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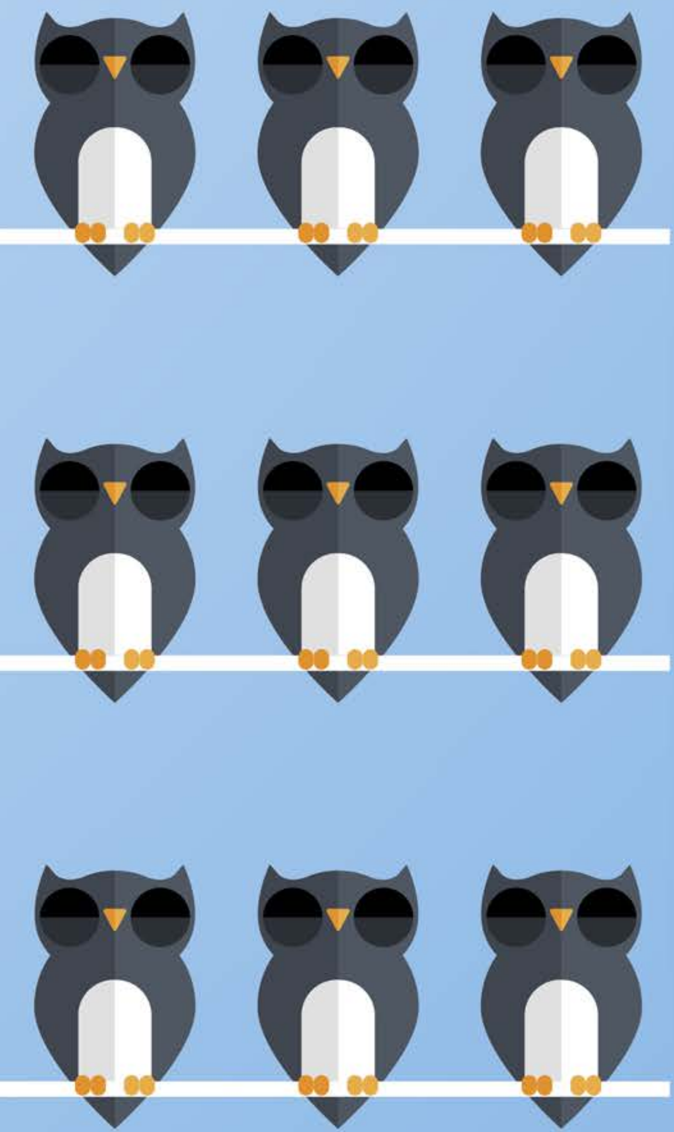
ISOLATION?



Mark Abbott, ValvTechnologies, USA, examines the challenges to effectively isolating hot, high-pressure fluids in oil and gas, and the modern valve solutions which exist to address this issue.

Isolation is an age-old problem in flow control. In this context, isolation refers to the ability of a valve to stop the flow of process material without leaking. Conceptually, successful isolation is the ability to take a pipe spool out of line with an upstream valve closed against any manner of hot, high-pressure process media and not have any of the fluid or pressure leak into the area previously occupied by the missing pipe spool. Whether isolating to keep process streams separate, to protect workers when changing out or working on equipment downstream, or to keep process fluid from spilling on the ground, the challenges are similar. The results can be disastrous when valves fail to properly isolate.

Consider cases common to hydrocarbon processing where failure to properly isolate the fluid causes both financial effects and drives frustration:

Hydrocracker plant

In a hydrocracker plant, the isolation of the exchangers is critical as they need to be cleaned from time to time. Completely removing the process flow is necessary. Plants may have parallel exchangers; when operators cannot isolate each exchanger in turn, they must bring the whole unit down to clean the exchangers which stops production and costs money. Low-level globe valves are commonly used in this application and are susceptible to a build-up of salts on the seat surfaces from the crude. This consistently interferes with the valve's ability to seal and provide isolation.

Atmospheric crude unit

An atmospheric crude unit can improve its productivity by recycling the leftover vapours through a pump-around loop. However, when the gate valves in the system fail to seal due to a salt build-up on the sealing surfaces, it is no longer possible to perform maintenance downstream on the pump and exchangers. This drives the operator to shut down the entire unit when they need to service the equipment, as the leaking gate valves make isolation impossible.

Fluid catalytic cracking unit (FCCU)

In an FCCU, the slurry decant process commonly relies on gate valves to control the flow of process fluid. The process fluid includes catalyst and coke fines, which tend to foul the gate valves, resulting in the valves' failure to completely stop flow. This failure makes cleaning the cyclic filters nearly impossible and, in turn, puts the pumps and exchanges

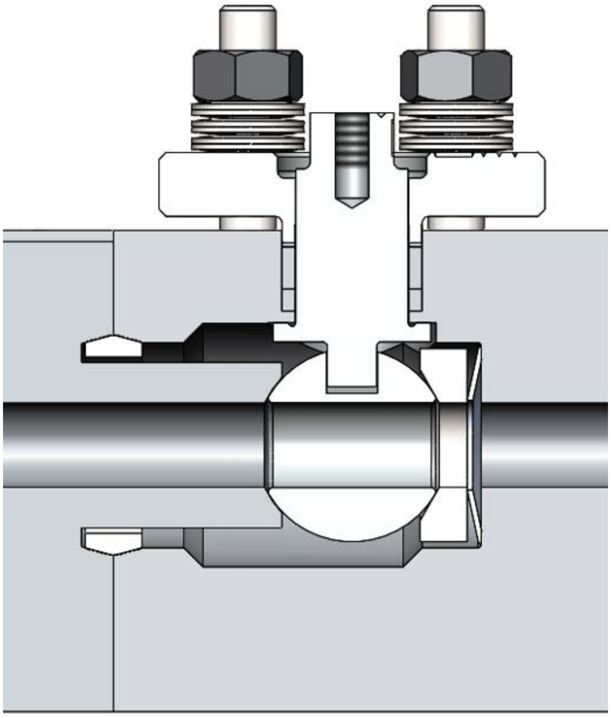


Figure 1. V Series valve sealing components.

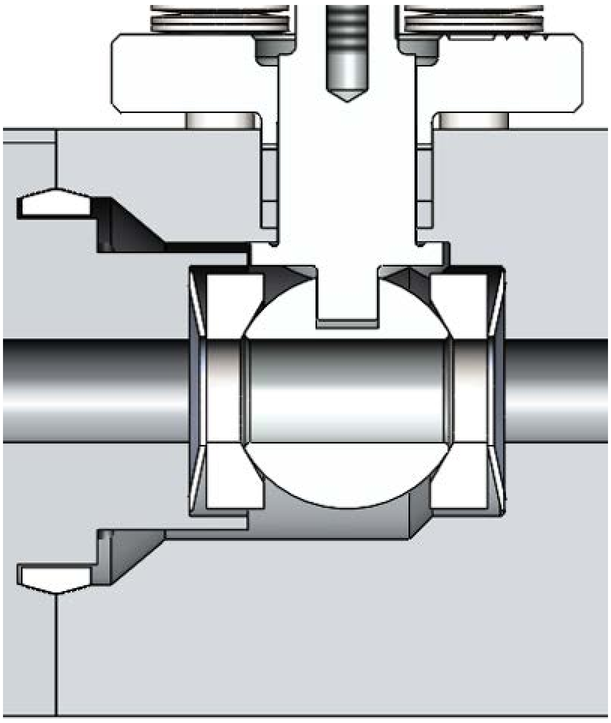


Figure 2. Common symmetric dual seat design ball valve.

Table 1. Examples of the thermal growth properties of different materials		
Material	**Coefficient of thermal expansion (CTE µm/m-˚C)**	**Growth of 6 in. circle at 400˚C**
Body and end cap SA-182 F347H	18.9	1.094 mm
Ball of I718 SB-637 N07718	13.0	0.752 mm
Recommended ball material SA-638 660	18.5	1.071 mm

further downstream at risk, as they may not be adequately protected. The inability to isolate the system from upstream pressure creates a serious safety issue as the flow is 700˚F. This creates a high-risk environment for personnel if it leaks so much as a drip.

Coke fractionator

A coke fractionator may use a wedge plug valve to isolate the flow between the drums. If the isolation valves cannot seal and isolate the drums, the coker unit cannot run at a reduced rate while the isolated drum is cleaned and repaired. When repairs become mandatory, the entire unit must be shut down, all because an isolation valve failed to isolate. This can have knock-on effects of shutting down production much further upstream if the facility cannot handle the coke product elsewhere.

Modern valve designs

To address situations like these, ValvTechnologies designed the V Series valve, which is based on a seat-supported design, where one seat is part of the end cap and the seating surface is machined into the leading edge of a spigot while the other seat floats freely on the other side of the ball (Figure 1).

This new design approaches isolation from several directions to help the valve isolate. First, the design does not present an extra leak path. In some other designs, fluid can pass around either side of the seat, between the ball and seat or between the end cap and seat, as shown in Figure 2. In a seat-supported design, the fluid must pass between the ball and seat to enter the downstream bore as no other path is available. In this manner, the number of points that require tolerance and tight control is reduced from two to one.

How many floating seats are needed?

Having a loose downstream seat also introduces issues of seat warpage due to temperature or other deformations which can compromise the ability of the seat to seal. While the valves are designed and tested at ambient temperature, the loose seat may fit tightly in a pocket and snug against the ball, producing a successful seal. However, as temperatures rise, the varying materials and internal stresses in those materials have been shown to cause the seat to warp or twist, reducing surface seat contact down to line contact or worse. Any particles in the process fluid that can easily perforate a line contact and then lodge underneath the exposed edge of the seat does not allow it to return to its prior shape when cooled. When the seat is deformed at temperature and not providing surface contact with the ball or end cap geometry, it fails to fully isolate the process material.

It has been said in the real estate industry that the most important aspect of a property is its location. This is equally true of the ball-to-seat interface on the downstream side, where sealing happens in isolation. If the ball is not properly located on the seat surface, the spherical contact cannot happen. With the design of the V Series product, the end cap seat provides a fixed spherical seat within the valve. The ball is pressed against this seat by an upstream seat and a Belleville® spring, as shown in Figure 3. The two spherical surfaces will find their

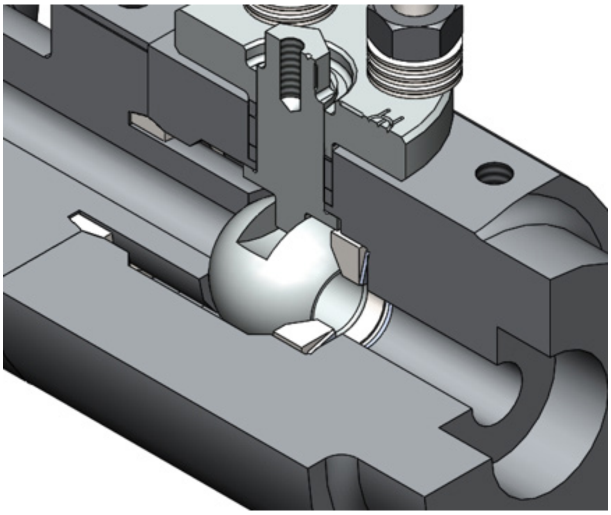


Figure 3. Spherical seat contact.

contact and maintain their respective centrelines due to the nature of the spherical geometry. The stem plugs into a slot in the ball to incite the forces to turn the valve, but does not push down, only turning the ball. The end cap-to-body bolting does the rest by holding the end cap and body together tightly.

As a result, the interface between the ball and the end cap seating surface is maintained. Isolation is dependent on the contact between the end cap and ball.

The metal-to-metal seat surface provides temperature stability, as it does not melt or soften substantially as temperatures rise, as many sealing materials do in valves. In addition, the tightly compressed surface between the ball and end cap on the V Series is energised by the Belleville spring at low differential pressure, but then the downstream pressure provides additional compressive force especially at high differential pressure. The design of the seat scrapes any process material from the ball during cycling and ensures the ball and seat remain in contact to seal.

Material selection and geometry

From a stress point of view, the spigot moves the mechanical seating stress further away from the other areas of stress; the end cap to body bolting and the stem gland loading region. By separating these regions by a distance, the overall stress levels are reduced as the stresses cannot combine or superimpose to as high a degree. Lower stress in the valve means a more stable valve and a much lower chance of a component failure in operation. Failure due to superimposed stress can include body cracks, internal cracks, leaks outside the valve or complete valve failure. The separation of the stressed regions on the V Series allow the loading of the Belleville spring to focus solely on sealing the ball to the end cap and isolating the flow in the closed position.

Selection of material is an important part of making a metal seat-supported ball valve work. Consider the components detailed in Table 1. Many isolation applications occur with high temperature process fluids that are commonly at high-pressure. As a result, the material within the valve will undergo thermal growth. Table 1 illustrates how thermal growth is normalised over a 6 in. distance, and it is clearly evident that the I718 ball, while common in some applications, is not compatible with the body and end cap material as they grow at a substantially different rate. Changing the ball to SA-638 type 660 brings the thermal growth much closer to that of the ball and end cap, resulting in a valve which will seal at elevated temperatures.

Summary

Failure of a valve to isolate the process material can have a substantial impact on the surrounding equipment and the safety of workers. High-temperatures and high-pressures are typical in hydrocarbon processes. Frequently, isolation is needed to maintain downstream equipment, which without proper maintenance, places production levels and workers at risk. The valve product outlined in this article has provided isolation for more than 30 years in industrial processes around the world. The seat-supported design allows the valve to isolate flows that are both high-temperature and high-pressure, sealing against liquids, gases, slurries and more.

EPA mandate on coke drum venting

Implemented in 2016, the US Environmental Protection Agency (EPA) issued a Risk and Technology Review (RTR) mandate in coke drum venting for petroleum refineries. Components of the rule included: new emissions for refinery storage tanks, continuous regeneration units (CRUs) and delayed coker units (DCUs); work practice standards to reduce emissions from atmospheric pressure relief devices (PRDs) and flares; continuous benzene monitoring at the refinery fence line to improve the management of fugitive emissions; and elimination of exemptions to emission limits for uncontrolled releases during start-up, shutdown and malfunction.

The rule imposes monitoring and reporting of emission releases from pressure relief devices to the atmosphere. The regulation calls for a programme of process changes and pollution prevention aimed at reducing visible emissions by major pressure release devices. This change affects a wide-range of applications including DCUs and its coking processes. Older coker valves are challenged to meet the rule and, because of this, refineries in the hydrocarbon industry must modify their existing process.

To meet EPA standards, ValvTechnologies recently installed zero-leakage coker valves in refineries in Texas and Louisiana, US, ranging from sizes 14 to 20 in. 300# ANSI flanged with HVOF RiTech® coating. The valves are composed of C12 and carbon steel body materials and, based on the plant's needs, designed with either pneumatic or electric actuation.

ValvTechnologies supplied these refineries with severe service technology to extend the valve's isolation capabilities, improve its processes with minimal shutdown maintenance, and save operators thousands of dollars eliminating the need to install expensive emission reduction technology. In addition, the company's engineered solution ensures plants are in compliance with the EPA's strict air-quality standards.