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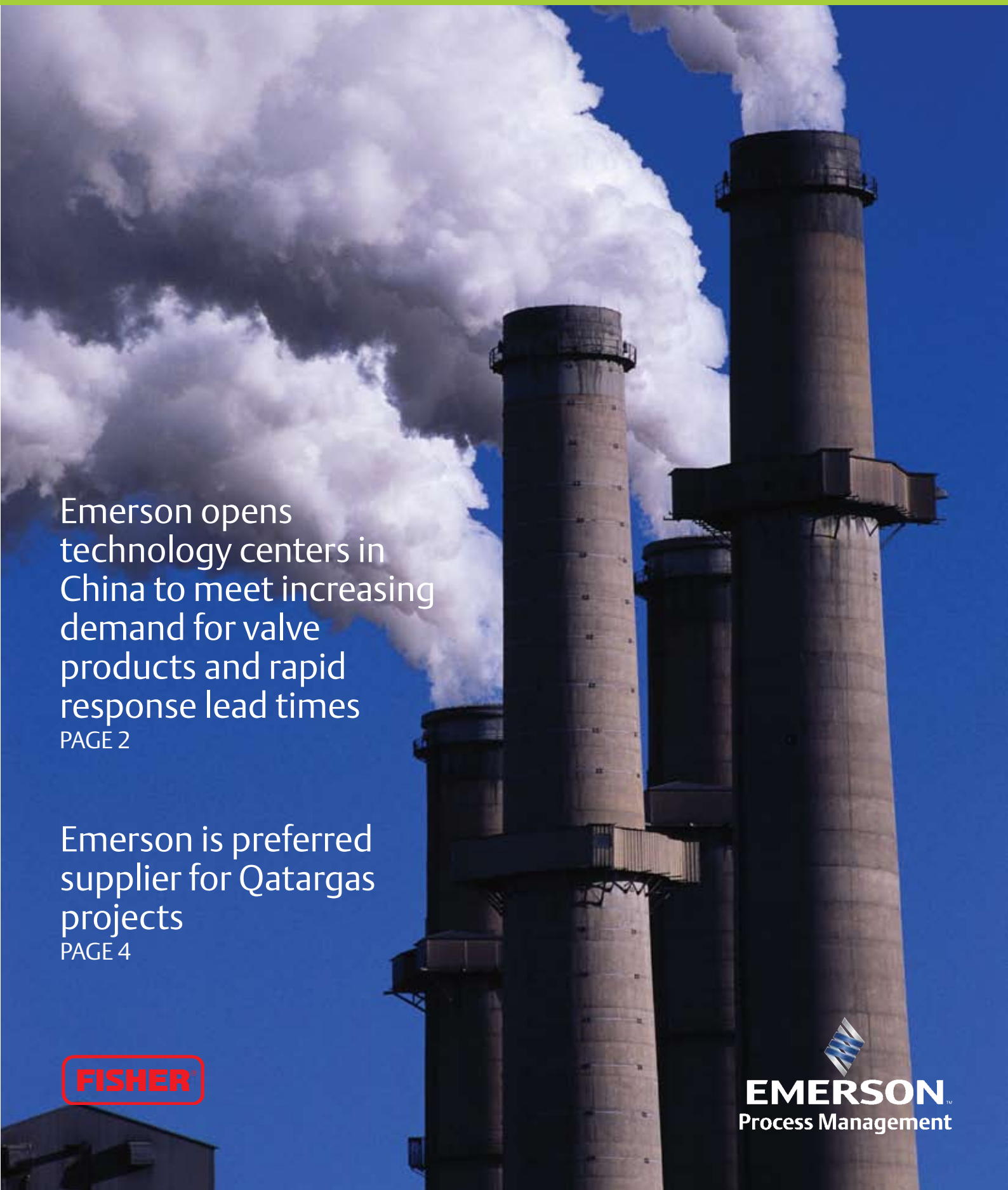
FISHER IN CONTROL



Emerson opens technology centers in China to meet increasing demand for valve products and rapid response lead times

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Process Management

Emerson opens technology centers in China to meet increasing demand for valve products and rapid response lead times

A defining moment for Emerson and probably one of the first breakthroughs in the industry – Emerson officially opened two technology centers, modeled on a campus concept, in Tianjin China on June 5, 2007. The investment is expected to help further strengthen Emerson's current premier position in process control worldwide by bringing industry-leading brand products closer to the customer.

Spanning 12,000 sqm in the Wuqing Development Area, the new centers are a unique combination of both the Fisher® control valve and Valve Automation manufacturing and technology centers, and material supplies under one roof. It also houses one of the most advanced flow laboratories in operation today.

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"It is truly great to celebrate this milestone of commitment to the people and customers of China and the rest of Asia. The facilities that you see here are world class, state-of-the-art in every way. The Wuqing Tech Center means new products, products made to your local needs. The production facility offers you a new level of speed, flexibility, and service."

Terry Buzzbee
President of the Fisher® division

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The centers offer rapid-response manufacturing and support services. Emerson's FisherFAST™ program provides quick delivery of spare parts support which offers quick replacement parts. Control valve services are also available to provide diagnostics, repair, plant start-up and outage management. Here, Emerson research and product design engineers will investigate valve technologies and verify valve-performance capabilities. On-site Emerson engineers, who specialize in control valve technologies, will aid Asia Pacific industries by recommending valve and instrument products to meet a wide variety of flow-control requirements.

"We are augmenting technology leadership with global manufacturing capability and a suite of engineering services to provide the best solutions for our customers. We will establish many service centers, which will be located near the plants."

Mike Train
President of Emerson
Process Management Asia Pacific

Celebrated with great pomp and high spirits, over 200 over people, which included customers, key suppliers and top Emerson Process Management employees, attended the Opening. Four VIP speakers took to the stand to deliver keynote speeches, one of whom was the General Manager of the Wuqing Development Area, Mr Zhong Shu Ming. The event reached its high point when the centers were declared officially open in a ribbon-cutting ceremony. This was followed by fire crackers, confetti, a lion dance performance and a plant tour. A buffet dinner brought the day to a happy ending for all.

Emerson is preferred supplier for Qatargas projects

Emerson has successfully secured a long-term alliance - for 20 years - agreement with Qatargas Operating Company to supply digital automation solutions for the oil, gas and liquefied natural gas (LNG) facilities.

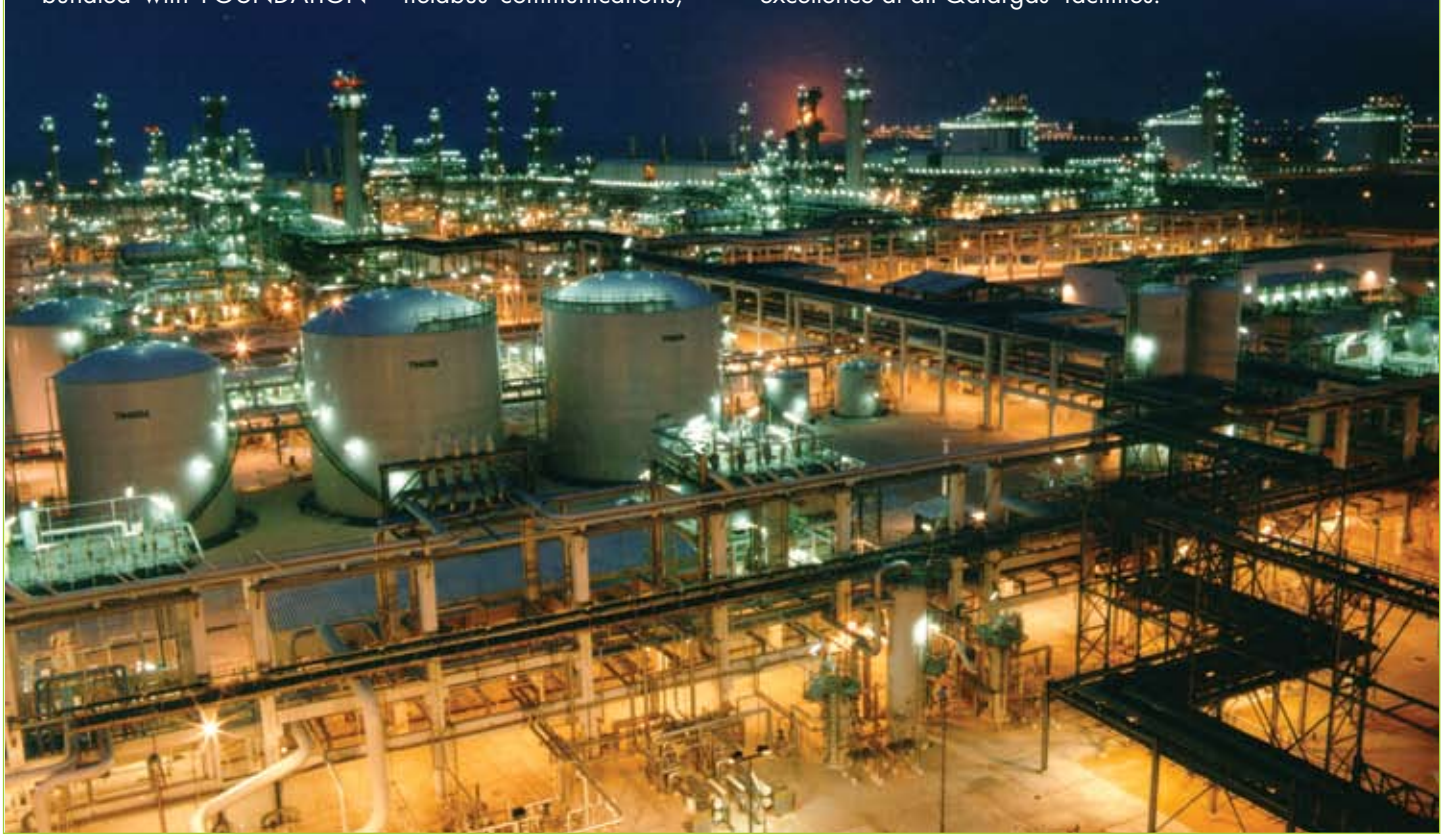
Under this contract, Emerson will be responsible for the whole continuum of services, from engineering, project management, installation, commissioning, and long term support. Emerson will help Qatargas improve and sustain operational excellence for the oil, gas, and petrochemical facilities in Qatar through the best-in-class technologies and products under the PlantWeb® digital plant architecture bundled with FOUNDATION™ fieldbus communications, third party equipment integration and information technology services.

Qatargas was established in 1984, and pioneered the LNG business in Qatar, which is also the world's first and largest todate. In July 2005, Qatargas Operating Company Limited was formed for the purpose of operating and maintaining the assets of Qatargas 1, Qatargas 2, Qatargas 3, Qatargas 4, Laffan Refinery and other assets. Ensuring the continued success through the best available automation is thus of extreme importance.

Emerson has been actively involved in several Qatar projects in the last four years as the Main Instrumentation Controls Contractor and supplier. Selection is critically based on several qualifying factors:

- Emerson's sound reputation and credibility as a world class automation leader,
- Emerson's business model emphasises both project and operation needs, including continuous improvement and long term operational support.
- Emerson's proven performance consistently over many large projects in previous collaboration.

John Berra, President of Emerson Process Management, who also signed the agreement said, "We are excited and honored to join Qatargas in this automation alliance. The alliance and the projects represented give Emerson the best possible opportunity to bring together services and technology to help this valued customer sustain and improve its process and asset performance. We are committed to continued, effective, and efficient project development of Qatargas 2, 3 and 4, as well as long term operational excellence at all Qatargas' facilities."

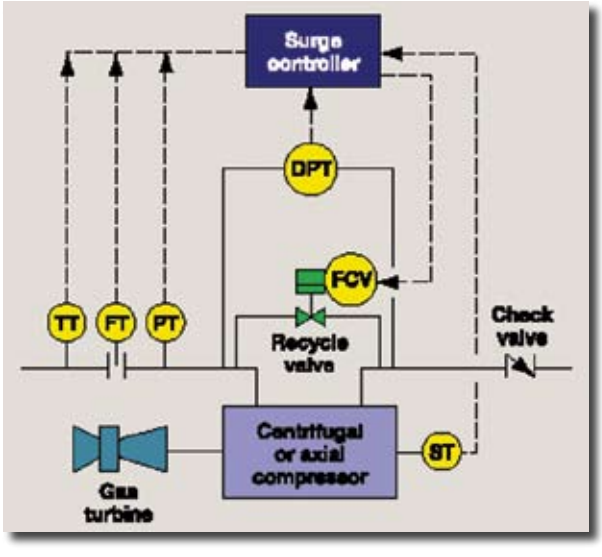


Engineered Solutions: Fisher Optimized Compressor Antisurge Control Valves

Whether in petrochemical facilities, gas transmission pipelines or LNG facilities, the compressor systems are some of the most critical pieces of the equipment in the entire plant. For example, in an LNG facility, the refrigerant compressors can cost on the order of $50M each. This is a sizeable investment that requires the latest technology in order to gain the optimum efficiency from the compressor and turbine driver while also protecting the compressor from failure during an upset condition.

Whether looking at an axial or a centrifugal compressor, one of the biggest areas of concern is the potential for surge conditions. To fully understand the effects that this condition can have on a system, it is best to review the surge condition itself. Imagine that a compressor is turning at a speed to maintain a desired downstream pressure. If there is a sudden decrease in downstream demand, the downstream pressure will spike and the compressor can not maintain the flow due to the increased head across the compressor. If the pressure spike is large enough, flow can then move back through the compressor. As the head across the compressor bleeds down, flow will then go back through the compressor in the forward direction. Surging of the compressor can lead to catastrophic failure after only a short amount of time. Outside of the worst consequence, other effects include upsetting of operations, altering internal compressor clearances and overstressing of the seals. The costs alone of replacing the compressor seals is in the order of $20K to $50K. In order to prevent the system from experiencing a surge event, the speed of the compressor can be altered to an operating point away from the surge line, but this is a very inefficient way of controlling the event. Another way to prevent a surge event from occurring to install an antisurge system. The antisurge system consists of a surge controller, an antisurge valve and a variety of additional accessories.

The figure shows a typical antisurge control schematic. The surge controller takes into account the temperature (TT), flow (FT) and pressure (PT) upstream of the compressor, the head across the compressor (DPT) and the compressor speed (ST). Other variables may be included depending upon the constituency of the gas. The surge controller will operate the compressor as close to the surge line as possible to maximize compressor and gas turbine efficiency without jeopardizing the performance of the compressor.



In the event of a potential surge condition, the antisurge controller will send a signal to the antisurge valve to open to required set point to pass a given amount of flow back to the inlet of the compressor. Depending upon the process upset, this may require a small amount of valve opening or full valve opening. In the event that the valve must go wide open, it must do so in less than two seconds. If the valve does not open quickly, it can expose the compressor to additional surges. Not only must the antisurge valve open quickly, it must possess enough capacity to pass the required amount of flow to protect against a surge event. Because of the high differential pressure between the inlet and outlet of the compressor (1000 psi or greater), there is the potential for noise generation as flow is bypassed around the compressor. To eliminate the potential for noise and subsequent vibration, the valve must possess noise attenuating trim. These factors are critical to the valve operation, but one factor that is often overlooked is the dynamic performance of the valve when not experiencing the need for full stroke capability. As a result, the valve actuator accessories are adjusted to meet the stroking time requirements, but at the expense of controllability and overall robustness.

Improved Valve Internals Eliminate Axial and Radial Plug Motion

One area that has created issues with antisurge valves and other valves used in compressible fluids has been unstable operation and vibration at certain valve travels. Two different mechanisms can cause these issues with vibration and control.

The first mechanism is created by pressure imbalances that can be experienced with standard balanced valve plugs. If there is a sudden change in upstream pressure, the difference in pressures cannot be registered on both sides of the plug immediately and can cause the valve to experience repeated axial motion. This motion can drastically affect control and can lead to issues with compressor efficiency and operation. Repeated axial plug motion can also cause pressure pulsations in the downstream piping. This can cause excessive vibration in the piping system.

The other mechanism that can create issues with control and vibration is when the valve is first lifted off of the seating surface. At this point, the plug can begin to move radially against the valve cage. This action can cause extreme valve and piping vibration.

In the Fisher optimized antisurge control valves, there are two improvements that have been made to eliminate both of these issues. What is a called a fully balanced plug is used to eliminate the potential for pressure imbalances on the

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balanced valve plug. This design reacts to transient pressure changes and pulsations in the fluid better than standard balance constructions by changing the natural frequency of the plug assembly. Now, any pressure changes that occur in the fluid are quickly registered from the bottom side of the plug to the top side due to less restriction thus equalizing the forces.

To eliminate the potential radial vibration a lower metal piston ring is installed into a machined groove at the lower end of the valve plug. This ring effectively eliminates any flow that can move between the plug and cage and any associated vibration. By controlling the clearance flow, the overall turndown of the valve can also be increased.

Noise and vibration control are key components of antisurge valve selection, but they are not the only issues that must be explored. The ability to provide fast, accurate control is as important if not more. The next section will look at the advancements made in actuation and accessory selection.

Selecting the Right Actuator and Accessories

As mentioned previously, because of the fast stroking requirements for antisurge valves, one could easily make the mistake that the only requirement for selection of the actuator and accessories is to make the valve move quickly. This couldn't be further from the truth. It is key to fully understand the step response requirements for every application. Certain fast stroking applications may have requirements detailing the amount of overshoot that can occur with a certain sized step response.

Let's begin by looking at the requirements around the actuator itself. In the past, because of the fast stroking speed requirements for this application, the use of electro hydraulic actuators was pursued. This was because of the fast acting nature of the device and its ability to yield accurate step responses. Over time, it was determined that not only was the system extremely expensive from an initial capital expenditure, the maintenance and cost surrounding the operation made them very unattractive.

With significant improvements in pneumatic technology, the pneumatic actuator is today's common choice for antisurge applications. Most commonly used are double acting piston type actuators that have a fail-safe action. With antisurge valves, the fail-safe is in the open position and is accomplished by use of a trip system. With larger antisurge systems, the actuators can become very large in order to provide enough force to obtain the required shutoff and to overcome any packing and internal valve friction. With the larger size comes the potential for damage when the actuator is stroked fast from closed to full open. If the actuator is operated in this manner, the piston can hammer against the top of the actuator casing causing vibration and the potential for actuator damage.

In order to overcome this possibility, the Fisher 585CLS actuator can be installed with an air-brake system. This system engages during the last three to five percent travel to slow down the piston to prevent it from hammering against the top of the actuator casing. If the actuator is not supplied with an air-brake system, damage can occur to the actuator, positioner and accessories while also potentially inducing damaging vibration into the downstream piping.

It is also important to review friction that can occur inside of the actuator itself. Chrome plating the actuator cylinder reduces friction between the casing and the piston. Also coating the piston with a wear band will eliminate issues with galling in the actuator cylinder.

When it comes to the accessories, the common approach to gaining fast stroking speeds is to incorporate volume boosters into the system. The booster amplifies the air volume enabling the valve to open or close quickly. In order for the boosters to operate properly, the air on the other side of the piston must be relieved quickly. Quick-exhaust valves have met this need in the past.

Quick-exhaust valves are three-way valves that have an elastomeric disk that switches flow between ports. A few inches of water column pressure differential will cause the disk to switch, making quick-exhaust valves fast-acting, on-off devices. To reduce sensitivity, a pneumatic bypass valve is often piped around the quick-exhaust valve. Quick-exhaust valves have been applied successfully on low pressure spring and diaphragm actuators as well as high pressure piston actuators. However, when used on large volume actuators, they can introduce large overshoots that are difficult to attenuate by adjusting gains in the positioner or by adjusting the bypass valve around the quick-exhaust valve. In antisurge valves, quick-exhaust valves should not be used on piston actuators where tight throttling control is required or on those applications where large overshoots cannot be tolerated. Instead, for these applications, dynamic performance objectives should be achieved using multiple volume boosters.

By using multiple volume boosters, not only will performance improve, the ability to tune the accessories will be that much simpler. Over time, the elastomers in a quick-exhaust valve will degrade requiring repeated tuning with the bypass valves. Elimination of these devices in lieu of boosters will minimize the need to constantly tune the valves during scheduled shutdowns. The actuator and accessory selection is critical to the proper operation of the antisurge system and has been carefully considered in all Fisher optimized antisurge valves. It

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is also necessary to ensure that this selection is coupled with a control element that facilitates easy tuning and the ability to monitor performance on-line in real time.

Tuning & Control

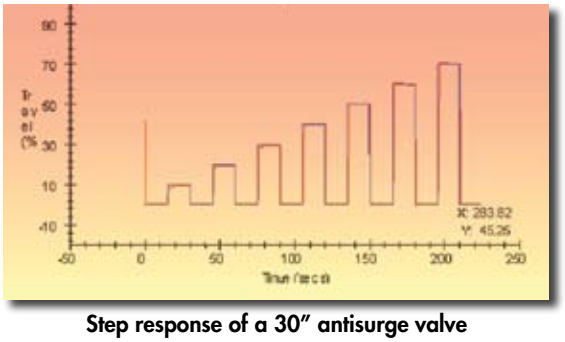
The control valve positioner holds the greatest potential to improve actuator control and response time. In the past, spool type positioners with fast response were typically used in these applications because of their ability to respond quickly to step changes. However, these devices require constant tweaking and do not allow the user any way to monitor the performance of the valve.

As the performance of smart positioners has improved, so has their ability to be used to facilitate tuning of the valve and the ability to predict potential problems before they occur. This has been brought about by improvements in the positioner gain settings and in performance monitoring equipment. The Fisher DVC6000 ODV smart positioner recommended for this application is a high gain, proportional-plus derivative controller that has three adjustments; forward path gain, minor-loop feedback gain and velocity feedback gain.

The forward path gain is used to set the speed of response where a higher gain value yields a faster response. The velocity feedback gain controls the secondary damping, which is used to attenuate slight overshoots in the response. The minor-loop feedback controls the primary damping and is used to reduce the cycling in the response and allow higher forward path gains to be used.

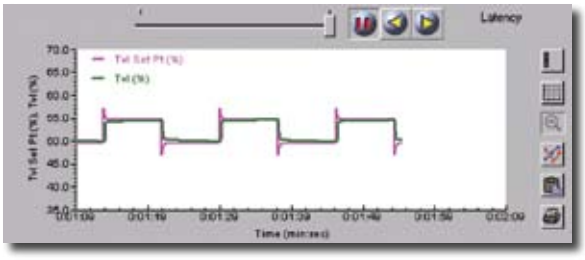
The primary tuning parameter is the forward path gain. Increasing the forward path gain will produce fast travel responses, low dead bands and a host of other desirable characteristics. However, if the forward path gain is set too high, the system may start to overshoot and enter into a limit cycle. To dampen the effects of a high forward path gain, two derivative feedback elements can be incorporated in the control algorithm. The primary damping element is relay motion feedback, often referred to as the 'minor-loop'. Increasing the minor-loop feedback will dampen the response, allowing higher forward path gains to be placed in the positioner. A secondary damping element is velocity feedback. Increasing the velocity feedback gain will also dampen the response.

The figure below shows the results of a step response performance of a 30" antisurge valve with 24" of travel beginning with 10 percent steps up to 70 percent steps. Notice that the higher gain setting allows the valve to react quickly to the step response change with minimal overshoot. It should be noted that the valve met the stroke time requirements while dramatically improving the ability for accurate closed loop control.



Step response of a 30" antisurge valve

For steps of smaller than 5 percent, using a conventional positioner, the step signal from the positioner may be sluggish, especially for large piston actuators. The DVC6000 ODV incorporates a patent pending lead lag filter to the servo loop which can be configured to overdrive the set point sufficiently to improve the response to small amplitude steps.



This type of positioning system, coupled with the applicable accessories has yielded extraordinary results. Analysis has found that by using this type of system, the resolution is a mere one-quarter percent with a one-percent dead time when looking at one-eighth percent input increments. Linearity of the signal to valve performance is also less than 0.5 percent for any given point of travel.

With traditional antisurge systems, it could take an experienced technician up to twelve hours to properly tune one valve. By eliminating the quick exhaust valves and including the latest in smart technology, tuning of a Fisher optimized antisurge actuation can be reduced down to 30 minutes per valve.

Partial-Stroke Testing and On-Seat Diagnostics

An antisurge valve is typically in a fully closed position with tight shutoff on a large percentage of its life in service. Yet, it is expected to stroke open quickly and accurately when the need arises. Developments in the digital positioner has brought the partial stroke feature, previously confined to the emergency shutdown (ESD) valves, to the antisurge valves through the DVC6000 ODV.

With the partial stroke feature, the user can now automatically and safely stroke the valve to a preset small percentage opening while the valve is in service, without impacting the process. In the process, the DVC will be able to perform diagnostics such as valve packing friction and valve sticking. Keeping the servo active with pressure control even when the valve is at tight shutoff, the DVC is able to continuously monitor its own health and warn the user of any potential problems such as plugging of the I/P, supply pressure changes and air path leakage.

Conclusion

The proper selection of antisurge valves relies on more than just meeting noise and stroking speed requirements. Elimination of the potential for damaging vibration in the system is normally the biggest concern, which goes beyond just selecting a low-noise valve trim. Advances have been made in overall trim selection that provides better control while eliminating the potential for axial or radial vibration.

Meeting the stroking speed requirement is only the first piece of the puzzle. Ensuring that the valve can perform accurately and quickly when operating in a closed loop mode is an important point to consider. By eliminating the need for unreliable quick exhaust valves, the performance of the entire system can be improved. When coupled with the latest in smart positioner technology, the gains can be increased allowing for faster closed loop response while preventing dramatic overshoot in the system. By combining the latest technologies from the valve to the actuator to the positioner to the accessories, one can be sure that they will achieve the optimal performance of the antisurge system.

Emerson is recognized industry leader

CONTROL Readers Consider Emerson No. 1

For the 14th consecutive year, Emerson Process Management has been voted the best supplier of process management technologies in CONTROL Magazine's 2007 Readers' Choice Awards. Emerson's intelligent measurement, final control and analytical field devices as well as its control/automation systems – all key components of its industry-leading PlantWeb® digital plant architecture – have consistently won the most categories. Emerson's professional services also led the user voting in this year's Readers Choice Awards.

Emerson was named the best for delivering quality products and customer service – in engineering, plant operations, research and development and other technical areas. Industry professionals were asked to enter the name of the best provider in each category rather than selecting from a list of suppliers. Emerson products and software received 31 first place awards, nearly four times the nearest competitor. Emerson's professional services received top rankings in seven customer service performance categories, more than twice the nearest competitor.

Frost & Sullivan Awards

Emerson earned the 2007 Frost & Sullivan Company of the Year Award for Industrial Automation and Process Control. Global customer value was cited as Emerson was honored for the fourth consecutive year.

Industry Consultants, Frost & Sullivan has selected Emerson Process Management, an Emerson business (NYSE: EMR), as Company of the Year for industrial automation and process control. The 2007 Company of the Year Award recognizes Emerson for continuously providing services and innovations that help its customers worldwide drive their performance to new heights in an increasingly challenging marketplace.

Frost & Sullivan presents the award annually after conducting interviews with all market participants, customers, and suppliers, and after performing extensive secondary and technology research. Criteria including the number of new customers, new segments, commitment to business expansion and market growth are considered, as well. The recipient is chosen for exhibiting exceptional customer service, management, consistent growth, and for having positive social and economic impact on local and national communities and customers.

Emerson has always been on the forefront of technological innovation, most recently illustrated by the company's introduction of its revolutionary Smart Wireless automation solutions. These field-proven solutions extend the predictive capabilities of PlantWeb® digital architecture to improve plant availability and performance, delivering new data to users that previously were physically and economically out of reach.

Access to more data expands the power of local and mobile operators and plant personnel to improve predictive operations and boost plant availability and performance. Emerson's Smart Wireless solutions have demonstrated in field trials and initial deployment extreme reliability and up to 90 percent reduction in installed cost when compared to wired networks.

Emerson's proven solutions are powering robust growth for the company, which saw a 16 percent rise in fiscal 2006 worldwide sales.

"We are honored to receive this recognition from Frost & Sullivan for the fourth consecutive year," commented John Berra, president of Emerson Process Management. "Certainly we owe this success to our close automation partnerships with customers who are building and modernizing facilities around the world to meet the ever-growing resource, energy, and production demands in safe and environmentally friendly ways."

Frost & Sullivan also selected Emerson Process Management to receive the 2006 Frost & Sullivan Award for Customer Value Enhancement within automation and software solutions for the pharmaceutical industry.

As a leading automation supplier, Emerson differentiates itself by turning its vision of providing integrated solutions into a reality. Islands of automation are eliminated to enable seamless flow of real-time information across the entire enterprise, helping customers achieve incremental operational advantage.

The PlantWeb® architecture empowers customers with predictive intelligence, eliminates hassles associated with paper-based records, and helps personnel view real-time records and comply with FDA regulations and initiatives such as Process Analytical Technology (PAT). In addition, it helps pharmaceutical customers eliminate errors or deviations across multiple batches.

The Customer Value Enhancement Award recognizes a company's ability to expand its customer base, while maintaining its installed base, with more innovative value creation and enhancement strategies than competing vendors. The Award recognizes a company's successful sales entry, customer acquisition and service strategies, and the degree to which those strategies have met customers' stated needs and requirements.

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