



Severe Service Valve Specifications for Hydrometallurgy Applications



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Abstract

The technology behind industrial applications such as Hydrometallurgy continues to evolve, as do the corresponding regulations and specifications that ensure the safety of workers and the environment. Valves make up key aspects of this technology, and often represent the single point of failure for entire operations. More often than not, the valves being used in Hydrometallurgy applications are known as Severe Service Valves (SSVs) due to their ability to withstand the extreme conditions. Most experts agree that SSVs are identified by applications, and that these applications are challenging to the valve's ability to provide a minimum acceptable level of performance over a minimum acceptable duration. The Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry has designated Ross Waters, President of CGIS, as Lead to the Task Force put in place to determine the minimum requirements a valve needs to be able to perform to when faced with extreme conditions, whether from pressure, temperature, toxicity, solids, or usage. This paper serves to determine what the minimum requirements are for SSVs in Hydrometallurgy applications. It will draw on five decades of industry experience from one of Canada's leading valve experts.

Introduction to SSVs

Severe Service Valves

Severe Service Valves (SSVs) mean different things to different people. Until today, defining SSVs had little if any global agreement or recognition. That is about to change as the Manufacturers Standardization Society (MSS) has accepted an application to produce a Standard Practice so defining them.

This paper provides information about the selection of SSVs in all industries but focusses on metallurgical processes and applications and offers examples to illustrate the successful and unsuccessful use of these valves. All of this with the purpose of raising the awareness of the industry on all sides, from the suppliers and manufacturers, specifiers and to the users and owners of them. It also supplies tools to understand where and why to separate SSVs from general purpose or commodity valves (GPVs).

SSVs are often identified by applications, and these applications are challenging to the valve's ability to survive. Within these applications the elements that make the service severe are being analyzed, quantified and qualified. From this, we expect to offer objective and repeatable definitions and guidance to improve the experience of SSVs, reduce unnecessary costs, provide longer service life and process runs, improve safety and reduce environmental issues.

All Industries Use SSVs

SSVs can be found throughout all industries, however some industries harbour many more challenges than others. For example, municipal water treatment will have fewer SSV opportunities or needs than mining or chemical industries. In general, valves have two basic uses; they either control a process variable like pH, or they isolate the process. No matter what type of valve – from ball, butterfly, check or globe – all fit somewhere into the basic role of control or isolation.



The dilemma is for the valves to remain in service providing one of those singular functions and performing at a basic level required or demanded by the process. Severe services challenge that performance and life expectancy. SSVs must deliver a minimum performance over a minimum period of time. The valve industry does have a better understanding and agreement of what defines a Severe Service Control Valve (SSCV). Table 1 provides some reasonable thresholds that can be applied to any control valve situation and be used to make a reasonable determination that the application is severe and therefore requires a SSV.

Table 1. Determining Factors for Severe Service Control Valves (SSCVs)

Condition	Formula/Reference	Threshold	Notes
Cavitation	$(P1-Pv)/(P1-P2)$	$\sigma > \sigma_i$	Cavitation index per ISA-RP75.23
Choked flow	FL	$Q > Q_{choked}$	ISA-RP75.23
Erosive flow	Velocity normal flow	$>8 \text{ m/s inlet}$	Clean liquids
Flashing	$P2/Pv$	≤ 1.0	Liquids only
High alloy metallurgy	B16.34	$> \text{Group 3.1}$	-
High energy state	$dP(\text{Pa}) \times Q$	$>100 \text{ kW}$	Q is volumetric flow
High noise	IEC 60534-8-3&4	$>85 \text{ dB}$	-
High turn down ratio	Q_{max}/Q_{min}	>10	-
Scale precipitation	-	$>1 \text{ mm/y}$	-
Slurry	-	$>10 \% \text{ solids } >5 \text{ m/s}$	Suspended solids
Temperature	-	-	-
high normal operating	-	$>425 \text{ }^\circ\text{C}$	Or as per B16.34
low normal operating	-	$<-50 \text{ }^\circ\text{C}$	Fluid temperatures

An example would be where the fluid will likely be near or at a cavitating state. ISA RP75.23 provides basic formulas that can be used to determine whether the fluid will or will not cavitate in service. At this state, fluids are accelerated and their vapour pressure is reduced in a proportional relationship. Should the pressure reduce below the media's vapour pressure, the fluid will separate into two or more phases during a condition known as flashing. Flashing by itself can and will be erosive, but if the downstream pressure recovery is such that the fluid is above its vapour pressure, the resultant collapse of the flashed gas creates the damaging condition of cavitation.

Two of the most challenging hydrometallurgical severe service control applications are found on every autoclave circuit; these are the pressure let-down valve and the vent control valve. Of these the pressure let-down application gets the most attention. A very limited number of manufacturers specialize on this application and offer angle body globe control valves that take the autoclave operating pressure and reduce it to atmospheric pressure through the valve body. This creates an incredible velocity increase and separates the autoclave solution into different phases. Recent design work has produced significantly prolonged service life by enlarging the interior valve gallery, adding rotational flow guidance and focusing the discharge through improved flow geometries through choke tubes and blast targets.

For isolation valves we have far less agreement or easy to accept definitions of SSVs. Table 2 provides some reasonable thresholds, although it is admitted, we are still debating and discussing these, and it appears we may need to a combination of thresholds to occur in order to qualify as severe. For example, if we use the

temperature threshold of 260 °C – the upper useable limit of fluorocarbons – this eliminates one of the world’s best seat material options and we are forced into metal seats which are far more challenging to use and produce “tight” shut-off isolation performance. “Tight” itself needs further definition and objective measurements and is in fact being defined by MSS.

Table 2. Determining Factors for Severe Service Isolation Valves (SSIVs)

Condition	Formula/Reference	Threshold	Notes
Available on demand	IEC 61508 & 61511	100 %	
Category M fluids	B31.3	All	
Cryogenic fluids		<-150 °C	
Fugitive emissions	ISO 15848-1 & 2	<500 ppm	VOCs
High alloy metallurgy	B16.34	>Group 2.4	Also all unlisted high alloys
High dP	dP/P1	>0.8	
Solids deposition		>1 mm/y	
Slurry >10% solids		>20 barG	
Tightness of closure	FCI 70.2	>Class V	
Temperature	>260 °C	>260 °C	

One significant lack in most isolation valve datasheets is a clear expectation of isolation performance. For many in the industry, we blindly use FCI 70.2 as the performance level. You will see Class V or Class VI listed frequently. These classes do offer a measurement for “allowable” leak rate. The anomaly is that the title of the Standard is Allowable Leak Rate for Control Valves. Control valves can leak because they should not be used as isolation valves, and SSIVs should not.

The valve industry is only just now catching up with the demands of highest performance valves and providing us with better tools that have been available in the past. For instance, we currently don’t have an industry Standard to source an isolation valve performance that doesn’t allow some passing (seat leakage). One can reference a valve test Standard such as API 598 or ISO 5208 and add a required performance statement like “valve seat testing to API 598 resilient seat”, but that eliminates metal seated valves from selection even though some metal seated valves are capable of the tightest isolation. For now, the most common isolation valve performance Standard in North America is FCI 70.2, yet it has no category for zero seat leakage.

An example of an SSIV could appear as a process isolation requirement to provide better than FCI 70.2 Class V shut-off for two years continuous service. A typical application for this example in hydrometallurgy would be an autoclave block valve. This application has proven to be one of the most challenging of all SSIV applications. Failure to remain “tight” causes severe damage to the valve’s seats, balls and end-caps. Any passing of the erosive, corrosive and abrasive fluid at the differential pressures experienced in typical autoclave circuits allows more passing until such time as the valves, even in their martyr and master twin configuration, fail to hold autoclave pressure and the clave is forced to shut-down. This is an expensive loss of production as it can take several days to depressurize, cool, flush, heat and repressurize. The block valve’s significant acquisition cost pales to the loss of production.



The limiting factor in these ball valves is the surface coating for the ball and seats – Titanium Dioxide. Different surface preparations, methods of application, powder size and under-coatings haven't yet stopped facilities for looking to the next technology to push what was a one cycle confidence into many hundreds. A new technology that significantly increases the surface coating "adherence" beyond that of TiO₂ is in the trial stages and looks full of promise.



Figure 1. Autocalve Block Valve Damaged Ball

The focus on SSVs has uncovered a lack of data that has been responsible for making the proper selection more challenging and therefore more prone to failures. When one compares the datasheet of a control valve with one for an isolation valve, you will commonly discover that a fundamentally important element is missing from the isolation valve datasheet. You will be provided the static conditions in the datasheet; maximum design temperature, pressure, pipe size, media, Class, material of construction and often flowrates from minimum to maximum.

For a control valve this is all one really needs because the control valve operates 100 % in the dynamic conditions that can be calculated from the data between minimum and maximum flowrates. But for an isolation valve which is typically static for most of its service life, without knowing the number of cycles and normal operating position – normally Open or Closed – one cannot properly consider the effects of the dynamic conditions that occur when transitioning between Open and Closed or vice versa. It is this transitional state that exposes the valve to very different conditions than when it is at rest and when it is most vulnerable

SSVs and Hydrometallurgy

Hydrometallurgy Applications Where SSVs Are Found

SSVs are found throughout hydrometallurgical applications, and especially so in the higher-pressure applications found in pressure oxidation (POx) or pressure acid leaching (PAL). But even the lower pressure applications found in atmospheric leaching can bring valves to a short life or make them into non-useable pipe extensions.

In the leaching process, corrosive media combined with dissolved solids often precipitate out, confounding the valve's ability to move or seal properly. Experience has taught us to look beyond the simple selection of materials based upon the data sheet. It is imperative to consider all of the static and dynamic conditions that

will be encountered throughout the valve's installed life and look out to the valve's end-of-life cycle to arm it with the features that are needed to survive.

For SSVs in hydrometallurgy, typical challenges include the deposition of solids that precipitate out of the media during temperature, pressure or flow changes. These solids can interfere with the valve's ability to perform its role as an isolation or control valve. For an SSIV this is often seen as an inability of the seat to seal properly, allowing passage which can be detrimental to the process integrity or erosive to the valve itself and cause increasing damage to the sealability. The deposition rate of the solids can be substantial.

One valve design challenge required the 10 in Class 300 titanium grade 12 valve to close after one month where a deposit of nickel sulphide of up to 1 mm per day for 30 days was possible. This required a thrust output far higher than is normal and we selected a cylinder bore nearly twice the diameter usually supplied, and used oversized tubing, pilot solenoids and quick exhausts so that we could get the 5.5 barG compressed air we used as the cylinder power into and out of it quickly. The strategy has worked since installation in 2005 and despite an 18-month plant closure when BHP divested itself of the plant, shuttered it and First Quantum Minerals bought it.

This shut down provided an interesting proof point when comparing the recommended 17.4PH cylinder rods to the industry standard chrome plated carbon steel rods. Upon restart of the plant, none of the cylinder actuated valves supplied needed to be serviced or replaced, while the vast majority of other industry standard valves needed new cylinders due to the atmospheric corrosion at the plant site.

Selecting actuation for hydrometallurgical applications requires a far deeper analysis and addition of safety factors in order to provide the long-term reliability that the process requires. Is not as simple as taking the maximum differential pressure and the minimum air or power supply and determining from the valve's torque or thrust value what actuator to select. We must consider the effects of inactivity, cycle requirements, normal rest position, media influence over time, upset conditions and availability on demand; all within the valve's ability to handle the added torque or thrust and not be damaged.

SSV Specifications for Hydrometallurgy Applications

When isolation valves leak by passing energy, differential pressure can produce a velocity increase and the media can become a destructive agent, removing mass from the seating areas. This makes the leak worse and eventually the isolation valve is incapable of operating in its intended form.

Determining the minimum level of isolation that is required at the end of the service life of an SSIV is critical. That demands understanding what the life cycle of the valve will be and all of the conditions that will be experienced during the valve's life. Without this full knowledge it is extremely difficult to select the valve type, the sealing system, materials of construction, valve bore, the operator, whether manual or automated, or special options demanded by the application.

When looking at containment (and the purpose of the valve is isolation), we need to think about resistance to corrosion from a clean process fluid. Design codes like ASME B16.34 provide operating pressure and temperature limits for each pressure Class at various operating temperatures for categories of materials. For example, valves of ASME Standard Class 300 for Group 2.2 materials, consisting of several grades of stainless steels including the common forged and wrought 316 and cast CF8M, have a working pressure by



Class in barG at a range of temperature. A Class 300 valve of this material operating between -6.6 to 37.8 °C (20 to 100 °F) has a 49.6 barG (720 psig) pressure limit, the valve's maximum allowable working pressure (MAWP). In order to meet that working pressure the manufacturer will produce a valve body with a minimum body wall thickness. This wall thickness will be thicker than necessary to add a safety margin. In the factory testing, this extra safety is proved by pressurizing the body 50% beyond the maximum allowable working pressure during its factory hydro test. So if the corrosion begins to reduce the wall thickness either evenly or in discrete pockets or sections, the valve becomes vulnerable to loss of containment.

If you refer to the Figure 2. Sulphuric Acid Isocorrosion Chart you will find lines depicting less than or equal to 0.5mm/y (20 mpy) corrosion. Note how alloy CF8M is only suitable for very weak or very strong acid at low temperatures and alloy CD4MCu disappears from suitability while two others that were in the same suitable category remain for a range of higher temperatures.

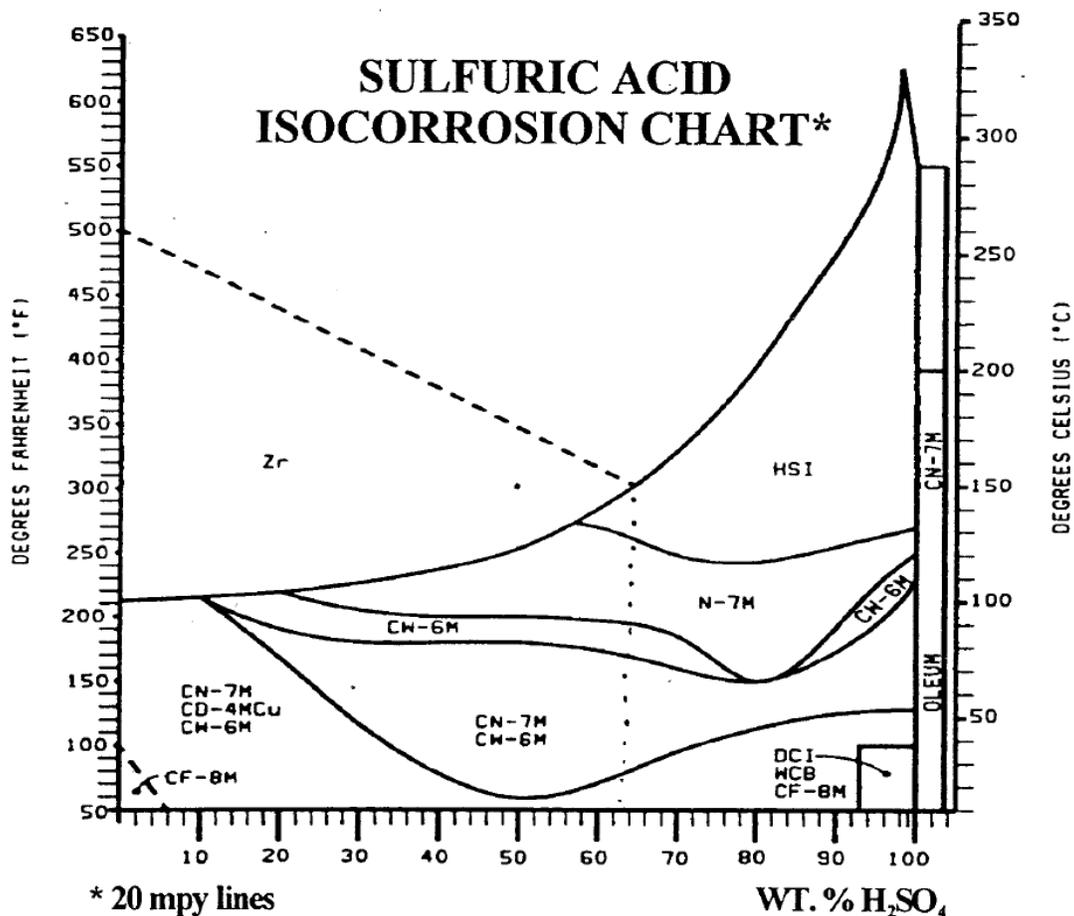


Figure 2. Sulfuric Acid Isocorrosion Chart, courtesy of Flowserve

Key Factors for Selecting SSVs in Hydrometallurgical Processes

Respecting the overall piping system's corrosion allowance, often expressed as x mm/y (mpy), you generally select valves with a trim (the sealing parts) that have less than 0.025 mm/y (1 mpy) corrosion rating while

the body would have less than 0.50 mm/y (20 mpy). This practice leads to examining the body wall thickness during the time one examines the piping. Some SSVs applications would demand a lower corrosion allowance, based on the severity of an upset, the time period between maintenance turnarounds or minimum process runs.

Table 3. Valve Position and In Situ Health

Type	Position	Phase	Severity	Determining Factor/s
Isolation	Open Fully	Steady Dynamic	Medium	Pipeline flow variation
Isolation	Cycling Closed	Accelerating Dynamic	High	Number/duration of cycles
Isolation	Cycling Open	Decelerating Dynamic	High	Number/duration of cycles
Isolation	Closed Fully	Steady Static	Low	Tightness of closure

Table 4. Corrosion Allowance Data for Valve Health (mil per year)

Corrosion Allowance	Valve Health
< 0.025 mm/y (1 mpy)	Excellent
< 0.50 mm/y (20 mpy)	Good
< 1.27 mm/y (50 mpy)	Satisfactory
> 1.27 mm/y (50 mpy)	Poor

Knife Gates Valves and Their Use in Hydrometallurgy

Knife gates can be broken down into five types – Conventional, Through-Gate, Line, Push-Through and Guided Shear Gate. All have been and are used in mining, mostly successfully. However, when the process involves acidic leaching, two of the five that are often used, Lined and Push-Through, fail regularly and cause environmental damage as well as cost the facility an increased OPEX. While their designs work well in low pressure, low cycle, and neutral pH applications where discharge is benign, this is not true when the applications have higher cycle frequencies, higher pressure or are corrosive with acidic pregnant solutions. For these applications, only Guided Shear Gates should be chosen.

Using two recent projects, we examined the details on what was requested technically and where these details cause issues. One of the projects is a Pressure Oxidative Leaching (POL) facility in Canada and the other is a Pressure Oxidation (POx) facility in the Caribbean. There are many others in Pressure Acid Leaching (PAL) as well as Atmospheric Leaching (AL) we have evidence from.

In the case of the POL project, early engineering design pointed to a decision to use a push-through style of knife gate. Experience with this style of knife gate valve made us believe it would be problematic, specifically in any of the acidic services where the valve was required to cycle; every cycle produces a discharge and more cycles produce greater discharge.

The nature of the push-through knife gate design allows the body to be constructed of a material that does not necessarily have to be resistant to the process fluid, as the valve's elastomer sleeves fully isolated the body from the process. That observation is valid when the body is not subjected to corrosive attack from valve discharges or leaks from the valve itself or surrounding equipment.

After alerting the engineering design team to this concern, a decision was made to only use push-throughs on manual applications and use a different style of knife gate for the automated applications as it was determined these would have a higher cyclic requirement. The RFQ continued to use the original valve codes that were developed to identify push-through knife gates. This meant a bidder who had experience in hydrometallurgy and offered a style of valve where the body was in contact with the process only had the gate material to use as a key to metallic body material selection; or in the case of a lined knife gate, a resistant body liner that acted like the sleeves of a push-through protecting the valve body from corrosion.

For CGIS, this meant that a valve with a titanium gate must have a titanium body; experience had shown us that push-through or lined knife gates suffer a very high percentage of failure and OPEX is far higher than a properly selected knife gate.

Our offer also paid particular attention to the actuation selection. We have seen uncounted numbers of valves in the field where the cylinder is far too small to power the valve open or closed on demand due to the significant changes that occur on valve thrust while in service. Applying a robust safety margin for thrust was the result of seeing valves in actual service and knowledge that a successful automated valve was one that continued to provide the closing or opening power at the end of the valve's useful life; not only when it was new.

When the actuator is a spring cylinder, this is even more important, not only from a valve operation point of view, but also from a safety perspective when cylinder seal replacement is necessary. A push-through design won the manual and a lined knife gate won the many hundreds of automated valves. Since 2013, we have maintained contact with the facility and while not wishing any ill will on the site, we predicted that they would suffer from the decision to use the valves they chose. During a site visit on April 15, 2016 we began looking at some of the problems that have arisen as predicted and a program to replace the worst performers is underway.



Figure 3. Failed corroded ductile iron body with titanium gate protected by a Teflon liner at a POL facility

The cost savings from using a ductile iron body with a protective inner Teflon liner is false economy when they fail in a short time frame from external corrosion. What else was striking about this 10-inch lined valve was the size of the bore of the spring return cylinder, and the lack of extended tie-rods that would allow a safe decompression of the spring when undoing the cylinder tie-rods in order to replace the pneumatic piston and rod seals during maintenance. We estimated the cylinder bore to be 10-inches on this valve rated to 150-psig CWP.

Comparing the above valve with what we quoted provides these differences:

CGIS Recommendation

Actual Selection

Valve body Titanium Grade 2

Valve Body Ductile Iron ASTM A395

Cylinder bore DN 450 (18-inch)

Cylinder bore DN 250 (10-inch)

Tie-rods extended

Tie-rods not extended

One other significant difference between the lined knife gate and our recommended guided shear gate was the very specific need of load distribution and filler rings and gaskets that the lined valves required when installed in certain types of pipe. Flange gaskets are required for some piping and not for others. Filler rings are required with every lined valve, load distribution rings are required with rubber-lined or PTFE lined piping, but not with FRP piping. The load rings are 1.27 cm (0.50 in) thick and when required are used on both sides of the valve, adding 2.54 cm (1.0 in) to the valve face to face (which makes them non-compliant with B16.10, MSS-SP-81, MSS-SP-135).

The level of complexity of installing the lined valves into the various pipes and obtaining the proper filler ring height is high and requires a detailed user data matrix for each valve size and connection type as well as a substantial dedicated inventory of rings and gaskets. The added time it took to install these valves would have been substantial as would mistakes. Guided Shear gates require no special rings and mate conveniently against both flat and raised face flanges with simple standard gaskets – no load or filler rings required.

The second case is a large POx plant in the Caribbean. The same knife gate manufacturers that were selected for the POL project in Canada were selected for this plant, although the push-through knife gates included automated versions as well as manual. As the community of hydrometallurgy is very tight and close, information travels around and problems that began to surface at the POx facility were seen by people who had seen the same issues at other plants. Some of these common issues were acidic discharges damaging the valves as well as surrounding equipment and building structures including the floors; as well as automated valves not being able to fully cycle open or closed.

Push-through knife gates either freely discharge the process on every stroke (a discharge that grows with the number of cycles and age and type of the elastomer sleeves) or the discharge can be contained with the addition of a discharge containment plate or drainage system. If you add a containment plate or system to control the discharge, you need to ensure the materials are compatible with the process fluid. If acidic, the body needs to be corrosion resistant as well. This defeats the cost advantage of using the sleeves to protect the body from corrosion, as does the cost of the containment system. A program is now underway to replace this type of knife gate with the non-discharge guided shear gate.



This facility uses a great deal of lime to neutralize the acidic process fluids. Lime slurries vary in their effect on valve thrust due to the nature of their solids concentration, precipitation rates and adhesiveness. CGIS has analyzed these applications and learned that one needs to size the actuator generously as well as use anti-stick body and blade coatings and polish all interior surfaces.

In this case, a decision was made to select one bid from others. It was based on what was clearly a standard method of passing through to procurement a number of technically acceptable offers. Since the technically acceptable offers presented equipment that should operate substantially in the same way, procurement selects the best commercial package. That is a valid methodology.

The problem is that the technical acceptable review can be flawed. For SSIVs the level of detail presented must be far more detailed than is necessary for GPVs. Beyond the standard information of size, connection, piping material, media, temperature, pressure, actuation and selected body and trim materials, it is essential to have a deeper understanding of the required cycling duty of the valve and the media. SSIVs are not just pieces of pipe; isolation valves have a dynamic phase when they cycle and if this dynamic phase is not fully understood, one cannot fully appreciate what the consequences can or will be.

The media may have very different characteristics when flowing normally or when stopped. These conditions not only occur during the valve's Normally Open or Normally Closed positions; but depending on the types of valves, can occur in trapped cavities within the valve. If you don't analyse carefully what these changes can do for the valve's operating thrust or torque, you run the danger of under-powering the actuators selected and then having a valve that cannot provide the duty it was designed to.

There are no universal hard and fast rules on cylinder sizing; one uses the basic information provided on the valve datasheet: Valve Size, Line Design Pressure, Shut-Off Pressure, Media (to ascertain a media factor for sizing), Actuator Power Supply (pneumatic, hydraulic, electric), and Actuator Action.



Figure 4. 9-Tonne, 9 m (30 ft) long Spring Return Pneumatic DN 700 Class 300 Guided Shear Gate

We recommend applying five media factors (Lubricating, Clean and Clear, Mild Slurry, Severe Slurry, Scaling) to the torque or thrust of a new valve based on the design pressure load on the valve and using the lowest power value if there is a range, e.g. 6.5 barG 80 for 6.5 - 9.3 barG air supply or 104.4 barG for 104.4 - 207.9 barG hydraulic supply.

CGIS then applies a generous safety factor to ensure the valve will cycle on demand after it has been installed in the application and aged due to its normal functioning. This safety factor does have a cost impact but it has led to a history of 100 % success of availability of the valve on demand. This in turn led to CGIS obtaining the first SIL 3 approval from Lloyds

for a knife gate valve. It also produced an extraordinary creation.

The above valve is a case for “just because it can be done, doesn’t mean it should”. We pleaded with the client to allow us to provide the hydraulic fail-safe actuator version and dedicated accumulator, but his demands were to use pneumatic power inside and hydraulic power outside. The customer is always right, so we supplied four units and a few years later, four replacement hydraulic actuators and accumulators to eliminate the earthquakes the plant felt when the valves closed.

For hydrometallurgical plants, overwhelming evidence exists detailing that push-through knife gates should not be used on applications that are acidic, require a reasonable number of cycles and operate at higher pressures, or for alkaline applications that exhibit substantial solids deposition.

Guided shear gates have the most features and best fundamental design to operate in these challenging conditions and provide the greatest degree of success. They are not more expensive than other knife gate types when all parts of the valve design are compared to the same parts of the other valve types that are required to operate successfully for a number of years. Understanding how valves operate, perform, and what the application needs is vital to selection; as is clear objective communication.

Summary

SSVs for hydrometallurgical applications should meet or exceed the single or combined thresholds provided in Tables 1 and 2 as well provide the base duty of the valve, be it isolation or control for a minimum agreed upon operating duration.

This means:

- Valves must deliver longer than 1 year and a day operating service
- Corrosion allowances must be tighter than the pipe they are mounted in
- Actuation must provide significantly higher output than that used with GPVs; size on worst case conditions
- More complete operating conditions must be supplied to ensure the best valve technology is chosen
- CAPEX while important must be balanced with OPEX
- Experience counts; don’t expect GPV suppliers/manufacturers to be able to supply SSVs

Hydrometallurgy offers many challenging situations to valves. Apart from some misunderstandings and subjective terminology used for years which have prevented a more successful betterment of the industry, the processes developed over the last many decades and newer ones utilizing chloride leaching to handle increasing complex ore bodies place more extreme requirements on valves to perform as envisaged by the process designers and owners.

The valve industry is working to provide better information to ensure the correct selection of SSVs and the proper language to nominate the valve so that it can function in service and meet or exceed our expectations. We have discovered the need for more details on the actual process dynamics including the percentage of time spend during different dynamic conditions as well as upsets, and to consider what those

dynamic situations are doing that could damage the function of the valves, whether immediately or over time as the sum of the damage adds up.

There is a place for SSVs just as there is a place for GPVs and knowing where to draw that line is essential in obtaining the best, safest and lowest cost valve solutions. In the coming months, we will see better tools for identifying SSVs, including new Standards of SSV testing, defining SSVs, Standard Practices for corrosion resistant lined valves and deeper knowledge that will assist us all in providing better valves for the most challenging applications.

