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The Emerson severe service team provides global customers with Fisher® severe service control valve solutions. Whether it is severe service applications for the power, hydrocarbon, chemical or pulp and paper industry, these technical experts deliver sound solutions to address critical applications for aerodynamic noise, cavitation and out-gassing issues, as well as particulate erosion. Please visit our website or contact your local Emerson Process Management sales office for more information on how the severe service team can help you.

Outgassing Versus Flashing - What are the Differences?

While outgassing and flashing may seem similar to many process engineers, the driving forces and the effects on a control valve are quite different. Flashing occurs when the pressure of a fluid falls below its vapor pressure. At this point, the fluid begins to change from a liquid to a vapor, both of which have the same chemical makeup. The vapor pressure is a function of the fluid temperature and, therefore, flashing is a function of both the pressure and temperature of the fluid. For the fluid to flash, heat must transfer from the liquid during the vaporization process and this requires time.

Outgassing results in a liquid and gas mixture as well, but the driving force is strictly due to the fluid pressure being below the saturation pressure of a gas dissolved in a liquid. Once the fluid pressure is below that saturation point the gas comes out of solution and the liquid and gas have a different chemical makeup. The best illustration of outgassing is what occurs when a bottle of champagne is opened. Immediately, the pressure inside the bottle drops to atmospheric, which is below the saturation pressure of the dissolved carbon dioxide. The same holds true in a control valve. A fluid with the required heat transfer takes a certain amount of time to flash whereas outgassing requires no heat transfer and occurs much faster. Downstream of the valve the two phenomena can appear to be similar, but at the throttling point the difference can be dramatic.

Flashing is well understood behavior and valve sizing for flashing is covered by standard liquid sizing calculations. Outgassing, which can occur in many combinations of liquids and gases, does not follow a specified thermodynamic path and special valve sizing routines are required to handle it. Likewise, valve and trim styles as well as material selected for flashing applications may not be suitable for outgassing. So how can you tell if your application may have an outgassing or flashing problem? Two indicators are the liquid and gas exiting the valve have different molecular weights and the valve is providing liquid-level control for a phase separation process.

Your local Emerson Sales or Local Business Partner office can help obtain the best solution to your outgassing or flashing problems.

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Fisher® Control Valves Help Minimize Flashing Damage

Flashing can result in significant erosion damage to a control valve and adjacent piping. There is no erosion coefficient, no industry standards, and no scientific means for predicting the intensity of flashing damage. However, Emerson understands that flashing damage potential is a function of many factors which include flow rate, fluid velocity, pressure drop, corrosive nature of fluid, body geometry, and valve body and trim material.

Flashing cannot be prevented by the control valve as flashing phenomenon is a direct result of application conditions and fluid properties. However, selecting a control valve designed with special consideration of flashing can avoid or minimize the flashing damage and then extend valve service life. Emerson engineers worldwide are trained to recognize flashing problems and address them in the most effective manner.

When flashing is encountered, control valves can be selected just as they are for erosive fluids. Emerson offers several valve styles and options that are best suited for flashing application. These include angle body with hardened liner, straight-through eccentric rotary plug and high chrome molybdenum globe valve with expanded ends and robust trim.

Fisher angle vales are designed with a flow path that causes only a single change in fluid direction. This design has less opportunity for liquid droplets to impinge on critical valve surfaces compared to the tortuous path provided by globe valves. Fisher angle valves are available with replaceable, hardened liner in the outlet area to provide increased protection against erosion damage. The liner is generally made of hardened material and serves as a sacrificial part. It prevents liquid droplets from impinging directly on the valve body and significantly minimizes body damage and extends service life. As the liner can be replaced much more economically than the valve body, maintenance cost can be reduced also. Fisher EA series valves have proven successful in flashing applications for many years.

Fisher V500 valves provide a straight−through flow path that minimizes the potential for erosion damage to critical parts. Fisher V500 features very robust and massive inner components which can tolerate erosive fluid and extend the service life of the valve. The eccentric plug and seat ring are available in a variety of erosion-resistant materials including solid alloy 6, chrome carbide coating, and ceramics.

Fisher EW valves are another field-proven solution for flashing applications. Fisher recommends alloy steel construction, which contains additional chrome and molybdenum, to provide enhanced resistance to erosion. Fisher EW valves feature expanded body end connections to reduce the fluid velocity and thus eliminate flashing damage. There are also several hardened materials available for trim to eliminate erosion damage.

Which valve style is best for your application? Sliding stem angle valves in the flow-down direction are most common and the best solution overall for flashing applications. For installations where piping cannot be structured to angle valve requirements, the Fisher V500 valve is recommended. The Fisher EW is a good solution for pressure drops of less than 400 psig (28 bar). Class V is the recommended minimum shutoff required for flashing control. When the valve is in the closed position, with leakage greater than Class V, flashing damage will occur downstream of the valve seat which can limit valve life and impact plant operation.

Fisher EA Angle Valve

Fisher V500 Valve

Fisher EW Valve

Fisher® Control Valves Combat Outgassing

Outgassing can cause problems in a control valve because of the sudden increase in flow volume once the gas comes out of solution. Because the gas has a much larger volume than the liquid, the flow area needs to be larger or else the velocity of flow will increase. A restricted flow area can create a stream of high velocity liquid droplets with the potential to be erosive to any surface they impinge upon.

Another problem is the release of energy that the valve and piping are subjected to and the potential for high vibration levels. A valve designer must reduce these damaging effects. To design or select the proper trim, the engineer must know the pressure and volume of the gas coming out of solution. The flow passages can then be correctly designed to control the velocity of the fluid through the trim. Since outgassing is not a thermodynamic process that can be predicted accurately, the designer must account for this inaccuracy in sizing and selecting a suitable trim.

The simplest and oldest solution to outgassing is to use a single-stage pressure drop. A flow-down angle body design, such as the Fisher 461, has been successfully used for many years. Its expanded outlet reduces the velocity effects and a swage in the downstream piping can further reduce the velocity of flow. The angle body design helps the fluid to change direction gently and avoid an increase in turbulence and the direct impingement of the fluid on the plug and seat ring.

An alternative is to split the pressure drop into two or more stages. However, as the number of stages increases it becomes increasingly difficult to correctly account for the change in volume. Some manufacturers try to stage the pressure drop using a series of flow restrictors in the trim, but the results are questionable and difficult to justify given the increase in complexity and cost.

The Fisher DST-G valve reduces the pressure drop through defined reduction stages. Between these stages are open volumes that allow the fluid to recover before entering the next stage to ensure that the velocity between stages is low. The last stage is a series of vertical slots around the circumference of the trim, flowing from the inside to the outside. These slots split the total flow into smaller pockets thereby reducing the energy released by the fluid in each flow passage and reducing vibration and velocity effects on the outlet. The small passages also increase the frequency of noise generated so that it does not transmit as well through the downstream piping.

For low volume outgassing, it is acceptable to drop pressure through more stages and the Fisher NotchFlo™ DST valve uses a series of notches cut into the valve plug to create these. In this design, the flow moves upward through the trim and plug notches each being a definitive pressure drop.

Good shutoff is another important feature for valves used in outgassing applications. Any leakage between the plug and seat will generate outgassing and quickly damage the seating surfaces. In the pressure-staged designs described above, Class V shutoff is standard and any leakage that does occur is staged through the trim at low velocity.

Fisher 461 Valve

Fisher DST-G Valve

Fisher NotchFlo™ Valve

Fisher® DST-G Valves Selected for Challenging Hydrocracker Application

Refineries in Europe are building new hydrocracker units to meet the increasing demand for diesel fuel and to process heavier sour crude. Hydrocracking is one of the most versatile of all petroleum refining processes. As hydrocracking takes place, sulphur, nitrogen, and oxygen are almost completely removed and olefins are saturated so that products are a mixture of essentially pure paraffins, naphthalenes, and aromatics. This flexibility gives the hydrocracking process a particularly important role as refineries attempt to meet the challenges of today's economic climate.

In a typical hydrocracking process the feedstock is heated and fed to a reactor containing a catalyst where the reaction takes place. The reactor effluent is sent to a hot separator where conversion products are flashed overhead and heavy unconverted products are taken as hot liquid bottoms. The vapors from the hot separator are fed to a cold separator where recycle gas is separated from the product. The product is sent to the fractionation and the recycle gas is returned to the reactor via the recycle gas compressor.[1]

The separator letdown valves are uniquely challenged due to outgassing, which can result in noise, erosion, vibration, and plugging due to the presence of the catalyst. In a control valve operating in a pressure range of 2,000 to 3,000 psid (138 to 207 bar), the exiting mixture of vapor and liquid can result in severe damage to the valve trim and also result in noise and vibration.

The Emerson sales office in Spain recently was awarded a project consisting of 20 valves for a hydrocracker project in Europe. As a part of the project, Emerson is supplying Fisher DST-G valves with alloy steel bodies and hard-faced trim to withstand erosion and a pressure drop of 1800 psid (124 bar) at temperature of 608° F (320° C). The DST-G valve, with its unique passage and a slotted cage on the downstream, can withstand the catalyst particles and also attenuate noise. The valves were selected based on Fisher's proprietary "bracketing" method of sizing which takes into account the amount of vapor content at the outlet of the valve and estimates the downstream area to accommodate the volumetric expansion at the outlet of the valve. The plant is scheduled for startup in mid 2011.

[1] Robert A. Meyers, *Handbook of Petroleum Refining Processes*, Third Edition.

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