Application Data

Purge & Pressurized (Ex p) Motors designed for Potentially Explosive Atmospheres

OVERVIEW

There are many different types of plants/factories in the world that during the manufacturing process produce potentially explosive gases. Typically they are Oil Refineries, Chemical, Pharmaceutical, Oil / Gas Drilling & Production, Paint plants, etc.

During the manufacturing process or because of the base product, potentially explosive gases will or may be present, which can be ignited by electrical energy. In order to avoid the ignition of gases, it is important to prevent arcs, sparks or incandescent particles from electrical apparatus happening. There are several forms of electrical explosion protection. The types of electrical equipment to be protected will determine how the protection should be accomplished.

Example:

(Intrinsically Safe) Water Level & Flow Instrument

Often available for use with 24V dc hence it can be supplied "Intrinsically Safe". Any electrical energy generated will not be of sufficient power to cause ignition of any gases. IEC symbol for "Intrinsically Safe" is Ex i.

(Flameproof/Explosion-proof) Space Heater or Small & Medium Electric Motors

Operates at 110, 230, 430V ac and therefore cannot be made Intrinsically Safe. The housing is designed to contain a potential ignition of gas. The housing is either a casting or made from heavy plate. IEC symbol for "Flameproof" or "Explosion-proof" is Ex d.

(Purge & Pressurization) Large Electric Motors

Any high voltage apparatus can be protected using this method of protection, by creating an internal pressure greater than the external atmosphere and then purge the housing of explosive gases before applying the electrical power. IEC symbol for Purge & Pressurization is Ex p.

National & International Standards

There are several National and International Standards published and it is important to determine the standards to which the plant has been classified. Although most standards are similar, there are differences that have to be considered. Representatives from most Industrialized Countries produce the IEC (International Electrotechnical Commission) Standards, which form the basis of all other National Standards. IEC 60079- Standards is the basis for standards in Australia, Brazil, Canada, Europe, Japan, USA, etc.

In the 1970's, Europe used the IEC Standards as the basis for producing their own range of standards. As the recently published IEC standards are so similar to the EN (European Norm), Europe has started to replace the EN standards with the IEC standards.

The USA can use the IEC as an option to divisions. Other countries either adopt the IEC or other National standards. Sometimes it is the User/Operator that determines the standards to be used on a plant in a particular country.

Purge & Pressurization (Ex p and 'X' Purge)

Purging & Pressurization is a technique that has been accepted in the industry to protect Electrical Equipment, Electric Motors, Control Panels, VDU's (Screens), Analyzers, etc. The principle of maintaining a positive pressure inside the housing to prevent the ingress of potentially explosive gases from the atmosphere is in itself simple.

But prior to applying power to the equipment a Purge is required to remove any potentially explosive gas that may be present in the housing. The Purge period is to reduce the internal gases that may be present to below 25% of the (LEL) Lower Explosive Limit or sometimes referred to as (LFL) Lower Flammable Limit.

Purge Period

The Purge period (Time) is specified within the standards as follows:

EN 60079-2 / IEC 60079-2 = 5 Volume Changes
(Motors 5 Free Internal volumes + 5 rotor volumes) or Purge Test

Alternatively:
EN 60079-2 / IEC 60079-2 = Purge Test using simulated gases

North America NFPA 496 = 4 Volume Changes
(Motors 10 Internal Free Volume Changes)

Once the purge period has been completed and the electric motor has been pressurized the power can be applied. With electric motors the purge period (timer) is interlocked with the motor switchgear to prevent the motor being started until the purge period has been complete. The motor can then be stopped and started at any time independent of the purge system.

When the motor is online and the motor pressure falls below the minimum pressure specified, either the switchgear would disconnect the power to the motor or an Alarm is initiated by the purge system. The action taken is dependent on area classification and the operator.

Minimum Pressure

European = 50 Pa (0.2 "WC)
IEC/EN 60079-1
Zone 1 = 50 Pa (0.2 "WC)
Zone 2 = 25 Pa (0.1 "WC)
NFPA 496 = 25 Pa (0.1 "WC)

Action on "Loss of Pressure"

Internal Components	Zone 1 / Div 1	Zone 2 / Div 2
Incendive	Disconnect Power	Alarm Only
Non Incendive	Alarm Only	Alarm Only

Zone 2 / Division 2

The IEC 60079-2 Ex p Standard (published in 2001) includes the principle of X, Y, Z based upon the USA NFPA 496 and is defined as Ex pz (Zone 2 with general purpose internal components) and Ex py (Zone 1 with Non Incendive internal components). A label must be fixed to the enclosure specifying the Purge Time and the Purge Flow Rate. The Purge Period is then manually timed before power can be applied manually. As electric motors are not normally local to plant personnel it is more desirable to have an automatic system i.e. Ex px (Zone 1).

IEC and NFPA

Internal Components	Zone 1 / Div 1	Zone 2 / Div 2
Incendive	Disconnect Power Ex px ('X' Purge)	Alarm Only Ex pz ('Z' Purge)
Non Incendive	Alarm Only Ex py ('Y' Purge)	Alarm Only Ex pz ('Z' Purge)

IP Rating

The IP Rating refers to water and dust ingress. With pressurization the housing must also be designed to prevent air leakage. If this is remembered when the initial design is taking place, it normally means that the IP Rating is also achieved.

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The motor casing must be at least IP40. When designing the motor for pressurization it is best to aim for at least IP56 but the bearing seals may be less than IP56 and hence the reference to IP40. If compressed air is used as the Purge Medium then it must be remembered that compressed air can be expensive to produce, so leakage around the bearings should be reduced to a minimum.

MiniPurge Ex p & 'X' Purge System

The following is based on using the MiniPurge Leakage Compensation (LC) compressed air system. Leakage Compensation implies the use of a high purge flow rate to remove any potential explosive gas from the internals of the motor after which the purge outlet closes to allow the system to "Top-Up" for leakage's and maintain a positive pressure.

Purging

Expo Technologies, Purge & Pressurization Systems always measure the Purge Flow Rate at the outlet of the pressurized enclosure via the "Relief Valve". This is the only true and safe way to ensure the enclosure has been purged effectively. All standards state "Airflow THROUGH the enclosure during purging shall be designed to avoid air pockets" or have similar statements. The only true way to insure that the flow is THROUGH the enclosure is to measure it on the outlet. Notified Bodies "Test Houses" have been inconsistent on this interpretation.

The European standard EN 50016 & the IEC 60079-2 both stipulate the Purge Flow Rate shall be monitored at the outlet of the pressurized enclosure. This is a clear statement whereby measurement of flow at a defined purge outlet is a requirement. It is a requirement within the European Standard that ALL pressurized enclosures have to have a "Purge Test" completed to determine the purge time. This purge test is also a requirement for some IEC, Ex p applications. The Purge Test involves "filling" the enclosure with 70% of simulated gas, helium for lighter than air gas and/or argon for heavier than air gas. . Then the concentration of the gas is checked at several points in the enclosure, where gas may be trapped, and the time it takes to remove to 25% LEL (LFL) of the simulated gas is noted. This is a very costly and time consuming test to perform and if the motor and purge system are designed correctly, the tests will normally prove the motor will require between 5 and 10 internal free volume changes to be purged effectively. This test is often required under IEC.

Internal Pressures CACA (TEAAC) and CACW (TEWEC) Motors.

In large motors with Air to Air (CACA) or Air to Water (CACW), Heat Exchangers are fitted with a circulating fan on the rotor drive shaft. A negative pressure will be created at the "eye" of the fan and a higher pressure will be created on the discharge side of the fan. Different pressures will be seen throughout the motor casing. The minimum pressure in the motor when running must be increased to give a positive pressure throughout the motor housing. (Note: CACA motors require an internal pressure greater than the Ambient Pressure. The Ambient Pressure being the pressure seen at the Heat Exchanger air inlet.) This is achieved by the following Tests:

Motor Pressure Tests and Pressure Settings

1) The MiniPurge system Low Pressure Sensor should be connected (6 mm Pipe) to the lowest pressure point in the motor. Normally the "eye" of the circulating fan.

2) A manometer is connected to the Low Pressure Sensor, test point. The motor is started, and pressure readings taken during start-up and at full running speed. The full range of pressures seen should be noted. When the motor is static, the MiniPurge Leakage Compensation Valve will be adjusted to give the Normal Working Pressure. This is made up of the "Minimum Pressure" stated by the standard (see 2 above) plus, the lowest pressure seen plus, a "Lower Effective Working Band" which will also include for possible pressure losses due to additional leakage's that may occur over a period of time. Each machine has different working characteristics so this can only be completed by the test. e.g.

Minimum in the standard = 50 Pa (0.2" WC)
Minimum Pressure observed (see 2)
= Minus 200 Pa [þ to 200 Pa] (0.8" WC)
Lower Effective Working Band = 400 Pa (1.6" WC)
Normal Working Pressure = 50 + 200 + 400 = **650 Pa** (2.6" WC)

Hard (Fast) / Soft (Slow) Start Motors

Some motors have the facility of Soft/Hard Starts where more care is required for setting the Normal Working Pressure. Normally, it is not possible for the manufacturer to simulate a Hard Start at the manufacturing plant; it is the commissioning engineer's responsibility to finalize the settings. Pressure drops of 1,500 Pa (5.9" WC) have been noted when running up on a Hard Start. The circulation fan together with the small clearances through the rotor creates this reduction in pressure on start-up.

Relief Valve

A Relief Valve has to be fitted to prevent an overpressure in fault condition. The MiniPurge is supplied with the Relief Valve as standard and is designed and sized so in a fault condition the maximum supply of compressed air from the MiniPurge Control Unit can be discharged safely.

Setting of the Relief Valve

The Relief Valve (RLV) is normally factory set but can be adjusted by the motor manufacturer should it be found necessary. Taking the above example, the motor has a Normal Working Pressure of 650 Pa. Again there needs to be an "Upper Effective Working Band" of say 200 - 400 Pa. The RLV must be set on a Rising Pressure as follows: - e.g.

Normal Working Pressure = 650 Pa (2.6" WC)
Maximum Pressure observed (see 2) = 300 Pa {plus 200 Pa to compensate for negative figure} = 500 Pa (2.0" WC)
Upper Effective Working Band = 400 Pa (1.6' WC)
RLV setting = 1550 Pa (6.1" WC)

Test Pressure

The motor housing has to withstand a minimum overpressure of 200 Pa (0.79" WC) or 1.5 times the maximum working pressure, whichever is the greater. This Test Pressure is based on the maximum pressure monitored when Purging is taking place or seen in operation. This Test is to ensure that the leakages are not excessive and that there will be no distortion of the housing.

For the example, the "Test Pressure" for the motor casing will be 1.55 KPa x 1.5 = 2.325 KPa (9.2" WC)

In practice the RLV setting can be as low as 1000 Pa [1 KPa] (4' WC) or above 12 KPa (47" WC).

At 12 KPa (47" WC) the Test Pressure would be x 1.5 = 18 KPa (71" WC).

With the possible pressures that can be generated the design of the Motor Casing, Motor Bearings and Motor Heat Exchanger are all very important.

MiniPurge Fitted with CLAPS (Patented)

Some machines will have very little internal pressure variations and the standard MiniPurge systems are very effective but it is dependent on the type and design of the motor. The above illustrates that there can be a wide pressure variations causing the motor manufacturer additional time on the test bed when building, commissioning and the plant operator additional problems with the ongoing maintenance.

The CLAPS "Closed Loop Automatic Pressurizing System" overcomes these problems and makes the total installation very reliable. The standard MiniPurge when requested to include for the "Closed Loop Automatic Pressurizing System" is simple in operation.

The "CLAPS Sensor" is factory set to a predetermined pressure and once the purge cycle has been completed the "CLAPS Automatic Leakage Compensation Valve" (CLAPS ALCV) is adjusted to a pressure just below the CLAPS Sensor pressure. Once the CLAPS ALCV is set and the motor started, the pressure variation in the motor is sensed by the CLAPS Sensor and signals the CLAPS ALCV to increase the flow of air and compensate for the potential pressure reduction and vice versa. The motor will then continuously operate at a constant pressure with ease for the Motor Manufacturer and the Plant Operator.

Purge Systems using Fan/ Blower Air

Electric Motors sometimes replace the Heat Exchanger and use fan / blower air for cooling. This fan air can be the purge medium used for purge and pressurization protection. Leakage Compensation using Fan air (LCF) Ex p or 'X' Purge systems are available but are not part of this document.

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