 In W.C.	
±60 mbar	up to	±300 mbar	(DN 300/12")
±24 In W.C.	up to	±120 In W.C.	

Devices with higher set pressure or vacuum are available upon request, for lower set pressures or vacuum refer to type DZ/E.

Function and Description

The PROTEGO® in-line valve DZ/E-F is a state-of-the-art pressure or vacuum relief valve in right angle design for higher system pressures. Typically the valve is installed in the in- or outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system. As this device is equipped with a spring higher set pressures can be reached compared to the DZ/E.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for pressure and vacuum relief. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) and a rugged valve body. After the excess pressure is discharged or vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- compact right angle design saves space
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- spring loaded for elevated set pressures
- maintenance friendly design

Designs and Specifications

The valve pallet is spring loaded. Lower set pressures for pressure and vacuum are achieved by using the weight loaded type DZ/E.

Two different right angle designs are available:

In-line pressure or vacuum relief valve, standard design **DZ/E-F -** $\boxed{-}$

In-line pressure or vacuum relief valve with heating jacket **DZ/E-F -** $\boxed{H}$

Additional special devices available upon request.

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	110 / 4.33	110 / 4.33	125 / 4.92	125 / 4.92	170 / 6.69	190 / 7.48	230 / 9.06	275 / 10.83	325 / 12.80	350* / 13.78
b	75 / 2.95	75 / 2.95	90 / 3.54	90 / 3.54	115 / 4.53	120 / 4.72	160 / 6.30	225 / 8.86	275 / 10.83	300 / 11.81
c	150 / 5.91	150 / 5.91	170 / 6.69	170 / 6.69	235 / 9.25	280 / 11.02	335 / 13.19	420 / 16.54	505 / 19.88	565 / 22.24
d	435 / 17.13	435 / 17.13	445 / 17.52	445 / 17.52	605 / 23.82	700 / 27.56	970 / 38.19	1205 / 47.44	1275 / 52.36	1330 / 52.36

Dimensions for pressure or vacuum relief valve with heating jacket upon request

* for ANSI 12" = 400 mm / 15.75 inches

Table 2: Material selection for housing

Design	A	B	
Housing Heating jacket (DZ/E-F-H-...)	Steel Steel	Stainless Steel Stainless Steel	Option: Housing with ECTFE-lining Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Gasket	WS 3822	PTFE	
Valve pallet	A	A	

Table 3: Material of valve pallet

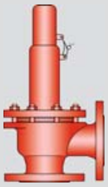
Design	A
Pressure range [mbar] [In W.C.]	±60 up to ±500 ±24 up to ±200
Valve pallet	Stainless Steel
Sealing	Metal to Metal
Spring	Stainless Steel

Special materials upon request

Devices with higher set pressure or vacuum are available upon request, for lower set pressures or vacuum refer to type DZ/E.

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Pressure or Vacuum Relief Valve, In-Line

PROTEGO® DZ/E-F

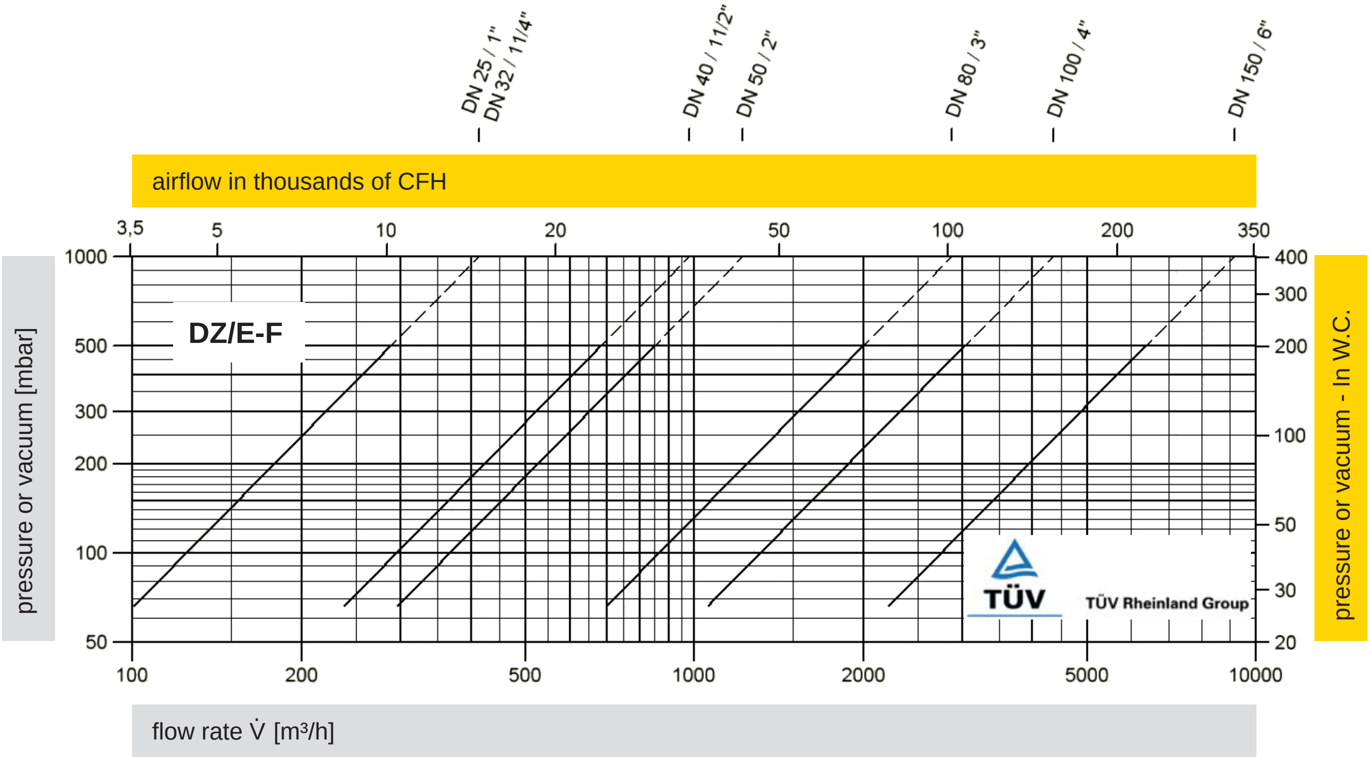
Type	Heating jacket	Nominal size	Material (housing)	Set pressure or set vacuum	Material (valve pallet)	Flange connection type
DZ/E-F –	–	–	–	/ –	–	
Design		Tab. 1	Tab. 2	Setting [mbar] Setting [In W.C.]	Tab. 3	Tab. 4

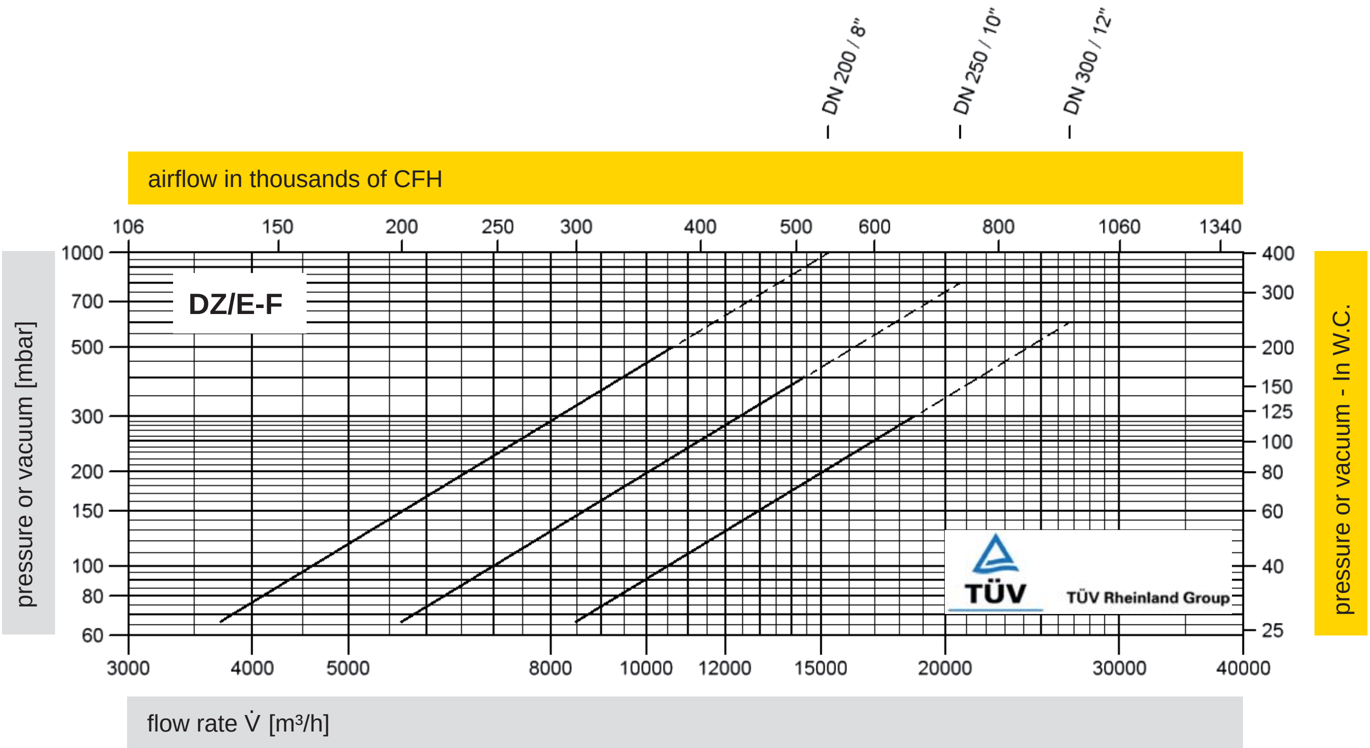
Order example

DZ/E-F –	H –	50 –	B –	200 / – –	A –	DIN

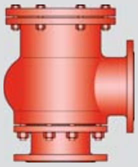
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® DZ/E-F





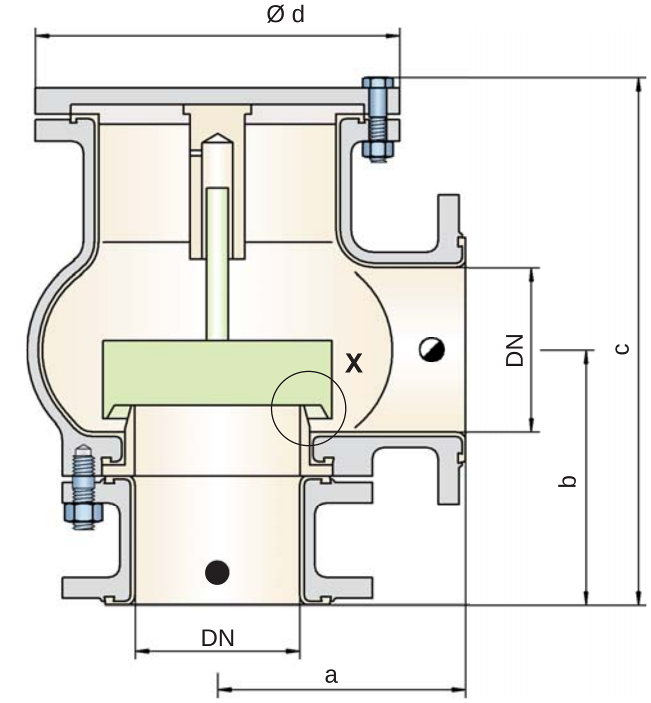
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



Pressure or Vacuum Relief Valve, In-Line

With PFA Lining

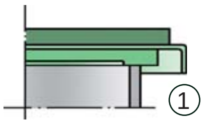
PROTEGO® DZ/EA



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Detail **X**



Flow direction marked at the housing by →

Pressure or vacuum settings:

±5.0 mbar up to ±50 mbar
±2.0 In W.C. up to ±20 In W.C.

For higher set pressure or vacuum refer to type DZ/EA-F

Function and Description

The lined PROTEGO® in-line valve DZ/EA is a state-of-the-art pressure or vacuum relief valve in right angle design. The lining makes this model a perfect solution for corrosive, polymerizing or sticky media. All internal parts are manufactured from PTFE or other highly corrosion resistant materials. Typically the valve is installed in the in- or out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for pressure and vacuum relief. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by specially finished PTFE valve seats or by use of hastelloy valve seats and with individually lapped valve pallets (1). After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- internal lining and correct material selection makes this type the perfect solution for corrosive, polymerizing and sticky media
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- compact right angle design saves space
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Design and Specification

The valve pallet is weight loaded. Higher set pressures for pressure and vacuum are achieved by using spring loaded type DZ/EA-F.

In-line pressure or vacuum relief valve, standard design **DZ/EA**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions

Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	168 / 6.61	180 / 7.09	200 / 7.87	228 / 8.98
b	167 / 6.57	177 / 6.97	200 / 7.87	232 / 9.13
c	330 / 12.99	390 / 15.35	445 / 17.52	485 / 19.09
d	200 / 7.87	240 / 9.45	280 / 11.02	335 / 13.19

Table 2: Material selection for housing

Design	A	B	C	D	
Housing	Steel	Steel	Stainless Steel	Stainless Steel	Semi-conductive material and special material (i.e. ETFE) upon request
Lining	PFA	PFA	PFA	PFA	
Cover	Steel	Steel	Stainless Steel	Stainless Steel	
Valve seat	PTFE	Hastelloy	PTFE	Hastelloy	
Guiding disc	PTFE	PTFE	PTFE	PTFE	
Valve pallet	A	A, B	A	A, B	

Table 3: Material selection for valve pallet

Design	A	B	
Pressure range [mbar] [In W.C.]	±5 up to ±50 ±2 up to ±20	±5 up to ±50 ±2 up to ±20	Special materials upon request For higher set pressure or vacuum refer to type DZ/EA-F
Valve pallet	PTFE	Hastelloy	
Sealing	PTFE	Metal to Metal	

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type — Nominal size — Material (housing) — Set pressure or set vacuum — Material (valve pallet) — Flange connection type

DZ/EA	–		–		–	/	–		–	

Tab. 1 — Tab. 2 — Setting [mbar] / Setting [In W.C.] — Tab. 3 — Tab. 4

Order example

DZ/EA	–	80	–	B	–	20 / –	–	A	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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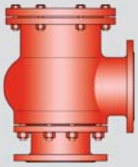
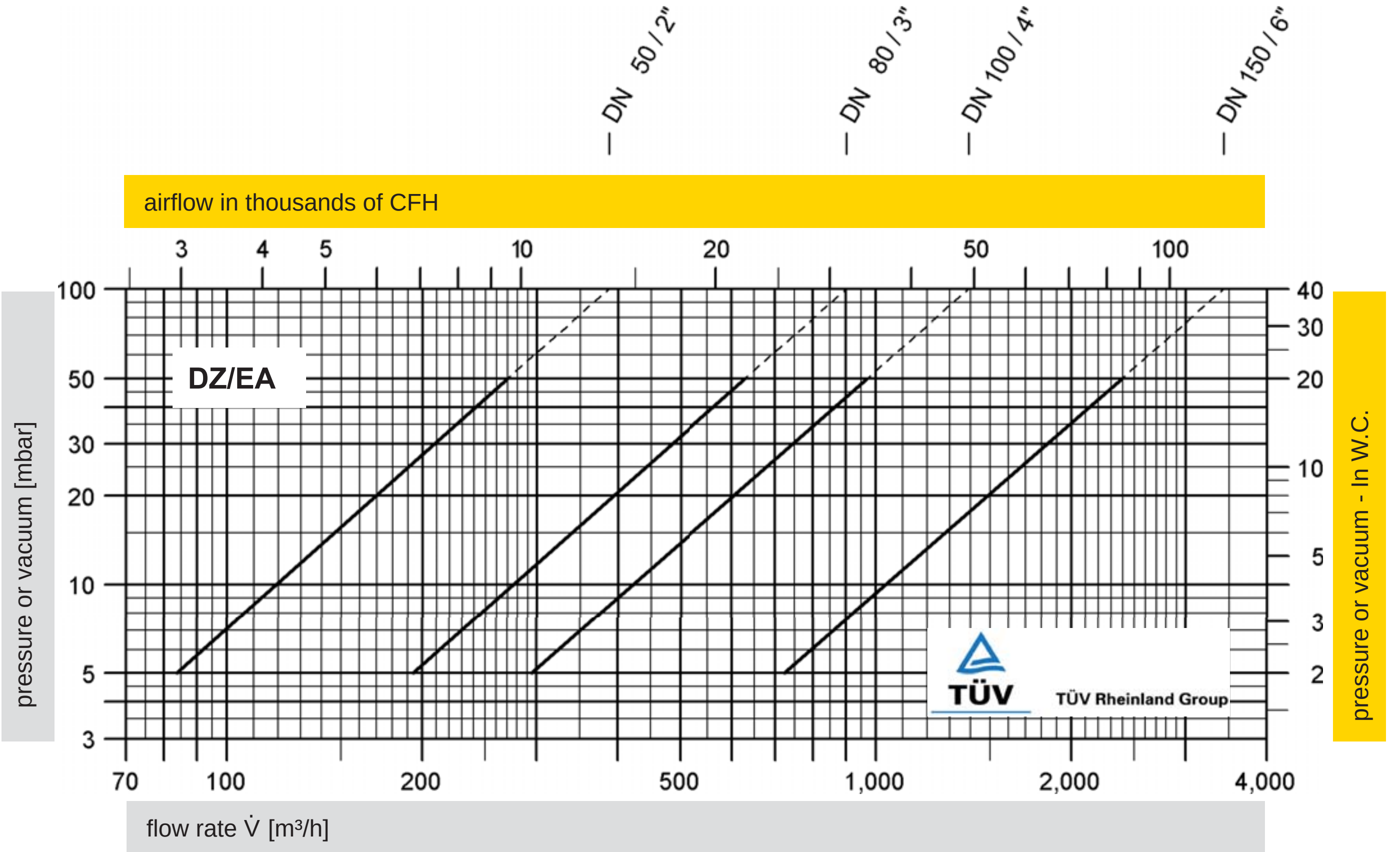
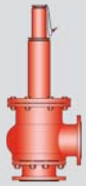




The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

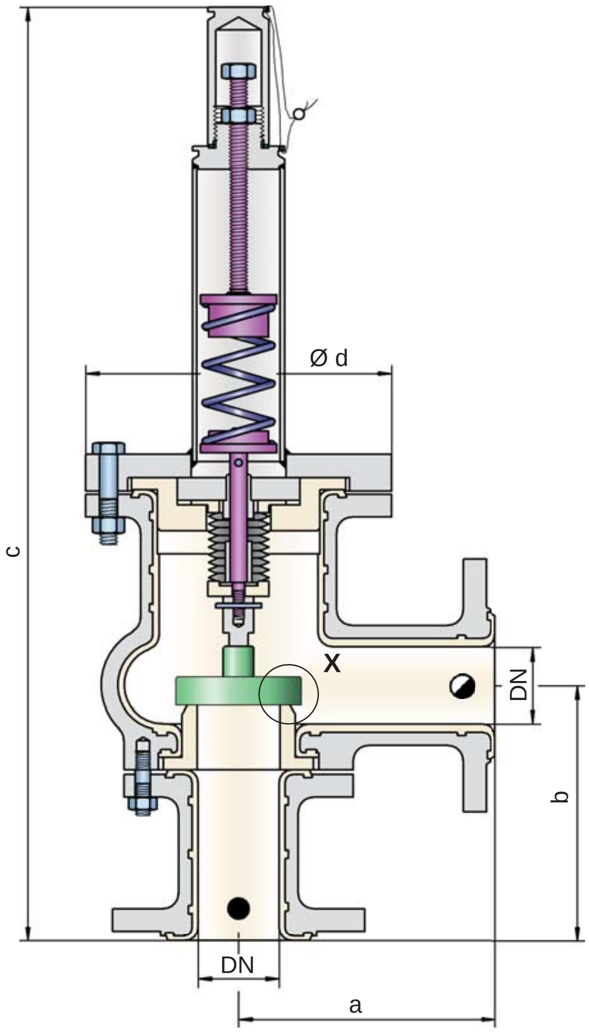
Notes:



Pressure or Vacuum Relief Valve, In-Line

With PFA Lining

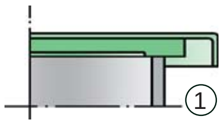
PROTEGO® DZ/EA-F



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Detail **X**



Flow direction marked at the housing by ➝

Pressure or vacuum settings:

±60 mbar up to ±500 mbar
±24 In W.C. up to ±200 In W.C.

For lower set pressure or vacuum refer to type DZ/EA

Function and Description

The lined PROTEGO® in-line valve DZ/EA-F is a state-of-the-art pressure or vacuum relief valve in right angle design for higher set pressures. The lining makes this model a perfect solution for corrosive, polymerizing or sticky media. All internal parts are manufactured from PTFE or other highly corrosion resistant materials. Typically the valve is installed in the in- or out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system. This spring loaded model allows higher set pressures than the DZ/EA.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by specially finished PTFE valve seats or by use of hastelloy valve seats and with individually lapped valve pallets (1). After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- internal lining and correct material selection makes this type the perfect solution for corrosive, polymerizing and sticky media
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- compact right angle design saves space
- housing designed to 150 psi (PN 10)
- spring loaded design for higher set pressures
- maintenance friendly design

Designs and Specifications

The vent pallet is spring loaded. Lower set pressures for pressure and vacuum are achieved by using the type DZ/EA.

In-line pressure or vacuum relief valve, standard design **DZ/EA-F**

Additional special devices available upon request.

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	168 / 6.61	180 / 7.09	200 / 7.87	228 / 8.98
b	167 / 6.57	177 / 6.97	200 / 7.87	232 / 9.13
c	615 / 24.21	785 / 30.91	915 / 36.02	1160 / 45.67
d	200 / 7.87	240 / 9.45	280 / 11.02	335 / 13.19

Table 2: Material selection for housing

Design	A	B
Housing	Steel	Stainless Steel
Lining	PFA	PFA
Cover	Steel	Stainless Steel
Valve seat	Hastelloy	Hastelloy
Guiding disc	PTFE	PTFE
Valve pallet	A	A

Semi-conductive material and special material (i.e. ETFE) upon request

Table 3: Material for valve pallet

Design	A
Pressure range [mbar] [In W.C.]	±60 up to ±500 ±24 up to ±200
Valve pallet	Hastelloy
Spindle / Guiding	Hastelloy
Sealing	Metal to Metal

Special materials upon request

Devices with higher set pressure or vacuum are available upon request, for lower set pressures or vacuum refer to type DZ/EA

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

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Type — Nominal size — Material (housing) — Set pressure or set vacuum — Material (valve pallet) — Flange connection type

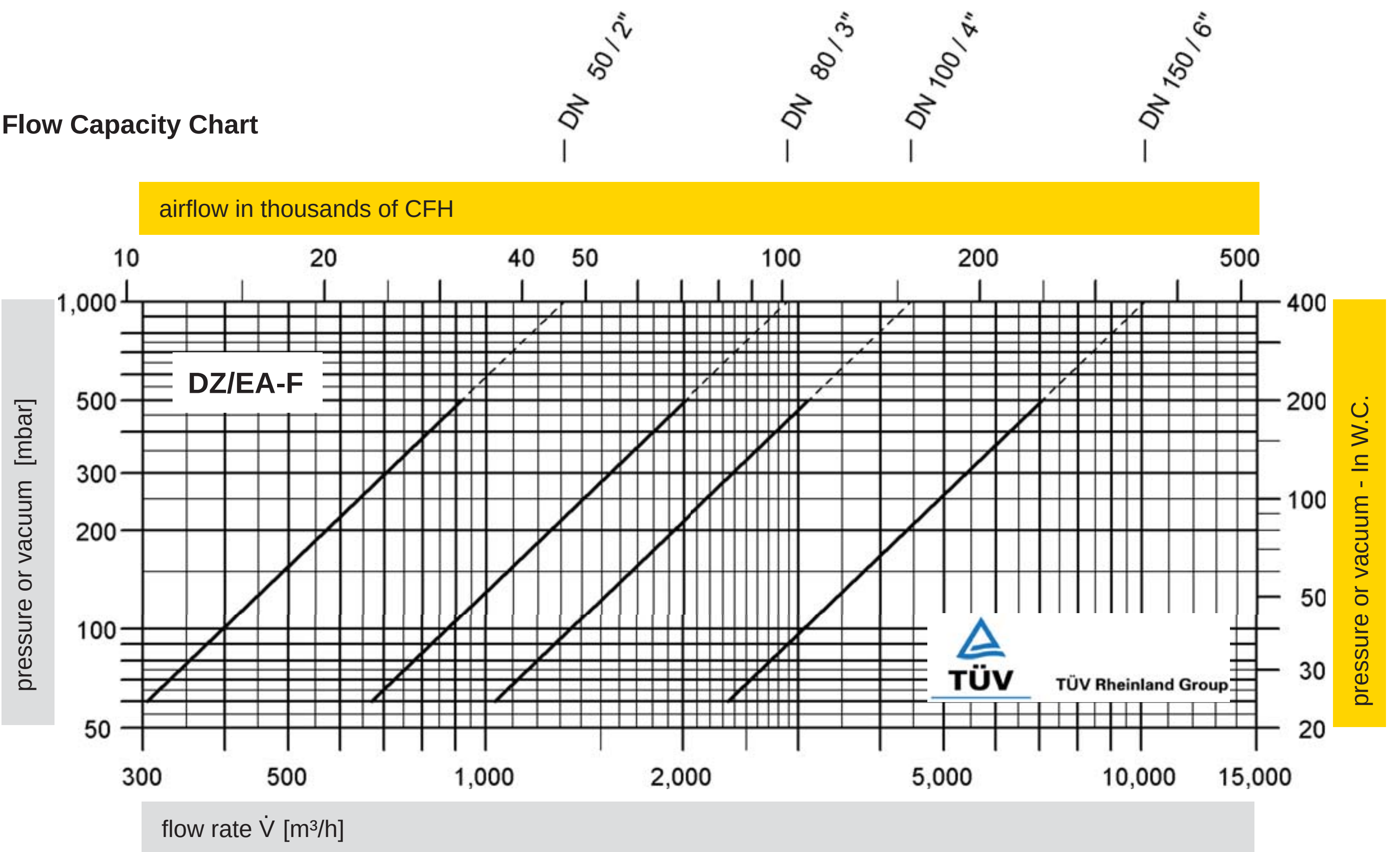
DZ/EA-F	–		–		–	/	–		–	
		Tab. 1		Tab. 2		Setting [mbar] / Setting [In W.C.]		Tab. 3		Tab. 4

Order example

DZ/EA-F	–	80	–	B	–	200 / –	–	A	–	DIN

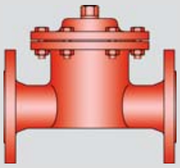
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



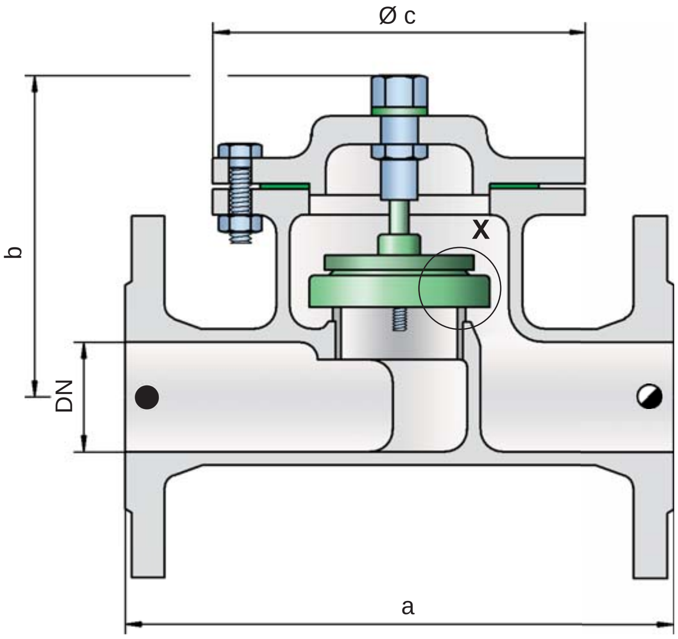
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:

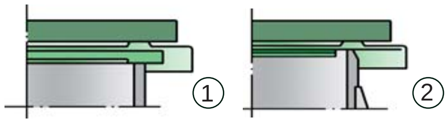


Pressure or Vacuum Relief Valve, In-Line

PROTEGO® DZ/T



Detail **X**



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Flow direction marked at the housing by →

Pressure or vacuum settings:

DN 25 and 32	±3.5 mbar	up to	±60 mbar
DN 1" and 1 ¼"	±1.4 In W.C.	up to	±24 In W.C.
DN 40 up to 300	±2.0 mbar	up to	±60 mbar
DN 1 ½"up to 12"	±0.8 In W.C.	up to	±24 In W.C.

For higher set pressure or vacuum refer to type DZ/T-F

Function and Description

The PROTEGO® in-line valve DZ/T is a state-of-the-art pressure or vacuum relief valve. Typically the valve is installed in the in- or out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Designs and Specifications

The valve pallet is weight loaded. Higher set pressures for pressure and vacuum are achieved by using spring loaded type DZ/T-F.

Two different designs are available:

In-line pressure or vacuum relief valve, standard design	**DZ/T - –**
In-line pressure or vacuum relief valve with heating jacket	**DZ/T - H**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Tabelle 1: Dimensions										Dimensions in mm / inches
To select the nominal size (DN), please use the flow capacity chart on the following page										
DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	220 / 8.66	220 / 8.66	250 / 9.84	250 / 9.84	340 / 13.39	380 / 14.96	460 / 18.11	550 / 21.65	650 / 25.59	700 / 27.56
b	140 / 5.51	140 / 5.51	190 / 7.48	190 / 7.48	210 / 8.27	240 / 9.45	305 / 12.01	460 / 18.11	515 / 20.28	555 / 21.85
c	150 / 5.91	150 / 5.91	170 / 6.69	170 / 6.69	235 / 9.25	280 / 11.02	335 / 13.19	420 / 16.54	505 / 19.88	565 / 22.24

Dimensions for pressure or vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing			
Design	A	B	C
Housing Heating jacket (DZ/T-H-...)	Steel Steel	Stainless Steel Stainless Steel	Hastelloy Stainless Steel
Valve seat	Stainless Steel	Stainless Steel	Hastelloy
Gasket	WS 3822	PTFE	PTFE
Valve pallet DN 40 - 300 / 1 ½" - 12"	A, C, E, F	A, C, E, F	B, D, G
Valve pallet DN 25 - 32 / 1" - 1 ¼"	H, I, J	H, I, J	–

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material selection for valve pallet							
DN 40 - 300 / 1 ½" - 12"							
Design	A	B	C	D	E	F	G
Pressure range [mbar] [In W.C.]	±2.0 up to ±3.5 ±0.8 up to ±1.4	±2.0 up to ±3.5 ±0.8 up to ±1.4	±3.5 up to ±14 ±1.4 up to ±5.6	±3.5 up to ±14 ±1.4 up to ±5.6	±14 up to ±60 ±5.6 up to ±24	±14 up to ±60 ±5.6 up to ±24	±14 up to ±60 ±5.6 up to ±24
Valve pallet	Aluminium	Titanium	Stainless Steel	Titanium	Stainless Steel	Stainless Steel	Hastelloy
Sealing	FEP	FEP	FEP	FEP	Metal to Metal	PTFE	Metal to Metal

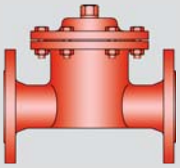
DN 25 - 32 / 1" - 1 ¼"			
Design	H	I	J
Pressure range [mbar] [In W.C.]	±3,5 up to ±15 ±1.4 up to ±6.0	±15 up to ±60 ±6.0 up to ±24	±15 up to ±60 ±6.0 up to ±24
Valve pallet	PTFE	Stainless Steel	Stainless Steel
Sealing	PTFE	Metal to Metal	PTFE

Special materials upon request

For higher set pressure or vacuum refer to type DZ/T-F

Table 4: Flange connection type	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request



Pressure or Vacuum Relief Valve, In-Line

PROTEGO® DZ/T

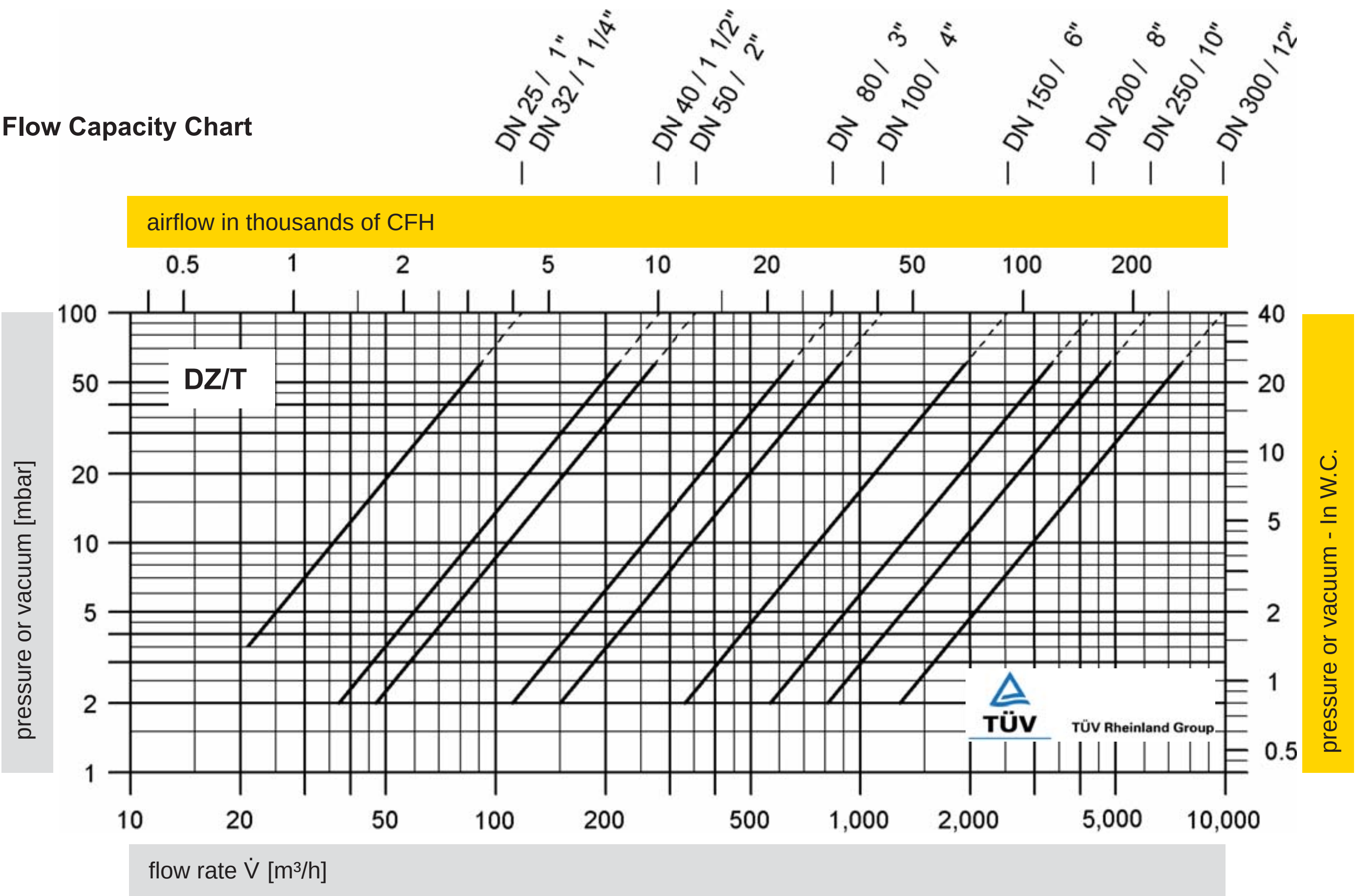
Type	Heating jacket	Nominal size	Material (housing)	Set pressure or set vacuum	Material (valve pallet)	Flange connection typet
DZ/T				/		
Design	Tab. 1	Tab. 2		Setting [mbar] / Setting [In W.C.]	Tab. 3	Tab. 4

Order example

DZ/T	H	80	B	50 / –	E	DIN

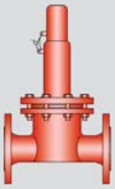
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



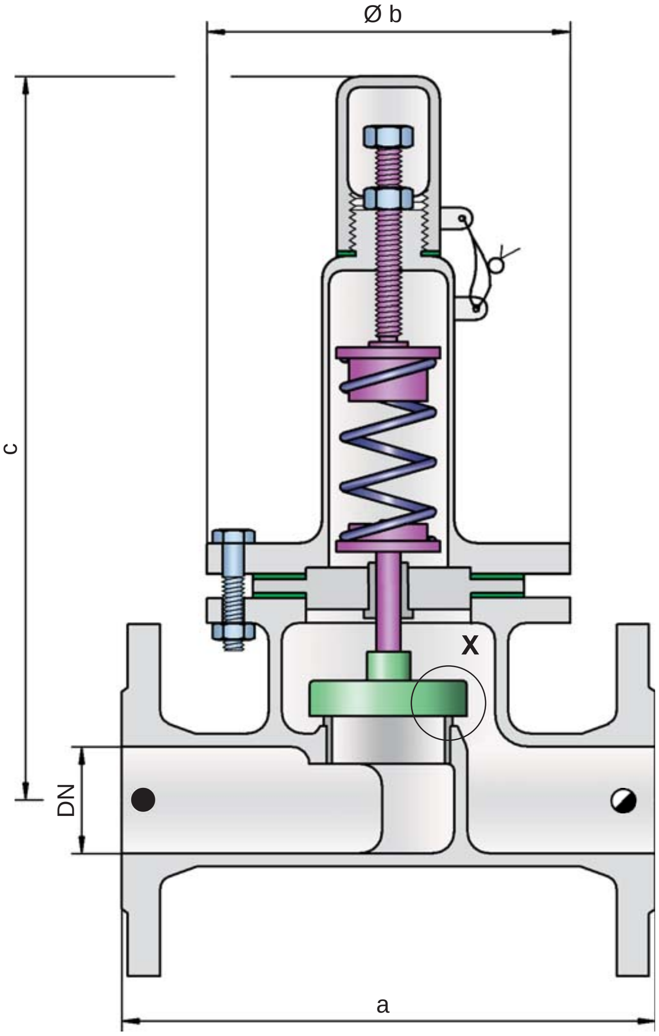
The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:



Pressure or Vacuum Relief Valve, In-Line

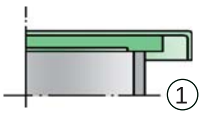
PROTEGO® DZ/T-F



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Detail **X**



Flow direction marked at the housing by →

Pressure or vacuum settings:

±60 mbar up to ±500 mbar
±24 In W.C. up to ±200 In W.C.

Devices with higher set pressure or vacuum are available upon request, for lower set pressures or vacuum refer to type DZ/T.

Function and Description

The PROTEGO® in-line valve DZ/T-F is a state-of-the-art pressure or vacuum relief valve for higher system pressures. Typically the valve is installed in the in- or out-breathing lines of Tanks, Vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system. As this device is equipped with a spring higher set pressures can be reached compared to the DZ/T.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic is the same for pressure and vacuum relief. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) and rugged valve bodies. After the excess pressure is discharged or the vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be used as pressure or vacuum relief valve
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- spring loaded for elevated set pressures
- maintenance friendly design

Designs and Specifications

The valve pallet is spring loaded. Lower set pressures for pressure and vacuum are achieved by using the weight loaded type DZ/T.

Two different designs are available:

In-line pressure or vacuum relief valve, standard design **DZ/T-F - –**

In-line pressure or vacuum relief valve with heating jacket **DZ/T-F - H**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	25 / 1"	32 / 1 ¼"	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	220 / 8.66	220 / 8.66	250 / 9.84	250 / 9.84	340 / 13.39	380 / 14.96	460 / 18.11	550 / 21.65	650 / 25.59	700 / 27.56
b	150 / 5.91	150 / 5.91	170 / 6.69	170 / 6.69	235 / 9.25	280 / 11.02	335 / 13.19	420 / 16.54	505 / 19.88	565 / 22.24
c	395 / 15.55	395 / 15.55	420 / 16.54	420 / 16.54	570 / 22.44	680 / 26.77	940 / 37.01	1160 / 45.67	1215 / 47.83	1255 / 49.41

Dimensions for pressure or vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B
Housing Heating jacket (DZ/T-F-H-...)	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Gasket	WS 3822	PTFE
Valve pallet	A	A

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material of valve pallet

Design	A
Pressure range [mbar] [In W.C.]	±60 up to ±500 ±24 up to ±200
Valve pallet	Stainless Steel
Sealing	Metal to Metal
Pressure spring	Stainless Steel

Special materials upon request

Devices with higher set pressure or vacuum are available upon request, for lower set pressures or vacuum refer to type DZ/T.

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

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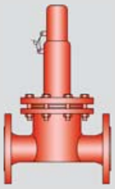


Pressure or Vacuum Relief Valve, In-Line

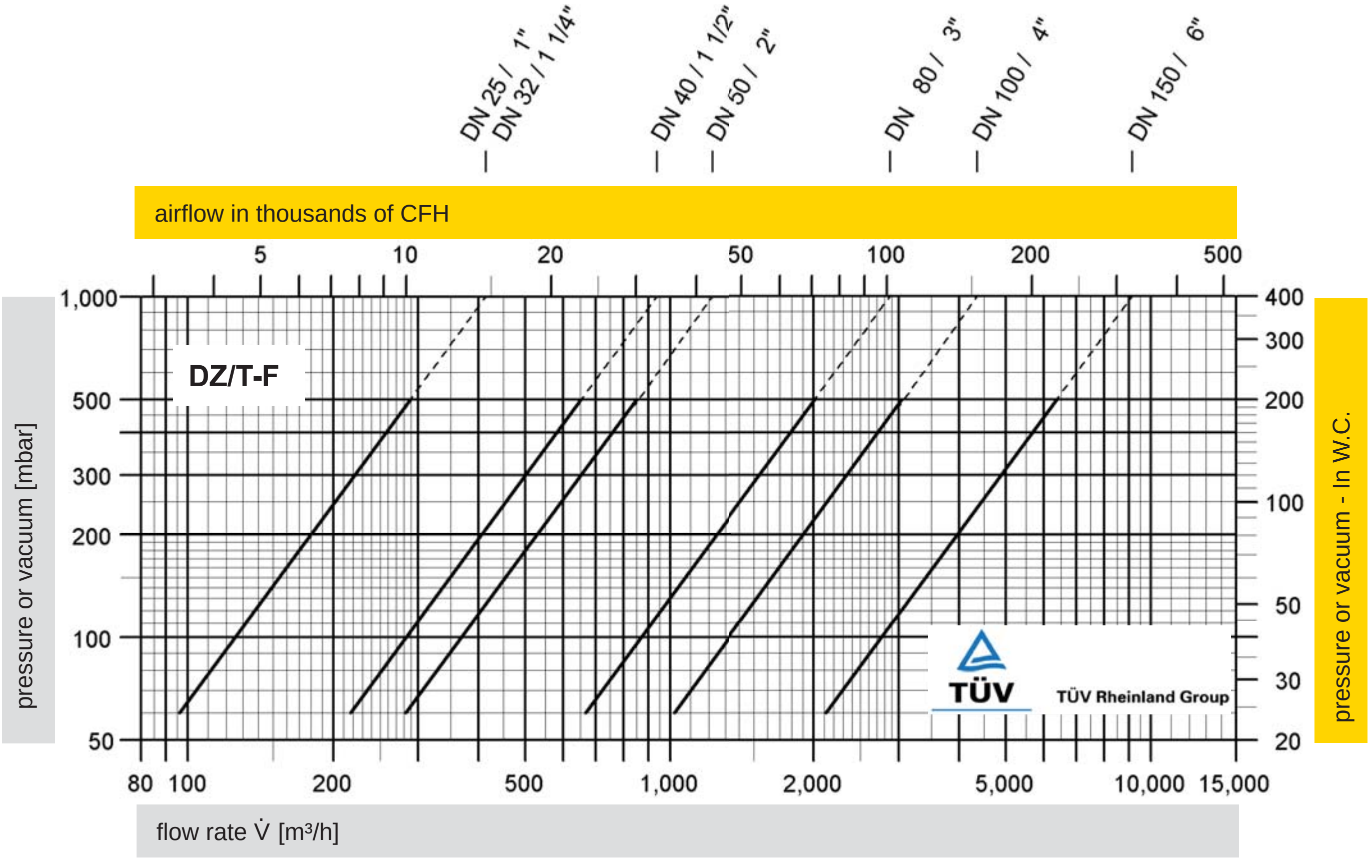
PROTEGO® DZ/T-F

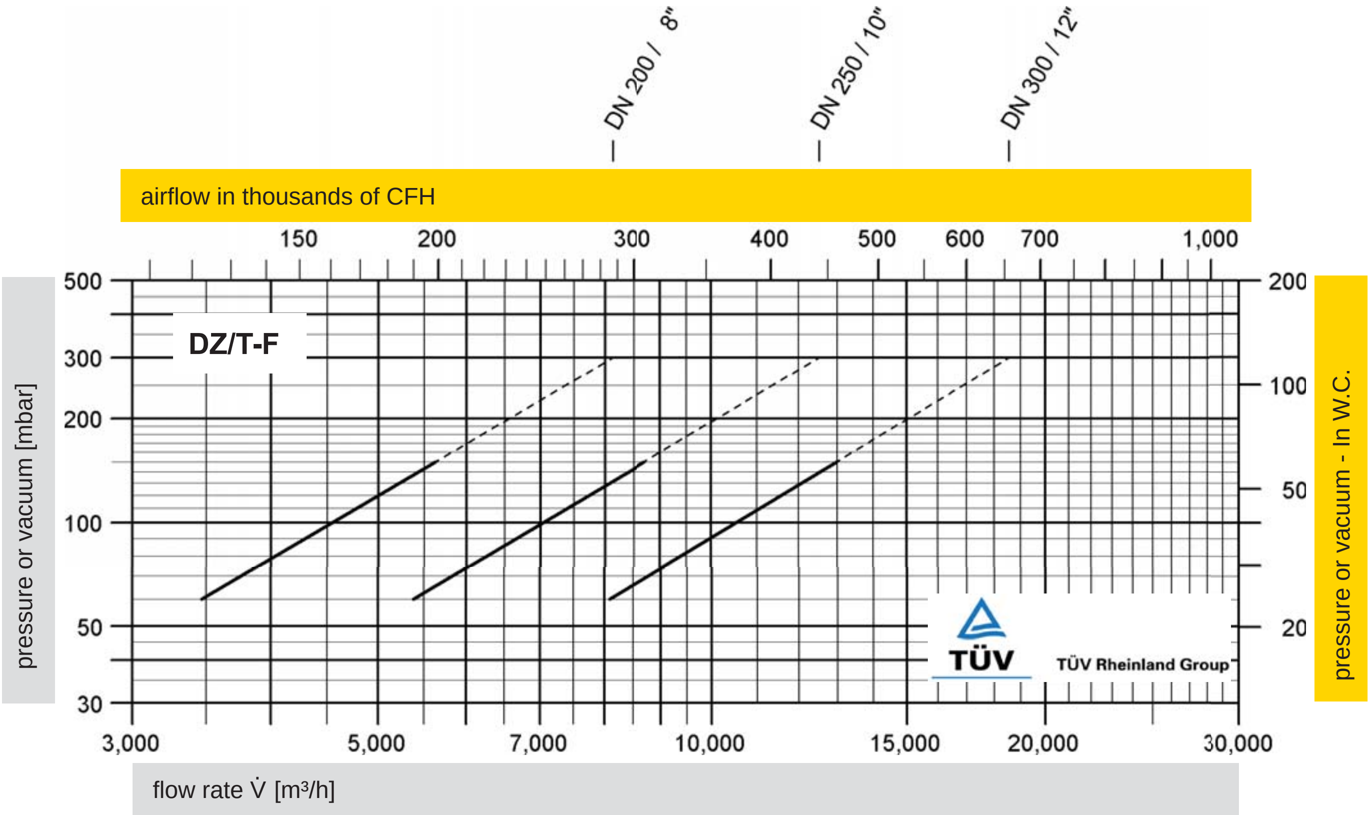
Type	Heating jacket	Nominal size	Material (housing)	Set pressure or set vacuum	Material (valve pallet)	Flange connection type
DZ/T-F	–	–	–	/	–	–
Design		Tab. 1	Tab. 2	Setting [mbar] / Setting [In W.C.]	Tab. 3	Tab. 4

Order example

DZ/T-F	H	50	B	200 / –	A	DIN

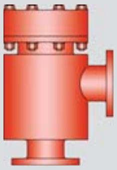
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





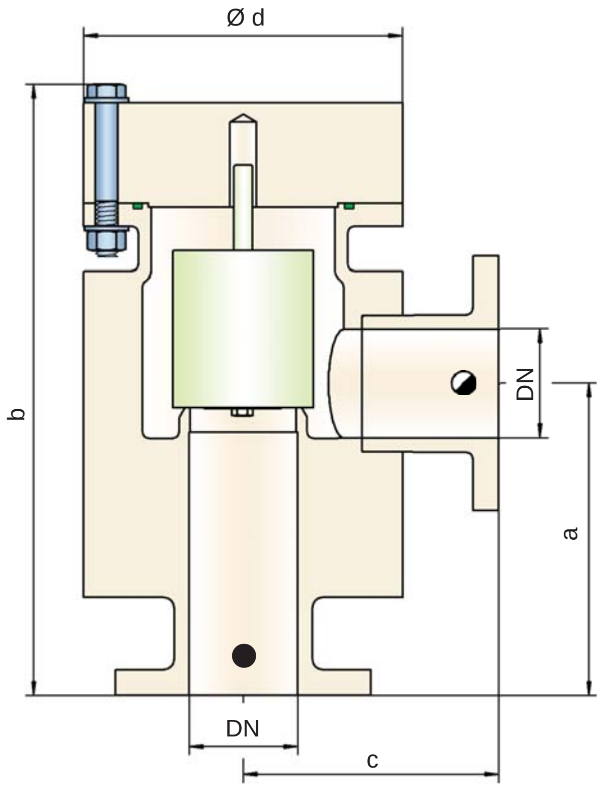
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.



Pressure or Vacuum Relief Valve, In-Line

PROTEGO® R/KSM



● = Tank connection for pressure relief function

◐ = Tank connection for vacuum relief function

Flow direction marked at the housing by ➞

Pressure or vacuum settings:

±5.0 mbar	up to	±100 mbar
±2.0 In W.C.	up to	± 40 In W.C.

Function and Description

The PROTEGO® in-line valve R/KSM is a state-of-the-art pressure or vacuum relief valve in right angle design made out of highgrade synthetic material. Typically the valve is installed in the in- or out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high or low pressure. The valve prevents emission losses almost up to the set pressure or provides protection from product entry into the system. The valve is a perfect solution for corrosive, polymerizing or sticky media.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic for pressure and vacuum side is the same.

Due to our highly developed manufacturing technology, the tank pressure is maintained up to the set pressure, with a tightness that is far superior to the conventional standard. This feature is facilitated by special valve seats made of high quality synthetic material or PTFE. After the excess pressure is discharged or vacuum is compensated, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- can be used as pressure or vacuum relief valve
- compact right angle design saves space
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- corrosion resistant valve
- weight reduction in comparison to steel/stainless steel
- smooth surface
- different plastics can be combined
- maintenance friendly design

Design and Specification

The valve pallet is weight loaded. Highest set pressure range can be reached with metal valve pallets.

In-line pressure or vacuum relief valve, standard design **R/KSM -**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics.

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"
a	200 / 7.87	245 / 9.65	300 / 11.81	370 / 14.57	625 / 24.61 (650 / 25.59)*
b	376 / 14.80	521 / 20.51	563 / 22.17 (523 / 20.59)*	687 / 27.05 (651 / 25.63)*	914 / 35.98 (912 / 35.91)*
c	150 / 5.91	200 / 7.87	225 / 8.86	280 / 11.02	350 / 13.78
d	180 / 7.09	250 / 9.84	300 / 11.81	350 / 13.78 (405 / 15.94)*	560 / 22.05 (500 / 19.68)*

* Dimensions in brackets only for PVDF

Table 2: Material selection for housing

Design	A	B	C
Housing	PE	PP	PVDF
Valve seat	PE	PP	PVDF
Gasket	FPM	FPM	FPM
Valve pallet	A, C, D	B, C, D	C, D

Special materials upon request

Table 3: Material selection for valve pallet

Design	A	B	C	D
Pressure range [mbar] [In W.C.]	±5.0 up to ±17 ±2.0 up to ±6.8	±5.0 up to ±17 ±2.0 up to ±6.8	±10 up to ±32 ±4.0 up to ±12.8	±30 up to ±100 ±12 up to ± 40
Valve pallet	PE	PP	PVDF	Hastelloy
Sealing	PTFE	PTFE	PTFE	PTFE
Spindle guide	PE	PP	PVDF	Hastelloy

Special materials and devices with higher set pressure or vacuum are available upon request

Table 4: Flange connection type

EN 1092-1, Form A or DIN 2501, Form B, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

Type — Nominal size — Material (housing) — Set pressure or set vacuum — Material (valve pallet) — Flange connection type

R/KSM	–		–		–	/	–		–	
		Tab. 1		Tab. 2		Setting [mbar] Setting [In W.C.]		Tab. 3		Tab. 4

Order example

R/KSM	–	200	–	A	–	25 / –	–	C	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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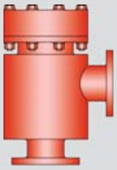
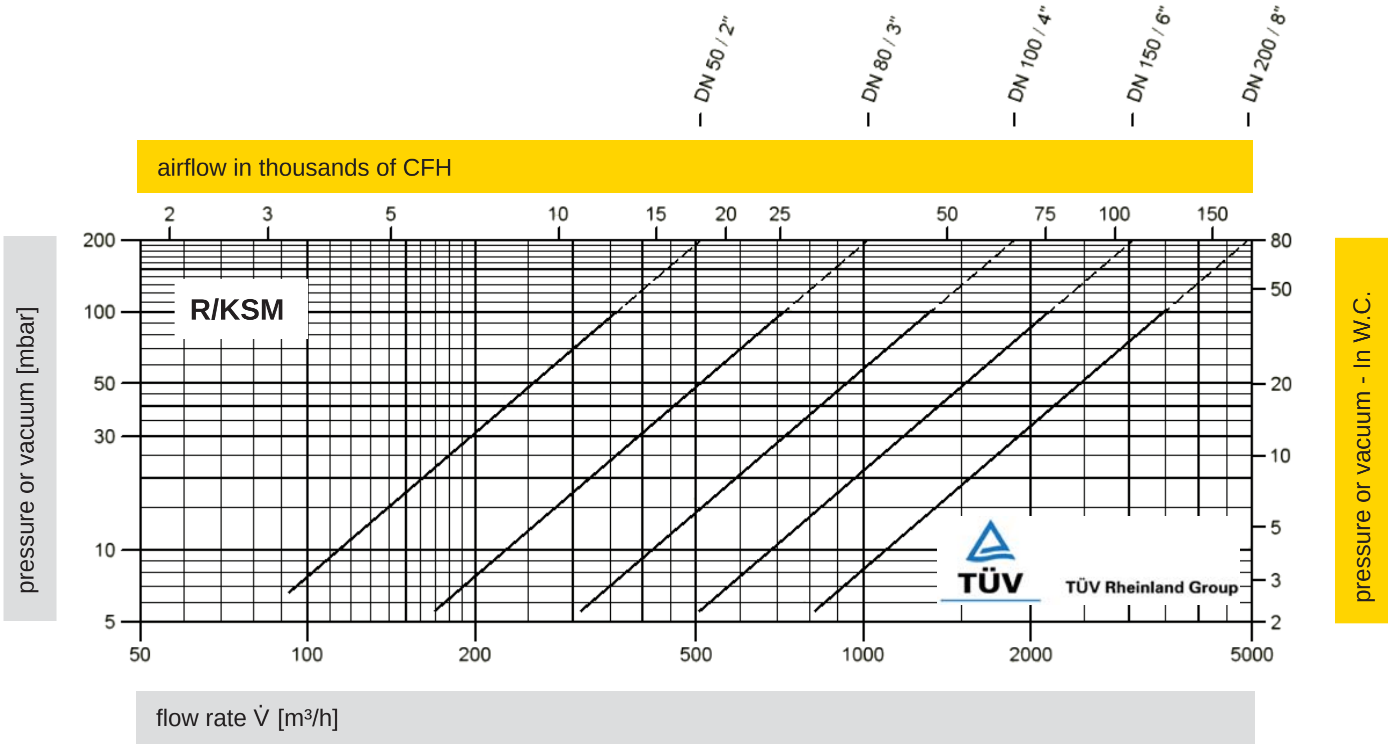


Pressure or Vacuum Relief Valve, In-Line

Flow Capacity Chart

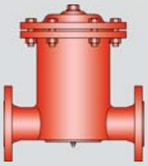
PROTEGO® R/KSM



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

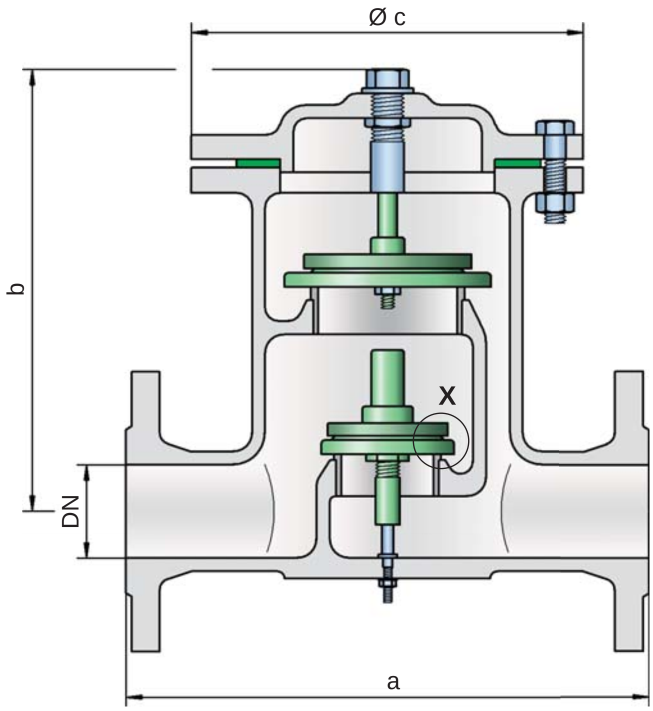
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:

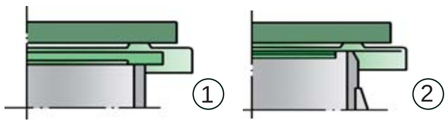


Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZT



Detail **X**



Tank connection depends upon flow capacity, set pressure and set vacuum for in- and outbreathing

Pressure or vacuum settings:

Upper valve pallet:	±2.0 mbar	up to ±60 mbar
	±0.8 In W.C.	up to ±24 In W.C.
Lower valve pallet:	±3.5 mbar	up to ±50 mbar
	±1.4 In W.C.	up to ±20 In W.C.

For higher set pressure refer to type DV/ZT-F. Lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZT is a state-of-the-art pressure and vacuum relief valve. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and provides protection from product entry into the system. Due to its design the lower valve pallet is one size smaller than the upper valve pallet.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Designs and Specifications

The valve pallets are weight loaded. Higher set pressures are achieved by using spring loaded type DV/ZT-F

Two different designs are available:

In-line pressure and vacuum relief valve, standard design	**DV/ZT -** $\boxed{–}$
In-line pressure and vacuum relief valve with heating jacket	**DV/ZT -** $\boxed{\text{H}}$

Additional special devices available upon request.

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following page

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	280 / 11.02	280 / 11.02	340 / 13.39	390 / 15.35	520 / 20.47
b	270 / 10.63	270 / 10.63	290 / 11.42	355 / 13.98	425 / 16.73
c	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35

Larger sizes upon request

Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B
Housing Heating jacket (DV/ZT-H-...)	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Gasket	WS 3822	PTFE

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material selection for upper valve pallet

Design	A	B	C	D
Pressure range [mbar] [In W.C.]	±2.0 up to ±3.5 ±0.8 up to ±1.4	±3.5 up to ±14 ±1.4 up to ±5.6	±14 up to ±60 ±5.6 up to ±24	±14 up to ±60 ±5.6 up to ±24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	PTFE

Special materials upon request

For higher set pressures refer to type DV/ZT-F

Table 4: Material selection for lower valve pallet

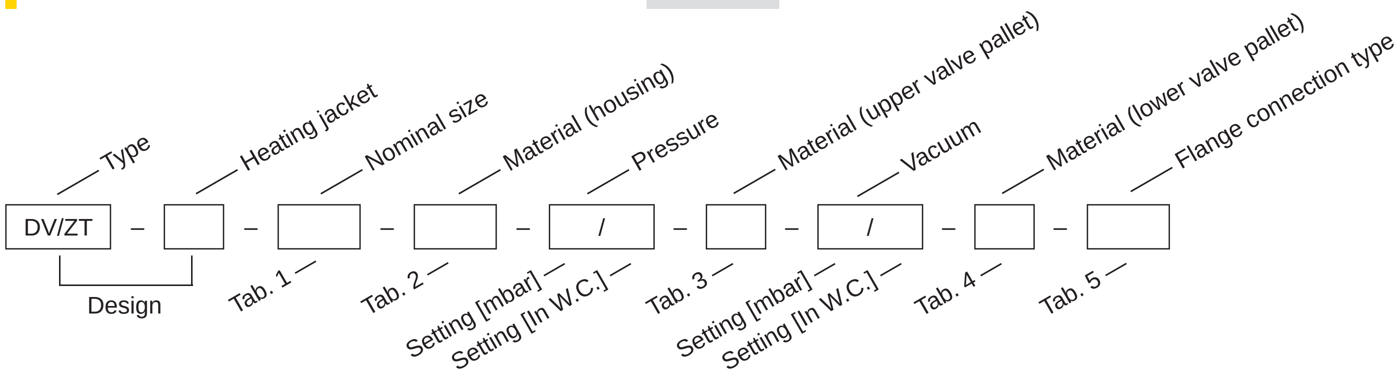
Design	A	B	C	D	E	F
Pressure range [mbar] [In W.C.]	±3.5 up to ±5.0 ±1.4 up to ±2.0	±5.0 up to ±14 ±2.0 up to ±5.6	±14 up to ±35 ±5.6 up to ±14	±35 up to ±50 ±14 up to ±20	±14 up to ±35 ±5.6 up to ±14	±35 up to ±50 ±14 up to ±20
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special materials and lower set vacuum upon request

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request



Order example

DV/ZT	H	100	B	30 / –	C	-4,0 / –	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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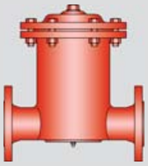
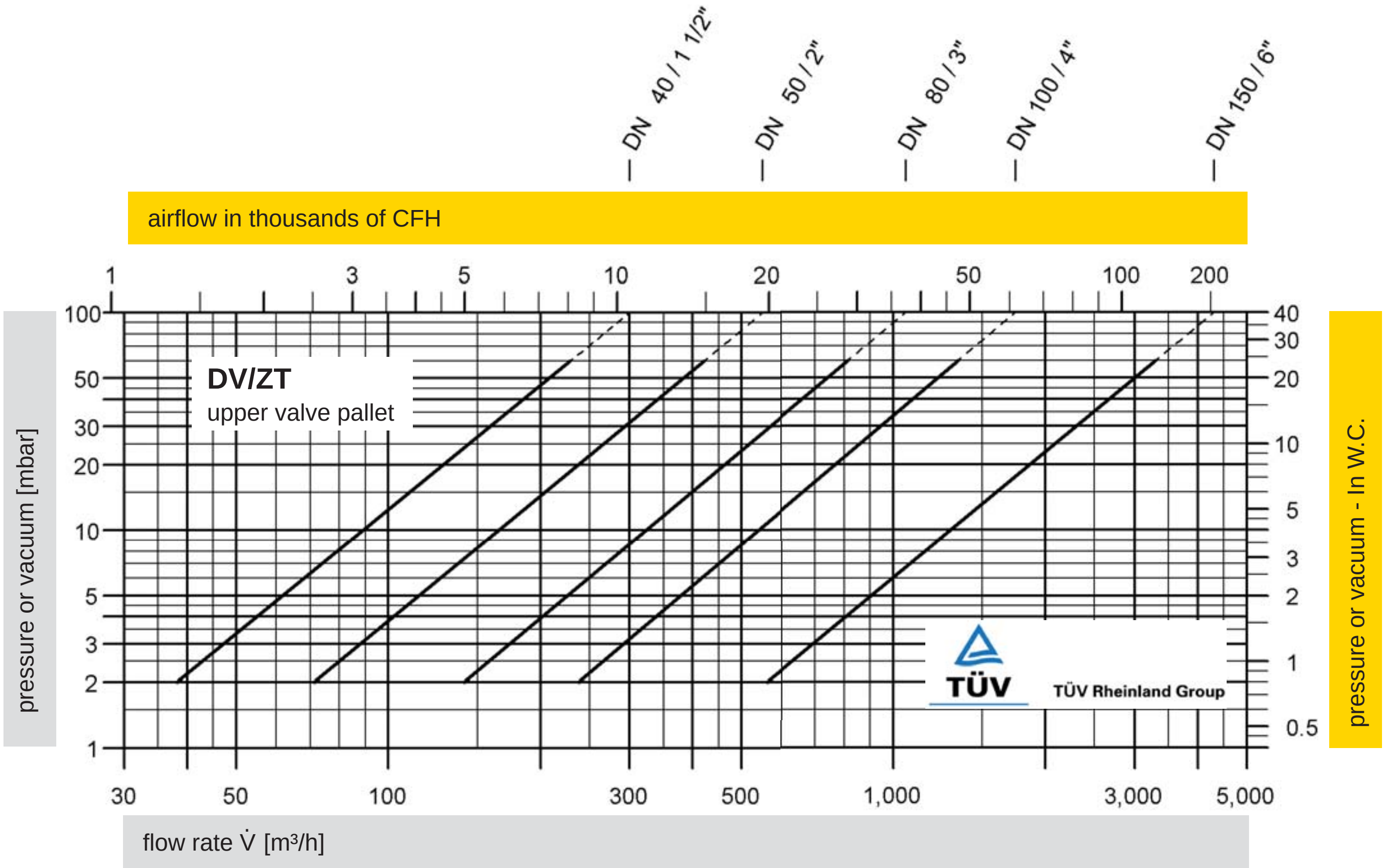
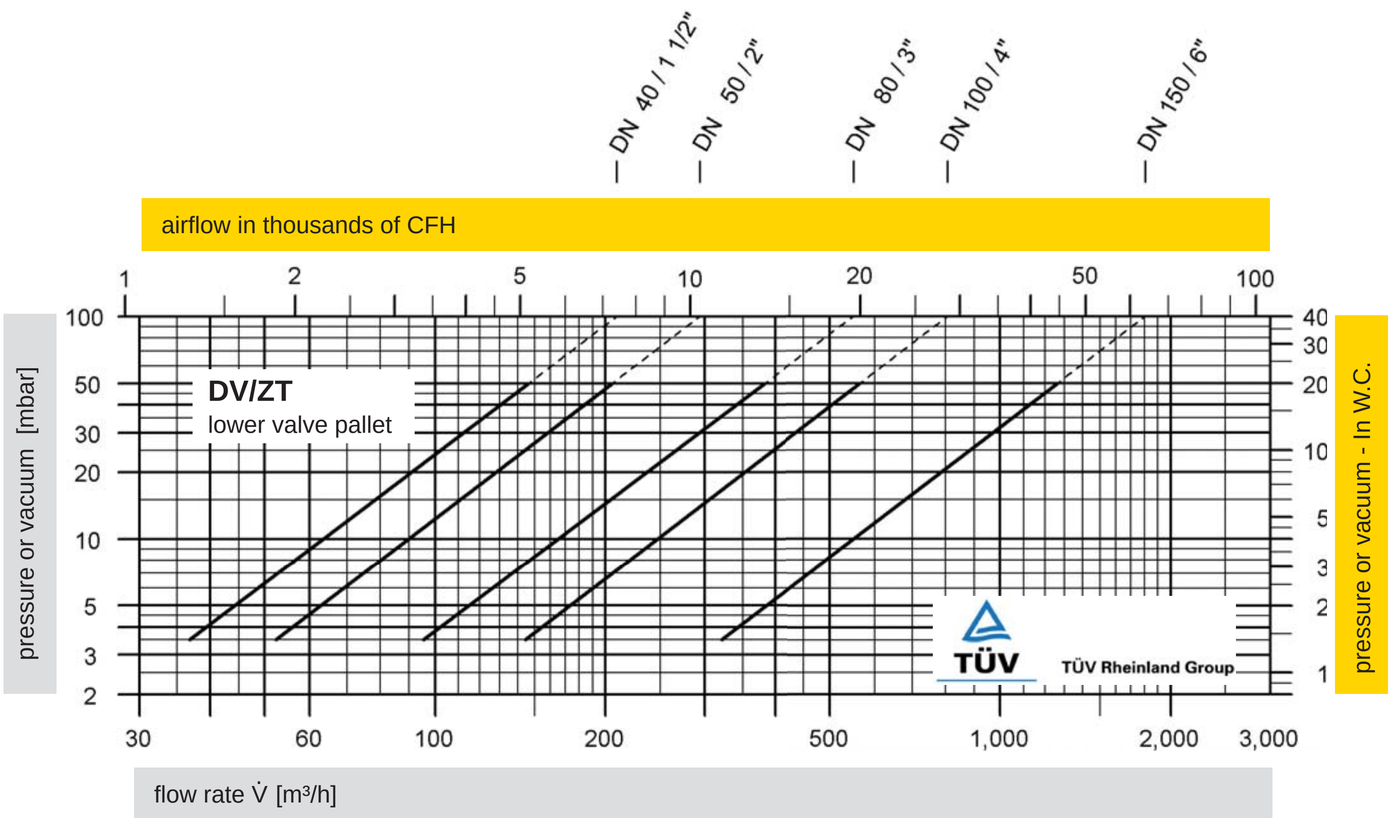


Pressure and Vacuum Relief Valve, In-Line

Flow Capacity Charts

PROTEGO® DV/ZT



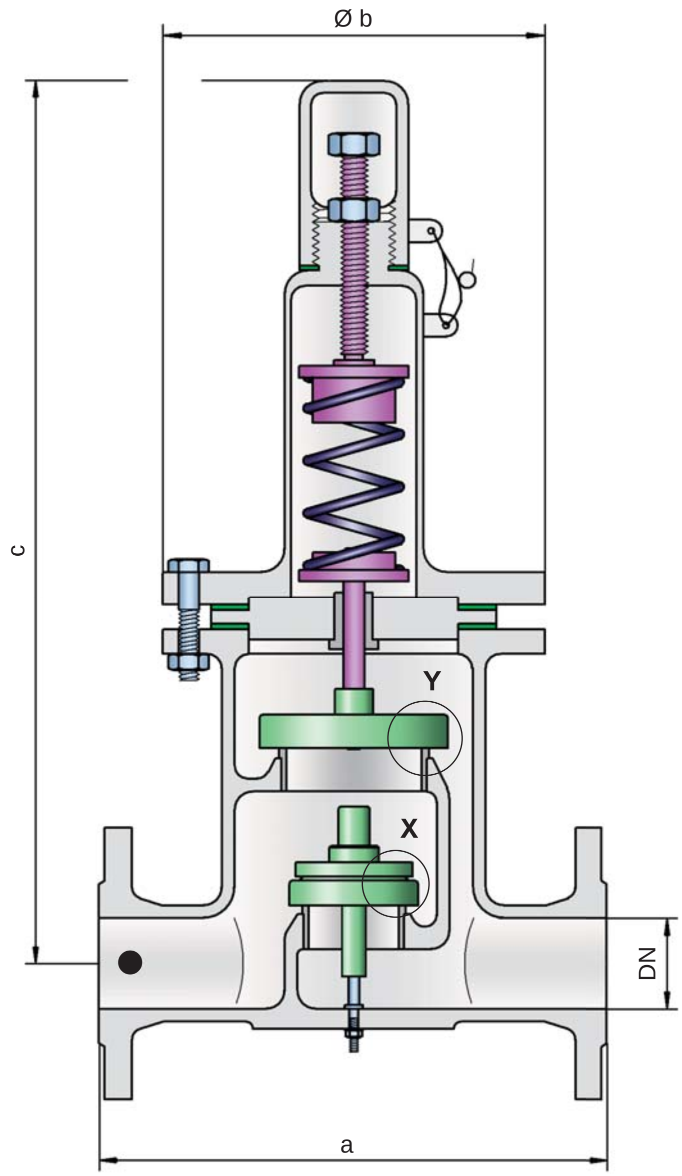


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow $\dot{V}$ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

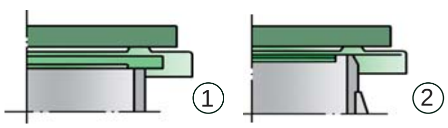
Notes:

Pressure and Vacuum Relief Valve, In-Line

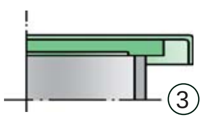
PROTEGO® DV/ZT-F



Detail **X**



Detail **Y**



● = Tank connection

Settings:

Pressure:	+60 mbar	up to +500 mbar
	+24 In W.C.	up to +200 In W.C.
Vacuum:	-14 mbar	up to -50 mbar
	-5.6 In W.C.	up to -20 In W.C.
Vacuum:	-3.5 mbar	up to -14 mbar
	-1.4 In W.C.	up to -5.6 In W.C.
	by set pressure up to +150 mbar / +60 In W.C.	

For lower set pressure refer to type DV/ZT.
Higher set pressure and lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZT-F is a state-of-the-art pressure and vacuum relief valve. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and provides protection from product entry into the system. Due to its design the vacuum valve pallet is one size smaller than the pressure valve pallet. Due to the spring loaded design higher set pressures can be achieved.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1), (3) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm and a rugged valve body. After the excess pressure is discharged or the vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- spring loaded on pressure side to achieve higher set pressures
- maintenance friendly design

Designs and Specifications

The pressure valve pallet is spring loaded, the vacuum valve pallet weight loaded. Lower set pressures for the pressure side are achieved through weight loaded type DV/ZT.

Two different designs are available:

In-line pressure and vacuum relief valve, standard design **DV/ZT-F** $\boxed{-}$

In-line pressure and vacuum relief valve with heating jacket **DV/ZT-F -** $\boxed{H}$

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	280 / 11.02	280 / 11.02	340 / 13.39	390 / 15.35	520 / 20.47
b	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35
c	605 / 23.82	605 / 23.82	730 / 28.74	870 / 34.25	1170 / 46.06

Larger sizes upon request
Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	
Housing Heating jacket (DV/ZT-F-H-...)	Steel Steel	Stainless Steel Stainless Steel	Option: Housing with ECTFE-lining Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Gasket	WS 3822	PTFE	

Table 3: Material of pressure valve pallet

Design	A	
Pressure range [mbar] [In W.C.]	>+60 up to +500 >+24 up to +200	Special materials upon request
Valve pallet	Stainless Steel	For lower set pressure use type DV/ZT. Higher set pressure and lower set vacuum upon request.
Sealing	Metal to Metal	
Pressure spring	Stainless Steel	

Table 4: Material selection for vacuum valve pallet

Design	A*	B*	C	D	
Pressure range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20	Special materials and lower set vacuum upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	

* by set pressure up to +150 mbar / +60 In W.C.

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZT-F

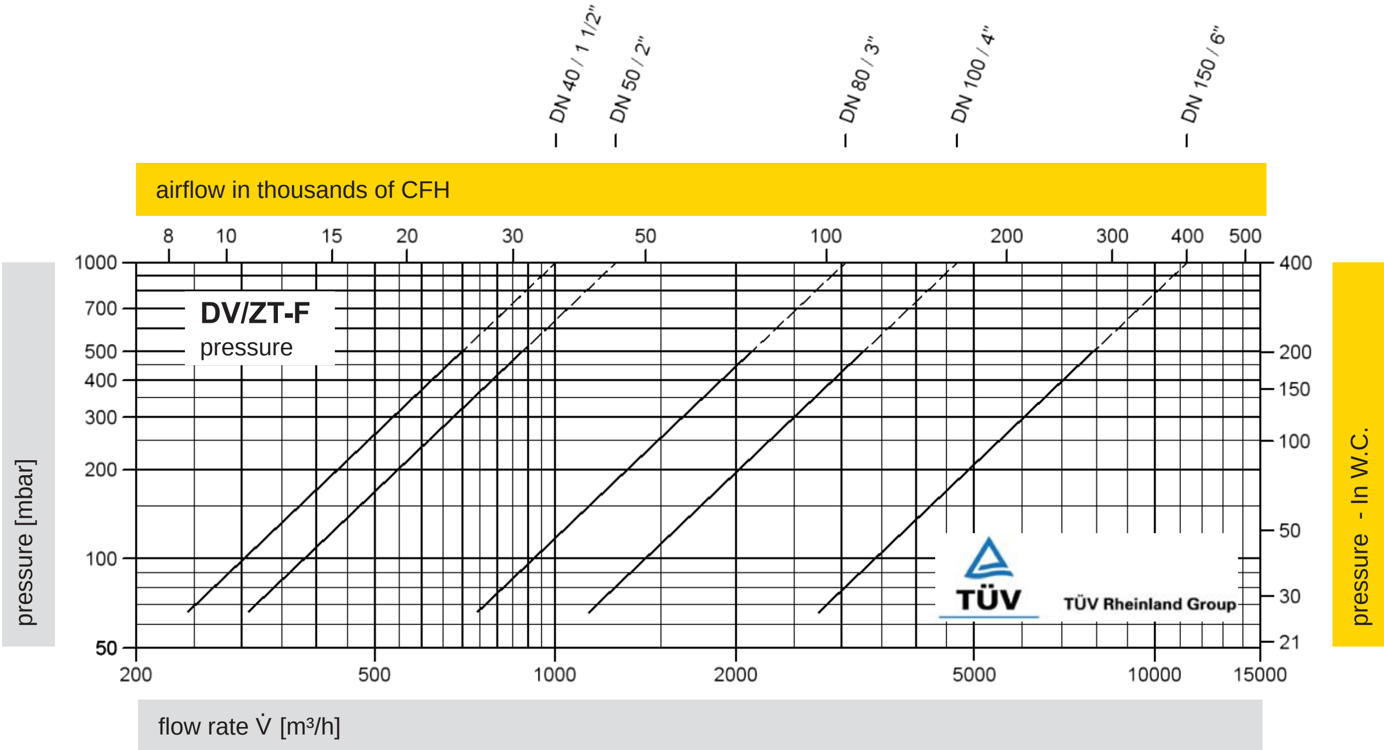
Type	Heating jacket	Nominal size	Material (housing)	Pressure	Material (pressure valve pallet)	Vacuum	Material (vacuum valve pallet)	Flange connection type
DV/ZT-F	–	–	–	/	–	/	–	–
Design	Design	Tab. 1	Tab. 2	Setting [mbar] / Setting [In W.C.]	Tab. 3	Setting [mbar] / Setting [In W.C.]	Tab. 4	Tab. 5

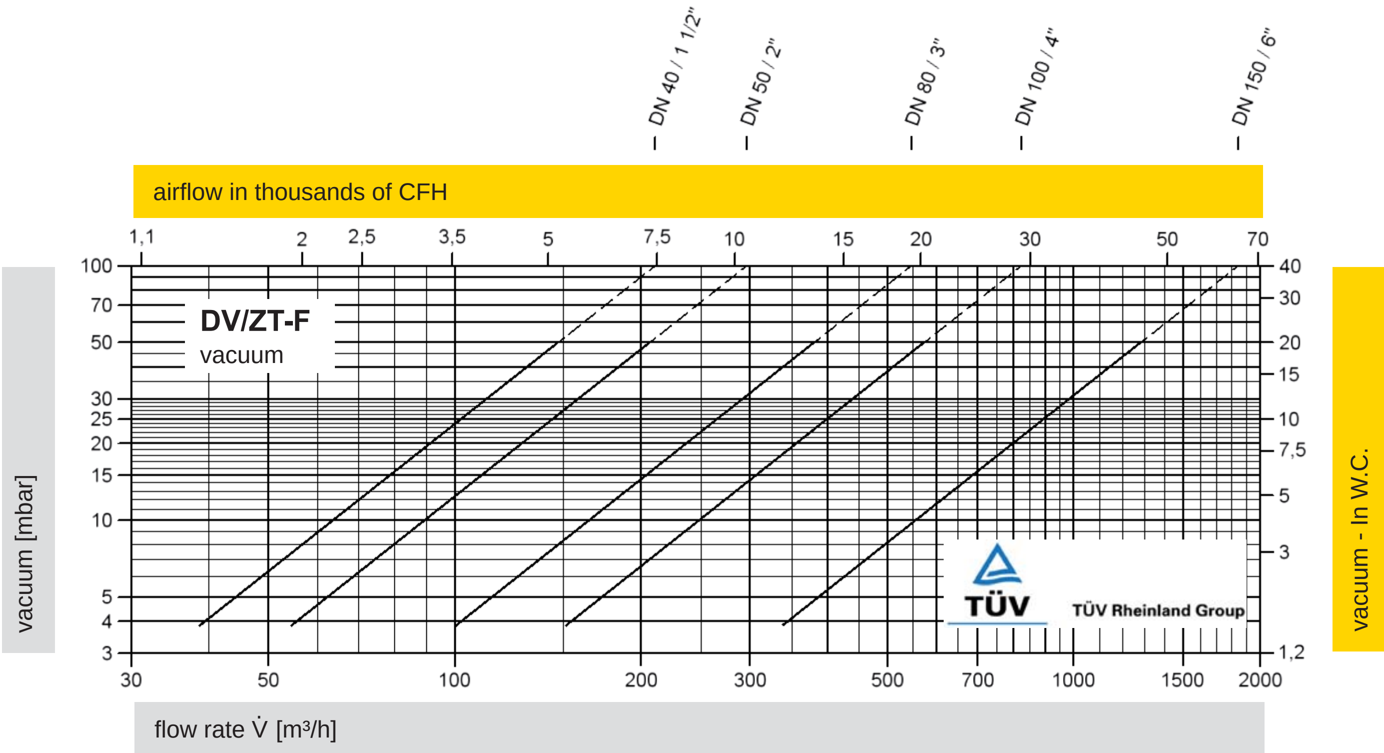
Order example

DV/ZT-F	H	100	B	300 / –	A	-4,0 / –	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

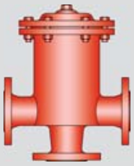
PROTEGO® DV/ZT-F





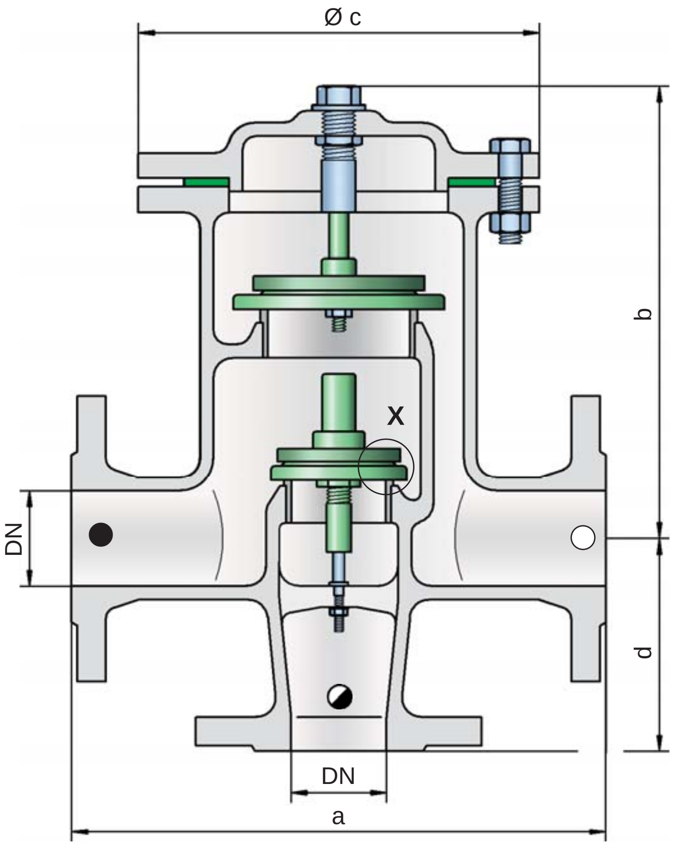
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

for safety and environment



Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZU



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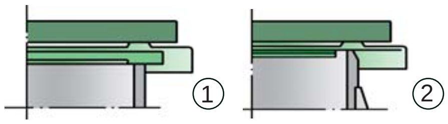


● = Tank connection

◑ = Inbreathing

○ = Outbreathing

Settings:

Pressure:	+2.0 mbar	up to +60 mbar
	+0.8 In W.C.	up to +24 In W.C.
Vacuum:	-3.5 mbar	up to -50 mbar
	-1.4 In W.C.	up to -20 In W.C.

For higher set pressure refer to type DV/ZU-F.
Lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZU is a state-of-the-art pressure and vacuum relief valve with separate flange connections for pressure and vacuum breathing. Typically the valve is installed in the in- and outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum. The valve is designed so that in cases in which the set pressure is exceeded the vapours are vented into a discharge pipe (i.e. vent header). When the set vacuum is exceeded atmospheric air is pulled into the system. Due to its design the vacuum valve pallet is one size smaller than the pressure valve pallet.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This "full lift type" technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic of the pressure and vacuum side is basically the same. However, the inbreathing will start as soon as the differential pressure between the connected inbreathing line and the tank is greater than the set pressure of the vacuum pallet. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the vent body and vent pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- "full lift type" technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- separate flange connection for in- and out-breathing line
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Designs and Specifications

The valve pallets are weight loaded. Higher set pressures are achieved by using spring loaded type DV/ZU-F

Two different designs are available:

In-line pressure and vacuum relief valve, standard design	**DV/ZU - –**
In-line pressure and vacuum relief valve with heating jacket	**DV/ZU - H**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	280 / 11.02	280 / 11.02	340 / 13.39	390 / 15.35	520 / 20.47
b	230 / 9.06	230 / 9.06	240 / 9.45	290 / 11.42	330 / 12.99
c	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35
d	165 / 6.50	165 / 6.50	200 / 7.87	240 / 9.45	300 /11.81

Larger sizes upon request
Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	
Housing Heating jacket (DV/ZU-H-...)	Steel Steel	Stainless Steel Stainless Steel	Option: Housing with ECTFE-lining
Valve seat	Stainless Steel	Stainless Steel	Special materials upon request
Gasket	WS 3822	PTFE	

Table 3: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +60 >+5.6 up to +24	>+14 up to +60 >+5.6 up to +24	Special materials upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	For higher set pressures refer to type DV/ZU-F
Sealing	FEP	FEP	Metal to Metal	PTFE	

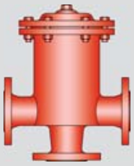
Table 4: Material selection for vacuum valve pallet

Design	A	B	C	D	E	F
Pressure range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special materials and lower set vacuum upon request

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZU

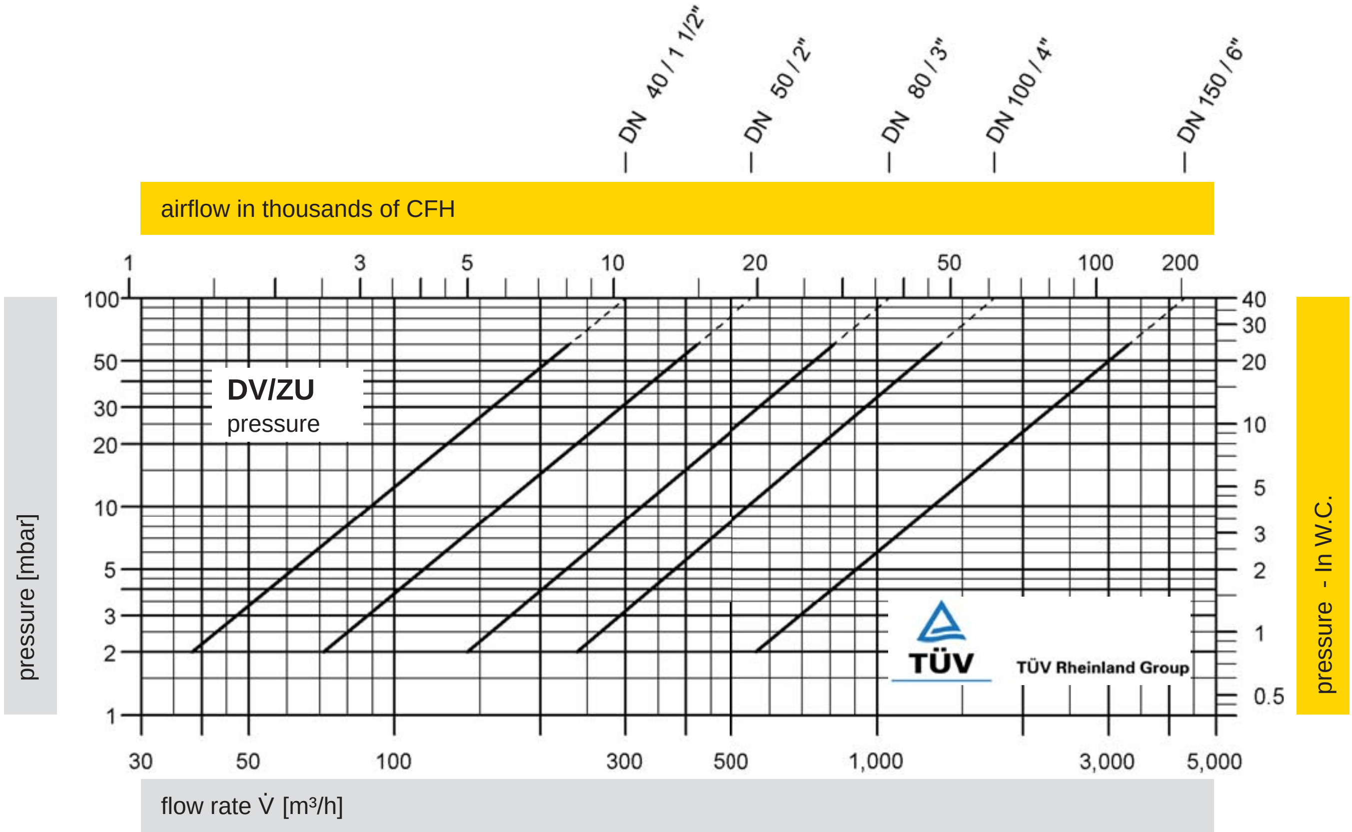
Type	Heating jacket	Nominal size	Material (housing)	Pressure	Material (pressure valve pallet)	Vacuum	Material (vacuum valve pallet)	Flange connection type
DV/ZU				/		/		
Design	Tab. 1	Tab. 2		Setting [mbar] Setting [In W.C.]	Tab. 3	Setting [mbar] Setting [In W.C.]	Tab. 4	Tab. 5

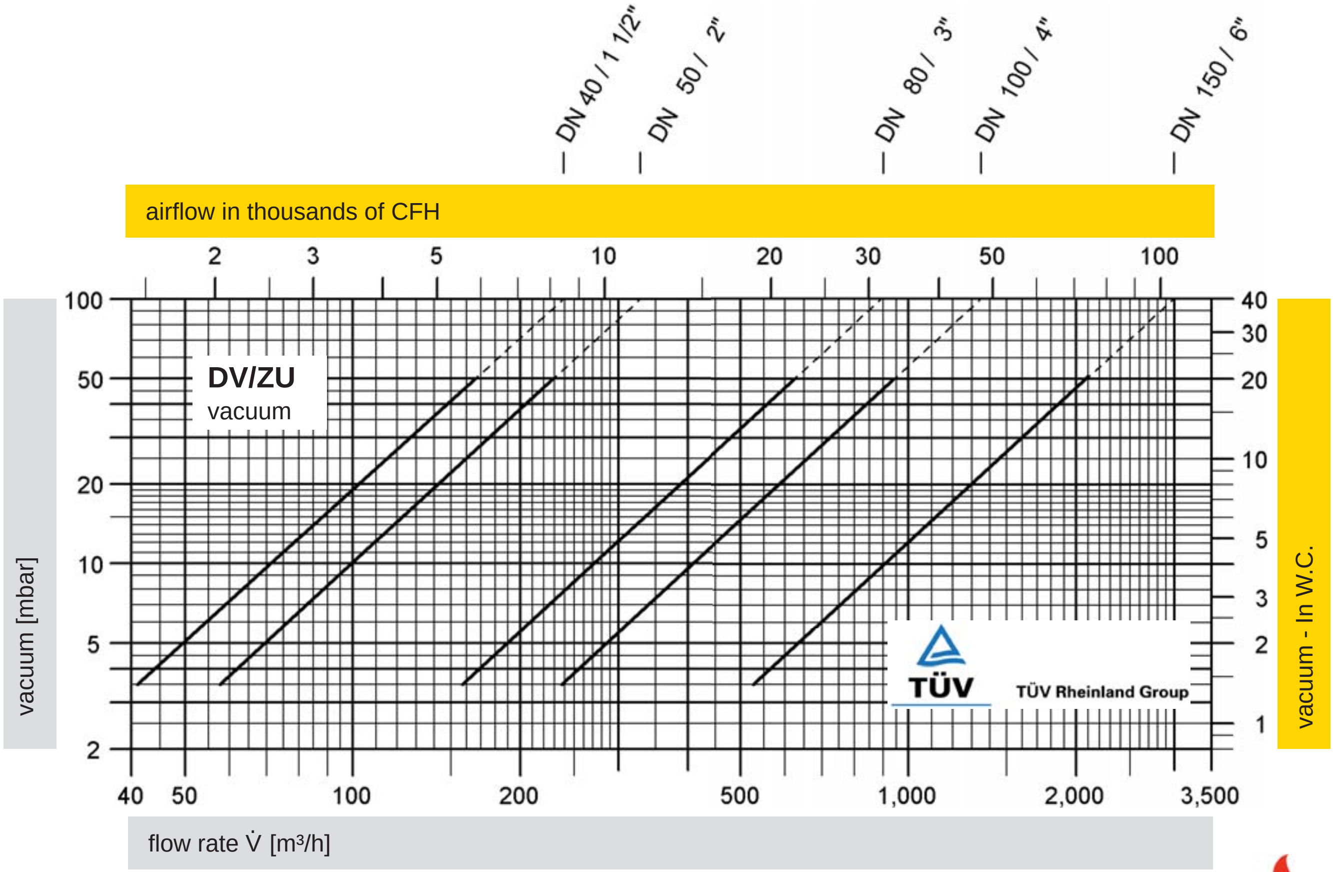
(Design covers the Type and Heating jacket boxes.)

Order example

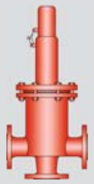
DV/ZU	– H	– 100	– B	– 30 / –	– C	– -4,0 / –	– A	– DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



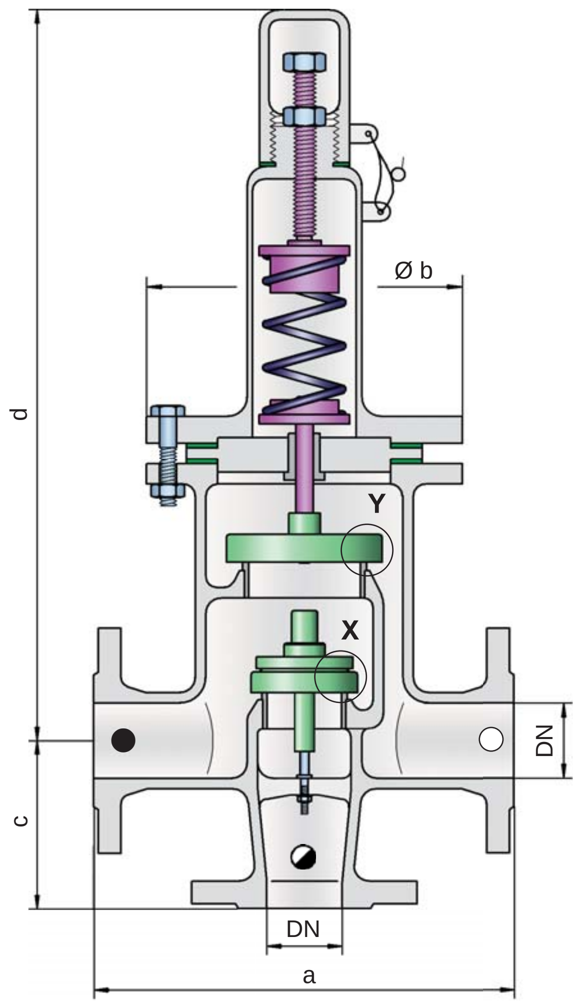


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZU-F



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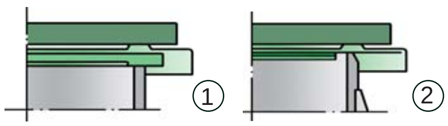

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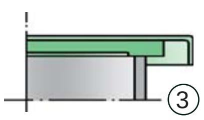

● = Tank connection

◐ = Inbreathing

○ = Outbreathing

Settings:

Pressure:	+60 mbar +24 In W.C.	up to +500 mbar up to +200 In W.C.
Vacuum:	-3.5 mbar -1.4 In W.C.	up to -50 mbar up to -20 In W.C.
Vacuum:	-3.5 mbar -1.4 In W.C.	up to -14 mbar up to -5.6 In W.C. by set pressure up to +150 mbar / +60 In W.C.

For lower set pressure refer to type DV/ZU.
Higher set pressure and lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZU is a state-of-the-art pressure and vacuum relief valve with separate flange connections for pressure and vacuum breathing. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum. The valve is designed so that in cases in which the set pressure is exceeded the vapours are vented into a discharge pipe (i.e. vent header). When the set vacuum is exceeded atmospheric air is pulled into the system. Due to its design the vacuum valve pallet is one size smaller than the pressure valve pallet. The spring loaded design of the pressure pallet allows achieving higher set pressures.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic of the pressure and vacuum side is basically the same. However, the inbreathing will start as soon as the differential pressure between the connected inbreathing line and the tank is greater than the set pressure of the vacuum pallet. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1), (3) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm and a rugged valve body. After the excess pressure is discharged or the vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- separate flange connection for in- and outbreathing line
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- spring loaded pressure side to achieve higher set pressures
- maintenance friendly design

Designs and Specifications

The pressure valve pallet is spring loaded, the vacuum valve pallet weight loaded. Lower set pressures for the pressure side are achieved through weight loaded type DV/ZU.

Two different designs are available:

In-line pressure and vacuum relief valve, standard design **DV/ZU-F** [–]

In-line pressure and vacuum relief valve with heating jacket **DV/ZU-F - [H]**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	280 / 11.02	280 / 11.02	340 / 13.39	390 / 15.35	520 / 20.47
b	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35
c	165 / 6.50	165 / 6.50	200 / 7.87	240 / 9.45	300 / 11.81
d	565 / 22.24	565 / 22.24	675 / 26.57	805 / 31.69	1070 / 42.13

Larger sizes upon request

Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B
Housing Heating jacket (DV/ZU-F-H-...)	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Gasket	WS 3822	PTFE

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material of pressure valve pallet

Design	A
Pressure range [mbar] [In W.C.]	>+60 up to +500 >+24 up to +200
Valve pallet	Stainless Steel
Sealing	Metal to Metal
Pressure spring	Stainless Steel

Special materials upon request

For lower set pressure use type DV/ZU
Higher set pressure and lower set vacuum upon request

Table 4: Material selection for vacuum valve pallet

Design	A*	B*	C	D
Pressure range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal

Special materials and lower set vacuum upon request

* by set pressure up to +150 mbar / +60 In W.C.

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

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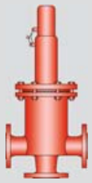


Pressure and Vacuum Relief Valve, In-Line

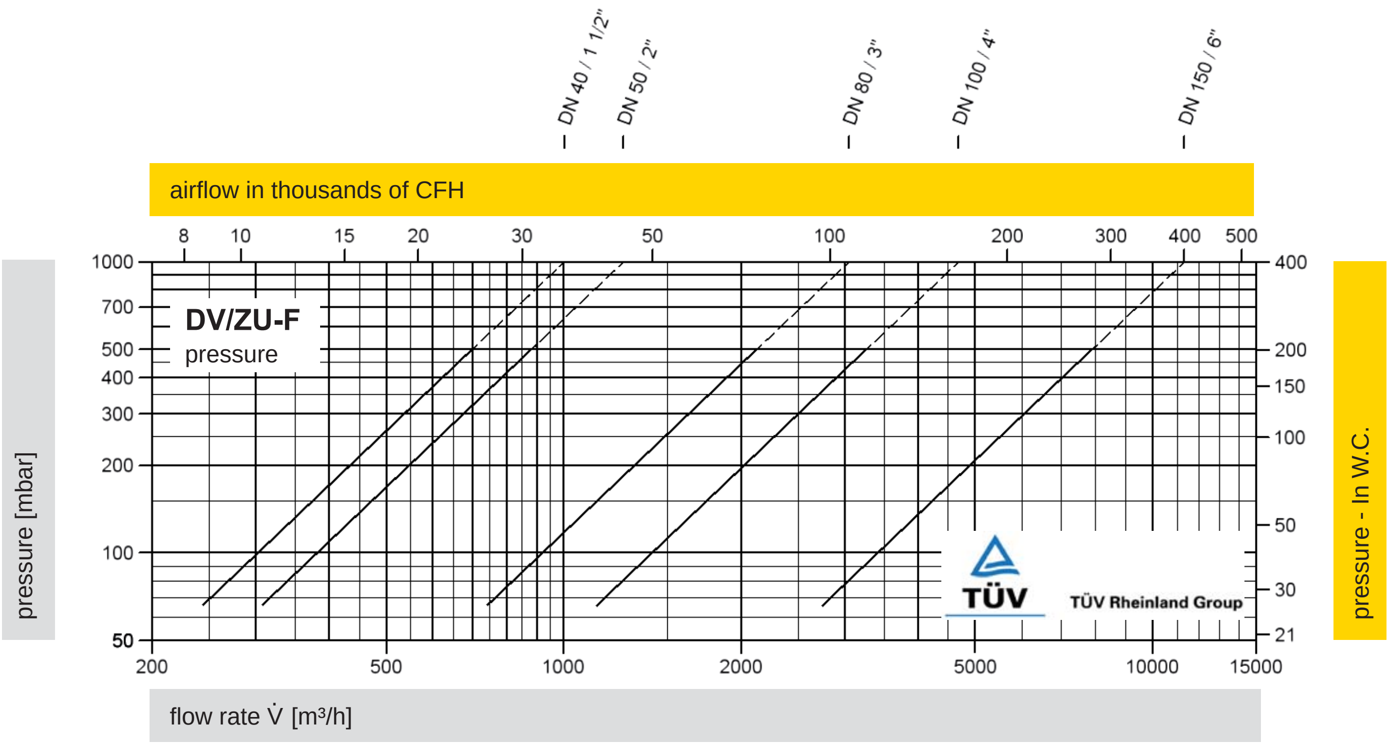
PROTEGO® DV/ZU-F

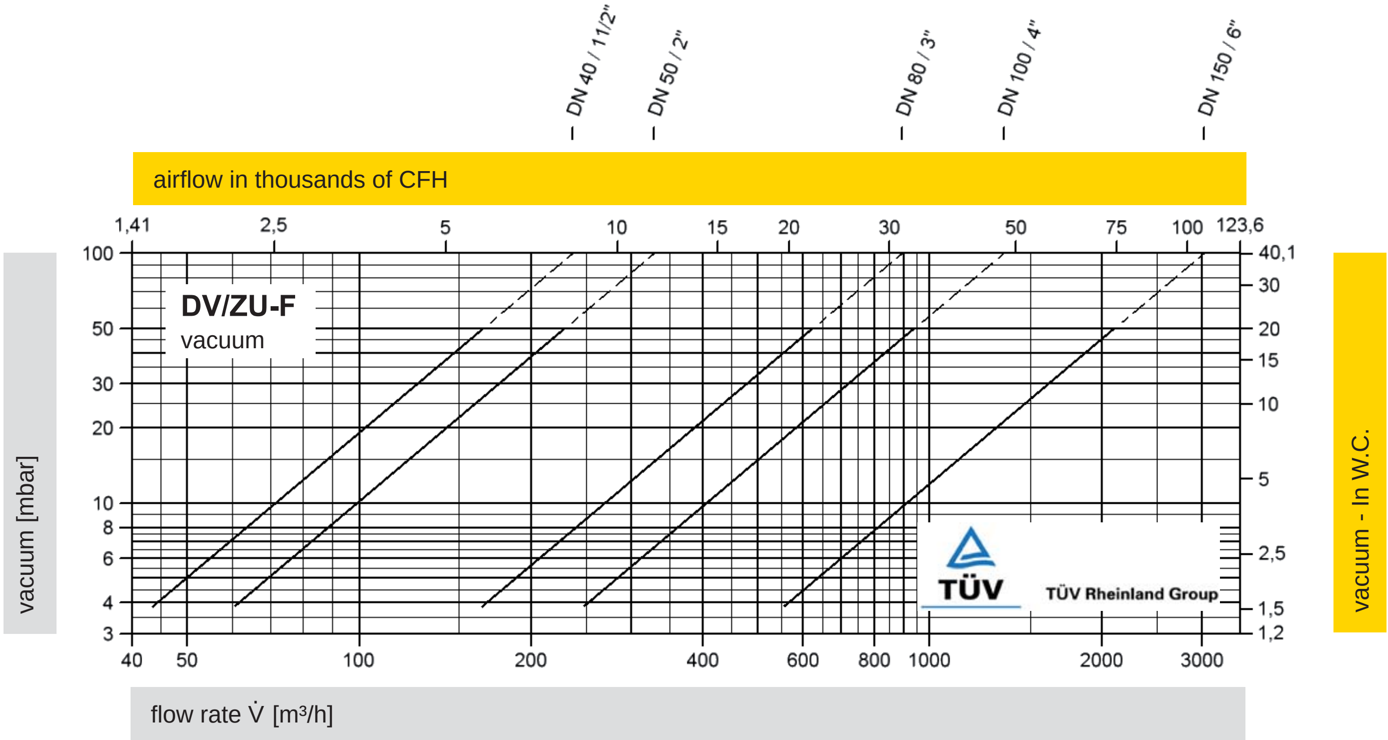
Type	Heating jacket	Nominal size	Material (housing)	Pressure	Material (pressure valve pallet)	Vacuum	Material (vacuum valve pallet)	Flange connection type
DV/ZU-F				/		/		
Design	Design	Tab. 1	Tab. 2	Setting [mbar] / Setting [In W.C.]	Tab. 3	Setting [mbar] / Setting [In W.C.]	Tab. 4	Tab. 5

Order example

DV/ZU-F	H	100	B	300 / –	A	-4,0 / –	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





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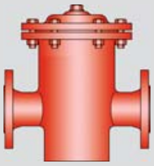
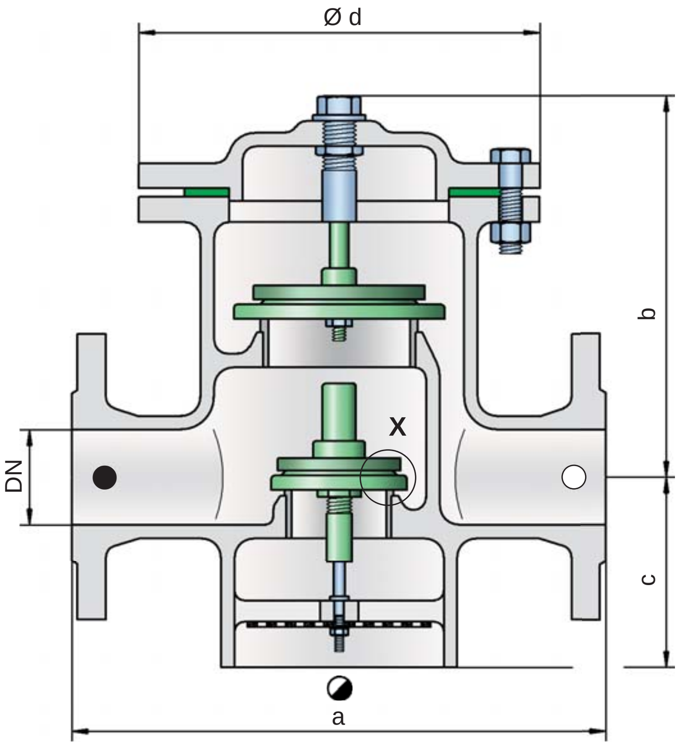
Conversion to other densities and temperatures refer to Technical Fundamentals.

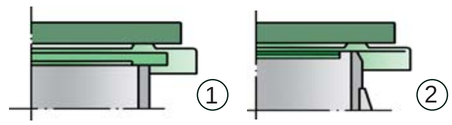


Pressure and Vacuum Relief Valve, In-Line

PROTEGO® DV/ZW



Detail **X**



● = Tank connection

◐ = Inbreathing

○ = Outbreathing

Settings:

Pressure:	+2.0 mbar	up to +60 mbar
	+0.8 In W.C.	up to +24 In W.C.
Vacuum:	-3.5 mbar	up to -50 mbar
	-1.4 In W.C.	up to -20 In W.C.

For higher set pressure refer to type DV/ZW-F.
Lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZW is a state-of-the-art pressure and vacuum relief valve with separate flange connections for use in a vent line. Typically the valve is installed in the in- and outbreathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum. The valve is designed so that in cases in which the set pressure is exceeded the vapours are vented into a discharge pipe (i.e. vent header). When the set vacuum is exceeded atmospheric air is pulled into the system. Due to its design the vacuum valve pallet is one size smaller than the pressure valve pallet.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The opening characteristic of the pressure and vacuum side is basically the same. However, the inbreathing will start as soon as the differential pressure between the atmospheric pressure and the tank is greater than the set pressure of the vacuum pallet. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged or vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology valve utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- flange connection for discharge line
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- maintenance friendly design

Designs and Specifications

The valve pallets are weight loaded. Higher set pressures are achieved by using spring loaded type DV/ZW-F

Two different designs are available:

In-line pressure and vacuum relief valve, standard design **DV/ZW - $\boxed{-}$**

In-line pressure and vacuum relief valve with heating jacket **DV/ZW - $\boxed{H}$**

Additional special devices available upon request.

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
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c	85 / 3.35	85 / 3.35	125 / 4.92	140 / 5.51	185 / 7.28
d	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35

Larger sizes upon request

Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B	
Housing Heating jacket (DV/ZW-H-...)	Steel Steel	Stainless Steel Stainless Steel	Option: Housing with ECTFE-lining Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Gasket	WS 3822	PTFE	

Table 3: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +60 >+5.6 up to +24	>+14 up to +60 >+5.6 up to +24	Special materials upon request For higher set pressures refer to type DV/ZW-F
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

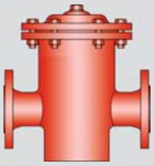
Table 4: Material selection for vacuum valve pallet

Design	A	B	C	D	E	F
Pressure range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special materials and lower set vacuum upon request

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Pressure and Vacuum Relief Valve, In-Line

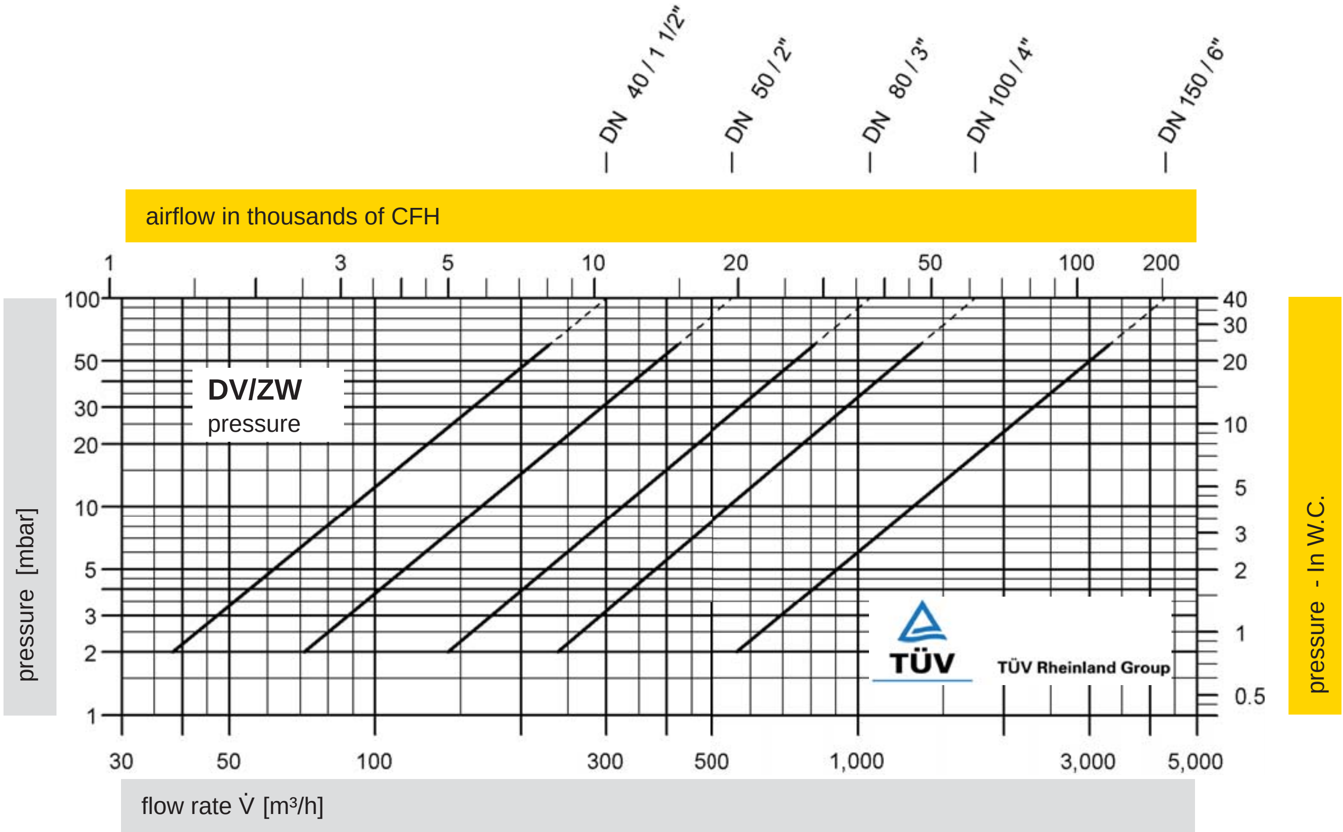
PROTEGO® DV/ZW

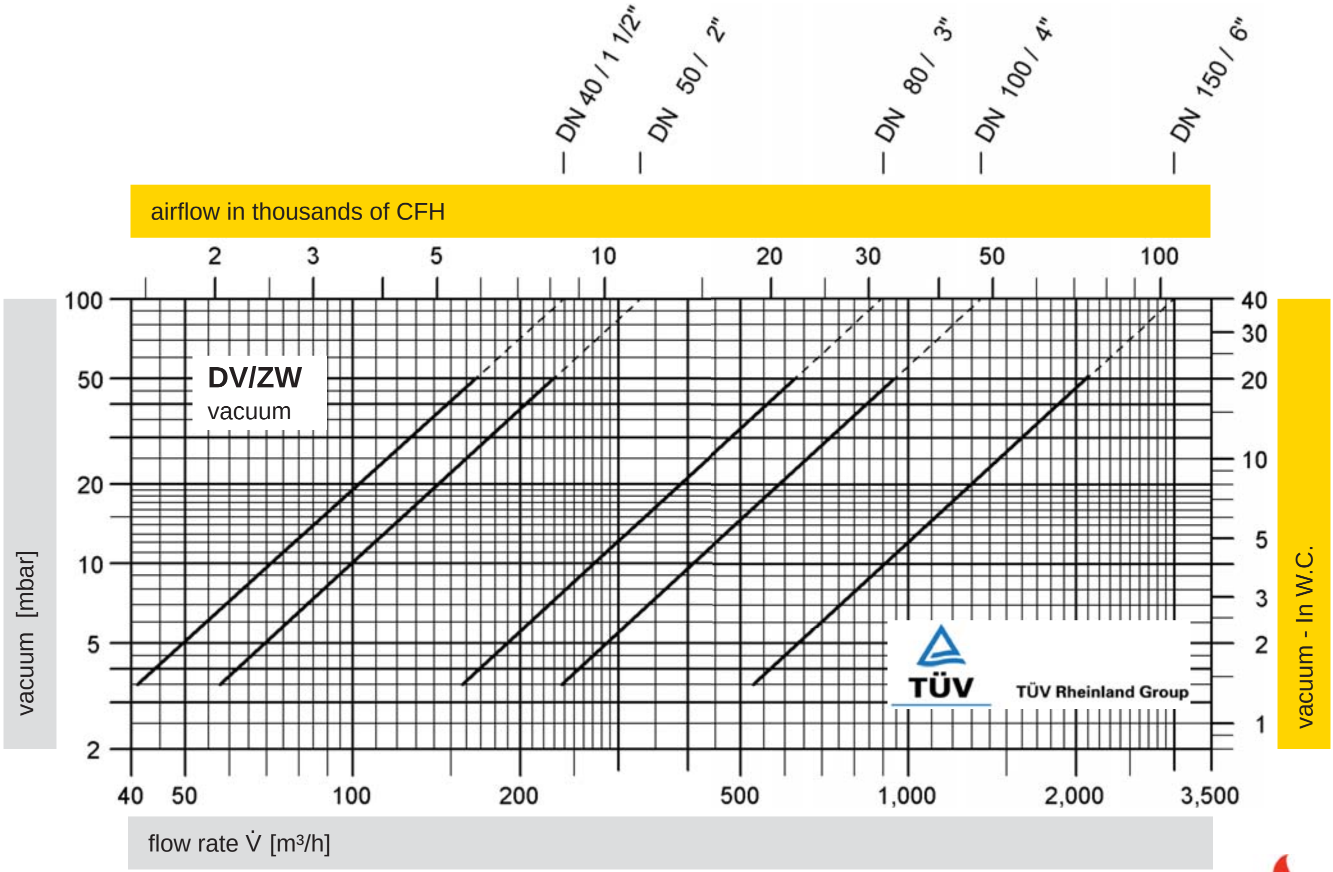
Type	Heating jacket	Nominal size	Material (housing)	Pressure	Material (pressure valve pallet)	Vacuum	Material (vacuum valve pallet)	Flange connection type
DV/ZW	–	–	–	/	–	/	–	–
Design		Tab. 1	Tab. 2	Setting [mbar] Setting [In W.C.]	Tab. 3	Setting [mbar] Setting [In W.C.]	Tab. 4	Tab. 5

Order example

DV/ZW	H	100	B	30 / –	C	-4,0 / –	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

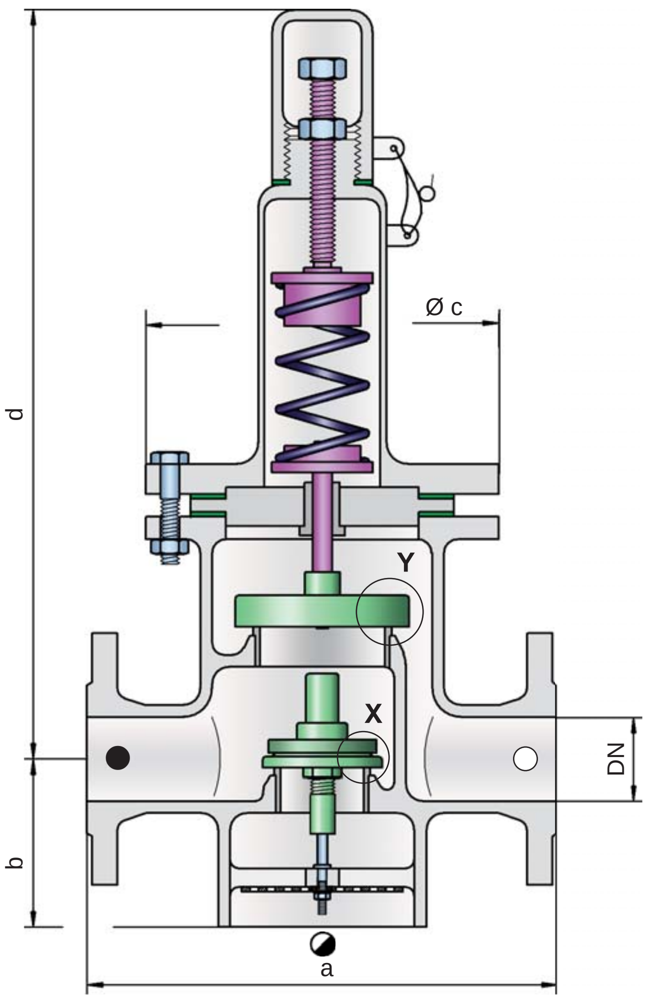




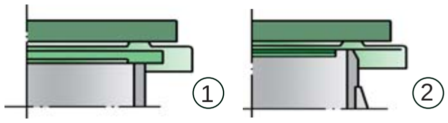
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Pressure and Vacuum Relief Valve, In-Line

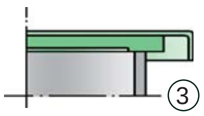
PROTEGO® DV/ZW-F



Detail **X**



Detail **Y**



● = Tank connection

◑ = Inbreathing

○ = Outbreathing

Settings:

Pressure: +60 mbar up to +500 mbar
+24 In W.C. up to +200 In W.C.

Vacuum: -3.5 mbar up to -50 mbar
-1.4 In W.C. up to -20 In W.C.

Vacuum: -3.5 mbar up to -14 mbar
-1.4 In W.C. up to -5.6 In W.C.
by set pressure up to +150 mbar / +60 In W.C.

For lower set pressure refer to type DV/ZW.
Higher set pressure and lower set vacuum upon request.

Function and Description

The PROTEGO® in-line valve DV/ZW-F is a state-of-the-art pressure and vacuum relief valve with flanged connections for use in a vent line. Typically the valve is installed in the in- and out-breathing lines of tanks, vessels and process apparatus to protect against unallowable high and low pressure. The valve prevents emission losses almost up to the set pressure and prevents air intake almost up to set vacuum. The valve is designed so that in cases in which the set pressure is exceeded the vapours are vented into a discharge pipe (i.e. vent header). When the set vacuum is exceeded atmospheric air breathes into the system. Due to its design the vacuum valve pallet is one size smaller than the pressure valve pallet. The spring loaded design of the pressure pallet allows higher set pressures than the DV/ZW model does.

The device will start to open as soon as the set pressure is reached and only requires 10% overpressure to full lift. Continuous investments into research and development have allowed PROTEGO® to develop a low pressure valve which has the same opening characteristic as a high pressure safety relief valve. This “full lift type” technology allows the valve to be set just 10% below the maximum allowable working pressure or vacuum (MAWP or MAWV) of the tank and still safely vent the required mass flow. The inbreathing will start as soon as the differential pressure between the atmospheric pressure and the tank is greater than the set pressure of the vacuum pallet. Due to our highly developed manufacturing technology the tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard. This feature is facilitated by valve seats made of high quality stainless steel and with individually lapped valve pallets (1), (3) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm and a rugged valve body. After the excess pressure is discharged or the vacuum is balanced, the valve reseats and provides a tight seal.

The optimized fluid dynamic design of the valve body and valve pallet is a result of many years of research work, which allow a stable operation of the valve pallet and optimized performance resulting in reduction of product losses.

Special Features and Advantages

- “full lift type” technology vent utilizes only 10% overpressure to reach full lift
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- based on 10% technology the set pressure is close to the opening pressure which results in best possible pressure management of the system compared to conventional 40%- or 100%- technology valves
- optimized flow performance, which reduces capital cost to a minimum as smaller sized valves may be used
- flange connection for discharge line
- can be installed in explosion hazardous areas
- housing designed to 150 psi (PN 10)
- spring loaded design on pressure side to achieve higher set pressures
- maintenance friendly design

Designs and Specifications

The pressure valve pallet is spring loaded, the vacuum valve pallet weight loaded. Lower set pressures for the pressure side are achieved through weight loaded type DV/ZW.

Two different designs are available:

In-line pressure and vacuum relief valve, standard design **DV/ZW-F** **[–]**

In-line pressure and vacuum relief valve with heating jacket **DV/ZW-F - [H]**

Additional special devices available upon request

Within piping systems the influence of backpressure has to be considered in deciding the set pressure and opening characteristics. For special design solutions (i.e. partial load operation) the valve can be supplied with standard valve pallets (with proportional opening function).

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	40 / 1 ½"	50 / 2"	80 / 3"	100 / 4"	150 / 6"
a	280 / 11.02	280 / 11.02	340 / 13.39	390 / 15.35	520 / 20.47
b	85 / 3.35	85 / 3.35	125 / 4.92	140 / 5.51	185 / 7.28
c	210 / 8.27	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35
d	565 / 22.24	565 / 22.24	675 / 26.57	805 / 31.69	1070 / 42.13

Larger sizes upon request
Dimensions for pressure and vacuum relief valve with heating jacket upon request

Table 2: Material selection for housing

Design	A	B
Housing Heating jacket (DV/ZW-F-H-...)	Steel Steel	Stainless Steel Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Gasket	WS 3822	PTFE

Option: Housing with ECTFE-lining

Special materials upon request

Table 3: Material of pressure valve pallet

Design	A
Pressure range [mbar] [In W.C.]	>+60 up to +500 >+24 up to +200
Valve pallet	Stainless Steel
Sealing	Metal to Metal
Pressure spring	Stainless Steel

Special materials upon request

For lower set pressure use type DV/ZW
Higher set pressure and lower set vacuum upon request.

Table 4: Material selection for vacuum valve pallet

Design	A*	B*	C	D
Pressure range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -50 <-14 up to -20
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal

Special materials and lower set vacuum upon request

* by set pressure up to +150 mbar / +60 In W.C.

Table 5: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN
ANSI 150 lbs RFSF	ANSI

other types upon request

Pressure and Vacuum Relief Valve, In-Line

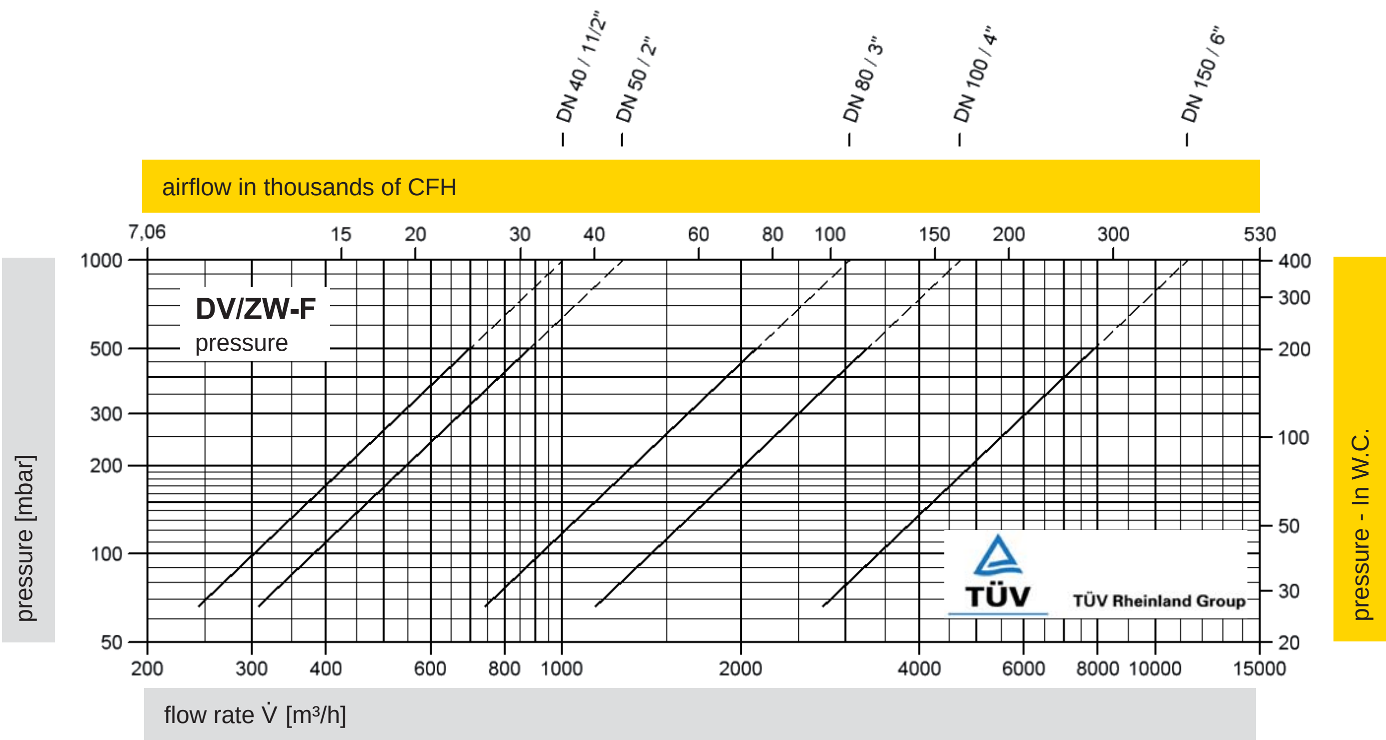
PROTEGO® DV/ZW-F

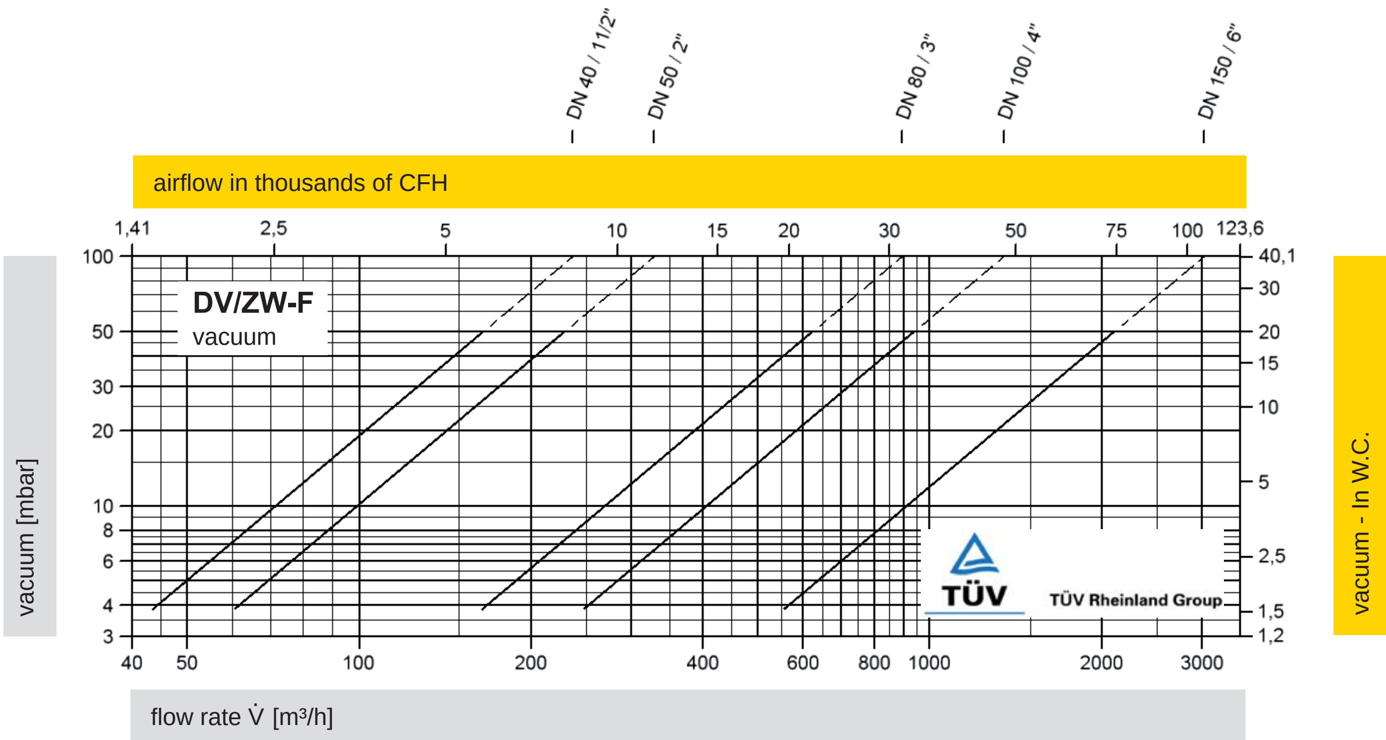
Type	Heating jacket	Nominal size	Material (housing)	Pressure	Material (pressure valve pallet)	Vacuum	Material (vacuum valve pallet)	Flange connection type
DV/ZW-F				/		/		
Design		Tab. 1	Tab. 2	Setting [mbar] / Setting [In W.C.]	Tab. 3	Setting [mbar] / Setting [In W.C.]	Tab. 4	Tab. 5

Order example

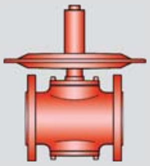
DV/ZW-F	H	100	B	300 / –	A	-4,0 / –	A	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





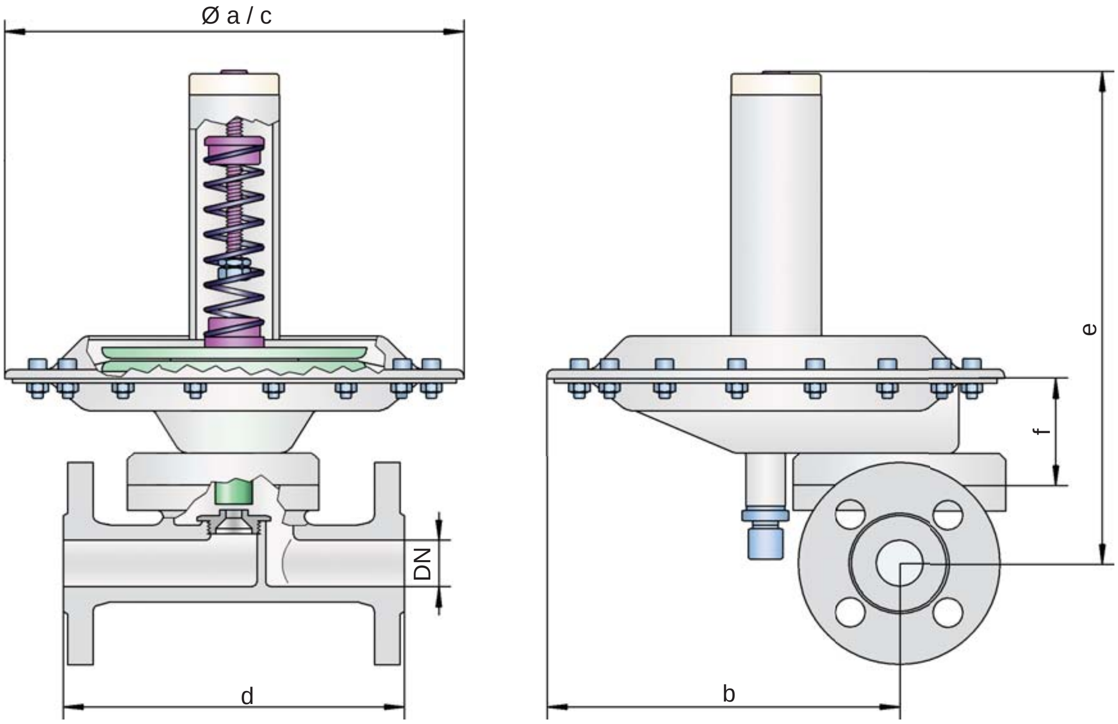
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



Blanketing Valve

low pressure reducing valve

ZM-R



Pressure range:
Supply pressure:
up to +16 bar /
+6424 In W.C.

Set pressure for
overpressure function:
up to +500 mbar /
+200 In W.C.

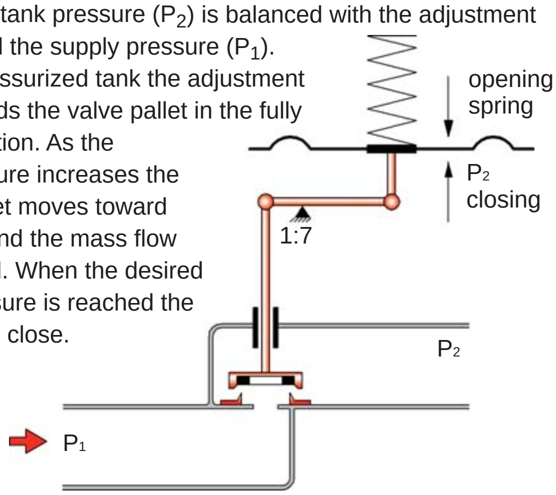
Set pressure for
vacuum function:
up to -200 mbar /
-80 In W.C.

Function and Description

The blanketing valve type ZM-R is a highly developed low pressure reducing valve. This valve is typically used to inert or blanket tanks, vessels or other process systems with nitrogen or other blanketing gases by controlling the tank pressure to its desired value. High nitrogen or blanketing gas supply pressures up to 16 bar / 232 psi are safely reduced down to only a few mbar / In W.C..

The ZM-R low pressure reducing valve is a direct acting one stage pressure control device. It is designed as a membrane controlled, spring loaded proportional acting valve. The valve controls the tank pressure by increasing flow as the tank pressure drops. This means that the mass flow through the device depends on the pressure differential of the set pressure to the actual tank pressure. When the actual tank pressure reaches the set pressure the control unit closes and there is no flow.

At the control membrane (which can be made from PTFE or Viton) the tank pressure (P_2) is balanced with the adjustment spring and the supply pressure (P_1).
In a depressurized tank the adjustment spring holds the valve pallet in the fully open position. As the tankpressure increases the valve pallet moves toward the seat and the mass flow is reduced. When the desired tank pressure is reached the device will close.



Should the tank pressure decrease the valve will open. If the plant is operated in a vacuum mode pressures down to -200 mbar / -80 In W.C. relative pressure can be accommodated.

Special features and advantages

- one stage pressure reduction within a relatively high pressure range
- large membrane surface to increase the closing force
- all functional and wetted parts are made of stainless steel (or hastelloy if required)
- easy adjustment of set pressure (within the pressure range of the specific spring)
- vertical or horizontal installation (set pressure has to be adjusted for horizontal installation)
- no external energy supply required
- optimized flow performance, which reduces capital cost to a minimum as smaller sized vents are needed
- the valve pallet is guided within the housing to protect against harsh weather conditions, i.e. preventing freezing of pallet in cold weather conditions
- reducing within the vacuum range is possible
- high accuracy
- can be installed in explosion hazardous areas
- housing designed to 16 bar / 150 psi
- maintenance friendly design

Design and Specification

Two different designs are available:

Blanketing valve for overpressure, standard design **ZM-R** **–**

Blanketing valve for vacuum, standard design **ZM-R / N**

Other special devices can be supplied on request

For in-line valves any back pressure, which will influence the set pressure and opening characteristics, has to be taken into account.

Table 1: Dimensions — Dimensions in mm / Dimensions in inches

To select the nominal size (DN), please use the flow rates on the following pages

DN	15 / ½"	25 / 1"	50 / 2"	100 / 4"	15 / ½"	25 / 1"	50 / 2"	100 / 4"
a	214	214	–	–	8.43	8.43	–	–
b	168	168	–	–	6.61	6.61	–	–
c*	–	–	214 / 360	360 / 600	–	–	8.43 / 14.17	14.17 / 23.62
d DIN	150	160	150	250 / 250	5.91	6.3	5.91	9.84 / 9.84
d ANSI	180	160	150	250 / 250	7.09	6.3	5.91	9.84 / 9.84
e	214	214	230	275 / 310	8.43	8.43	9.06	10.83 / 12.2
f	87	87	103	148 / 155	3.43	3.43	4.06	5.83 / 6.10

* depends upon size of diaphram

Table 2: Material selection for housing

Design	S	H	
Housing	Stainless Steel	Hastelloy	
Valve seat	Stainless Steel	Hastelloy	
Valve pallet	Stainless Steel	Hastelloy	
Valve seat sealing	FFKM	FFKM	
Gasket	PTFE	PTFE	
Diaphragm P	PTFE	PTFE	Marking P
Alternative: Diaphragm V	Viton	-	Marking V

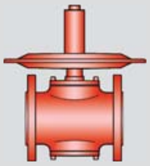
Optional:
Inner part of housing electropolished

Special materials upon request

Table 3: Selection for valve seat (depending on flow rate)

Size	Seat in mm / inches	Kvs	Number
25 / 1"	2,0 / 0.08	0,15	20
	4,5 / 0.18	0,60	45
	7,5 / 0.30	1,20	75
	10,0 / 0.39	1,70	100
	14,0 / 0.55	2,40	140
50 / 2"	14,0 / 0.55	2,80	140
	18,0 / 0.71	6,80	180
	26,0 / 1.02	14,50	260
100 / 4"	42,0 / 1.65	33,50	420
	55,0 / 2.17	68,00	550

* 1 Kvs = 0.86 Cv; 1 Cv = 1.17 Kvs



In-Line Pressure Reducing Valve

low pressure reducing valve

ZM-R

Table 4: Connection type			
FD	DIN 2501, PN 16	DIN	other types upon request
FA	ANSI 150 lbs RFSF	ANSI	
G	Thread	G or NPT	

Type (pressure) / Type (vacuum) / Nominal size / Material (housing) / Type of connection / Material (diaphragm) / Spring type / Valve seat number

ZM-R or ZM-R/N – [ ] – [ ] – [ ] – [ ] – [ ] – [ ]

Type — Tab. 1 — Tab. 2 — Tab. 4 — Tab. 2 — Tab. 3

Order example

ZM-R	–	–	25	–	S	–	FD	–	P	–	Selection by PROTEGO®	–	45

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow rates for P2 pressure range (Europe – metric units)

ZM-R 15 / ZM-R 25: flow rate (air, 0°C) at ΔP = P1 - P2 and valve full open										
P1 (bar) overpressure P2 (mbar)	0,15 [Nm³/h]	0,25 [Nm³/h]	0,40 [Nm³/h]	0,65 [Nm³/h]	1,00 [Nm³/h]	1,50 [Nm³/h]	2,50 [Nm³/h]	4,00 [Nm³/h]	6,00 [Nm³/h]	10,00 [Nm³/h]	Seat-Ø [mm]
10	6,2	8,1	10,3	13,2	16,5	20,6	28,8	41,1	57,5	90,3	Ø 4,5
	12,4	16,2	20,7	26,5	33,0	41,2	57,6	82,2	115,0	180,7	Ø 7,5
	17,5	23,0	29,3	37,6	46,7	58,4	81,6	116,5	163,0	256,0	Ø 10,0
	24,8	32,5	41,4	53,1	66,0	82,4	115,2	164,5	230,1	361,4	Ø 14,0
20	6,0	7,9	10,2	13,2	16,5	20,6	28,8	41,1	57,5	90,3	Ø 4,5
	12,0	15,9	20,5	26,4	33,0	41,2	57,6	82,2	115,0	180,7	Ø 7,5
	17,0	22,6	29,1	37,5	46,7	58,4	81,6	116,5	163,0	256,0	Ø 10,0
	24,0	31,9	41,1	52,9	66,0	82,4	115,2	164,5	230,1	361,4	Ø 14,0
100	3,8	6,7	9,4	12,8	16,4	20,6	28,8	41,1	57,5	90,3	Ø 4,5
	7,7	13,4	18,9	25,6	32,8	41,2	57,6	82,2	115,0	180,7	Ø 7,5
	10,9	18,9	26,8	36,3	46,5	58,4	81,6	116,5	163,0	256,0	Ø 10,0
	15,4	26,8	37,9	51,3	65,6	82,4	115,2	164,5	230,1	361,4	Ø 14,0
200	-	4,0	8,0	12,1	16,1	20,6	28,8	41,1	57,5	90,3	Ø 4,5
	-	8,0	16,1	24,2	32,3	41,2	57,6	82,2	115,0	180,7	Ø 7,5
	-	11,4	22,9	34,3	45,8	58,4	81,6	116,5	163,0	256,0	Ø 10,0
	-	16,1	32,3	48,4	64,6	82,4	115,2	164,5	230,1	361,4	Ø 14,0
500	-	-	-	7,8	14,2	20,1	28,8	41,1	57,5	90,3	Ø 4,5
	-	-	-	15,6	28,5	40,3	57,6	82,2	115,0	180,7	Ø 7,5
	-	-	-	22,1	40,4	57,1	81,6	116,5	163,0	256,0	Ø 10,0
	-	-	-	31,2	57,0	80,7	115,2	164,5	230,1	361,4	Ø 14,0

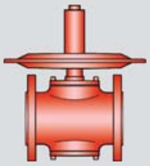
ZM-R 50: flow rate (air, 0°C) at ΔP = P1 - P2 and valve full open											
P1 (bar) overpressure P2 (mbar)	0,15 [Nm³/h]	0,25 [Nm³/h]	0,40 [Nm³/h]	0,65 [Nm³/h]	1,00 [Nm³/h]	1,50 [Nm³/h]	2,50 [Nm³/h]	4,00 [Nm³/h]	6,00 [Nm³/h]	10,00 [Nm³/h]	Seat-Ø [mm]
10	28,9 70,3 150,0	37,9 92,1 196,5	48,3 117,4 250,4	61,9 150,4 320,8	77,0 187,1 399,1	96,2 233,6 498,3	134,5 326,6 696,5	191,9 466,1 994,0	268,5 652,1 1390	421,6 1024 2183	Ø 14,0 Ø 18,0 Ø 26,0
20	28,0 68,1 145,3	37,3 90,6 193,3	47,9 116,5 248,4	61,7 150,0 319,9	77,0 187,1 399,0	96,2 233,6 498,3	134,5 326,6 696,5	191,9 466,1 994,0	268,5 652,1 1390	421,6 1024 2183	Ø 14,0 Ø 18,0 Ø 26,0
100	18,0 43,8 93,5	31,2 75,9 162,0	44,2 107,4 229,1	59,9 145,5 310,2	76,6 186,1 396,9	96,2 233,6 498,3	134,5 326,6 696,5	191,9 466,1 994,0	268,5 652,1 1390	421,6 1024 2183	Ø 14,0 Ø 18,0 Ø 26,0
200	- - -	18,8 45,8 97,6	37,7 91,6 195,3	56,5 137,4 293,0	75,4 183,2 390,6	96,2 233,6 498,3	134,5 326,6 696,5	191,9 466,1 994,0	268,5 652,1 1390	421,6 1024 2183	Ø 14,0 Ø 18,0 Ø 26,0
500	- - -	- - -	- - -	36,4 88,6 188,9	66,6 161,7 344,9	94,1 228,7 487,8	134,5 326,6 696,5	191,9 466,1 994,0	268,5 652,1 1390	421,6 1024 2183	Ø 14,0 Ø 18,0 Ø 26,0

ZM-R 100: flow rate (air, 0°C) at ΔP = P1 - P2 and valve full open											
P1 (bar) overpressure P2 (mbar)	0,15 [Nm³/h]	0,25 [Nm³/h]	0,40 [Nm³/h]	0,65 [Nm³/h]	1,00 [Nm³/h]	1,50 [Nm³/h]	2,50 [Nm³/h]	4,00 [Nm³/h]	6,00 [Nm³/h]	10,00 [Nm³/h]	Seat-Ø [mm]
10	346 703	453 921	587 1174	741 1504	922 1871	1151 2336	1609 3266	2296 4661	3212 6512	5045 10241	Ø 42,0 Ø 55,0
20	335 681	446 906	574 1165	739 1500	921 1871	1151 2336	1609 3266	2296 4661	3212 6512	5045 10241	Ø 42,0 Ø 55,0
100	216 438	374 759	529 1074	716 1455	917 1861	1151 2336	1609 3266	2296 4661	3212 6512	5045 10241	Ø 42,0 Ø 55,0
200	- -	225 458	451 916	676 1374	902 1832	1151 2336	1609 3266	2296 4661	3212 6512	5045 10241	Ø 42,0 Ø 55,0
500	- -	- -	- -	436 886	796 1617	1127 2287	1609 3266	2296 4661	3212 6512	5045 10241	Ø 42,0 Ø 55,0

Flow rates for P2 vacuum range (Type ZM-R/N) upon request

PROTEGO

for safety and environment



In-Line Pressure Reducing Valve

Flow rates for P2 pressure range (english/american units – non-metric)

ZM-R

ZM-R 15 / ZM-R 25: flow rate (air, 32°F) at ΔP = P1 - P2 and valve full open

overpressure P1 (psi) / P2 ("wc)	2.18 [SCFH]	3.63 [SCFH]	5.80 [SCFH]	9.43 [SCFH]	14.50 [SCFH]	21.76 [SCFH]	36.26 [SCFH]	58.02 [SCFH]	87.02 [SCFH]	145.04 [SCFH]	Seat-Ø [inch]
3.94	219	287	366	469	583	728	1018	1453	2032	3191	Ø 0.18
	439	574	732	938	1166	1456	2036	2905	4064	6382	Ø 0.29
	621	814	1037	1329	1652	2063	2884	4116	5758	9042	Ø 0.39
	877	1149	1464	1876	2333	2913	4072	5810	8128	12764	Ø 0.55
7.87	212	282	363	468	583	728	1018	1453	2032	3191	Ø 0.18
	425	565	726	935	1166	1456	2036	2905	4064	6382	Ø 0.29
	602	800	1029	1325	1652	2063	2884	4116	5758	9042	Ø 0.39
	849	1130	1452	1870	2333	2913	4072	5810	8128	12764	Ø 0.55
39.4	137	237	335	453	580	728	1018	1453	2032	3191	Ø 0.18
	273	474	670	907	1166	1456	2036	2905	4064	6382	Ø 0.29
	387	671	949	1285	1643	2063	2884	4116	5758	9042	Ø 0.39
	547	947	1339	1814	2320	2913	4072	5810	8128	12764	Ø 0.55
78.7	-	143	285	428	571	728	1018	1453	2032	3191	Ø 0.18
	-	285	571	856	1142	1456	2036	2905	4064	6382	Ø 0.29
	-	404	809	1213	1617	2063	2884	4116	5758	9042	Ø 0.39
	-	571	1142	1713	2284	2913	4072	5810	8128	12764	Ø 0.55
196.9	-	-	-	276	504	713	1018	1453	2032	3191	Ø 0.18
	-	-	-	552	1108	1426	2036	2905	4064	6382	Ø 0.29
	-	-	-	782	1428	2020	2884	4116	5758	9042	Ø 0.39
	-	-	-	1104	2016	2851	4072	5810	8128	12764	Ø 0.55

ZM-R 50: flow rate (air, 32°F) at ΔP = P1 - P2 and valve full open

overpressure P1 (psi) / P2 ("wc)	2.18 [SCFH]	3.63 [SCFH]	5.80 [SCFH]	9.43 [SCFH]	14.50 [SCFH]	21.76 [SCFH]	36.26 [SCFH]	58.02 [SCFH]	87.02 [SCFH]	145.04 [SCFH]	Seat-Ø [inch]
3.94	1023	1340	1708	2188	2722	3398	4750	6779	9483	14892	Ø 0.55
	2486	3254	4149	5314	6610	8253	11536	16462	23030	36166	Ø 0.71
	5300	6939	8846	11332	14094	17597	24600	35104	49109	77119	Ø 1.02
7.87	991	1318	1694	2182	2721	3398	4750	6779	9483	14892	Ø 0.55
	2407	3201	4115	5298	6608	8253	11536	16462	23030	36166	Ø 0.71
	5132	6827	8775	11298	14091	17597	24600	35104	49109	77119	Ø 1.02
39.4	638	1105	1563	2116	2707	3398	4750	6779	9483	14892	Ø 0.55
	1549	2684	3795	5139	6573	8253	11536	16462	23030	36166	Ø 0.71
	3304	5722	8093	10958	14017	17597	24600	35104	49109	77119	Ø 1.02
78.7	-	666	1332	1998	2664	3398	4750	6779	9483	14892	Ø 0.55
	-	1617	3235	4852	6470	8253	11536	16462	23030	36166	Ø 0.71
	-	3449	6898	10347	13796	17597	24600	35104	49109	77119	Ø 1.02
196.9	-	-	-	1288	2352	3327	4750	6779	9483	14892	Ø 0.55
	-	-	-	3129	5713	8079	11536	16462	23030	36166	Ø 0.71
	-	-	-	6672	12181	17227	24600	35104	49109	77119	Ø 1.02

ZM-R 100: flow rate (air, 32°F) at ΔP = P1 - P2 and valve full open											
overpressure P1 (psi) / P2 ("wc)	2.18 [SCFH]	3.63 [SCFH]	5.80 [SCFH]	9.43 [SCFH]	14.50 [SCFH]	21.76 [SCFH]	36.26 [SCFH]	58.02 [SCFH]	87.02 [SCFH]	145.04 [SCFH]	Seat-Ø [inch]
3.94	12245 24856	16033 32544	20438 41485	26181 53144	32562 66097	40656 82525	56834 115365	81101 164624	113458 230303	178171 361660	Ø 1.65 Ø 2.17
7.87	11857 24068	15772 32014	20272 41150	26102 52984	32555 66082	40656 82525	56834 115365	81101 164624	113458 230303	178171 361660	Ø 1.65 Ø 2.17
39.4	7633 15494	13221 26836	18697 37952	25316 51387	32384 65735	40656 82525	56834 115365	81101 164624	113458 230303	178171 361660	Ø 1.65 Ø 2.17
78.7	- -	7968 16175	15937 32350	23905 48525	31874 64699	40656 82525	56834 115365	81101 164624	113458 230303	178171 361660	Ø 1.65 Ø 2.17
196.9	- -	- -	- -	15414 31289	28142 57125	39800 80788	56834 115365	81101 164624	113458 230303	178171 361660	Ø 1.65 Ø 2.17

Flow rates for P2 vacuum range (Type ZM-R/N) upon request

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Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m^2
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	32 + 1,8 T_C
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9$ (T_F - 32)
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means
CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	= polytetrafluoroethylene
PVDF	= polyvinylidene fluoride
PFA	= perfluoroalkoxy polyme
FPM 70	= fluor carbon rubber
WS 3822	= aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	= ethylene chlorotrifluoro ethylene
FEP	= perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937 inch	1 inch		=	25,4 mm
1 m	= 3.2808 ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936 yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621 miles	1 mile		=	1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	=	6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	=	0,0929 m^2
	= 1.196	sq yards	1 sq yard	=	0,836 m^2
1km^2	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	=	16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	=	0,028317 m^3
	= 6.299	petr. barrels	1 petr. barrel	=	0,15876 m^3

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85 ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214 mph	1 mph	=	1,60934 km/h
1 m^3/h	= 4.403 gal/min (US)	1 gal/min (US)	=	0,227 m^3/h
	= 3.666 gal/min (UK)	1 gal/min (UK)	=	0,273 m^3/h
	= 0.5886 cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367 lb/min	1 lb/min	=	27,216 kg/h
		1 cu ft/h	=	0,028317 m^3/h

Torsion

1 Nm	= 0.723 lbf ft	1 lbf ft	= 1,38 Nm

Density

1 kg/dm^3	= 62.43 lb/cu ft	1 lb/cu ft	= 0,016 kg/dm^3

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

PROTEGO
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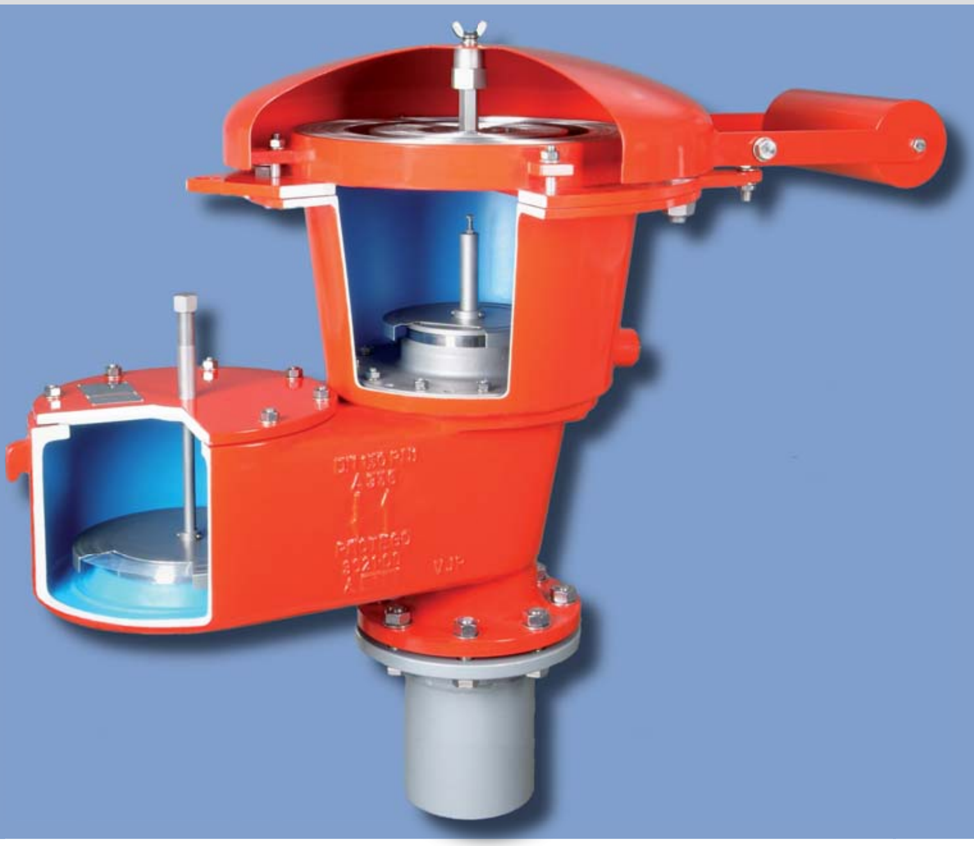
PROTEGO® **Pressure/Vacuum Relief Valves**

with Flame Arrester - end-of-line



Volume 7

PROTEGO
for safety and environment

Edition 2010

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

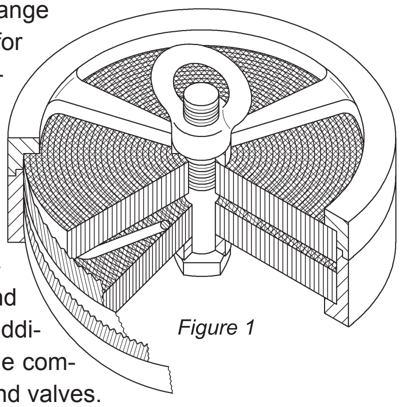
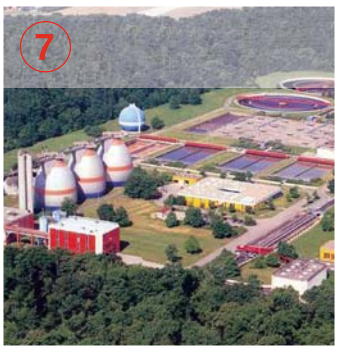


Figure 1

All of our devices are tested by independent national and international third parties in the world's largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.



The working principle and location of the installation of valves on tanks and apparatus is discussed in „Technical Fundamentals“ (Vol. 1). In this chapter pressure/vacuum relief valves with integrated flame arrester units – end-of-line – are introduced.

Function and Description

These valves are used to protect process units and equipment (i.e. tanks, pipelines) from exceeding maximum allowable operating pressures and vacuum. In addition theses devices protect against atmospheric deflagration. Some of the devices are also designed to protect against endurance burning (Figure 1).

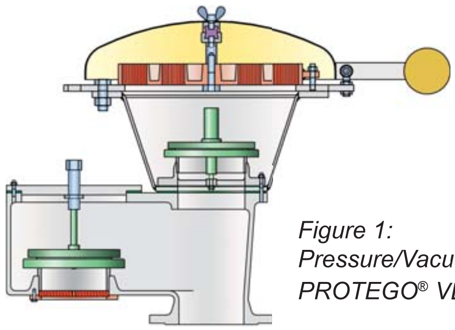


Figure 1: Pressure/Vacuum Relief Valve PROTEGO® VD/SV-HRL

PROTEGO® Pressure Relief Valves with an integrated flame arrester unit provide protection against unacceptable overpressure, atmospheric deflagration and endurance burning. In addition the devices reduce emissions almost up to the set pressure.

PROTEGO® Vacuum Relief Valves with an integrated flame arrester unit provide protection against unacceptable vacuum and atmospheric deflagration. In addition they avoid air intake almost up to the set pressure.

PROTEGO® Pressure Vacuum Relief Valves with an integrated flame arrester unit fulfil all the above mentioned functions for pressure and vacuum relief and protect against atmospheric deflagration or against atmospheric deflagration and endurance burning.

The special design of the PROTEGO® valves achieves full lift after 10% overpressure above the set pressure. This “full-lift-type-technology” allows for the use of set pressures just 10% below the maximum allowable working pressure (MAWP or Design Pressure) of the Tank. After just 10% overpressure above set pressure the valve will reach its full capacity to safely relieve the required mass flow. Conventional relief valves for low pressure applications need 80%-100% overpressure (API 2000) for reaching full lift and full relieving capacity. They open later and shut off earlier, which results in unnecessary product losses.

Special features and advantages

Specific investments into research and development allowed PROTEGO® to design a valve for low pressure applications providing you with the following advantages:

- 10% “full-lift-type-technology” reducing product losses (possible reduction of breathing losses greater than 30%)
- PROTEGO® valves open later and shut off earlier than conventional valves, which results in optimized pressure management and reduction of blanketing gas losses
- increased flow performance (result: smaller valves can be installed resulting in capital saving)
- lowest leak rates world wide for low pressure valves
- flame transmission proof for almost any chemical mixture
- valve pallet is guided within the housing to protect against harsh weather conditions
- flame arrester unit is not in contact with product vapour under normal operating conditions, which reduces maintenance intervals
- endurance burning protection against alcohols

To achieve the highest expectations of the industry for the lowest leak rates, our valve pallets and seats are manufactured from high quality stainless steel and are hand lapped in a special process. Air cushion technology is utilized for low set pressures.

Valves with integrated flame arrester units are available for substances from explosion groups IIA and IIB3 (NEC D and C) and special approvals are available for alcohols.

Main areas of application: as pressure and vacuum valves, as pressure relief valves, as pressure holding/conservation valves, as simple control valves for storage of flammable liquids

PROTEGO® Diaphragm Valves function as pressure vacuum relief valves. The flexible diaphragm allows them to work as a dynamic flame arrester, which provides endurance burning protection. For additional safety these devices are equipped with a static flame arrester unit. This “one-of-a-kind” diaphragm valve can be used under extreme cold weather conditions below freezing and for problem products, which i.e. tend to polymerize (Styrene, Acrylics). A specially designed valve seat combined with the flexible diaphragm prevents blocking of the valve through freezing product vapours at low temperatures. Ice bridges break and fall off through deformation of the diaphragm if pressure increases.

This device has no guiding elements which are likely to stick and keep the device closed.

Main areas of application: same as above in storage of flammable liquids and specifically for storage of monomers.

PROTEGO® High Velocity Pressure Relief Valves (Jet Valves) open and close almost immediately at set point. This function is achieved by an integrated magnet. Through this the overpressure needed from set point to full lift is practically 0%, which clearly reduces emissions. All PROTEGO® high velocity relief valves are tested for oscillating flow and are equipped with a specially designed valve cone and seat, which produces a vertical upright free jet during pressure relief. This ensures an effective leaning of the discharged vapours and reduces the gas concentration to a minimum in direct proximity (i.e. boat deck) of the valve. The devices functions on the working principal of a dynamic flame arrester and is approved for the vapour groups IIA, IIB3 and IIC (NEC D, C and B).

Main areas of application: transport of flammable liquids on tank ships and specially on shore applications.

Installation and servicing

All PROTEGO® devices are delivered with detailed installation and maintenance manuals. Please pay special attention to the warnings on how to remove transport protection if this has been installed in the device to prevent damage during transport. Specially developed check lists are available to ensure correct installation and operation of the device.

Selection and sizing

For a safe operation and protection of a plant, the selection and sizing of the correct PROTEGO® device is necessary. The following criteria have to be considered for pre-selection:

Function: Pressure relief, vacuum relief or combined pressure/vacuum relief, protection against atmospheric deflagration, or atmospheric deflagration and endurance burning.

Type of Valve: Weight loaded valve, diaphragm valve, high velocity pressure relief valve or high velocity pressure relief valve with combined vacuum valve.

Design: with horizontal or vertical connection to the protected vessel. These valves are weight loaded, so the pallet has to be installed in an horizontal orientation. The maximum achievable pressure setting will depend on the design of the valve. Metallic sealing or soft sealing are important criteria for low leak rates and have to be chosen based on the intended use.

Explosion group: IIA, IIB3, IIC (NEC D, C, B).

Process of combustion: endurance burning or atmospheric deflagration

Operating conditions: Polymerization, condensation, problems which lead to clogging of the FLAMEFILTER®, operating temperature, operating pressure, oxygen concentration, volume flow.

The **valve size** has to be determined so that the volume flow which has to be discharged does not lead to an increase of internal pressure above the maximum allowable working pressure of the vessel to be protected. For sizing the valves certified pressure/volume flow diagrams are provided. The operating conditions have to be known for correct sizing. Sometimes vessels are already equipped with pre-existing nozzles (i.e. old vessels). In such cases the volume flow may have to be discharge over several valves. For correct sizing superimposed and built-up backpressure must be considered.

Valve sizing:

The valve is sized dependent on the required volume flow, which is calculated (→ Chapter 1), or given.

Given: Volume flow (i.e. in- or out- breathing of a storage tank as sum of the pump rates and thermal breathing) $\dot{V}_{max}$ in m^3/h (CFH) and maximum allowable (tank-) pressure p in mbar (In W.C.).

Desired: Nominal valve size DN

Procedure: The required size of the valve can be taken from the intersection point of $\dot{V}_{max}$ and p valve operating pressure = max. allowable tank pressure. The pressure diagram show the valves flow performance in relation to the opening pressure and is determined at the full lift position of the pallet.

The set pressure of the valve has to be determined such that the required volume flow can be discharged safely. A valve with 10% overpressure characteristic has to be set 10% below the maximum allowable tank pressure.

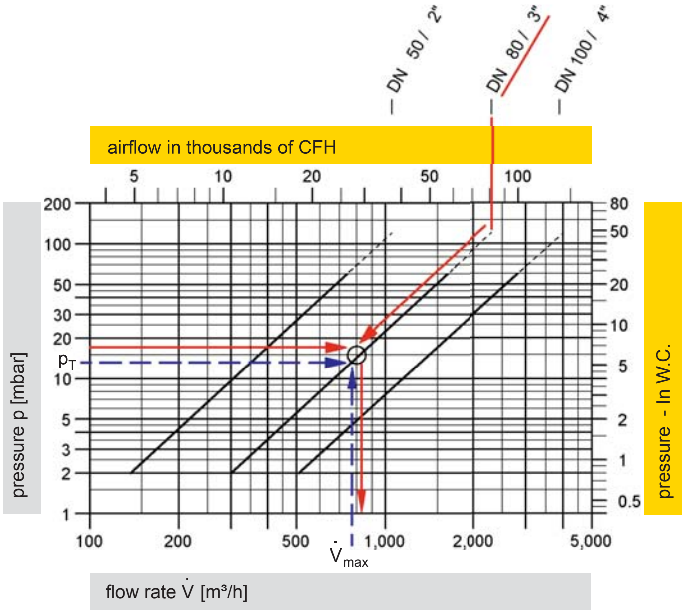
Many conventional valves require 100% overpressure to reach full lift. For these valves the set pressure will be 50% below of the maximum allowable tank pressure. These valves open earlier and shut off later allowing avoidable product losses.

Alternatively the valve performance may have to be checked if the required size and maximum allowable tank pressure are provided.

Given: (Tank-) nozzle size DN and maximum allowable (tank-) pressure p in mbar (In W.C.)

Desired: flow rate of valve in m^3/h (CFH) and set pressure p_{set}

Procedure: The intersection point of the straight line through p and the valve performance curve of the (nozzle-) size DN determine the flow rate $\dot{V}_{max}$. The set pressure p_{set} will be 10% (PROTEGO® - Technology), 40% or 100% below the maximum allowable (tank-) pressure p_T.



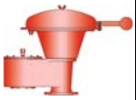
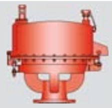
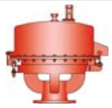
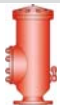
The set pressure of the valve (= valve starts to open) the maximum allowable pressure of the equipment minus the valves characteristic overpressure which is required for the valve to reach full lift.

The overpressure percentage of PROTEGO® valves is 10% (unless supplied otherwise). Within 10% overpressure the device will reach its performance at full lift. A further increase in flow performance will follow the curve in the pressure volume flow diagram.

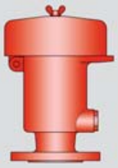
For choosing the correct material the plant and engineering specifications have to be considered.

PROTEGO® Pressure/Vacuum Relief Valves with Flame Arrester – end-of-line

	Type	Size	Pressure setting: positive setting range mbar / in W.C.	Pressure setting: negative setting range mbar / in W.C.	O = endurance burning proof X = prevent flashback in case of atmospheric deflagrations	Explosion group: ATEX	Explosion group: NEC	Approvals	Design O = horizontal connection X = vertical connection	O = soft sealing X = metallic sealing	O = for critical medium (polymerisation, corrosion, crystallisation)	O = Heating jacket, heating coil	Page
Pressure Relief Valves, Pallet Type													
	P/EB	50 - 80 2" - 3"	+3.5 up to +210/ +1.4 up to +84		O / X	IIA	D	ATEX	X	O / X		O	8-10
	P/EB-E	50 - 80 2" - 3"	+3.5 up to +210/ +1.4 up to +84		O / X	IIB1	–	ATEX	X	O / X		O	12-14
	P/EBR	80 - 100 3" - 4"	+3.5 up to +210/ +1.4 up to +84		O / X	IIA, IIB3	D, C	ATEX	X	O / X		O	16-19
	P/EBR-E	80 - 100 3" - 4"	+3.5 up to +210/ +1.4 up to +84		O / X	IIB1	–	ATEX	X	O / X		O	20-22
	BE/HR-D	150 -200 6" - 8"	+2.0 up to +35/ +0.8 up to +14		O / X	IIA	D	ATEX	X	O / X			24-26
Vacuum Relief Valves, Pallet Type													
	SV/E	50 - 300 2" - 12"		-2.0 up to -60/ -0.8 up to -24	X	IIB3	C	ATEX IMO	O	O / X		O	28-30
Pressure/Vacuum Relief Valves, Pallet Type													
	PV/EB	50 - 80 2" - 3"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -35/ -1.4 up to -14	O / X	IIA	D	ATEX	O	O / X		O	32-35
	PV/EB-E	50 - 80 2" - 3"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -35/ -1.4 up to -14	O / X	IIB1	–	ATEX	O	O / X		O	36-39
	PV/EBR	80 - 100 3" - 4"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -50/ -1.4 up to -20	O / X	IIA, IIB3	D	ATEX	O	O / X		O	40-44
	PV/EBR-E	80 - 100 3" - 4"	+2.0 up to +210/ +0.8 up to +84	-3.5 up to -50/ -1.4 up to -20	O / X	IIB1	–	ATEX	O	O / X		O	46-49
	VD/SV-AD and VD/SV-ADL	80 - 150 3" - 6"	+3.5 up to +35/ +1.4 up to +14	-2.0 up to -35/ -0.8 up to -14	X	IIB3	C	ATEX	X	O / X			50-53

	Typ	Nenn-weite	Druckeinstellung Über-druck mbar	Druckeinstellung Unter-druck mbar	O = dauerbrandsicher X = sicher gegen atmosphärische Deflagrationen	Explosions-gruppe ATEX	Explosions-gruppe NEC	Zulassungen	Bauform O= waagerechter Anschluss X = senkrechter Anschluss	O = Weich-Abdichtung X = metallische Abdichtung	O = Einsatz in kritischen Medien (Polymerisation, Korrosion, Kristallisation)	O = Heizmantel, Heizschlange	Seite
Über- und Unterdruckventile, Tellerventile (Fortsetzung)													
	VD/SV-HR	80 - 100 3" - 4"	+3,5 bis +35	-2,0 bis -35	O / X	IIA, IIB3	D, C	ATEX	X	O / X			54-58
	VD/SV-HRL	100 -150 4" - 6"	+3,5 bis +35	-2,0 bis -35	O / X	IIA	D	ATEX	X	O / X			60-63
	VD/TS	50 - 300 2" - 12"	+3,5 bis +50	-2,0 bis -25	X	IIB3	C	ATEX FM	X	O / X			64-67
Über-/ Unterdruckventile, Membranventile													
	UB/SF	80 - 150 3" - 6"	+3,5 bis zu +140	-3,5 bis -35	O / X	IIB3	C	ATEX	X	O	O	O	68-75
	UB/DF	80 - 150 3" - 6"	+3,5 bis zu +140		O / X	IIB3	C	ATEX	X	O	O	O	76-81
	UB/VF	80 - 150 3" - 6"		-3,5 bis -35	X	IIB3	C	ATEX	X	O	O	O	82-85
Überdruckventile, Hochgeschwindigkeitsventile													
	DE/S	80 - 150 3" - 6"	+100 bis +500		O / X	IIB3	C	ATEX	X	X			86-88
	DE/S-MK VI	80 - 150 3" - 6"	+60 bis +350		O / X	IIB3, IIC	C, B	ATEX IMO	X	X			90-93

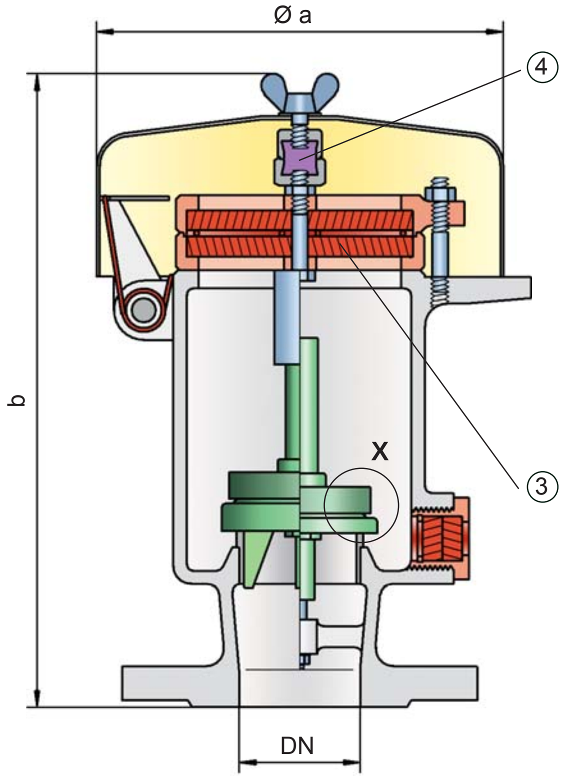
für Sicherheit und Umweltschutz



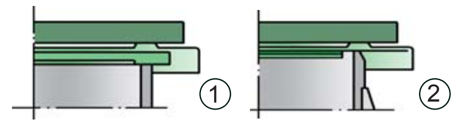
Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EB



Detail **X**



Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The deflagration-proof and endurance burning-proof P/EB type PROTEGO® valve is a highly developed pressure relief valve with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and prevents product losses almost up to the set pressure; it also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The P/EB valve is available for substances of explosion group IIA (NEC group D MESG > 0.90 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with a high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use in corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- PROTEGO® flame arrester unit provides protection against atmospheric deflagration and endurance burning
- flame arrester unit integrated into valve saves space, weight and reduces cost
- flame arrester unit protected from clogging through product vapour
- flame arrester unit has a low pressure drop
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallet to be replaced

Design Types and Specifications

The valve disc is weight-loaded. At set pressure >80 mbar (32.1 In W.C.), an elongated design is used

There are two different designs:

Pressure relief valve, basic design **P/EB - $\boxed{-}$**

Pressure relief valve with heating jacket **P/EB - $\boxed{H}$**
(max. heating fluid temperature +85°C / 185°F)

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58
b	287 / 11.30	452 / 17.80	289 / 11.38	454 / 17.87

Dimensions for Pressure Relief Valve with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
> 0,90 mm	IIA	D	

Table 3: Material selection for housing

Design	B	C	Special materials upon request
Housing Heating jacket (P/EB-H-...)	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	Special materials upon request
FLAMEFILTER® cage	Stainless Steel	
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for valve pallet

Design	A	B	C	D	Special materials and higher pressure settings upon request
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

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Type — Heating jacket — Nominal size — Explosion group — Material (housing) — Material (flame arrester unit) — Pressure — Material (valve pallet) — Flange connection type

P/EB	–		–		–		–		–		–	/	–		–	

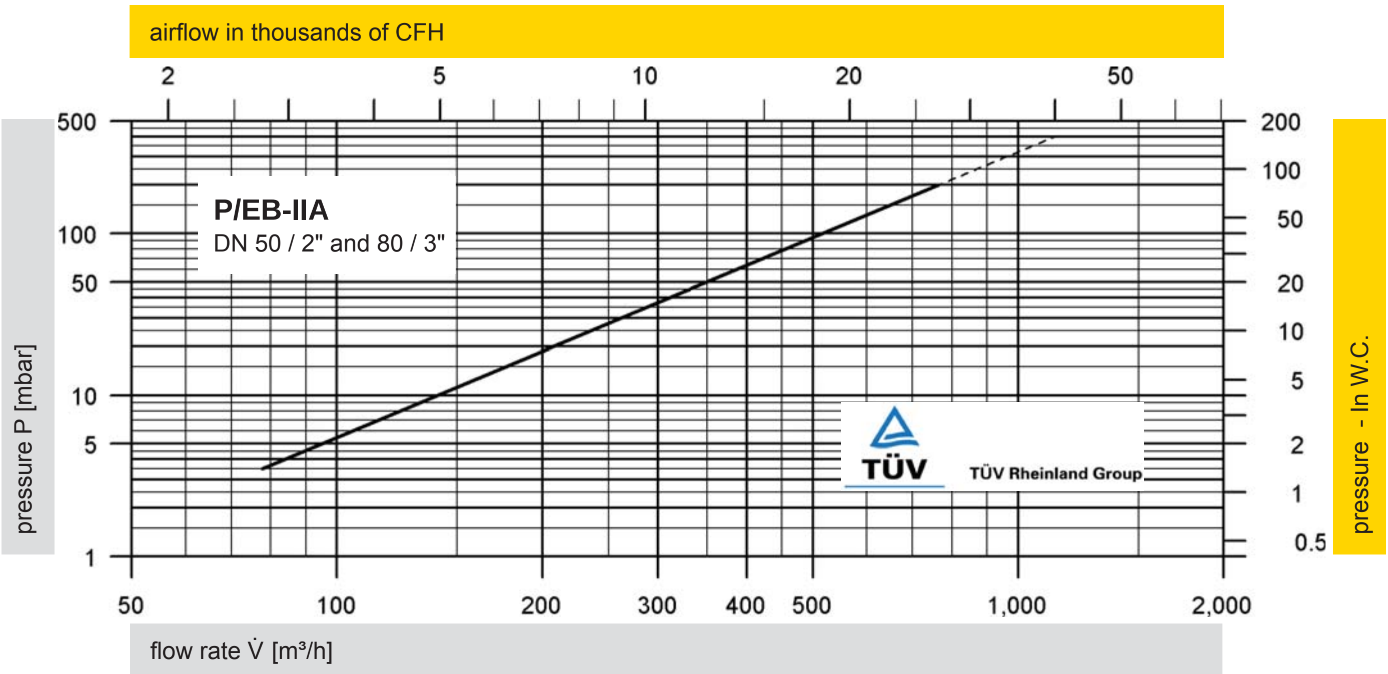
Design — Tab. 1 — Tab. 2 — Tab. 3 — Tab. 4 — Setting [mbar] / Setting [In W.C.] — Tab. 5 — Tab. 6

Order example

P/EB	–	H	–	50	–	IIA	–	B	–	A	–	50 /	–	D	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

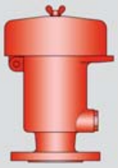
Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the Standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

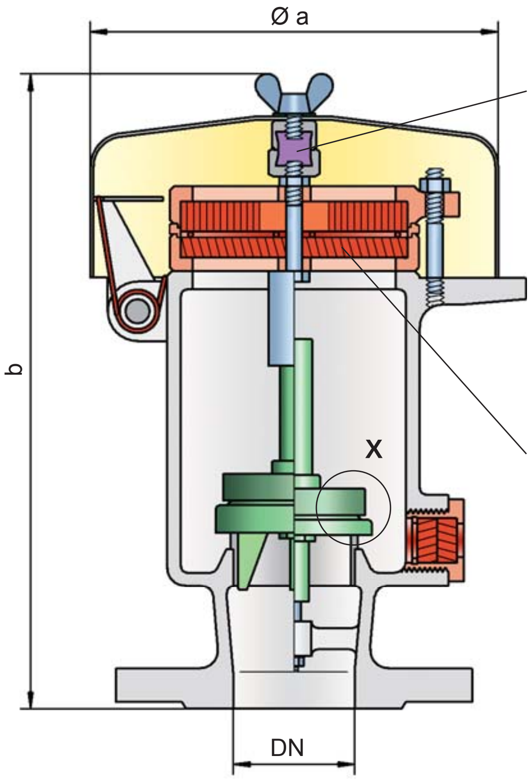
Notes:



Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EB-E



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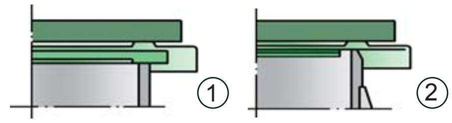

Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The deflagration proof and endurance burning-proof P/EB-E type PROTEGO® valve is a highly developed pressure relief valve for large flows with an integrated flame arrester unit that is specially used for applications handling ethanol. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and prevents product losses almost up to the set pressure; it also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The P/EB-E valve is available for substances of explosion group IIB1 (MESG ≥ 0.85 mm) and provides specific protection against deflagration and endurance burning of alcohol/air mixtures (such as ethanol/air).

The valve functions proportional, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- selecting set pressure close to relieving pressure results in product loss reduction
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning of alcohol/ air mixtures from explosion group IIB1
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- PROTEGO® flame arrester unit provides protection against atmospheric deflagration and endurance burning
- flame arrester unit integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced

Design Types and Specifications

The valve disc is weight-loaded. At set pressures >80 mbar (32.1 In W.C.), an elongated design is used

There are two different designs:

Pressure relief valve, basic design	**P/EB - E -** $\boxed{-}$
Pressure relief valve with heating jacket (max. heating fluid temperature +85°C / 185°F)	**P/EB - E -** $\boxed{H}$

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58
b	287 / 11.30	452 / 17.80	289 / 11.38	454 / 17.87

Dimensions for Pressure Relief Valve with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,85 mm	IIB1	–	Special approvals upon request

Table 3: Material selection for housing

Design	B	C	
Housing Heating jacket (P/EB-E-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	Special materials and higher pressure settings upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

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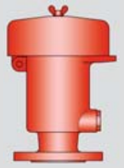
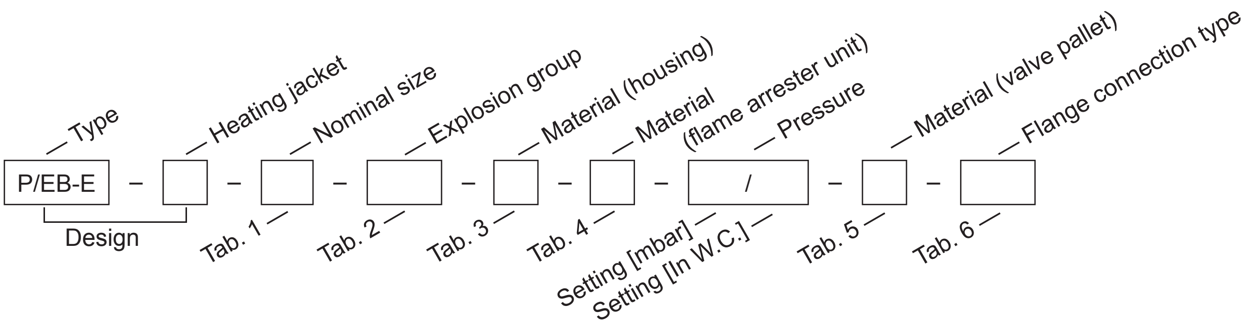


Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EB-E

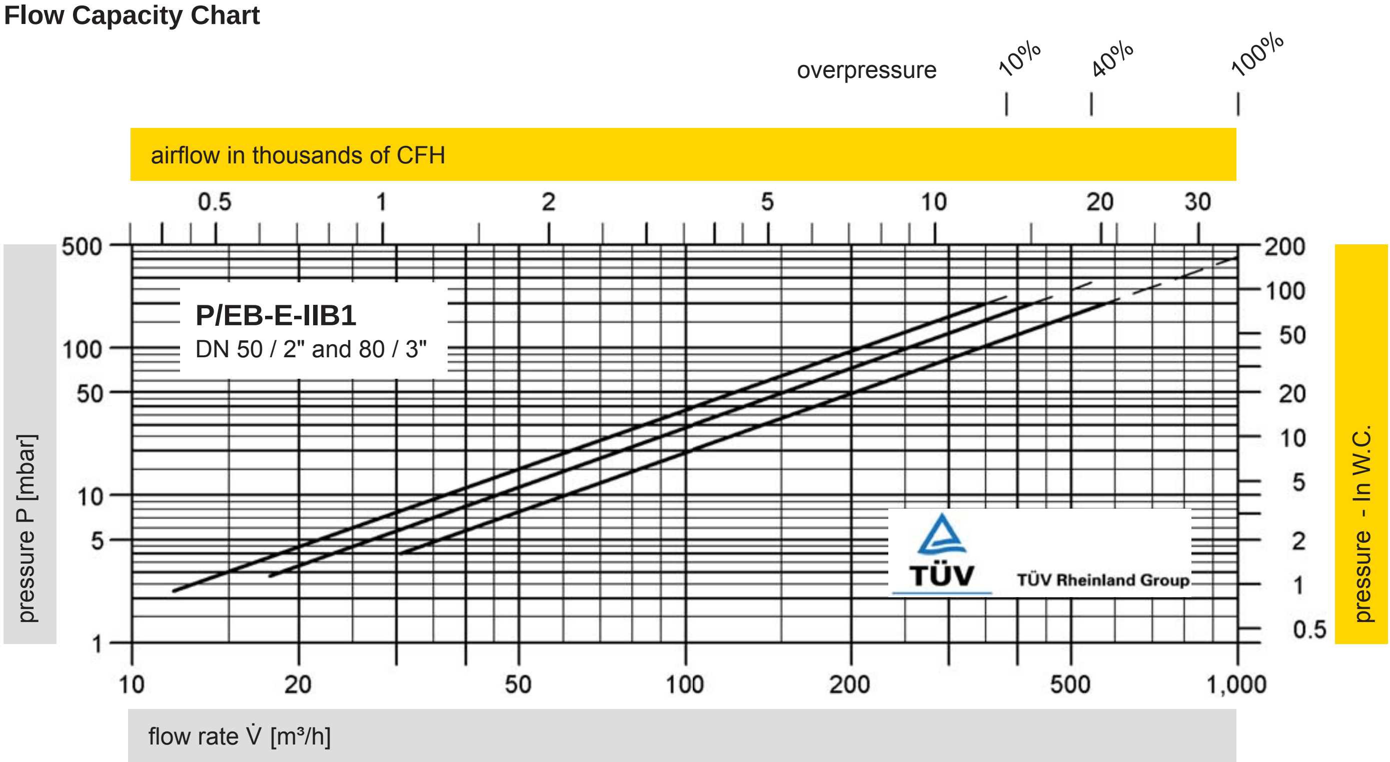


Order example

P/EB-E	– H	– 50	– IIB1	– B	– A	– 50 / –	– D	– DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

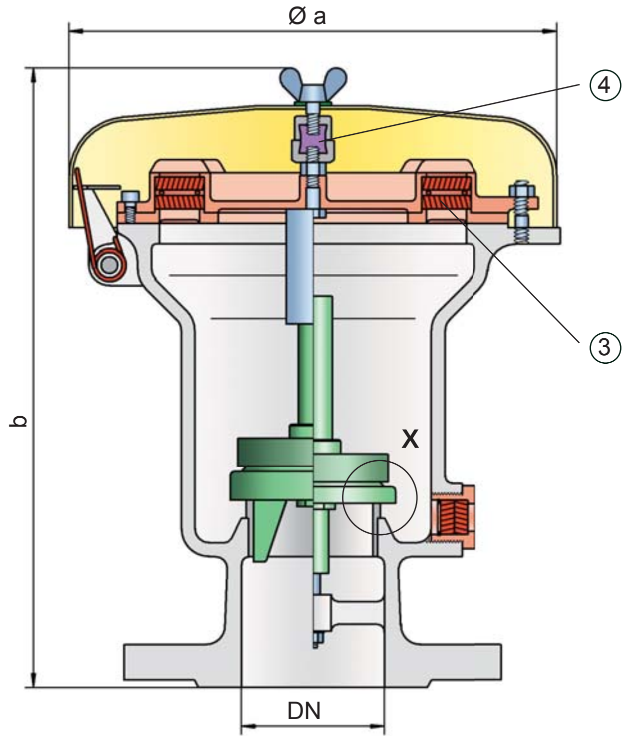
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:

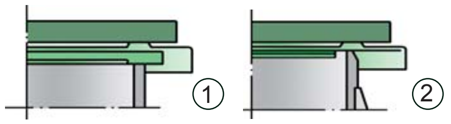
Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EBR



Detail **X**



Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The deflagration-proof and endurance burning-proof P/EBR type PROTEGO® valve is a highly developed pressure relief valve for large flows with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and prevents product losses almost up to the set pressure; it also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. P/EBR valves are available for substances from explosion groups IIA and IIB3 (NEC group D and C MESG ≥ 0.65 mm).

If the set pressure is reached for a valve approved for explosion Group IIA (NEC group D), the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range. Valves approved for explosion group IIB3 (NEC group C) function proportionally, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift for group IIA (NEC group D >0.9 MESG) vapours
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning for explosion group IIA and IIB3 (NEC group D and C) vapours
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- PROTEGO® flame arrester unit provides protection against atmospheric deflagration and endurance burning
- flame arrester unit integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced

Design Types and Specifications

The valve disc is weight-loaded. At set pressures >80 mbar (32.1 In W.C.), an elongated design is used

There are two different designs:

Pressure relief valve, basic design **P/EBR - $\boxed{-}$**

Pressure relief valve with heating jacket **P/EBR - $\boxed{H}$**
(max. heating fluid temperature +85°C / 185°F)

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90
b	345 / 13.58	505 / 19.88	345 / 13.58	505 / 19.88

Dimensions for Pressure Relief Valve with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
> 0,65 mm	IIB3	C	

Table 3: Material selection for housing

Design	B	C	
Housing Heating jacket (P/EBR-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	Special materials and higher pressure settings upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

PROTEGO
for safety and environment

Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EBR

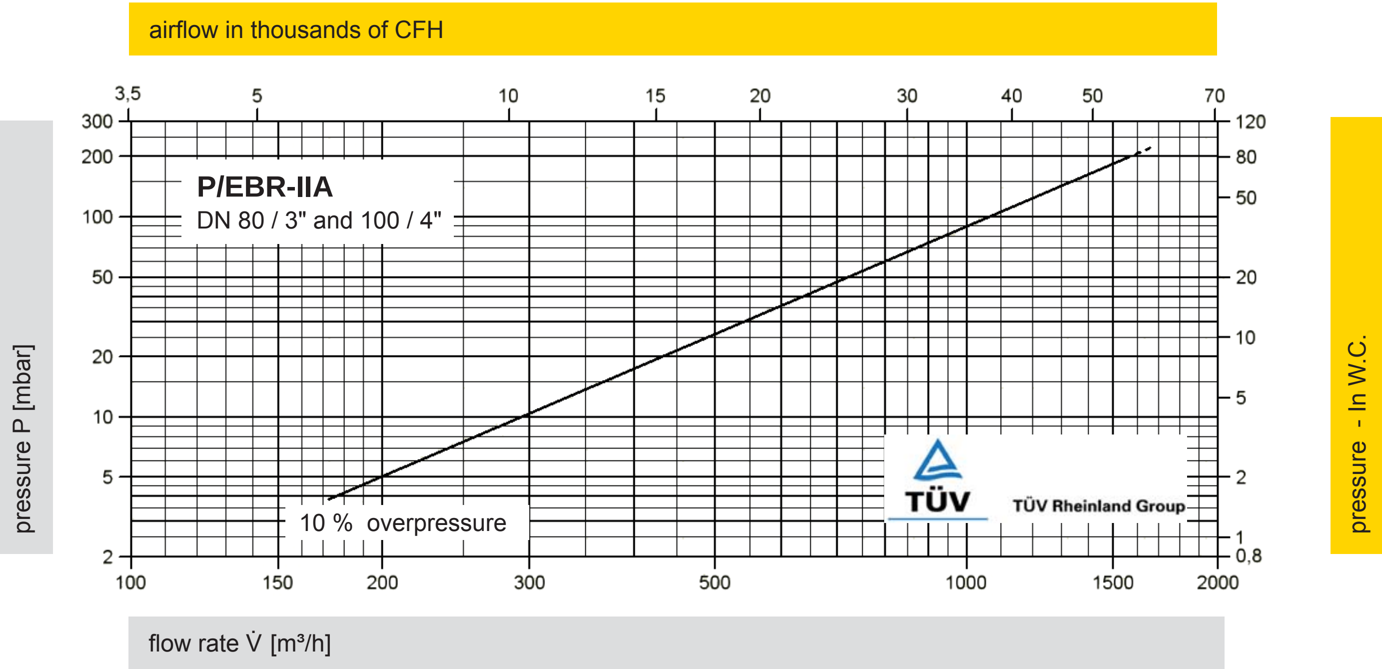
Type — Heating jacket — Nominal size — Explosion group — Material (housing) — Material (flame arrester unit) — Pressure — Material (valve pallet) — Flange connection type

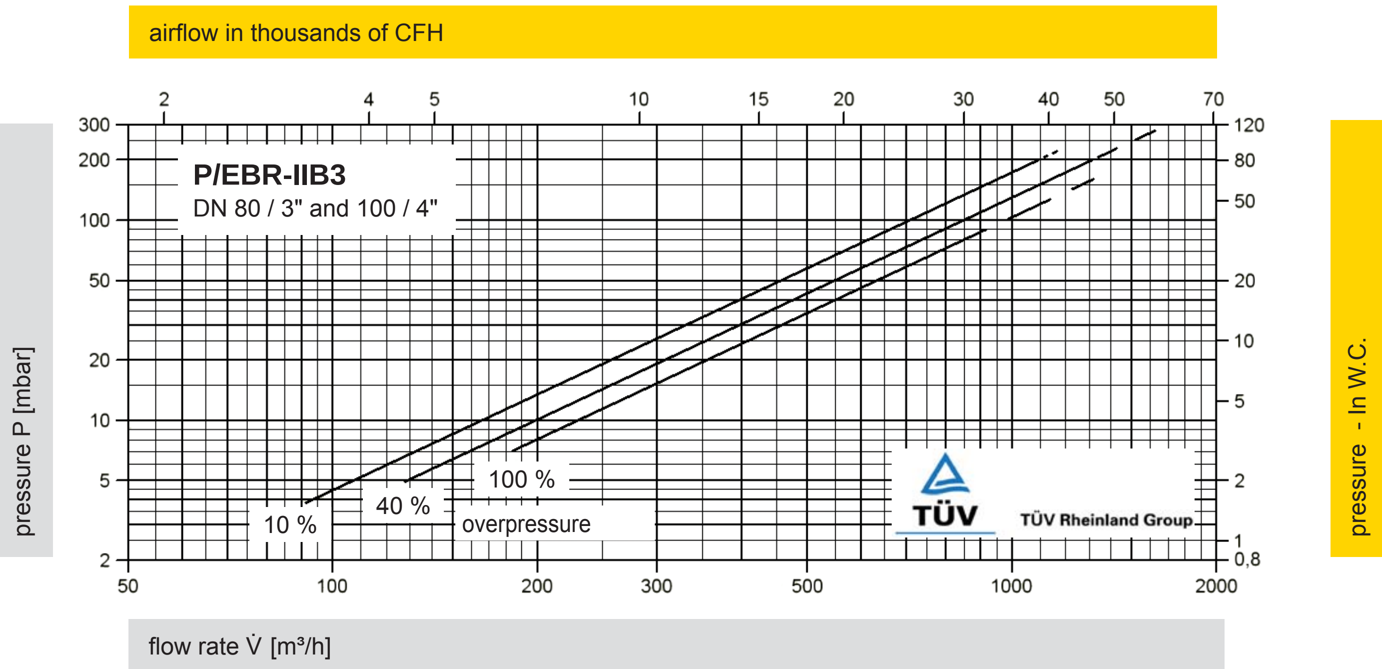
P/EBR	–		–		–		–		–		–	/	–		–	
Design		Tab. 1		Tab. 2		Tab. 3		Tab. 4				Setting [mbar] / Setting [In W.C.]		Tab. 5		Tab. 6

Order example

P/EBR	–	H	–	100	–	IIB3	–	B	–	A	–	50 / –	–	D	–	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”



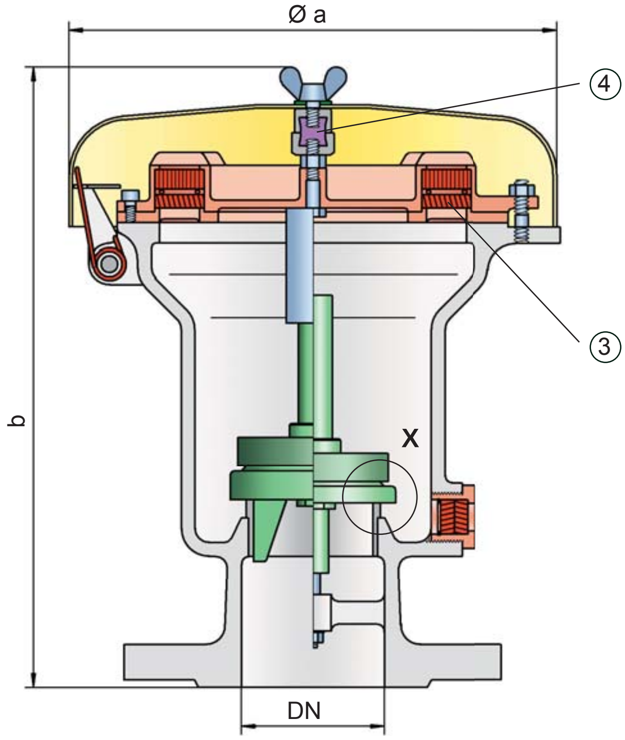


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EBR-E



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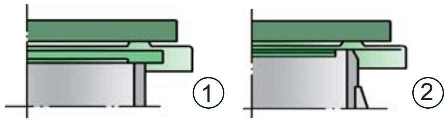


Pressure settings:

+3.5 mbar up to +210 mbar
+1.4 In W.C. up to +84 In W.C.
Higher pressure settings upon request.

Function and Description

The deflagration proof and endurance burning proof P/EBR-E type PROTEGO® valve is a highly developed pressure relief valve for large flows with an integrated flame arrester unit that is specially used for applications handling ethanol. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and prevents product losses almost up to the set pressure; it also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The P/EBR-E valve is available for substances of explosion group IIB1 (MESG ≥ 0.85 mm) and provides specific protection against deflagration and endurance burning of alcohol/air mixtures (such as ethanol/air).

The valve functions proportional, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- selecting set pressure close to relieving pressure results in product loss reduction
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning of alcohol/ air mixtures from explosion group IIB1
- high flow capacity through large flame filter cross-section, results in low pressure drop
- PROTEGO® flame arrester unit provides protection against atmospheric deflagration and endurance burning
- flame arrester unit integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced

Design Types and Specifications

The valve disc is weight-loaded. At set pressures >80 mbar (32.1 In W.C.), an elongated design is used

There are two different designs:

Pressure relief valve, basic design **P/EBR - E - –**

Pressure relief valve with heating jacket **P/EBR - E - H**
(max. heating fluid temperature +85°C / 185°F)

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"
Set pressure	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.	≤ +80 mbar ≤ +32.1 In W.C.	> +80 mbar > +32.1 In W.C.
a	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90
b	345 / 13.58	505 / 19.88	345 / 13.58	505 / 19.88

Dimensions for Pressure Relief Valve with heating jacket upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,85 mm	IIB1	–	Special approvals upon request

Table 3: Material selection for housing

Design	B	C	
Housing Heating jacket (P/EBR-E-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+14 up to +210 >+5.6 up to +84	Special materials and higher pressure settings upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® P/EBR-E

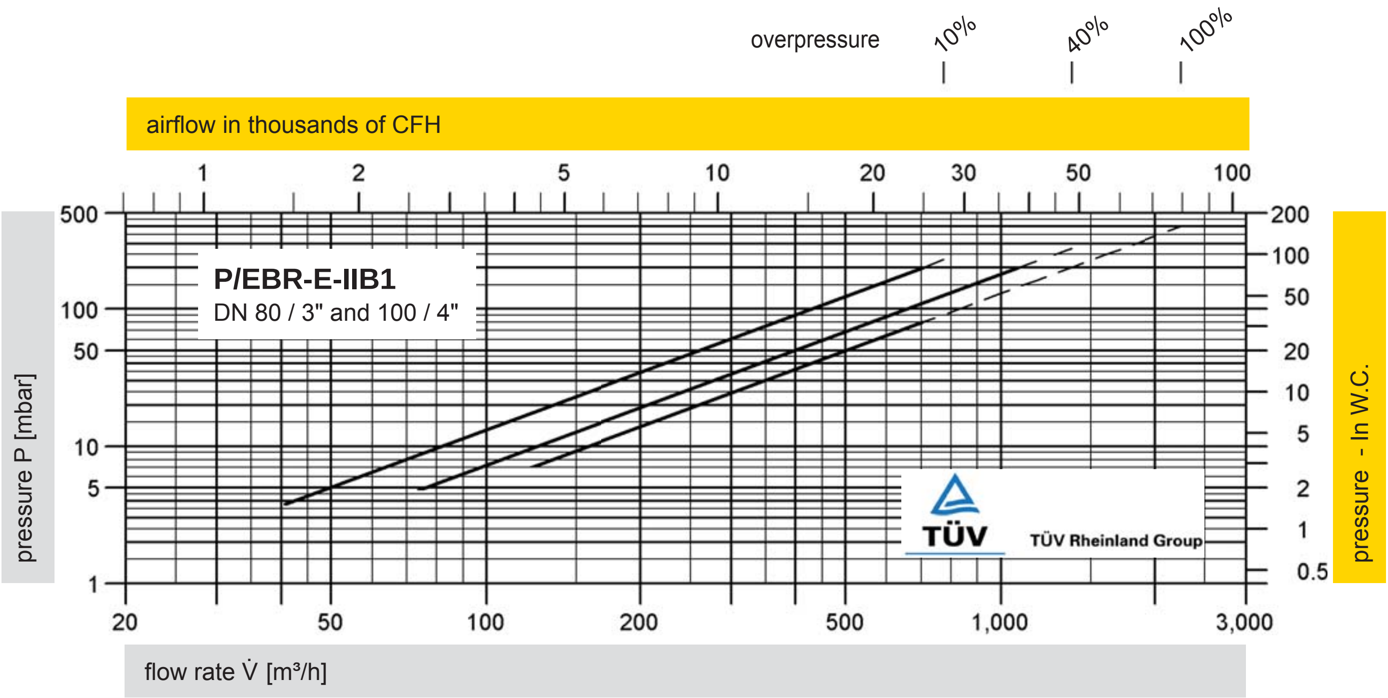
Type	Heating jacket	Nominal size	Explosion group	Material (housing)	Material (flame arrester unit)	Pressure	Material (valve pallet)	Flange connection type
P/EBR-E	–	–	–	–	–	– / –	–	–
Design	Tab. 1	Tab. 2	Tab. 3	Tab. 4		Setting [mbar] / Setting [In W.C.]	Tab. 5	Tab. 6

Order example

P/EBR-E	H	100	IIB1	B	A	50 / –	D	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

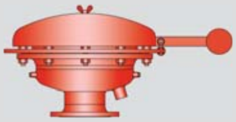
Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

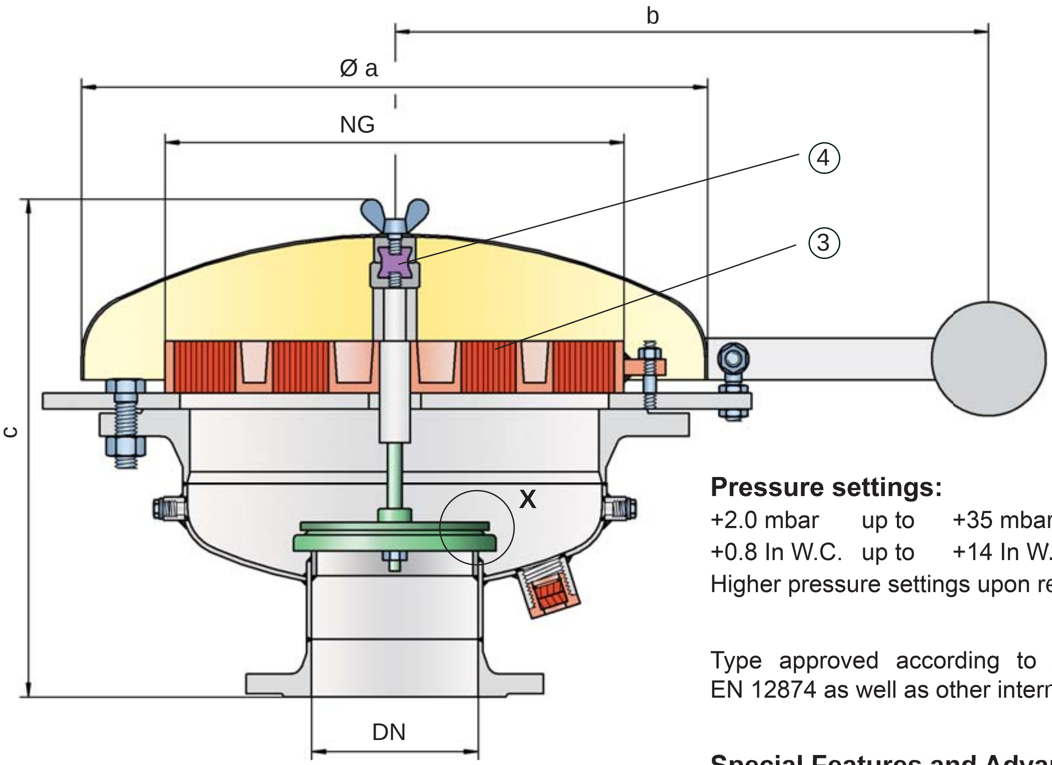
Notes:



Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® BE/HR-D



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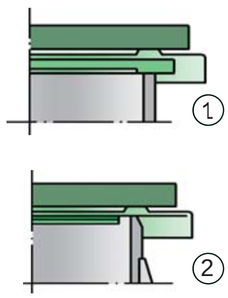

Pressure settings:

+2.0 mbar up to +35 mbar
+0.8 In W.C. up to +14 In W.C.
Higher pressure settings upon request.

Type approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Function and Description

The deflagration-proof and endurance burning-proof BE/HR-D type PROTEGO® valve is a highly developed pressure relief valve with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and prevents product losses almost up to the set pressure; it also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The BE/HR-D valve is available for substances of explosion group IIA (NEC group D MESG > 0.9 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 40% overpressure. The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Special Features and Advantages

- requires only 40% overpressure to full lift
- through 40% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging through product vapours
- flame-transmission-proof condensate drain
- maintenance-friendly design

Design and Specifications

The valve disc is weight-loaded.

Pressure relief valve, basic design **BE/HR-D-400/...**

Additional special devices available upon request

Table 1: Dimensions			Dimensions in mm / inches
To select the nominal size (DN), please use the flow capacity chart on the following page			
DN	150 / 6"	200 / 8"	NG = Nominal size
NG	400 / 16"	400 / 16"	
a	600 / 23.62	600 / 23.62	
b	545 / 21.46	545 / 21.46	
c	485 / 19.09	485 / 19.09	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request

Table 3: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	
Flame arrester unit	A	B	

Table 4: Material combinations of flame arrester unit

Design	A	B	
FLAMEFILTER® cage	Steel	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	Stainless Steel	

Table 5: Material selection for valve pallet

Design	A	B	C	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +35 >+5.6 up to +14	Special materials and higher pressure settings upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Type	Nominal size	Explosion group	Material (housing)	Material (flame arrester unit)	Pressure	Material (valve pallet)	Flange connection type
BE/HR-D-400 /	[ ] –	[ ] –	[ ] –	[ ] –	[/] –	[ ] –	[ ]
Design	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Setting [mbar] / Setting [In W.C.]	Tab. 5	Tab. 6

Order example

BE/HR-D-400 / 150 – IIA – A – A – 7 / – – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

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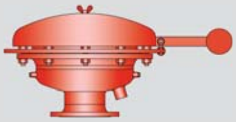
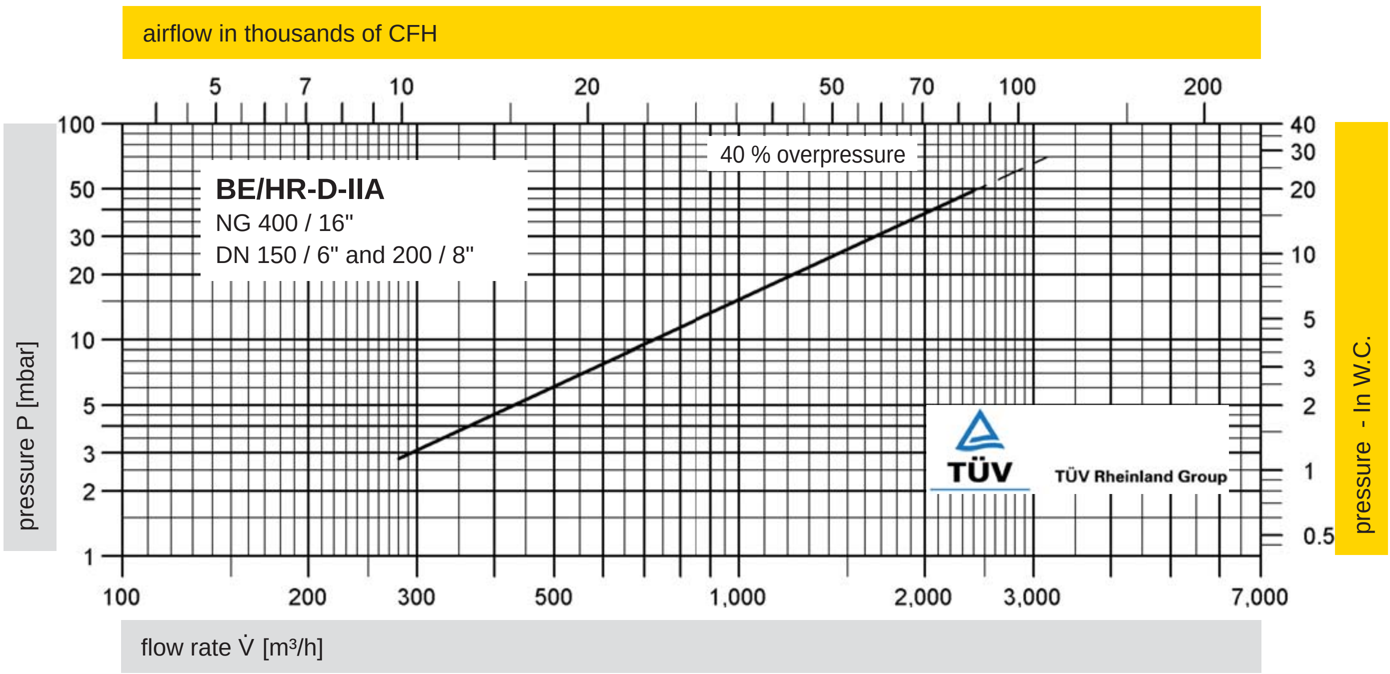


Pressure Relief Valve

Flow Capacity Chart

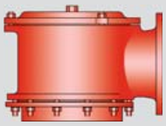
PROTEGO® BE/HR-D



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

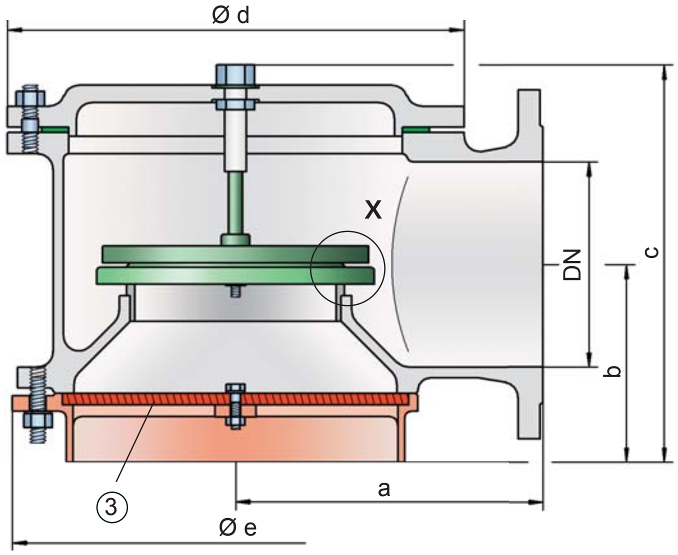
Notes:



Vacuum Relief Valve

deflagration-proof

PROTEGO® SV/E



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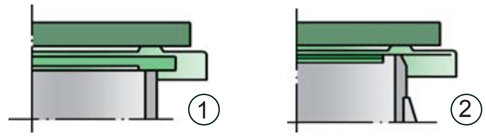


Vacuum settings:

-2.0 mbar up to -60 mbar (-0.2 kPa up to -6 kPa)

-0.8 In W.C. up to -24 In W.C.
Higher vacuum settings upon request

Function and Description

The deflagration-proof SV/E type PROTEGO® valve is a state of the art vacuum relief valve with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof inbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against vacuum and prevents inbreathing of air almost up to the set pressure; it also protects against atmospheric deflagration. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® SV/E valve is available for substances from explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

When the set vacuum is reached, the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set vacuum that is only 10% above the maximum allowable working vacuum (MAWV) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set vacuum with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use corrosive fluids. After the vacuum is equalized, the valve reseats and provides a tight seal.

If the valve is used in atmospheres forming an explosive mixture with air and the mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank.

The standard design is tested at an operating temperature up to +60°C / 140°F (T60) and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000. In addition numerous versions for higher operating temperature are available.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards. Additional certificates from classification associations for use on ships are also available.

Special Features and Advantages

- requires only 10% overpressure to full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- through 10% technology lower set vacuum can be reached which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- optimized flow performance
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- FLAMEFILTER® provides protection against atmospheric deflagration
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging through product vapour
- PROTEGO® flame arrester unit has a low pressure drop
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced
- an additional lifting gear can be purchased

Design Types and Specifications

The valve disc is weight-loaded. Higher vacuum can be achieved upon request with a special spring loaded design.

There are four different designs:

Vacuum relief valve, basic design	**SV/E-** $\boxed{–}$ **-** $\boxed{–}$
Vacuum relief valve with heating jacket (max. heating fluid temperature +85°C / 185°F)	**SV/E-** $\boxed{–}$ **-** $\boxed{H}$
Vacuum relief valve with lifting gear (ship design)	**SV/E-** $\boxed{S}$ **-** $\boxed{–}$
Vacuum relief valve with lifting gear (ship design) and heating jacket (max. heating fluid temperature +85°C / 185°F)	**SV/E-** $\boxed{S}$ **-** $\boxed{H}$

Additional special devices available upon request

Table 1: Dimensions							Dimensions in mm / inches
To select the nominal size (DN), please use the flow capacity chart on the following page							
DN	50 / 2"	80 / 3"	100 / 4"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	140 / 5.51	170 / 6.69	190 / 7.48	230 / 9.06	300 / 11.81	325 / 12.80	425 / 16.73
b	105 / 4.13	115 / 4.53	125 / 4.92	165 / 6.50	195 / 7.68	230 / 9.06	280 / 11.02
c	240 / 9.45	240 / 9.45	315 / 12.40	405 / 15.94	460 / 18.11	525 / 20.67	575 / 22.64
d	170 / 6.69	235 / 9.25	280 / 11.02	335 / 13.19	445 / 17.52	505 / 19.88	505 / 19.88
e	215 / 8.46	215 / 8.46	255 / 10.04	345 / 13.58	435 / 17.13	470 / 18.50	635 / 25.00

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Specification of max. operating temperature

≤ 60°C / 140°F	higher operating temperatures upon request
T60	Tmax. operating temperature

Table 4: Material selection for housing

Design	A	B	C	Special materials upon request
Housing Heating jacket (SV/E-(S)-H-...)	Ductile Iron –	Steel Steel	Stainless Steel Stainless Steel	
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel	
Gasket	WS 3822	WS 3822	PTFE	
Flame arrester unit	A	B	B	

Table 5: Material combinations of flame arrester unit

Design	A	B	Special materials upon request
FLAMEFILTER® cage	Ductile Iron	Stainless Steel	
FLAMEFILTER®	Stainless Steel	Stainless Steel	

Table 6: Material selection for valve pallet

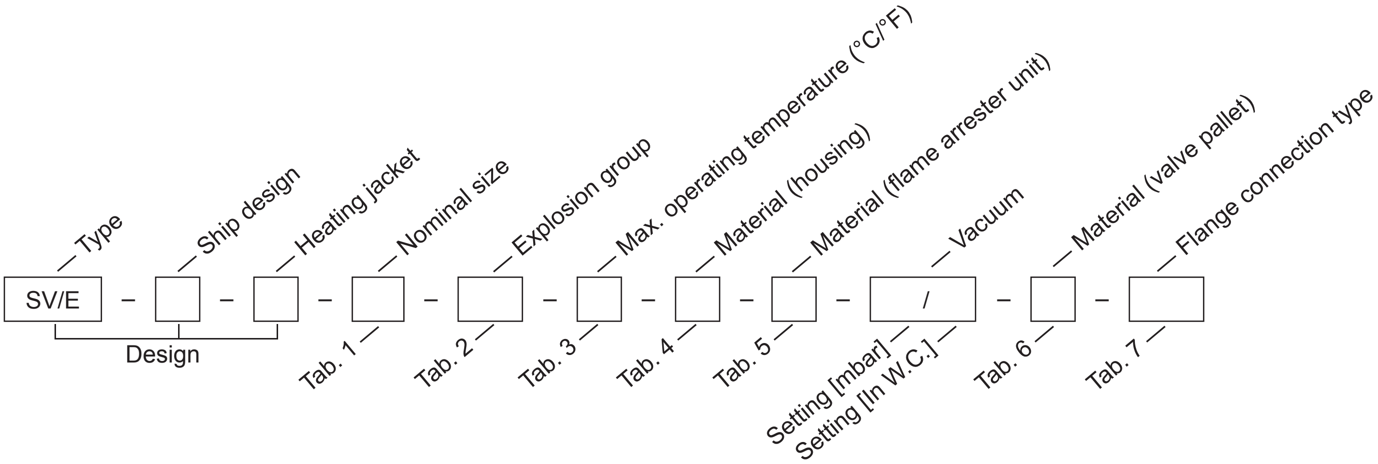
Design	A	B	C	D	E	F
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24	<-14 up to -35 <-5.6 up to -14	<-35 up to -60 <-14 up to -24
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE	PTFE

Special materials and higher pressure settings upon request

Table 7: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

for safety and environment

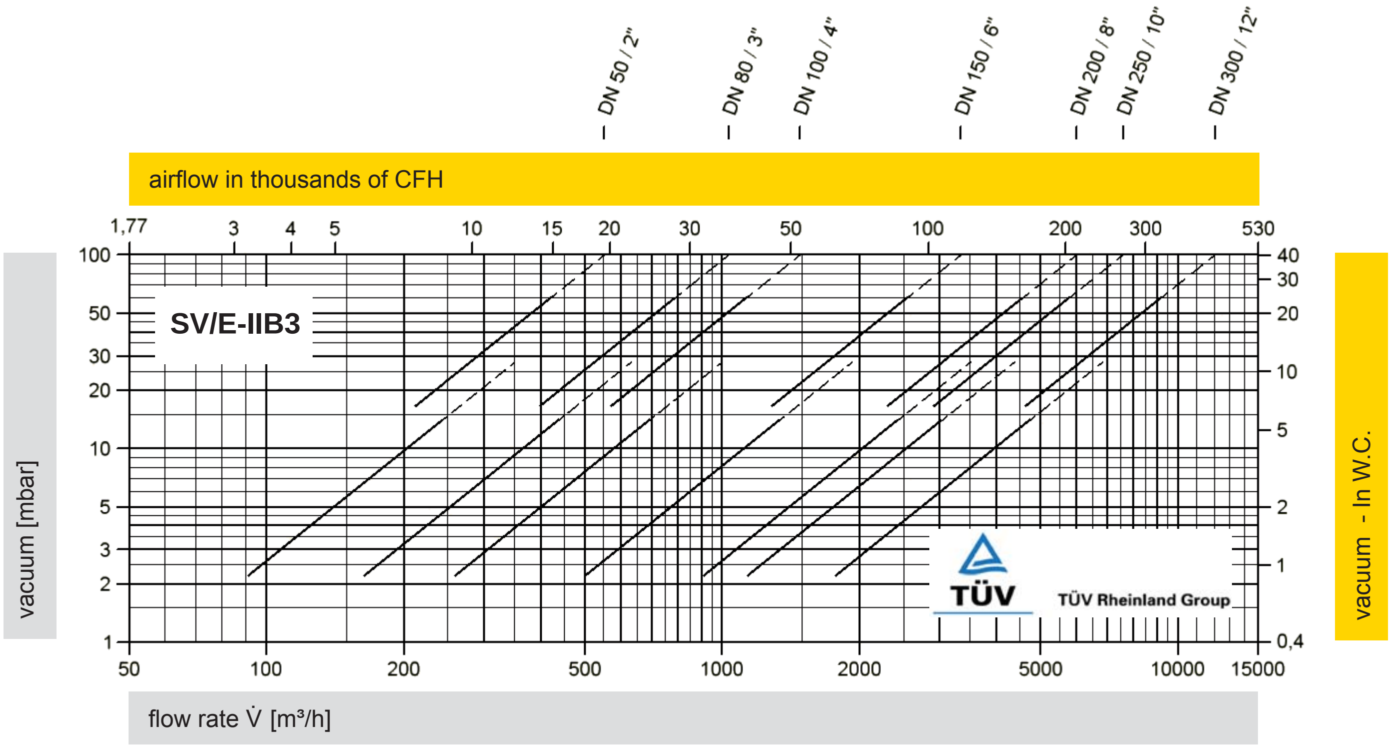


Order example

SV/E	–	S	–	H	–	100	–	IIB3	–	T60	–	A	–	A	–	10 / –	–	B	–	DIN

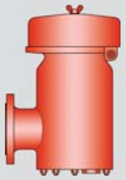
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

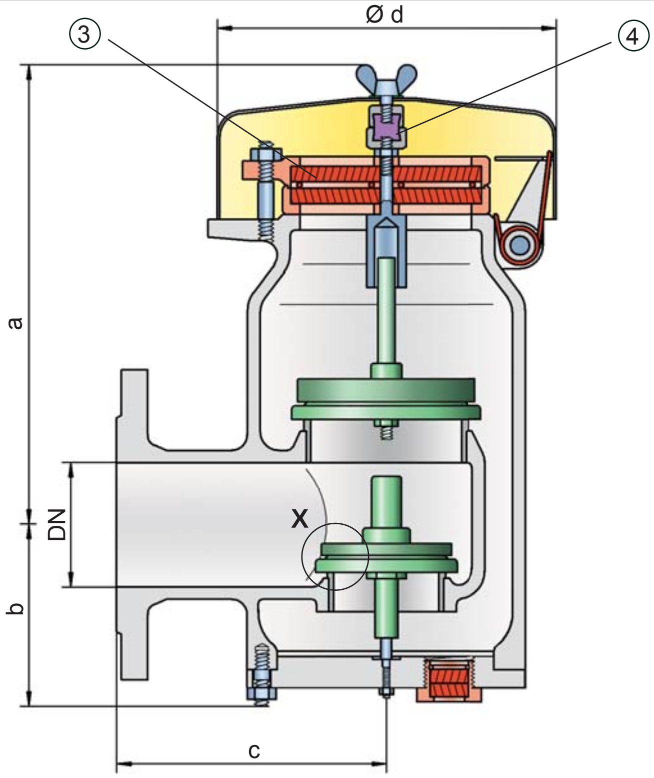
Notes:



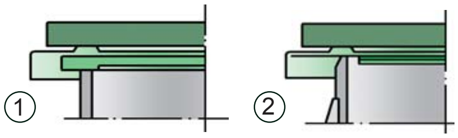
Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EB



Detail **X**



Settings:

pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 in W.C.	up to	+84 In W.C.
vacuum:	-14 mbar	up to	-35 mbar
	-5.6 in W.C.	up to	-14 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.
Higher and lower settings upon request

Function and Description

The atmospheric deflagration and endurance burning proof PV/EB type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration and endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® PV/EB valve is available for substances of explosion group IIA (NEC group D MESG > 0.9 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 10% over pressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) or maximum allowable working vacuum (MAWV) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Special Features and Advantages

- requires only 10% overpressure to full lift
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- increased design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging through product vapour
- PROTEGO® flame arrester unit has a low pressure drop
- flame transmission proof condensate drain
- maintenance friendly design
- special design with lifting gear can be purchased

Design Types and Specifications

Almost any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight loaded. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve discs are used.

There are two different designs:

Pressure/vacuum relief valve, basic design **PV/EB-** $\boxed{-}$

Pressure/vacuum relief valve with heating jacket (max. heating fluid temperature +85°C / 185°F) **PV/EB-** $\boxed{H}$

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"	
Set pressure	≤ +60 mbar ≤ +24.1 In W.C.	> +60 mbar > +24.1 In W.C.	≤ +60 mbar ≤ +24.1 In W.C.	> +60 mbar > +24.1 n W.C.	Dimensions for pressure/ vacuum relief valve with heating jacket upon request
a	308 / 12.13	443 / 17.44	308 / 12.13	443 / 17.44	
b	108 / 4.25	108 / 4.25	108 / 4.25	108 / 4.25	
c	165 / 6.50	165 / 6.50	167 / 6.57	167 / 6.57	
d	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request

Table 3: Material selection for housing

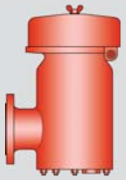
Design	B	C	
Housing Heating jacket (PV/EB-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seats	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+35 up to +210 >+14 up to +84	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	



Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

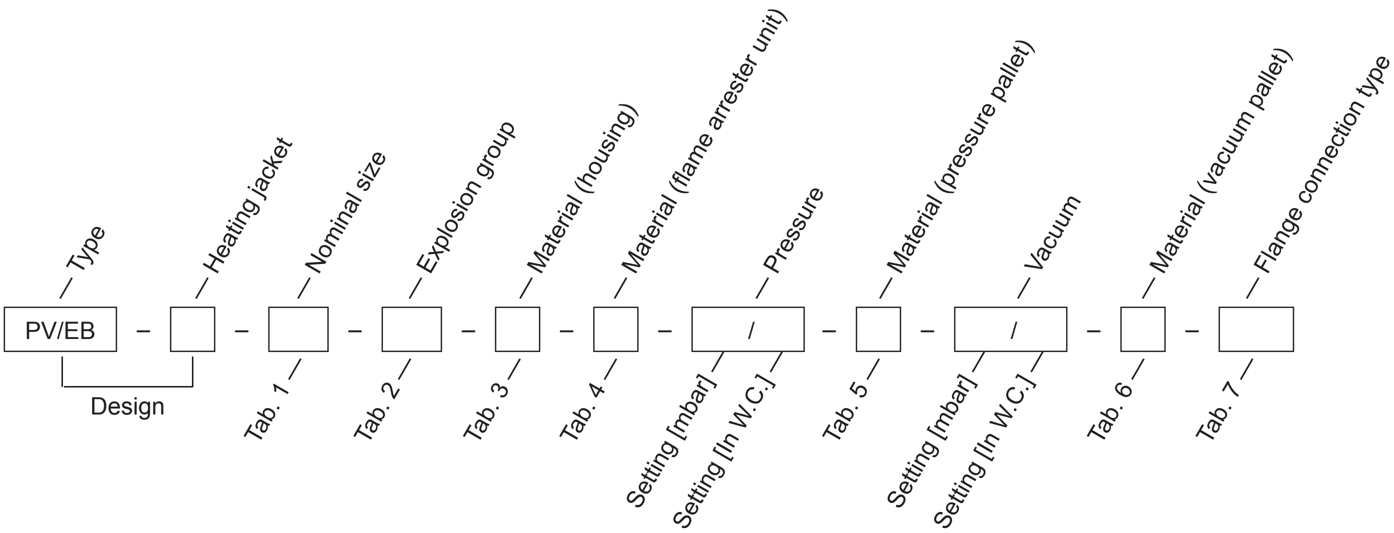
PROTEGO® PV/EB

Table 6: Material selection for vacuum pallet

Design	A	B	C	D	
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	Special material as well as higher set vacuum upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 7: Flange connection type

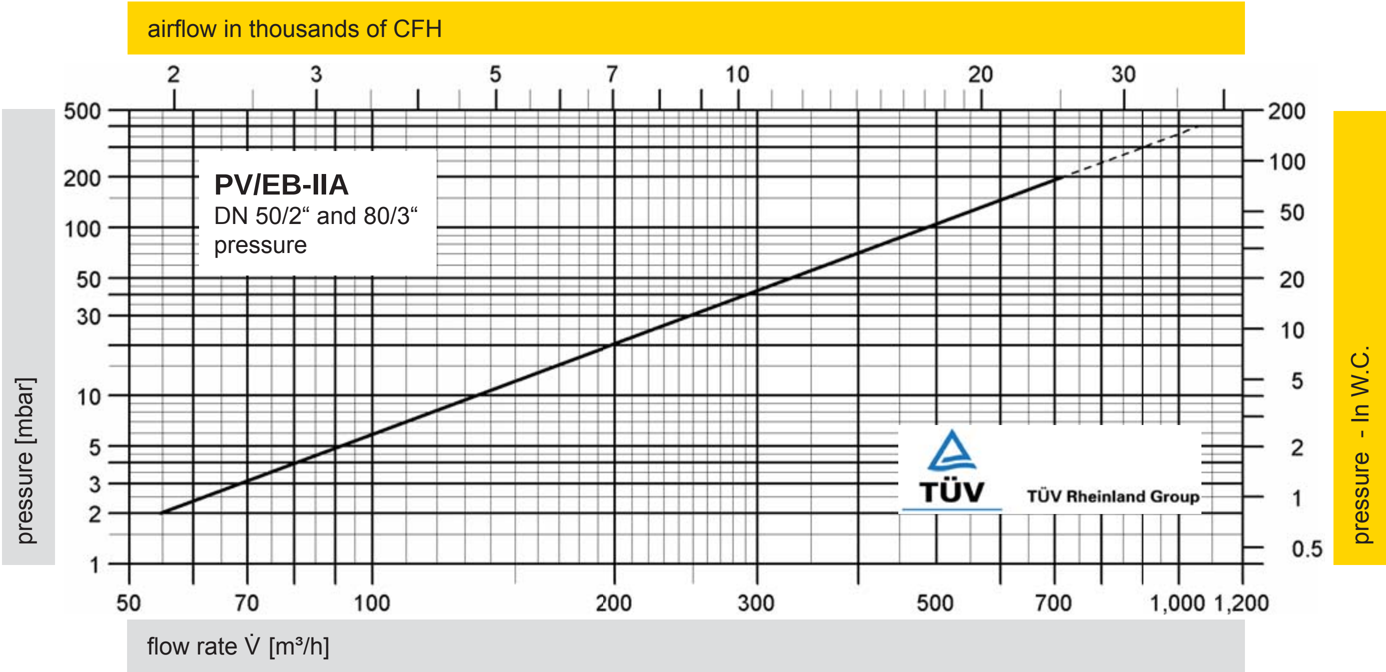
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

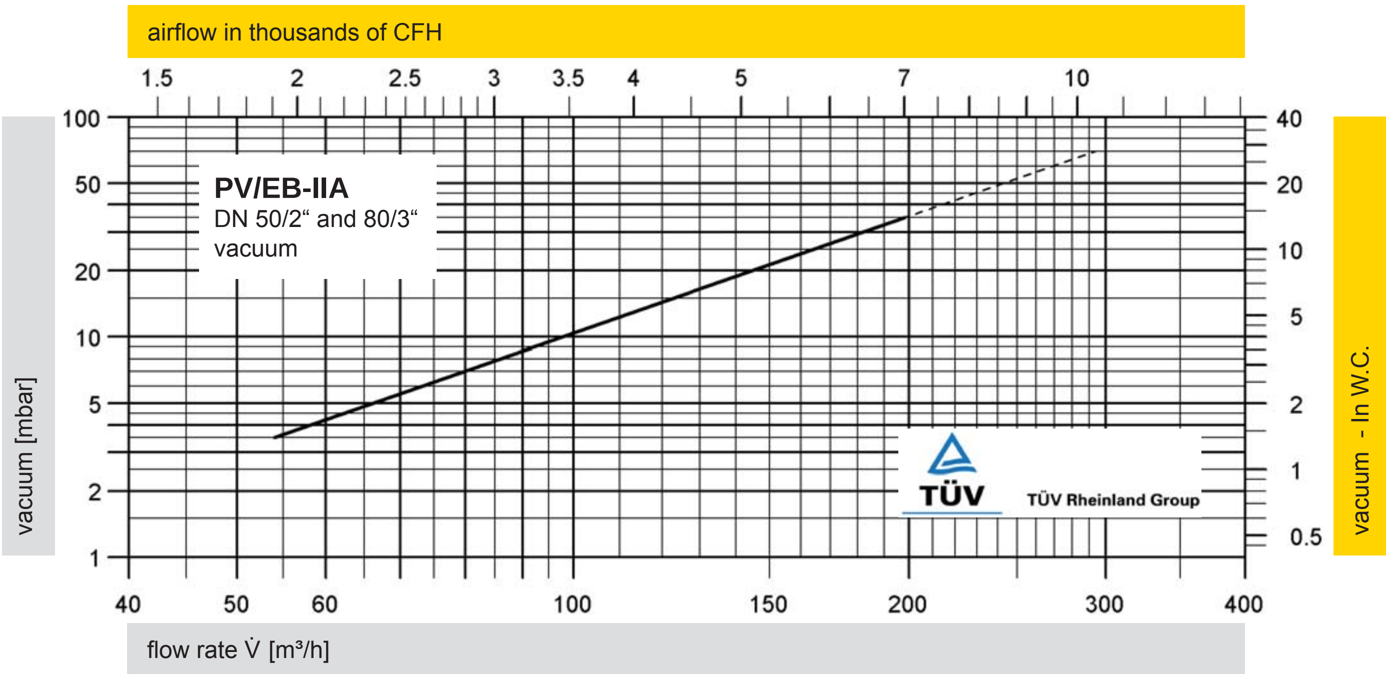


Order example

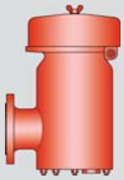
PV/EB – H – 50 – IIA – B – A – 50 / – – D – -10 / – – B – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





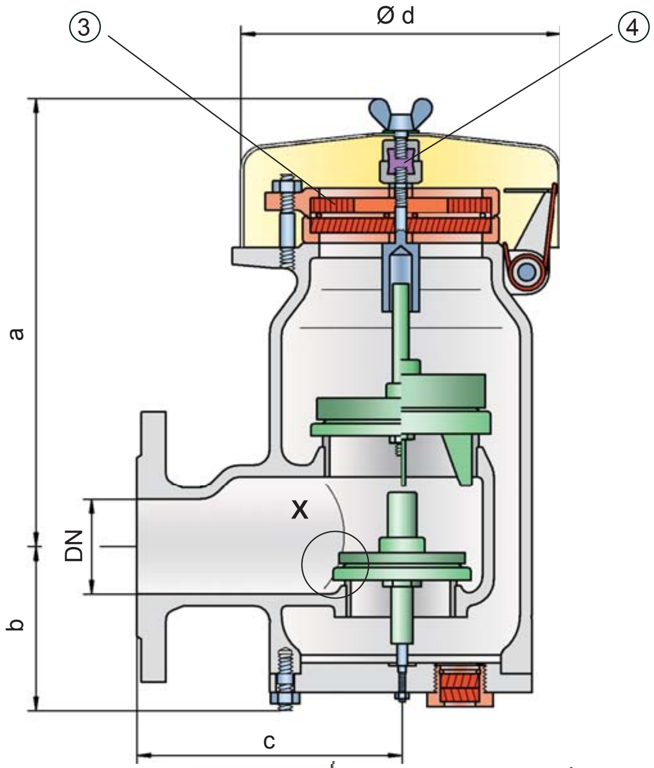
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

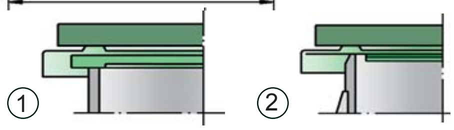


Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EB-E





Settings:

pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 in W.C.	up to	+84 In W.C.
vacuum:	-14 mbar	up to	-35 mbar
	-5.6 in W.C.	up to	-14 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.
Higher and lower settings upon request

Function and Description

The deflagration-proof and endurance burning-proof PV/EB-E type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester unit that is specially used for applications handling ethanol. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® PV/EB-E valve is available for substances of explosion group IIB1 (MESG ≥ 0.85 mm) and provides specific protection against deflagration and endurance burning of alcohol/air mixtures (such as ethanol/air).

The valve functions proportionally, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- selecting set pressure close to relieving pressure results in product loss reduction
- increased design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning of alcohol/air mixtures from explosion group IIB1
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced
- special design with lifting gear can be purchased

Design Types and Specifications

Almost any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight loaded. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve discs are used.

There are two different designs:

Pressure/vacuum relief valve, basic design **PV/EB-E- –**

Pressure/vacuum relief valve with heating jacket **PV/EB-E- H**
(max. heating fluid temperature +85°C / 185°F)

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	50 / 2"	50 / 2"	80 / 3"	80 / 3"	
Set pressure	≤ +60 mbar ≤ +24.1 In W.C.	> +60 mbar ≤ +24.1 In W.C	≤ +60 mbar ≤ +24.1 In W.C	> +60 mbar ≤ +24.1 In W.C	Dimensions for Pressure/ Vacuum Relief Valve with heating jacket upon request
a	308 / 12.13	443 / 17.44	308 / 12.13	443 / 17.44	
b	108 / 4.25	108 / 4.25	108 / 4.25	108 / 4.25	
c	165 / 6.50	165 / 6.50	167 / 6.57	167 / 6.57	
d	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,85 mm	IIB1	–	Special approvals upon request

Table 3: Material selection for housing

Design	B	C	
Housing Heating jacket (PV/EB-E-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seats	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

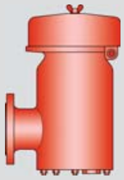
Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+35 up to +210 >+14 up to +84	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

PROTEGO
for safety and environment



Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EB-E

Table 6: Material selection for vacuum pallet					
Design	A	B	C	D	Special material as well as higher set vacuum upon request
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

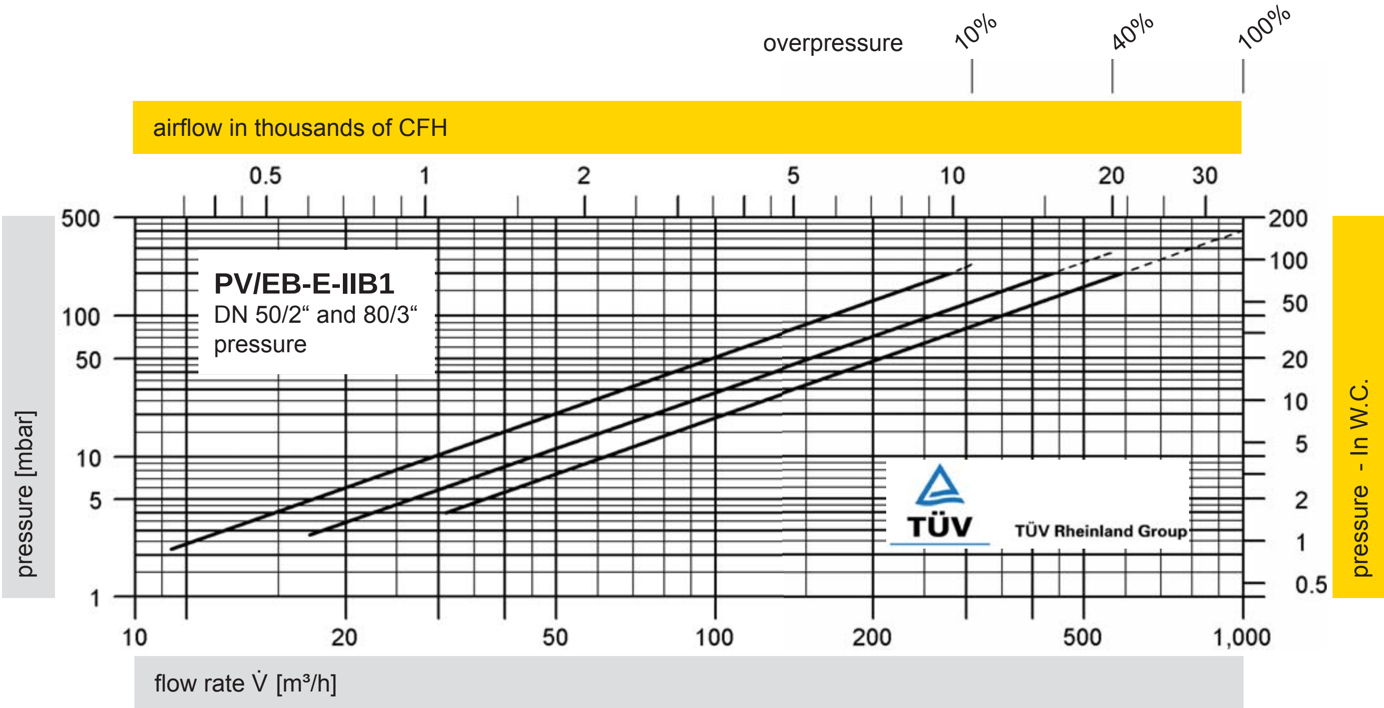
Type – Heating jacket – Nominal size – Explosion group – Material (housing) – Material (flame arrester unit) – Pressure – Material (pressure pallet) – Vacuum – Material (vacuum pallet) – Flange connection type

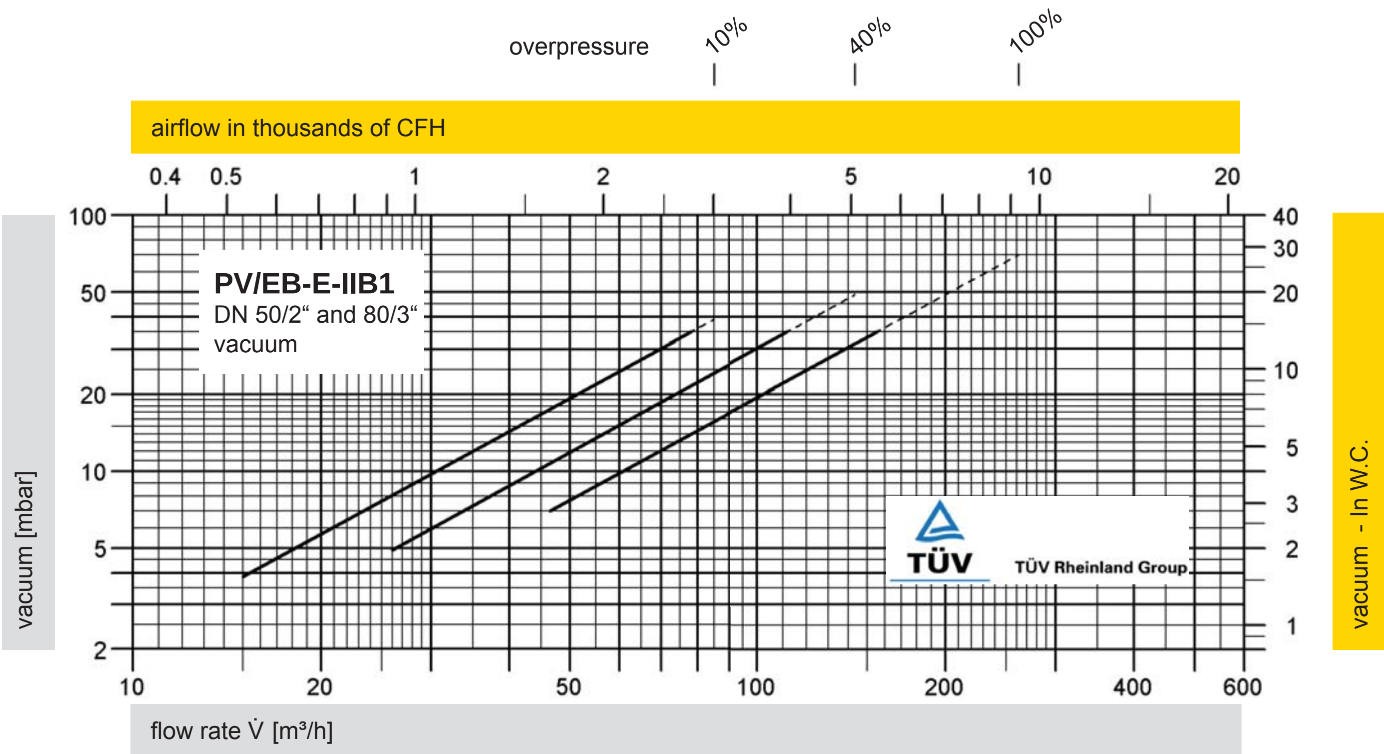
PV/EB-E – ☐ – ☐ – ☐ – ☐ – ☐ – ☐ / ☐ – ☐ – ☐ / ☐ – ☐ – ☐

Design; Tab. 1; Tab. 2; Tab. 3; Tab. 4; Setting [mbar] / Setting [In W.C.]; Tab. 5; Setting [mbar] / Setting [In W.C.]; Tab. 6; Tab. 7

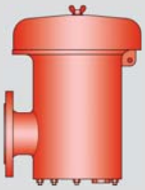
PV/EB-E – H – 50 – IIB1 – B – A – 50 / – – D – -10 / – – B – DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"





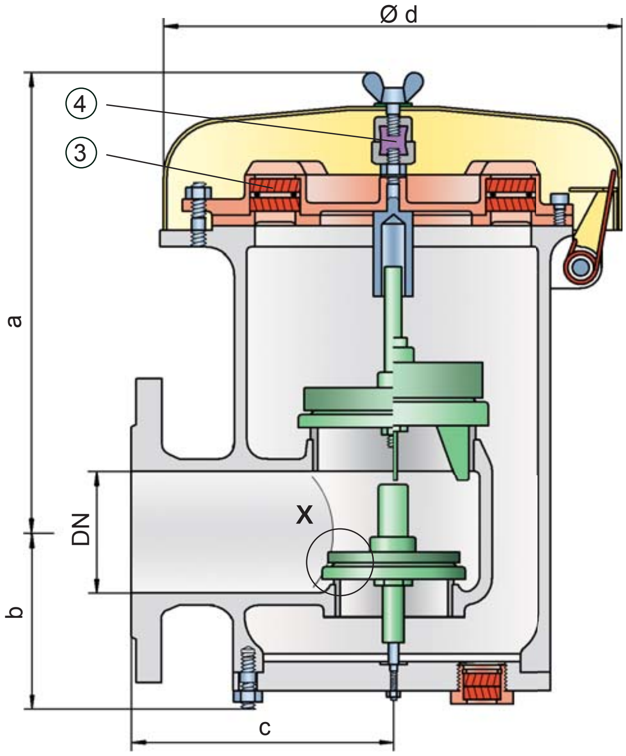
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



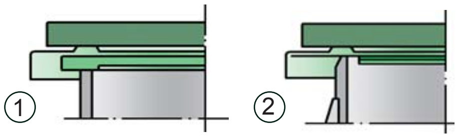
Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EBR



Detail **X**



Settings:

pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 In W.C.	up to	+84 In W.C.
vacuum:	-14 mbar	up to	-50 mbar
	-5.6 In W.C.	up to	-20 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.
Higher and lower settings upon request

Function and Description

The deflagration-proof and endurance burning-proof PV/EBR type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. PROTEGO® PV/EBR valves are available for substances from explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

The valve functions proportional, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- selecting set pressure close to relieving pressure results in product loss reduction
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced
- special design with lifting gear can be purchased

Design Types and Specifications

Almost any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight loaded. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve discs are used.

There are two different designs:

Pressure/vacuum relief valve, basic design	**PV/EBR-** –
Pressure /vacuum relief valve with heating jacket (max. heating fluid temperature +85°C / 185°F)	**PV/EBR-** H

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"	
Set pressure	≤ +35 mbar ≤ +14 In W.C.	> +35 mbar > +14 In W.C.	≤ +35 mbar ≤ +14 In W.C.	> +35 mbar > +14 In W.C.	Dimensions for pressure/ vacuum relief valve with heating jacket upon request
a	345 / 13.58	475 /18.70	345 / 13.58	475 /18.70	
b	141 / 5.55	141 / 5.55	141 / 5.55	141 / 5.55	
c	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	
d	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Material selection for housing

Design	B	C	
Housing Heating jacket (PV/EBR-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seats	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+35 up to +210 >+14 up to +84	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

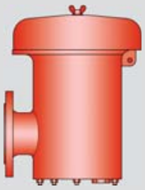
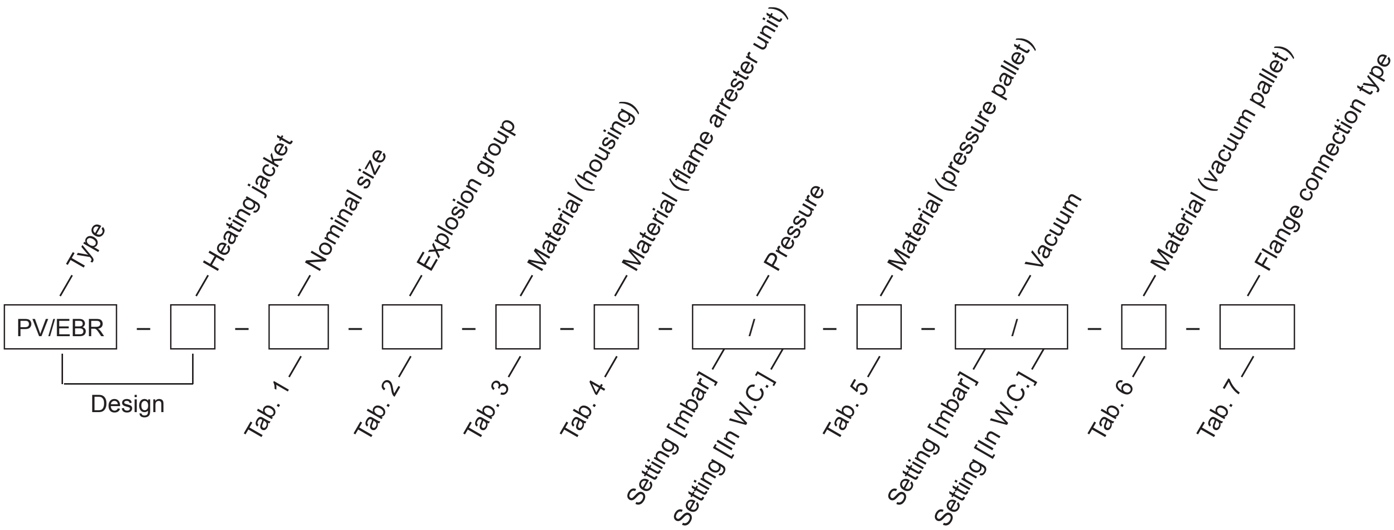


Table 6: Material selection for vacuum pallet					
Design	A	B	C	D	Special material as well as higher set vacuum upon request
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -50 <-5.6 up to -20	<-14 up to -50 <-5.6 up to -20	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

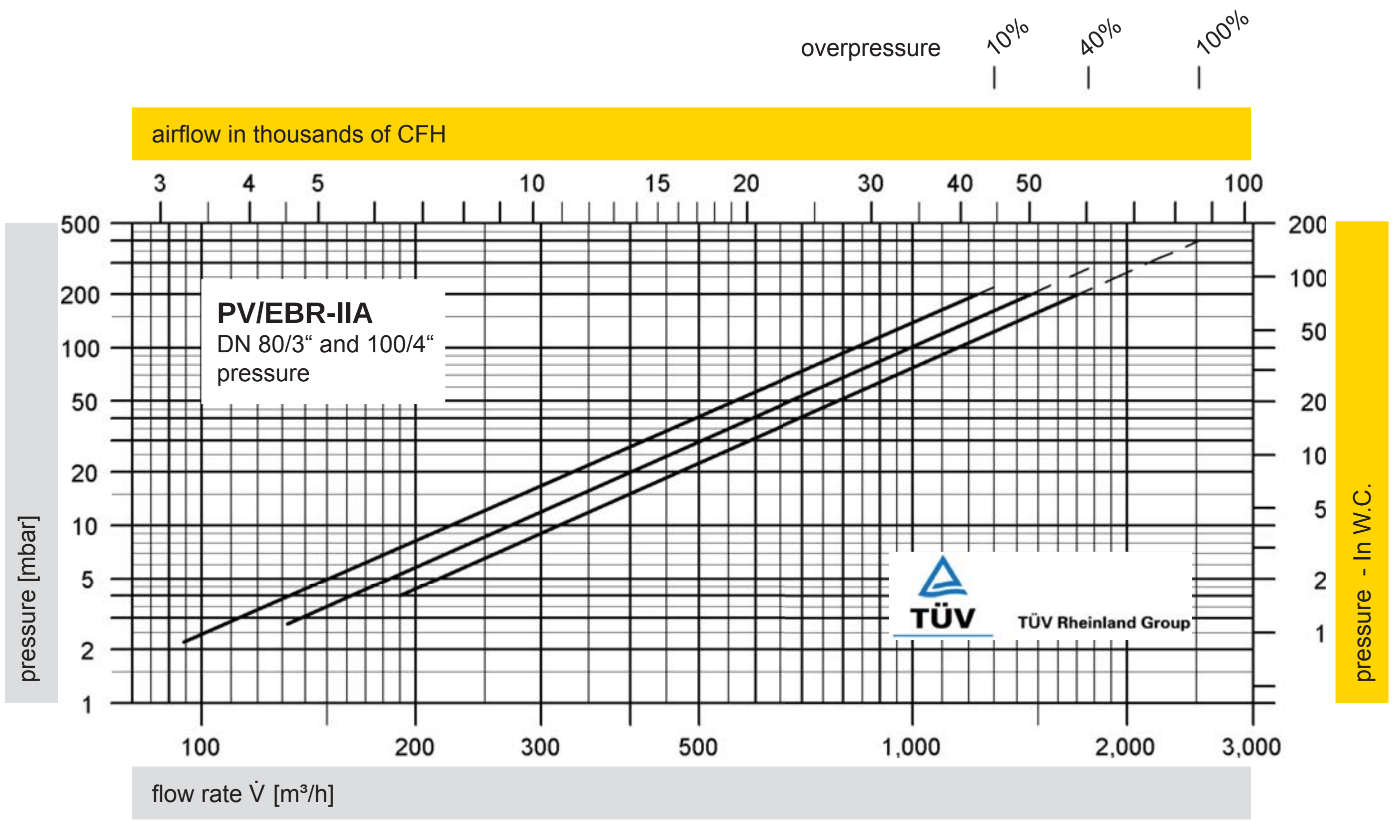
Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

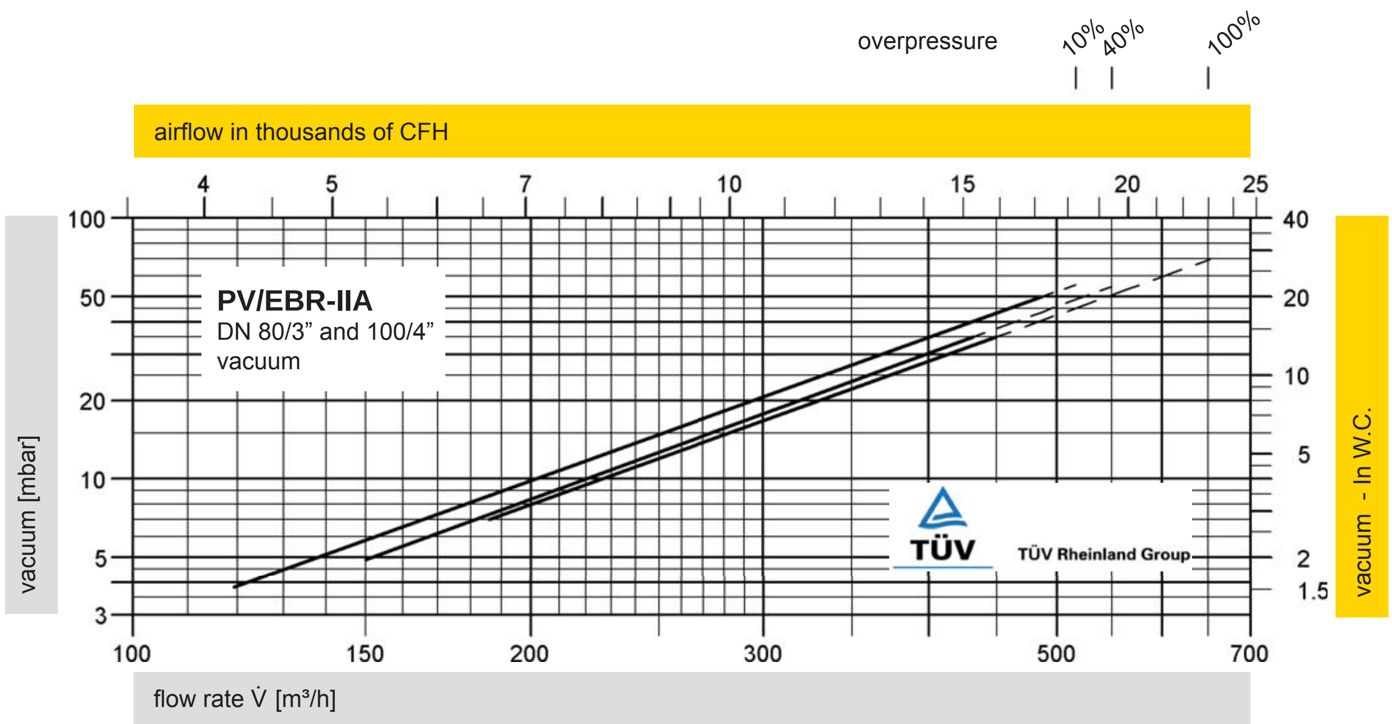


Order example

PV/EBR	H	100	IIA	B	A	50 / –	D	-10 / –	B	DIN

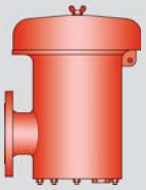
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

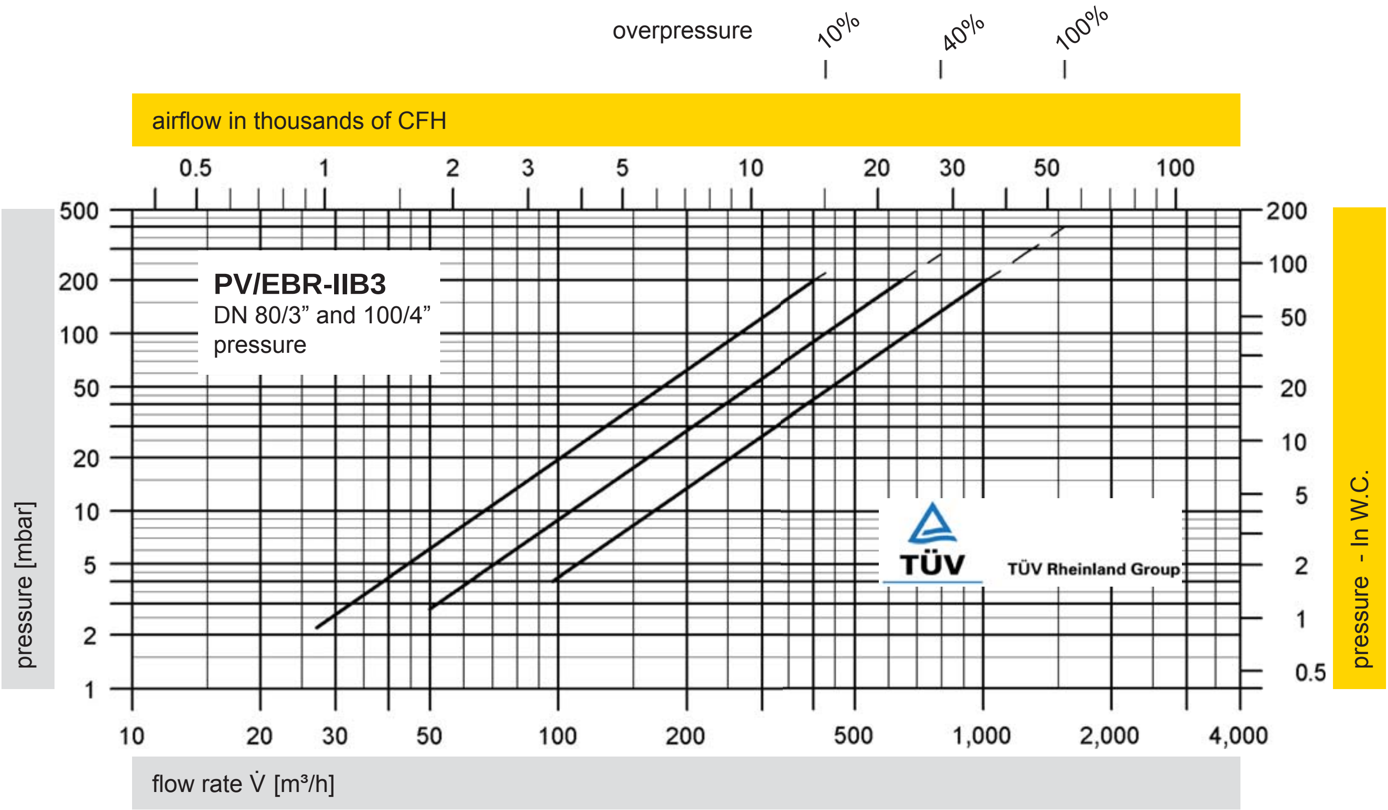
PROTEGO
for safety and environment

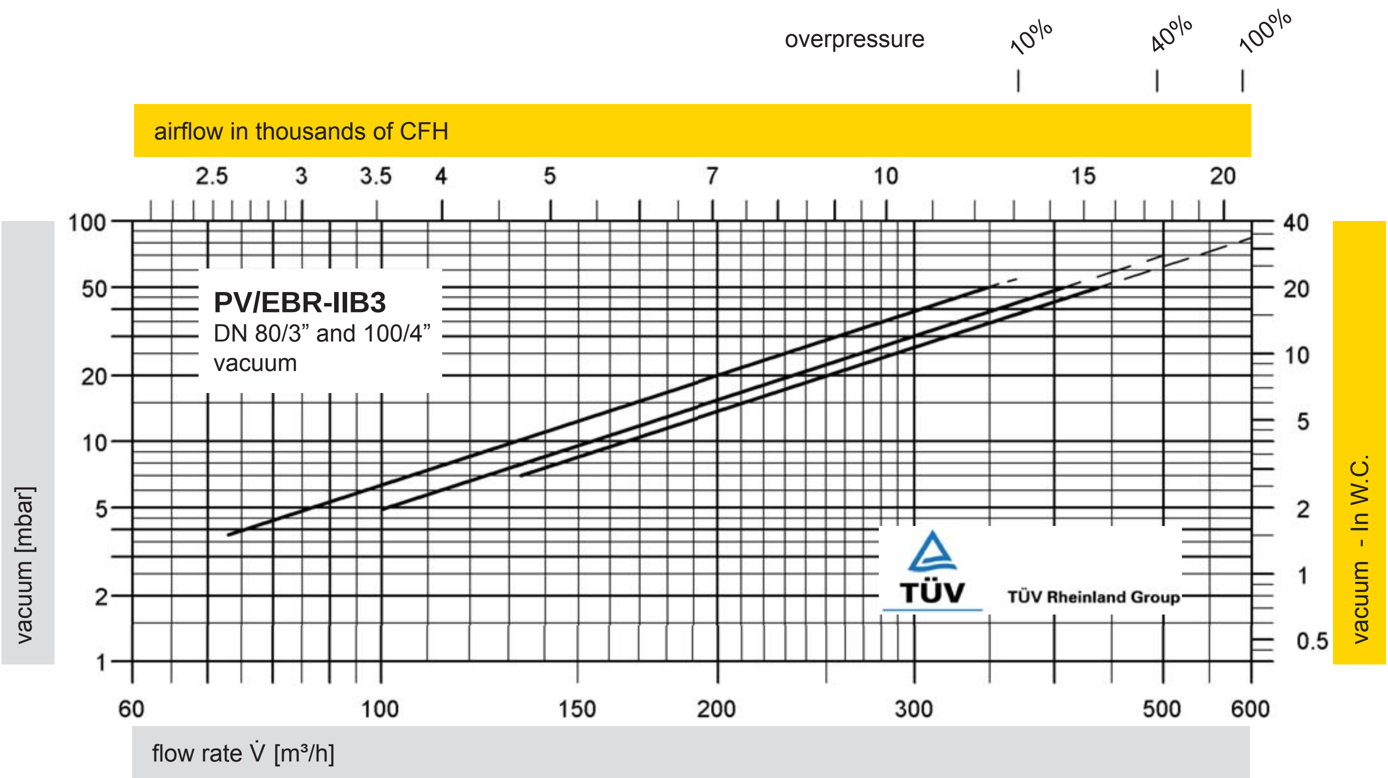


Pressure/Vacuum Relief Valve

Flow Capacity Charts

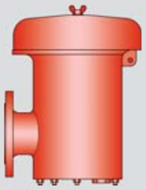
PROTEGO® PV/EBR





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

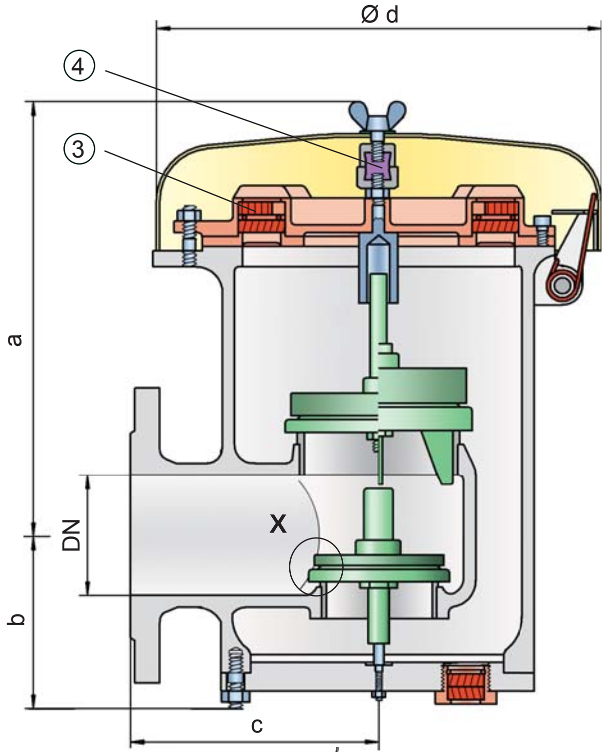
Notes:



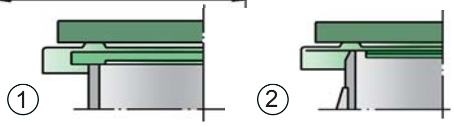
Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EBR-E



Detail **X**



Settings:

pressure:	+2.0 mbar	up to	+210 mbar
	+0.8 In W.C.	up to	+84 In W.C.
vacuum:	-14 mbar	up to	-50 mbar
	-5.6 In W.C.	up to	-20 In W.C.
vacuum:	-3.5 mbar	up to	-14 mbar
	-1.4 in W.C.	up to	-5.6 In W.C.

for presssure up to max. + 150 mbar / 60.2 In W.C.

Higher and lower settings upon request

Function and Description

The deflagration-proof and endurance burning-proof PV/EBR-E type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester that is specially used for applications handling ethanol. It is primarily used as a safety device for flame transmission proof outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® PV/EBR-E valve is available for substances of explosion group IIB1 (MESG ≥ 0.85 mm) and provides specific protection against deflagration and endurance burning of alcohol/air mixtures (such as ethanol/air).

The valve functions proportional, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- selecting set pressure close to relieving pressure results in product loss reduction
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA’s 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning of alcohol/ air mixtures from explosion group IIB1
- high flow capacity through large flame filter cross-section, results in low pressure drop
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and valve pallets to be replaced
- special design with lifting gear can be purchased

Design Types and Specifications

Almost any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight loaded. When the difference between the pressure and vacuum exceeds 150 mbar / 60.2 In W.C., special valve discs are used.

There are two different designs:

Pressure/vacuum relief valve, basic design **PV/EBR-E-** $\boxed{-}$

Pressure/vacuum relief valve with heating jacket (max. heating fluid temperature +85°C / 185°F) **PV/EBR-E-** $\boxed{\textbf{H}}$

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	80 / 3"	80 / 3"	100 / 4"	100 / 4"	
Set pressure	≤ +35 mbar ≤ +14 In W.C.	> +35 mbar > +14 In W.C.	≤ +35 mbar ≤ +14 In W.C.	> +35 mbar > +14 In W.C.	Dimensions for Pressure/ Vacuum Relief Valve with heating jacket upon request
a	345 / 13.58	475 / 18.70	345 / 13.58	475 / 18.70	
b	141 / 5.55	141 / 5.55	141 / 5.55	141 / 5.55	
c	218 / 8.58	218 / 8.58	218 / 8.58	218 / 8.58	
d	353 / 13.90	353 / 13.90	353 / 13.90	353 / 13.90	

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,85 mm	IIB1	–	Special approvals upon request

Table 3: Material selection for housing

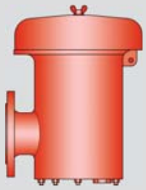
Design	B	C	
Housing Heating jacket (PV/EBR-E-H-...)	Steel Steel	Stainless Steel Stainless Steel	Special materials upon request
Valve seats	Stainless Steel	Stainless Steel	
Weather hood	Steel	Stainless Steel	

Table 4: Material combination of flame arrester unit

Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	
Spacer	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+2.0 up to +3.5 +0.8 up to +1.4	>+3.5 up to +14 >+1.4 up to +5.6	>+14 up to +210 >+5.6 up to +84	>+35 up to +210 >+14 up to +84	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	



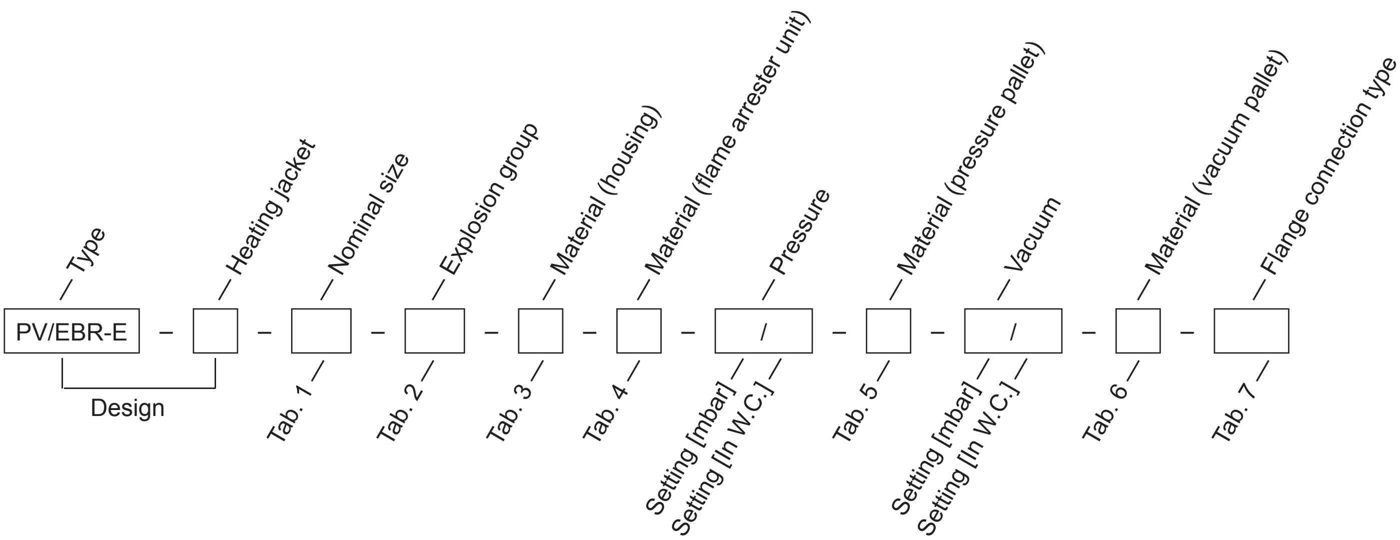
Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® PV/EBR-E

Table 6: Material selection for vacuum pallet					
Design	A	B	C	D	Special material as well as higher set vacuum upon request
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	<-5.0 up to -14 <-2.0 up to -5.6	<-14 up to -50 <-5.6 up to -20	<-14 up to -50 <-5.6 up to -20	
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

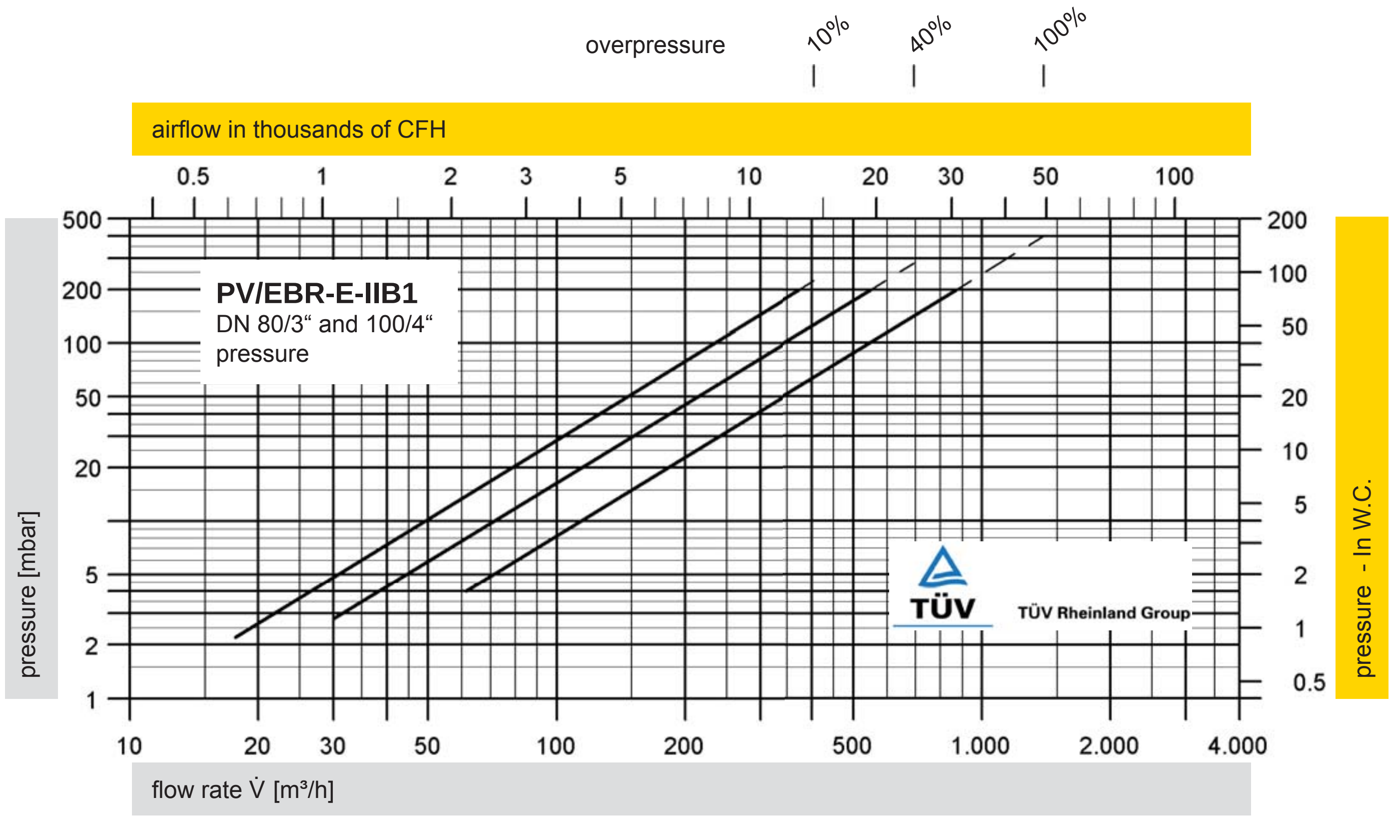


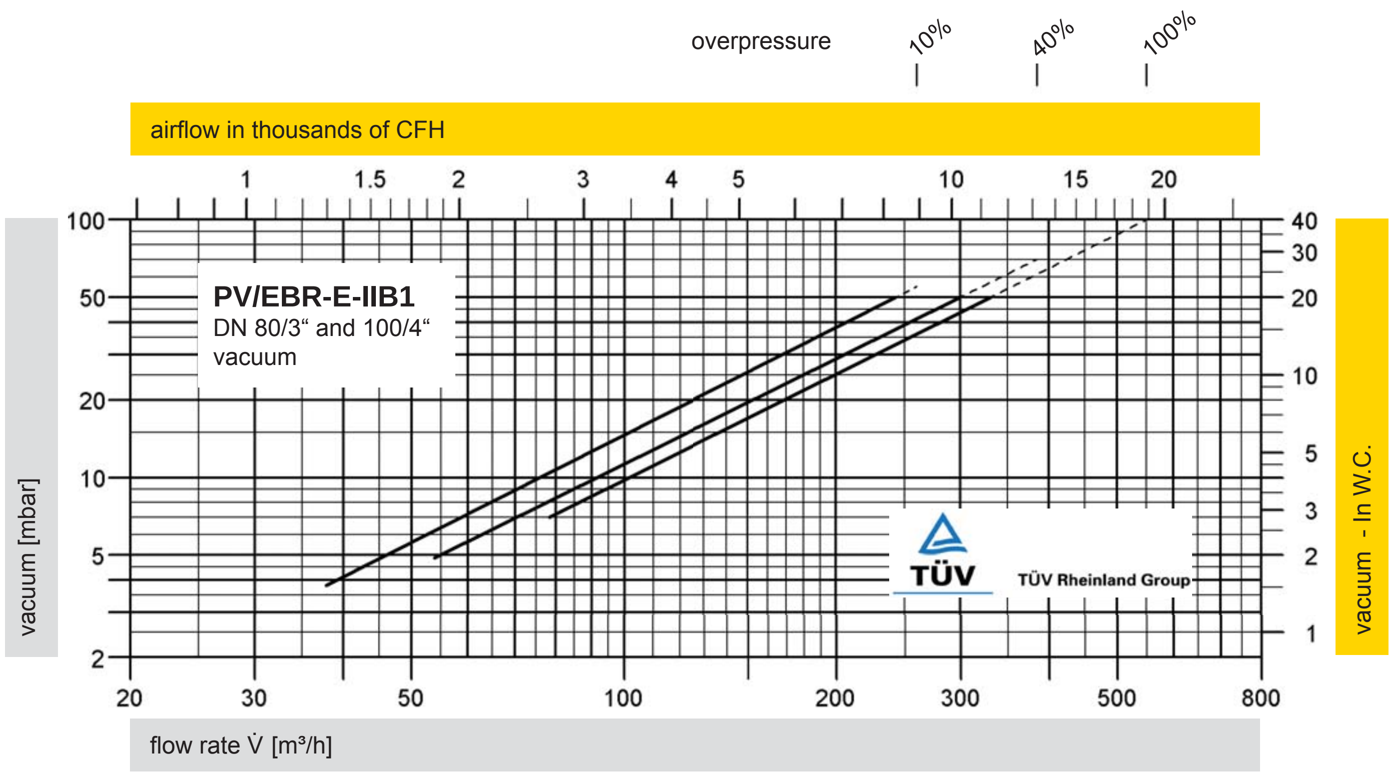
Order example

PV/EBR-E	–	H	–	100	–	IIB1	–	B	–	A	–	50 / –	–	D	–	-10 / –	–	B	–	DIN

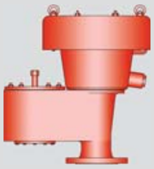
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® PV/EBR-E





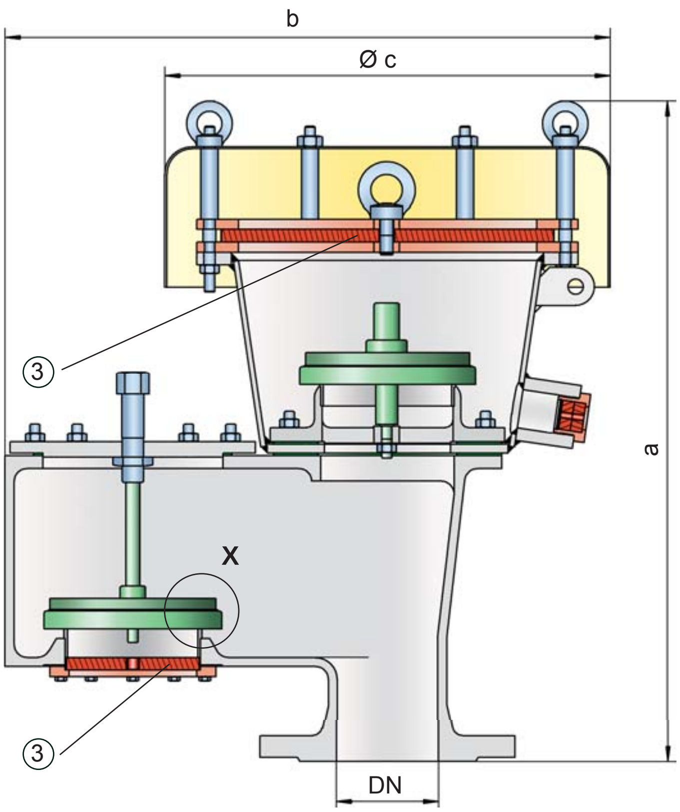
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

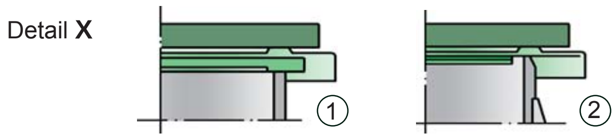


Pressure/Vacuum Relief Valve

atmospheric deflagration-proof

PROTEGO® VD/SV-AD and VD/SV-ADL





Settings:

pressure:	+3.5 mbar	up to	+35 mbar
	+1.4 in W.C.	up to	+14 in W.C.
vacuum:	-2.0 mbar	up to	-35 mbar
	-0.8 in W.C.	up to	-14 in W.C.

Higher and lower settings upon request

Function and Description

The deflagration proof VD/SV-AD(L) type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester unit. It is primarily used as a safety device for flame-transmission-proof in- and outbreathing in tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, preventing outbreathing of product vapour and inbreathing of air almost up to the set pressure and also protects against atmospheric deflagration. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The deflagration-proof PROTEGO® VD/SV-AD(L) valve is available for substances from explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) or maximum allowable working vacuum (MAWV) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the in- and outbreathing is completed the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission resulting from atmospheric deflagration into the tank. The vacuum side is also protected against atmospheric deflagration.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift
- through 10% technology set pressures and vacuum closer to MAWP and MAWV can be reached which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- FLAMEFILTER® provides protection against atmospheric deflagration
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging through product vapour
- FLAMEFILTER® has a low pressure drop
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTER® and the valve pallet to be replaced
- superior technology for API tanks with low MAWP and MAWV

Design Types and Specifications

Any combination of vacuum and pressure levels can be set for the valve

The valve discs are weight-loaded.

There are two different designs:

Pressure/vacuum relief valve with housing, standard design **VD/SV-AD**

Pressure/vacuum relief valve with expanded housing **VD/SV-ADL**

Additional special devices available upon request

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

	VD/SV-AD		VD/SV-ADL	
DN	80 / 3"	100 / 4"	100 / 4"	150 / 6"
a	540 / 21.26	565 / 22.24	650 / 25.59	760 / 29.92
b	475 / 18.70	575 / 22.64	700 / 27.56	855 / 33.66
c	350 / 13.78	350 / 13.78	600 / 23.62	600 / 23.62

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request

Table 3: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	Option: Housing with ECTFE-lining
Valve seats	Stainless Steel	Stainless Steel	Special materials upon request
Gasket	WS 3822	PTFE	
Weather hood	Stainless Steel	Stainless Steel	
Flame arrester unit	A, B	B	

Table 4: Material combinations of flame arrester units

Design	A	B	
FLAMEFILTER® cage	Steel	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+14 up to +35 >+5.6 up to +14	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Material selection for vacuum valve pallet

Design	A	B	C	D	
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	Special material as well as higher set vacuum upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

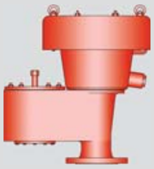


Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

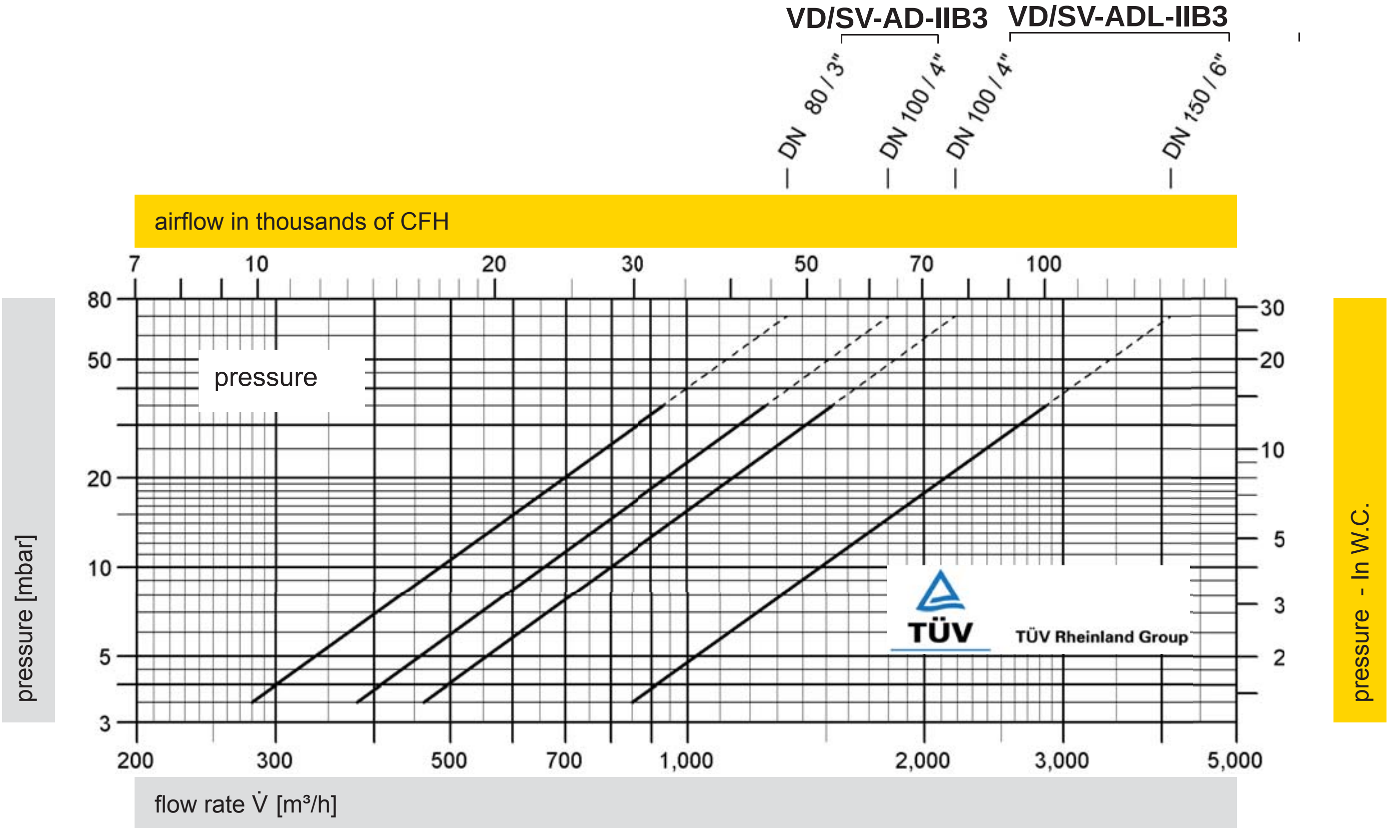
Type (standard housing)		Type (expanded housing)		Nominal size		Explosion group		Material (housing)		Material (flame arrester unit)		Pressure		Material (pressure pallet)		Vacuum		Material (vacuum pallet)		Flange connection type
VD/SV-AD	or	VD/SV-ADL	–		–		–		–		–	/	–		–	/	–		–	
Design				Tab. 1		Tab. 2		Tab. 3		Tab. 4		Setting [mbar] / Setting In W.C.]		Tab. 5		Setting [mbar] / Setting In W.C.]		Tab. 6		Tab. 7

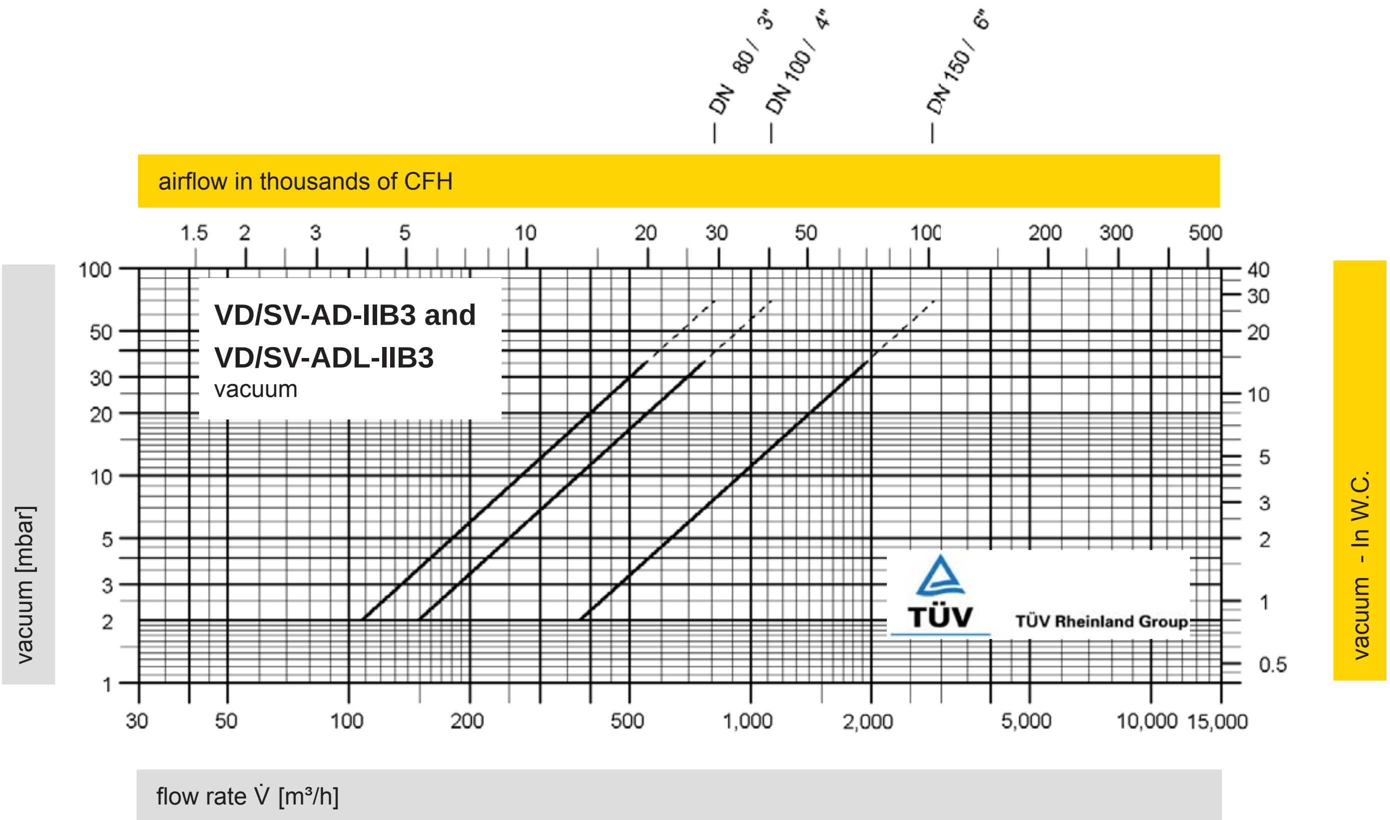
Order example

VD/SV-AD		——	–	100	–	IIB3	–	B	–	B	–	30 / –	–	C	–	-10 / –	–	B	–	DIN

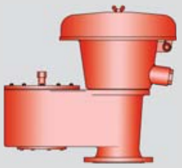
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® VD/AD and VD/SV-ADL





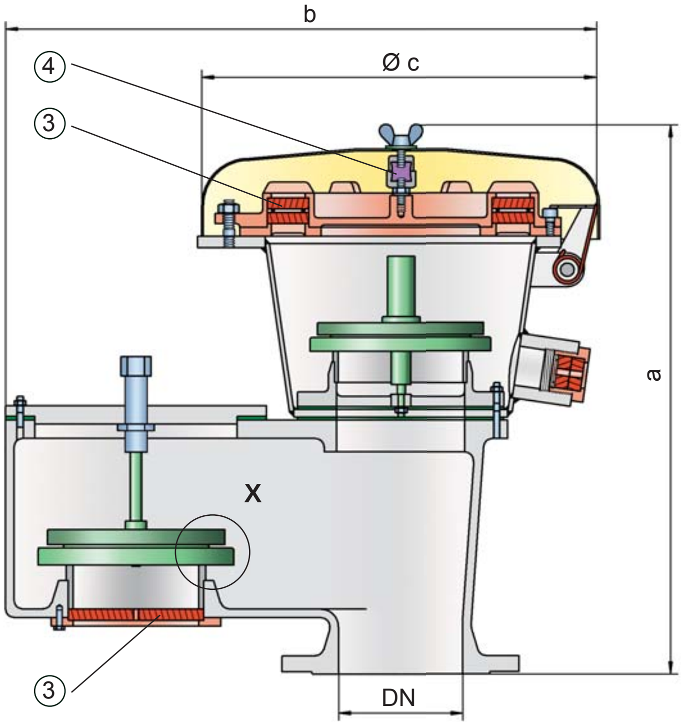
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® VD/SV-HR



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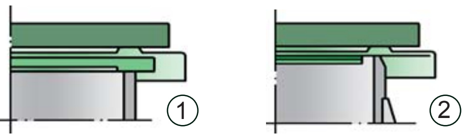


Settings:

pressure:	+3.5 mbar	up to	+35 mbar
	+1.4 In W.C.	up to	+14 In W.C.
vacuum:	-2.0 mbar	up to	-35 mbar
	-0.8 In W.C.	up to	-14 In W.C.

Higher and lower settings upon request

Function and Description

The deflagration-proof and endurance burning-proof VD/SV-HR type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester. It is primarily used as a safety device for flame-transmission-proof in- and out-breathing in tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, preventing outbreathing of product vapour and inbreathing of air almost up to the set pressure and also protects against atmospheric deflagration as well as endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The deflagration and endurance burning proof PROTEGO® VD/SV-HR device is available for substances from explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

If the set pressure is reached for a valve approved for explosion Group IIA (NEC group D), the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range. Valves approved for explosion group IIB3 (NEC group C) function proportionally, so the set pressures should be selected in relation to the proportional behaviour (such as a 10%, 40%, or 100% overpressure from the set pressure to the relieving pressure at which the required flow performance is reached).

The tank pressure is maintained up to set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere . If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift for explosion group IIA (NEC group D) vapours
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- more design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- the valve disc is guided within the housing to protect against harsh weather conditions
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- can be used as protective system according to ATEX in areas subject to explosion hazards (94/9/EC)
- safe against deflagration and endurance burning for explosion group IIA and IIB3 (NEC group D and C) vapours
- high flow capacity through large FLAMEFILTER® cross-section, results in low pressure drop
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- FLAMEFILTER® protected from clogging caused by product vapours
- flame transmission proof condensate drain
- maintenance friendly design
- modular design enables individual FLAMEFILTERS® and valve pallets to be replaced

Design and Specifications

Any combination of vacuum and pressure levels can be set for the valve.

The valve discs are weight-loaded.

Pressure/vacuum relief valve, basic design **VD/SV-HR**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	80 / 3"	100 / 4"
a	500 / 19.69	543 / 21.38
b	477 / 18.78	577 / 22.72
c	353 / 13.90	353 / 13.90

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Material selection for housing

Design	A	B	
Housing	Steel	Stainless Steel	Option: Housing with ECTFE-lining
Valve seats	Stainless Steel	Stainless Steel	Special materials upon request
Gasket	WS 3822	PTFE	
Weather hood	Steel	Stainless Steel	
Flame arrester unit	A	A	

Table 4: Material combination of flame arrester unit

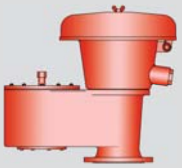
Design	A	
FLAMEFILTER® cage	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D	
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+14 up to +35 >+5.6 up to +14	Special material as well as higher set pressure upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	

Table 6: Material selection for vacuum valve pallet

Design	A	B	C	D	
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<+14 up to +35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14	Special material as well as higher set vacuum upon request
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	
Sealing	FEP	FEP	Metal to Metal	PTFE	



Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® VD/SV-HR

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

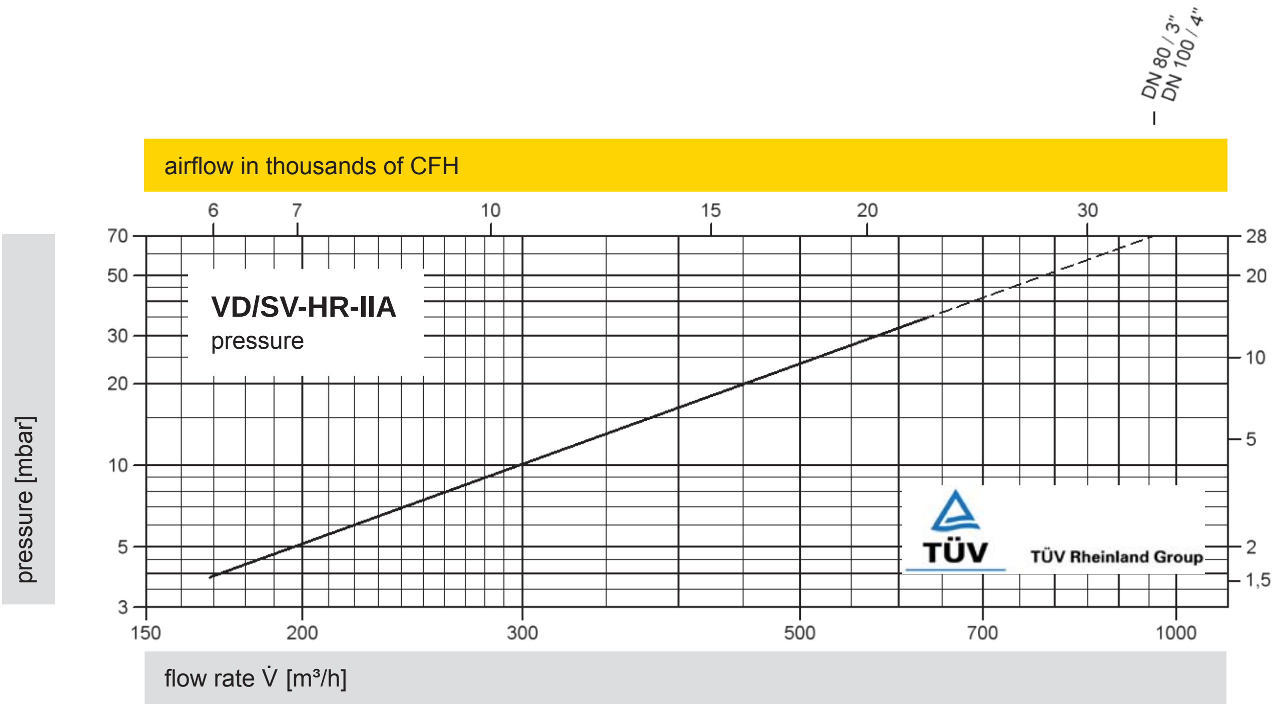
Type	Nominal size	Explosion group	Material (housing)	Material (flame arrester)	Pressure	Material (pressure pallet)	Vacuum	Material (vacuum pallet)	Flange connection type
VD/SV-HR –	–	–	–	–	/ –	–	/ –	–	
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Setting [mbar] / Setting [In W.C.]	Tab. 5	Setting [mbar] / Setting [In W.C.]	Tab. 6	Tab. 7

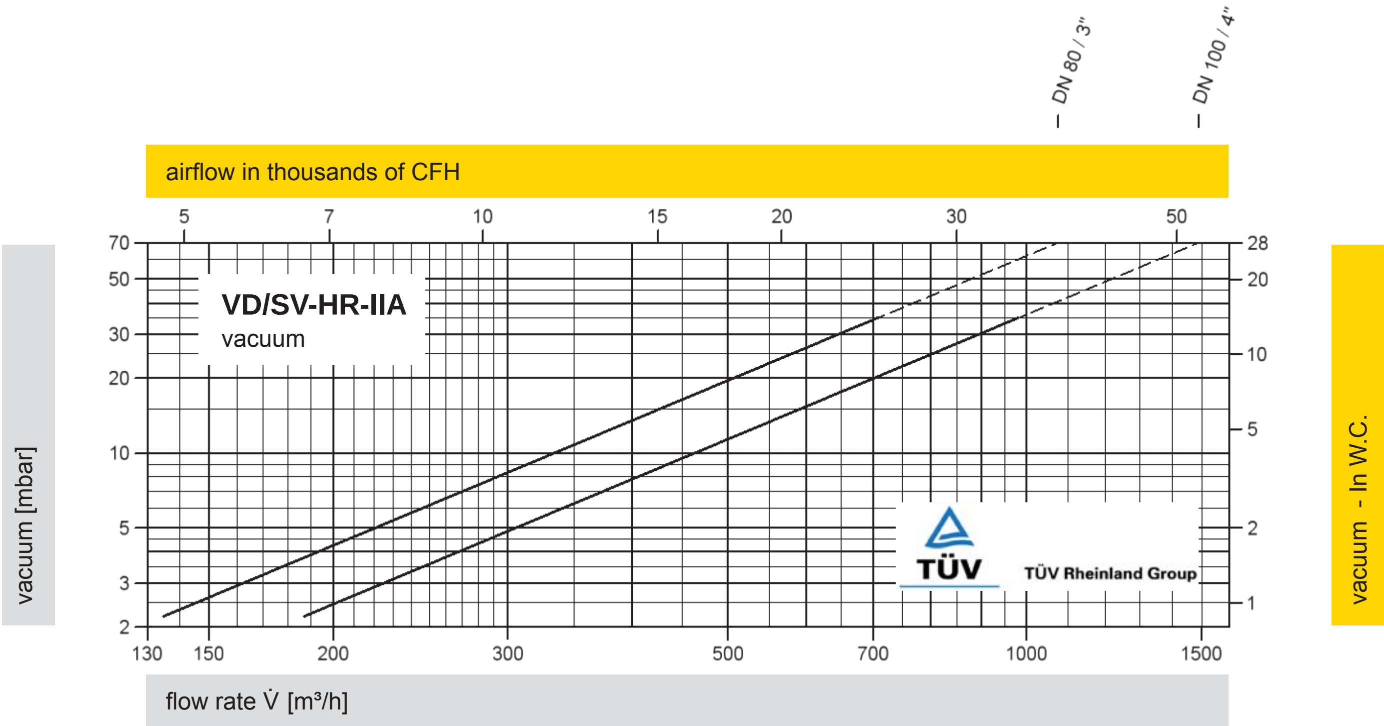
Order example

VD/SV-HR –	100 –	IIA –	A –	A –	30 / – –	C –	-10 / – –	B –	DIN

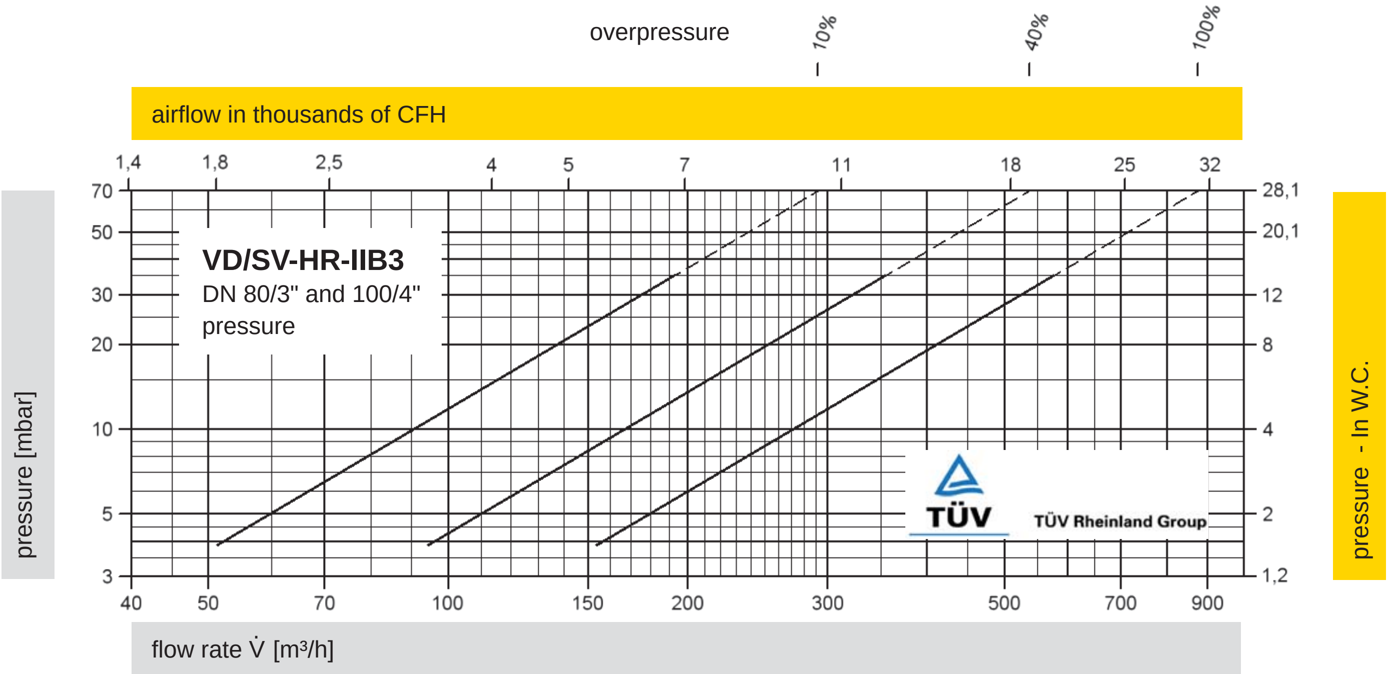
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® VD/SV-HR





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



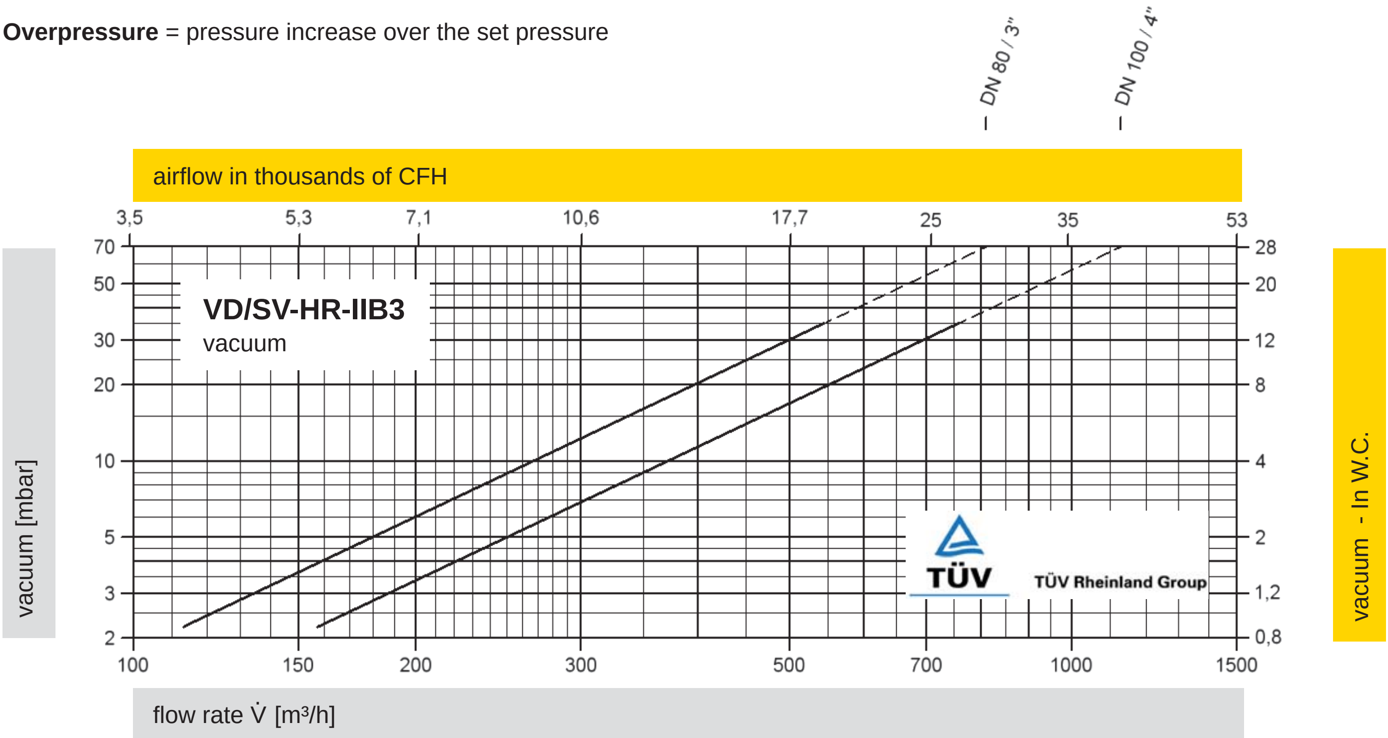
Remark

$$\text{set pressure} = \frac{\text{opening pressure resp. tank design pressure}}{1 + \frac{\text{overpressure}}{100\%}}$$

Set pressure = the valve starts to open

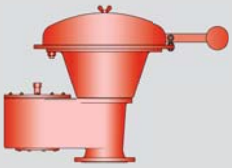
Opening pressure = set pressure plus overpressure

Overpressure = pressure increase over the set pressure



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

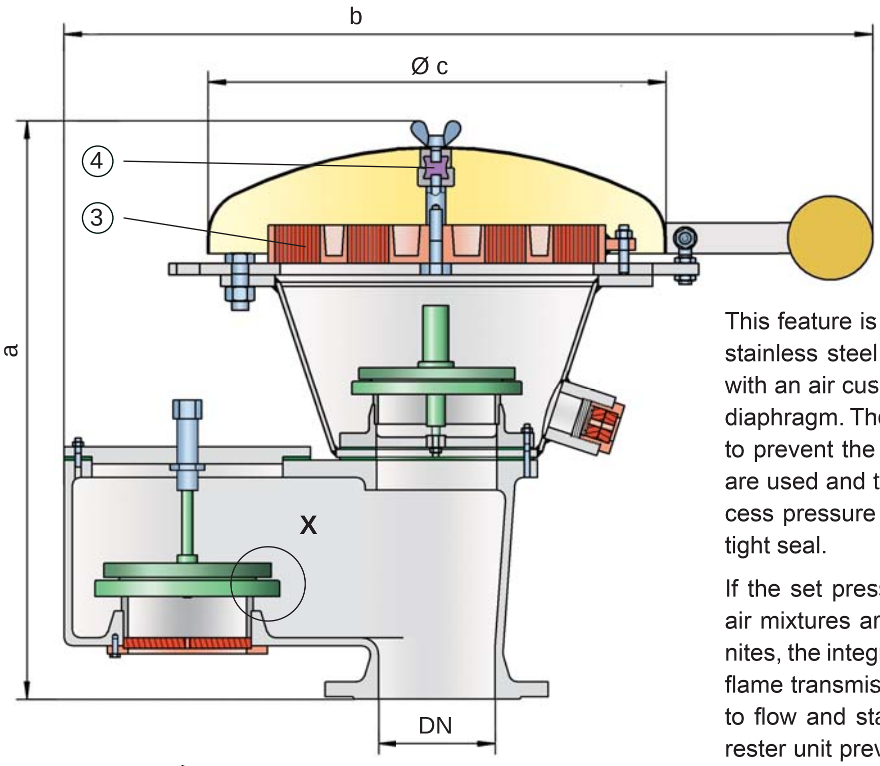
Notes:



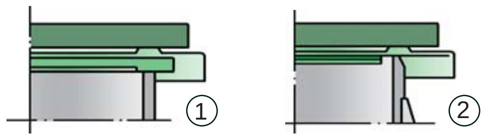
Pressure/Vacuum Relief Valve

deflagration- and endurance burning-proof

PROTEGO® VD/SV-HRL



Detail **X**



Settings:

pressure:	+3.5 mbar	up to	+35 mbar
	+1.4 In W.C.	up to	+14 in W.C.
vacuum:	-2.0 mbar	up to	-35 mbar
	-0.8 In W.C.	up to	-14 In W.C.

Higher and lower settings upon request

Function and Description

The atmospheric deflagration and endurance burning proof VD/SV-HRL type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration and endurance burning if stabilized burning occurs. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® VD/SV-HRL device is available for substances of explosion group IIA (NEC group D MESG > 0.9 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) or maximum allowable working vacuum (MAWV) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank. If additional mixture continues to flow and stabilized burning occurs, the integrated flame arrester unit prevents flashback as a result from endurance burning. The valve is protected and also fulfils its function under this severe service condition. The spring loaded weather hood opens as soon as the fusible element (4) melts.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- increased design flexibility through higher reseating pressures; vents reseat when conventional vent is still discharging costly product or nitrogen
- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- FLAMEFILTER® provides protection against atmospheric deflagration and endurance burning
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost

- FLAMEFILTER® protected from clogging through product vapour
- FLAMEFILTER® has low pressure drop
- flame transmission proof condensate drain
- maintenance friendly design
- superior technology for API tanks

Design and Specifications

Any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight-loaded.

Pressure/vacuum relief valve, basic design **VD/SV-HRL**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	100 / 4"	150 / 6"
a	650 / 25.59	760 / 29.92
b	1000 / 39.37	1155 / 45.47
c	600 / 23.62	600 / 23.62

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
> 0,90 mm	IIA	D	Special approvals upon request

Table 3: Material selection for housing

Design	A	B
Housing	Steel	Stainless Steel
Valve seats	Stainless Steel	Stainless Steel
Gasket	WS 3822	PTFE
Weather hood	Steel	Stainless Steel
Flame arrester unit	A, B	B

Option: Housing with ECTFE-lining

Special materials upon request

Table 4: Material combinations of flame arrester unit

Design	A	B
FLAMEFILTER® cage	Steel	Stainless Steel
FLAMEFILTER®	Stainless Steel	Stainless Steel

Special materials upon request

Table 5: Material selection for pressure valve pallet

Design	A	B	C	D
Pressure range [mbar] [In W.C.]	+3.5 up to +5.0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+14 up to +35 >+5.6 up to +14
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	PTFE

Special material as well as higher set pressure upon request

Table 6: Material selection for vacuum valve pallet

Design	A	B	C	D
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<+14 up to +35 <-5.6 up to -14	<-14 up to -35 <-5.6 up to -14
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	PTFE

Special material as well as higher set vacuum upon request

Table 7: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

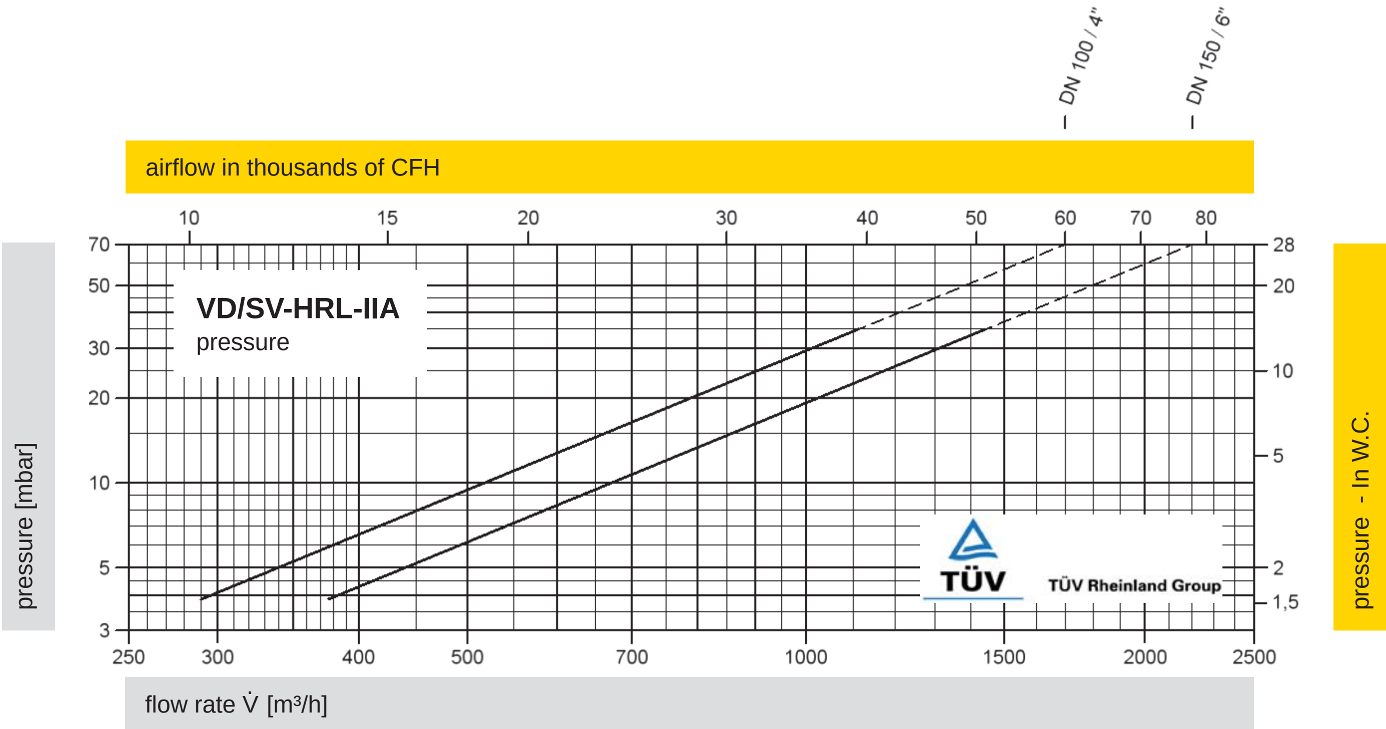
Type	Nominal size	Explosion group	Material (housing)	Material (flame arrester unit)	Pressure	Material (pressure pallet)	Vacuum	Material (vacuum pallet)	Flange connection type
VD/SV-HRL					/		/		
	Tab. 1	Tab. 2	Tab. 3	Tab. 4	Setting [mbar] / Setting [In W.C.]	Tab. 5	Setting [mbar] / Setting [In W.C.]	Tab. 6	Tab. 7

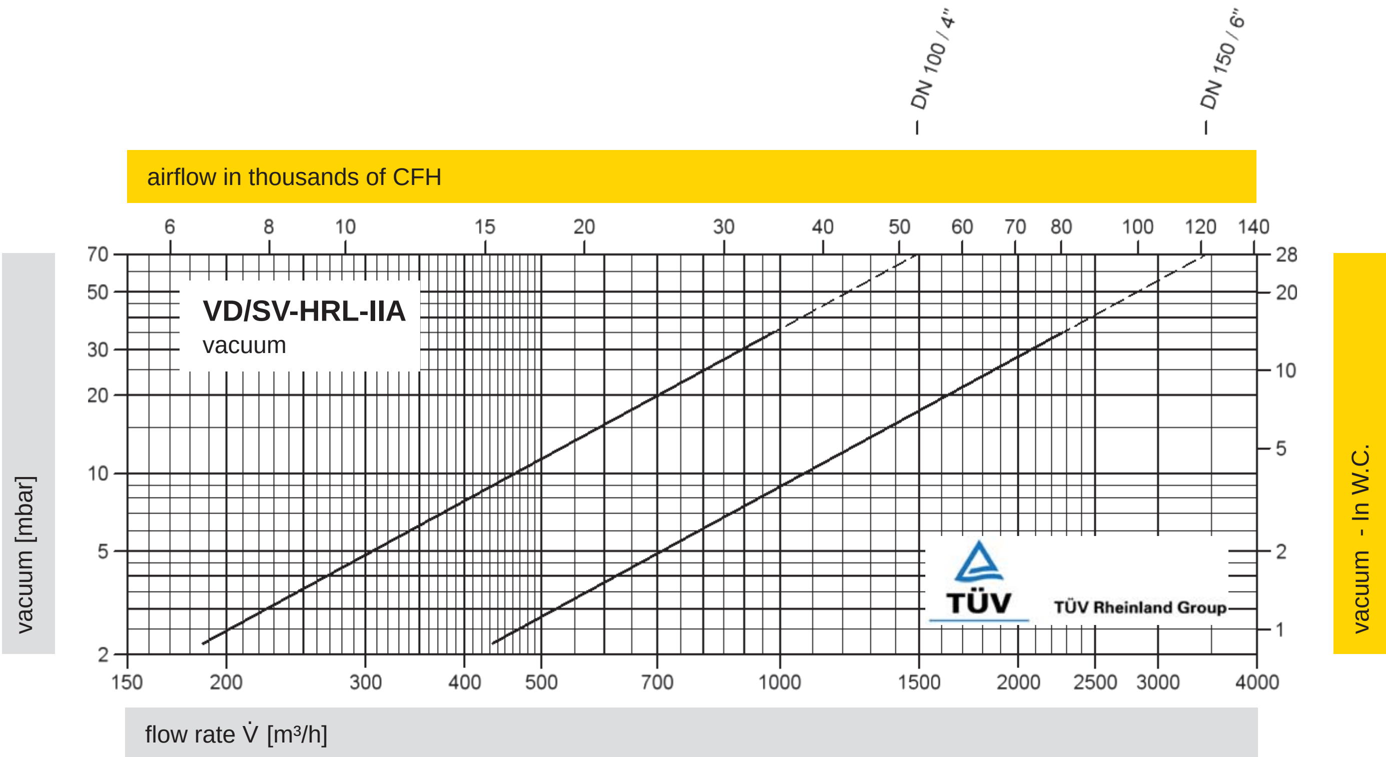
Order example

VD/SV-HRL	100	IIA	A	A	30 / –	C	-10 / –	B	DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® VD/SV-HRL





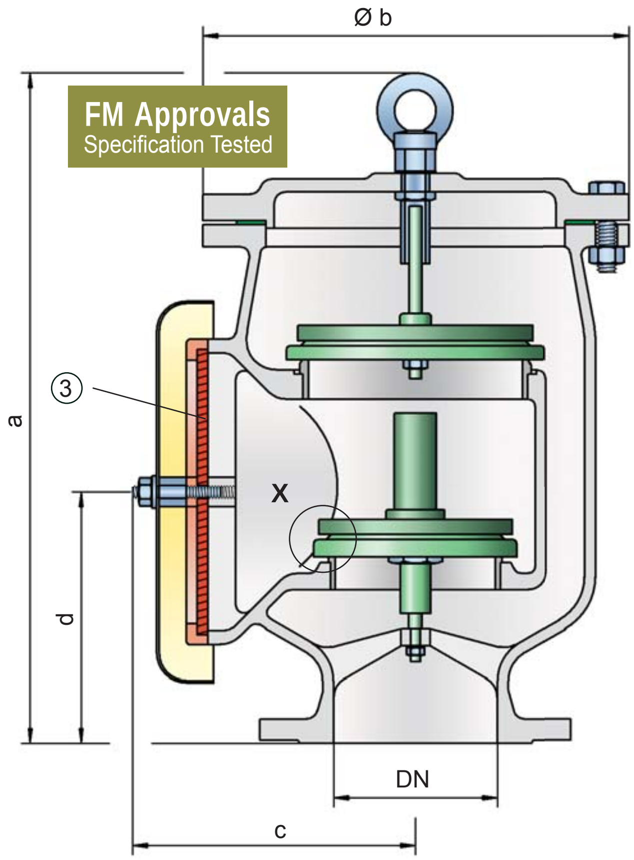
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

PROTEGO
for safety and environment

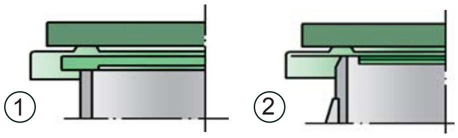
Pressure/Vacuum Relief Valve

atmospheric deflagration-proof

PROTEGO® VD/TS



Detail **X**



Settings:

pressure:	+3.5 mbar	up to	+50 mbar
	+1.4 In W.C.	up to	+20 In W.C.
vacuum:	-2.0 mbar	up to	-25 mbar
	-0.8 In W.C.	up to	-10 In W.C.

Higher and lower settings upon request

Function and Description

The atmospheric deflagration-proof VD/TS type PROTEGO® valve is a highly developed combined pressure/vacuum relief valve for high flow capacities with an integrated flame arrester unit. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and also protects against atmospheric deflagration. The PROTEGO® flame arrester unit is designed to achieve minimum pressure drop with maximum safety. The PROTEGO® VD/TS device is available for substances from explosion groups IIA to IIB3 (NEC group D to C MESG ≥ 0.65 mm).

When the set pressure is reached, the valve starts to open and reaches full lift within 10% overpressure. This unique 10% technology enables a set pressure that is only 10% below the maximum allowable working pressure (MAWP) or maximum allowable working vacuum (MAWV) of the tank. After years of development, this typical opening characteristic of a safety relief valve is now also available for the low pressure range.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by the valve seats made of high quality stainless steel and with individually lapped valve pallets (1) or with an air cushion seal (2) in conjunction with high quality FEP diaphragm. The valve pallets are also available with a PTFE seal to prevent the valve pallets from sticking when sticky products are used and to enable the use of corrosive fluids. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. If this mixture ignites, the integrated PROTEGO® flame arrester unit (3) prevents flame transmission into the tank.

The standard design is tested at an operating temperature up to +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000. In addition numerous versions for higher operating temperature are available.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- requires only 10% overpressure to full lift
- extreme tightness and hence least possible product losses and reduced environmental pollution
- through 10% technology higher set pressures can be used which results in product loss reduction compared to conventional 80% and 100% overpressure technology vents (compare API 2000)
- the valve disc is guided within the housing to protect against harsh weather conditions
- can be used as protective system according ATEX in areas subject to explosion hazards (94/9/EC)
- FLAMEFILTER® provides protection against atmospheric deflagration
- FLAMEFILTER® integrated into valve saves space and reduces cost
- FLAMEFILTER® protected from clogging through product vapour
- PROTEGO® flame arrester unit has low pressure drop
- optimized flow performance
- maintenance friendly design
- sturdy housing design
- superior technology for API tanks

Design and Specifications

Any combination of vacuum and pressure levels can be set for the valve. The valve discs are weight loaded.

Pressure/vacuum relief valve, basic design **VD/TS-**

Additional special devices available upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	50 / 2"	80 / 3"	100 / 4"	125 / 5"	150 / 6"	200 / 8"	250 / 10"	300 / 12"
a	340 / 13.39	430 / 16.93	490 / 19.29	610 / 24.02	610 / 24.02	705 / 27.76	765 / 30.12	930 / 36.61
b	210 / 8.27	280 / 11.02	310 / 12.20	390 / 15.35	390 / 15.35	445 / 17.52	505 / 19.88	560 / 22.05
c	152 / 5.98	174 / 6.85	207 / 8.15	267 / 10.51	267 / 10.51	302/ 11.89	372 / 14.65	460 / 18.11
d	125 / 4.92	150 / 5.91	180 / 7.09	230 / 9.06	230 / 9.06	270 / 10.63	310 / 12.20	445 / 17.52

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Selection of max. operating temperature

≤ 60°C / 140°F	≤ 100°C / 212°F	≤ 150°C / 302°F	≤ 180°C / 356°F	≤ 200°C / 392°F	≤ 250°C / 482°F	*upon request
Standard (std)	X0 *	X1 *	X2 *	X3 *	X4 *	

Table 4: Material selection for housing

Design	A	B	C	D	E
Housing	Aluminium	Cast Iron	Steel	Stainless Steel	Hastelloy
Valve seats	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Hastelloy
Gasket	WS 3822	WS 3822	WS 3822	PTFE	PTFE
Weather hood	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Hastelloy
Flame arrester unit	A	A	A	A	C
Pressure valve pallet	A-F	A-F	A-F	A-F	G-I
Vacuum valve pallet	A-E	A-E	A-E	A-E	F-H

Special materials upon request

Table 5: Material combination of flame arrester unit

Design	A	C	Special materials upon request
FLAMEFILTER® cage	Stainless Steel	Hastelloy	
FLAMEFILTER®	Stainless Steel	Hastelloy	

Table 6: Material selection for pressure pallet

Design	A	B	C	D	E
Pressure range [mbar] [In W.C.]	+3.5 up to +5,0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +35 >+5.6 up to +14	>+35 up to +50 >+14 up to +20	>+14 up to +35 >+5.6 up to +14
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal	Metal to Metal	PTFE
Weight	Stainless Steel	Stainless Steel	Stainless Steel	Lead	Stainless Steel

Design	F	G	H	I
Pressure range [mbar] [In W.C.]	>+35 up to +50 >+14 up to +20	+3.5 up to +5,0 +1.4 up to +2.0	>+5.0 up to +14 >+2.0 up to +5.6	>+14 up to +35 >+5.6 up to +14
Valve pallet	Stainless Steel	Titanium	Hastelloy	Hastelloy
Sealing	PTFE	FEP	FEP	Metal to Metal
Weight	Lead	Hastelloy	Hastelloy	Hastelloy

Special material as well as higher set pressure upon request

Pressure/Vacuum Relief Valve

atmospheric deflagration-proof

PROTEGO® VD/TS

FM Approvals
Specification Tested

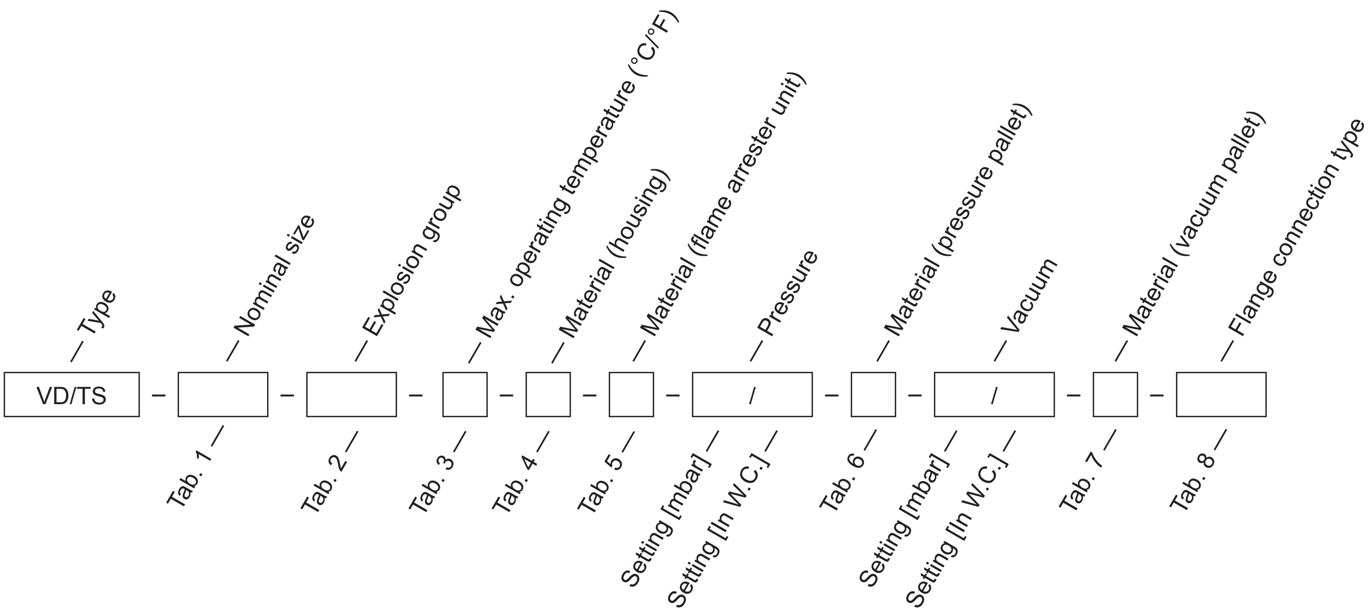
Table 7: Material selection for vacuum pallet

Design	A	B	C	E	F
Vacuum range [mbar] [In W.C.]	-2.0 up to -3.5 -0.8 up to -1.4	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -25 <-5.6 up to -10	<-14 up to -25 <-5.6 up to -10	-2.0 up to -3.5 -0.8 up to -1.4
Valve pallet	Aluminium	Stainless Steel	Stainless Steel	Stainless Steel	Titanium
Sealing	FEP	FEP	Metal to Metal	PTFE	FEP
Weight	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Hastelloy

Design	G	H	
Vacuum range [mbar] [In W.C.]	<-3.5 up to -14 <-1.4 up to -5.6	<-14 up to -25 <-5.6 up to -10	Special material as well as higher set vacuum upon request
Valve pallet	Hastelloy	Hastelloy	
Sealing	FEP	Metal to Metal	
Weight	Hastelloy	Hastelloy	

Table 8: Flange connection type

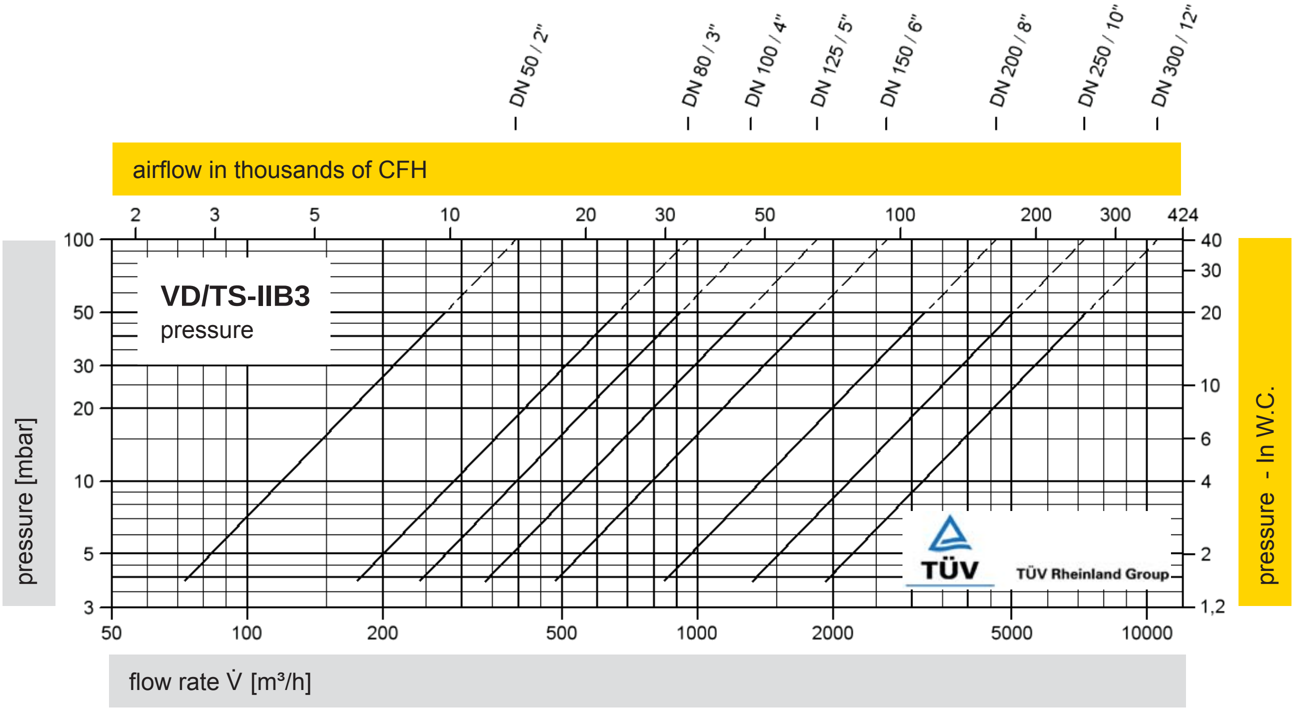
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



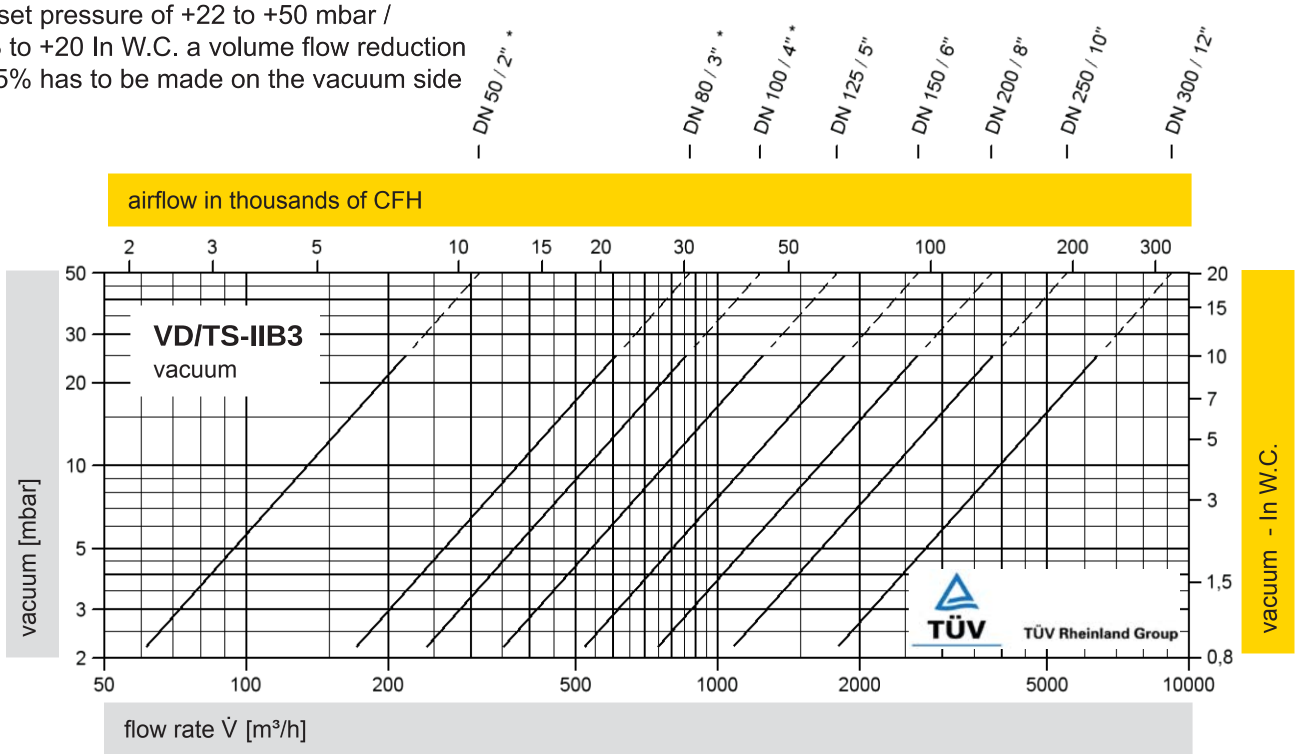
Order example

VD/TS	100	IIB3	(std)	A	A	30 / –	C	-10 / –	B	DIN

Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"



* at set pressure of +22 to +50 mbar / +8.8 to +20 In W.C. a volume flow reduction of 15% has to be made on the vacuum side

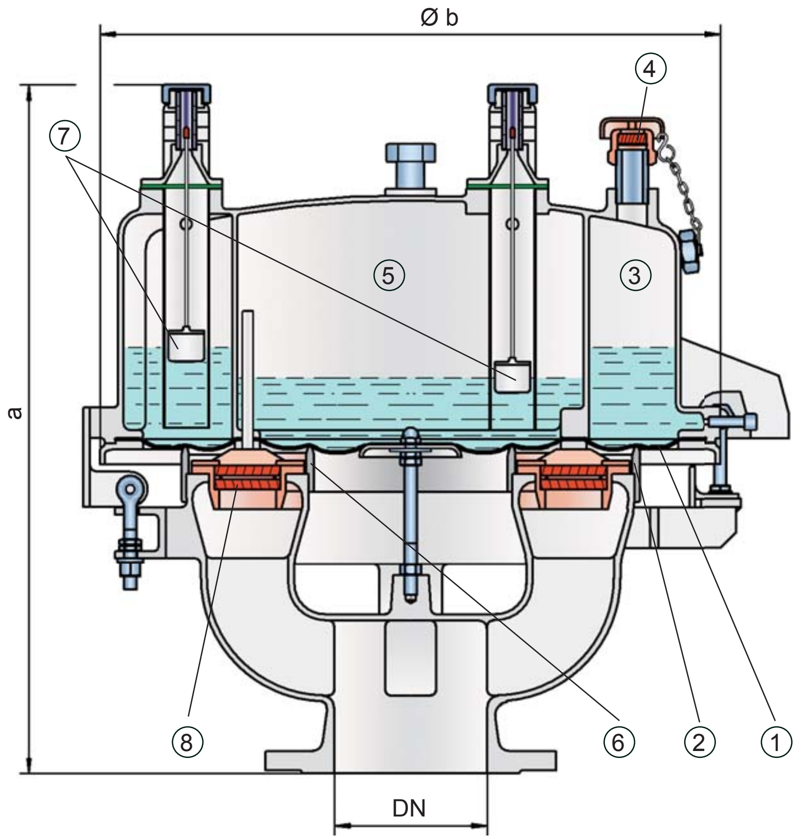


The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Pressure/Vacuum Diaphragm Valve

deflagration- and endurance burning-proof

PROTEGO® UB/SF



Settings:

pressure:	DN 80	+3.5 mbar	up to	+50 mbar
		+1.4 In W.C.	up to	+20 In W.C.
	DN 100	+3.5 mbar	up to	+45 mbar
		+1.4 In W.C.	up to	+18 In W.C.
	DN 150	+3.5 mbar	up to	+40 mbar
		+1.4 In W.C.	up to	+16 In W.C.

Higher pressure settings up to +140 mbar (56.2 In W.C.) in special design with additional liquid reservoir as well as lower pressure settings upon request.

vacuum:		–3.5 mbar	up to	–35 mbar
		–1.4 In W.C.	up to	–14 In W.C.

Higher and lower vacuum settings upon request

Function and Description

The deflagration- and endurance burning-proof UB/SF type PROTEGO® diaphragm valve is a state of the art pressure- and vacuum-relief valve combining the function of a dynamic and static flame arrester. Worldwide this design is unique. It is primarily used as a safety device for flame transmission proof in- and outbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure and vacuum, prevents the inbreathing of air and product losses almost up to the set pressure and protects against atmospheric deflagration and endurance burning if stabilized burning occurs. The PROTEGO® UB/SF diaphragm valve has proven its performance over many years in a great variety of severe applications in the petrochemical and chemical industry. Worldwide it is the only vent which functions in services such as styrene and acrylics. The set pressure is adjusted with a freeze resistant water glycol mixture, which assures safe operation under extreme cold weather conditions. The PROTEGO® UB/SF valve is available for substances of explosion group IIB3 (NEC group C MESG ≥ 0.65 mm).

When the pressure in the tank reaches the set pressure, the diaphragm (1) on the outer valve seat ring (2) is lifted and vapours vent to the environment. The set pressure is adjusted by the liquid (glycol water mixture) column height, which is filled into the outer ring chamber (3). The overpressure chamber is equipped with an opening (4) to keep the pressure in balance with the ambient pressure. The opening is equipped with a FLAMEFILTER® to avoid flame transmission into the overpressure chamber. If a vacuum builds up in the tank, it is transmitted through pressure balancing tubes into the vacuum chamber (5) (inner chamber). If the set vacuum, which depends on the liquid column height in the vacuum chamber, is reached the atmospheric pressure lifts the diaphragm off the inner valve seat ring (6). Ambient air can now flow into the tank. The liquid column heights, which affect the set pressures and vacuum, can be checked by floating level indicators (7).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our highly developed manufacturing technology. This is achieved because the liquid loaded diaphragm presses tightly around the special designed valve seat surface area, even when the operating pressure increases. This is extremely important to reduce leakage to an absolute minimum. After the excess pressure or vacuum is discharged, the valve reseats and provides a tight seal.

If the tank pressure exceeds the adjusted set pressure, explosive gas/product-vapour air mixtures exit. The speed at which these mixtures exit the annular gap between the diaphragm and the outer valve seat ring while overcoming the set pressure is much faster than the flame speed. If this mixture ignites, flashback into the tank is prevented. If the mixture flow continues, the dynamic flame arresting feature prevents flashback ignition even in the case of endurance burning. Even at relatively low flow rates, which occur during thermal outbreathing, the gap formed by the volumetric flow is so narrow that flames are extinguished in the gap and flashback is prevented. At very low pressure settings the explosion pressures resulting from an atmospheric deflagration may be strong enough to lift the diaphragm off the valve seat rings so that flashback could result. The ignition into the tank can be prevented by installing the PROTEGO® flame arrester unit (8). This flame arrester unit provides additional protection against atmospheric deflagration during regular maintenance and inspection.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- set pressure close to opening pressure enables optimum pressure maintenance in the system
- high flow capacity
- can be used as a protective system according to ATEX 94/9/EC in areas subject to an explosion hazard
- protection against atmospheric deflagrations and endurance burning for products up to explosion group IIB3 (NEC group C MESG ≥ 0.65 mm)
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- minimum pressure drop of the FLAMEFILTER®
- flame-transmission-proof pressure and vacuum chambers
- freeze protection at sub-zero conditions
- self draining function for condensate
- liquid column height is monitored by level indicators
- easy maintenance through hinged vent cap
- modular design enables individual FLAMEFILTERS® and valve diaphragm to be replaced
- particularly suitable for problematic products such as styrene, acrylics, etc.

Design Types and Specifications

Almost any combination of vacuum and pressure settings can be utilized for the valve. The diaphragm is pressurized by liquid. Higher pressures can be achieved upon request with a special liquid reservoir. When there is a substantial difference between the pressure and vacuum, special designs with weight-loaded vacuum discs are used.

There are two different designs:

Pressure/vacuum diaphragm valve, basic design **UB/SF -** $\boxed{–}$

Pressure/vacuum diaphragm valve with heating coil **UB/SF -** $\boxed{H}$
(max. heating fluid temperature +85°C / 185°F)

In addition to the standard design, a series of specially developed designs, which are particularly suitable for operating conditions to which these products are subjected, can be provided upon request (for example, for acrylics or styrene storage tanks, etc.).

Remark

$$\text{set pressure} = \frac{\text{opening pressure resp. tank design pressure}}{1{,}4}$$

Set pressure = the valve starts to open

Opening pressure = set pressure plus overpressure

Overpressure = pressure increase over the set pressure

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	pressure	80 / 3"	100 / 4"	150 / 6"
a	up to +28 mbar / +11.2 In W.C.	615 / 24.21	645 / 25.39	680 / 26.77
a	> +28 mbar / +11.2 In W.C.	765 / 30.12	795 / 31.30	830 / 32.68
b		410 / 16.14	485 / 19.09	590 / 23.23

Pressure settings > +50 mbar / +20 In W.C. (DN 80/3”), > +45 mbar / +18 In W.C. (DN 100/4”), > +40 mbar / +16 In W.C. (DN150/6”) with additional liquid reservoir - dimensions upon request

Dimensions for pressure/vacuum diaphragm valves with heating coil upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request

Pressure/Vacuum Diaphragm Valve

deflagration- and endurance burning-proof

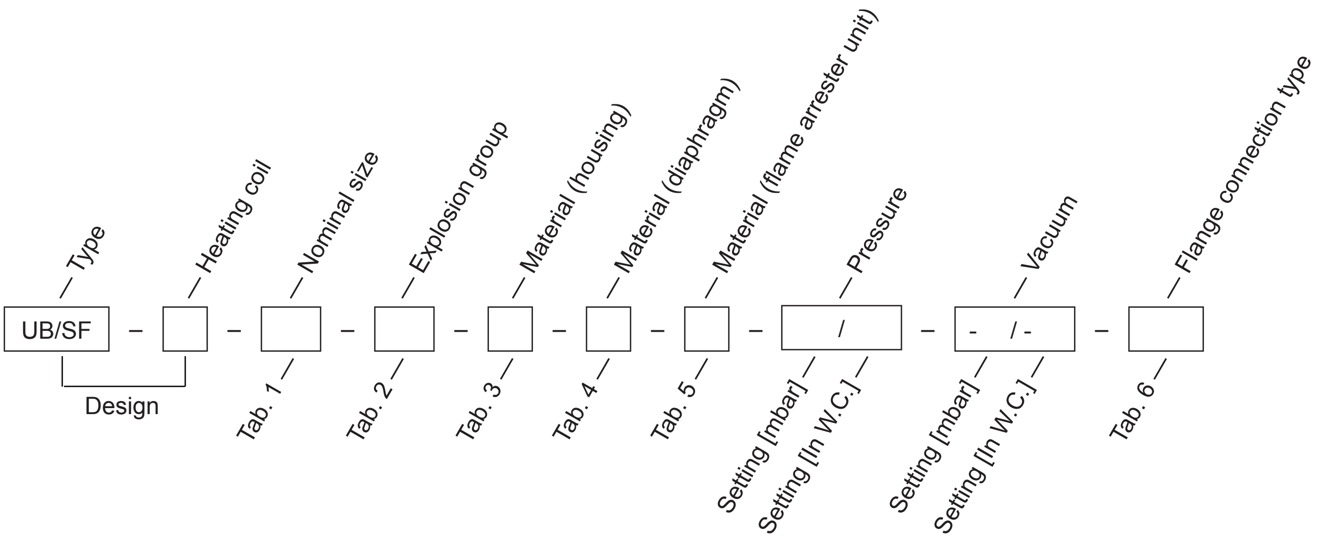
PROTEGO® UB/SF

Table 3: Material selection for housing				
Design	B	C	D	
Housing	Cast Iron	Steel	Stainless Steel	
Valve top	Stainless Steel	Stainless Steel	Stainless Steel	
Heating coil (UB/SF-H-...)	Stainless Steel	Stainless Steel	Stainless Steel	Option: Housing with ECTFE-lining
Valve seats	Stainless Steel	Stainless Steel	Stainless Steel	Special materials upon request
Gasket	FPM	FPM	PTFE	
Diaphragm	A, B	A, B	A, B	
Flame arrester unit	A	C	C	

Table 4: Material selection for diaphragm			
Design	A	B	Special materials upon request
Diaphragm	FPM	FEP	

Table 5: Material combinations of flame arrester unit			
Design	A	C	
FLAMEFILTER® cage	Cast Iron	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	Stainless Steel	
Spacer	Stainless Steel	Stainless Steel	

Table 6: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

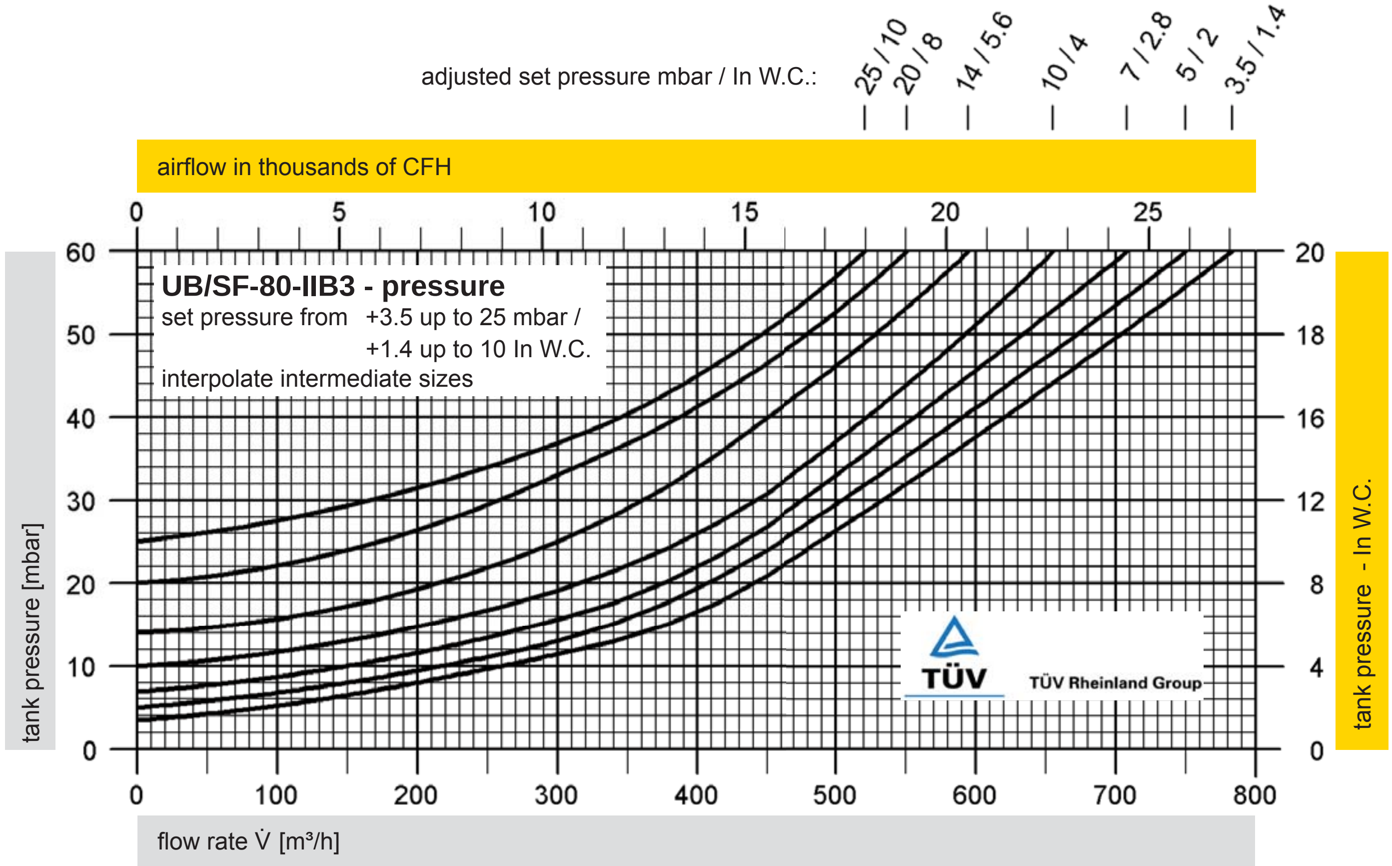


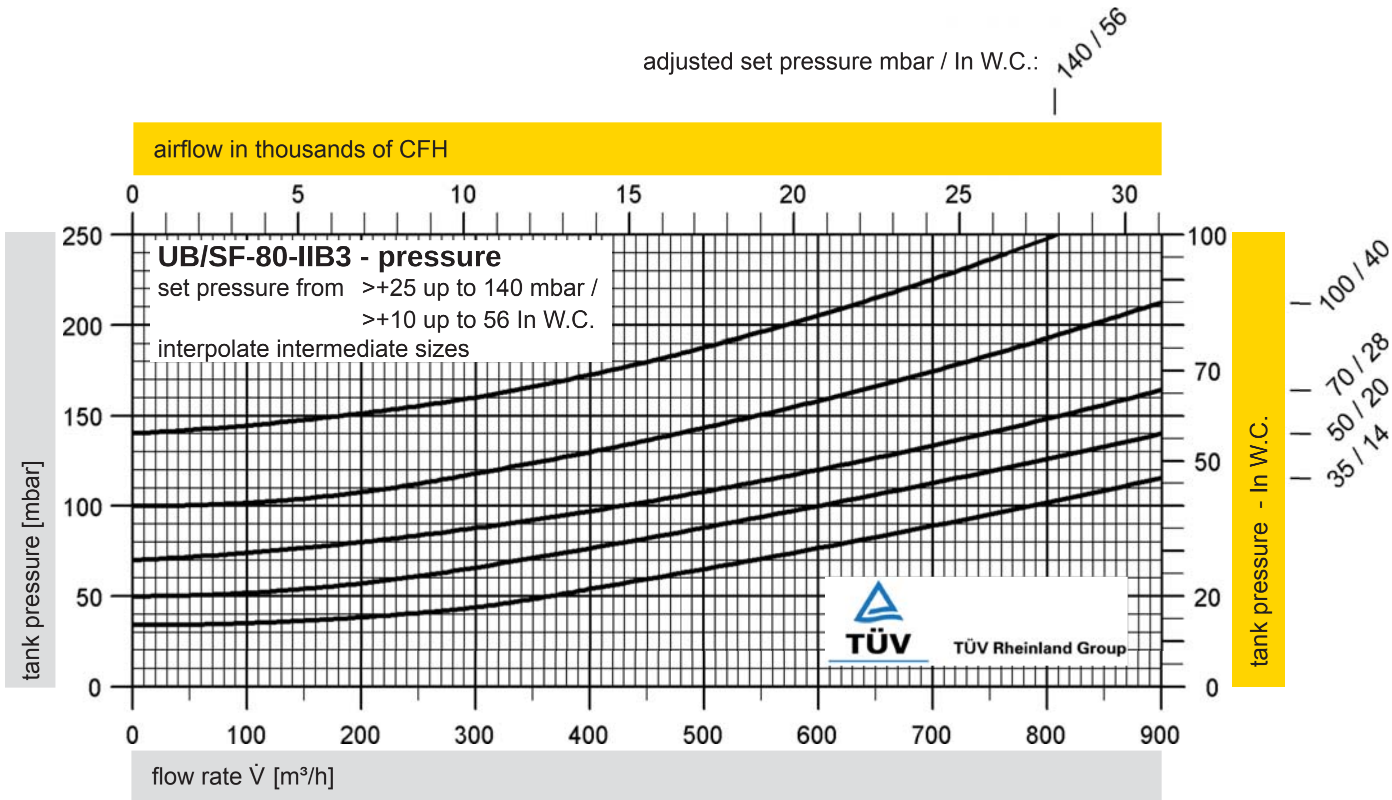
Order example

UB/SF – H – 100 – IIB3 – C – A – C – 10 / – – -5 / – – DIN

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

PROTEGO® UB/SF-80





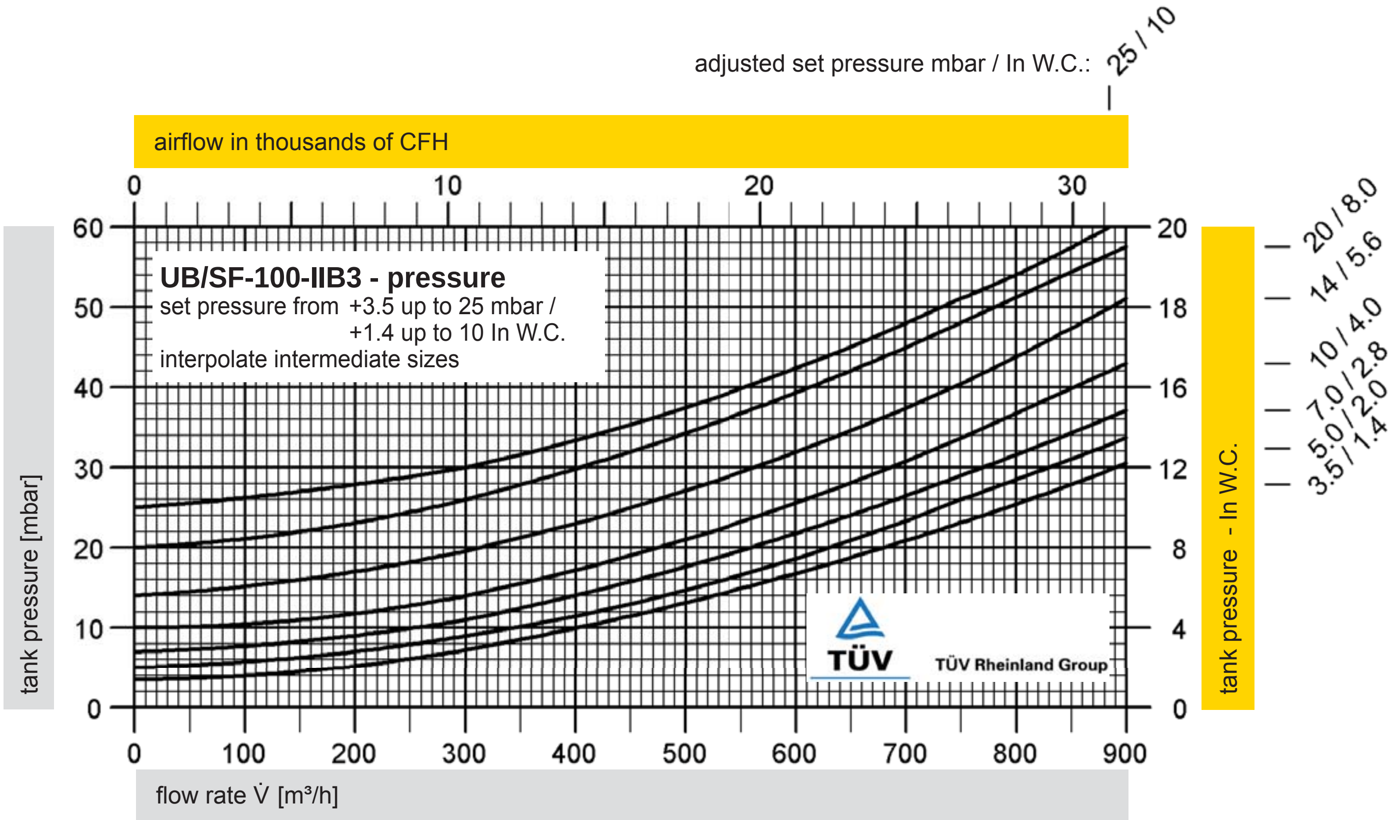
The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.

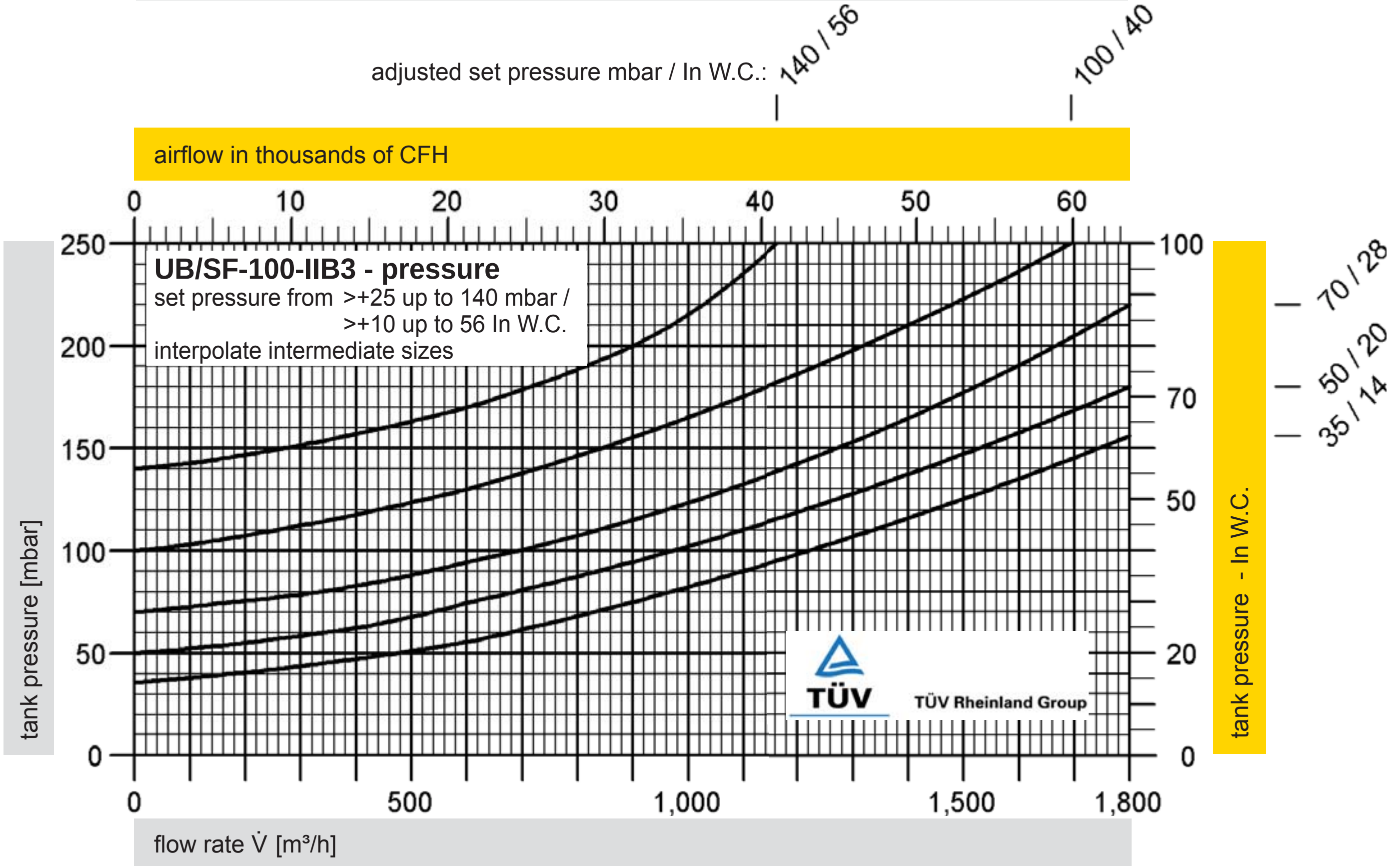
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.

Pressure/Vacuum Diaphragm Valve

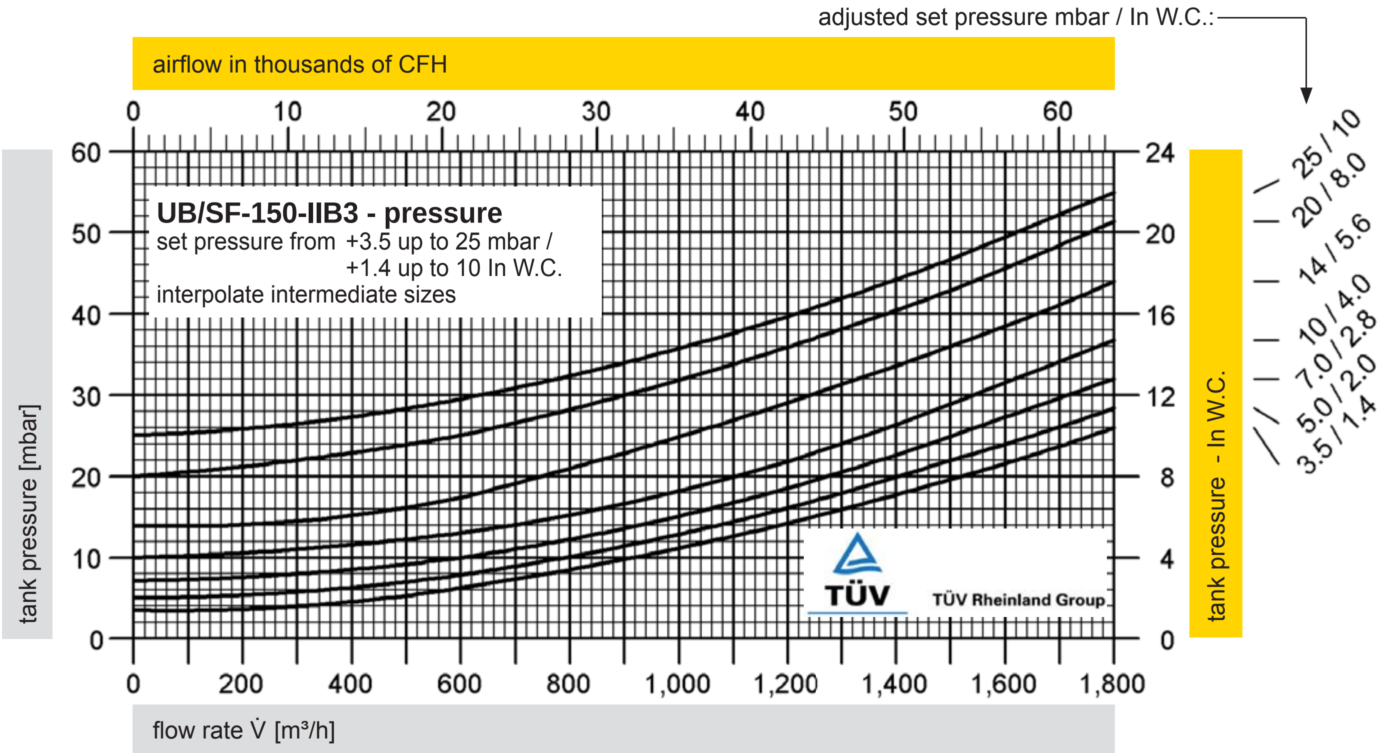
Flow Capacity Charts - Pressure

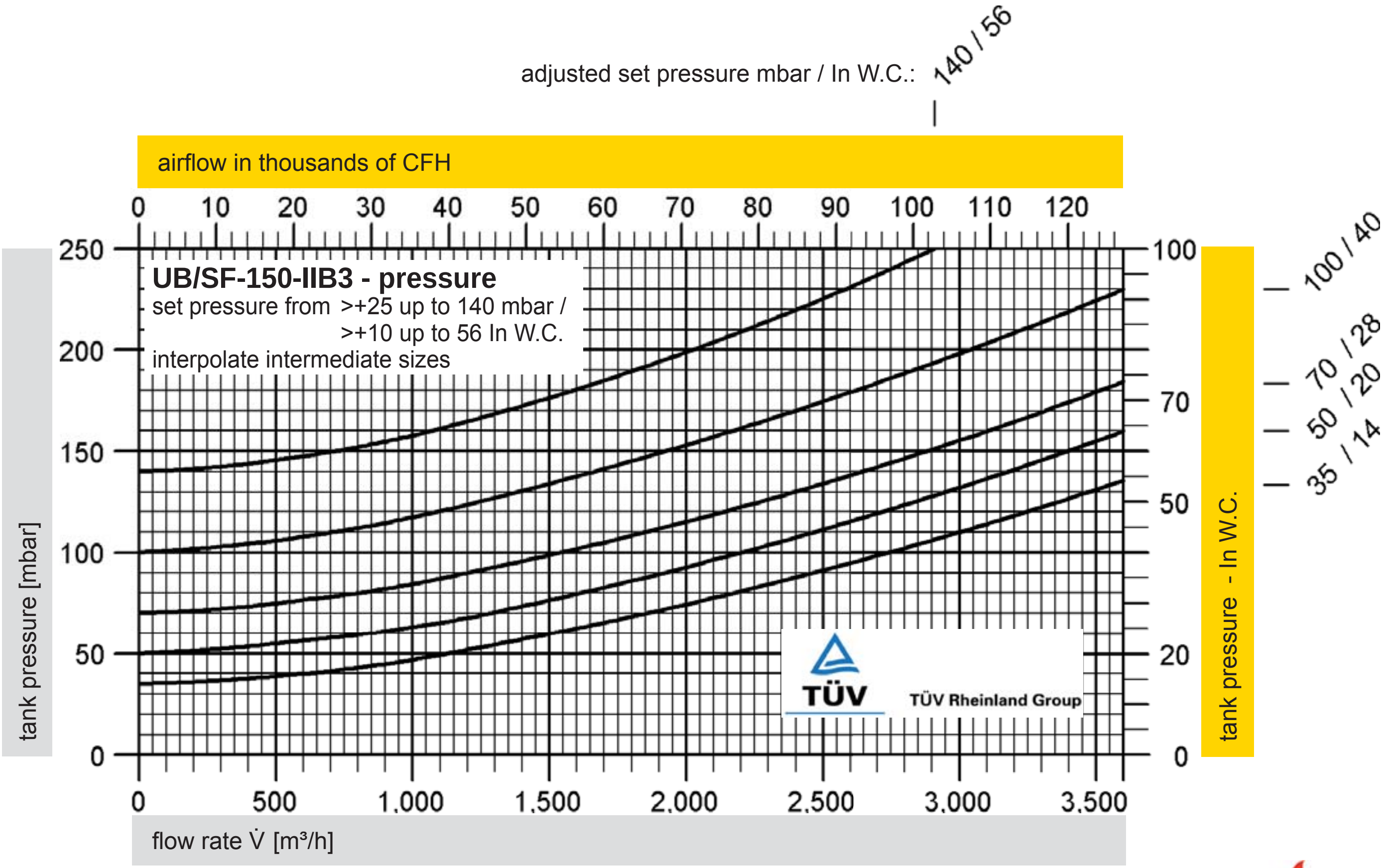
PROTEGO® UB/SF-100

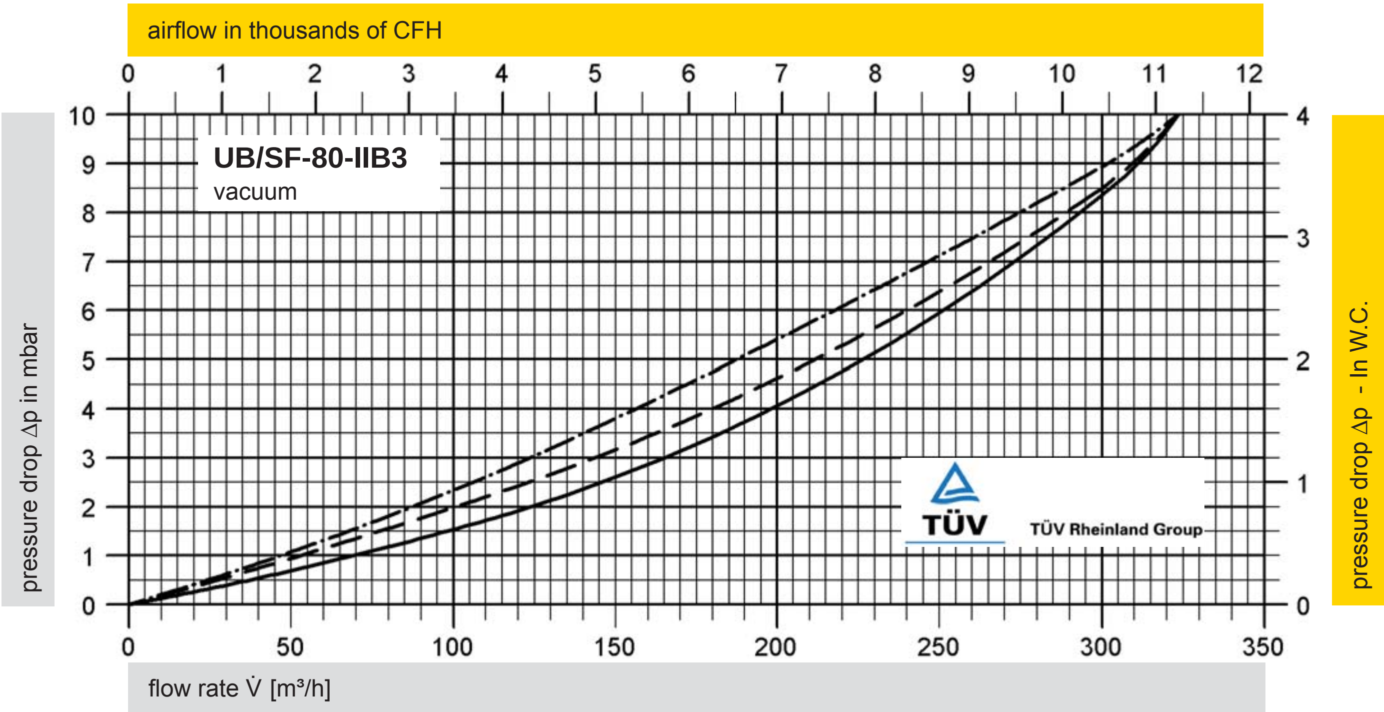




The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.


adjusted set pressure mbar / In W.C.:
airflow in thousands of CFH
0
10
20
30
40
50
60
UB/SF-150-IIB3 - pressure
set pressure from +3.5 up to 25 mbar /
+1.4 up to 10 In W.C.
interpolate intermediate sizes
25 / 10
20 / 8.0
14 / 5.6
10 / 4.0
7.0 / 2.8
5.0 / 2.0
3.5 / 1.4
tank pressure [mbar]
tank pressure - In W.C.
TÜV
TÜV Rheinland Group
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
flow rate V̇ [m³/h]


adjusted set pressure mbar / In W.C.:
140 / 56
airflow in thousands of CFH
0
10
20
30
40
50
60
70
80
90
100
110
120
UB/SF-150-IIB3 - pressure
set pressure from >+25 up to 140 mbar /
>+10 up to 56 In W.C.
interpolate intermediate sizes
100 / 40
70 / 28
50 / 20
35 / 14
tank pressure [mbar]
tank pressure - In W.C.
TÜV
TÜV Rheinland Group
0
500
1,000
1,500
2,000
2,500
3,000
3,500
flow rate V̇ [m³/h]



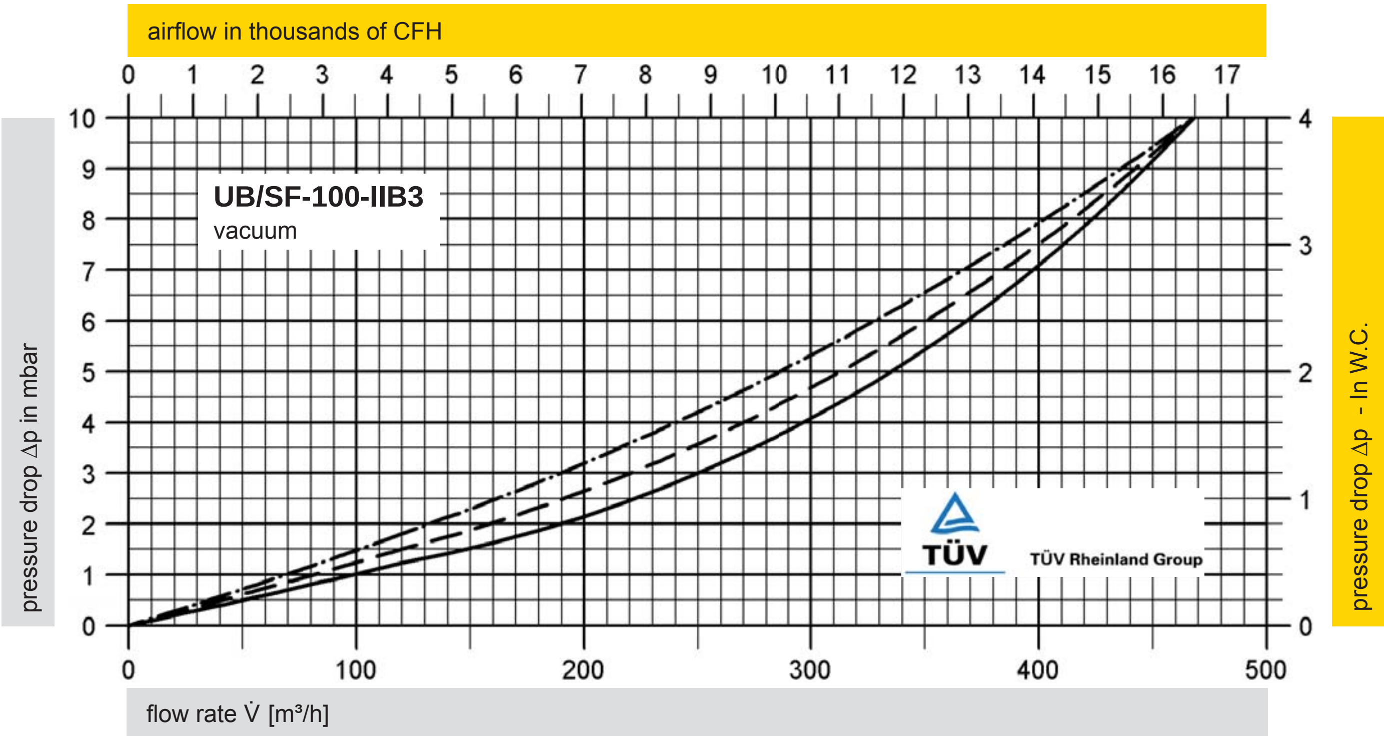
pressure drop = max. allowable tank design vacuum - valve set vacuum

adjusted set vacuum:

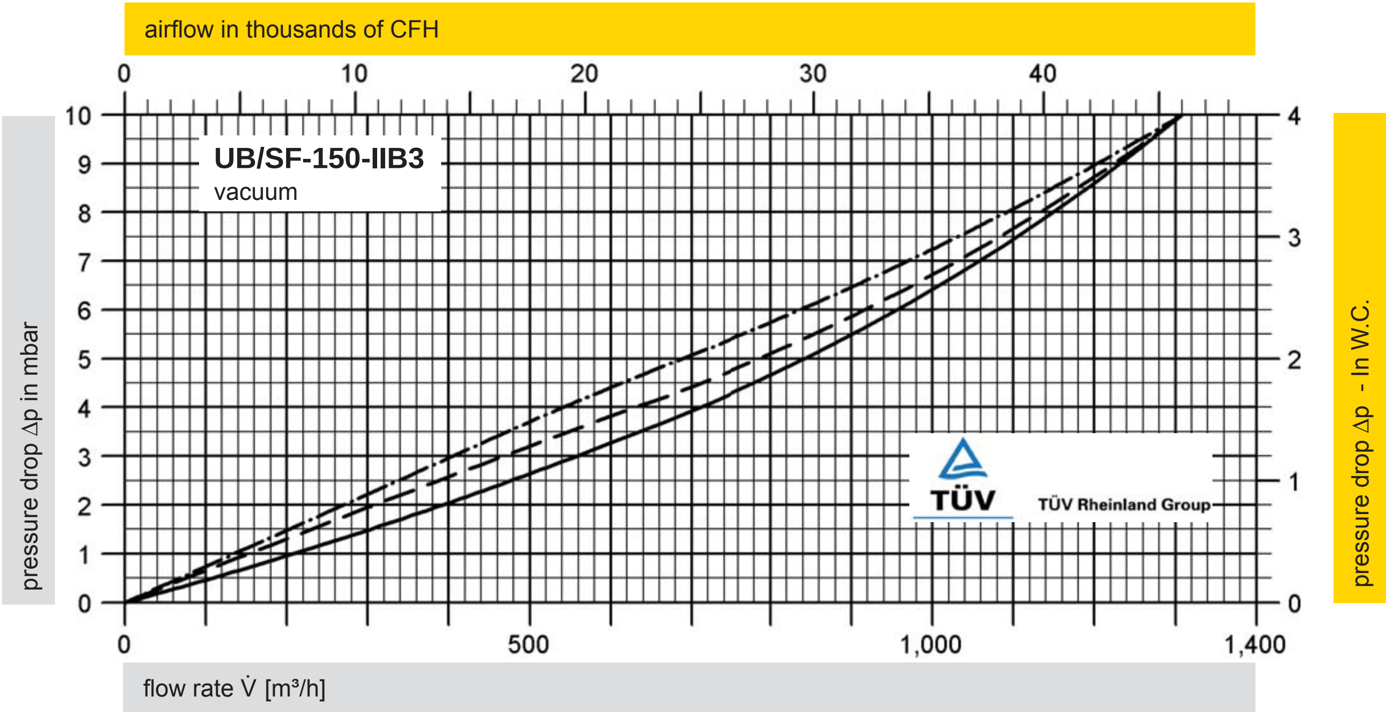
≤ -5 mbar / ≤ -2 In W.C.

> -5 mbar up to ≤ -7 mbar / > -2 In W.C. up to ≤ -2.8 In W.C.

> -7 mbar up to ≤ -35 mbar / > -2.8 In W.C. up to ≤ -14 In W.C.



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



pressure drop = max. allowable tank design vacuum - valve set vacuum

adjusted set vacuum:

≤ -5 mbar / ≤ -2 In W.C.

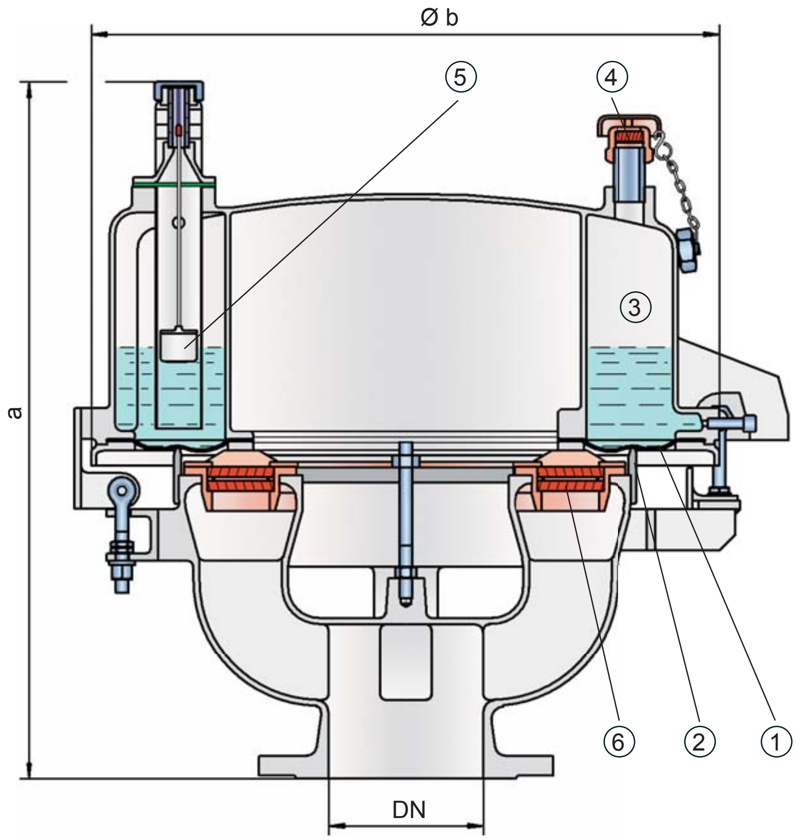
> -5 mbar up to ≤ -7 mbar / > -2 In W.C. up to ≤ -2.8 In W.C.

> -7 mbar up to ≤ -35 mbar / > -2.8 In W.C. up to ≤ -14 In W.C.

Pressure Diaphragm Valve

deflagration- and endurance burning-proof

PROTEGO® UB/DF



When the pressure in the tank reaches the set pressure, the diaphragm (1) on the outer valve seat ring (2) is lifted and vapors vent to the environment. The set pressure is adjusted by the liquid (glycol water mixture) column height, which is filled into the outer ring chamber (3). The overpressure chamber is equipped with an opening (4) to keep the pressure in balance with the ambient pressure. The opening is equipped with a FLAMEFILTER® to avoid flame transmission into the overpressure chamber. Ambient air can now flow into the tank. The liquid column height which affect the set pressures is checked by a floating level indicator (5).

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our highly developed manufacturing technology. This is achieved because the liquid loaded diaphragm presses tightly around the special designed valve seat surface area, even when the operating pressure increases. This is extremely important to reduce leakage to an absolute minimum. After the excess pressure is discharged, the valve reseats and provides a tight seal.

If the tank pressure exceeds the adjusted set pressure, explosive gas/product-vapour air mixtures exit. The speed at which these mixtures exit the annular gap between the diaphragm and the outer valve seat ring while overcoming the set pressure is much faster than the flame speed. If this mixture ignites, flashback into the tank is prevented. If the mixture flow continues, the dynamic flame arresting feature prevents flashback ignition even in the case of endurance burning. Even at relatively low flow rates, which occur during thermal outbreathing, the gap formed by the volumetric flow is so narrow that flames are extinguished in the gap and flashback is prevented. At very low pressure settings the explosion pressures resulting from an atmospheric deflagration may be strong enough to lift the diaphragm off the valve seat rings so that flashback could result. The ignition into the tank can be prevented by installing the PROTEGO® flame arrester unit (8). This flame arrester unit provides additional protection against atmospheric deflagration during regular maintenance and inspection.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Pressure Settings:

DN 80	+3.5 mbar	up to	+50 mbar
	+1.4 In W.C.	up to	+20 In W.C.
DN 100	+3.5 mbar	up to	+45 mbar
	+1.4 In W.C.	up to	+18 In W.C.
DN 150	+3.5 mbar	up to	+40 mbar
	+1.4 In W.C.	up to	+16 In W.C.

Higher pressure settings up to +140 mbar (56.2 In W.C.) in special design with additional liquid reservoir as well as lower pressure settings upon request.

Function and Description

The deflagration- and endurance burning-proof UB/DF type PROTEGO® diaphragm valve is a state-of-the-art pressure-relief valve combining the function of a dynamic and static flame arrester. Worldwide this design is unique. It is primarily used as a safety device for flame transmission proof out breathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against excess pressure prevents the inbreathing of air and product losses almost up to the set pressure and protects against atmospheric deflagration and endurance burning if stabilized burning occurs. The PROTEGO® UB/DF diaphragm valve has proven its performance over many years in a great variety of severe applications in the petrochemical and chemical industry. The set pressure is adjusted with a freeze resistant water glycol mixture, which assures safe operation under extreme cold weather conditions. The PROTEGO® UB/DF valve is available for substances of explosion group IIB3 (NEC group C MESG ≥ 0.65 mm).

Special Features and Advantages

- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- set pressure close to opening pressure enables optimum pressure maintenance in the system
- high flow capacity
- can be used as a protective system according to ATEX 94/9/EC in areas subject to an explosion hazard
- protection against atmospheric deflagrations and endurance burning for products up to explosion group IIB3 (NEC group C ≥ 0.65 mm MESG)
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- minimum pressure drop of the FLAMEFILTER®
- flame-transmission-proof pressure and vacuum chambers
- freeze protection at sub-zero conditions
- self draining function for condensate
- liquid column height is monitored by level indicators
- easy maintenance through hinged vent cap
- modular design enables individual FLAMEFILTER® and valve diaphragm to be replaced
- particularly suitable for problematic products such as styrene, acrylics, etc.

Design Types and Specifications

The diaphragm is pressurized by liquid. Higher pressures can be achieved upon request with a special liquid reservoir.

There are two different designs:

Pressure diaphragm valve, basic design **UB/DF - $\boxed{-}$**

Pressure diaphragm valve with heating coil **UB/DF - $\boxed{\text{H}}$**
(max. heating fluid temperature +85°C / 185°F)

In addition to the standard design, a series of specially developed designs, which are particularly suitable for the operating conditions to which these products are subjected, can be provided upon request (for example, for acrylics or styrene storage tanks, etc.).

Remark

$$\text{set pressure} = \frac{\text{opening pressure resp. tank design pressure}}{1{,}4}$$

Set pressure = the valve starts to open

Opening pressure = set pressure plus overpressure

Overpressure = pressure increase over the set pressure

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	pressure	80 / 3"	100 / 4"	150 / 6"
a	up to +28 mbar / +11.2 In W.C.	615 / 24.21	645 / 25.39	680 / 26.77
a	> +28 mbar / +11.2 In W.C.	765 / 30.12	795 / 31.30	830 / 32.68
b		410 / 16.14	485 / 19.09	590 / 23.23

Pressure settings > +50 mbar / +20 In W.C. (DN 80/3"), > +45 mbar / +18 In W.C. (DN 100/4"), > +40 mbar / +16 In W.C. (DN150/6") with additional liquid reservoir - dimensions upon request

Dimensions for pressure diaphragm valves with heating coil upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request

Pressure Diaphragm Valve

deflagration- and endurance burning-proof

PROTEGO® UB/DF

Table 3: Material selection for housing			
Design	B	C	D
Housing	Cast Iron	Steel	Stainless Steel
Valve top	Stainless Steel	Stainless Steel	Stainless Steel
Heating coil (UB/DF-H-...)	Stainless Steel	Stainless Steel	Stainless Steel
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel
Gasket	FPM	FPM	PTFE
Diaphragm	A, B	A, B	A, B
Flame arrester unit	A	C	C

Option: Housing with ECTFE-lining

Special materials upon request

Table 4: Material selection for diaphragm		
Design	A	B
Diaphragm	FPM	FEP

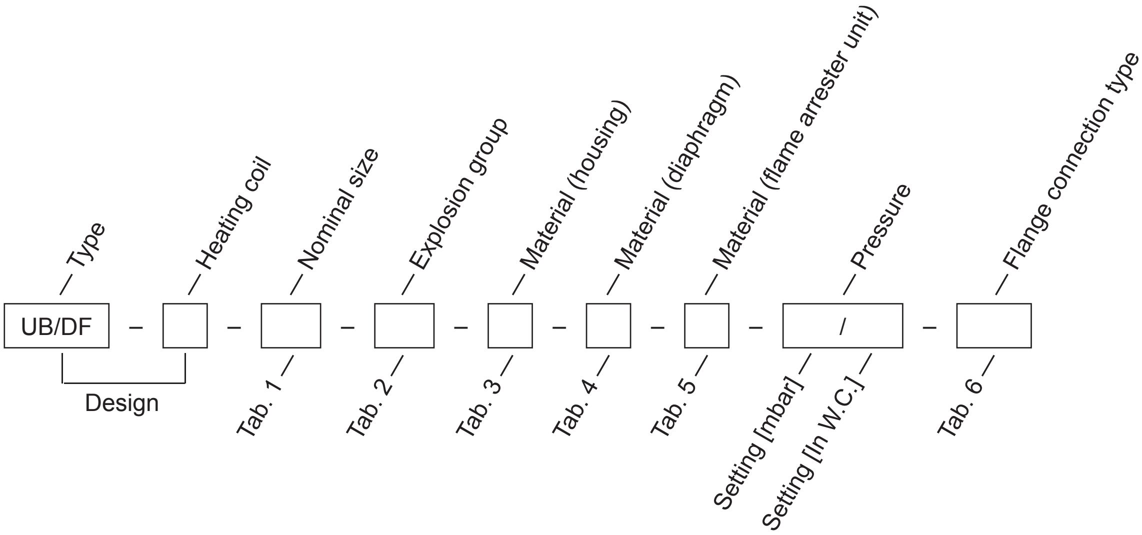
Special materials upon request

Table 5: Material combinations of flame arrester unit		
Design	A	C
FLAMEFILTER® cage	Cast Iron	Stainless Steel
FLAMEFILTER®	Stainless Steel	Stainless Steel
Spacer	Stainless Steel	Stainless Steel

Special materials upon request

Table 6: Flange connection type	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN
ANSI 150 lbs RFSF	ANSI

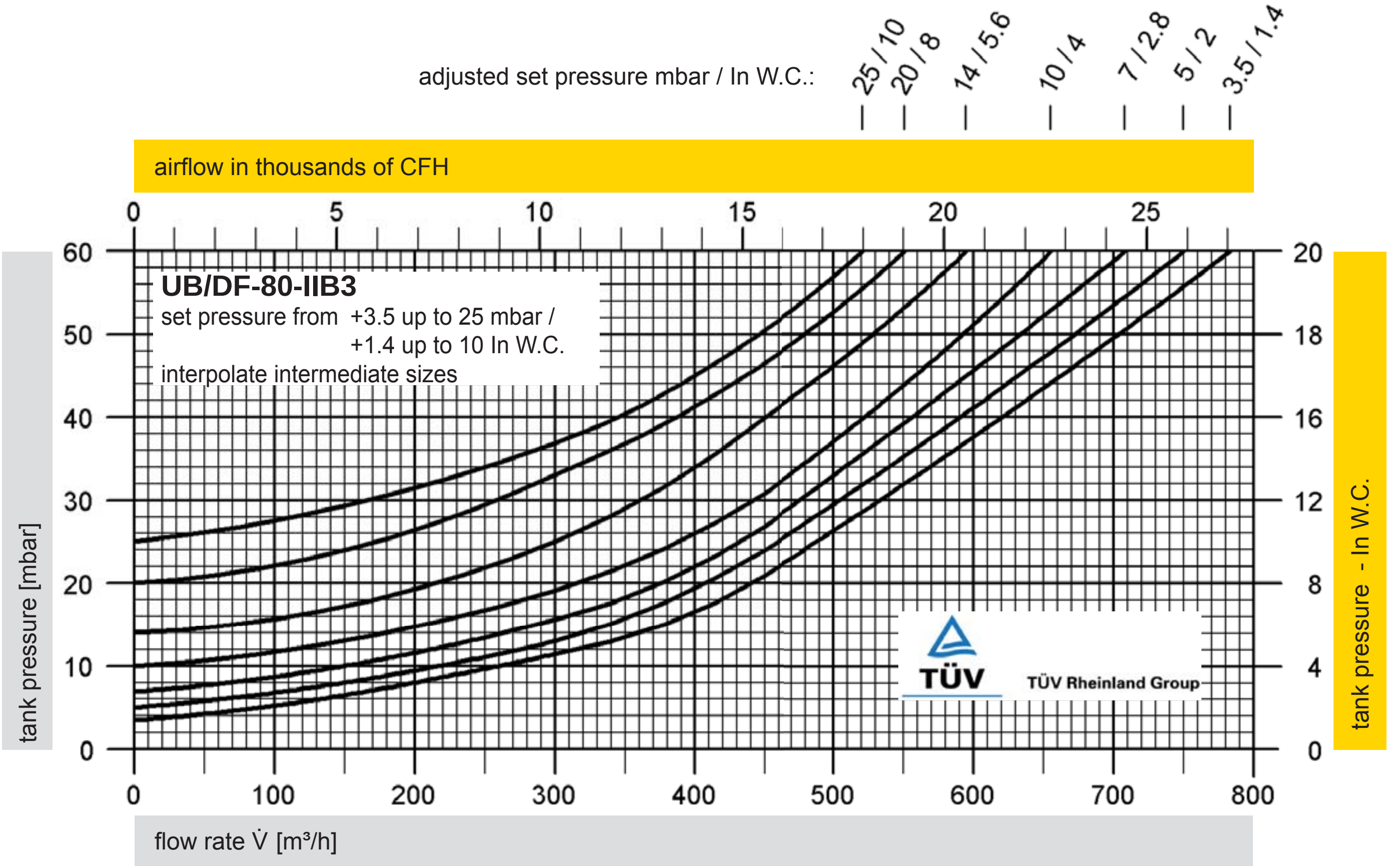
other types upon request

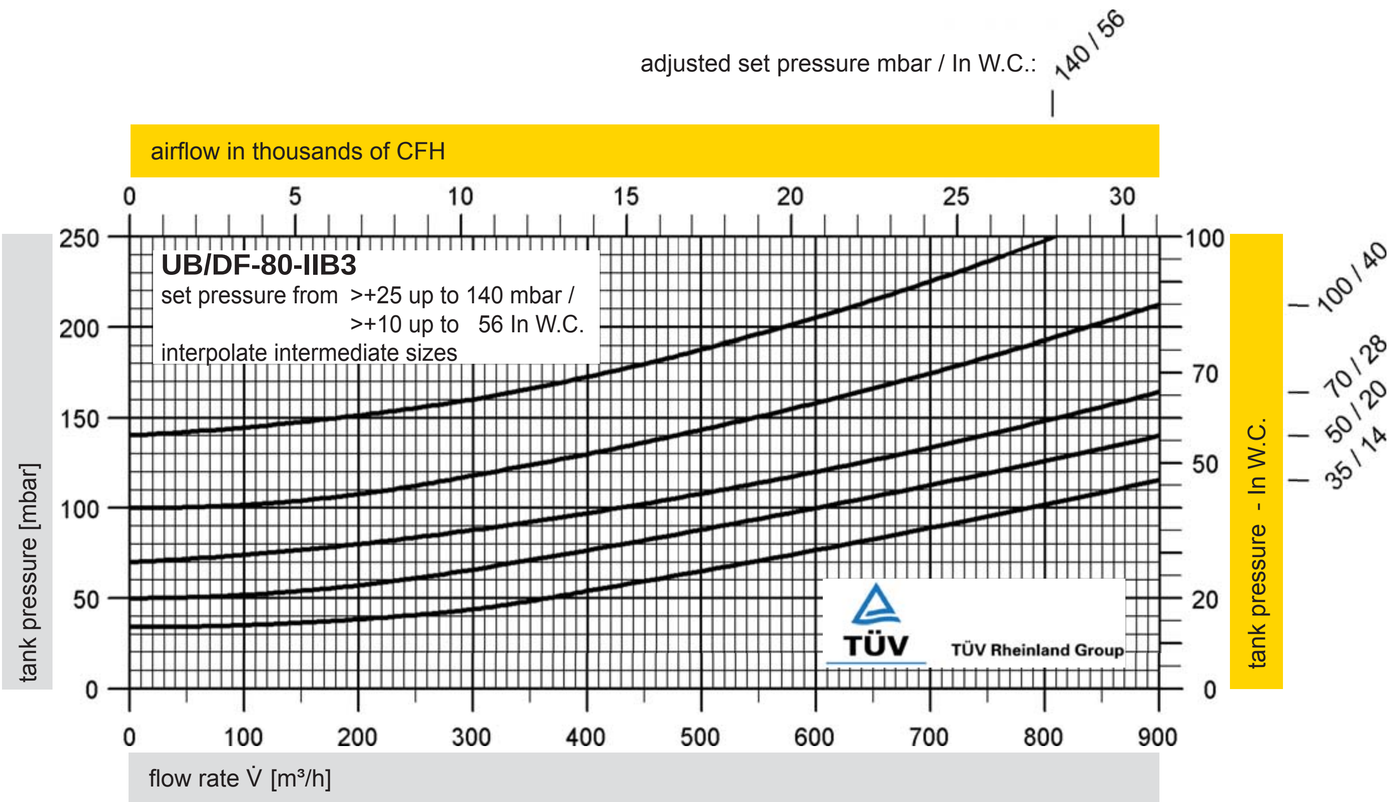


Order example

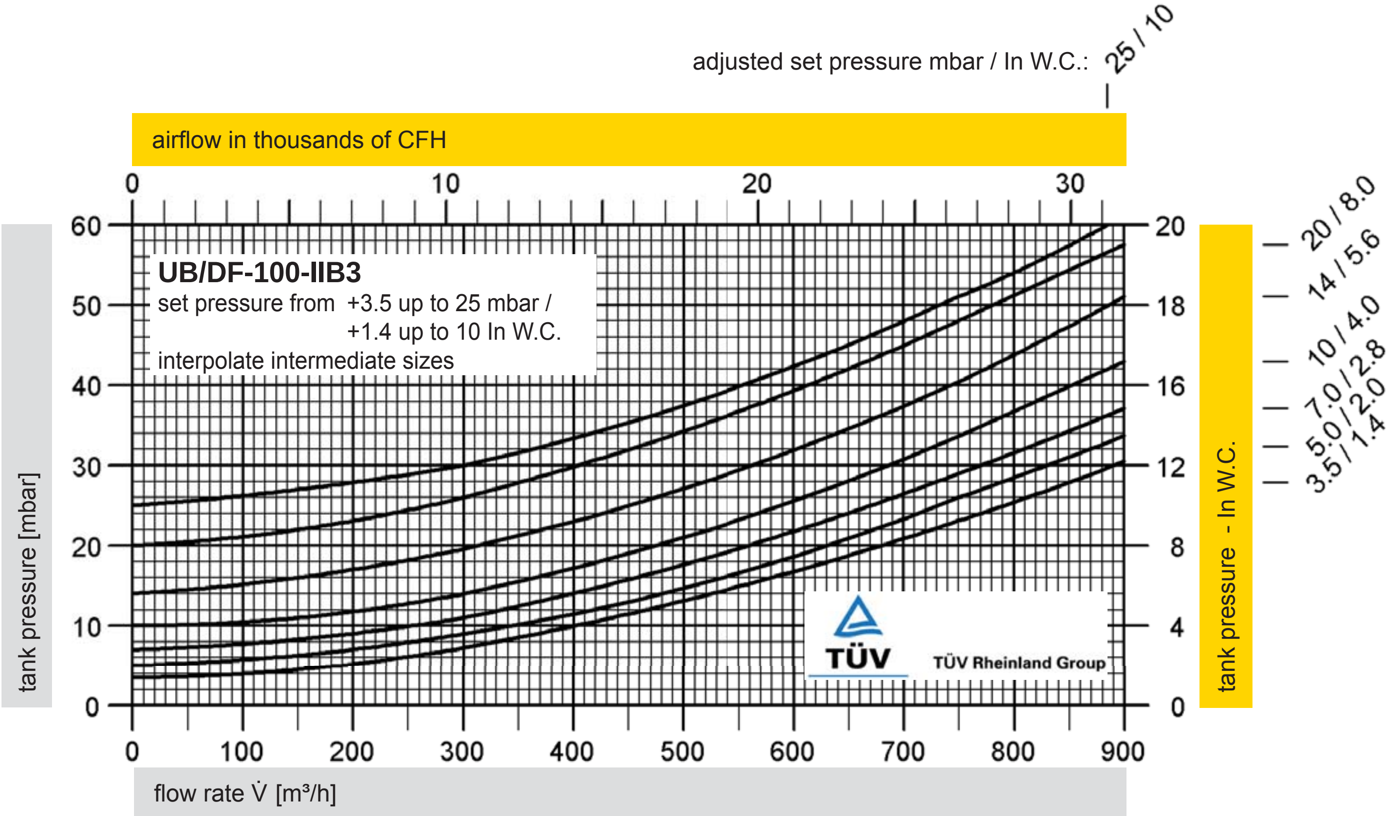
UB/DF – H – 100 – IIB3 – C – A – C – 10 / – – DIN

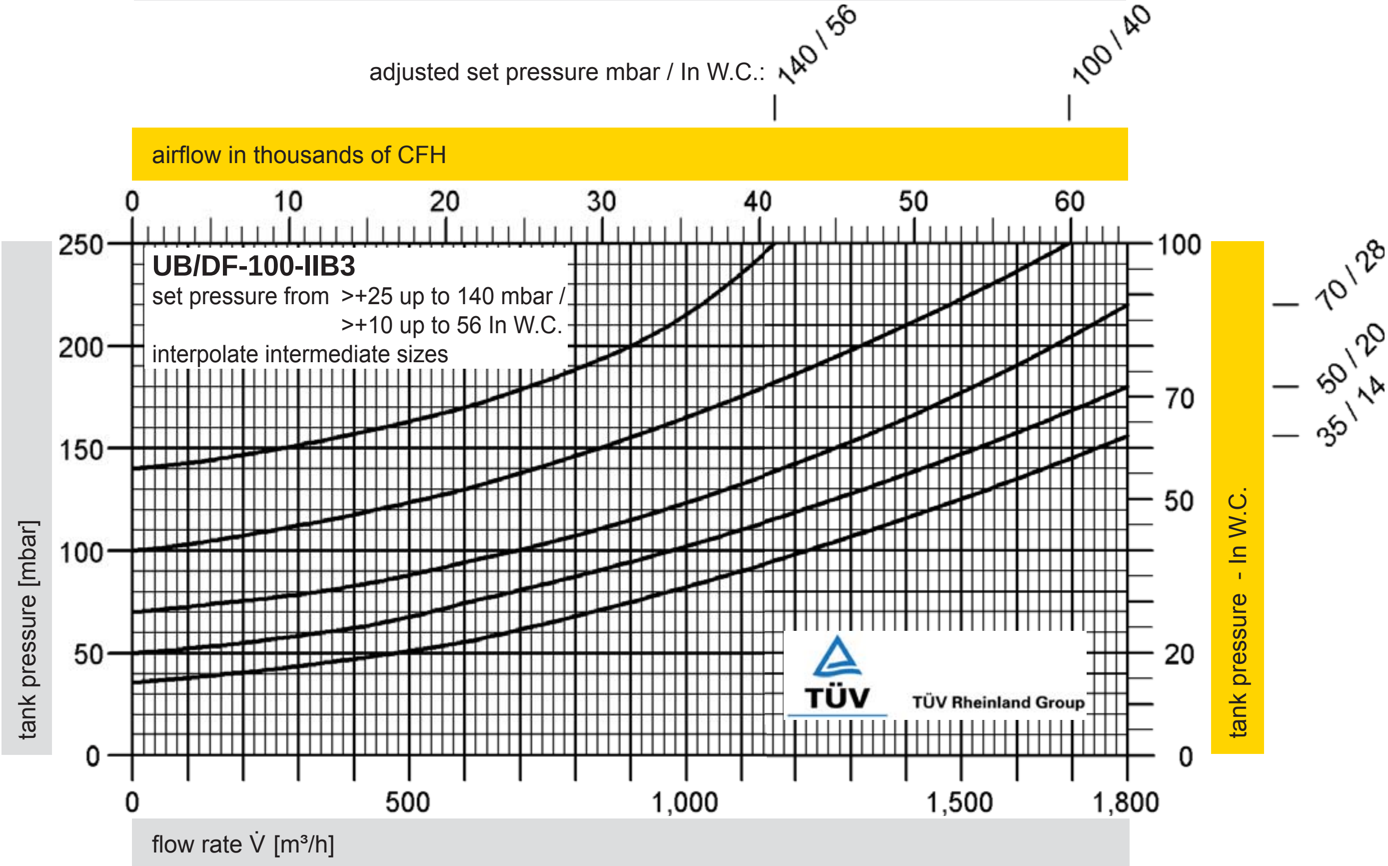
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar). Conversion to other densities and temperatures refer to Technical Fundamentals.





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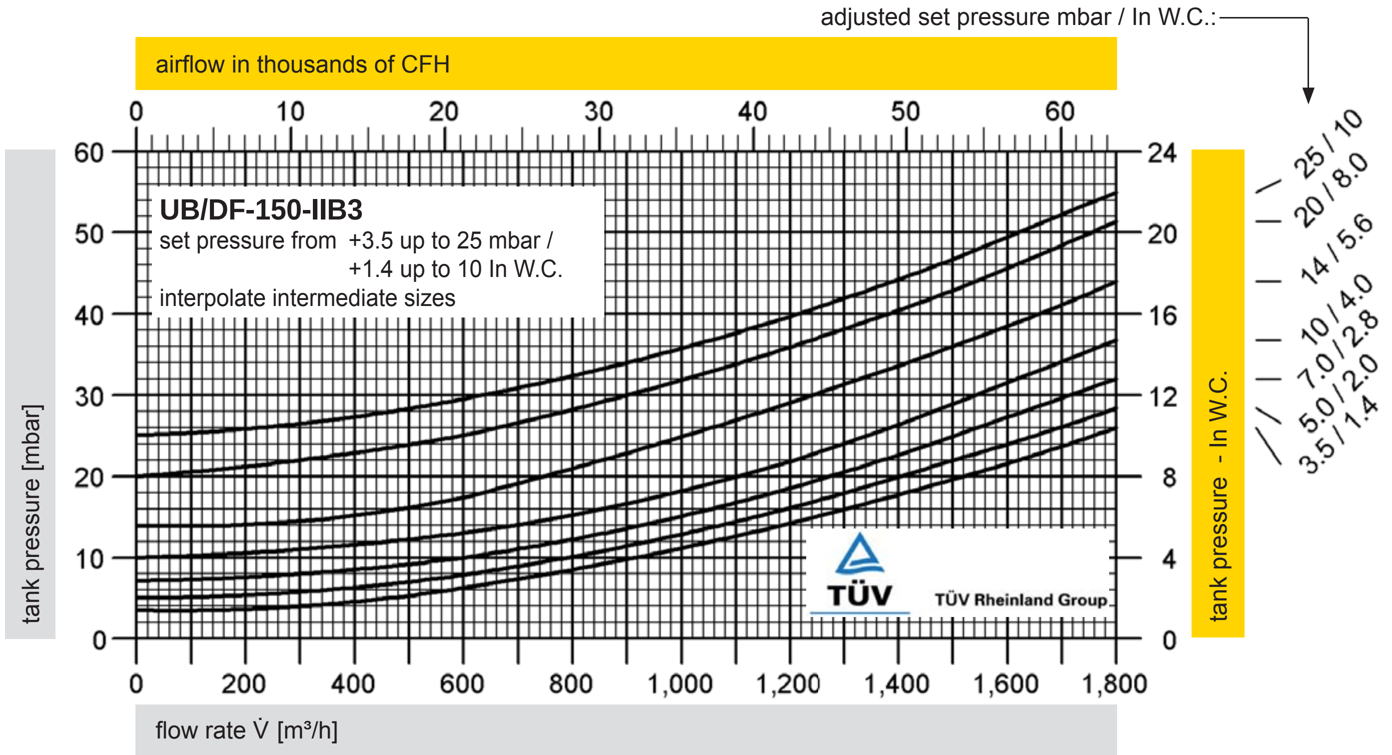
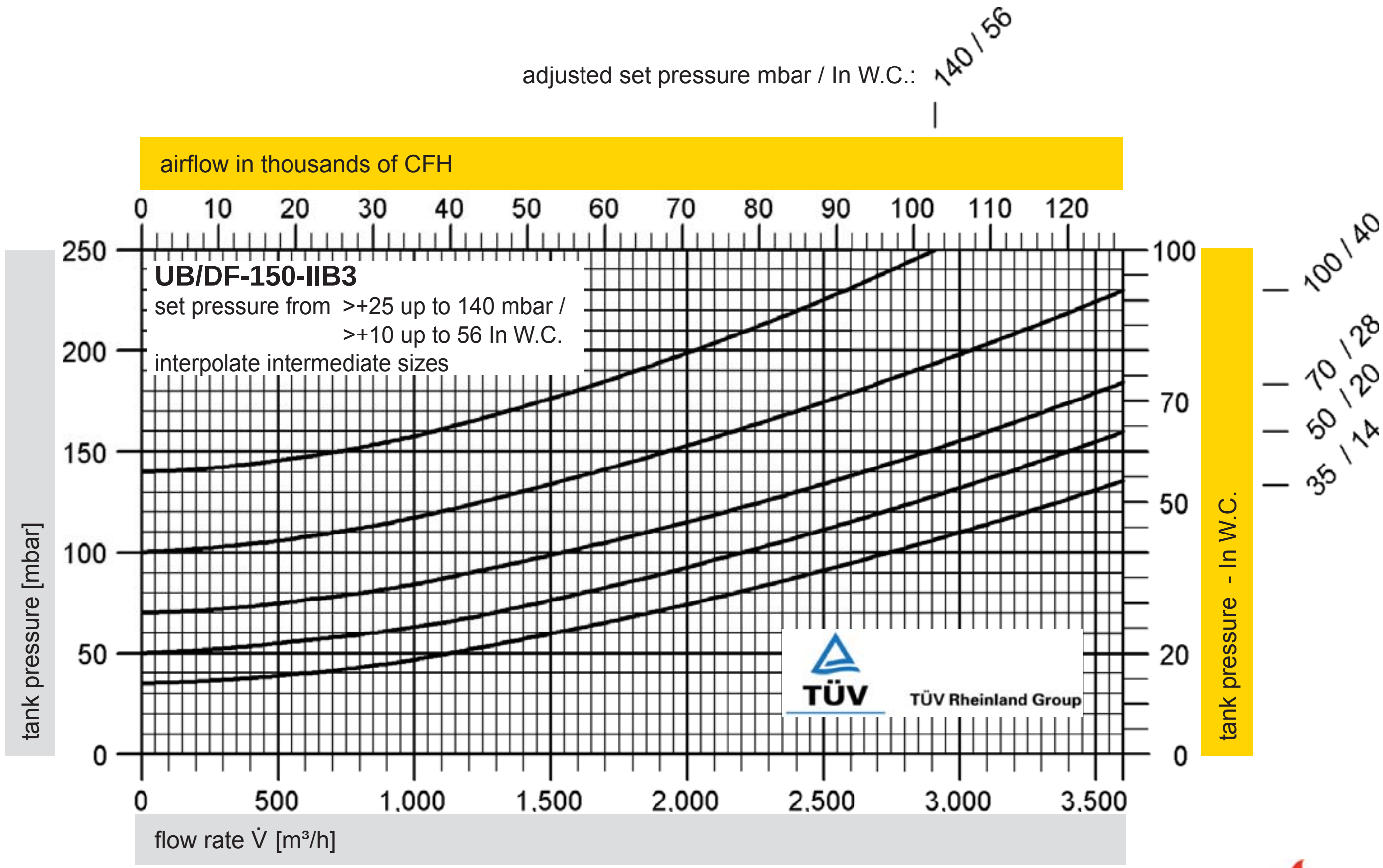
Volume flow V̇ in [m³/h] and CFH refer tothe standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

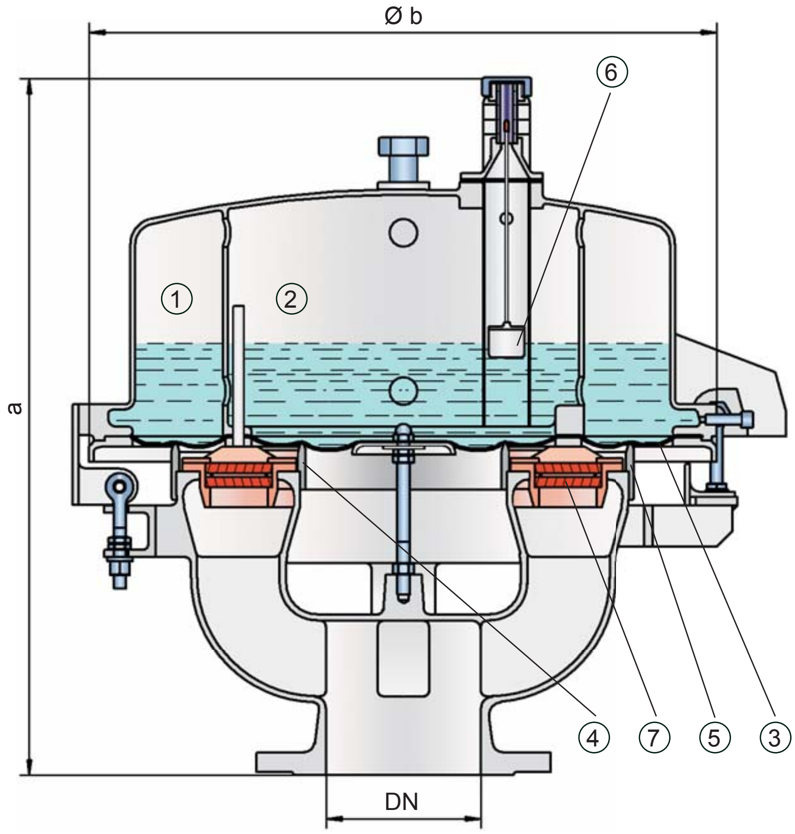

adjusted set pressure mbar / In W.C.:
airflow in thousands of CFH
0
10
20
30
40
50
60
UB/DF-150-IIB3
set pressure from +3.5 up to 25 mbar /
+1.4 up to 10 In W.C.
interpolate intermediate sizes
tank pressure [mbar]
60
50
40
30
20
10
0
24
20
16
12
8
4
0
tank pressure - In W.C.
25 / 10
20 / 8.0
14 / 5.6
10 / 4.0
7.0 / 2.8
5.0 / 2.0
3.5 / 1.4
TÜV
TÜV Rheinland Group
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
flow rate V̇ [m³/h]


adjusted set pressure mbar / In W.C.:
140 / 56
airflow in thousands of CFH
0
10
20
30
40
50
60
70
80
90
100
110
120
UB/DF-150-IIB3
set pressure from >+25 up to 140 mbar /
>+10 up to 56 In W.C.
interpolate intermediate sizes
tank pressure [mbar]
250
200
150
100
50
0
100
70
50
20
0
tank pressure - In W.C.
100 / 40
70 / 28
50 / 20
35 / 14
TÜV
TÜV Rheinland Group
0
500
1,000
1,500
2,000
2,500
3,000
3,500
flow rate V̇ [m³/h]

Vacuum Diaphragm Valve

deflagration-proof

PROTEGO® UB/VF



Vacuum Settings: –3.5 mbar up to –35 mbar
–1.4 In W.C. up to –14 In W.C.
Higher and lower vacuum settings upon request

Function and Description

The deflagration-proof UB/VF type PROTEGO® diaphragm valve is a state-of-the-art vacuum relief valve combining the function of a dynamic and static flame arrester. Worldwide this design is unique. It is primarily used as a safety device for flame transmission proof inbreathing on tanks, containers and process engineering apparatus. The valve offers reliable protection against vacuum build up, prevents the inbreathing of air and product losses almost up to the set vacuum and protects against atmospheric deflagration. The PROTEGO® UB/VF diaphragm valve has proven its performance over many years in a great variety of severe applications in the petrochemical and chemical industry. Worldwide it is the only vent which functions in services such as styrene and acrylics. The set vacuum is adjusted with a freeze resistant water glycol mixture, which assures safe operation under extreme cold weather conditions. The PROTEGO® UB/VF valve is available for substances from explosion group IIB3 (NEC group C MESG ≥ 0.65 mm).

If a vacuum builds up in the tank, it is transmitted through pressure balancing tubes into the vacuum chambers (1), (2). If the set vacuum, which depends on the liquid column height in the vacuum chamber, is reached the atmospheric pressure lifts the diaphragm (3) up off the inner and outer valve seat rings (4,5). Ambient air can now flow into the tank. The liquid column heights, which affect the set vacuum, can be checked by a floating level indicator (6).

The tank vacuum is maintained up to the set vacuum with a tightness that is far superior to the conventional standard due to our highly developed manufacturing technology. This is achieved because the liquid loaded diaphragm presses tightly around the special designed valve seat surface area, even when the operating vacuum increases. This is extremely important to reduce leakage to an absolute minimum. After the vacuum is balanced, the valve reseats and provides a tight seal.

At very low vacuum settings the explosion pressures resulting from an atmospheric deflagration may be strong enough to lift the diaphragm off the valve seat rings so that flashback could result. The ignition into the tank can be prevented by installing the PROTEGO® flame arrester unit (7). This flame arrester unit provides additional protection against atmospheric deflagration during regular maintenance and inspection.

The valve can be used up to an operating temperature of +60°C/ 140°F and meets the requirements of European tank design standard EN 14015 – Appendix L and API 2000.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- high performance seal reducing product loss below EPA's 500ppm rule preventing environmental pollution
- set vacuum close to the design vacuum enables optimum pressure maintenance in the system
- high flow capacity
- can be used as a protective system according to ATEX 94/9/EC in areas subject to an explosion hazard
- protection against atmospheric deflagrations for products up to explosion group IIB3 (NEC group C MESG ≥ 0.65 mm)
- FLAMEFILTER® integrated into valve saves space, weight and reduces cost
- minimum pressure drop of the FLAMEFILTER®
- freeze protection at sub-zero conditions
- self draining function for condensate

- liquid column height is monitored by level indicators
- easy maintenance through hinged vent cap
- modular design enables individual FLAMEFILTER® and valve diaphragm to be replaced
- particularly suitable for problematic products such as styrene, acrylics, etc

Design Types and Specifications

The diaphragm is pressurized by liquid.

There are two different designs:

Vacuum diaphragm valve, basic design **UB/VF -** $\boxed{-}$

Vacuum diaphragm valve with heating coil **UB/VF -** $\boxed{H}$
(max. heating fluid temperature +85°C / 185°F)

In addition to the standard design, a series of specially developed designs, which are particularly suitable for the operating conditions to which these products are subjected, can be provided upon request (for example, for acrylics or styrene storage tanks, etc.).

Table 1: Dimensions Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity charts on the following pages

DN	vacuum	80 / 3"	vacuum	100 / 4"	150 / 6"
a	up to -28 mbar / 11.2 In W.C.	615 / 24.21	up to -22 mbar / 8.8 In W.C.	645 / 25.39	680 / 26.77
a	< -28 mbar / 11.2 In W.C.	765 / 31.12	< -22 mbar / 8.8 In W.C.	795 / 31.30	830 / 32.68
b		410 / 16.14		485 / 19.09	590 / 23.23

Dimensions for vacuum diaphragm valve with heating coil upon request

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	Special approvals upon request
≥ 0,65 mm	IIB3	C	

Table 3: Material selection for housing

Design	B	C	D	
Housing	Cast Iron	Steel	Stainless Steel	
Valve top	Stainless Steel	Stainless Steel	Stainless Steel	
Heating coil (UB/VF-H-...)	Stainless Steel	Stainless Steel	Stainless Steel	Option: Housing with ECTFE-lining
Valve seat	Stainless Steel	Stainless Steel	Stainless Steel	Special materials upon request
Gasket	FPM	FPM	PTFE	
Diaphragm	A, B	A, B	A, B	
Flame arrester unit	A	C	C	

Table 4: Material selection for diaphragm

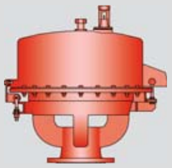
Design	A	B	Special materials upon request
Diaphragm	FPM	FEP	

Table 5: Material combinations of flame arrester unit

Design	A	C	
FLAMEFILTER® cage	Cast Iron	Stainless Steel	Special materials upon request
FLAMEFILTER®	Stainless Steel	Stainless Steel	
Spacer	Stainless Steel	Stainless Steel	

Table 6: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



Vacuum Diaphragm Valve

deflagration-proof

PROTEGO® UB/VF

Type	Heating coil	Nominal size	Explosion group	Material (housing)	Material (diaphragm)	Material (flame arrester unit)	Vacuum	Flange connection type
UB/VF							/	
Design		Tab. 1	Tab. 2	Tab. 3	Tab. 4	Tab. 5	Setting [mbar] / Setting [In W.C.]	Tab. 6

Order example

UB/VF – H – 100 – IIB3 – C – A – C – -5 / – – DIN

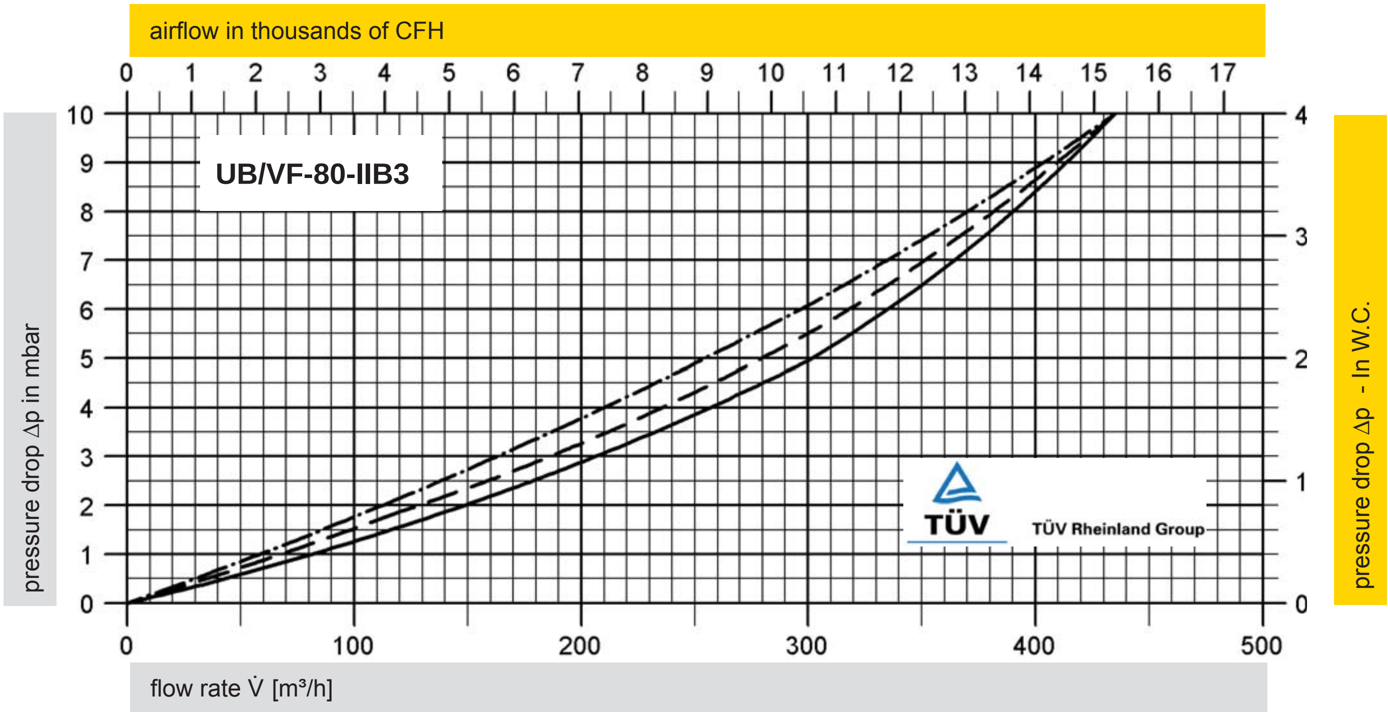
Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”

Flow Capacity Chart

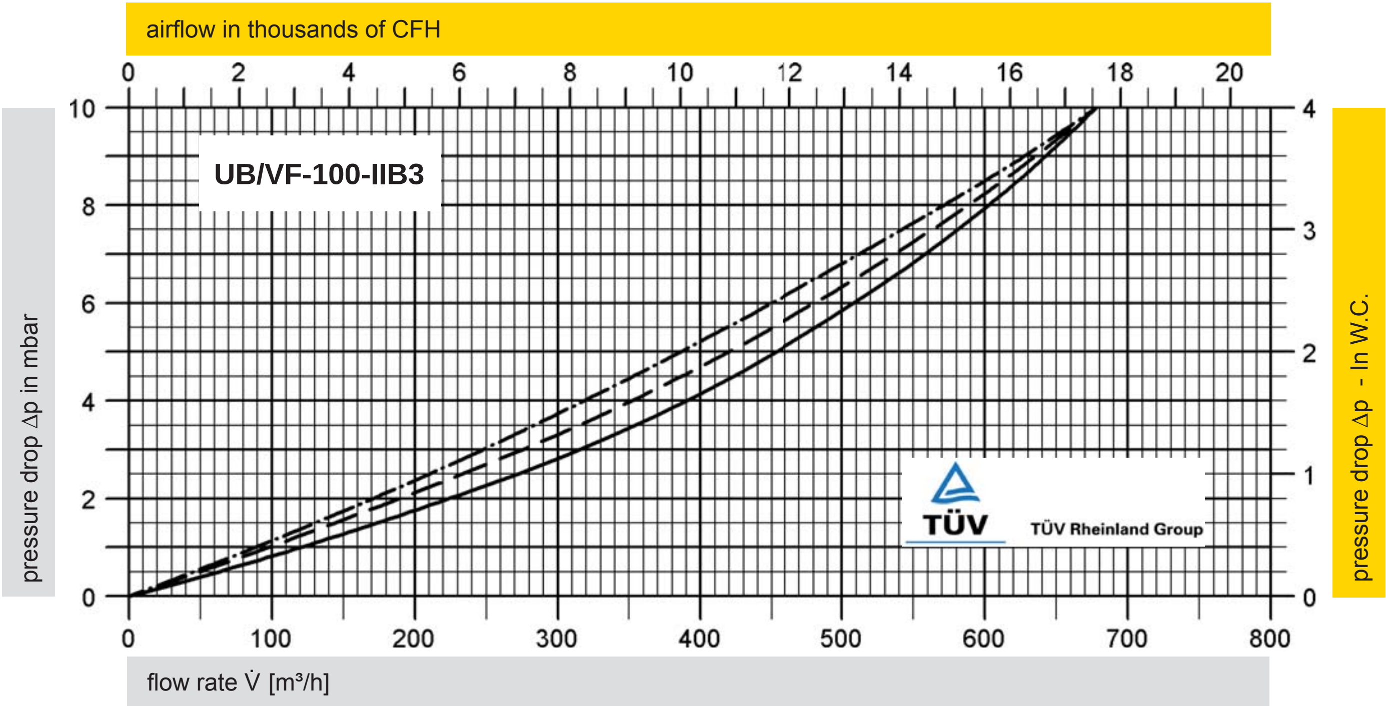
pressure drop = max. allowable tank design vacuum - valve set vacuum

adjusted set vacuum:

- (solid line) ≤ -5 mbar / ≤ -2 In W.C.
- (dashed line) > -5 mbar up to ≤ -7 mbar / > -2 In W.C. up to ≤ -2.8 In W.C.
- (dash-dot line) > -7 mbar up to ≤ -35 mbar / > -2.8 In W.C. up to ≤ -14 In W.C.



The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



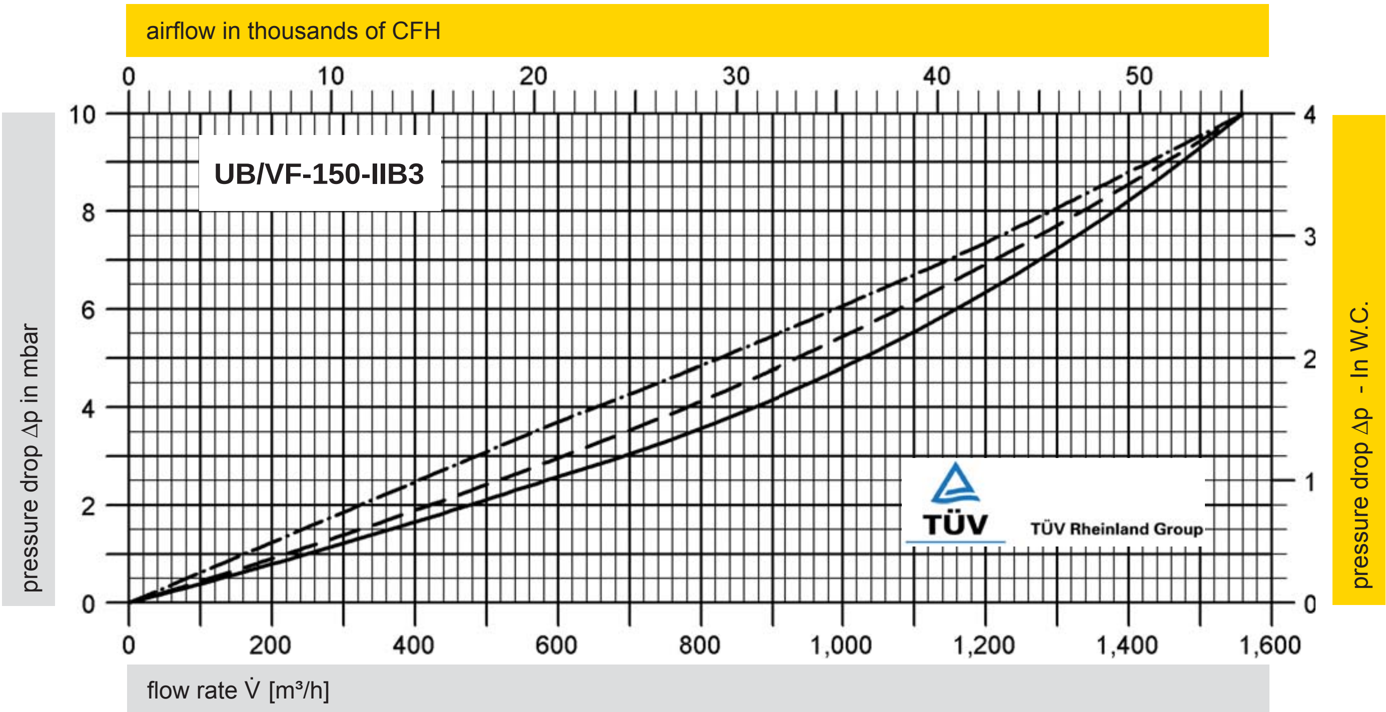
pressure drop = max. allowable tank design vacuum - valve set vacuum

adjusted set vacuum:

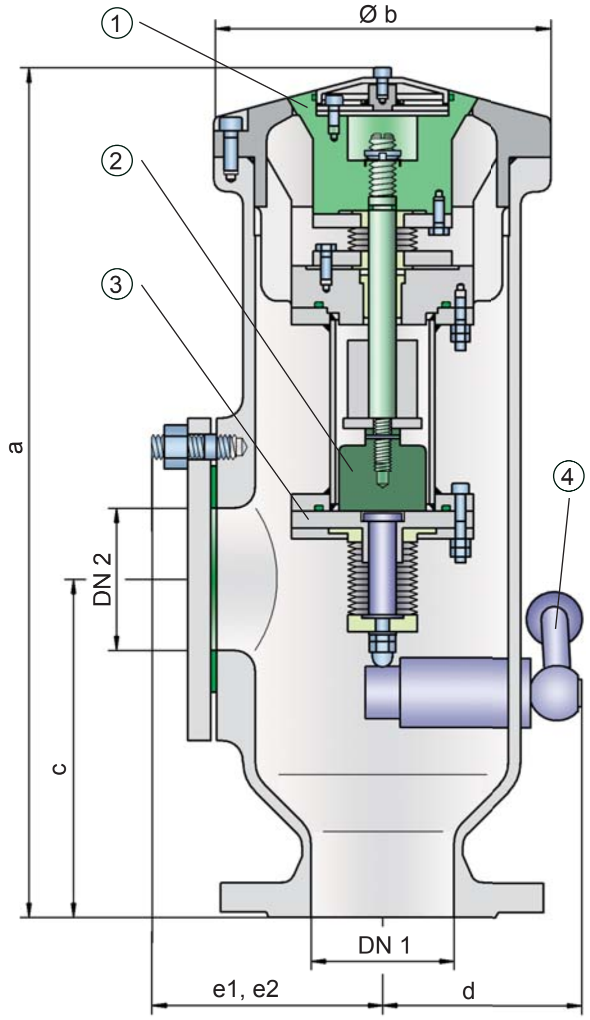
≤ -5 mbar / ≤ -2 In W.C.

> -5 mbar up to ≤ -7 mbar / > -2 In W.C. up to ≤ -2.8 In W.C.

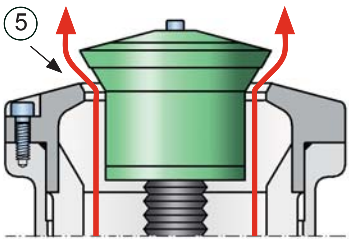
> -7 mbar up to ≤ -35 mbar / > -2.8 In W.C. up to ≤ -14 In W.C.



for safety and environment



operating position of valve - open



Pressure settings:

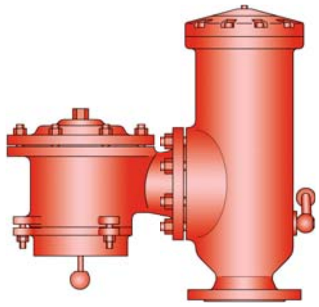
+100 mbar up to +500 mbar (10 kPa up to 50 kPa)
+40 In W.C. up to +200 In W.C.
Higher or lower pressure settings upon request

Function and Description

The deflagration- and endurance burning-proof DE/S type PROTEGO® valve is a state of the art high velocity vent valve working on the principle of a dynamic flame arrester. It is primarily used as a safety device for flame transmission proof venting of cargo spaces and loading systems of sea going tankers during the loading process and at sea. The valve offers reliable protection against excess pressure, prevents product losses almost up to the set pressure and provides protection against atmospheric deflagrations as well endurance burning if stabilized burning occurs. The PROTEGO® DE/S high velocity vent valve is available for substances of explosion group IIB3 (NEC group C MESG ≥ 0.65 mm).

The valve cone (1) is kept in a closed position by a corrosion resistant permanent magnet (2). The set pressure is adjusted by the distance of the permanent magnet to its counterpart (3). Upon reaching the set pressure (= cold differential test pressure), the valve opens directly to a full lift with only a minor pressure rise (jump characteristic). The set pressure is therefore very close to the maximum allowable working pressure (MAWP) of the cargo space.

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by valve seats made of high-quality stainless steel with an individually lapped valve cone. After the excess pressure is discharged, the valve reseats and provides a tight seal. The design of the valve cone and valve seat produces a vertical, free jet that transports the gases far away from the discharge opening. This keeps the deck free of gas. The shape of the valve cone and valve seat promotes the drainage of rainwater when closed. A function check of the valve is easily performed with a manual lift gear (4) that independently returns to its initial position after actuation. A lateral flange connection, DN2, is standard for a vacuum valve (such as the PROTEGO® SV/E-S, see page 28).



If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. When reaching the adjusted set pressure, the velocity at which the mixtures exit the valve cone gap (5) (the gap between the valve seat and the valve cone) is much higher than the flame velocity. If this mixture ignites, flashback into the tank is prevented. If the mixture flow continues and stabilized burning occurs, the dynamic flame arresting feature prevents flashback ignition even in the case of endurance burning. As the system pressure decreases, the discharge velocity at the valve cone gap decreases also. The design ensures, that even in the closing pressure range, the valve cone closes in a timely manner keeping the discharge velocity far above the flame velocity and thereby preventing flashback.

The valve can be used up to an operating temperature of +60°C / 140°F and meets the requirements of ADNR for type C ships and type N ships.

Type-approved according to ATEX Directive 94/9/EC and EN 12874 as well as other international standards.

Special Features and Advantages

- pressure is set with corrosion resistant permanent magnet
- jump characteristic within minimum overpressure to a full lift
- excellent tightness for minimum product loss and environmental pollution
- set pressure very near the relieving pressure enables optimum pressure maintenance in the system
- can be used as a protective system according to ATEX 94/9/EC in areas subject to an explosion hazard
- protection against atmospheric deflagrations and endurance burning
- high flow capacity
- maintenance-friendly design
- internal parts protected by bellows
- manual lift gear to pop valve cone
- side connection for a vacuum relief valve
- design promotes rain water drainage
- prevents gas build up on deck
- specially developed for in land water way barges

Design Types and Specifications

There are two different designs:

Pressure relief valve, basic design **DE/S -**

Pressure relief valve with lateral connection for vacuum relief valve **DE/S -...-** *

* additional DN 2 information

Additional special designs upon request

Table 1: Dimensions — Dimensions in mm / inches

To select the nominal size (DN), please use the flow capacity chart on the following page

DE/S with closed lateral connection DN 2				
DN 1	80 / 3"	100 / 4"	150 / 6"	
a	515 / 20.28	515 / 20.28	515 / 20.28	
b	195 / 7.68	195 / 7.68	195 / 7.68	
c	220 / 8.66	220 / 8.66	220 / 8.66	
d	120 / 4.72	120 / 4.72	120 / 4.72	
e1	145 / 5.71	145 / 5.71	145 / 5.71	
DE/S with lateral connection for vacuum relief valve DN 2				
DN 1	80 / 3"	100 / 4"	150 / 6"	150 / 6"
DN 2	80 / 3"	80 / 3"	80 / 3"	150 / 6"
a	515 / 20.28	515 / 20.28	515 / 20.28	515 / 20.28
b	195 / 7.68	195 / 7.68	195 / 7.68	195 / 7.68
c	220 / 8.66	220 / 8.66	220 / 8.66	220 / 8.66
d	120 / 4.72	120 / 4.72	120 / 4.72	120 / 4.72
e2	100 / 3.94	100 / 3.94	100 / 3.94	100 / 3.94

Table 2: Selection of explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request

Table 3: Material selection

Design	A	B	D
Housing	Steel	Stainless Steel	Hastelloy
Valve seat	Stainless Steel	Stainless Steel	Hastelloy
Valve cone	Stainless Steel	Stainless Steel	Hastelloy
Bellow	PTFE	PTFE	PTFE
Gasket	WS 3822	PTFE	PTFE

Special materials upon request

PROTEGO
for safety and environment

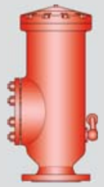
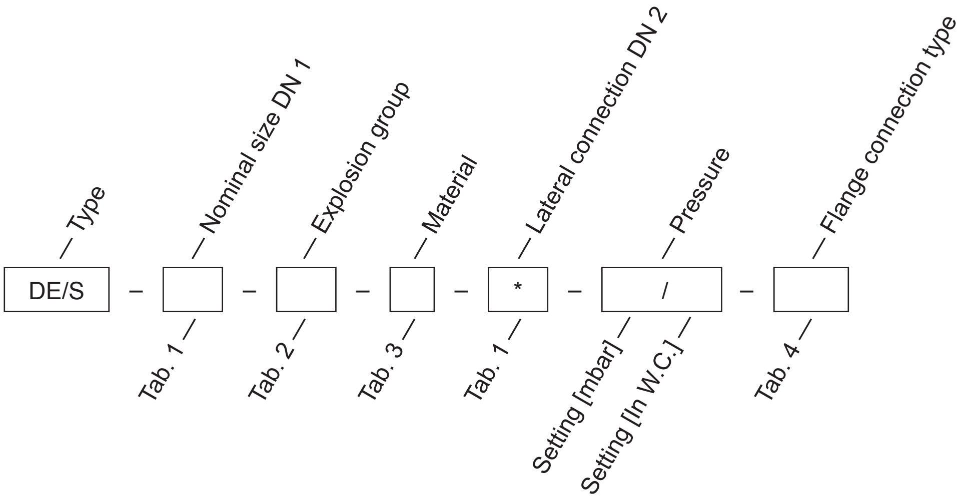


Table 4: Flange connection type		
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	



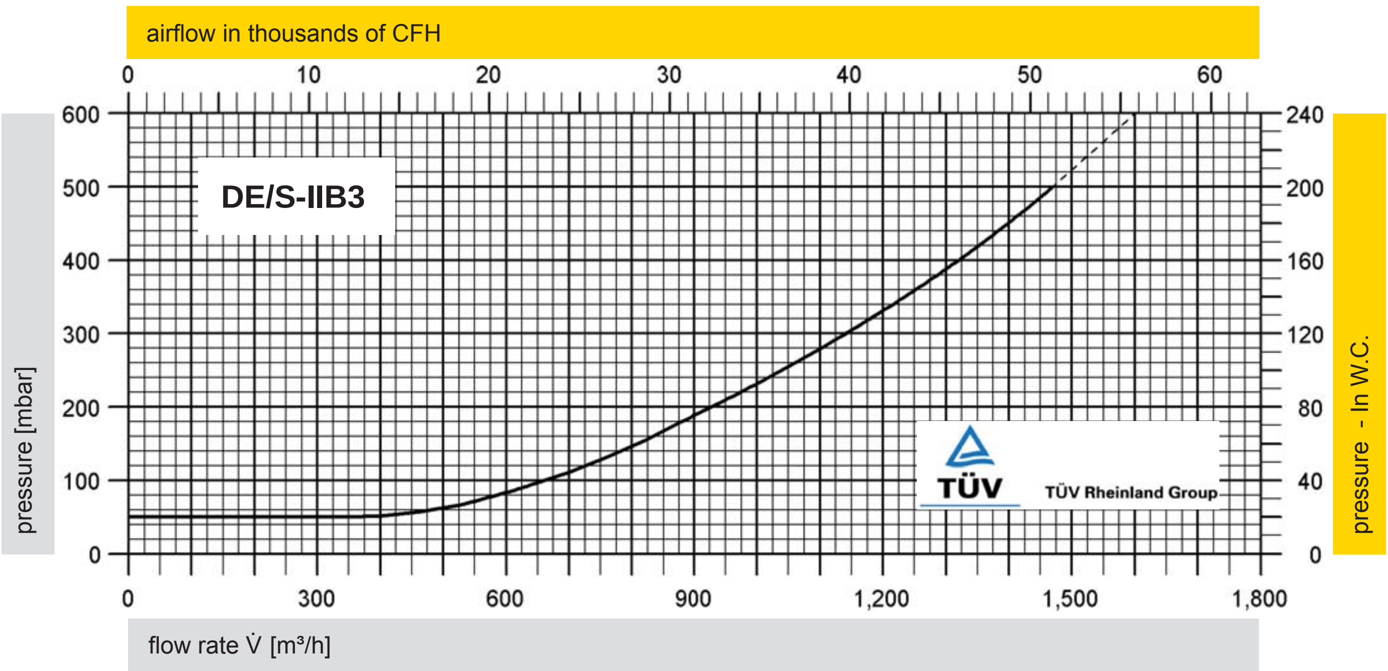
Order example

DE/S	–	100	–	IIB3	–	B	–	80*	–	200 / –	–	DIN

* indication necessary only for valve with lateral connection for vacuum relief valve

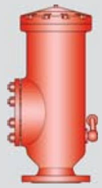
Materials and chemical resistance: See Vol. 1 "Technical Fundamentals"

Flow Capacity Chart



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

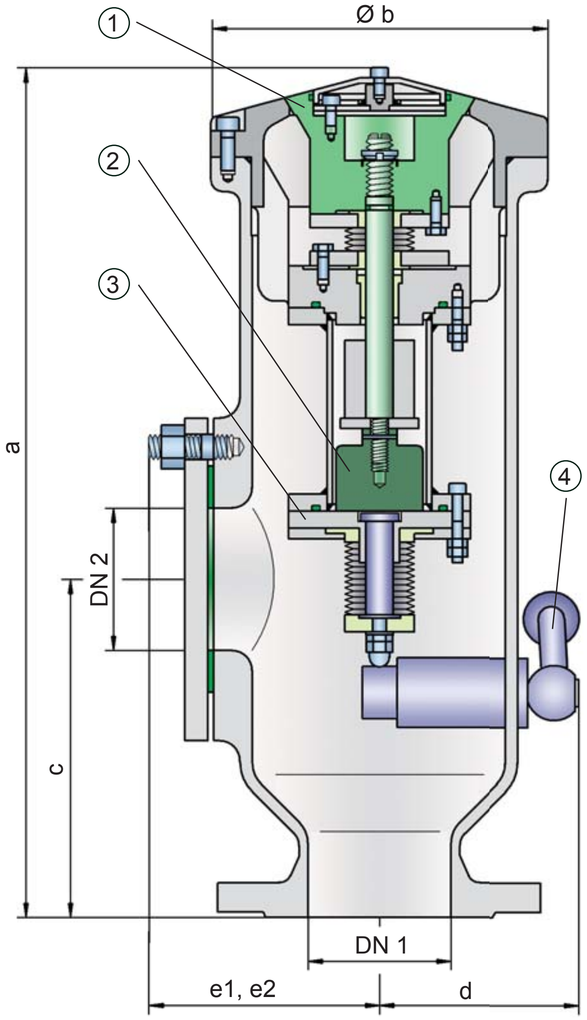
Notes:



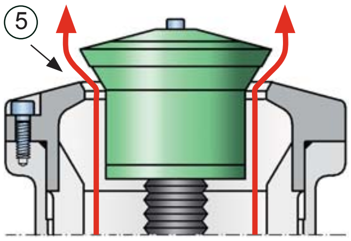
High Velocity Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® DE/S-MK VI



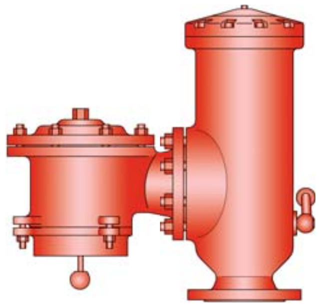
operating position of valve - open



Pressure settings:

+60 mbar up to +350 mbar (6 kPa up to 35 kPa)
+24 In W.C. up to +140 In W.C.
Higher or lower pressure settings upon request

The tank pressure is maintained up to the set pressure with a tightness that is far superior to the conventional standard due to our state of the art manufacturing technology. This feature is ensured by valve seats made of high-quality stainless steel with an individually lapped valve cone. After the excess pressure is discharged, the valve reseats and provides a tight seal. The design of the valve cone and valve seat produces a vertical, free jet that transports the gases far away from the discharge opening. This keeps the deck free of gas. The shape of the valve cone and valve seat promotes the drainage of rainwater when closed. A function check of the valve is easily performed with a manual lift gear (4) that independently returns to its initial position after actuation. A lateral flange connection, DN2, is standard for a vacuum valve (such as the PROTEGO® SV/E-S, see page 28).



If the set pressure is exceeded, explosive gas/product-vapour air mixtures are released to the atmosphere. When reaching the adjusted set pressure, the velocity at which the mixtures exit the valve cone gap (5) (the gap between the valve seat and the valve cone) is much higher than the flame velocity. If this mixture ignites, flashback into the tank is prevented. If the mixture flow continues and stabilized burning occurs, the dynamic flame arresting feature prevents flashback ignition even in the case of endurance burning. As the system pressure decreases, the discharge velocity at the valve cone gap decreases also. The design ensures, that even in the closing pressure range, the valve cone closes in a timely manner keeping the discharge velocity far above the flame velocity and thereby preventing flashback.

The PROTEGO® DE/S-MK VI high velocity pressure relief valve is also approved for oscillating flow. If a very long pipe is installed between the cargo space and valve, chattering can occur due to the resistance in the pipe or resonance phenomena. This can especially occur during partial load operation. This so called „hammering“ does not occur when a sufficient flow passes through the valve and the flow in the upstream line does not stop.

Function and Description

The deflagration proof and endurance burning proof DE/S-MK VI type PROTEGO® device is a state of the art high velocity vent valve working on the principle of a dynamic flame arrester. It is primarily used as a safety device for flame transmission proof venting of cargo spaces and loading systems of sea going tankers during the loading process and at sea. The valve offers reliable protection against excess pressure, prevents product losses almost up to the set pressure and provides protection against atmospheric deflagrations as well as endurance burning if stabilized burning occurs. The PROTEGO® DE/S-MK VI high velocity vent valve is available for substances of explosion groups IIB3 and IIC (NEC group C MESG ≥ 0,65 mm and B MESG < 0,50 mm). This makes it the world‘s first approved endurance burning proof flame arrester for explosion group IIC (NEC group B).

The valve cone (1) is kept in a closed position by a corrosion resistant permanent magnet (2). The set pressure is adjusted by the distance of the permanent magnet to its counterpart (3). Upon reaching the set pressure (= cold differential test pressure), the valve opens directly to a full lift with only a minor pressure rise (jump characteristic). The set pressure is therefore very close to the maximum allowable working pressure (MAWP) of the cargo space.

The design is therefore a function of the required flow capacity. Accordingly, there are two different designs: one with a lift of 10 mm and one with 50 mm. The design for explosion group IIC (NEC group B) is only available with a lift of 10 mm.

The valve can be used at an operating temperature up to +60°C / 140°F; since the valve is approved for group IIB3 (NEC group C) vapours, it also meets the requirements of European Marine Equipment Directive 96/98/EC (MED).

Type-approved according to ATEX Directive 94/9/EC and EN 12874; approved according to IMO MSC/Circular 677, 1009 by GL (the C version), and other international standards.

Special Features and Advantages

- pressure is set with corrosion resistant permanent magnet
- jump characteristic within minimum overpressure to a full lift
- excellent tightness for minimum product loss and environmental pollution
- set pressure very near the relieving pressure enables optimum pressure maintenance in the system
- can be used as a protective system according to ATEX 94/9/EC in areas subject to an explosion hazard
- protection against atmospheric deflagrations and endurance burning
- high flow capacity
- maintenance-friendly design
- internal parts protected by bellows
- manual lift gear to pop valve cone
- side connection for a vacuum relief valve
- design promotes rain water drainage
- prevents gas build up on deck by meeting IMO requirements for minimum free jet velocity
- specially developed for sea going vessels but also useful for on shore systems
- world's first endurance burning flame arrester approved for explosion group IIC (NEC group B)

Design Types and Specifications

There are four different designs

Pressure relief valve, basic design with 10 mm lift	**DE/S-MK VI - 10**
Pressure relief valve, basic design with 50 mm lift	**DE/S-MK VI - 50**
Pressure relief valve with 10 mm lift and lateral connection for a vacuum relief valve	**DE/S-MK VI - 10 - ***
Pressure relief valve with 50 mm lift and lateral connection for a vacuum relief valve	**DE/S-MK VI - 50 - ***

* additional DN 2 information

Additional special designs upon request

Table 1: Dimensions — Dimensions in mm / inches

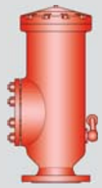
To select the nominal size (DN), please use the flow capacity charts on the following pages

DE/S with closed lateral connection DN 2

DN 1	80 / 3"	100 / 4"	150 / 6"
a	515 / 20.28	515 / 20.28	515 / 20.28
b	195 / 7.68	195 / 7.68	195 / 7.68
c	220 / 8.66	220 / 8.66	220 / 8.66
d	120 / 4.72	120 / 4.72	120 / 4.72
e1	145 / 5.71	145 / 5.71	145 / 5.71

DE/S with lateral connection for vacuum relief valve DN 2

DN 1	80 / 3"	100 / 4"	150 / 6"	150 / 6"
DN 2	80 / 3"	80 / 3"	80 / 3"	150 / 6"
a	515 / 20.28	515 / 20.28	515 / 20.28	515 / 20.28
b	195 / 7.68	195 / 7.68	195 / 7.68	195 / 7.68
c	220 / 8.66	220 / 8.66	220 / 8.66	220 / 8.66
d	120 / 4.72	120 / 4.72	120 / 4.72	120 / 4.72
e2	100 / 3.94	100 / 3.94	100 / 3.94	100 / 3.94



High Velocity Pressure Relief Valve

deflagration- and endurance burning-proof

PROTEGO® DE/S-MK VI

Table 2: Selection of explosion group

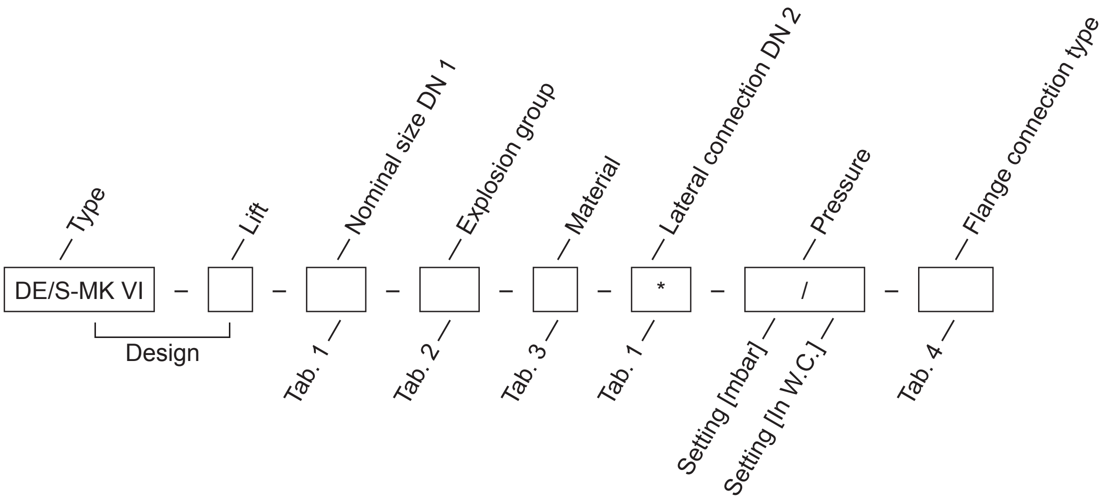
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)	
≥ 0,65 mm	IIB3	C	Special approvals upon request
< 0,50 mm	IIC	B	

Table 3: Material selection

Design	A	B	C	
Housing	Steel	Stainless Steel	Hastelloy	Special materials upon request
Valve seat	Stainless Steel	Stainless Steel	Hastelloy	
Valve cone	Stainless Steel	Stainless Steel	Hastelloy	
Bellow	PTFE	PTFE	PTFE	
Gasket	WS 3822	PTFE	PTFE	

Table 4: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

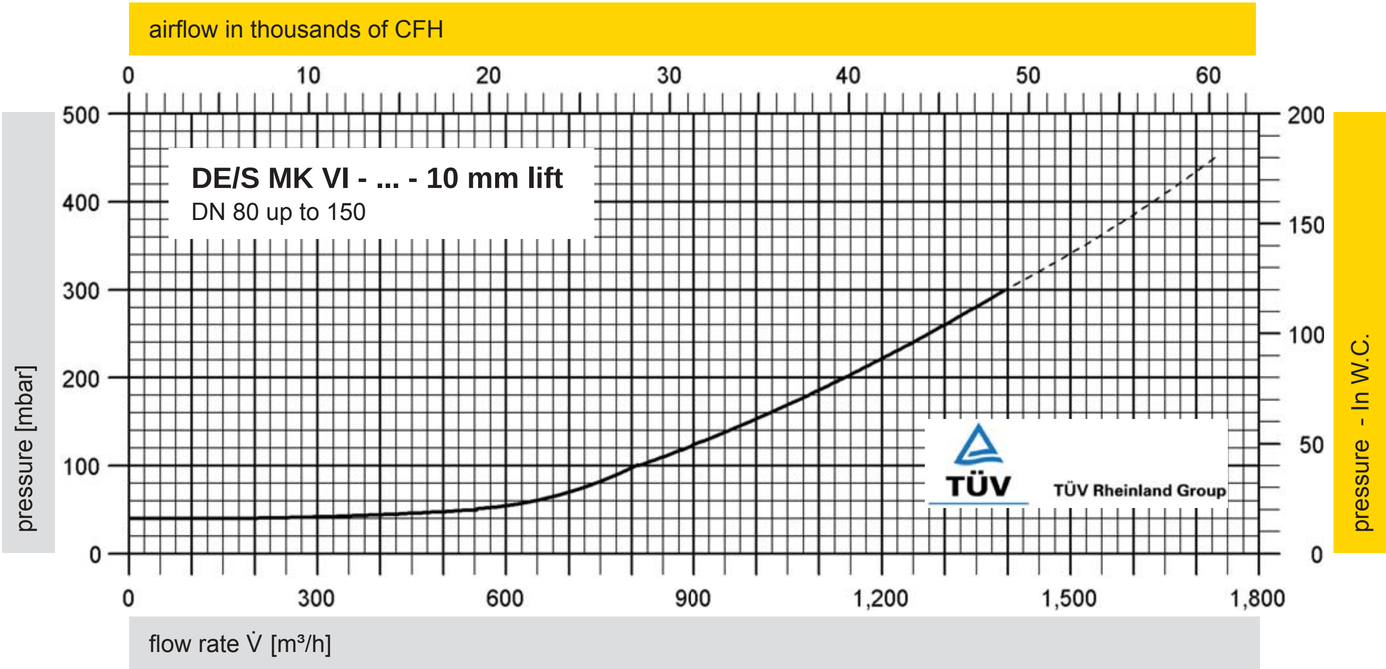


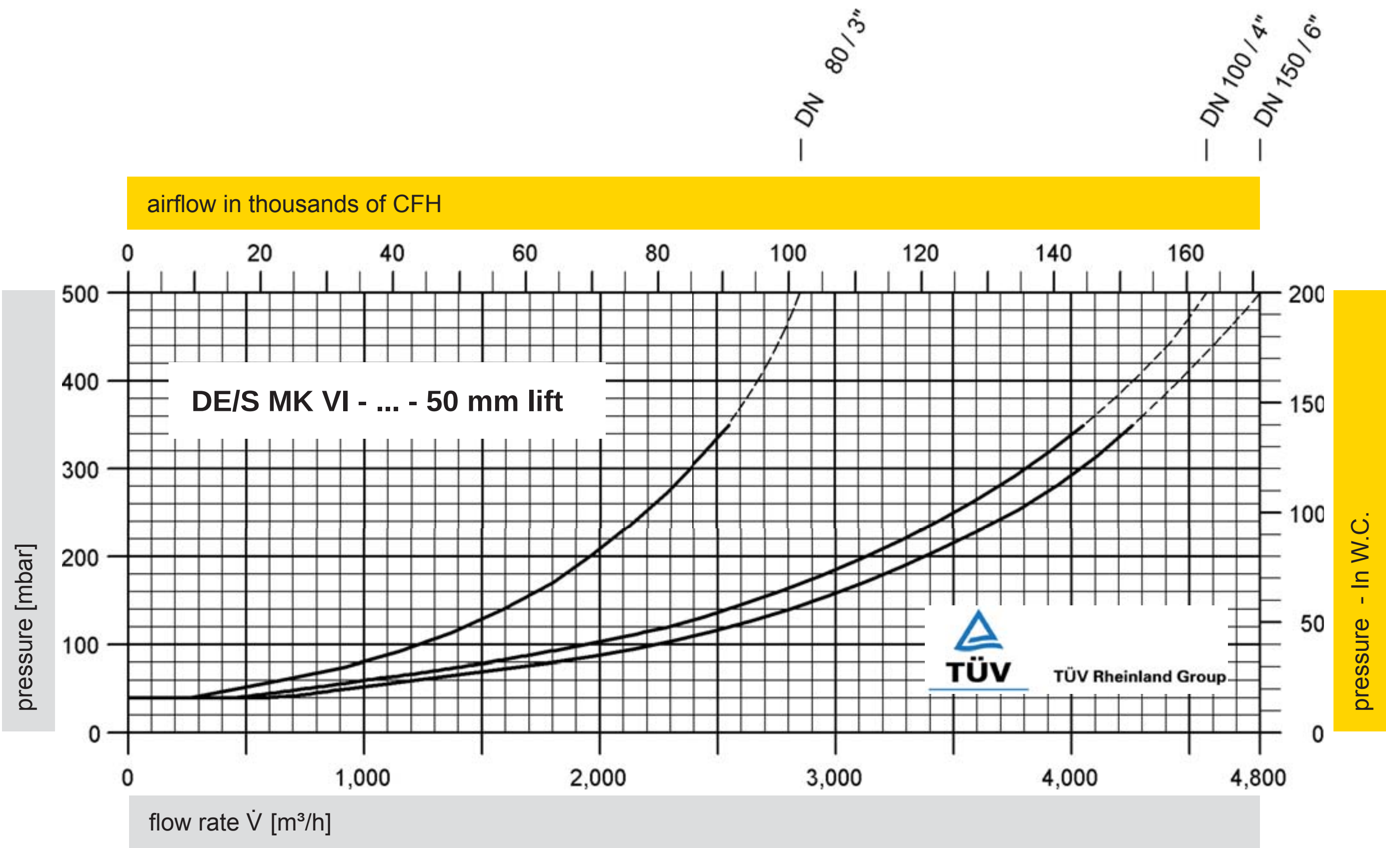
Order example

DE/S-MK VI	–	10	–	100	–	IIB3	–	A	–	80*	–	200 / –	–	DIN

* indication necessary only for valve with lateral connection for vacuum relief valve

Materials and chemical resistance: See Vol. 1 “Technical Fundamentals”





The flow capacity charts have been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and CFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft²	=	47,88 N/m²
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m²
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft²	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m²	1 psi	=	1 lb/in²

Temperature

To convert ºC in ºF use	T_F	=	$32 + 1{,}8\ T_C$
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$5/9\ (T_F - 32)$
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means
CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	= polytetrafluoroethylene
PVDF	= polyvinylidene fluoride
PFA	= perfluoroalkoxy polyme
FPM 70	= fluor carbon rubber
WS 3822	= aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	= ethylene chlorotrifluoro ethylene
FEP	= perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937 inch	1 inch		=	25,4 mm
1 m	= 3.2808 ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936 yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621 miles	1 mile		=	1,609 km

Area

1cm²	= 0.1550	sq inch	1 sq inch	=	6,4516 cm²
1 m²	= 10.7639	sq ft	1 sq ft	=	0,0929 m²
	= 1.196	sq yards	1 sq yard	=	0,836 m²
1km²	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm³	= 0.06102	cu inch	1 cu inch	=	16,3870 cm³
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
1 m³	= 35.315	cu ft	1 cu ft	=	0,028317 m³
	= 6.299	petr. barrels	1 petr. barrel	=	0,15876 m³

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85 ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214 mph	1 mph	=	1,60934 km/h
1 m³/h	= 4.403 gal/min (US)	1 gal/min (US)	=	0,227 m³/h
	= 3.666 gal/min (UK)	1 gal/min (UK)	=	0,273 m³/h
	= 0.5886 cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367 lb/min	1 lb/min	=	27,216 kg/h
		1 cu ft/h	=	0,028317 m³/h

Torsion

1 Nm = 0.723 lbf ft   1 lbf ft = 1,38 Nm

Density

1 kg/dm³ = 62.43 lb/cu ft   1 lb/cu ft = 0,016 kg/dm³

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

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PROTEGO
for safety and environment

PROTEGO® **Tank Accessories and Special Equipment**

Volume 8

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for safety and environment

More than 50 years ago, PROTEGO® started developing special devices for protecting systems against explosions as well as pressure and vacuum relief valves that meet the highest standards for performance, pressure conservation, and tight seals. This yielded the original Braunschweiger FLAMEFILTER® (Fig. 1) as well as a series of additional innovations that led to numerous patents and imitators. In close cooperation with scientific institutions, continued technical challenges were overcome to meet the increasing requirements for safety and environmental protection.

Today, these products are used throughout the world under the brand names PROTEGO® and FLAMEFILTER® mainly for the following applications:

1. In tank farms for refineries and chemical plants
2. In processing plants for chemical and pharmaceutical industries
3. In vapour combustion plants
4. In ship building, offshore platforms, in loading facilities
5. In vapour recovery systems
6. As component for machineries and devices
7. In biogas and landfill applications
8. In flare systems

Our comprehensive product range reliably protects systems for generating, storing, and transporting gases and liquids of every hazard category against dangers such as endurance burning, deflagration and detonation. Our complete line of valves enables tank farms to be safely and economically ventilated. In addition, PROTEGO® offers unique combinations of flame arresters and valves.

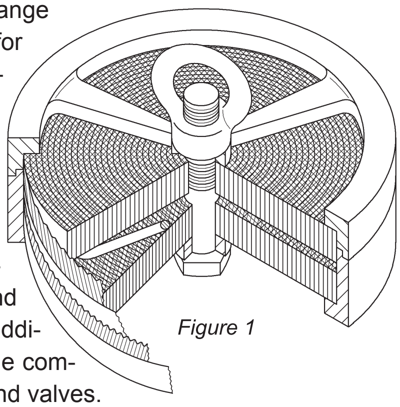
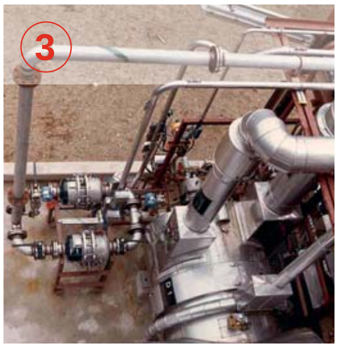
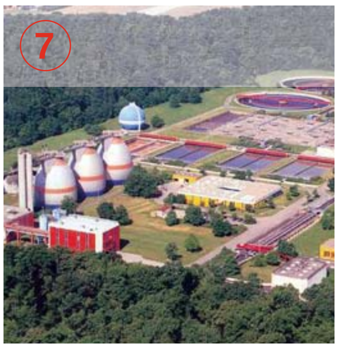


Figure 1

All of our devices are tested by independent national and international third parties in the world‘s largest test facility and have got at least one of the many certifications. The actual performance of the devices is determined in a modern flow measuring test rig to obtain reliable data for their practical use.

PROTEGO®, FLAMEFILTER®, and FLAMMENFILTER® are international trademarks owned by Braunschweiger Flammenfilter GmbH.





Tanks in tank farms and large vessels need not only to be equipped with flame arresters or pressure and vacuum valves, but in addition they need special equipment, which meets similar high requirements, to operate safely.

Special Valves with Safety Functions

For emergency shut-off or for extraordinary operating conditions it is necessary to provide **internal safety valves** so that product leakage can be prevented quickly after a pipe burst. **Change-over valves** facilitate trouble-free valve maintenance.

Gauging and Sampling Equipment

Gauge hatches with or without a gauging mark allow the use of **gauging and sampling devices** in the tank. If there is connection to explosive atmosphere flame-transmission-proof integrated flame arresters protect the tank.

For sampling and local venting in tanks that store flammable liquids PROTEGO® has designed special **sampling and air bleed valves** with flame arrester elements.

Explosion-proof **floor drains** pass flammable liquids (such as Kerosene) into catch tanks and prevent ignition inside. If an outside ignition source ignites the explosive atmosphere there is no flame transmission.

Swing Pipe Systems and Skimming Systems

When filling the product into a tank dirt particles deposit near the bottom. In order to pump out the liquid as uncontaminated as possible near the surface **float controlled swing pipe systems** are used for fixed roof tanks either as single or double bend models. Liquids with lower specific weight swim on top of the liquids with higher specific weight. They are separated by skimming with a float operated skimming system.

Together with the tank operator or tank contractor we develop the best way to ensure both economical and safe operation.

Floating Roof Tank Equipment

For floating roof tanks the **drainage system for the floating roof** must be designed very precisely. Every movement of the floating roof must be taken into account and the load on the joints must not affect the free moving space. In case of restricted movement the system will crack, the pipes will bend and the joints will be stuck. In order to prevent the water in the system from standing and freezing, ensure sufficient drain to the lateral tank nozzle. Many years of experience are incorporated in the supplied systems that work without disruptions – starting from the **roof drain valves** to the systems with ball bearing joints or metal hose joints. With lowered floating roofs in maintenance positions the completely drained space below the floating roof must be vented through a **lift-actuated vent valve**. When storing flammable liquids in the tank venting is to be done through flame arresters.

Special Equipment

Hygroscopic products must be vented with dry air when stored. **Air-drying devices** with drying pearls prevent the air from saturating with humidity.

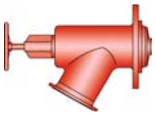
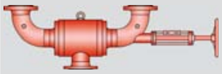
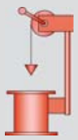
A special safety device is the **hydraulic flame arrester**. It is a collection device for large volume flows in pipelines collecting exhaust air from various plant areas, and it also functions as a backflow prevention device as it prevents the exchange of vapours. With extremely low pressure losses thanks to its relatively large drill holes in the sparge pipes the hydraulic flame arrester is insusceptible to clogging and therefore provides high plant availability. It can be used as flame arrester with substances of all explosion groups and provides protection against all types of combustion. The hydraulic flame arrester has to be monitored and controlled by instrumentation. Early involvement of our engineers in plant design is necessary to make the right selection.

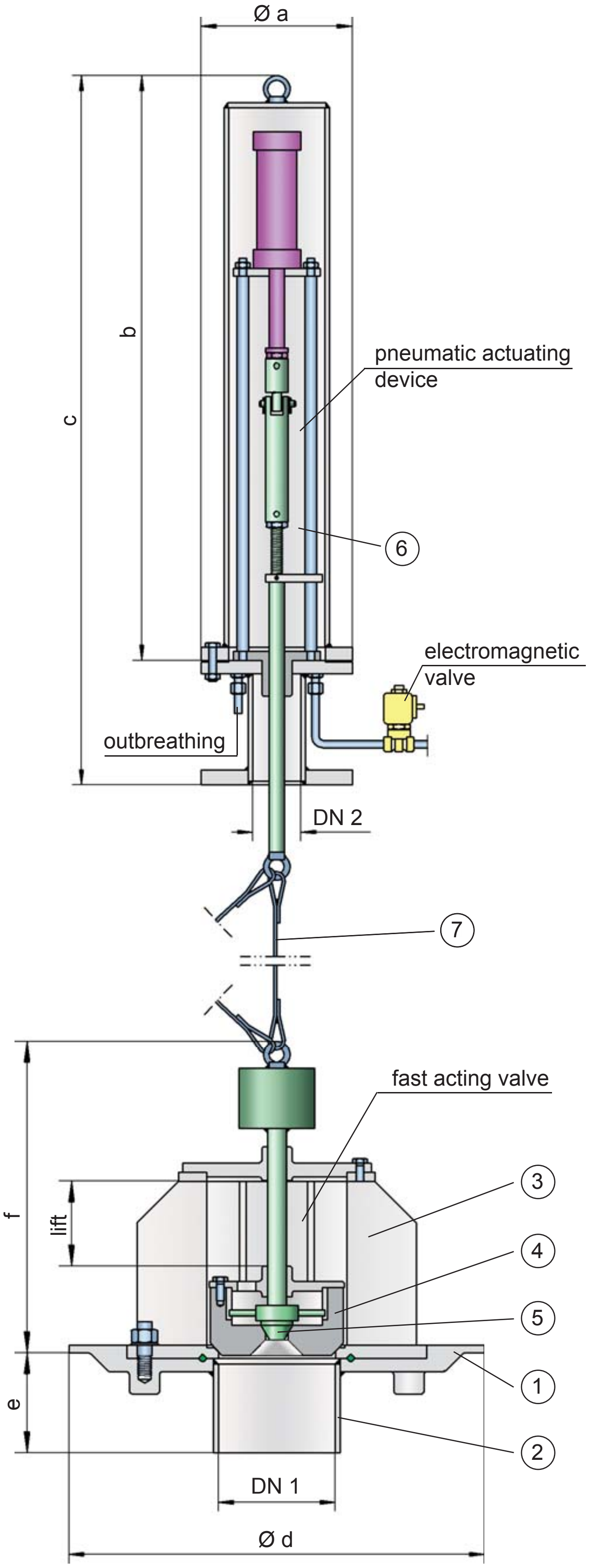
Selection

The special valves, systems and devices are designed together with the operator, engineering company and tank contractor. PROTEGO® prepares a quotation based on the detailed system specifications.

Selection Guide

PROTEGO® Tank Accessories and Special Equipment

	Type	Size	Description	Page
Special Safety Valves				
	NB/AP	150 - 200 6" - 8"	Fast Action Bottom Drain Valve with pneumatic actuator	8-9
	SI/F	50 - 200 2" - 8"	Internal Safety Valve	10-11
	WV/T	80 - 250 3" - 10"	Change-Over Valve	12-13
Gauging and Sampling Equipment				
	PF/K PF/TK	100 - 200 4" - 8"	Gauge Hatch	14-15
	PU	25 - 50 1" - 2"	Gauging and Sampling Pipe, deflagration proof	16-17
	H/P		Manual Gauging Device	18
	VP/HK with PS/E, PR/0, PT/S, PG/H	100 - 150 4" - 6"	Gauging and Sampling Device with accessories	20-21
Deflagration proof Special Valves				
	ZE/WU	15 - 25 G½" - G1"	Sampling and Air Bleed Valve, deflagration proof	22-23
	ZE/TK	15 - 25 G½" - G1"	Condensate Drain Valve, deflagration proof	24-25
Deflagration proof Floor Drains				
	AS/S	100 4"	Floor Drain, deflagration proof	26-27
	AS/D	150 6"	Floor Drain, deflagration proof	26-27



If fast acting valve is open, drag coefficient amounts to 1,5

Function and Description

Fast acting bottom drain valves type NB/AP from PROTEGO® are applied to tank seal draining nozzles to avoid leakage during a hazardous situation (pipe burst). For this reason the devices are also called “Quick Shut off Bottom Drain Valves”. They are mainly used for low temperature liquefied medium (down to -196°C / -321°F) storage tanks.

The device mainly consists of the bottom plate (1), which has to be welded onto the vessel bottom, a nozzle (2), which needs to be welded to the emptying line and the flanged fast acting valve (3) with valve piston (4) and release valve cone (5) and the complete pneumatic actuating device (6), which is mounted to the roof of the vessel. Through lapped metallic valve pallet and release vent cone the required leak tightness is achieved.

The fast acting valve (3) and the actuator system (6) are connected by an actuator rope (7). An additional emergency rope allows the opening of the fast acting valve if the main actuator rope is damaged.

During normal operation a pneumatic cylinder holds the device in the open position. The piston in the pneumatic cylinder is actuated by a control line. The piston rod is retracted with the actuation spindle to lift the valve piston and keeps the valve open during normal operation. In the emergency case a remote release through a control valve closes the bottom drain valve. To close the bottom drain valve the control valve is actuated to vent the pneumatic cylinder. The dead weight of the valve piston lets it fall down and the valve closes. The control function has to be designed in such a way that the valve closes by itself even during loss of energy (Fail-Safe-Concept).

The design of the device is independent of the nominal diameter. The nominal diameter DN 1 is preset by the emptying line – standard is DN 150mm / 6”.

Under normal operation the valves are working unpressurized. To re-open the valve after a quick-shut-off a pressure is considered which is resulting of the liquid column above and the pressure in the gas head space.

Material selection is in accordance to the product and the operating temperature.

The bottom plate is welded in the tank bottom. Size and weld seam must consider the engineering requisition.

Design Types and Specifications

Table 1: Dimensions								Dimensions in mm / inches
DN 1	DN 2	a	b	c	d	e	f	Hub
150 / 6"	80 / 3"	200 / 7.87	1130 / 44.49	1430 / 56.30	550 / 21.65	175 / 6.89	465 / 18.31	160 / 6.30
200 / 8"	80 / 3"	200 / 7.87	1130 / 44.49	1430 / 56.30	600 / 23.62	175 / 6.89	470 / 18.50	160 / 6.30

Table 2: Material of fast action bottom drain valve	
Bottom plate with nozzle	*
Valve housing with valve cone	Stainless Steel
Gasket	*
Actuator rope	Stainless Steel

* upon request

Table 3: Material of actuating device	
Housing	Stainless Steel
Actuator spindle	Stainless Steel
Guide bushing	Copper
Gasket	PTFE
Protective cap	Stainless Steel
Pneumatic cylinder	Aluminium

Table 4: Flange connection type DN 2
EN 1092-1, Form B, PN 40 or upon request

Selection and Design

The main process data and product properties of the stored medium as well as the temperature of the stored product determine the material for the specific valve. Subsequently the **nominal diameter** and the **type of connection** are checked and selected.

The valve is available in nominal diameters of DN 150 mm / 6" and DN 200 mm / 8", whereas the connection for the pneumatic actuating device has a nominal diameter of DN 80 mm / 3".

The length of the actuator rope and of the emergency rope is determined by the height of the tank. The final adjustment is completed during installation. The material for the gasket is determined based on the operating conditions and/or other special requirements.

The material of the valve bottom plate needs to be compatible to the material of the tank bottom plate. If the material of the bottom plate is provided by the tank manufacturer, then close coordination between manufacturing planning and installation planning is necessary.

For special requirements the valve and the actuation system (e.g. with inductive position indicator) can be supplied with a special design.

Deviations from our standard design will be sized and specified with the support of our engineers for the specific application.

Necessary Data for Specification

Stored medium

Operating temperature T (°C or °F)

Operating pressure p (bar or psi)

Connection size DN 1

Tank height (m or ft)

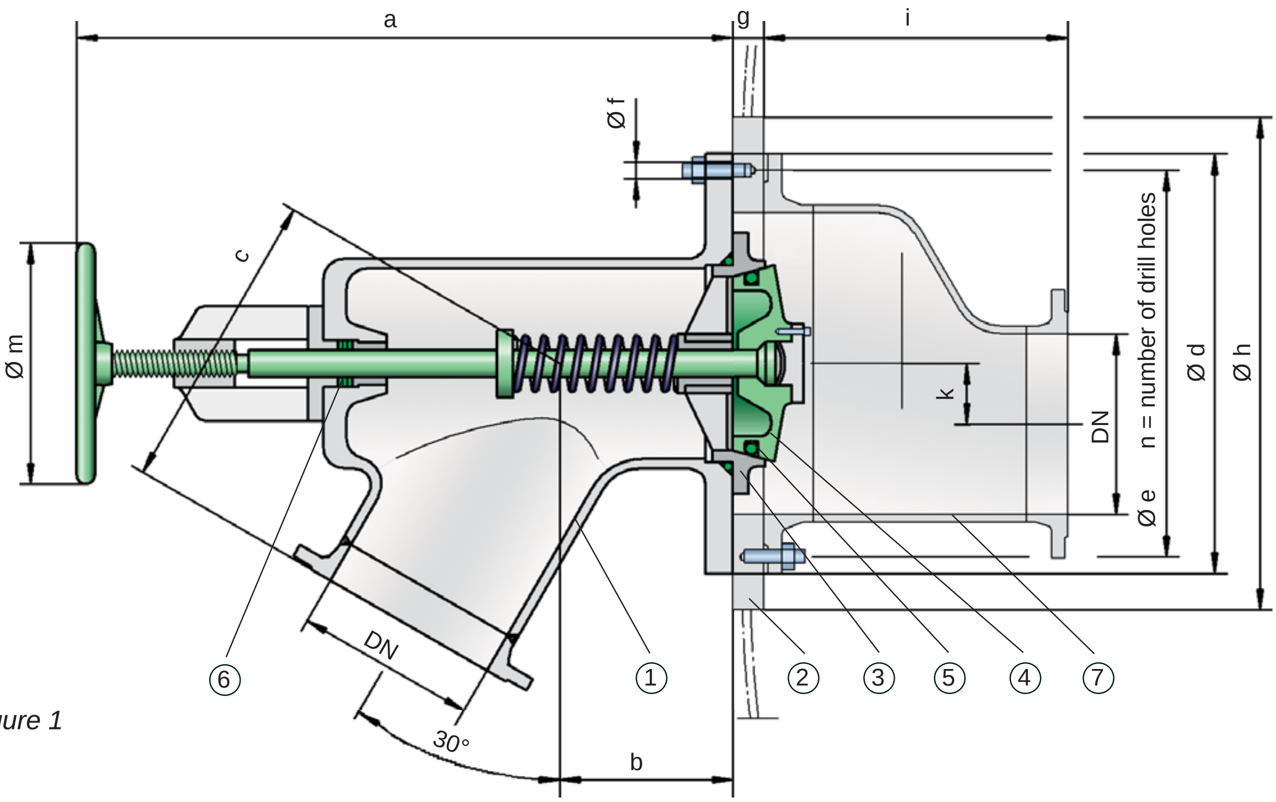


Figure 1

Function and Description

The PROTEGO® internal safety valve type SI/F is a shut-off valve and protects the downstream liquided lines of storage tanks and tanks in process plants of the chemical, petrochemical and pharmaceutical industries, thus increasing both safety and availability of the plants.

The internal safety valve SI/F (figure 1) consists of housing (1), mounting flange (2), valve seat (3), valve disc (4) and sealing (5). The mounting flange is welded into the tank shell. The valve seat is replaceable. The valve seat and valve disc have lapped metallic surfaces and an additional O-ring to ensure the required tightness. The spindle sealing (6) can be adjusted or replaced and is designed for a test pressure of 25 bar / 363 psi.

A gate valve that is supplied by the user and serves for normal operation is connected to the external nozzle of the housing. The internal safety valve is kept open under normal operating conditions. It is only closed for longer shut-downs, in case of emergency or for necessary repairs to the gate valve.

It is closed by an „internal sealing“, i.e. the valve is closed inside the tank. This ensures that the tank cannot leak in case of damage to external components or leakages in any connected pipelines.

The special design of PROTEGO® tank shut-off valves of type SI/F is such that only the mounting flange (2) is welded to the tank shell, and so most other parts can be replaced. Replacement of important external parts does not require the draining of the tank. This fact provides significant operation advantages.

Type SI/F by PROTEGO® is available in a range of nominal sizes and materials. Optionally, the internal safety valve can be equipped with an internal nozzle (7) to connect to a suction and filling pipe or a swing pipe system (SI/FA).

Tank shut-off valves of this type are usually operated manually. Versions with an explosion proof electric actuator for direct or remote control are also available.

Alternatively it is possible to use special versions with pneumatic control (SI/DP) under specific tank design (e.g. double-shell tank – figure 2).

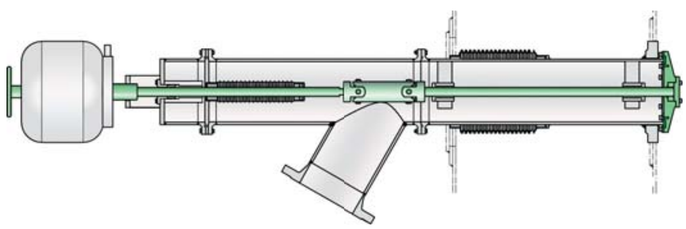


Figure 2

Design Types and Specifications

Two designs are available:

Internal safety valve, standard design **SI/F**

Internal safety valve with internal connection nozzle (7) **SI/FA**

Table 1: Dimensions — Dimensions in mm / inches

DN	a	b	c	d	e	f	g	h	i	k	m	n
50 / 2"	371/14.61	75/2.95	170/6.69	240/9.45	205/8.07	14/0.55	30/1.18	305/12.01	250/9.84	54/2.13	200/7.87	8
65 / 2 ½"	400/15.75	85/3.35	190/7.48	305/12.01	205/8.07	14/0.55	30/1.18	305/12.01	240/9.45	45/1.77	200/7.87	8
80 / 3"	416/16.38	90/3.54	200/7.87	330/12.99	230/9.06	14/0.55	30/1.18	330/12.99	290/11.42	53/2.09	200/7.87	8
100 / 4"	434/17.09	100/3.94	225/8.86	270/10.63	230/9.06	14/0.55	30/1.18	330/12.99	270/10.63	40/1.57	200/7.87	8
150 / 6"	658/25.91	130/5.12	320/2.60	410/16.14	370/14.57	18/0.71	40/1.57	505/19.88	440/17.32	78/3.07	400/15.75	12
200 / 8"	725/28.54	145/5.71	365/14.37	540/21.26	405/15.94	18/0.71	45/1.77	540/21.26	450/17.72	68/2.68	400/15.75	12

Table 2: Material selection

Design	A	B
Housing	Steel	Stainless Steel
Valve seat	Stainless Steel	Stainless Steel
Valve disc	Stainless Steel	Stainless Steel
Spring	Stainless Steel	Stainless Steel
Bushing	PTFE	PTFE
Hand wheel	Steel	Steel
Spindle sealing	PTFE	PTFE
Mounting flange	Steel	Stainless Steel

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Selection and Design

Together with the customer our engineers design and specify the valve for each specific application. The relevant plant specifications are taken into account when defining the required nominal sizes and connection types. Also the operating temperature and resulting special operating conditions may require special materials. The mounting flange material must be compatible with the tank material. If there are special requirements for the valve or operating parameters please contact us: If necessary we will arrange for special designs.

Necessary Data for Specification

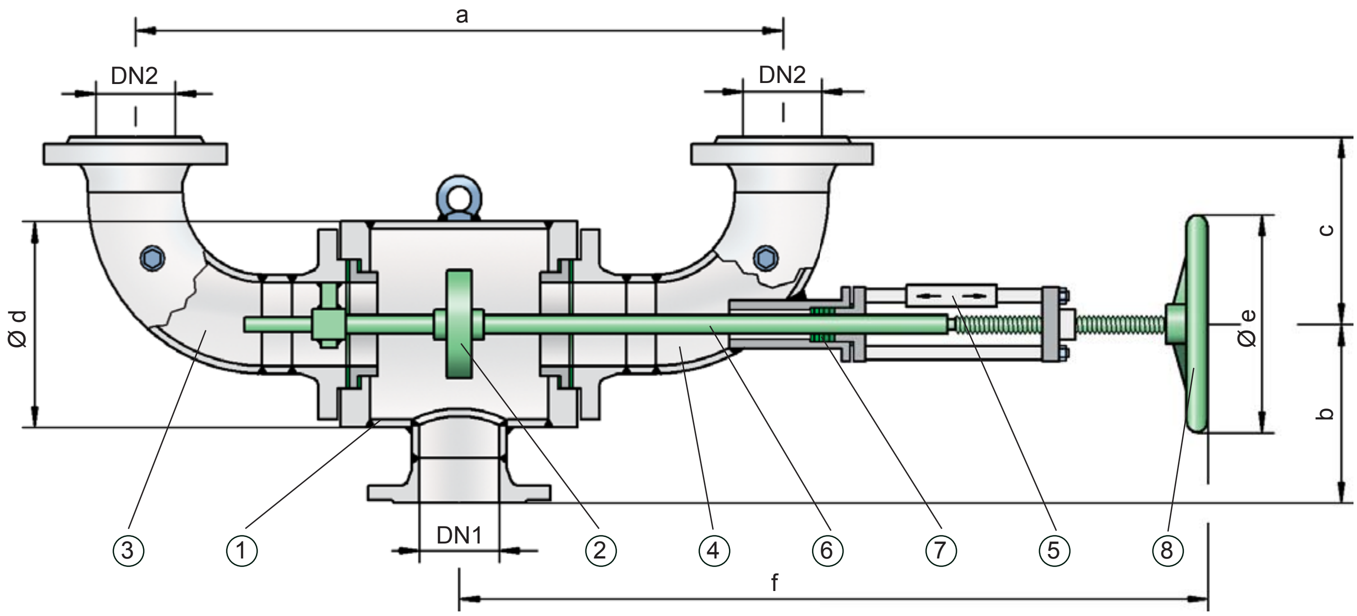
Stored medium

Tank height (m or ft)

Tank material

Connection diameter of drain pipe, DN (mm or inch)

PROTEGO® WV/T



Function and Description

PROTEGO® change-over valves type WV/T are mainly used together with other valves or safety devices (e.g. PROTEGO® flame arresters) on cryogenic storage tanks and on tanks in process plants of chemical, petrochemical and pharmaceutical industries. They increase the operating safety of the technical equipment to be protected because each valve or safety device can be checked, maintained or repaired without any service break-down.

The valves mainly consist of housing (1) with flange connections DN 1 and two lateral connection elbows (3, 4) with flange connections DN 2 and the valve disc (2). If necessary it is possible to displace and turn the connection elbows. The valve seats are replaceable. The valve disc (2) with metallic sealing surface is movable on the valve spindle (6). This ensures good adjustment to the valve seats even with high temperature differences. The sealing between valve disc and valve spindle is provided by an O-ring. The valve spindle is guided by bearing bushings; to the outside it is sealed by an adjustable packing (7).

The change-over valve allows the operator to block one valve or safety device at a time by operating the handwheel (8). In normal operation the valve disc (2) is in central position and the gas/liquid flows through the two connection elbows (3, 4). By turning the hand wheel (8) to the stop, one of the connection elbows (3 or 4) is blocked while the other one remains open. The actual position of the valve disc (2) can be identified from the position indicator (5) displayed on the valve spindle (6).

Due to their design and appropriately selected materials the valves are distinguished by their high functional safety and very good flow rates. All elements that affect the function are made out of stainless steel.

Because of the variable nozzle positions the design of the PROTEGO® change-over valves WV/T facilitates connection of valves or other safety devices both with angle or straightthrough connection without additional adaptors.

Positions of nozzles

I.

II.

III.

Change-over valves of type WV/T stand out by their simple design, easy handling, the option of quick replacement of components that effect the function and consequently by their excellent availability and operational reliability. The lapped metallic sealing surfaces ensure a high degree of tightness even in low temperature ranges.

These valves are not flame transmission proof and do not refer to the European Explosion Protection Directive 94/9/EC, even if installed in explosive atmosphere.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition.

Design Types and Specifications

Special devices in heatable design can be used under specific operating conditions:

- with crystallizing products or products which tend to form deposits that affect the function
- in use under extreme weather conditions in winter (frost), when product vapour might condensate in the undercooled valve, so ice bridges could develop, which could probably block the valve disc

Table 1: Dimensions — Dimensions in mm / inches

DN1	80 / 3"	100 / 4"	150 / 6"	200 / 8"	200 / 8"	250 / 10"
DN2	80 / 3"	100 / 4"	150 / 6"	150 / 6"	200 / 8"	250 / 10"
a	780 / 30.71	780 / 30.71	960 / 37.80	960 / 37.80	1130 / 46.12	1450 / 57.09
b	250 / 9.84	250 / 9.84	310 / 12.20	310 / 12.20	330 / 13.47	360 / 14.17
c *	303 / 11.93	205 / 8.07	285 / 11.22	285 / 11.22	367 / 14.98	450 / 17.72
d	273 / 10.75	273 / 10.75	324 / 12.76	324 / 12.76	355 / 14.49	457 / 17.99
e	250 / 9.84	250 / 9.84	250 / 9.84	250 / 9.84	400 / 16.33	400 / 15.75
f	905 / 35.63	905 / 35.63	1070 / 42.13	1070 / 42.13	1195 / 48.78	1515 / 59.65
f_{min}	810 / 31.89	810 / 31.89	950 / 37.40	950 / 37.40	1170 / 47.76	1360 / 53.54
f_{max}	995 / 39.17	995 / 39.17	1190 / 46.85	1190 / 46.85	1310 / 53.47	1695 / 66.73

* for connection flange DIN PN16 resp. from DN 200 DIN PN 10

Table 2: Material selection

Design	A	B
Housing and connection elbows	Steel	Stainless Steel
Valve disc	Hastelloy	Hastelloy
Packing	PTFE	PTFE
Spindle sealing	FPM	FPM
Handwheel	Steel	Steel

The connection flange material must be compatible to the material of the plant component. Special models of change-over valves are available for specific requirements.

Table 3: Flange connection type

EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN	other types upon request
ANSI 150 lbs RFSF	ANSI	

Selection and Design

Together with the customer our engineers design and specify the valve for the specific case. The relevant plant specification is taken into account when defining the required nominal sizes and connection types. In standard versions the maximum allowable service temperature is +200°C / 392°F under a maximum allowable operating pressure of 6 bar / 87 psi. The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, designs in special stainless steel quality should be selected.

Necessary Data for Specification

Stored medium

Service temperature (°C or °F)

Operating pressure (bar or psi)

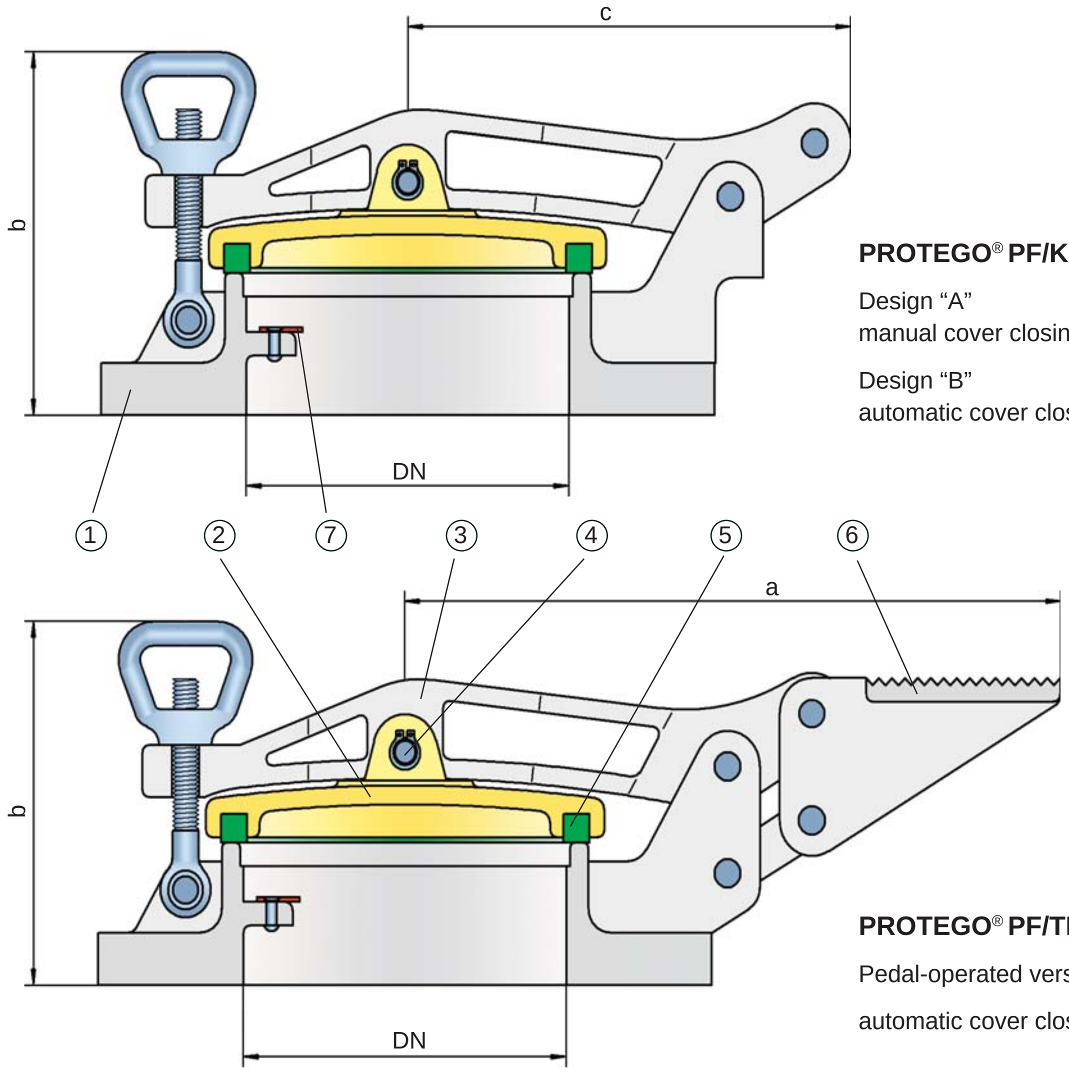
Tank material

Tank nozzle DN1 (mm or inches)

Tank nozzle DN2 (mm or inches)

Position of nozzle I, II or III

PROTEGO® PF/K, PF/TK



PROTEGO® PF/K

Design “A”
manual cover closing

Design “B”
automatic cover closing

PROTEGO® PF/TK

Pedal-operated version

automatic cover closing

Function and Description

PROTEGO® gauge hatches types PF/K and PF/TK are used as lockable gauge nozzles which are only opened for gauging or sampling. They can for instance be used in combination with PROTEGO® manual gauge devices, type H/P, or with the gauging and sampling devices, type VP/HK. Special designs with nozzles suitable for welding to the tank are also available.

The gauge hatches PF/K and PF/TK mainly consist of housing (1), cover (2) and bracket (3). The hinge bolt (4) connects the cover (2) with the bracket (3). Sealing between housing (1) and cover (2) is achieved through the gasket (5). As a standard the housing has stainless steel gauge marks (7).

In the pedal-operated version PF/TK the gauging nozzle pedal (6) is connected to both the housing (1) and the bracket (3). The cover (2) opens up to 80° and closes automatically.

As an option the version PF/K can be delivered with automatic cover closing.

When using non flame transmission proof gauge hatches PF/K and PF/TK, it is necessary to take specific safety precautions during the gauging and sampling of flammable or contaminated liquids in order to prevent external sources of ignition from flashing into the tank and gases from escaping.

For gauging or sampling open the cover of the gauge hatch. Covers that close automatically have to be kept open during the gauging and sampling procedure. After finishing the gauging and sampling close and lock the gauge hatch properly so that the tank is completely gas-tight.

Gauge hatches should not be opened during tank filling due to evapouration and emission. They should be locked and protected against unintended opening.

Design Types and Specifications

Depending on the intended use the following designs are available:

Gauge hatch with flange	**PF/K**	not closing automatically
Gauge hatch with flange	**PF/K**	closing automatically
Gauge hatch with flange and pedal	**PF/TK**	closing automatically

Table 1: Dimensions		Dimensions in mm / inches	
DN	100 / 4"	150 / 6"	200 / 8"
a	260 / 10.24	305 / 12.01	330 / 12.99
b	150 / 5.91	155 / 6.10	175 / 6.89
c	160 / 6.30	205 / 8.07	235 / 9.25

The nominal size depends on the dimensions of the gauging and sampling device.

Table 2: Material selection			
Design	A	B	C
Housing	Aluminium	Steel	Stainless Steel
Cover	Aluminium Stainless Steel*	Steel	Stainless Steel

The combination of steel and aluminium in explosive environments is prohibited due to ignition danger.
* only for PF/TK-100

Flange Connection Type

The flange connection is to EN 1092-1, Form A or DIN 2501, Form B, PN 16; DN 200 PN10. Optionally, the connecting flange can be made according to any international standard.

Necessary Data for Specification

Stored product

Tank material

Tank nozzle DN (mm or inches)

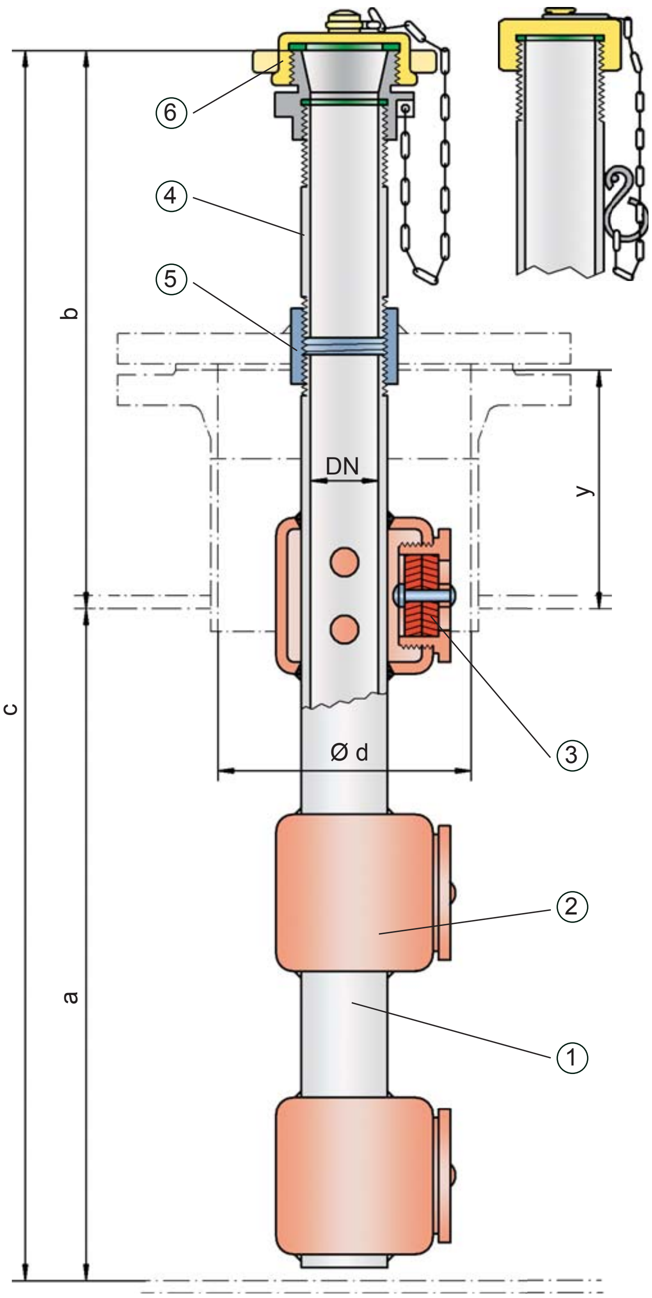
PROTEGO
for safety and environment

Gauging and Sampling Pipe

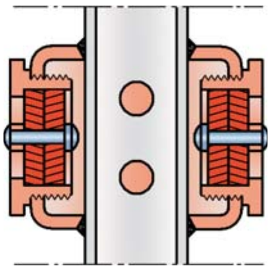
deflagration proof

PROTEGO® PU

Design A **Design B**



DN 40 / 1½" and 50 / 2"



Function and Description

PROTEGO® deflagration proof gauging and sampling pipes with integrated flame arresters type PU are used for explosion-proof gauging of tank contents and therefore protect the tank. The gauging and sampling pipes of type PU serve mainly for tank gauging in horizontal tanks using fuel dip stick or manual gauging device e.g. of type H/P by PROTEGO®. Furthermore it is possible to take samples with suitable sampling pots. DN 50 / 2" is suitable for deflagration proof sampling.

The gauging and sampling pipes of type PU consist of insert pipe (1) with flame arresters (2) – equipped with FLAMEFILTER® (3) – connecting pipe (4), bushing (5) to be welded in the nozzle cover and cap (6). The number of flame arresters depends on the length of the gauging pipe. Please note the maximum dimension of 1.2 m / 3.94 ft for measure b and 4.1 m / 13.45 ft for measure c.

Type PU ensures flame transmission protection against atmospheric deflagrations or in-line deflagrations of gas/air mixtures or product vapour/air mixtures of substances from explosion group IIA (MESG > 0.9 mm, NFPA group D) in all ranges of flammable concentrations up to a service temperature of +60°C / 140°F.

In normal operation the gauging pipe is closed with the cap. It is opened only for tank content gauging or sampling. If the escaping mixtures of product vapour/air ignite through external sources the flame arresters prevent flash back of atmospheric deflagrations or in-line deflagrations into the tank or the plant to be protected.

This device is type approved and tested according to the European Standard EN 12874 – Flame Arresters – as a protective system according to European Directive 94/9/EG – equipment intended for use in potentially explosiv atmospheres. EC-Type Examination Certificates issued by a European notified body are available. Examination certificates from other approval authorities are available on request.

Design Types and Specifications

Table 1: Dimensions	Dimensions in mm / inches
The measures a, b, y must be given with the order	
DN	minimum size d
25 / 1"	150 / 5.91
32 / 1¼"	150 / 5.91
40 / 1½"	200 / 7.87
50 / 2"	200 / 7.87

Table 2: Material selection		
Design	A	B
Gauging pipe	Steel	Stainless Steel
Weld-in bushing	Steel	Stainless Steel
Cap	Brass	Stainless Steel
FLAMEFILTER® cage	Steel	Stainless Steel
FLAMEFILTER®	Stainless Steel	Stainless Steel

In design A the connecting pipe is equipped with reducing piece and blind cap – each with integrated sealing and chain. In design B the connecting pipe is closed with a hexagon cap connected to the retainer ring via chain and wire hoop. On request a tank car coupling according to EN 14420-6 is available as closing cap for DN 50.

Table 3: Explosion group		
MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
> 0,90 mm	IIA	D

Special approvals upon request

Selection and Design

Select the required nominal sizes based on the gauging equipment size or nominal sizes of the connecting nozzle. Specify measures a, b and y for the definition of the quantity of integrated flame arresters.

The device must be sufficiently resistant to corrosion through product vapour/air mixtures. This applies mainly to the FLAMEFILTER®. If necessary, designs in special stainless steel quality should be selected.

Necessary Data for Specification

Storage product

Tank diameter (m or ft)

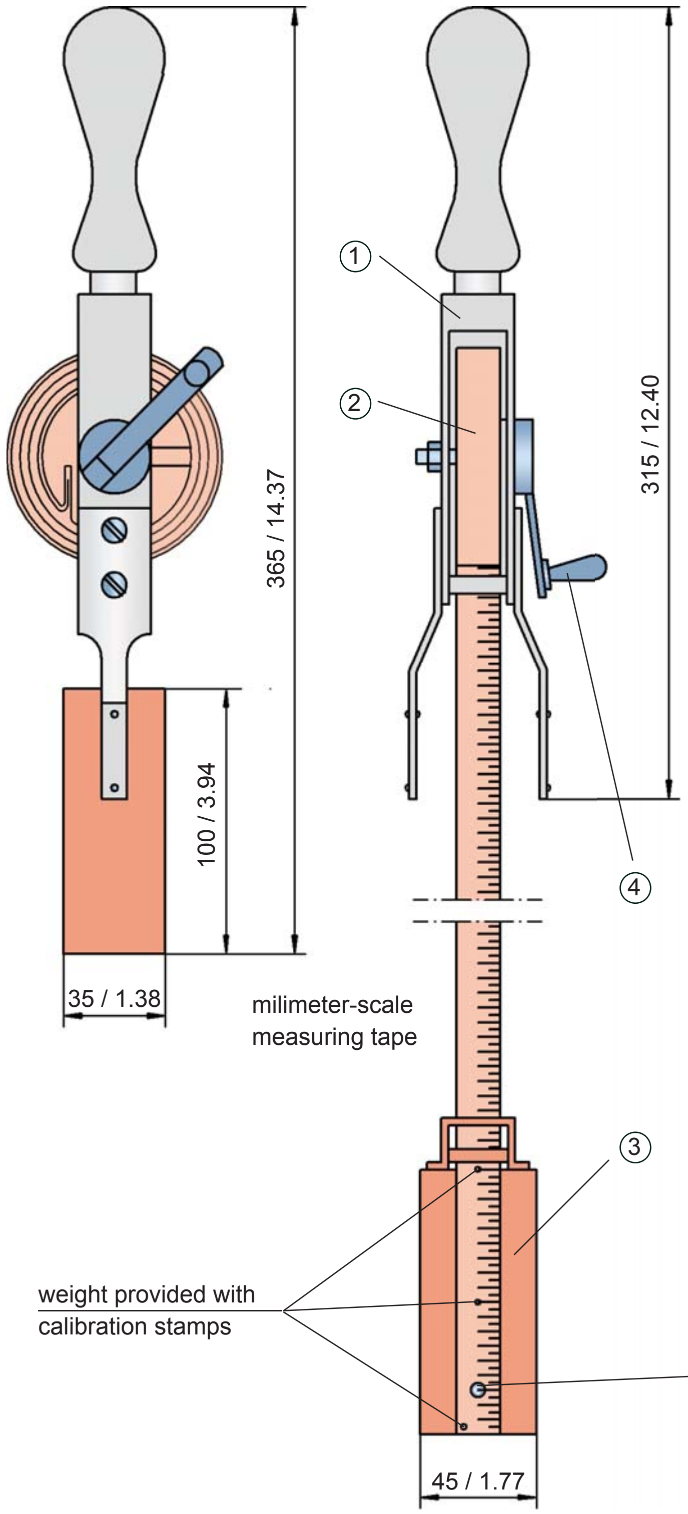
Tank nozzle height y (m or ft)

Length a (m or ft)

Length b (m or ft), max. 1.2 m / 3.94 ft

Please note the maximum length of 4.1 m / 13.45 ft for measure c

Gauging pipe diameter DN (mm or inches)



Function and Description

The PROTEGO® manual gauging device type H/P is used to gauge the liquid level in either horizontal or vertical above-ground tanks which are used to store either non-flammable or flammable liquids. It may also be used for storage tanks approved by customs.

The device consists of a light metal frame with handle (1), the tape roll for the stainless steel measuring tape (2) with lowering weight (3) of either stainless steel or brass and the crank handle (4).

The black anodized millimeter-scale measuring tape is calibrated by customs.

For gauging the measuring tape including lowering weight is placed through the open gauging nozzle into the gauging pipe and lowered slowly until it reaches the gauging plate. The operator will feel the lowering weight hit the plate by the load relieving in the crank handle. The tape is slowly wound up until the wet section of the measuring tape appears. Now the liquid level can be read. This method is both simple and inexpensive.

For sampling attach a sampling pot to the lowering weight. Alternatively a thermometer may be attached for temperature readings.

Necessary Data for Specification

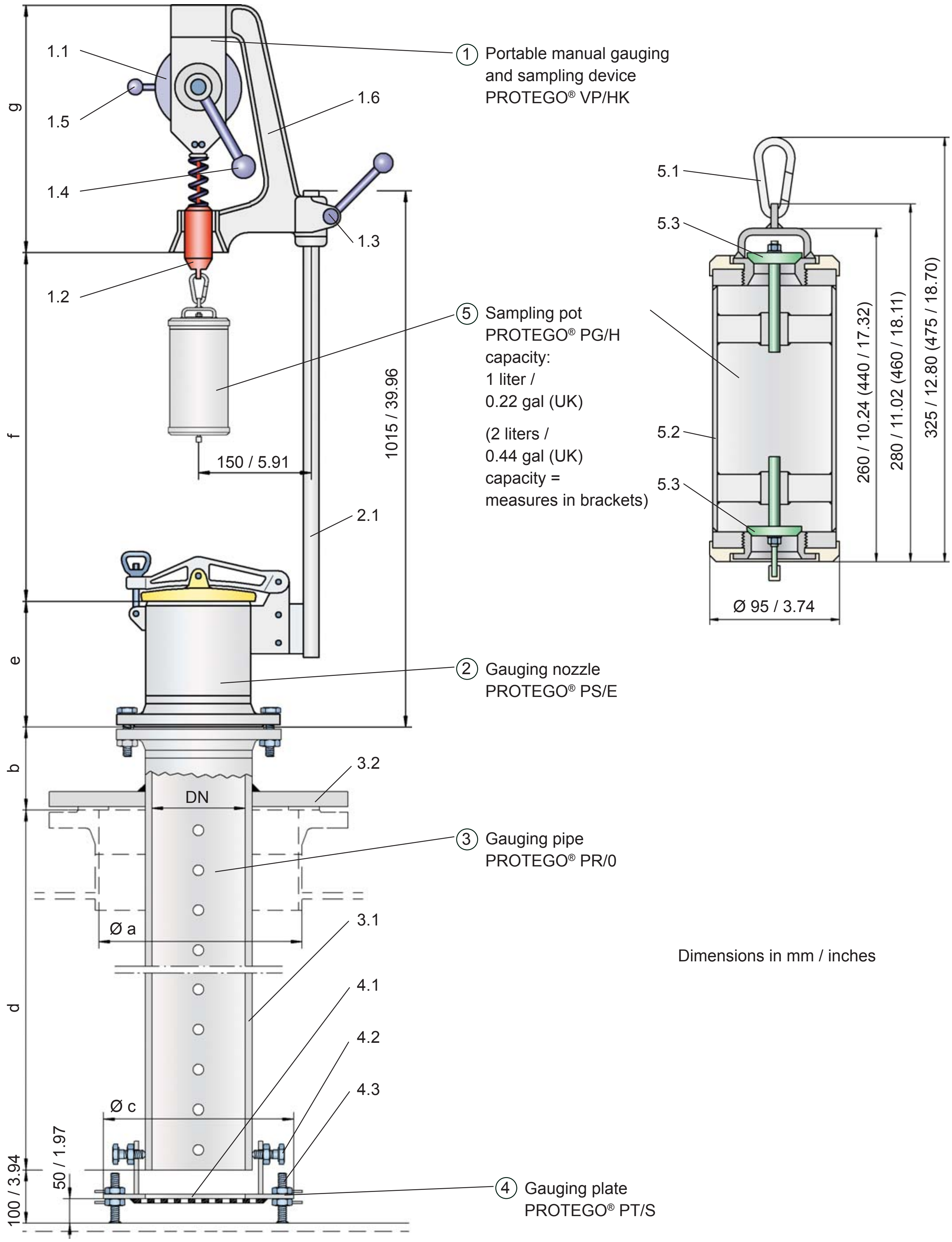
Specify the **tank dimensions** for the length of the measuring tape.

As a standard the measuring tape and lowering weight are made of stainless steel; optionally a brass lowering weight is available.

Dimensions in mm / inches

Notes:

PROTEGO® VP/HK with PS/E, PR/0, PT/S and PG/H



Dimensions in mm / inches

Function and Description

The PROTEGO® gauging and sampling assembly consists of the manual gauging and sampling device VP/HK (1), the gauging nozzle PS/E (2), the gauging pipe PR/0 (3), the gauge plate PT/S (4) and the sampling pot PG/H (5). This assembly serves for gauging (determination of liquid level) and sampling in horizontal or vertical aboveground tanks which store non-flammable or – if equipped appropriately – flammable liquids, the device may also be used for storage tanks approved by customs.

The portable manual gauging and sampling device VP/HK (1) consists of a light metal frame (1.6), a guide bushing for the stainless steel measuring tape (1.1) with lowering weight (1.2) made of stainless steel or brass, the locking clamp (1.3), crank handle (1.4) and tape brake (1.5). The millimeter-scale measuring tape – black anodized – is calibrated by customs.

The portable gauging and sampling device VP/HK is attached by a clamp to the fixing rod (2.1) of the gauging nozzle.

The gauging pipe PR/ 0 (3) is made of an insert- pipe with holes (3.1). The slip-on flange (3.2) is included in the shipment and has to be welded on during on-site assembly.

The gauging nozzle with hinged cover and clip-lock PS/E (2) is attached to the counter-flange of the gauging and sampling pipe. The locking nozzle has the fixing rod (2.1) attached for connecting the gauging and sampling device VP/HK.

The gauge plate PT/S (4) consists of the gauge plate (4.1), the guide screws (4.2) for the gauging pipe PR/0 (3) and the adjusting pins (4.3) to be welded to the tank bottom.

The sampling pot PG/H (5) consists of housing (5.2) with metallic sealing valve discs (5.3) and snap-hook (5.1). The sampling pot is made of stainless steel and has conductive plastic caps. Specify the required capacity (1 l or 2 l / 0.22 gal (UK) or 0.44 gal (UK).

For gauging release the tape brake (1.5) and use the crank handle (1.4) to put the measuring tape (1.1) including lowering weight through the open gauging nozzle (2) into the gauging pipe (3); lower it slowly until it hits the gauge plate. You will feel the lowering weight hit the table by the load relieving in the crank handle lever. Slowly wind up the tape until the wet section of the measuring tape appears on the edge of the guide bushing. Apply the brake and read the liquid level.

For sampling use the snap hook to attach the sampling pot PG/H (5) on the lowering weight (1.2) and lower it through the gauging pipe PR/0 (3) down into the tank. During lowering the valve discs (5.3) are open. They close when changing the direction on the crank handle (1.4) at the required dip depth and thus collect the trapped liquid. In this way samples of the liquid can be taken at any desired level. The required sampling level can be read from the measuring tape at the upper edge of the guide bushing; it is the dip depth. Then wind up the pot with the trapped liquid up to the spring stop, unhook it and empty it into a prepared container by lifting the spindle of the lower valve disc.

The entire assembly can be calibrated. In combination with the PROTEGO® gauging pipe PR/0 it is not flame transmission proof and therefore not suitable for flammable liquids. Flame-transmission-proof gauging or sampling is possible in combination with the PROTEGO® deflagration proof gauging pipe, type PU.

Design Types and Specifications

The assembly can be ordered either as complete unit or in individual devices. Please specify the nominal diameters DN for gauging nozzle and gauging pipe.

1) Manual gauging and sampling device VP/HK including

2) Gauging nozzle PS/E, DN (mm or inches)

3) Gauging pipe PR/0, DN (mm or inches)

4) Gauge plate PT/S

5) Sampling pot PG/H

Table 1: Dimensions — Dimensions in mm / inches

DN	a	b	c	e	f	g
100 / 4"	150 / 5.91	150 / 5.91	305 / 12.01	300 / 11.81	640 / 25.20	280 / 11.02
150 / 6"	200 / 7.87	150 / 5.91	375 / 14.76	300 / 11.81	640 / 25.20	280 / 11.02

Measure d must be given with the order

Table 2: Material selection

Measuring tape (1.1)	Stainless Steel
Lowering weight (1.2)	Stainless Steel
Crank handle (1.4)	Aluminium
Frame (1.6)	Aluminium
Gauging nozzle (2)	Steel or Stainless Steel
Gauging pipe (3)	Steel or Stainless Steel
Gauging plate (4)	Steel or Stainless Steel
Sampling pot (5)	Stainless Steel

Selection and Design

The materials of the tank and storage medium determine the basic materials to be selected.

Necessary Data for Specification

Tank material and stored product are required for selecting the materials of gauging nozzle, gauging pipe and gauge plate.

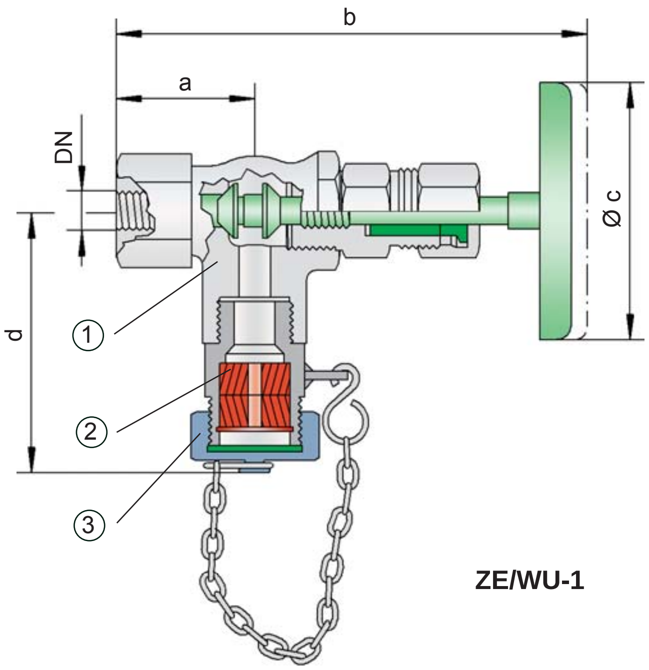
Specify the **tank dimensions** for the lengths of tape and gauging pipe PR/0.

Specify the required capacity for the sampling pot PG/H (1 l or 2 l / 0.22 gal (UK) or 0.44 gal (UK)).

Sampling and Air Bleed Valve

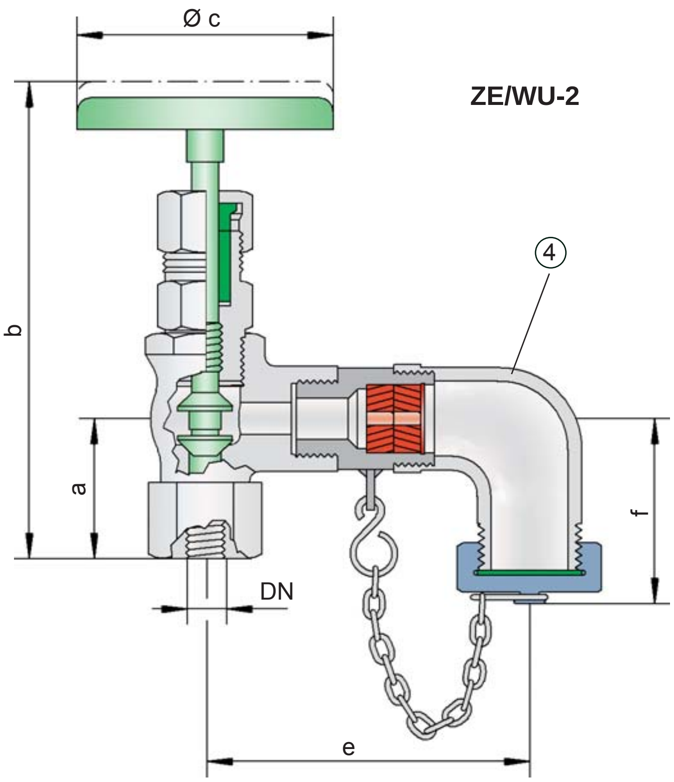
deflagration proof

PROTEGO® ZE/WU



ZE/WU-1

Standard design up to PN 25



ZE/WU-2

Function and Description

The PROTEGO® sampling and air bleed valve ZE/WU is used for flame transmission proof venting of pipelines and equipment that store or transport flammable liquids, and for taking liquid samples.

The valve incorporates an end-of-line deflagration flame arrester. If the gas/air mixtures or product vapour/air mixtures ignite during venting the valve prevents flash back into the system component to be protected.

The sampling and air bleed valve of type ZE/WU consists of the threaded angle valve (1) with hand wheel and female thread (pipe thread G½"up to G1") and the flame arrester (2) with cover (3).

Optionally the elbow fitting (4) is available as outlet for sampling. The flame arrester (2) consists of the flame arrester cage with FLAMEFILTER®.

The valve opens with the hand wheel. For sampling hold a suitable container ready.

Simple, sturdy design. Suitable for nearly all flammable liquids. Installation in any position.

Flame transmission protection is guaranteed against atmospheric deflagrations of gas/air mixtures or product vapour/air mixtures of explosion groups IIA, IIB1, IIB2, IIB3 and IIB (NFPA group D to C) up to a service temperature of +60°C / 140°F.

This device is Type Approved and tested according to the European Standard EN 12874 – Flame Arresters – as a protective system according to European Directive 94/9/EG – Equipment Intended for Use in Potentially Explosive Atmospheres. EC-Type Examination Certificates issued by a European Notified Body are available. Examination certificates from other approval authorities are available on request.

Designs and Specifications

There are two designs available:

Sampling and air bleed valve, standard design	**ZE/WU - 1**
Sampling and air bleed valve with elbow	**ZE/WU - 2**

Special designs are available on request.

Table 1: Dimensions Dimensions in mm / inches

DN	a	b	Ø c	d	e	f
15 / G½"	40 / 1.57	140 / 5.51	70 / 2.76	80 / 3.15	96 / 3.78	67 / 2.64
20 / G¾"	50 / 1.97	165 / 6.50	85 / 3.35	80 / 3.15	89 / 3.50	67 / 2.64
25 / G1"	65 / 2.56	200 / 7.87	100 / 3.94	95 / 3.74	104 / 4.09	67 / 2.64

Table 2: Explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
≥ 0,50 mm	IIB	C

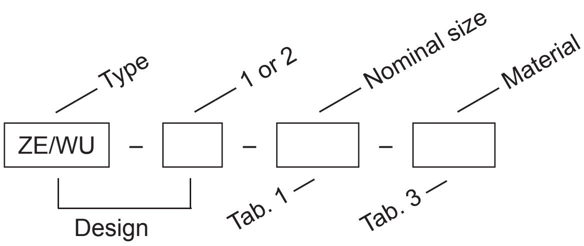
Table 3: Material selection

Design	A	B
Threaded angle valve	Steel	Stainless Steel
Elbow	Stainless Steel	Stainless Steel
Cover	Stainless Steel	Stainless Steel
FLAMEFILTER®	Stainless Steel	Stainless Steel

The valve must be sufficiently resistant to corrosion through the gas/air mixtures or product vapor/air mixtures. This applies mainly to the FLAMEFILTER®.

Table 4: Type of connection

Pipe thread DIN ISO 228 T1	DIN



Order example

ZE/WU	–	1	–	¾"	–	B

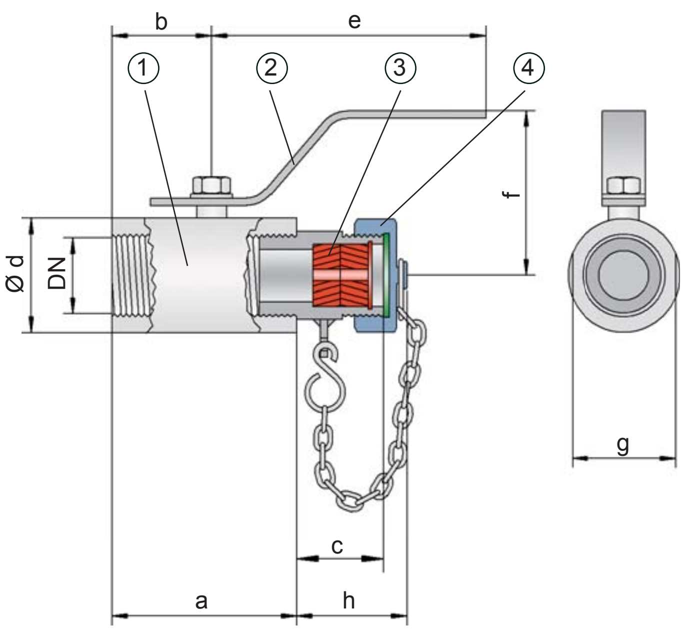
Materials and chemical resistance:
Technical information upon request

Condensate Drain Valve

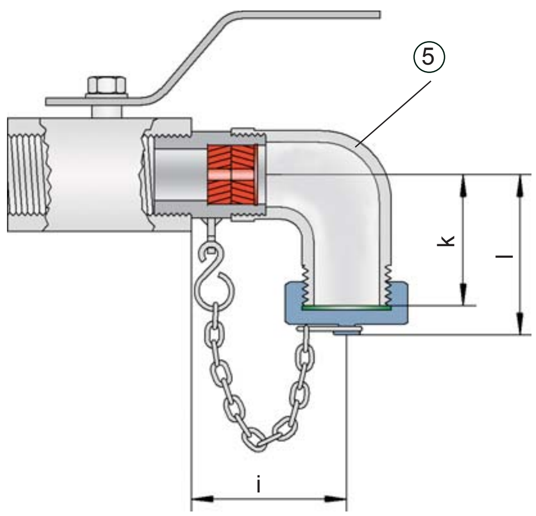
deflagration proof

PROTEGO® ZE/TK

ZE/TK-1



ZE/TK-2



Function and Description

The PROTEGO® condensate drain valve type ZE/TK is used for flame transmission proof condensate drainage on valves or parts of the plant such as tanks, pipelines, etc., where flammable liquids may condensate and therefore flammable product vapour/air mixtures could develop. Furthermore the drain valves can be used for the venting of tanks, parts of plants and lines that store or transport flammable liquids. The drain valve incorporates an end-of-line deflagration flame arrester.

The condensate drain valve type ZE/TK consists of the ball valve (1) with hand lever (2) and female thread (pipe thread G½" up to G1") and the flame arrester (3) with cover (4).

Optionally the elbow fitting (5) is available as outlet.

The flame arrester (3) consists of flame arrester cage and FLAMEFILTER®.

The ball valve is opened with the hand lever. When draining condensate hold a suitable container ready. When draining flammable and/or toxic products observe the appropriate safety provisions.

Simple, sturdy design. Suitable for nearly all flammable liquids. The condensate drain valve may be installed in any position.

Flame transmission protection is guaranteed against atmospheric deflagrations of product vapour/air mixtures of explosion groups IIA, IIB1, IIB2, IIB3 and IIB (NFPA groups D to C) up to a service temperature of +60°C / 140°F.

This device is Type Approved and tested according to the European Standard EN 12874 – Flame Arresters – as a protective system according to European Directive 94/9/EG – Equipment Intended for Use in Potentially Explosive Atmospheres. EC-Type Examination Certificates issued by a European Notified Body are available. Examination certificates from other approval authorities are available on request.

Designs and Specifications

There are two designs available:

Condensate drain valve, standard design	**ZE/TK - 1**
Condensate drain valve with elbow	**ZE/TK - 2**

Special designs are available on request.

Table 1: Dimensions — Dimensions in mm / inches

DN	a	b	c	Ø d	e	f	g	h	i	k	l
15 / G½"	60 / 2.36	30 / 1.18	33 / 1.30	32 / 1.26	110 / 4.33	55 / 2.17	27 / 1.06	45 / 1.77	54 / 2.13	38 / 1.50	67 / 2.64
20 / G¾"	65 / 2.56	35 / 1.38	33 / 1.30	38 / 1.50	110 / 4.33	60 / 2.36	34 / 1.34	45 / 1.77	54 / 2.13	38 / 1.50	67 / 2.64
25 / G1"	73 / 2.87	40 / 1.57	33 / 1.30	45 / 1.77	110 / 4.33	65 / 2.56	41 / 1.61	45 / 1.77	54 / 2.13	38 / 1.50	67 / 2.64

Table 2: Explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
≥ 0,50 mm	IIB	C

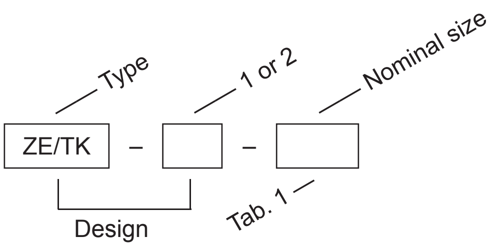
Table 3: Material

Ball valve	Stainless Steel
Elbow	Stainless Steel
Cover	Stainless Steel
FLAMEFILTER®	Stainless Steel

The valves must be sufficiently resistant to corrosion through the gas/air mixtures or product vapour/air mixtures. This applies mainly to the FLAMEFILTER®. If necessary, designs in special stainless steel quality should be selected.

Table 4: Type of connection

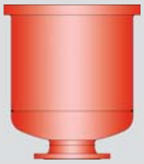
Pipe thread DIN ISO 228 T1	DIN



Order example

ZE/TK – 1 – ¾"

Materials and chemical resistance:
Technical information upon request

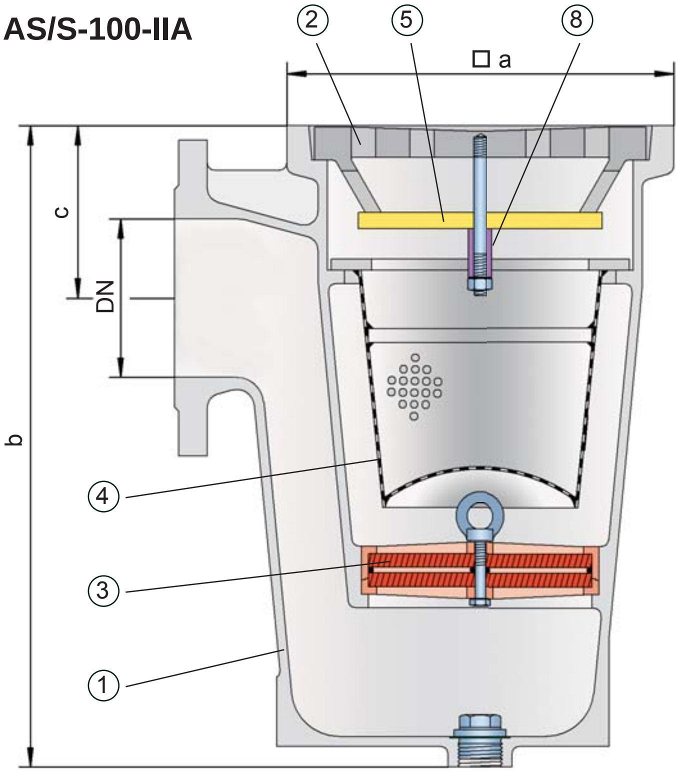


Floor Drain

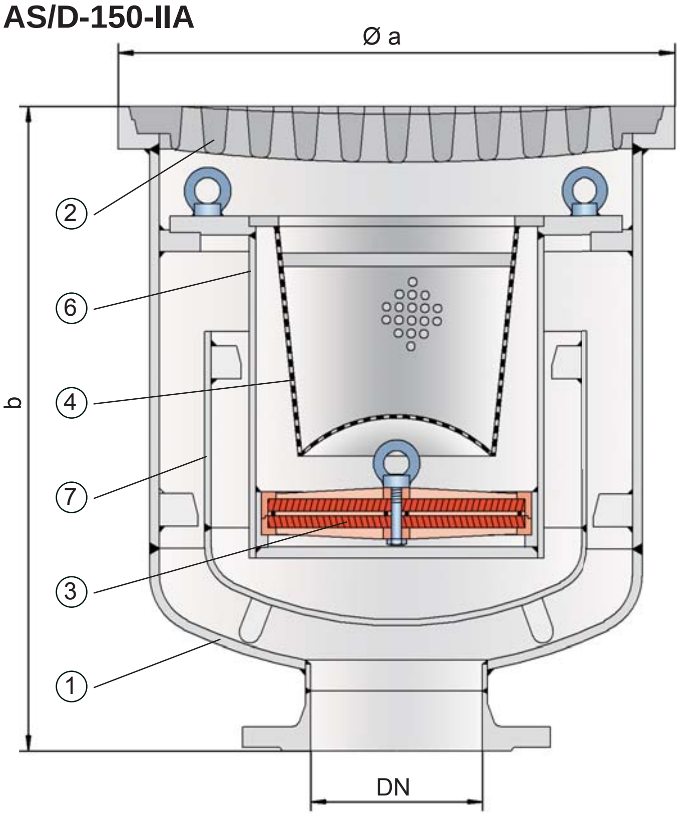
deflagration proof

PROTEGO® AS/S and AS/D

AS/S-100-IIA



AS/D-150-IIA



Function and Description

PROTEGO® deflagration proof floor drains of types PROTEGO® AS/S or PROTEGO® AS/D provide flame transmission proof protection of surface water pipelines or pipelines which lead to underground storage tanks of flammable and non-flammable liquids; they can for instance protect rainwater lines during fueling on airfields or helicopter bases. Deflagration proof floor drains of types PROTEGO® AS/S or PROTEGO® AS/D prevent gas/air mixtures or product vapour/air mixtures of flammable liquids that may ingress into the drainage system from exploding within the pipelines if there is risk of ignition by any external sources.

If an ignition occurs the flame arrester prevents flashback of atmospheric deflagrations into the drainage pipeline to be protected.

PROTEGO® floor drains of types AS/S and AS/D consist of housing (1), inlet grid (2), PROTEGO® flame arrester unit (3), strainer basket (4) and – if applicable – the self-extinguishing element (5) (only type AS/S). Type PROTEGO® AS/D is equipped with an insert (6) for the PROTEGO® flame arrester unit (3) and the immersion insert (7). The PROTEGO® flame arrester unit consists of flame arrester cage, FLAMEFILTER® and spacers. The housing has a flange connection to DIN 2501 or any other international standard. The types differ by their flange connections: PROTEGO® AS/S with lateral and PROTEGO® AS/D vertical flange connection. In type PROTEGO® AS/S the housing has an additional lock screw with gasket. The removable strainer basket protects the PROTEGO® flame arrester unit against clogging up and facilitates maintenance.

In the event of damage when critical quantities of flammable liquids or gas mixtures continue to enter the drainage system for a longer period, there is a hazard of stabilized burning on the surface of the flame arrester in addition to the deflagration hazard. Therefore the bottom drain PROTEGO® AS/S can be optionally equipped **with** a self-extinguishing element. In case of fire the self-extinguishing element closes the drain and prevents explosions in the drainage system: Stabilized burning above the FLAMEFILTER® burns down a fusible link (8) and a cover plate closes the strainer basket. The flame extinguishes and the flowing of flammable gases is stopped.

Deflagration proof floor drains of types PROTEGO® AS/S or PROTEGO® AS/D **without** self-extinguishing elements are always used when the operating conditions require drainage even in case of fire.

According to the type examination certificates the PROTEGO® AS/S-100-IIA or PROTEGO® AS/D-150-IIA **without** self-extinguishing elements are flame-transmission-proof against atmospheric deflagrations and short time burning of gas/air mixtures or product vapour/air mixtures of explosion group IIA (NEC group D) up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi – for limited use with flammable liquids of explosion group IIA (NEC group D) with flashpoints ≥ 35°C / 95°F and ignition temperature ≥ 220°C / 428°F.

So, floor drains with and without self-extinguishing elements may be used for typical aviation fuels such as Jet-A and Kerosene.

The deflagration proof special designs of PROTEGO® type AS/D-80-IIA without self-extinguishing element and PROTEGO® type AS/S-100-IIA including self-extinguishing element can be used for all flammable liquids of explosion group IIA (NEC group D) up to an operating temperature of +60°C / 140°F and an absolute operating pressure up to 1.1 bar / 15.9 psi.

These devices are Type Approved and tested according to the European Standard EN 12874 – Flame Arresters – as a protective system according to European Directive 94/9/EG – Equipment Intended for Use in Potentially Explosive Atmospheres. EC-Type Examination Certificates issued by an European Notified Body are available. Examination certificates from other approval authorities are available on request.

Design Types and Specifications

There are three designs available:

AS/S lateral flange connection,
without self-extinguishing element

AS/S lateral flange connection,
with self-extinguishing element

AS/D vertical flange connection,
without self-extinguishing element

Selection and Design

Regarding flow resistance the floor drain is designed for surface water contaminated with liquid hydrocarbons (gasoline, avgas – specific density max. 1.2 kg/m^3 / 0.075 lb/cu ft). Any other requirements must be specified in your order.

The devices must be sufficiently resistant to corrosion through the gas/air mixtures or product vapour/air mixtures. This applies mainly to the FLAMEFILTER®. If necessary, designs in special material quality should be selected.

The clearance has to be taken into account when dimensioning the ground excavations for vertical or horizontal pipelines

Necessary Data for Specification

Possible composition of flammable liquids

Design

Table 1: Dimensions for AS/S

DN	100 / 4“
a	285 / 11.22
b	465 / 18.31
c	125 / 4.92

Dimensions in mm / inches

Table 2: Dimensions for AS/D

DN	80 / 3“	150 / 6“
a	300 / 11.81	516 / 20.31
b (PN16)	270 / 10.63	550 / 21.65
b (ANSI 150 lbs)	290 / 11.42	

Dimensions in mm / inches

Table 3: Explosion group

MESG	Expl. Gr. (IEC/CEN)	Gas Group (NEC/NFPA)
> 0,90 mm	IIA	D

Table 4: Material

Housing	Steel
Strainer basket	Stainless Steel
Flame arrester cage	Stainless Steel
FLAMEFILTER®	Stainless Steel

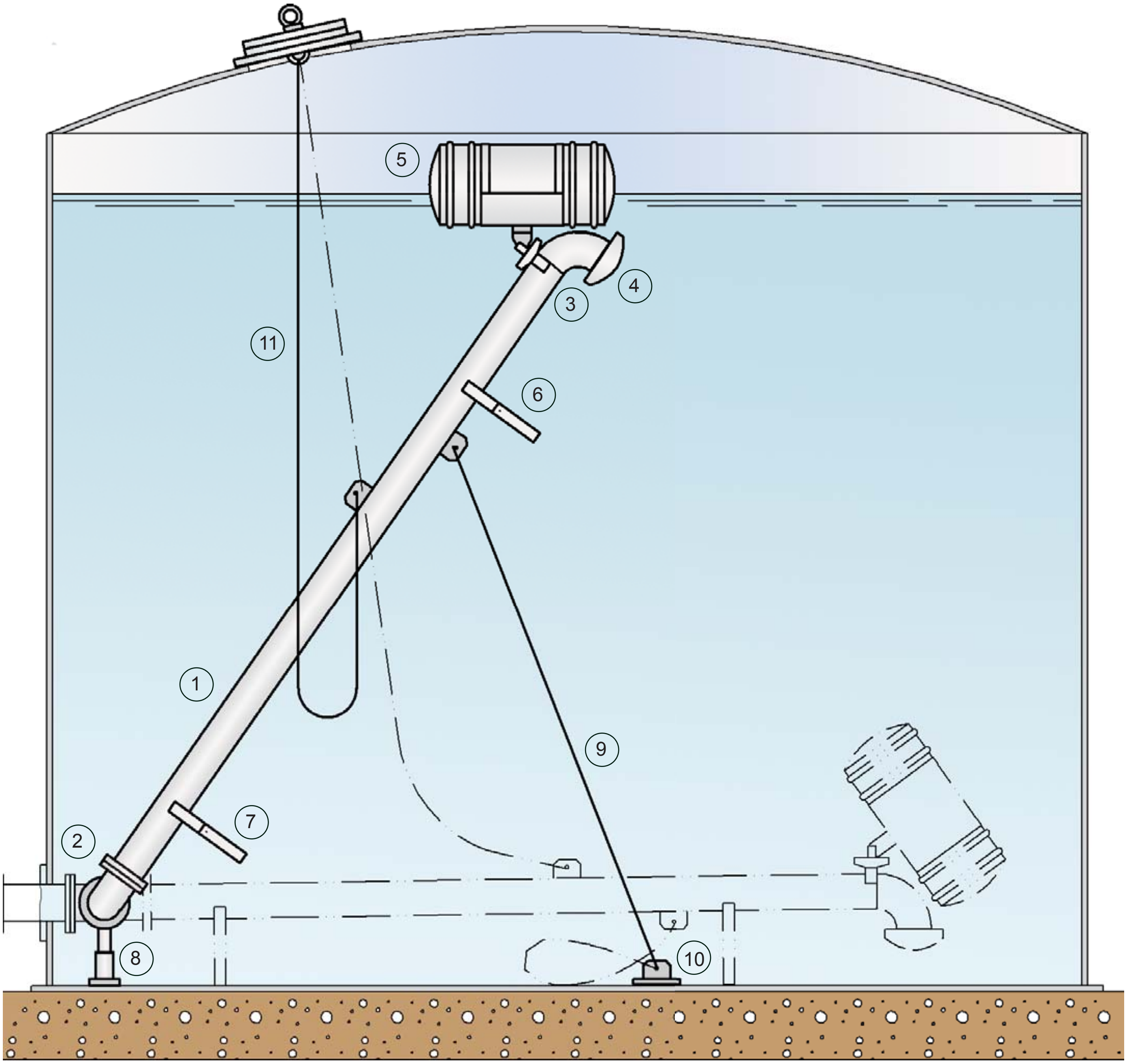
Special materials upon request

Table 5: Flange connection type

AS/S: EN 1092-1, Form B1 or DIN 2501, Form C, PN 16, DN 100	EN or DIN
AS/D: EN 1092-1, Form B1 or DIN 2501, Form C, PN 16	EN or DIN

Flange connections according to other international standards on request.

PROTEGO
for safety and environment



Function and Description

The PROTEGO® swing pipe unit SA/S is a float-operated suction system for fixed roof tanks, fixed roof tanks with internal floating roof, floating roof tanks or horizontal tanks. It can be used with tanks that store either non-flammable or flammable liquids. The product is removed below the liquid level. Such systems are used when it is important that the stored medium is *always* removed from below the liquid level. Full emptying of the tank is not possible using the swing pipe unit.

The swing pipe system mainly consists of the swivel joint (2) including the hinge foot (8) to be welded to the tank bottom, the swing pipe (1) with inlet elbow (3) and one or more floats (5). The scope of supply also includes the lift stop rope (9) (including the necessary clamps, thimbles and shackles) of which one end is mounted to the swing pipe (1) and the other end to the lug on the bottom (10) which has to be welded to the tank bottom.

The hinge foot is connected to the swivel joint. The hinge foot height is adjusted on site and has to be welded to the tank bottom. The hinge foot is in the standard scope of supply.

If necessary the swing pipe with inlet elbow can be supplied in flanged sections. On request we can weld the swing pipe sections together on site.

The swing pipe has a fixed foot (6) and if necessary also a loose foot (7). The inlet elbow (3) of the swing pipe has a suction inlet cup (4) attached to it.

For emergency operation of the swing pipe it is possible to supply the system with an emergency rope (11) which can be attached to the swing pipe and a hand hole.

The system works automatically, so the float (5) keeps the swing pipe (1) in the appropriate position with the tank's filling level. The inlet elbow (3) and the suction inlet cup (4) move in accordance with the liquid level. When using the unit in floating roof tanks or fixed roof tanks with floating roof the float is guided below the tank roof.

The float (5) design is calculated using the specific density of the stored liquid.

If pumps are connected to the suction system they have to be dry-running proof for the case that there is no more liquid to be removed.

The lift stop cable (9) is used to keep the system on maximum shear angles, while the fixed foot (6) or loose foot (7) – if any – supports the system at the minimum level or with an empty tank.

The system design incorporates many years of experience in the mineral oil industry. The float is arranged in such a way that no air can be sucked in at any of the pipe positions. Additionally the swing pipe has drill holes in order to minimize the buoyancy of the swing pipe (this prevents the rising liquid level from closing the pipe opening and allows the swing pipe to work as a float itself. It also prevents the inlet elbow from rising above the liquid level which otherwise could occur with the larger sizes).

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition and therefore can be installed in explosive atmosphere.

Design Types and Specifications

The swing pipe system described here is the standard design. Special designs are available on request such as those for horizontal tanks. Please do not hesitate to ask for further information.

Customized solutions can be developed together with the customer for special applications.

Double-bend swing pipe systems have to be used in tanks with small diameters and large heights.

Material

The pipes are seamless or welded pipes of aluminium, steel or stainless steel. The floats are made of stainless steel, the ball bearing joints are of steel or stainless steel.

Flange Connection Type

The standard tank flange connection is to EN 1092-1 or DIN 2501, PN 16. Optionally, the tank connecting flange can be made according to any international standard.

Selection and Design

The appropriate dimensions of the individual parts and most importantly the system's hinge length are determined depending on the required nominal diameter and the container or tank dimensions. The design has to take into account other tank equipment such as heating pipes, etc.. Openings of sufficient size have to be provided for installing the system into the tank. The minimum manhole diameters are specified for approval in the system drawing.

Materials for swing pipe and swivel joints are selected according to the tank specification, and the operator and manufacturer are involved in the selection. The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, designs in special material quality should be selected.

Necessary Data for Specification

Tank diameter (m or ft)

Tank height (m or ft)

Maximum filling level (m or ft)

Tank nozzle height (m or ft)

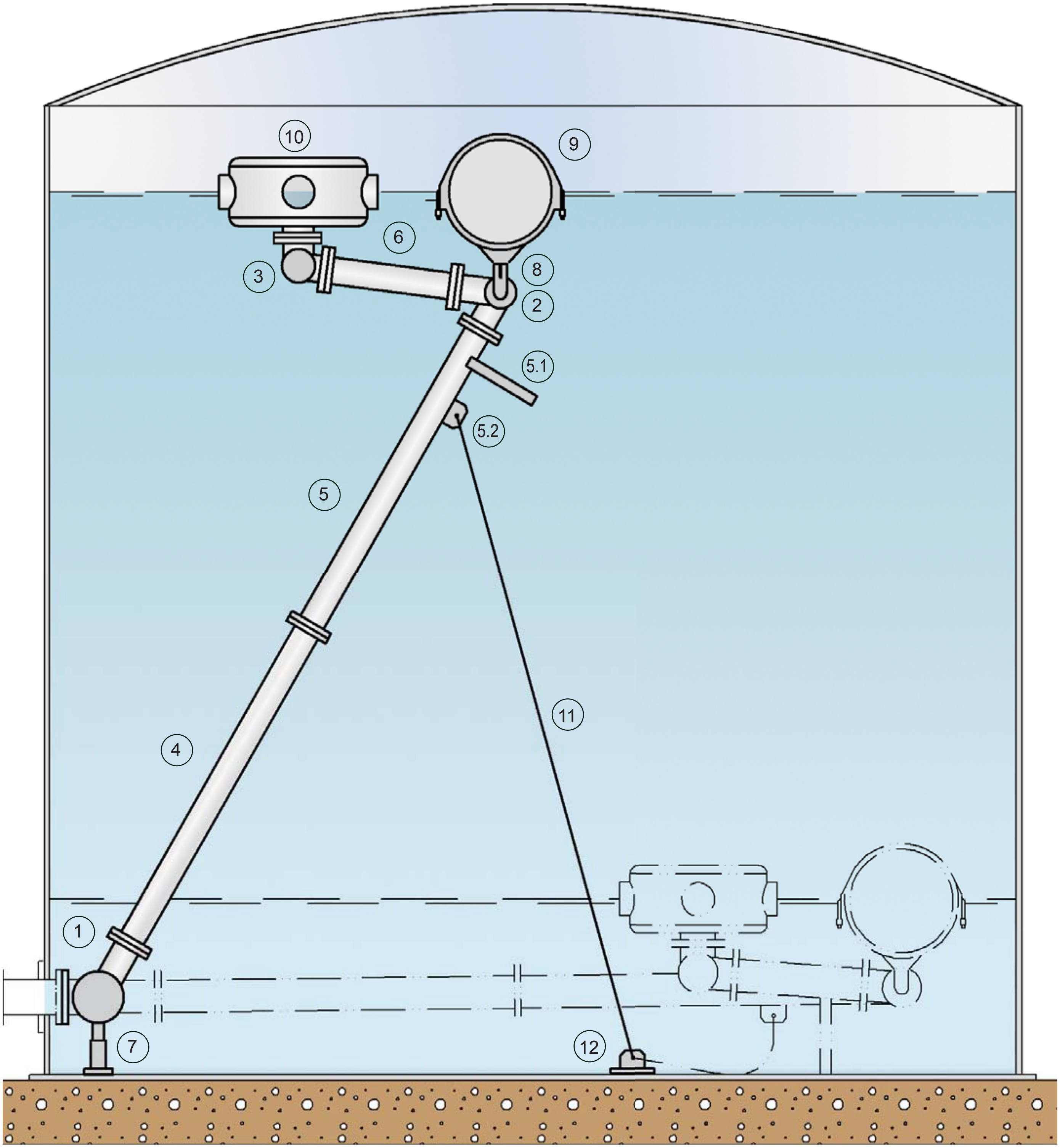
Nominal diameter (DN in mm or inches)

Stored product

Other tank equipment

Float-Operated Skimming System

PROTEGO® SA/DA



Function and Description

The PROTEGO® skimming system type SA/DA is a float-operated swing pipe unit with a separate skimmer. It can be used in fixed roof tanks that store either non-flammable or flammable liquids and where it is necessary to separate liquids with different density. The design guarantees that a product of lower specific weight can be sucked off the surface of a medium with higher specific weight. Systems of this type are used as oil skimming systems in slop tanks in order to suck the oil residues off the surface of the tank contents.

The skimming system mainly consists of the swivel joint (1), the hinge foot (7) afterwards to be welded to the tank bottom, the swing pipes (4, 5) with support (5.1), the swivel joint (2) with float crossbar (8) including fixing equipment, the lifting float(s) (9), the two upper swing pipes (6), the upper swivel joint (3) and the skimming float (10). The scope of supply also includes the lift stop rope (11) one end of which is attached to the lug of swing pipe (5.2) and the other end to the lug (12) that has to be welded to the tank bottom on site.

The system works automatically, so the lifting float(s) (9) keep(s) the swing pipes (4, 5) in an optimum position with the tank's filling level. As a result the skimming float (10) is always kept at the same pre-adjusted operating depth regardless of the liquid level.

The specific densities of the actual liquids are used for calculating the design of both the lifting floats (9) and the skimming float (10).

If pumps are connected to the skimming system they have to be dry-running proof in case there are no product residues on the liquid surface to be skimmed.

The lift stop rope (11) limits the system to the maximum filling level or keeps it on maximum shear angles while the support (5.1) holds the system at the required minimum level with an empty tank.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition and can be installed in explosive attmosphere.

The system design incorporates many years of experience in the mineral oil industry.

When using systems of this type please note that in particular with thin skim layers the actual storage medium may be sucked off to a certain extent.

Design Types and Specifications

The skimming system described here is the standard design. Special designs are available on request. Please do not hesitate to ask for further information.

Customized solutions can be developed together with the customer for special applications.

Double-bend skimming systems have to be used in tanks with small diameters and large heights.

Material

In general the pipes with nominal sizes DN 80 / 3", DN 100 / 4" or DN 150 / 6" are made of stainless steel. Float and ball bearing joints are made of stainless steel. Different materials are available.

Flange Connection Type

The standard tank flange connection is to EN 1092-1 or DIN 2501, PN 16. Optionally, the tank connecting flange can be made according to any international standard.

Selection and Design

The appropriate dimensions of the individual elements and most importantly the system's hinge length are determined depending on the required nominal diameter and the specified container or tank dimensions. The design has to take into account other tank equipment such as heating pipes, etc.. Openings of sufficient size have to be provided for installing the system into the tank.

Materials for swing pipe and swivel joints are selected according to the tank specification, and the operator and manufacturer are involved in the selection.

The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, designs in special material quality should be selected.

Necessary Data for Specification

Tank diameter (m or ft)

Tank height (m or ft)

Maximum filling level (m or ft)

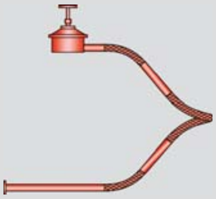
Tank nozzle height (m or ft)

Tank nozzle length (m or ft)

Nominal diameter (DN in mm or inches)

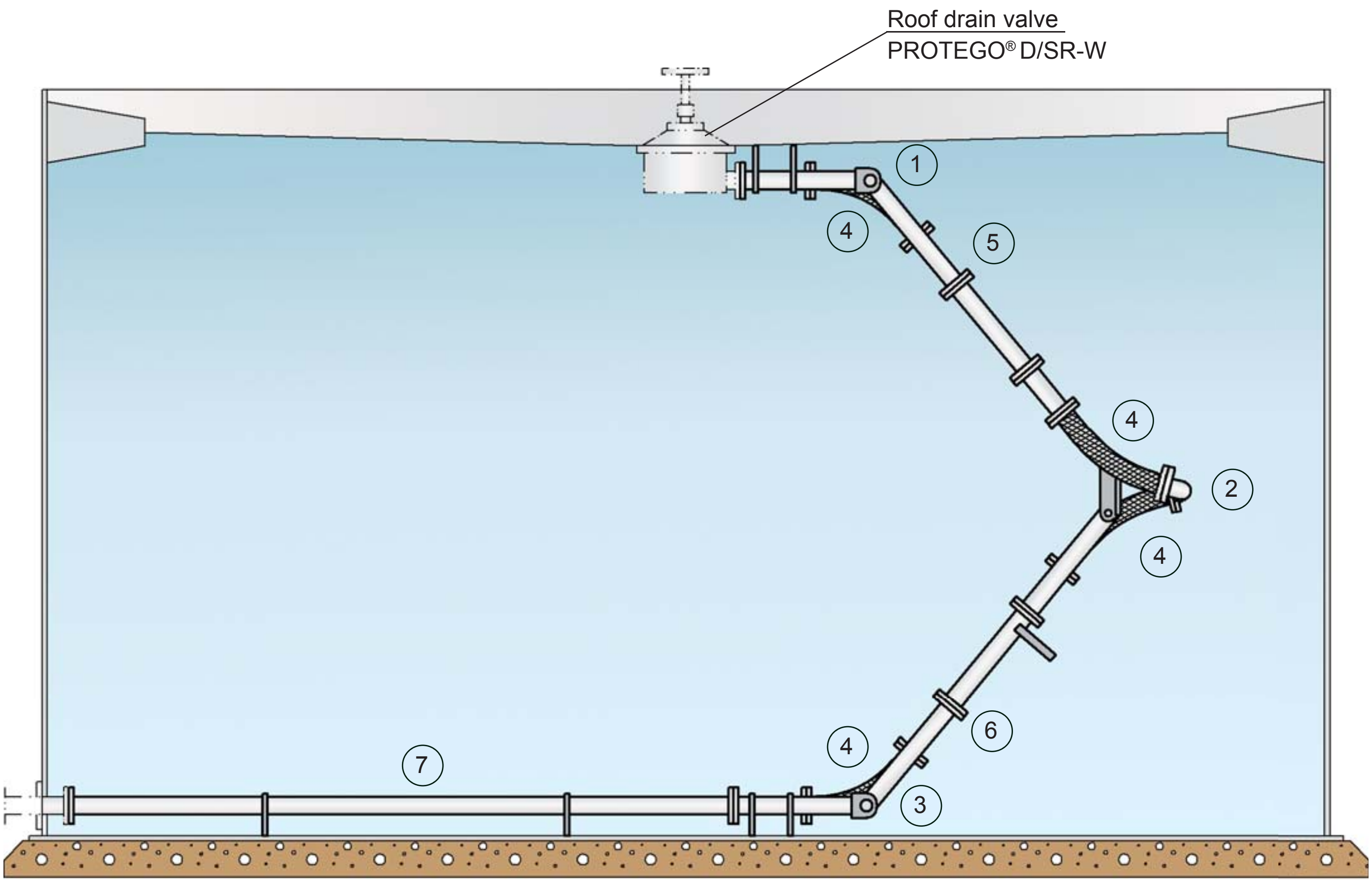
Specific weight of the storage medium

Specific weight of the surface medium



Floating Roof Drainage System with Metal Hose Joints

PROTEGO® SE/K



Function and Description

The PROTEGO® floating roof drainage system type SE/K is produced as a so-called single scissor-pipe-system. It is used in floating roof tanks or fixed roof tanks with an internal floating roof and can be used for tanks storing either non-flammable or flammable liquids in regions where the temperatures may fall below freezing point. The floating roof drainage system drains the rainwater off the floating roofs of storage tanks into the sewer pipe, and ensure that the rainwater is not contaminated by the stored product.

The floating roof drainage system SE/K mainly consists of the joints (roof joint (1), intermediate joint (2) and bottom joint (3)), the metal hoses (4), the upper scissor pipe (5) and the lower scissor pipe (6). The so-called hinge length of the system is determined by the lift of the floating roof.

The upper scissor pipe is connected to the roof drain valve which is not part of standard scope of supply. When the roof drain valve is open the system works automatically, in other words the rainwater on the floating roof can flow through the scissor pipes into the connected drain pipe.

Compared to conventional systems this special PROTEGO® design excels by its perfect operational safety; it is completely self-contained and pressure-proof and none of its sealing elements is under dynamic stress.

Contrary to conventional systems the drain water doesn't pass through the actual joints: Therefore sealing elements such as gaskets, O-rings, etc., which may leak, are not required.

General forces which may occur due to dislocation or uneven movements of the floating roof are absorbed through design and arrangement of the joints and thus have no negative effects on the system.

The lower scissor pipe (6) has a fixed foot including supporting feet. The metal hoses (4) are special corrugated hoses with additional protective braiding.

The roof joint (1) and the bottom joint (3) consist of components that are connected with the metal hose (4). The intermediate joint (2) consists of the intermediate joint bearing and the intermediate joint components that are connected with the metal hoses (4).

All developing forces are absorbed by this robust bearing which is surrounded and therefore lubricated by the storage medium. As a consequence the flexible elements such as metal hoses (4) are completely pressure-balanced and under bending stress only within the permitted limits.

The bottom pipe (7) – if part of the supply – is equipped with adjustable supporting feet.

The operating safety of this special design is optimal because it is a self-contained pressure-proof system where the sealing elements are not under dynamic stress.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition and can be installed in explosive atmosphere.

Design Types and Specifications

Customized solutions that vary from the standard design are available on request.

Valves such as PROTEGO® D/SR or D/SR-W can be used as roof drain valves. For information about the function and description of these roof drain valves please refer to the separate data sheets.

Material Selection

The scissor pipes DN 80 / 3" or DN 100 / 4" are seamless steel pipes, the metal hoses are made from stainless steel. As an option the scissor pipes may be made from stainless steel.

Flange Connection Type

The standard tank flange connection is to EN 1092-1 or DIN 2501, PN 16. Optionally, the tank connecting flange can be made according to any international standard.

Selection and Design

The PROTEGO® floating roof drainage system type SE/K is available in nominal sizes DN 80 / 3" and DN 100 / 4".

The appropriate dimensions of the individual elements and most importantly the system's hinge length are determined depending on the required nominal size and the tank dimensions.

The design has to take into account other tank equipment such as heating pipes, etc. Openings of sufficient size (e.g. manhole) have to be provided for installing the system into the tank. The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, models in special material quality should be selected.

Necessary Data for Specification

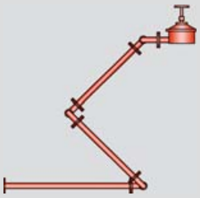
Tank diameter (m or ft)

Tank height (m or ft)

Tank nozzle height (m or ft)

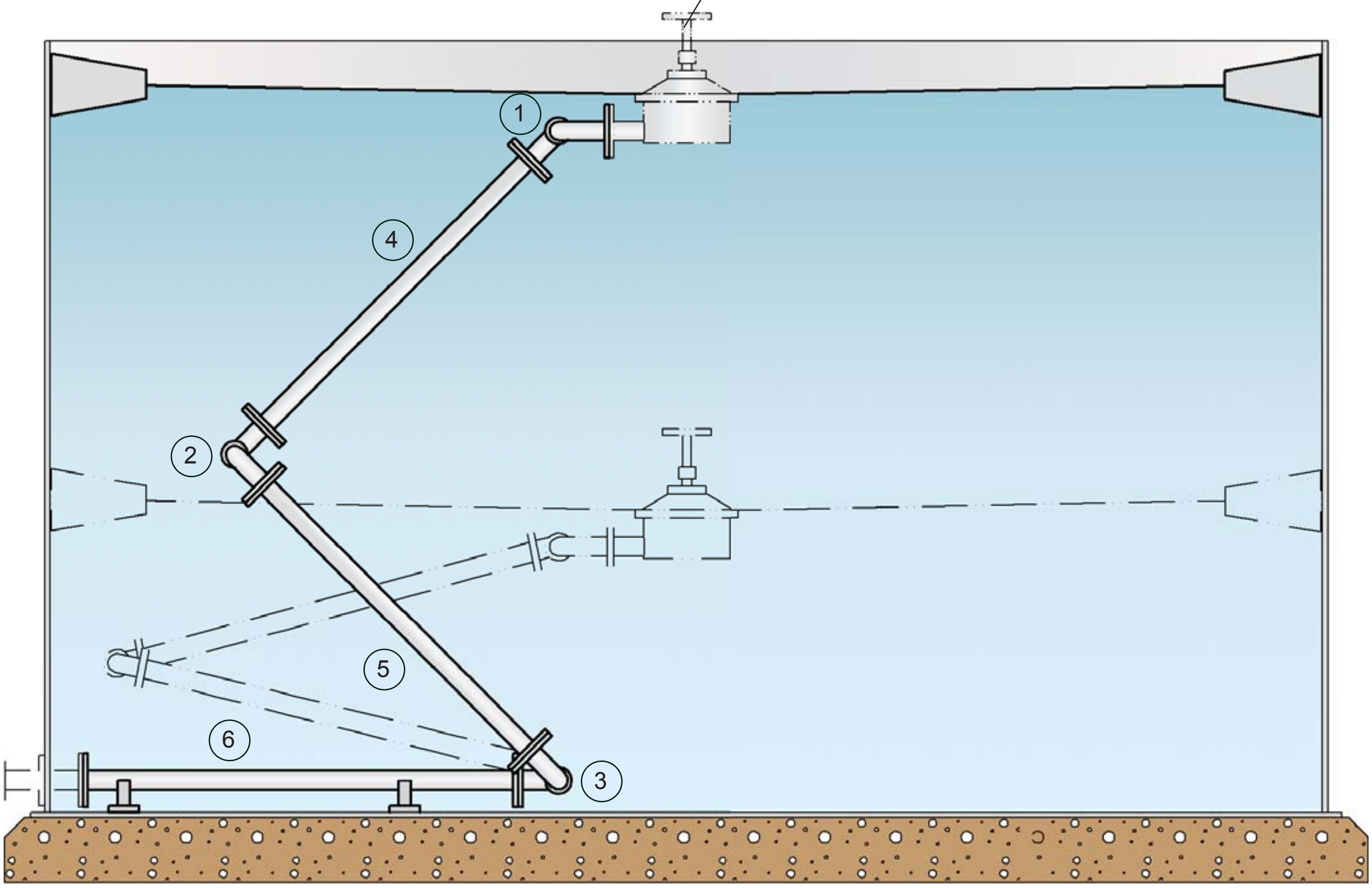
Highest and lowest level of the floating roof (m or ft)

Other tank equipments



Floating Roof Drainage System with Ball Bearing Joints

PROTEGO® SE/CK



Function and Description

The PROTEGO® floating roof drainage system type SE/CK is produced as a so-called single scissor-pipe-system. It is used in floating roof tanks or fixed roof tanks with an internal floating roof and can be used for tanks storing either non-flammable or flammable liquids. The floating roof drainage system drains the rainwater off the floating roofs of storage tanks into the sewer pipe, and ensures that the rainwater is not contaminated by the stored product.

The floating roof drainage system mainly consists of the joints (roof joint (1), intermediate joint (2) and bottom joint (3)), the upper scissor pipe (4) and the lower scissor pipe (5). The so-called hinge length of the system is determined by the lift of the floating roof.

The upper scissor pipe is connected to the roof drain valve which is not part of the standard scope of supply. When the roof drain valve is open the system works automatically, in other words the rainwater on the floating roof can flow through the scissor pipes into the connected drain pipe.

Usually the joints are ball bearing joints with an appropriate sealing.

General forces which may occur due to dislocation or uneven movements of the floating roof are absorbed through design and arrangement of the joints and thus have no negative effects on the system.

The lower scissor pipe can be equipped with a support foot.

The bottom pipe (6) – if part of the supply – can be optionally equipped with adjustable supporting feet.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition.

Design Types and Specifications

Customized solutions that vary from the standard design are available on request.

Valves such as PROTEGO® D/SR or D/SR-W can be used as roof drain valves. For information about the function and description of these roof drain valves please refer to the separate data sheets.

Material Selection

The scissor pipes of the matching nominal sizes DN 80 / 3", DN 100 / 4" or DN 150 / 6" are made of seamless steel pipes. The ball bearing joints are made of steel. Different materials are available on request.

Flange Connection Type

The standard tank flange connection is to EN 1092-1 or DIN 2501, PN 16. Optionally, the tank connecting flange can be made according to any international standard.

Selection and Design

Floating roof drainage systems of type SE/CK are available in the nominal sizes DN 80 / 3", DN 100 / 4" and DN 150 / 6".

The appropriate dimensions of the individual elements and most importantly the system's hinge length are determined depending on the required nominal size and the tank dimensions.

The design has to take into account other tank equipment such as heating pipes, etc. Openings of sufficient size (e.g. manhole) have to be provided for installing the system into the tank. The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, models in special material quality should be selected.

Necessary Data for Specification

Tank diameter (m or ft)

Tank height (m or ft)

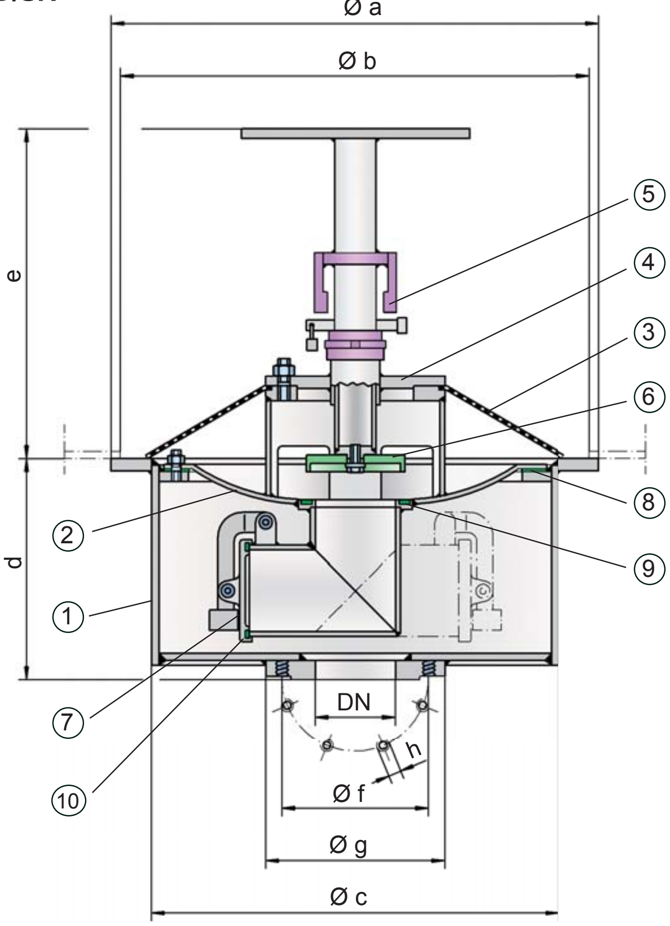
Tank nozzle height (m or ft)

Highest and lowest level of the floating roof (m or ft)

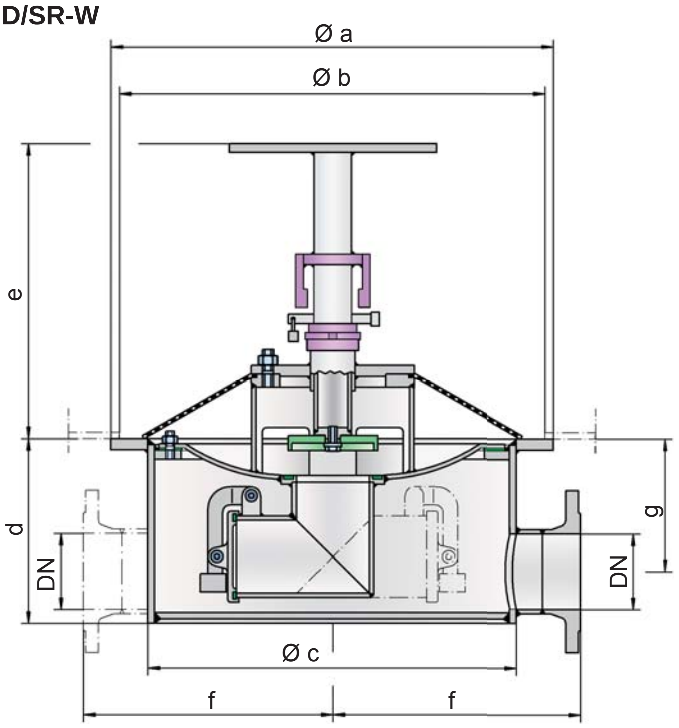
Other tank equipments

PROTEGO® D/SR and D/SR-W

D/SR



D/SR-W



Function and Description

PROTEGO® roof drain valves types D/SR or D/SR-W function like collection bowls and pass the collected rain water from the floating roof through the scissor pipes of a PROTEGO® floating roof drainage system, such as SE/K or SE/CK, into the sewage water system. They are used on floating roof tanks, which store flammable and non-flammable liquids. Under normal operating conditions the roof drain valve is open. If there is danger of freezing the valve is closed manually by the quick-action shut-off (5). In case of any leakage the non-return valve (7) prevents the stored medium from escaping to the floating roof. The inlet screen (3) protects the roof drain valve from any dirt, leaves or nesting birds.

Sealing between valve housing (1) and valve housing insert (2) is achieved through a flat gasket (8). The valve housing insert (2) and the non-return valve (7) contain the gaskets (9, 10).

To close the inlet press the valve disc (6) with the quick-action shut-off (5) down on the gasket (9) in the valve housing insert. In the standard design the insert (2) is equipped with a non-return valve (check valve) (7). The non-return valve (7) is hinged. The inlet screen (3) is fastened between the cover (4) and the valve housing insert (2).

These valves are not flame-transmission-proof and therefore they are not subject to the European Explosion Protection Directive 94/9/EG when used in explosive atmosphere.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition and can be installed in explosive atmosphere.

Design Types and Specifications

Two designs are available:

Roof drain valve with vertical connection	**D/SR**
Roof drain valve with horizontal connection	**D/SR-W**

As an option a special design of the roof drain valve is available with protection against unauthorized closing of the quick-action shut-off.

Table 1: Dimensions D/SR		Dimensions in mm / inches	
DN	80 / 2"	100 / 4"	150 / 6"
a	550 / 21.65	600 / 23.62	650 / 25.59
b	490 / 19.29	540 / 21.26	590 / 23.23
c	450 / 17.72	500 / 19.69	550 / 21.65
d	240 / 9.45	280 / 11.02	330 / 12.99
e	490 / 19.29	490 / 19.29	490 / 19.29
f	160 / 6.3	180 / 7.09	240 / 9.45
g	200 / 7.87	220 / 8.66	285 / 11.22
h	M 16	M 16	M 20

Table 2: Dimensions D/SR-W		Dimensions in mm / inches	
DN	80 / 2"	100 / 4"	150 / 6"
a	550 / 21.65	600 / 23.62	650 / 25.59
b	490 / 19.29	540 / 21.26	590 / 23.23
c	450 / 17.72	500 / 19.69	550 / 21.65
d	205 / 8.07	250 / 9.84	320 / 12.6
e	490 / 19.29	490 / 19.29	490 / 19.29
f	285 / 11.22	320 / 12.6	350 / 13.78
g	150 / 5.91	180 / 7.09	225 / 8.86

Table 3: Material selection		
Design	A	B
Housing	Steel	Stainless Steel
Non-return valve	Red Brass	Red Brass
Valve disc	Steel	Stainless Steel
Quick-action shut-off	Steel	Stainless Steel
Gasket	PUR	PUR

The device must have sufficient corrosion resistance with regard to the stored media. If necessary, designs in special stainless steel quality should be selected.

Flange Connection Type

In type D/SR the housing bottom is equipped with a loose flange with threaded holes according to EN 1092-1 or DIN DIN 2501, PN 16, or optionally according to any other international standard.

In the standard model of type D/SR-W the housing is equipped with a lateral flange connection to EN 1092-1 or DIN 2501, PN 16. Optionally, the connecting flanges can be made according to any other international standard. An additional flange connection is available as extra.

Selection and Design

The specified maximum rainfall is required to determine the required nominal size. Alternatively, the connection size of the roof drain valve corresponds with the existing nominal dimension of the floating roof drainage system. Roof drain valves with 2 or 3 non-return valves are available as an option.

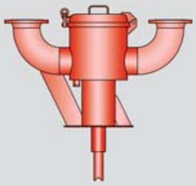
Necessary Data for Specification

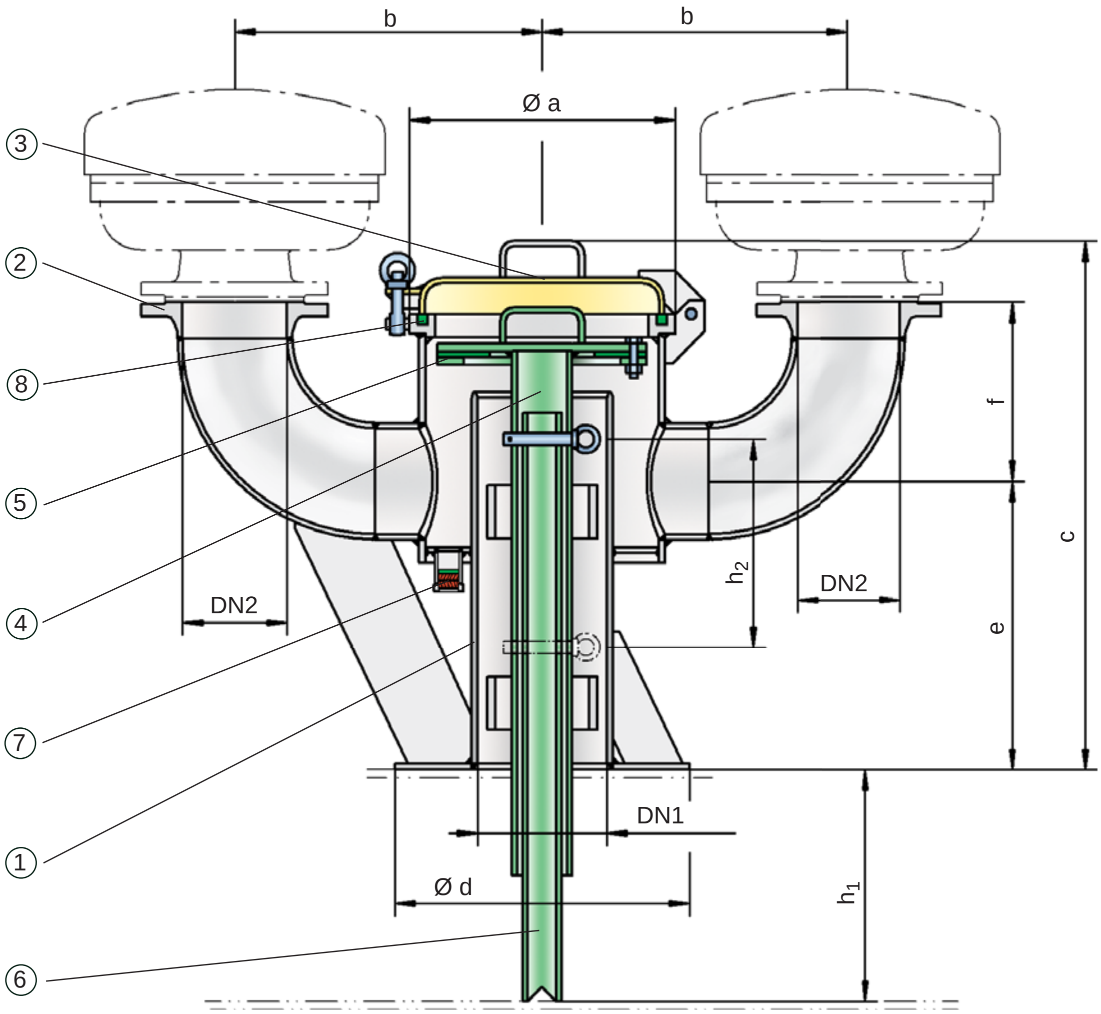
Maximum rainfall to be drained off (m^3/h or CFH)

Material of floating roof

Connection size of the floating roof drainage system DN (mm or inches)

Design of floating roof drainage system





Function and Description

PROTEGO® lift-actuated vent valves type AL/DK provide automatic venting of floating roof tanks storing non-flammable and flammable liquids, when the floating roof is lowered on its supports and the tank is either finally drained or refilled. When the floating roof is in its lowest position the valve is forced to open through lift actuation and this prevents unacceptable vacuum during final draining or unacceptable pressure during refilling.

All elements that affect the function are built in stainless steel. Therefore due to its design and choice of materials the valve has high functional safety and very good flow rates.

In general the device consists of a housing (1) with sheet-metal panel to be welded on the floating roof, two connection nozzles (2) for installation of vent caps with or without integrated flame arresters, cover (3), lift (4) including valve pallet (5), lift pipe (6) and the condensate drain valve (7) which can be flame transmission proof if required.

A flat gasket is attached to the valve pallet (5) and provides sealing. The cover (3) is sealed by a sealing cord (8).

As the lowest position of the floating roof varies for operation and assembly specify the dimensions h_1 and h_2:

h_1: Distance between lower edge of sheet-metal panel (or mounting flange) and tank bottom in lowest position of floating roof (operating position with empty tank).

h_2: Distance between floating roof in lifted assembly position and height of floating roof in fully lowered operating position, if tank is empty.

The appropriate distance is applied to the lift length in order to guarantee that the valve opens properly in the lowest position of the floating roof in either the operating or tank maintenance position.

If the floating roof supports are changed from operating position to maintenance position the lift has to be lengthened as well. This is done with an adjustable locking pin that is secured with a bolt.

The valve is not flame transmission proof.

A hazard analysis (which considers the material selection and function of the device) shows that the device doesn't have any potential sources of ignition. Therefore they are not subject to the European Explosion Protection Directive 94/9/EG when used in explosive atmosphere.

As a rule lift-actuated vent valves of type AL/DK are combined with PROTEGO® vent caps type BE/HR which are deflagration proof and resistant against endurance burning. This ensures flame transmission proof ventilation. If resistance against endurance burning is not required the valves can alternatively be combined with PROTEGO® deflagration proof devices type LH/AD.

Designs and Specifications

Table 1: Dimensions			Dimensions in mm / inches
DN1	200 / 8"	200 / 8"	200 / 8"
DN2	100 / 4"	150 / 6"	200 / 8"
a	350 / 13.78	350 / 13.78	350 / 13.78
b	465 /18.31	465 / 18.31	515 / 20.28
c	870 / 34.25	870 / 34.25	870 / 34.25
d	450 / 17.72	450 / 17.72	450 / 17.72
e	385 / 15.16	385 / 15.16	415 / 16.34
f	420 / 16.54	285 / 11.22	370 / 14.57

As a standard the connection on the floating roof (DN1) is DN 200.

Flange connections for vent caps vary from DN 100 to DN 200 depending on the calculated venting requirement of the space below the lowered floating roof.

Table 2: Material	
Housing	Steel
Valve guide	Stainless Steel
Gasket	FPM

The device must have sufficient corrosion resistance with regard to the media to be stored or transported. If necessary, models in special material quality should be selected.

Table 3: Flange connection type DN2	
EN 1092-1, Form B1 or DIN 2501, Form C, PN 16; from DN 200 PN 10	EN or DIN
ANSI 150 lbs RFSF	ANSI

Flange connections according to other international standards on request.

Selection and Design

The number of lift-actuated vent valves as well as quantity and nominal size DN2 of the vent caps on the lift-actuated vent valve are determined by the calculated venting volume flow, which in turn depends on the tank dimensions. Specify **tank height** and **tank diameter** as well as the **support height** of the floating roof (lowest operating position and lowest maintenance position, measures $\mathbf{h_1}$ and $\mathbf{h_2}$) for calculating the required venting rate for sizing. The required quantity and nominal size DN2 will then be defined based on the calculated flow rate from the thermal venting and pump rate in lowest floating roof position (Nm³/h or CFH) or based on the maximum acceptable tank pressure p_T (mbar / In W.C.) according to the flow capacity charts. Special models are available on request.

Flow rates and pressure losses of vent caps BE/HR or LH/AD have additionally to be taken into account according to the appropriate charts in the relevant data sheets or operating instructions.

Necessary Data for Specification

Stored product

Tank diameter (m or ft)

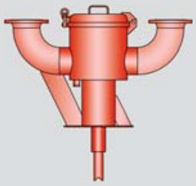
Tank height (m or ft)

Support height h_1 (operating position with empty tank)

Support height h_2 (lifted assembly position)

Maximum allowable tank pressure p_T (mbar or In W.C.)

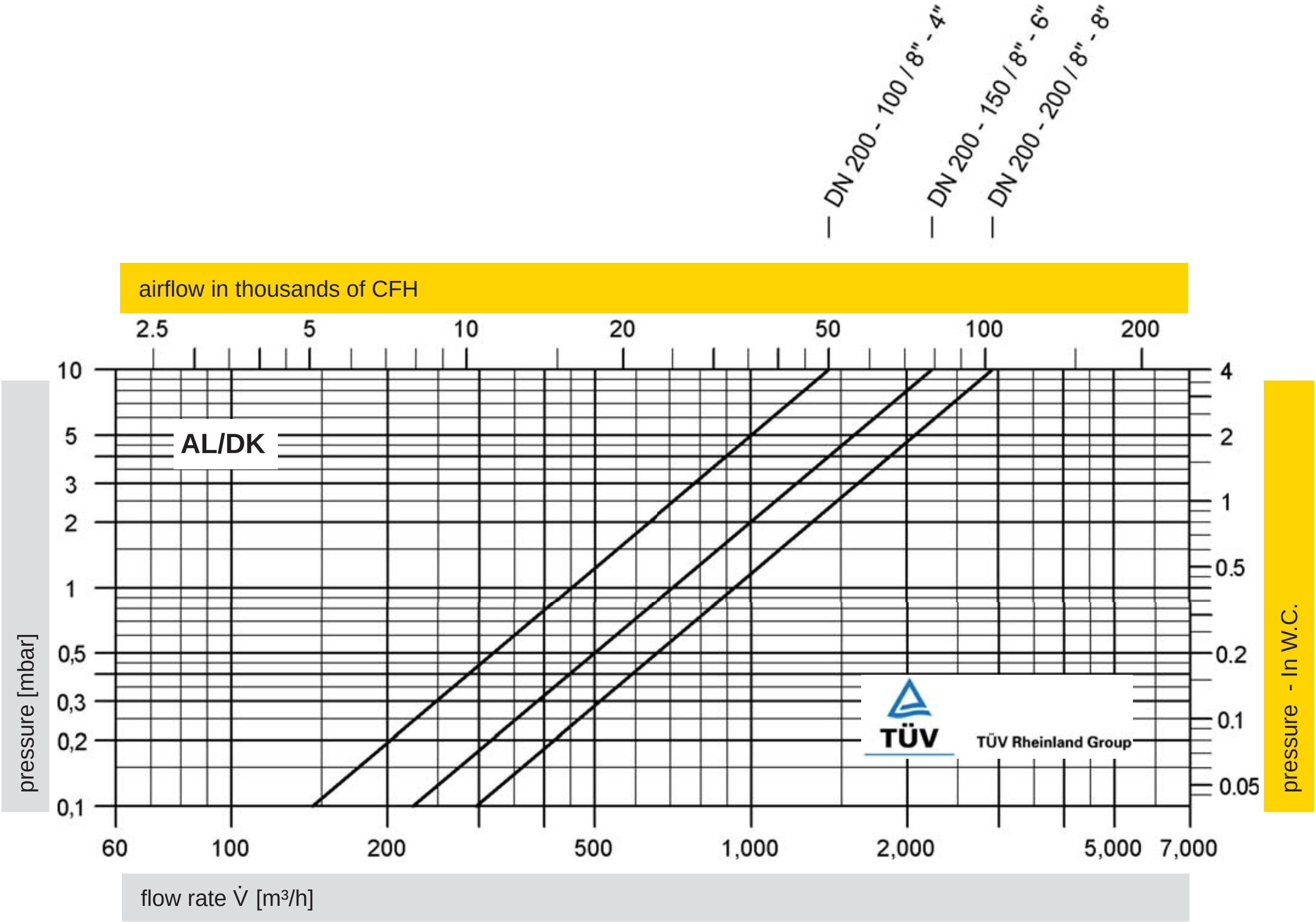
Pump rate (m³/h or CFH)



Vent Valve, Lift-actuated

Flow Capacity Chart

PROTEGO® AL/DK



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.
Volume flow V̇ in [m³/h] and SCFH refer to the standard reference conditions of air 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.

Notes:

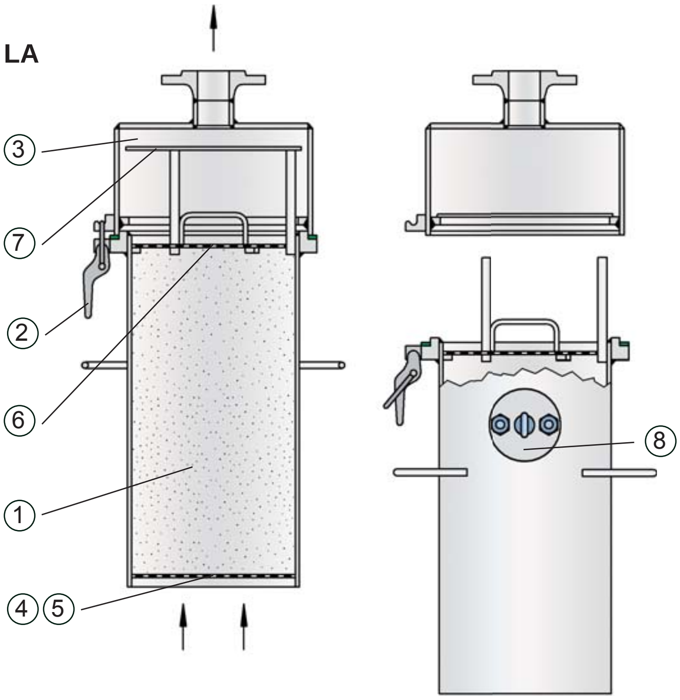
Air-Drying Device

PROTEGO® LA and LA/V

Function and Description

PROTEGO® Air-drying device of types LA or LA/V is used when suction air must be dried for atmospheric venting of storage tanks where only little or no humidity is allowed to get into the tank or the stored product due to the process engineering. They are usually used in vertical or horizontal aboveground tanks which store non-flammable or flammable liquids, and which must not be vented with humid air for safe operation.

LA



The single device LA mainly consists of the drying agent container (1). Its snap closing elements (2) connect it to the connection head (3) with flange connection according to DIN 2501 or to any other international standard.

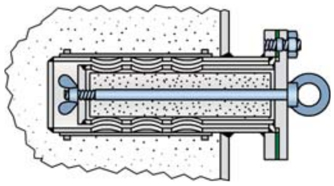
The bottom screen (4) and the protective strainer (5) are firmly welded into the drying agent container (1). The upper strainer cover (6) is loose. It can be removed easily to add or remove the drying agent. The connection head (3) contains the sealing plate (7) that closes the connection head opening when taking the drying agent container off. No humid air can be sucked in when changing the drying agent container.

The upper part of the drying agent container (1) holds the integrated control cartridge (8). The control cartridge can be removed during operation. It shows if the drying agent contains humidity and has to be replaced for regeneration.

Depending on the required flow rates or prescribed pressure losses the drying agent containers are delivered in two sizes – type I or type II. As parts of a modular system they are assembled into larger performance units.

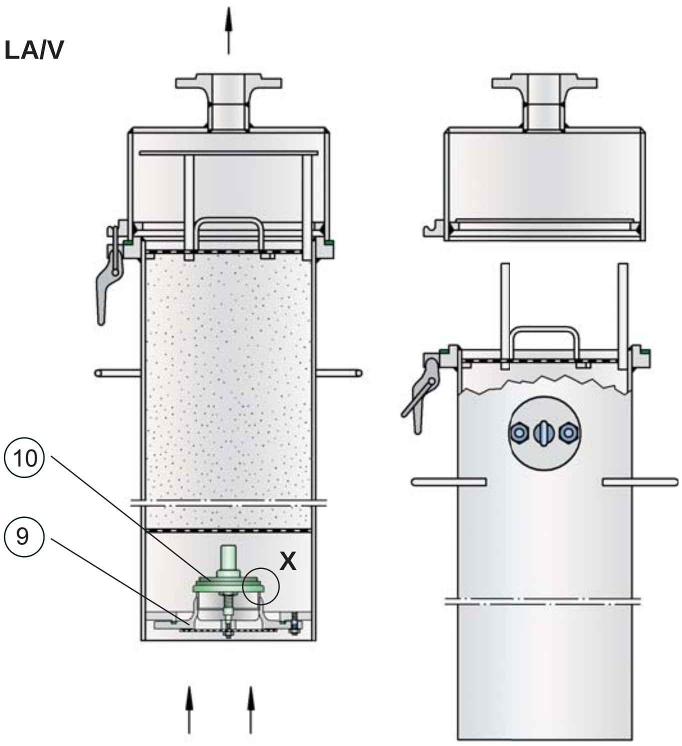
KC® drying pearls are used as the drying agent. The control cartridge (figure 1) is filled with special KC® indicator drying pearls. The required filling levels are specified in the relevant operating instructions.

Figure 1



The air-drying device type LA/V is essentially similar to type LA. Additionally it has a replaceable check valve (9) with protective strainer and valve pallet (10) integrated in the inlet connection. When no air is sucked in through the air-drying device the device is sealed and tight towards the atmosphere. So at high air humidity the drying agent in the lower area of the drying agent container cannot absorb moisture.

LA/V



Detail **X**

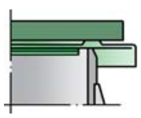


Figure 2

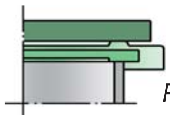


Figure 3

The design of the full lift valve pallet (10) depends on the set pressure:

- Vacuum range I -3,5 up to -5,0 mbar / -1.4 up to -2 In W.C.
- Vacuum range II -5,0 up to -14,0 mbar / -2 up to -5.6 In W.C.
- Vacuum range III -14,0 up to -35,0 mbar /-5.6 up to -14 In W.C.

The FEP diaphragm with air cushion sealing (figure 2) is used as valve pallet sealing up to pressure range II. From pressure range III, a lapped metallic sealing is used (figure 3).

Designs and Specifications

There are two designs available:

Air-drying device, basic design **LA**

Air-drying device with check valve **LA/V**

Table 1: Material selection Type LA		
Design	A	B
Housing	Steel	Stainless Steel
Bottom screen	Stainless Steel	Stainless Steel
Protective strainer	Stainless Steel	Stainless Steel
Cover	Steel	Stainless Steel

Table 2: Material selection Type LA/V		
Design	A	B
Housing	Steel	Stainless Steel
Bottom screen	Steel	Stainless Steel
Protective strainer	Stainless Steel	Stainless Steel
Cover	Steel	Stainless Steel
Valve insert	Stainless Steel	Stainless Steel

Table 3: Material selection for valve pallet			
Design	A	B	C
Vacuum range [mbar] [In W.C.]	-3.5 up to -5.0 -1.4 up to -2.0	≥-5.0 up to -14 ≥-1.4 up to -5.6	≥-14 up to -35 ≥-5.6 up to -14
Valve pallet	Aluminium	Stainless Steel	Stainless Steel
Sealing	FEP	FEP	Metal to Metal

Flange Connection Type

The connection flange is to EN 1092-1 or DIN 2501, PN 16. Optionally, the connecting flange can be made according to any international flange standard.

Selection and Design

In a system shown in figure 4 (see page 44) the maximum vacuum in the tank is calculated depending on the volume flow of the pressure loss Δp_{LA} of the air-drying device LA and the opening pressure p_O of the vent valve DZ/T or DV/ZU (see volume 6) or the tank pressure p_T given in the relevant capacity chart.

In a system according to figure 5 (see page 44) the maximum vacuum in the tank is calculated depending on the volume flow of the pressure loss Δp_{LA} of the air-drying device LA – plus check valve set pressure p_{VR} – and opening pressure p_O of the vent valve DZ/T or DV/ZU (see volume 6) or the tank pressure p_T given in the relevant capacity chart.

Additionally, the pressure loss in the pipeline between air-drying device and vent valve has to be taken into account, however usually it is negligible.

Necessary Data for Specification

Maximum allowable tank vacuum p_T (mbar or In W.C.)

Maximum possible volume flow $\dot{V}$ (m³/h or CFH) (when emptying the tank)

Pressure loss or pipeline length

Tank material

Dimensions and Weights

See systems for arrangements page 46

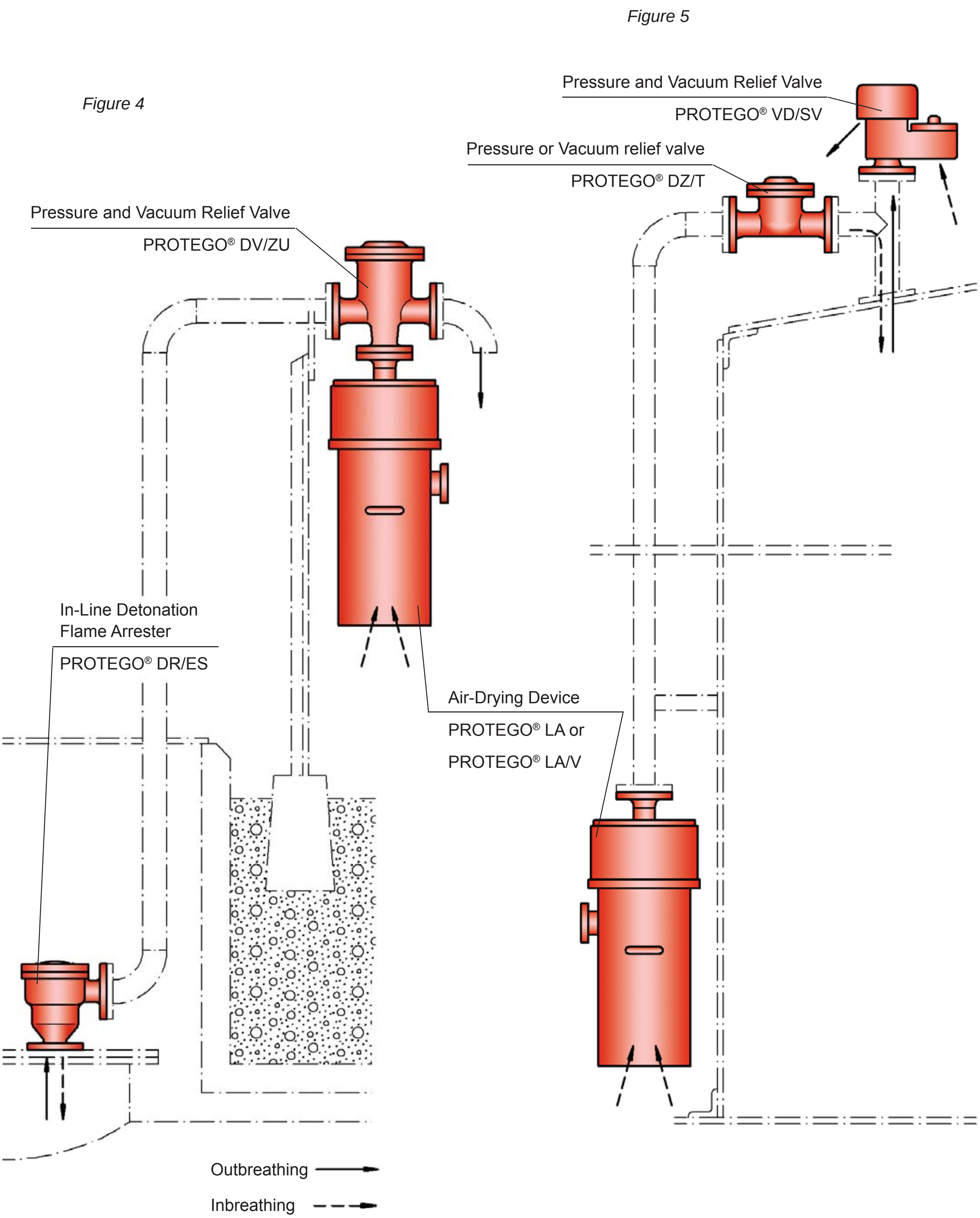


Figure 4
Pressure and Vacuum Relief Valve
PROTEGO® DV/ZU
In-Line Detonation
Flame Arrester
PROTEGO® DR/ES
Air-Drying Device
PROTEGO® LA or
PROTEGO® LA/V
Figure 5
Pressure and Vacuum Relief Valve
PROTEGO® VD/SV
Pressure or Vacuum relief valve
PROTEGO® DZ/T
Outbreathing
Inbreathing

Air-drying devices of types LA or LA/V may be integrated into complete tank venting systems (see figures 4 and 5).

If flammable liquids are stored in the tank then flame arresters have to be installed in addition to the air-drying device and the pressure and vacuum relief valves. Depending on the operating conditions it is also possible to combine other vent valves with the integrated air-drying device.

When the set vacuum is reached in the tank the vacuum relief valve – for instance PROTEGO® type DZ/T or DV/ZU on figures 4 and 5 – connected to the air-drying device opens and the drying device LA sucks in atmospheric air while the drying agent (KC® drying pearls) absorbs the atmospheric humidity.

The drying agent must be replaced and regenerated when fully saturated. Using a control cartridge it is easily possible to determine whether the drying agent is saturated with humidity.

If the specified pressure is reached in an example following figures 4 or 5 the pressure side of the combined pressure and vacuum relief valve opens and the product vapour/air mixture escapes into the atmosphere. The valve could be for instance PROTEGO® type VD/SV or DV/ZU. Alternatively it is possible to pass the product vapour/air mixture through a suitable valve – e.g. PROTEGO® type DV/ZU into an exhaust line or exhaust system. Under pressure the vacuum side of the above valves remains closed and the product vapours cannot pass into the drying agent.

In larger tanks it is recommended to also use combined pressure and vacuum relief valves e.g. PROTEGO® type VD/SV. They ensure that in an emergency (failure of air-drying device) atmospheric air can be sucked in directly through the vacuum side. Often direct atmospheric emergency venting is required yet it is neither possible nor necessary to size the air-drying device for the maximum volume flow calculated (pump flow-rate and thermal flow according to EN 14015 or API 2000). Maximum thermal flow occurs only rarely and it is therefore usually sufficient to size the air-drying device according to the pump flow-rate for emptying and a thermal flow portion of approximately 25%.

Essentially the air-drying device type LA/V functions like type LA. However, a check valve allows inbreathing only when the entire venting system – the tank and the drying container – is under vacuum at the set pressure of the check valve.

The devices are designed for venting rates sufficient for the breathing of storage tanks. However, they do not replace any valves designed for emergency venting.

The drying agent saturation can be easily monitored using a control cartridge. The drying agent can be regenerated. Drying agent and control drying pearls are not included in the scope of supply of air-drying device of types LA or LA/V with the appropriate vent valves. As an option it is possible to order drying agent or control pearls together with the device.

Figure 6 (page 46) shows the combination options of PROTEGO® LA/V air-drying device in complete units. The overall dimensions, filling volumes and filling weights are also given in this figure.

Air-Drying Device

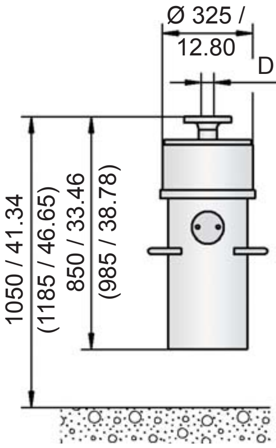
System arrangements

PROTEGO® LA and LA/V

Example arrangements of air-drying devices to complete systems for larger volume flows and nominal sizes

Note:
Overall dimensions differ in LA and LA/V (values in brackets refer to LA/V)

Figure 6



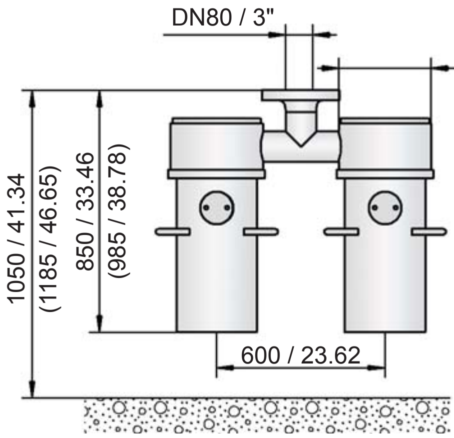
DN 50 / 2"

1 container for

filling material type I

0,03 m³ filling volume

22,5 kg weight



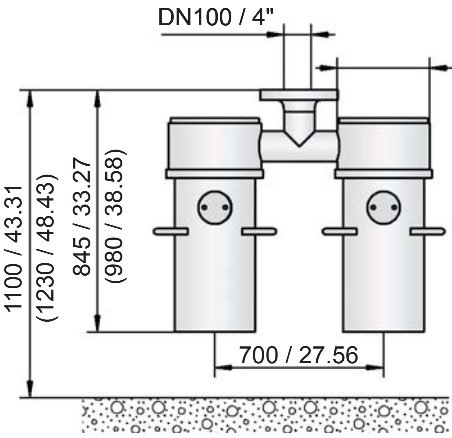
DN 80 / 3"

2 containers for

filling material type I

0,06 m³ filling volume

45 kg weight



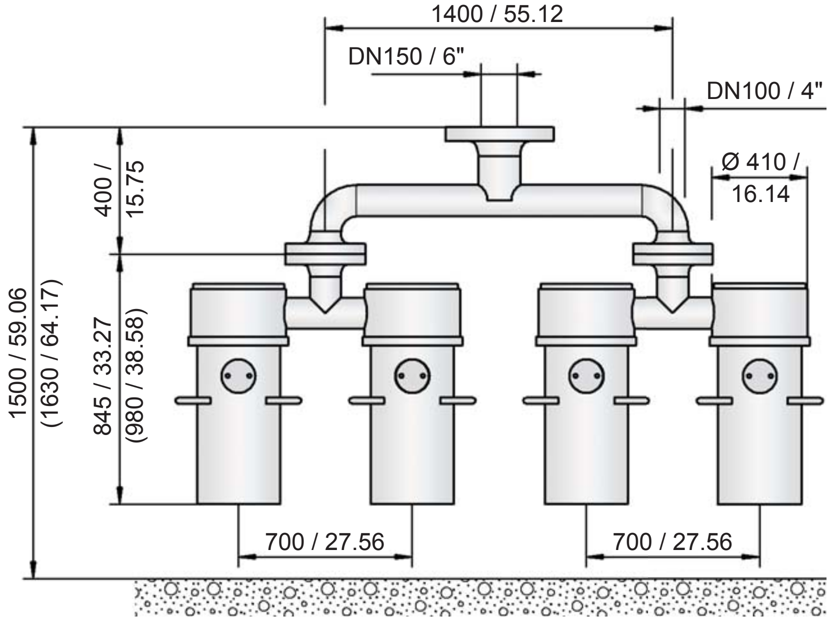
DN 100 / 4"

2 containers for

filling material type II

0,1 m³ filling volume

80 kg weight



DN 150 / 6"

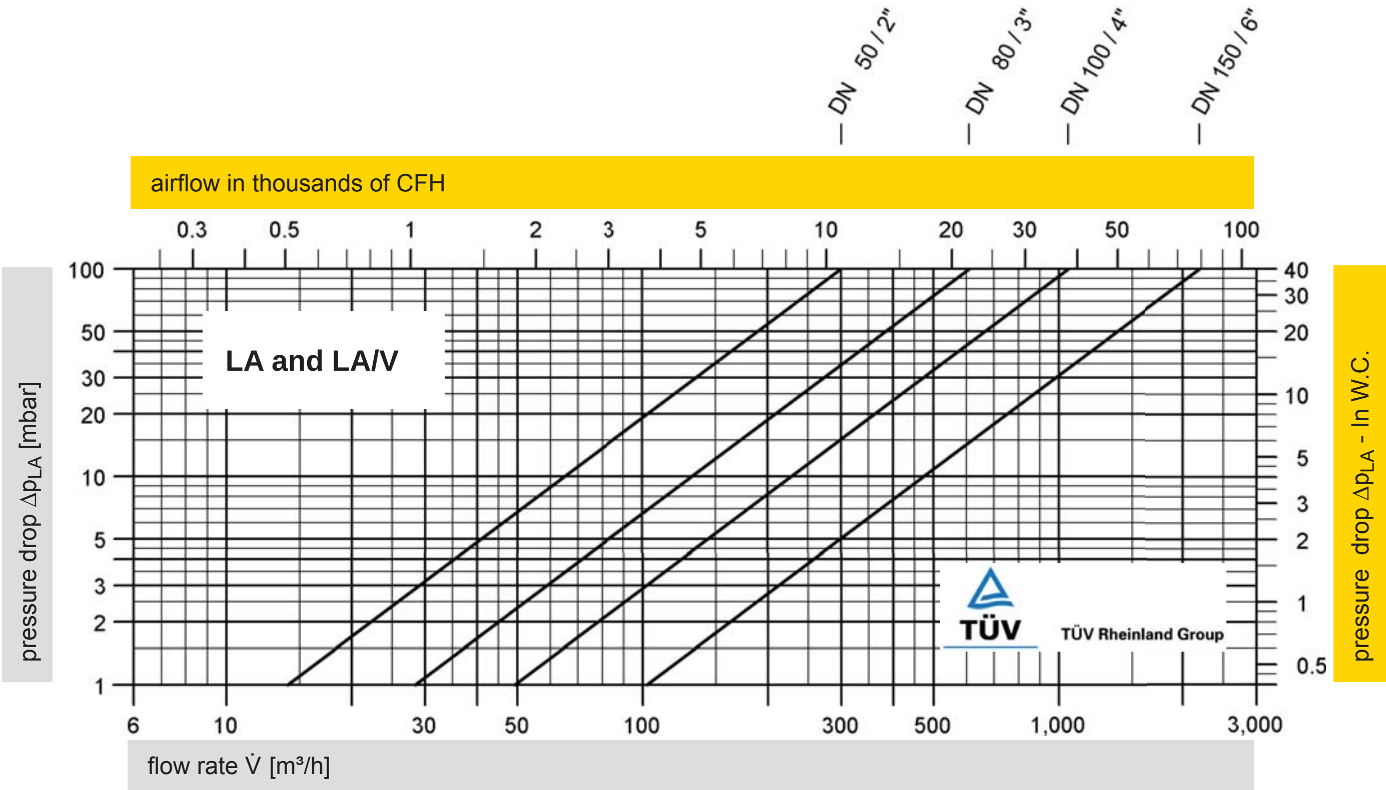
4 containers for

filling material type II

0,2 m³ filling volume

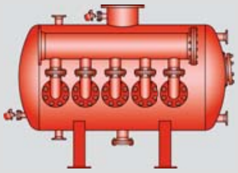
160 kg weight

Dimensions in mm / inches



The flow capacity chart has been determined with a calibrated and TÜV certified flow capacity test rig.

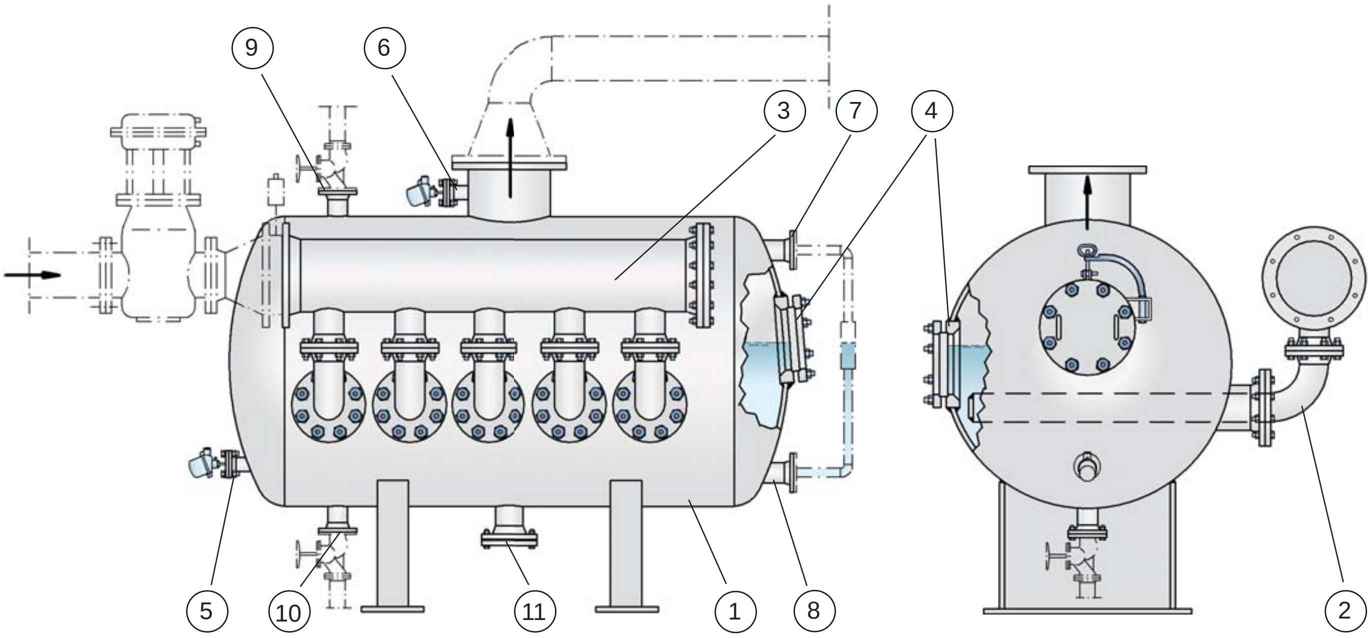
Volume flow V̇ in [m³/h] and SCFH refer to the standard reference conditions of air ISO 6358 (20°C, 1bar).
Conversion to other densities and temperatures refer to Technical Fundamentals.



Hydraulic Flame Arresters

deflagration proof, detonation proof and short-time burning proof

PROTEGO® TS/P, TS/E and TS/W



Function and Description

PROTEGO® hydraulic flame arresters of type TS/… are mainly designed to protect hazardous process plants which are connected either to waste air incineration plants or thermal combustion systems. Hydraulic flame arresters of the TS/… series are particularly suitable to protect plants which supply heavily contaminated, sticking, polymerizing or even foaming substances into a waste air incineration plant. Generally it is necessary to protect the plant against in-line deflagration, stable detonation and endurance burning hazards taking into account the plant's operating conditions.

The PROTEGO® TS/… series of hydraulic flame arresters guarantees flame transmission protection during short time burning, deflagration and stable detonation of gas/air mixtures or product vapour/air mixtures of the relevant explosion groups in all ranges of flammable concentrations up to a service temperature of +60 °C / 140 °F and under an operating pressure up to 1.1 bar / 15 psi (absolute).

Flame arresters of type TS/… are the only hydraulic flame arresters which have been tested and certified for substances of all explosion groups.

Type approval is according to the ATEX Directive 94/9/EC and European Standard EN 12874. Testing to other international standards is available on request.

Hydraulic flame arresters of series TS/… mainly consist of the immersion tank (1) with off gas nozzle and connection nozzles for the sparge pipes, the sparge pipes (2) with elbows and connection flanges as well as the manifolds (3) with connection flanges. To allow measurement of the immersion liquid temperature the tank (1) has minimum of one nozzle (5), and for measuring the temperature of the off gas there is a minimum of one connection for each exhaust gas nozzle (6) for insertion of temperature sensors. Additionally the tank has two nozzles (7, 8) for level measurement, two nozzles (9, 10) for level control, and one nozzle (11) for draining. Inspection-glasses (4) are included for inspection of the immersion liquid and gas space. The sparge pipes can be pulled out of the hydraulic flame arrester to allow cleaning of the drill holes and the pipes. At the off gas inlet the manifold has the required flange connection and the relevant number of nozzles for distributing the off gas into required number of sparge pipes.

In PROTEGO® hydraulic flame arresters of type TS/… the flammable mixtures are passed through a water seal with a defined immersion depth. The mixture flow is prorated up and passed to the individual sparge pipes. The sparge pipes have small drill holes and therefore produce defined bubble columns. In case of an ignition in the flowing gas mixture the flame is prevented from transmission into the inlet line. The following parameters have a significant effect on the flame arresting efficiency of the device in case of deflagrations, detonations or short time burning:

- Mixture volume flow,
- Immersion depth from the water seal's surface to the upper edges of the drill holes in the sparge pipes,
- Water temperature in the hydraulic flame arrester
- Sizes, form and density of the bubbles and therefore the precise drill hole diameter in the sparge pipes.

If the mixture ignites under certain operating conditions within the hydraulic flame arrester and burns directly on the liquid surface prevention of flame transmission can only be guaranteed for a limited amount of time. Therefore a number of temperature sensors are installed in the gas space and when reaching a specified temperature they trigger appropriate emergency functions upstream in the system connected (shut down, inerting, etc.).

A high accuracy volume flow meter must be installed as an essential technical safety element. It has to guarantee that the maximum allowable volume flow, on which the design of the hydraulic flame arrester has been based, is recorded and limited so that emergency functions are triggered if the off gas volumes exceed the safe level. In addition, a minimum flame-transmission-proof immersion height is necessary, i.e. an adequate water level must be guaranteed by suitable measuring equipment.

The pressure loss of a hydraulic flame arrester at maximum volume flow equals losses at inflow and outflow of approximately 12 to 18 mbar / 4.8 to 7.2 In W.C. plus the immersion depth, e.g. 350 mm = 35 mbar / 13.8 In = 14.1 In W.C., so the total is between 47 and 53 mbar / 18.9 and 21.3 In W.C.

Instrumentation

The efficiency and function of the PROTEGO TS/… hydraulic flame arrester requires measurement and control equipment for the filling level, volume flow and temperature of the system. It is necessary to maintain the minimum operating immersion depth and measure the maximum mixture volume flow, maximum gas temperature and minimum water temperature. If the safe operational envelope is exceeded, the measurement and control equipment must quickly initiate automatic emergency functions. Measurement and control safety equipment must be explosion proof and approved for zone 0.

Measurement and control equipment is not part of standard scope of supply.

Maximum Volume Flow

The maximum allowable operating volume flow is calculated by multiplying the number of sparge pipes by the maximum allowable operating volume flow for each sparge pipe at its immersion depth.

In special cases it may not be necessary to measure the volume flow provided that the volume flow limitation is guaranteed by other components in the system such as a conveyor system or a choke in combination with a decompression device.

Level Measurement and Level Control

The operating immersion depth should be kept constant by a controlled automatic water supply so that the level does not fall below the minimum immersion depth.

Temperature Measurement and Limitation

In order to prevent endurance burning in the arrester the off gas supply must be stopped automatically when the temperature exceeds T = 80°C / 176 °F at the gas outlet. Temperature sensors monitor the mixture temperature.

If the water temperature falls below T < 10°C / 50 °F (danger of freezing) or rises above the limiting temperature in the gas space, a quick action gate valve must shut automatically and stop the off gas supply.

As an option temperature sensors can be supplied.

Design Types and Specifications

The hydraulic flame arresters are designated by explosion groups, diameters and numbers of sparge pipes. They are designed in modules and type tested for the corresponding explosion groups.

For explosion group IIA (NFPA group D)
Types TS/P 1000 / 40" or TS/P 2000 / 80"

For explosion group IIB3 (NFPA group C)
Types TS/E 1000 / 40" or TS/E 2000 / 80"

For explosion group IIC (NFPA group B)
Types TS/W 1000 / 40" or TS/W 2000 / 80"

The number of sparge pipes depends on the design volume flow.

Example: TS/E-1000-5 is a hydraulic flame arrester for substances of explosion group IIB3 (NFPA group C) with a diameter of 1000 mm / 40" and 5 sparge pipes.

Dimensions

Standard diameters of TS/… series hydraulic flame arresters are 1000 mm / 40" and 2000 mm / 80". Alternatively diameters from 600 mm / 24" to 3000 mm / 120" are available depending on the off gas volume flow. Hydraulic flame arresters with diameters from 2000 mm / 80" and larger have a restriction plate to prevent wave motions in the sparging zone. All outlet headers and inlet headers as well as internal are components relevant for technical safety, and it is therefore not allowed to change their design and function nor that of the hydraulic flame arrester!

Material Selection

The material selection is determined by the exhaust air process data. Tank designs of steel, stainless steel, coated steel or steel lined with ECTFE or resin are available depending on the application. The sparge pipes are made of stainless, hastelloy or plastic.

Flange Connection Type

The standard flange connections are made to EN 1092-1 or DIN 2501, PN 16 (from DN 200, PN 10). Optionally, the connecting flanges can be made according to any international standard.

Selection and Design

The static immersion depth and the resistance due to dynamic flow in the sparge pipes and the off gas supply lines create the total pressure loss. The manufacturer's advice about technical safety is absolutely necessary in any case!

For particularly corrosive mixtures the hydraulic flame arrester may be coated. The materials of tank, installations and sparge pipes have to be selected according to the corrosive properties of the mixture.

Data Necessary for Specification

The following operational data is required for the technical safety of the hydraulic flame arrester design:

Off gas volume flow taking into account the maximum possible volume flow (m³/h or CFH)

Off gas composition (vol.%)

Operating temperature (°C or °F)

Materials, Terms and Conversion Tables

Pressure

1 bar	= 14.504 psi	1 lb/ft^2	=	47,88 N/m^2
	= 29.530 inch Hg		=	0,4788 mbar
	= 0.987 atm		=	0,0470 mm WC
	= 401.47 inch H_2O			
1 mbar	= 0.0145 psi	1 inch WC	=	249,08 N/m^2
	= 0.0295 inch Hg		=	2,4908 mbar
	= 0.4019 inch H_2O		=	25,4 mm WC
	= 2.089 lb/ft^2	1 inch Hg	=	33,864 mbar
1 kPa	= 10 mbar	1 psi	=	68,94757 mbar
1 inch H_2O	= 2,49089 mbar	1 inch Hg	=	33,8639 mbar
1 Pa	= 1 N/m^2	1 psi	=	1 lb/in^2

Temperature

To convert ºC in ºF use	T_F	=	$32 + 1{,}8\ T_C$
	0ºC	=	32ºF
	100ºC	=	212ºF
To convert ºF in ºC use	T_C	=	$^5/_9\ (T_F - 32)$
	0ºF	=	-17,8ºC
	100ºF	=	37,8ºC

Material

DIN Material Number	DIN-Material	ASTM-Material	
0.6020	GG 20	A 278-30	C.I.
0.7040	GGG 40	A 536-77	C.I.
1.0619	GS-C 25	A 216 Gr. WCB	C.S.
1.4301	X5 CrNi 18 10	A 240 Gr. 304	S.S.
1.4408	G-X6 CrNiMo 18 10	A 351 Gr. CF 8 M	S.S.
1.0425	P 265 GH	A 515 Gr. 60	C.S.
1.4541	X6 CrNiTi 18 10	A 240 Gr. 321	S.S.
1.4571	X10 CrNiMoTi 18 10	A 240 Gr. 316 Ti	S.S.
3.2581	G-Al-Si 12	A 413	Alu
Ta	Tantal	UNS R05200	
2.4610	NiMo 16 Cr 16 Ti	UNS N06455	C-4
2.4686	G-NiMo 17 Cr	UNS N30107	Casting
2.4602	NiCr 21 Mo 14 W	UNS N06022	C-22
2.4819	NiMo 16 Cr 15 W	UNS N10276	C-276

The applicable materials are specified in the quotation or the order acknowledgement:
In general the following means
CS (Carbon steel) = 1.0619 or 1.0425
SS (Stainless steel) = 1.4408 or 1.4571
Hastelloy = 2.4686 or 2.4602

Important differences: US decimals in accordance to SI-System

e.g.	1 m	= 100 cm	= 100,00 cm	(UK/US: 100.00 cm)
	1 km	= 1.000 m	= 1.000,00 m	(UK/US: 1,000.00 m)

Sealings and Coatings

PTFE	= polytetrafluoroethylene
PVDF	= polyvinylidene fluoride
PFA	= perfluoroalkoxy polyme
FPM 70	= fluor carbon rubber
WS 3822	= aramide and anorganic fibers as well as mineral reinforcement materials bonded with NBR rubber
ECTFE	= ethylene chlorotrifluoro ethylene
FEP	= perfluoroethylene propylene

DN	10	15	20	25	32	40	50	65	80	100
Size	1/4	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4

DN	125	150	200	250	300	350	400	450	500	600
Size	5	6	8	10	12	14	16	18	20	24

DN	700	800	900	1000	1200	1400	1600	1800	2000
Size	28	32	36	40	48	56	64	72	80

Length

1 cm	= 0.3937	inch	1 inch		=	25,4 mm
1 m	= 3.2808	ft	1 ft	= 12 inch	=	0,3048 m
	= 1.0936	yards	1 yard	= 3 ft	=	0,9144 m
1 km	= 0.621	miles	1 mile		=	1,609 km

Area

1cm^2	= 0.1550	sq inch	1 sq inch	=	6,4516 cm^2
1 m^2	= 10.7639	sq ft	1 sq ft	=	0,0929 m^2
	= 1.196	sq yards	1 sq yard	=	0,836 m^2
1km^2	= 100	hectares			
	= 0.3861	sq miles			
	= 247	acres			

Volume

1 cm^3	= 0.06102	cu inch	1 cu inch	=	16,3870 cm^3
1 liter	= 0.03531	cu ft	1 cu ft	=	28,317 liter
	= 0.21998	gal (UK)	1 gal (UK)	=	4,5461 liter
	= 0.26428	gal (US)	1 gal (US)	=	3,785 liter
1 m^3	= 35.315	cu ft	1 cu ft	=	0,028317 m^3
	= 6.299	petr. barrels	1 petr. barrel	=	0,15876 m^3

Mass

1 g	= 0.03527 oz	1 oz	=	28,35 g
1 kg	= 2.2046 lb	1 lb	=	16 oz
			=	0,4536 kg

Velocity and Volume Flow

1 m/s	= 196.85	ft/min	1 ft/min	=	0,508 cm/s
1 km/h	= 0.6214	mph	1 mph	=	1,60934 km/h
1 m^3/h	= 4.403	gal/min (US)	1 gal/min (US)	=	0,227 m^3/h
	= 3.666	gal/min (UK)	1 gal/min (UK)	=	0,273 m^3/h
	= 0.5886	cu ft/min	1 cu ft/min	=	28,317 liter/min
1 kg/h	= 0.0367	lb/min	1 lb/min	=	27,216 kg/h
			1 cu ft/h	=	0,028317 m^3/h

Torsion

1 Nm = 0.723 lbf ft   1 lbf ft = 1,38 Nm

Density

1 kg/dm^3 = 62.43 lb/cu ft   1 lb/cu ft = 0,016 kg/dm^3

Safety devices are installed to prevent damage. The requirements need to be defined as early as the engineering stage so that a suitable device can be specified. After delivery and startup, function must be ensured at all times. The comprehensive PROTEGO® program range requires preventive services, assistance during start-up, and qualified maintenance for long term trouble-free operation.

Technical Advice

Experienced PROTEGO® professionals are available to answer the many and complex questions regarding application. They are trained to consider issues relating to process engineering from a safety perspective. Standard and tailored solutions are generated based on current regulations and state-of-the-art information.

Training

By offering continuing education and regular training for the employees of our domestic and foreign customers, we make sure that state-of-the-art knowledge is incorporated into system engineering. We regularly conduct training seminars that cover the theory of technical fundamentals, examples of applications and practice in installing and servicing PROTEGO® devices. The seminars can be offered either at our place of business or at the customers.

Installation and Servicing

We value service and maintenance just as highly as product quality. Qualified operating and service instructions are sufficient for trained professional technicians to perform maintenance tasks. We can provide our trained field service technicians for installation and servicing, or you can use our authorized workshops. The key is trained personnel who are sufficiently prepared for their tasks in our manufacturing plant. Trained qualified professional shops are given a certificate and are authorized to perform maintenance on PROTEGO® devices. We will provide you with contacts in your region.

Research and Development

Our R&D center continuously reviews and develops our devices and incorporates product features relevant to safety engineering. In addition, we develop devices jointly with the customer for customer-specific requirements. The result: Continuous improvement of the performance and quality of flame arresters and valves as well as superior knowledge from basic research, which is incorporated into the design of process engineering systems.

Spare Parts Service

We have original spare parts for you in our headquarter as well as in support centers worldwide. Original spare parts and regular servicing tailored to the respective operating conditions guarantee trouble-free operation.

PROTEGO

for safety and environment

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