

Choosing the Right Ball Valve to Curb Fugitive Emissions



Series 60 ball valves by Swagelok, featuring a flange-type body seal. The valve consists of three discrete sections that are joined together with flanges, seals and bolts.

Fugitive emissions are usually described as a wide range of emissions not confined to a stack, duct or vent, including emissions from bulk handling or processing of raw materials, windblown dust and other industrial processes. When a leak is extensive enough to pose harm to the environment, it produces fugitive emissions.

Focusing on external leaks from ball valves, the critical point is to select the correct ball valve for the application. Two design features are especially important in controlling fugitive emissions — the body seal design and the stem seal design.

The two most common types of body seal design are the screw type and the flange type. While the screw type is

a stronger seal, enabling higher system pressure, the flange type allows fast and easy maintenance with the valve in line.

In the screw-type fitting, the sealing area is relatively small and can be an especially efficient seal, enabling effective sealing at pressures as high as 1378 bar. In addition, the design enables a wide range of end connection choices.

In valves employing the flange-type body seal, the valve body consists of three discrete sections that are joined together with flanges, seals and bolts. Because the sealing area across these components is larger, this design usually results in a lower pressure rating. However, these valves have fewer geometric constraints on the sealing material, and therefore allow a wider choice of sealing materials. Another advantage of the flange-type design is the ease of maintenance.

In a ball valve, there must be some means of ensuring that the system

media does not leak from the stem and body interface. This is the role of the stem seal. With sufficient cycling frequency, all stem seals are subject to wear, which can lead to leakage. However, some seals are more effective than others in certain applications.

The most basic and primitive technology is a one-piece gasket that encircles the stem. The gasket, usually made of polytetrafluoroethylene (PTFE), is crushed — filling the space between the stem and the body housing. Unfortunately, PTFE and other similar packing materials are subject to cold flow, which can be exacerbated by pressure and temperature, and lead to leakages.

To reduce the risk of fugitive emissions, the one-piece packing design should be reserved for applications with minimal fluctuations in temperature and pressure, limited cycling, and where inspection and monitoring will be frequent and regular.

A two-piece chevron stem packing design allows for wider temperature and pressure ranges, and regular and easy actuation without excessive wear. A chevron packing consists of two matched gaskets, one fitting inside the other. For the chevron seal to work correctly, the two PTFE gaskets must be held in place to reduce cold flow during thermal cycling.

Another effective stem seal technology is the O-ring design. When properly designed, this technology provides flexibility for applications requiring a broad pressure range.

The O-ring is usually made from a highly elastic material, such as fluoro-carbon FKM. A proper stem design with an O-ring configuration requires a backup ring or some other mechanism, usually made of PTFE, which will contain the O-ring under high pressure. In

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terms of temperature, pressure and chemical attack, the design is limited by the specifications of the elastomer.

Beyond issues relating to stem seal design, there are some additional causes of leaks from the stem. These have to do with the alignment of the stem. There are two basic causes of misalignment. In the first case, misalignment may result from improper installation of the actuator, causing the stem to become tilted, resulting in uneven wear of the stem seal. In the second case, damage to the seat seal inside the valve may cause the stem to tilt.

Ball valves can employ either a floating or trunnion ball design. In a floating ball design, the ball is not fixed inside the housing but floats between two

seats. In the shutoff position, the ball seals against the seat on the low-pressure side, and is pushed downstream by a positive pressure differential.

By contrast, the trunnion design employs a ball, but the ball is not a discrete sphere. Rather, its geometry includes two cylinders, the “trunnions,” affixed to the ball at the top and bottom. The unit fits into a space in the valve body and cannot move along the flow axis.

In the case of high differential pressure across the seat, a free-floating ball can be pushed too far downstream. In the absence of an advanced seat design, the ball may not return to the center position. As a result, the stem will tilt to one side and uneven stem wear will occur.

The trunnion design prevents excessive movement of the ball downstream. The trunnions keep the ball centered and the stem properly aligned.

Different designs have different strengths and relative merits, which directly impact fugitive emissions. The real cost of a valve is not the purchase price but the overall cost of ownership. Considering that raw material feedstock prices are increasing, the frequency and severity of environmental noncompliance fines are growing, as are direct and indirect costs associated with frequent maintenance; it becomes imperative that failure and replacement become key factors in the decision of which valve is best suited to one's needs. 💡