Severe Service Valves

Technologies and Markets

The identification of severe service valve markets is illustrated by an analysis of the molecular sieve switching valve where a unique solution was needed.

By

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There are many difficult applications for valves. High temperatures, abrasive solids, corrosive fluids, and rapid cycling are just some of the conditions which challenge the industry. Both isolation and control valves must be designed appropriately. The valve industry has referred to these applications as “Severe Service.” The problem is that there is no precision in the definition. The annual market for these valves is anywhere from $6 to $14 billion/yr. depending upon how you define SSV. As a result the McIlvaine Company is working with the industry to obtain consensus.

We were delighted to learn that **Ross Waters president of CGIS** has been active in defining severe service valves. His company has extensive and lengthy experience in the supply of severe service valves in multiple industries in various countries. We interviewed him on the subject and obtained some insightful answers.

Q: Why should there be a consensus definition of severe service valves?

Ross: “It’s for the betterment of our industries. Valve providers, users and designers have a number of tools and information available to select valves, but my experience is that many applications require a far deeper analysis and understanding than others and a universally accepted objective definition of what constitutes severe service will aid in ensuring that the valves selected will provide the service the application demands. The application dictates the valve. As more of us apply our intellect to improving valve performance in diverse applications, more and more objective measureable information will replace the subjective information we have allowed to falsely give us comfort.”

Q: Where does this initiative presently stand?

Ross: “It is moving ahead in fits and spurts. We have begun to see individual companies adopt the concept and amend their Approved Manufacturers Lists (AMLs) with Severe Service Valve sections and entries. A few months ago we saw on a valve data sheet “not a commodity valve”! I expect to have a better answer after the annual meetings at the Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) in May 2016.”

Q: Where are severe service valves needed?

Ross: “SSVs can be found in non-return, isolation and control functions. Severe Service Control Valves (SSCVs) do have reasonable industry agreement on what can define Severe Service. However, Severe Service Isolation Valves (SSIVs) do not. Non-return (check) valves for Severe Service applications should be treated as control valves and sized so that its operation is consistent with flow-rates of the process rather than the pipe size they are typically selected for.

“Control valves take energy out of a piping system; isolation valves contain the energy and non-return valves delay and reduce the energy from its full effects on the isolation and control valves. All valve design functions require basic information, but for those valves destined for severe service, it is imperative to have a comprehensive understanding of the factors that affect their in-service performance.”

Q: Can you give us some specific examples of severe service valve applications?

Ross: “The classic one that keeps me intrigued is the autoclave block valve application. While we have had autoclaves used in the minerals processing industry for over 70 years, the commercialization of nickel laterite ores through the use of pressure acid leaching (PAL) has not yet reached twenty years. In the early years anecdotal evidence suggests a reliable potential valve life of a handful of cycles. Today manufacturers are reaching for a few hundred, and while this order of magnitude increase in cycle life is valuable, in many cases this will only provide a working life of several months. In order to improve the efficiency, safety and profitability, industry needs to have reliable block valves that can guarantee years of life.

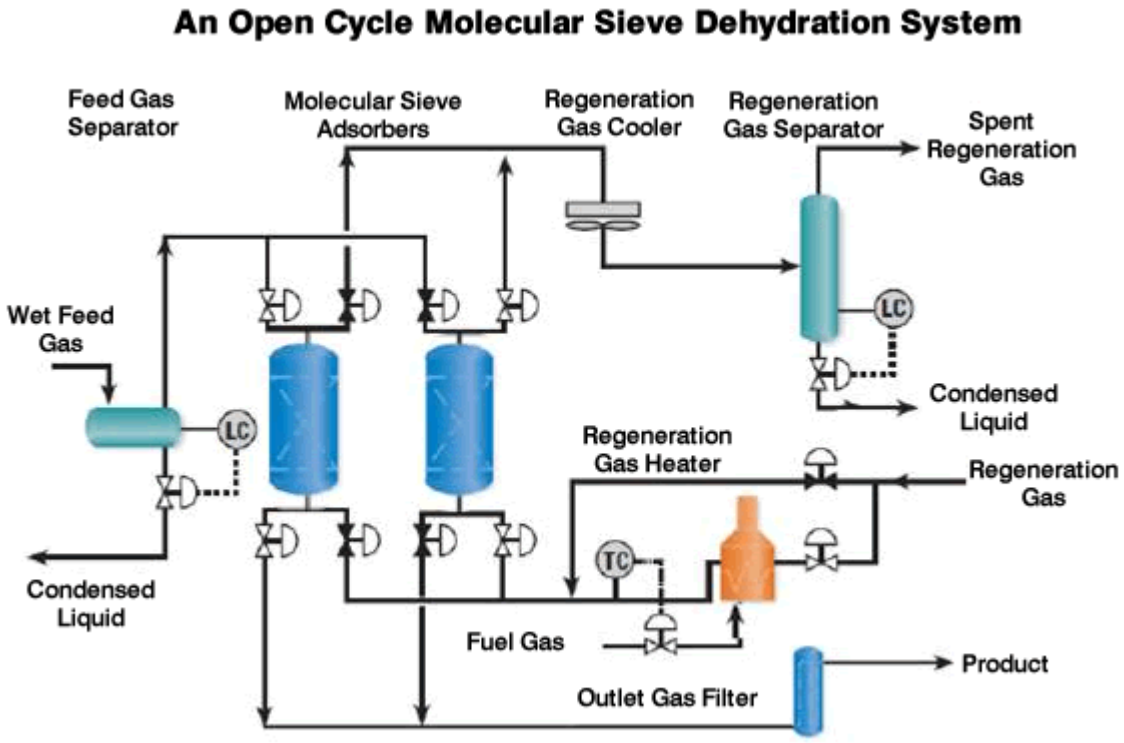
“Isolating mineral slurries is also a challenging application, especially at higher pressures and velocities. CGIS has commissioned a slurry test loop to provide some insight into the number of cycles one can reasonably expect to obtain using different valve types, materials and configurations. We plan to have more definitions to add or refine to the ones we have proposed in Defining Severe Service Valves published two years ago.” (Editor’s note: Ross wrote an article on this subject which was published in Valve World, June, 2015)

Ross further identified the following severe service applications: Autoclave let-down, Boiler Feedwater, Choke valves, Coal gasification, Compressor anti-surge, Engine test stands, Fluids with high out-gassing potential, HP separator drains, Minimum flow recycle, Solar power molten salt, Slurry control, Toxic/Lethal Service, and Turbine by-pass

Seals are critical components of severe service valves. What are the considerations? **Ken Lavelle, president of Flowserve Seals** summed it up for us.

“There are multiple sealing options for today’s valves, depending on the design and service conditions of the valve. Common material options are many forms of PTFE and graphitic materials, which can be reinforced, or live loaded. Metal bellows seals are also available as hermetic options which do not need adjustment”.

The Mcilvaine Company is now providing detailed analyses of severe service valves in the power industry and is also involved with the process technology in many industries where severe service valves are needed. A few years ago Mcilvaine helped one of the large oil and gas companies determine better ways of removing mercury from natural gas. Mcilvaine also publishes a market forecast for coalescing filters to remove liquids from natural gas. Mcilvaine analyses absorption and dehydration. The molecular sieve is widely used for dehydration in gas extraction and processing. The molecular sieve switching valve is a good example of the severe service requirement.



Molecular Sieve Courtesy of UOP

The molecular sieve dehydration unit is an important process in any plant that uses natural gas as a feed stock. These units are critical in drying natural gas and the processes that follow such as the extraction of Natural Gas Liquids and the production of Liquefied Natural Gas. Switching valves are vital to the proper and efficient operation of these molecular sieve dehydration units.

These valves are subject to high temperatures and frequent cycling. Not many valve types are capable of withstanding 1000 cycles/yr in a hot, dry and sometimes hostile environment. The importance of leak-free valve performance in molecular sieve service cannot be overstated according to Flowserve and ValvTechnologies. For the deep gas drying process, it is imperative to meet the required specifications for optimum NGL purification and products processing. Any leakage caused by the switching valves will

lead to compromised product quality output. Furthermore, leaking valves can retard catalyst performance by allowing the formation of hydrates.

During regeneration, the desiccant routinely emits a gritty, dust-like powder which can escape the columns and enter the piping and valves. This abrasive dust can quickly erode valve seats and seals. **Flowserve, ValvTechnologies** and others caution that for enhanced unit availability and increased process throughput, considerable care must be taken in the selection of both valve type and its materials of construction. These decisions will significantly mitigate potential seat damage and optimize the sealing capabilities of the switching valves.

Many valves have been used on this service but few are performing as might be wished. Three valve designs are usually found in molecular sieve unit switching valve service: (1) metal-seated ball valves; (2) metal-seated, triple off-set butterfly valves; and (3) metal-seated, non-contacting, rising stem ball valves. Some rotary valve options such as the triple offset butterfly valves are relatively inexpensive to purchase and may perform adequately in the near term. Operators, however, have generally found them to be deficient in sealing capability, expected service life and total cost of ownership. Process disruption, high MRO expense and the inability to deliver a minimum of five years of continuous service between planned shutdowns have all been persistent negatives.

Historically the rising stem ball valve (RSBV) has been used in this application. But the selection is complicated and depends to some extent on the severe conditions. Flowserve generalizes that this valve with its friction-free linear movement and mechanically energized metal seat has proven it to be the most suitable design for optimal long-term performance in severe applications, **Cameron** also recommends the rising stem ball valve. Cameron says it provides tight shutoff, withstands frequent cycling, and handles high temperatures better than other valve types in this service.

ValvTechnologies draws some different conclusions based on specific experiences. They say that more long-term success has been realized with metal seated quarter turn ball valves and can cite installations were the rising stem ball valves have been replaced. ValvTechnologies' zero-leakage carbide coated metal seated ball valves were selected and installed for a major operator's sour gas plant in Monkman, British Columbia, replacing rising stem ball valves that lasted one year in service. These valves feature the same design proven since ValvTechnologies' produced the seat supported fixed ball design.

The first installation in a molecular sieve lasted eight years after its initial installation, providing severe service zero-leakage isolation. Given a conservative one day shut-down per year to replace other designed valves in a plant processing 220mmcfd of saleable gas at $750,000 per day, which is $6 million improved efficiency over the course of eight years.

ValvTechnologies' metal seated ball valves were also selected by an oil and gas plant in Kazakhstan that was facing hundreds of millions of dollars in production losses annually. A major global oil company placed a multimillion dollar order with ValvTechnologies for molecular sieve switching valves to replace their existing rising stem ball valves.

The issues in this service, which handles gas with an H_2S content of over 20%, included leakage to atmosphere, unreliable operation, mechanical breakdowns and unscheduled shutdowns. In addition to the safety and environmental concerns, the client faced threats to the integrity of the downstream equipment. The initial response to these challenges included the planning of a full parallel dehydration facility to cope with the ongoing concerns with the legacy equipment.

Upon careful review of the application the selection was made to employ ValvTechnologies' seat supported design technology. The selected materials included Inconel 825 for the valve body components and Inconel 718 for the internals.

The operational performance of the valves since startup has exceeded the client's expectations. With this experience, the client felt confident to cancel the scheduled parallel installation project, which saved them hundreds of millions of dollars.

Coatings play an important role in making valves suitable for severe service. Hard coatings such as tungsten carbide are being used. Companies like ValvTechnologies have developed processes to address safety, reliability and performance. HVOF RiTech™ is a high velocity oxygen fuel coating process, with properties of high density and negligible porosity. A hot, high velocity gas jet sprays a coating of molten particles onto the ball and seat surfaces. An oxygen fuel mixture is forced through a spray gun nozzle and ignited. A mixture of powdered materials (tungsten, carbide, nickel, chromium, etc.) are also forced through the spray gun nozzle. The ignited gas forms a circular flame surrounding the powder as it flows from the nozzle for uniform heating, melting and acceleration (5000-6000° F at >7000 fps).

Benefits of the HVOF RiTech™ process include**:**

- Improved quality
- Abrasion/corrosion protection
- Improved wear resistance
- Improved performance
- Ability for components to operate in higher and/or lower temperatures
- Ability to operate in the most severe service applications

- Improved efficiency

We asked **Jake Brunsberg of Plasma Coatings** for his thoughts on the opportunities for coatings to improve severe service valve performance. Jake responded “Unique solutions to severe service challenges can be provided with technologies such as HVOF and Hardfacing applications such as PTA, and Laser Cladding. New engineered carbide coatings are emerging to tackle applications in the toughest environments. We are continually working to stay on the cutting edge of these developments to work with companies to tackle these severe application environments.”

The molecular sieve is just one of the thousands of severe service valve applications which need to be continually reviewed. So there is a substantial task ahead. Many of the valve suppliers are willing and able to pursue the goal of properly defining each application and analyzing the best options in terms of valve design and materials. McIvaine looks forward to reporting their progress and analyzing the market implications.