PLANTSERVICES

The fundamentals of fluid handling: What you need to know

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Understanding the advantages of double-acting actuators

Spring return actuators have their place, but double-acting actuators thrive in heavy industrial piping systems.

By Gilbert Welsford Jr., ValveMan.com

Actuators convert process signals into mechanical motion, causing valves to open or close, thereby controlling the flow of fluids. These devices are available in different designs and sizes to aid the automation of diverse piping systems. Actuators enhance the accuracy and precision of processes since they guarantee the smooth operation of valves irrespective of the cycling requirements. When selecting valves for particular applications, it is imperative to consider their actuation methods.

Pneumatic and hydraulic actuators rely on the pressure of air or fluid to manipulate the position of a valve. Both categories of actuators are either spring return or double-acting. Spring return actuators are single-acting. Therefore, any section mentioning single-acting actuators in this article will be referring to spring return actuators. How does the design of these actuators affect their efficiencies?

A spring return actuator has a spring on one side of the piston to keep the valve in its desired position. Such actuators can either have normally closed or normally open configurations. In a normally closed orientation, frequently referred to as fail-closed, the force from the pressurized air or oil (for hydraulic) is supplied from the unloaded side of the piston. The force from the pressurized fluid overcomes the spring force, compressing it to open the valve. Withdrawing the supply of the pressurized fluids causes the spring to retract and return the valve to its closed position. The inverse configuration of this setup keeps the valve at a normally open setting. Supplying pressurized fluid closes the valve, while withdrawing fluid pressure causes the spring to open the valve.

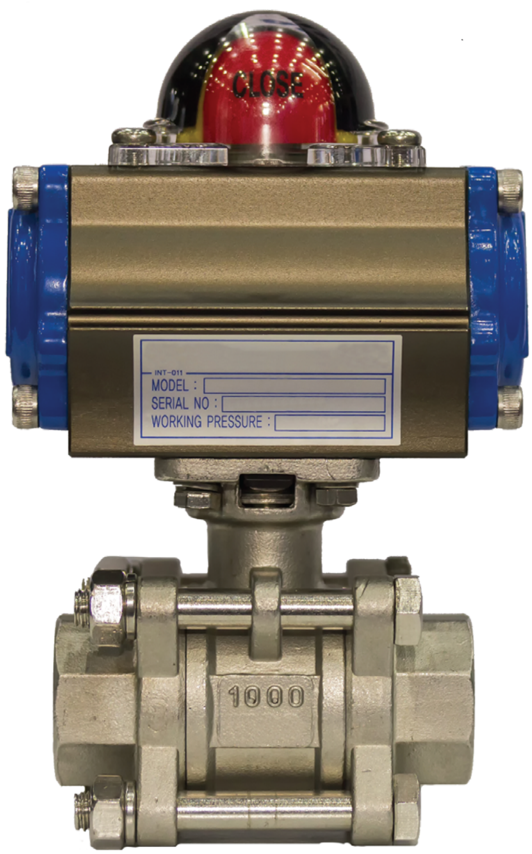

Figure 1. The high thrust strength capabilities and small sizes of double-acting actuators make them preferable for highly demanding industrial pipelines.

In contrast, a [double-acting actuator]() contains two compartments for holding pressurized fluids. One end of the compartment serves as the intake for pressurized fluid, while the other is the exhaust. Supplying pressurized fluids into the cylinder sections changes the location of the piston, thus varying the position of the valve. Double-acting actuators provide better control over the flow rates of valves.

The main advantage of spring-return actuators lies in their ability to quickly retract and return the valves to their original positions when there is a loss of fluid pressure or power. However, they have several drawbacks, making double-acting actuators a favorite alternative for several processes. Below are some areas where double-acting actuators will come in handy for piping systems.

1. BETTER THRUST STRENGTH

Overall, piping systems with large pipes require large valves that demand high actuating forces. It is vital to minimize resistance by the actuating mechanisms to improve the reliability and responsiveness of these valves. The presence of a spring in a single-acting actuator technically reduces the thrust strength of the actuator. The single-acting valve actuators have to be larger since they must overcome the torque of the valve and the spring forces. It translates to oversizing the single-acting actuators, meaning that more material is needed for manufacturing the actuator, ultimately increasing its cost. The springs also increase the overall size of the actuators making them significantly heavier than their double-acting counterparts.

A double-acting actuator delivers maximum actuation forces in both directions (see Figure 1). The thrust requirement for double-acting actuators is lower than that of single-acting actuators. The high thrust strength capabilities and small sizes of double-acting actuators make them preferable for highly demanding industrial pipelines.

2. ABILITY TO HANDLE HIGH TORQUE LOADS

Single-acting actuators are popular in moderately cycled applications and small diameter pipelines, meaning they handle low torque applications. Heavy industrial applications demand robust valves and actuators that can effectively control flow rates. These piping systems have high torque requirements, pointing to massive energy consumption. As stated earlier, the torque delivered by a spring-return actuator is dictated by the rigidity of the spring. Double-acting actuators of small sizes can deliver better torque than their single-acting counterparts. They require little fluid pressure for bi-directional valve operation, thus lowering the demand for energy needed to pressurize the actuators. Double-acting actuators are popular with heavy-duty industrial and chemical processing valves.

3. STABLE CONTROL

Some piping systems experience rapid and frequent changes to fluid properties like pressure and temperature, which affect their reliability and efficiency. In addition to the variability of the fluid properties potentially influencing the forces required to stroke the valve, in those with spring return actuators, the spring resistance consistently provides an opposing force that the system must also take into account and overcome, thus impacting operational efficiency. The roles of valves using a spring return mechanism are often limited to fully opening or closing the valve.

The actuating forces of a double-acting actuator are controlled by the linear positions of the piston, giving them better stability. The pressure difference between the two compartments of the actuator determines how far the piston moves. In the process, it controls the extent to which the valve opens or closes. With this characteristic, you can easily alter the flow rates of the system to satisfy process requirements. For frequently cycled valve applications, the spring in a single-acting actuator becomes susceptible to fatigue. It reduces the accuracy and the stability of the actuator. Double-acting actuators are simply more reliable over time since most systems and valve applications are designed for long-term use.

4. MAINTAIN LAST FAIL POSITION

Loss of actuating power may occur during the routine operation of a pipeline. Maintaining a fail-safe is vital for facilitating a safe process shut down. In the oil and gas industry, choke valves must remain in their failed positions for flow rates to remain constant once production resumes. For a spring return actuator, the immediate course of action will be the expansion of the spring, which will lead to rapid valve shutdown. It causes rapid pressure buildup on pipe sections, which can cause pipe rupture. Such critical applications require the use of double-acting actuators. The fluid pressure within the actuator's compartment will hold the valve in one position until the actuating power is restored. They facilitate a steady shutdown to rectify the root cause of the actuator power loss.

5. SAFETY LEVELS

The reliability of the actuators lies in their mechanical construction. For a start, we know that the spring loses its tensile strength after several operating cycles. Additionally, some applications require continuous venting of the service fluid. Venting remains constant as long as the valve holds its last fail position. A normally open valve using a spring return actuator will revert to an open position after actuating pressure is lost, preventing the fluid from venting.

On the contrary, a double-acting actuator will come to a stop mid-stroke when a power loss occurs. The setup will allow the service fluid to continue venting, thus eliminating any safety incidents. Double-acting actuators can provide dependable valve operation for longer than their spring return counterparts.

RIGHT SIZE, RIGHT TYPE

In many applications, the advantages of double-acting actuators outweigh those of a spring return actuator. When sizing pipelines, choose the right type and size of an actuator to ensure adequate flow rates, durable service, reliability, and process safety. Double-acting actuators are preferable for use with heavy-duty valves found in the petrochemical industry.

About the Author

Gilbert Welsford Jr. is the founder of ValveMan.com and a third-generation valve entrepreneur. He has learned valves since a young age and has brought his entrepreneurial ingenuity to the family business in 2011 by creating the online valve store - ValveMan.com. Gilbert's focus is building on the legacy his grandfather started, his father grew, and he has amplified.


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Optimizing grab sample quality and safety

Maximizing profitability during large-scale facility construction requires a uniquely designed system.

By Matt Dixon, Swagelok Company

Building large-scale industrial facilities like chemical refineries, wastewater treatment plants, manufacturing sites, or oil and gas platforms is complicated. Industrial construction often includes pre-approved schematics of fluid systems that are then built by subcontractors on-site, which does not allow contractors to fine-tune the system as it is built. Leaks of potentially harmful fluids not only put the operators at risk but can also lead to costly environmental damage. In addition, correcting any potential shortcomings that exist because of improper system design could require taking the system offline for an unknown period of time. Such downtime can be damaging to a plant's operations, not only costing money in the short term but potentially harming a facility's competitiveness over the long term.

For these reasons, careful planning of industrial fluid systems should be at the forefront of any industrial facility construction. Though every fluid system is unique to a facility's specific circumstances, there are some universal considerations that must be examined before a system is built to avoid issues in the future.

ESTABLISHING EFFECTIVE GRAB SAMPLING SYSTEMS

Grab sampling is a process by which a sample is extracted from a fluid system for remote laboratory analysis (see Figure 1). Plant operators use sampling to ensure the fluid meets critical quality standards throughout a facility. Common grab sampling points include near storage containers, on long transport lines, and on process lines at flare locations. In addition, samples may be analyzed before and after a commodity is transferred to determine the value of the cargo, particularly if there is a custody change.

It is especially important to pay close attention to the construction of grab sampling systems when building large-scale facilities. The key to avoiding simple grab sampling system errors is to build them using criteria specific to each facility. Standardized approaches may save time in the short term but may lead to unforeseen problems down the road.

Advancements in grab sampling systems have helped make the process simpler, safer, and more repeatable. For plants that have been following the same grab sampling process for years, it is worth considering making improvements that could drive greater sampling efficiency and accuracy.

For example, grab sampling panel designs must account for flushing and purging to ensure that transport lines are clean and free of contaminants. Flushing the lines may take an excessive amount of time if the design is not optimized, especially for

Figure 1. With grab sampling, operators extract a sample from a fluid system and take it away for remote laboratory analysis. Images © 2022 Swagelok Company

longer transport lines. Also, it is important that purge gases not be introduced back into the system where they could potentially contaminate or otherwise impact the quality of the process fluid. Modern panels incorporate safeguards to ensure purge gases stay within the confines of the sampling system.

Elsewhere, some new sampling panels have been designed with heightened user convenience in mind. Obtaining samples, venting, flushing, and purging are all accomplished by operating a series of different valves. Today, some geared valve assemblies are designed to activate the necessary valves in the proper sequence, helping the operator more easily control fluid routing through the panel. Additionally, technicians can more easily isolate gauges when performing maintenance. Geared valve assemblies also help minimize the chance of operator error by preventing valves from being activated out of sequence.

THE IMPORTANCE OF PROPER GRAB SAMPLING DESIGN

Given the importance of accurate sampling on overall plant operations, it is important to minimize the external factors that can affect samples and possibly taint the results. To be useful, samples should reliably reflect the quality or true process conditions of the systems. That is why it is vital to design grab sampling systems properly, with accurate analyses in mind. Even seemingly simple variables in a system's design can have an outsized effect on sample quality and therefore negatively impact the results. Ultimately, your system design should ensure your samples are:

1. **Timely**: The more time it takes for a sample to reach the sample container from the process line, the more opportunity there is for contamination and degradation to take place. During the design process, this calculation must be taken into account and adjusted accordingly to keep those times as minimal as possible.
2. **Representative**: Samples should be representative of the process fluid in the system at any given time. Unnecessary variation can render the eventual analysis moot and can be mitigated through well-designed systems.
3. **Compatible**: As the system is constructed, care should be taken to choose system materials that are compatible with the sample being taken. Selecting compatible materials will help reduce the amount of maintenance and repairs necessary over the life of the system.

Additionally, proper design of sampling systems can help prevent waste and minimize unnecessary danger to the operator and the environment.

To ensure the grab sampling system is built to provide samples that are timely, representative, and compatible, it is helpful to enlist the support of experienced advisors to help in the following areas:

Selecting the appropriate sampling vessel: Choosing the appropriate sample container during the design stage—one that can handle the process pressures and temperatures without leaking—will help enhance safety for operators. Choosing between sample cylinders or bottles is one of the first decisions to be made for liquid grab sampling and is largely dictated by the type of sample being collected. Sample volatility and toxicity may necessitate the use of sample cylinders. Sample bottles can be effective for collecting nonvolatile, nontoxic liquids.

Assisting with probe selection: To achieve the optimal level of accuracy, it is important to extract the sample from the process tube or pipe from the ideal location. Bringing in an external advisor from a trusted supplier to identify the best location can make the process easier. They may also be able to give advice about which probe size is appropriate for the application in question. Finally, advisors can help by performing specific calculations to establish the system design, including the right tubing lengths and component diameters. Having this assistance at the beginning of the design process will prevent problems from occurring once the system is operational.

Determining grab sample location and grab sample panel placement: To ensure the most accurate sampling results, grab sample points should be located on the process lines at strategic points. In addition, the grab sample panel should be placed in an easily accessible area so operators can collect samples safely. It should not be too high or difficult to reach. For maximal performance, operators should be able to safely retrieve samples and transport them to the laboratory for offline analysis.

Conducting temperature and pressure calculations: Standardized system designs often overlook the need to make specific calculations to maintain sample quality. Specifically, temperature and pressure calculations like the Joule-Thomson (JT) calculations should be conducted to predict the temperature effects of pressure changes. These parameters allow operators to monitor the sample and ensure it does not change phase during the sampling process. For example, if pressure drops, which could cause the gas to cool past its dew point, liquid will form and change the composition of the sample. This can prevent an accurate analysis from being done at the off-site laboratory, skewing how the facility maintains its system.

Conducting purge-time calculations: It is essential to ensure that sample nozzles, probes, transport lines, and panels be purged completely between uses. Otherwise, residual fluids may compromise the next sample. Operators must be able to perform the proper calculations to determine how long the system must be purged to ensure a fresh sample the next time the equipment is used. There are several other calculations an advisor can assist with, including time-delay calculations and phase-change calculations for different fluid mixtures.

Before doing any large-scale industrial construction, proper heed should be given to the design of the fluid and grab sampling systems. Finding suppliers who can advise on best practices for the layout of the system can be a significant help. The earlier the advisors are brought into the project—including during facility construction—the more easily they can make the complex process run smoother and ensure the completed fluid system will follow best practices for quality, safety, and profitability.

About the Author

Matt Dixon is application commercialization manager for Swagelok Company, and has extensive experience in sampling systems.