The Most Popular Construction Techniques for Solenoid Valves for Use in Hazardous Locations

Whitepaper

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I. Why Choose a Plastic Encapsulated Valve Over an Explosion Proof Metal Valve for a Hazardous Location Application?

In a hazardous location application one may be better served by a valve with a plastic encapsulated coil as opposed to a valve that utilizes an all metal containment construction method.

II. What is a Hazardous Location

Hazardous locations are defined as a building or area where fire or explosion hazards may exist due to the presence of flammable gasses, vapors, liquids, combustible dust, or ignitable fibers. The quantity or concentration of these items must be sufficient to present a hazardous location condition.

1) Typical gases that can make an area hazardous include Acetylene, Hydrogen, Ethylene, Gasoline vapors and Propane.

2) Dusts that can make an area hazardous include Aluminum, Magnesium, Carbon Black, Coal, Coke, Grain, Flour, Sugar, and certain Polymers.

III. Safety Techniques Used in Hazardous Location Rated Valves

There are a number of solenoid valve construction techniques that prevent an explosion when used in a hazardous location. While the external temperatures of electrical devices must be limited to a safe level below the auto-ignition temperature of the hazardous ambient, one of the following construction techniques must also be employed to inhibit an electrical component failure from creating an explosion:

1) Flame Proof (Explosion Proof) – Utilizes thick metal components that surround the coil, this method will contain the explosion and ensure that any escaping gases are cooled below the ignition temperature of the surrounding atmosphere. The cooling occurs by only allowing the hot gas to pass by precision machined surfaces which are also known as flame paths. The internal volume of the coil containing housing and the energy content of the hazardous gas dictate the fit and length of these flame paths.

2) Encapsulation – The coil is completely encapsulated and thus sealed in a plastic resin. This method creates a solid barrier between the solenoid coil windings and the surrounding explosive atmosphere. With the coil completely sealed with no free internal volume, the explosive atmosphere cannot come in contact with the windings. Potential arcs created by a failing coil will therefore not cause ignition of the surrounding atmosphere.

3) Powder Filled – The electrical components are completely surrounded with a glass or quartz powder to prevent ignition of the surrounding explosive atmosphere.

4) Oil Immersion – The electrical components are immersed in a liquid that separates the components from the surrounding explosive atmosphere.

5) Hermetically Sealed – A method that encases electrical components in glass segregating them from the surrounding explosive atmosphere.

6) Pressurized (Purged) – The enclosure housing the electrical components is pressurized with an inert gas that prevents the surrounding hazardous atmosphere from entering the enclosure.

7) Intrinsically Safe – Prevents an explosion by limiting and controlling electrical and thermal energy available for ignition.

IV. Advantages and Disadvantages of the Most Common Hazardous Location Solenoid Valves

The three most common construction techniques for producing Hazardous Location solenoid valves are Flameproof, Encapsulated and Intrinsically Safe. This paper will focus on these three constructions.

1) Flameproof (Explosion Proof) – This is the most common technique and has been in use for many decades. The biggest advantages come from its perceived rugged construction and it proven history of reliable service.

   a. Advantages

      i. A rugged all metal design

      ii. The external housing can be used as the return flux path for the solenoid

iii. A proven history of reliable service

iv. Market acceptance

b. Disadvantages

i. Costly to machine the tight tolerance flame paths

ii. Exposed metal is susceptible to corrosion. With the housing typically made of magnetic steel, it must be plated to achieve an acceptable level of corrosion resistance.

iii. The flame path design requires larger components than the encapsulated concept

iv. An explosion proof valve certified to be used in the A & B gas group locations is typically not cost effective to make because of the flame path size requirements.

2) Encapsulated Coil – While not a new concept, this approach to hazardous location approval is gaining market share as more consumers are becoming aware of the distinct advantages inherent in this design.

a. Advantages

i. The encapsulated design is a cost effective solution for gas groups A & B.

ii. The encapsulated design provides a smaller package size when compared to the metal explosion proof concept.

iii. The encapsulated design is more cost effective to manufacture than the metal explosion proof concept.

iv. The encapsulated design offers a higher level of environmental protection (IP 66) when compared to the all metal explosion proof concept.

v. The encapsulated coil eliminates the need for a conduit sealoffs. For Division 1 and Zone 1 locations, electrical components are required to be segregated from the main conduit system through the use of a sealoff fitting. With properly designed encapsulated coils, the electrical coil is inherently sealed which eliminates the need for the sealoff.

vi. The encapsulated design is physically tough. The plastic design sometimes is misperceived as a delicate device. However, in order to achieve agency ratings using the encapsulation technique, the encapsulated coil has to be exposed to 13 different solvents (Acidic Acid, Acetone, Ammonium Hydroxide, Benzene, Ethanol Acetate, Furfural, 2-Nitro Propane, N-Hexane, Methanol, Methyl Ethyl Ketone, thylene Dichloride, and Diethyl Ether) and then traumatized by a 5 foot pound ball drop test. Any subsequent crack that propagates into the winding area is a failure.

vii. Without the need for a bulky housing, more volume can be used for coil windings. This inherently yields a more electrically efficient design in the same size package as a flameproof design. The increase in efficiency can then be exploited to reduce power levels which will inherently yield better T ratings. (The T rating refers to the temperature at which the explosive atmosphere auto-ignites. Lower power levels yield lower total temperatures of the coil and thus allow it to be used in hazardous areas that have lower auto-ignition temperatures.) Low power levels also lend themselves for use in Intrinsically Safe applications. Lastly, the better efficiency can also be utilized to increase the valve flow and/or maximum operating pressure differential performance.

viii. Being encapsulated, it is inherently moisture resistant which allow the use in areas that require up to an ingress protection of IP66. The majority of the exposed coil is also plastic which is much more corrosion resistant than plated steels which are typical in flameproof designs.

b. Disadvantages

i. With the majority of the external surface of the coil made of plastic, there is a misconception that this style device is not as rugged as a flameproof version. Consequently, this has inhibited wide spread market acceptance.

3) Intrinsically Safe Valve – This technique is popular outside North America where Zone classifications are used. It is also the only accepted technique allowed for Zone 0 locations.

a. Advantages

i. Very low power consumption.

ii. The only allowed technique for Zone 0 areas.

iii. Industrial wiring can be much less expensive as the conduit and wiring requirements are less stringent than for items that are classified as explosion proof.

b. Disadvantages

i. With very low power consumption, the ability of the solenoid can limit pressure and flow ratings for direct acting valves.

ii. A matched, power limiting barrier must be used and mounted in a nonhazardous location.

V. Summary

While there are several different construction techniques that are feasible for making a solenoid valve safe for use in hazardous (combustible) locations, there are three that are widely used in many industries. One of the oldest and most popular is the explosion proof (flameproof) technique that uses metallic housings with precision machined flame paths. While these large, robust structures have been the staple for many decades, the encapsulated technique which seals the electrical coil in plastic from the explosive atmosphere has been gaining momentum and consequently more market share. The benefits of this technique can also be exploited to make intrinsically safe solenoids which are the only technique that is accepted for Zone 0 applications.

For more information about solenoid valves, please contact Sales at info@peterpaul.com.

ABOUT PETERPAUL

Peter Paul Electronics, founded in 1947, is a premier manufacturer of solenoid valves including high flow, explosion proof, high pressure, plastic, safety and mini valves. PeterPaul configures possibilities from solenoid valves that operate with power as low as 1/2 watt to pressure as high as 5000 psi. PeterPaul is located in New Britain, Connecticut and Fajardo, Puerto Rico. High quality design, innovative research and product development set PeterPaul apart from other manufactures. Continuous improvement is in the fabric of the company on all levels with people having years of experience, dedication and pride.

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