How to Select a Pepperl+Fuchs EPV – Pressure Relief Vent

Technical White Paper

Purge + Pressurization Products

EPV – Enclosure Protection Vent

Your automation, our passion.

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Introduction

Purging and pressurization is a protection method that allows standard enclosures with non-hazardous electrical equipment within the enclosure to operate safely in an explosive environment.

When using the purging and pressurization method, there are several factors to consider. All systems require a pressure relief vent as dictated by the standards for this protection method, which is typically overlooked by DIY users. This technical white paper will explain why a pressure relief vent is required and how to select the proper vent from the numerous options available.

Abstract

Purging and pressurization systems provide protection to standard ordinary location electrical equipment within a standard enclosure meant to operate in a hazardous area. Compared to the explosionproof or flameproof method of protection this protection concept is more cost-effective and prevents an explosion from happening.

This white paper does not cover the standards and steps required for commissioning and operating this system, however, it does cover the requirements for a pressure relief device and considers the cost of air to run these systems. The selection of the pressure relief vent depends on several factors and system parameters. The cost of air is evaluated for the purging and pressurization mode, both of which is required for a hazardous gas environment. The cost of air for a purging and pressurization system is most often overlooked and should be considered when selecting a method and pressure relief vent.

Purging and Pressurization Terms

Pressurization

Technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere. Source: IEC 60079-2:2014 (CENELEC - EN 60079-2 Explosive atmospheres - Part 2: Equipment protection by pressurized enclosure “p”)

Pressurized enclosure

Enclosure in which a protective gas is maintained at a pressure greater than that of the external atmosphere.
Source: IEC 60079-2:2014

Pressurization control system

Also known as a pressurization system or a pressurizing system—a collection of safety devices used to monitor and maintain the safety upon which pressurization depends.

Pressurized equipment

An overall assembly of a pressurized enclosure, pressurization control system, and the protected equipment.

Protective gas

Air or inert gas used for maintaining an overpressure and, if required, dilution and purging. Source: IEC 60079-2:2014

Protected equipment

The equipment internal to the pressurized enclosure, protected by pressurization.

Overpressure

Pressure inside the pressurized enclosure above the surrounding potentially explosive atmosphere.

Minimum overpressure

The minimum amount of pressure required to maintain safety within the pressurized enclosure.

Maximum overpressure

The maximum pressure that can be safely handled by the pressurized enclosure.

Purge pressure

Pressure within the pressurized enclosure during the purge cycle.

Purge cycle

Period of time where a high volume of protective gas is sent through the pressurized enclosure for the purpose of flushing the enclosure and the contents of the enclosure.

Safety device

Device used to implement or maintain the integrity of the type of protection. Source: IEC 60079-2:2014

Ignition-capable equipment

Equipment that during intended operation constitutes a source of ignition for a specified potentially explosive atmosphere.
Source: IEC 60079-2:2014

Pressurization – Function Principle

To better understand the concept, consider the ignition triangle. Three things are needed to pose a fire or explosion threat in a gas- or vapor-related application:

- A source of ignition
- The right amount of oxygen
- Presence of the correct amount of fuel

Due to this basic concept, ignition is not possible if a concentration of a material is below the minimum level, also known as the “lower flammable limit” or LFL. That is, provided that the oxygen content is not raised above what is normal for standard atmospheric conditions. The fact that all flammable or combustible materials have a minimum concentration to pose a fire or explosion hazard is one of the key concepts that is utilized as part of the protection method.

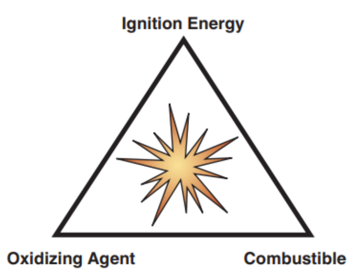


Figure 1 The ignition triangle consists of 3 components

Gas Applications

In general, pressurization works by maintaining an area within the pressurized equipment that is well below the LFL of the surrounding, potentially explosive gas atmosphere. An enclosure containing ignition-capable equipment first goes through a purge cycle. The intent of this is to flush the inside of the enclosure to the point that any remaining levels of gas trapped inside after the purge cycle time are well below the LFL of the flammable or combustible material(s) for which the pressurized equipment is designed. Immediately after this, a positive pressure is maintained within the protected equipment in relation to the surrounding, potentially explosive atmosphere. This positive pressure, known as minimum overpressure, prevents the surrounding, potentially explosive atmosphere from entering the now “clean” enclosure. Once the volume within the pressurized equipment is considered safe, energy can be applied to the ignition-capable electrical equipment within the pressurized enclosure and it can be allowed to operate normally. If the minimum overpressure level is lost, the system either alerts the operator to take immediate action, or the system initiates an automatic shutdown in order to maintain the safety of the equipment in the hazardous area.

Dust Applications

Adding to the three aspects above in the ignition triangle, dust explosions also involve confinement and dispersion.

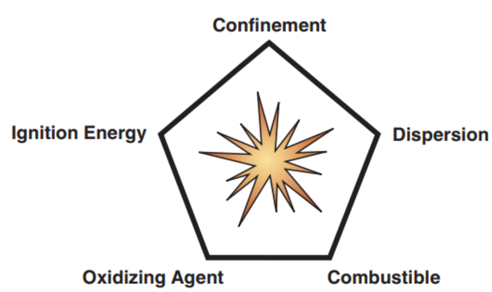


Figure 2 The ignition pentagon for dust adds confinement and dispersion

For dust applications, the purge cycle is replaced by a physical cleaning. This is done to remove all hazardous dusts from the internal components of the pressurized enclosure for the pressurized equipment. After that, the enclosure is pressurized.

Purging Enclosures in Dust Atmospheres

A high airflow purge cycle is not used when purging an enclosure in a dust hazardous area. First, such a purge cycle would likely cause a dispersion of the dust within the confinement of the pressurized enclosure. In addition, the purge cycle airflow could cause dispersion outside of the pressurized enclosure. Dispersion in either area is a risk that needs to be avoided. Second, the dust is likely not to be fully purged from the enclosure in the same way that the gas/vapor is purged.

The inside of the pressurized equipment is to be cleaned in a way that is not likely to create a dust cloud. For example, using a vacuum cleaner is preferred over blowing out the equipment with pressurized air. Another consideration is that the vacuum cleaner may also need to be classified for use in the hazardous area. Moreover, it is important to understand that all areas within the enclosure need to be cleaned. This means that any dust in the protected equipment also needs to be removed.

After cleaning the inside, the enclosure is closed and immediately brought to the required positive minimum overpressure. Once again, this positive pressure prevents the surrounding, potentially explosive atmosphere from entering the now "clean" enclosure. Once the area within the pressurized enclosure is considered safe, energy can be applied to the electrical devices within the pressurized enclosure and they can be allowed to operate normally. In the event that the minimum overpressure level is lost, the system either alerts the operator to take immediate action or initiates an automatic shutdown in order to maintain the safety of the equipment in the hazardous area.

The above explanations generally describe pressurization in typical applications. Generally, the enclosures used for these applications are not perfectly sealed. Therefore, a constant source of protective gas is needed to maintain the minimum overpressure. This typical pressurization scenario is known as leakage compensation. This will be the general focus of this publication. There are special considerations for gas and vapor applications, where the hazardous substance is directly plumbed into the pressurized enclosure as part of the pressurized equipment. For these applications, a modification to the pressurization principle, known as dilution, is generally implemented. For more information, see chapter "Applications Working with a Containment System (Dilution)".

The Types of Purging and Pressurization

For Class/Division applications, the Types of pressurization systems covered by NFPA496 are defined as the following:

Type X

Allows unclassified equipment to be located in the protected enclosure and operated in a Division 1 location after successful purging (if not dust) and pressurization of the protected enclosure. If the enclosure pressure drops below the overpressure minimum, then the enclosure power must be de-energized and cannot be energized until a successful purge cycle.

Type Y

Allows Division 2 rated equipment to be located in the protected enclosure and operated in a Division 1 location after successful purging (if not dust) and pressurization of the protected enclosure. Unlike a Type x system, all equipment within the protected enclosure must be Division 2 rated. If the enclosure pressure drops below the overpressure minimum, the enclosure power either has to be de-energized and cannot be energized until a successful purge cycle completed, or the power can remain on but an audible and/or visual alarm has to be initiated.

Type Z

Allows unclassified equipment to be located in the protected enclosure and operated in a Division 2 location after successful purging (if not dust) and pressurization of the protected enclosure. If the enclosure pressure drops below the overpressure minimum, then the enclosure power either has to be de-energized and cannot be energized until completion of a successful purge cycle, or the power can remain on but an audible and/or visual alarm has to be initiated.

For Zone applications, IEC60079-2 gives a similar definition of the types of pressurization systems:

pxb

In general, this is the same principle as Type X. It allows for the use of ignition-capable equipment inside the pressurized enclosure for applications in Zone 1 or 21.

pyb

In general, this is the same principle as Type Y. It allows for the use of Zone 2 or 22 rated equipment inside the pressurized enclosure for applications in Zone 1 or 21.

pzc

In general, this is the same principle as Type Z. It allows for the use of ignition-capable equipment inside the pressurized enclosure for applications in Zone 2 or 22.

While the levels of classification seem to be similar, the details required for each protection concept can be different. It is important to be aware of the specific requirements relative to the installation based on Zone or Class/Division. Please consult the pertaining standards.

What is a Pressure Relief Vent

When purging and/or pressurizing an enclosure, a protection vent or relief vent is required to control the maximum overpressure of an enclosure for both gas and dust applications. These vents not only act as a pressure relief device but are also used to release the protective gas during purging. In Division1/Zone 1 applications, they actually measure the flow through the vent for proper purging.

Despite the fact that purging is not required for dust applications, there could still be a catastrophic failure in the system as is the case when too much air flow enters the protective enclosure. Without a pressure relief vent the enclosure will most likely fail under excess pressure.

One of the requirements of a pressure relief vent is the spark and particle barrier at the exhaust. Most likely the purge flow or excess pressure flow will exhaust into the hazardous area. Because the equipment within the enclosure can be operating, and these devices are ignition-capable, any spark generated within the enclosure cannot exit the enclosure into the hazardous area so the spark barrier is required on the vent. The integrity of the spark arrestor is determined by testing and evaluation performed by the certification lab. As a result, it is very important to make sure the vent being used is certified by a recognized third-party approval agency.

Example of pressure relief vent spark and particle barrier Pepperl+Fuchs EPV 7500: The spark and particle barrier consists of a wire mesh

Vent Mounting

The original style vents, EPV-1 ... 5 relied on gravity to keep the enclosure sealed below its breaking pressure and were ordered according to the location of the vent.

Ex: EPV-_-SA-00 vent could only be mounted on top of the enclosure

EPV-_-SA-90 vent is intended to be mounted on the side of the enclosure

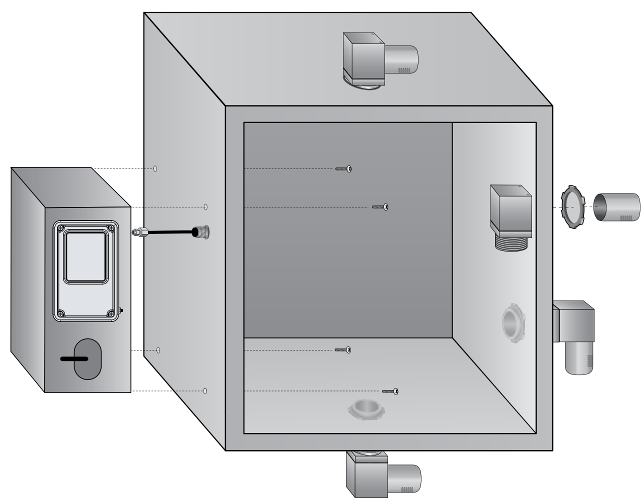
Our newer designs allow for any mounting configuration with one unit. These newer units are not gravity-dependent and allow the customer to switch mounting configurations with the same unit.

Newer design, universal mount

When working with this type of pressure relief vent for purging and pressurization, it must be noted that the vent could be releasing pressure inside the enclosure while the equipment is operating. Consequently, this introduces an ingress point on the enclosure to the outside environment. Placement of the vent should be in a location where it is less vulnerable to the outside environment lwhere dirt, dust, and water ingress may occur.

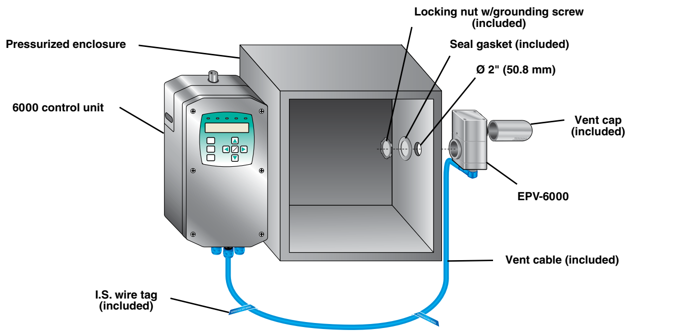
With the newer vents, the advantage is the universal mount design. This allows the customer to order a vent and change the orientation of the mounting on the enclosure at any time. Another useful feature is that the vents can be mounted inside or outside the enclosure with only the vent cap located outside the enclosure.

Below is an illustration showing the mounting of the EPV-7500 or EPV-5500 vents. These vents do not have any electronics, therefore internal or external mounting is simple.

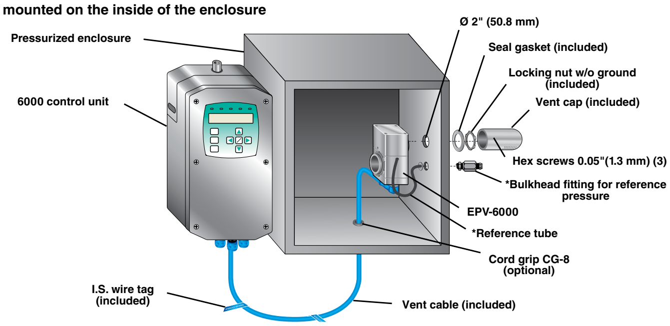


For the EPV-6000 or EPV-6500 type vents, which require a flow measurement, there is a differential pressure sensor inside which requires pressure readings from both inside and outside the enclosure. When mounting the vent on the outside, there is no need to add any extra tubing as the enclosure pressure port reading is taken via the tube that extends out of the vent inlet, which is always located inside the enclosure. Whereas the outside pressure port is located on the vent body outside the enclosure. When mounting inside the enclosure, the outside pressure port is now inside the enclosure and needs a connection to the outside of the enclosure.

Vent mounted on the outside of the enclosure



Vent mounted on the inside of the enclosure



*Reference tubing and hardware included with EPV-6000-SS models

Breaking pressures of the relief vents

The breaking pressures of the relief vents are defined as what enclosure pressure they begin to start to open. Below this pressure, they will be closed but may leak slightly from the nature of the design. At the breaking pressure, they will start to release pressure from the enclosure. The flow of protective gas from the enclosure will depend on the enclosure pressure. Many of the vents have variable flow depending on the pressure within the enclosure

Maximum pressure of the relief vents

The mechanisms within the EPV vents allow a variable flow depending on the enclosure pressure above the breaking pressure. For purging, the flow is measured either by a flow sensor in the vent or by the correlation of flow vs. enclosure pressure. The maximum pressure for the vent depends on what the maximum enclosure pressure can withstand. For certification of the complete solution, a proof test is required to confirm no permanent deformation of the enclosure based on an overpressure test at 1.5 x the maximum enclosure pressure. The vent will have flow and pressure curves or values indicating what the pressure will be for a certain flow. This can be tested with the enclosure to guarantee the proof testing is met.

Normally the vent is not affected by a flow at higher enclosure pressures. The enclosure integrity has to be evaluated to determine the maximum flow, which relates to pressure, for the enclosure to withstand. Even though the pressure within the enclosure during purging can get as high as 4" w.c. You should always remember 27.7" w.c. (69.2 mbar) equals 1 psi which can be quite destructive to a structure of an enclosure.

Example: Overpressure required for a typical control cabinet

Consider a typical control cabinet with a door of 3 ft. x 6 ft. (0.9 m x 1.83 m). The surface area of this door is 2592 in^2 (1.67 m^2). At the minimum overpressure requirements found in NFPA 496 and in IEC 60079-2:2014 for pzc of 0.1 w.c. (25 Pa), the force on the door is about 9.4 lbs. (4.2 kg). This seems acceptable, but still poses a risk when the door is opened under pressure if the person is not expecting the added force. Additionally, consider a purge cycle where the internal pressures can increase to about 4 w.c. (1000 Pa) or more. An internal pressure of 4.0 w.c. (1000 Pa) results in a force on the door of about 376 lbs. (170.5 kg)! A typical single point latch is not likely to be designed to handle anywhere near this amount of force.

This simple example shows the high forces that an enclosure is subjected to during the overpressure tests. It illustrates the absolute need for a multiple-door-latch system, especially for large enclosures, and manifests how the failure to consider these requirements can pose an operational danger. The considerations needed for the enclosure design and selection process are not to be taken lightly. Also, due to these strength requirements, in addition to UV and electrostatic concerns, plastic- or polymer-based enclosures are typically not used.

The Type X/pxb and pyb and Type Y or Z / pzc Vents

EPV-6000 is Type X/pxb and the EPV-6500 is Type X/pxb and pyb

The EPV-6000 and EPV-6500 are very similar in design. The IEC60079-2 Standard requires that all purging systems in a Zone 1 application monitor the flow at the exhaust of the vent. The EPV-6000/6500 vents have an internal flow sensor that will measure the flow. They also have a differential pressure sensor to indicate the enclosure pressure. These vents work with their corresponding control unit which provides IS power and communications for reporting flow and pressure. The flow sensor is positioned in the middle of the vent opening for the measurement of flow. The differential pressure sensor requires a low and high port for measurement. The high port side is measured via a tube sticking through the grated opening of the vent which extends about ¾" from the opening. The low pressure port, which is usually measuring atmospheric pressure, is located on the side of the vent with a sintered element for protection from dirt, water, and bugs and containts the required spark arrestor. The exhaust of the vent can be rotated so that it is facing away from any intruding environmental conditions, and as required has a spark arrestor.

These vents are designed to be mounted to the enclosure via a locknut for external mounting, or the structure is mounted to the enclosure with the vent body inside the enclosure and the cap on the outside for an internal mount. For an internal mount, the sintered element is removed so that a tube fitting can be attached to reference the outside pressure through tubing and a bulkhead fitting. The models EPV__SS-__ with the SS (stainless steel) come with the fittings and tubing for an internal mount. The EPV-__-AA-__ do not. The idea is that for stainless steel applications, the '-SS' vent comes with a marine grade aluminum body and a stainless steel cap. As a result, only the cap is exposed to the external environment, so that all wetted material is stainless steel.

The EPV-7500 and EPV-5500 is Type Y or Z / pzc

The EPV-5500 and EPV-7500 are very similar in design with the exception that the EPV-5500 has an exhaust cap with two rows of slots and the EPV-7500 has three rows of slots. This is the reason they have different purging flows. Both vents do not have any electronics in them because the flow and pressure is measured by the 5500 or 7500 control unit and is not required by the standards to measure flow at the exhaust. The vent opening and cap designs are the same as the EPV-6000/6500 vents, therefore the mounting is the same.

EPV-6000 / EPV-6500 Class I or II, Division 1 / Zone 1 or 21

EPV-5500 / EPV-7500 Class I or II, Division 2 / Zone 2 or 22

Types of vents

The EPV's have three levels of operation.

- During purging, they have to open up and allow the excess pressure / flow to exhaust out of the enclosure. The NFPA496 and IEC60079-2 Standards requires the free volume of the enclosure to be flushed out multiple times before the enclosure is considered free of hazardous gas. For NFPA496 four volume changes, and for the IEC60079-2 5 volume changes are required. For motors, both standards require ten volume changes; however, for the calculation the stator volume can be subtracted from the free volume.
- After purging or pressurization of the enclosure, the flow rate is reduced to compensate for leakages from the enclosure and vent. Even though the vent is sealed, it still leaks slightly through the flapper or plunger mechanism.
- If, during operation (pressurization) of the system, the enclosure pressure starts to increase, the vent will begin to open up and release excess pressure. The point when the vent starts to open is considered the breaking pressure.

The EPV vents can be selected by their flow rate / enclosure pressure and their leakage rate during pressurization. The nomenclature for the vents includes options for this. For example, let's look at the EPV-7500 vent. The nomenclature for this vent is very similar to the other vents

Material

There are situations where the specifications of the vent require it to be stainless steel. In these cases, the '-SS' version will provide the customer with a 316 stainless steel cap and spark arrestor with the vent body in marine grade aluminum. The idea is that the body of the vent is mounted inside the enclosure and only the cap is located outside the enclosure. The '-AA' version has a cap and body supplied in marine grade aluminum.

Note

If the EPV-6000 and 6500 body is mounted inside the enclosure the ambient pressure port on the side of the vent must be referenced to the pressure outside the pressurized enclosure. The EPV-6000/6500 with the '-SS' version comes with fittings and tubing to extend the port to the outside.

Configuration

This defines the flow rate and enclosure pressure during purging. It also includes the breaking pressure of the vent, and the leakage through the vent when the enclosure pressure is under the breaking pressure of the vent, which is important during pressurization.

E	P	V	-	7	5	0	0	-	A	A	-	0	1

Configuration
01 35 SCFM (990 l/min) max flow, brk. press. 0.8" wc (2 mbar)
02 35 SCFM (990 l/min)max flow, brk. press. 1.4" wc (3.5 mbar)
03 16 SCFM (452 l/min) max flow, brk. press. 1.5" wc (3.8 mbar)
04* 14 SCFM (396 l/min) max flow, brk. press. 1.4" wc (3.5 mbar)

Material
AA Body and cap: 6061T aluminum
SS Body: 6061T aluminum, cap: 316L stainless steel

Series of vent
7500 7500 Series

* The only possible combination with these options is "EPV-7500-AA-04"

Flow rate

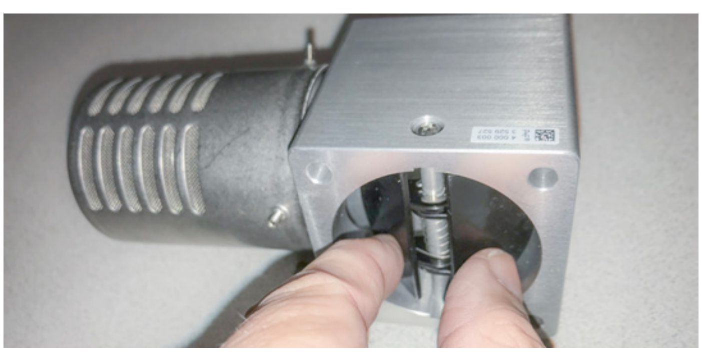
The mechanism for the flow through the vent is a flapper or plunger opening that is mounted inside the vent. The design will depend on the values of the three parameters mentioned. The vents use either a flapper or a plunger design with a spring to hold them closed. The flapper design has two versions, one spring or two springs hold down the two flappers to produce a seal. This design holds the flapper down onto the aluminum opening. The single spring design has the highest flow rate for the lowest enclosure pressure for purging; however, it has the highest leakage rate through the flapper for pressurization. The plunger design has a spring and sits on an O-ring to provide the best seal during pressurization; however, it has the lowest flow rate and highest enclosure pressure during purging.

Eliminating one configuration:

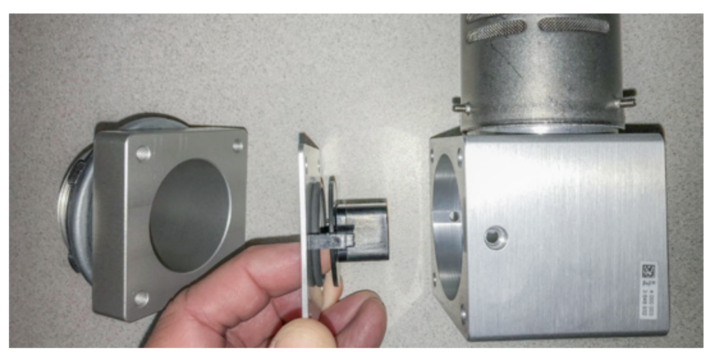
For the simplicity of selecting vents based on these three parameters, it seems that the vents with the flappers with one spring or two springs are very similar in results. The vent with two springs is used for specialized applications requiring a better sealed vent to reduce the leakage rate and was developed prior to the plunger style vent. Once the newer plunger style vent was developed there were much fewer applications requiring the flapper with two springs. Even though the flapper vents with two springs are still available, we should not consider it for specifying a vent. In the graph below only the single spring and plunger style vents are presented.

The two spring vents are designated as the following

- EPV-7500/5500-...02
- EPV-6000-...03/04
- EPV-6500-...03



Flapper design (one or two spring)

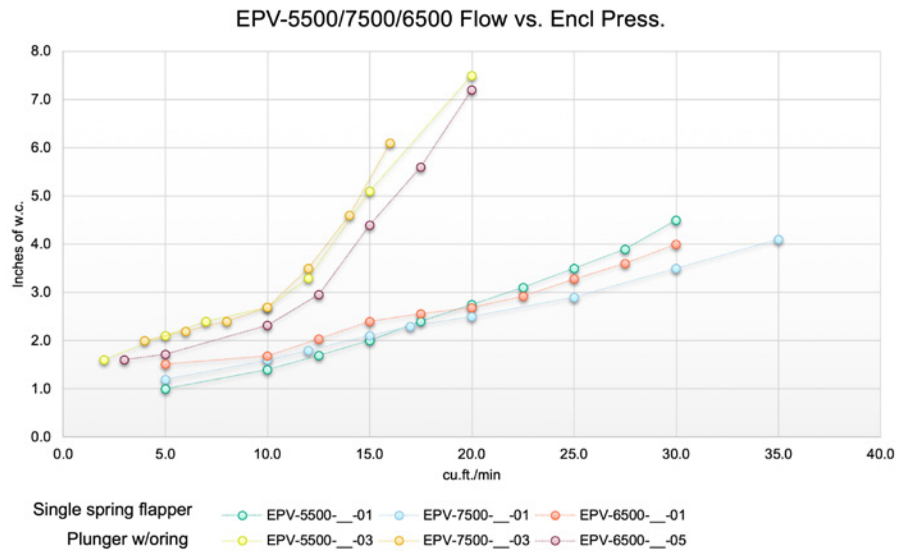


Plunger design

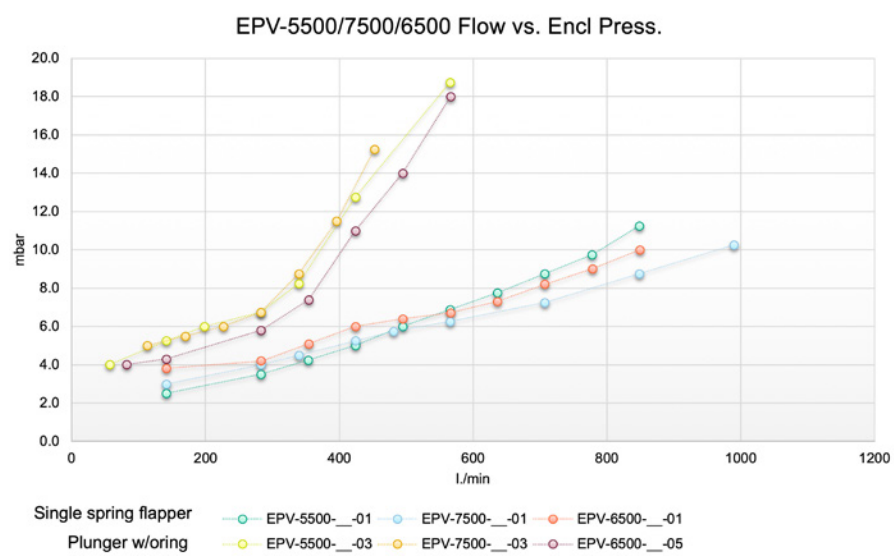
On the graphs on the right it is easy to see that the plunger style vent has a higher enclosure pressure for the same flow rate than the single spring flapper vents. The reason for this is that the plunger style vent seals better when the enclosure is pressurized and below its breaking pressure.

For simplicity of explanation the EPV-6000 vent is not shown because the flow/pressure is based on four flow rates, 5, 12, 20, 30 cu.ft./min (141, 339, 565, 848 l/min). The pressure for these flows is very similar to the EPV-6500 vents.

The leakage rate of the vent is the amount of flow that will exit through the vent when under its breaking pressure. Even though the vents are supposed to be sealed below this pressure, there are still small openings in the flapper and plunger design that cannot be avoided. Also, there is still some pressure being exerted on the flapper from the small pressurization pressure required to operate the equipment in the enclosure safely. The orientation of the vent also plays a role in providing a better seal, because even though these vents are universally mounted, a better seal is achieved when the flapper or plunger mechanism is horizontal and facing up as opposed to facing down. In addition, gravity has its effect although the vents are sealed with a spring. The leakage rates shown below are when the vents are facing down which results in the most leakage. When facing up, leakage can be reduced by 5 – 15 %.



Imperial Units



Metric Units

Leakage rate at pressurization in cu.ft. /hour (l/hr)

	@0.25"wc (0.63 mbar)	@0.75"wc (1.9 mbar)	Type
EPV-5500-__-01	21 (593)	58 (1640)	Single spring
EPV-7500-__-01	21 (593)	58 (1640)	Single spring
EPV-6000-__-01/02	21 (593)	58 (1640)	Single spring
EPV-6500-__-01	21 (593)	58 (1640)	Single spring
EPV-5500-__-03	9.2 (260)	22 (622)	Plunger
EPV-7500-__-03	9.2 (260)	22 (622)	Plunger
EPV-6000-__-05/06	9.2 (260)	22 (622)	Plunger
EPV-6500-__-05	9.2 (260)	22 (622)	Plunger

The 6000 purge system can use two vents for one control unit, and the EPV-6000 vents are coded with a different address for communication back to the control unit, therefore there are two vents listed above. They are exactly the same except for their communication address.

This leakage rate should be taken as only one source of leakage from the enclosure. It should be noted that normal IP64, NEMA 4 enclosures will still leak under pressure and will usually be factors higher than what the vent will leak. Enclosures are designed to keep some dust, dirt, and moisture from getting in, however, they are not designed to keep pressure from escaping.

The breaking pressures of the vents refer to the point at what enclosure pressure they begin to start to open. Below this pressure they will be closed but may leak slightly by the nature of the design.

Breaking pressure

Vent	In. wc. (mbar)	Type
EPV-5500-__-01	0.8 (2.0)	Single spring
EPV-7500-__-01	0.8 (2.0)	Single spring
EPV-6000-__-01/02	0.8 (2.0)	Single spring
EPV-6500-__-01	0.8 (2.0)	Single spring
EPV-5500-__-03	1.5 (3.8)	Plunger
EPV-7500-__-03	1.5 (3.8)	Plunger
EPV-6000-__-05/06	1.5 (3.8)	Plunger
EPV-6500-__-05	1.5 (3.8)	Plunger

Which vent to use for which application

The selection of an EPV vent comes down to two system parameters. The first is the area classification which is based on Class/Division or Zone. Once the preferred control unit is selected for the application, the final vent selection will depend on the three parameters discussed above—purge flow, enclosure pressure, and leakage.

Below are a few examples of enclosure sizes and comparing them with the selection of the single spring and plunger vent.

For the examples below:

Purge time = # of exchanges x enclosure volume / Flow rate = # min

Force on door = (H" x L") x Purge pressure / 27.7" / psi = # lbs.

Example 1: Small enclosure purging

- Enclosure volume = H x L x W = 24"x24"x6" = 2 cu.ft. (0.054 cu. meters)
- # of exchanges = 4
- Vent selected: EPV-7500-__-01
- Leakage rate of vent during pressurization = 25 cu.ft./hr (0.4 cu.ft./min) (11.3 l/min)

Example 2: Same as example 1 but using the -03 vent

- Enclosure volume = H x L x W = 24"x24"x6" = 2 cu.ft. (0.054 cu. meters)
- # of exchanges = 4
- Vent selected: EPV-7500-__-03
- Leakage rate of vent during pressurization = 15 cu.ft./hr / 0.25 cu.ft./min (7.0 l/min)

Flow rate – cu.ft./min (l/min)	Purging pressure – "wc (mbar)	Purge time – minutes	Force on door (H x L) –lbs. (kg)
5 (141)	1.3 (3.3)	1.6	27 (12.2)
10 (339)	1.6 (4.0)	0.8	33 (15.0)
20 (565)	2.5 (6.3)	0.4	52 (23.6)
30 (848)	3.5 (8.8)	0.3	72 (32.6)

Example 1: Small enclosure purging using EPV-7500-__-01 (single spring)

Flow rate – cu.ft./min (l/min)	Purging pressure – "wc (mbar)	Purge time – minutes	Force on door (H x L) –lbs. (kg)
4 (113)	2.0 (5)	2.0	41 (18.5)
10 (282)	2.7 (6.8)	0.8	56 (25.3)
16 (452)	6.1 (15)	0.5	127 (57.5)
30 (848)	n/a	n/a	n/a

Example 2: Same as example 1 but using EPV-7500-__-03 (plunger)

Example 1a: Large enclosure purging

- Enclosure volume = H x L x W = 72" x 72" x 36" = 108 cu.ft. (3.01 cu. meters)
- # of exchanges = 4
- Vent selected: EPV-7500-__-01
- Leakage rate of vent during pressurization = 25 cu.ft./hr / 0.4 cu.ft./min (11.3 l/min)

Example 2a: Same as example 1a but using the -03 vent

- Enclosure volume = H x L x W = 72" x 72" x 36" = 108 cu.ft. (3.01 cu. meters)
- # of exchanges = 4
- Vent selected: EPV-7500-__-03
- Leakage rate of vent during pressurization = 15 cu.ft./hr / 0.25 cu.ft./min (7.0 l/min)

From these examples we determine that the single spring vent, EPV-7500-__-01 is better suited for larger enclosures since it has the highest flow rate for the lower enclosure pressure. This will allow the enclosure to purge faster without causing too much stress on the enclosure during the purging process. Granted, the leakage during pressurization will be greater than what is expected for plunger vents. However, usually in larger enclosures, the leakage rate from the enclosure far exceeds the leakage rate of the vent and is insignificant in the overall evaluation.

The plunger style, EPV-7500-__-03, when used with smaller enclosures, results in the same purging time as the spring style, but will have a higher enclosure pressure during the purging process. As we can see, for smaller enclosures this may not be a problem because of the size and the benefit of the lower leakage rate during pressurization. Smaller enclosures are usually better sealed and create less leakage than larger ones since the vent is a significant part of the calculation of the total leakage rate.

Flow rate – cu.ft./min (l/min)	Purging pressure – "wc (mbar)	Purge time – minutes	Force on door (H x L) –lbs. (kg)
5 (141)	1.3 (3.3)	86	243 (110)
10 (339)	1.6 (4.0)	43	300 (136)
20 (565)	2.5 (6.3)	21	467 (211)
30 (848)	3.5 (8.8)	14	655 (297)

Example 1a: Same as example 1 but using EPV-7500-__-01 (single spring)

Flow rate – cu.ft./min (l/min)	Purging pressure – "wc (mbar)	Purge time – minutes	Force on door (H x L) –lbs. (kg)
4 (113)	2.0 (5)	108	374 (169)
10 (282)	2.7 (6.8)	43	505 (229)
16 (542)	6.1 (15)	27	1141 (517)
30 (848)	n/a	n/a	n/a

Example 2a: Same as example 1a but using EPV-7500-__-03 (plunger)

The plunger style vent is selected for nitrogen-based purge systems where the purging gas is nitrogen. The cost of nitrogen and access to it mounts up the cost when there are excess leakages from the enclosure. Many sources of nitrogen are from a compressed gas cylinder. Therefore reducing the leakage will reduce the amount of gas consumed and reduce the amount of maintenance necessary to exchange of cylinders. Also with nitrogen-based systems asphyxiation has to be addressed around the enclosure, especially in closed areas, so if the vent can't be extended away from the enclosure then the lowest leakage rate is desired to reduce asphyxiation.

From a leakage cost, the better sealed vent will be more cost-effective over the lifespan of the system. Looking only at the leakage rate of the vent and not the enclosure, the cost of air can add up when multiple systems are operating. If we consider the cost of air to be around $0.28/1000 cu. ft. based on an average size compressor and the electric rate of $0.1/KWH, then the cost of air through these vents is as follows when below its breaking pressure.

The cost of air = Leakage from vent x time on x $0.28/1000 cu.ft. producing air

Based on operation of 8hr/day at 260 days/yr.

Vent style	@0.25"wc (0.63 mbar)	@0.75"wc (1.9 mbar)
Single spring	$12	$34
Plunger	$5	$13

Based on operation of 24hr/day at 365 days/yr.

Vent style	@0.25"wc (0.63 mbar)	@0.75"wc (1.9 mbar)
Single spring	$51	$142
Plunger	$22	$55

The leakage from the vent is usually a small part of the total leakage of the system, and if the enclosure is not well sealed then the leakage from this enclosure could be many factors more than the vent. It is always a good idea to design the enclosure so that it will seal well when in operation and to periodically check the sealing of the enclosure throughout its life cycle.

Dilution applications – The EPV-6500-_-07/08 continuous vent

Dilution applications typically involve gas analyzers since the analytical function occurs within the pressurized enclosure and involve bringing in a stream of hazardous gas for analysis. Any equipment, including piping, that contains this hazardous gas that is located within the pressurized enclosure is called a containment system. The containment system may potentially leak under normal and abnormal conditions, with either a known or unknown leakage rate of the hazardous gas. If the leakage rate is known, then the 6500 purge and pressurization system may be used to dilute the specific area within the pressurized enclosure to allow the surrounding electronic equipment to operate. If there is an unknown release, nitrogen is typically used and dilution is not required.

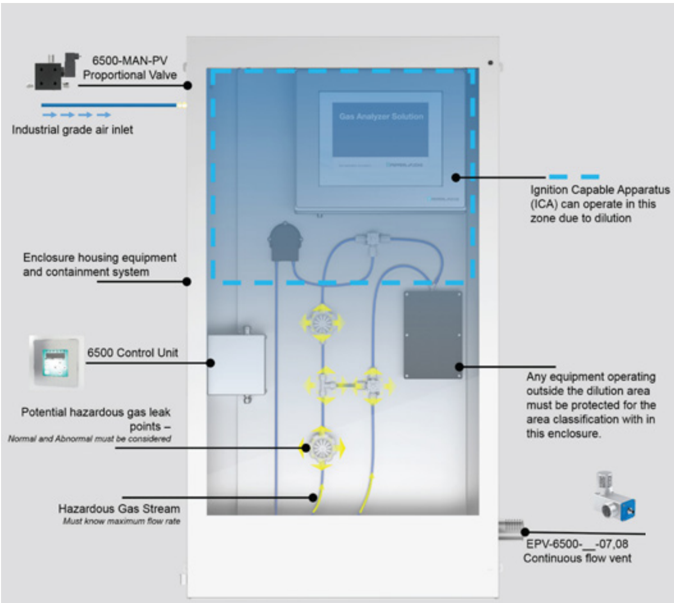
Please refer to the IEC60079-2 or the NFPA496 for determination of the type of dilution, or if it can be done at all.

The following example explains the dilution area and how potential leak points in the containment system can affect the positioning of equipment. It is suggested that any equipment that needs to operate in the enclosure that is an ignition-capable apparatus (ICA) should be isolated from the leaking containment system. The example below has some partitions to isolate the ICA from the containment system. The protective gas supply is introduced into the enclosure at the location of the ICA and dilutes the area so that the equipment can operate when the system is operating.

Warning!

Refer to applicable standard for level of dilution required for safe operation of the ICA.

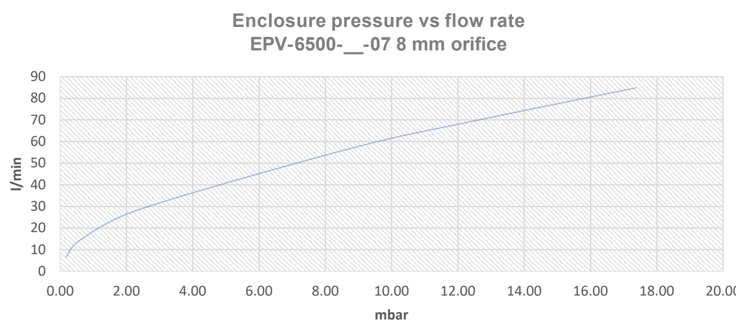
Any equipment operating within the enclosure outside the dilution area would have to be protected for the hazardous area, e.g., Ex e, m, i, etc.



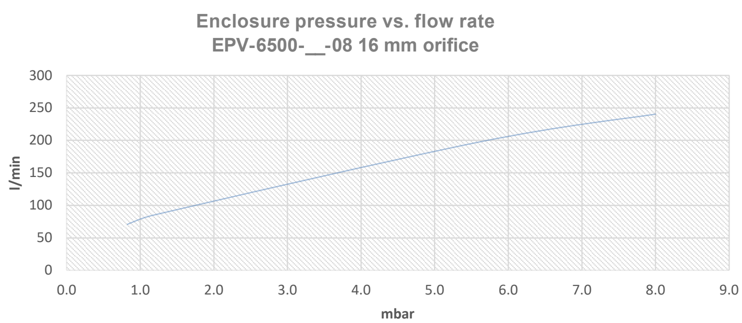
For dilution to properly be applied, the 6500 system would have to use the continuous vent (EPV-6500-__-07 or 08) and a proportional valve like the 6500-MAN-PV. The continuous vent accurately measures the pressure and flow across an open orifice plate inside the vent to provide flow vs. pressure curves for setting up the dilution requirement. For the setup, the 6500 will purge the enclosure at a user-defined flow rate and after purging, the flow will settle at a user-set dilution flow. The 6500 menu also has a MIN FLOW SP (minimum flow setpoint) that can be used to alarm the user if the dilution flow is too low. For shutting down the system, the vent flow/ pressure curves and the enclosure pressure for the shutdown flow in the curves can be used for the minimum overpressure value to de-energize enclosure contacts.

For dilution applications the flow rate of the release of hazardous gas has to be known for selection of the proper vent. There are two sizes of EPV-6500 continuous vents that will cover the continuous flow of most applications. From the graphs below, a selection of proper vents can be determined.

These graphs should only be used for representation of flow and pressure through each type of vent and not for calculating purge time. They can be used for estimating purge time, however, the actual purge time will be automatically calculated by the 6500 control unit. These graphs are used to determine which vent type will be best suited for the application.



8 mm orifice



16 mm orifice

Conclusion

This white paper must only be considered a guideline and depends on the enclosure, the application, and vent used. This information is a starting point and will hopefully help in the selection of a vent to use and will provide information on why and how these vents operate.

For more information on purge and pressurization systems please visit our website and also download our purge and pressurization compendium that covers many purging and pressurization topics.

Your automation, our passion.

Explosion Protection

- Intrinsic Safety Barriers
- Signal Conditioners
- FieldConnex® Fieldbus Infrastructure
- Remote I/O Systems
- Electrical Explosion Protection Equipment
- Purge and Pressurization Systems
- HMI Systems
- Mobile Computing and Communications
- HART Interface Solutions
- Surge Protection
- Wireless Solutions
- Level Measurement

Industrial Sensors

- Proximity Sensors
- Photoelectric Sensors
- Industrial Vision
- Ultrasonic Sensors
- Rotary Encoders
- Positioning Systems
- Inclination and Acceleration Sensors
- Vibration Sensors
- Industrial Ethernet
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