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VALVES, PUMPS AND TURBOMACHINERY

Simplify safety valve installation and maintenance

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Hazardous materials and dangerous reactions are commonplace in petrochemical, refining and specialty chemical processing units. As an added layer of protection for plant personnel, equipment and the environment, companies usually install safety shutdown systems that depend on highly reliable, safety-critical shutdown valves to move the process to a safe state.

This article discusses recent design enhancements in safety-rated digital valve controllers that can dramatically improve reliability and simplify the maintenance of safety valves. These new design enhancements incorporate fewer components, provide increased diagnostic coverage and performance feedback, and enable partial stroke testing.

Safety shutdown valves. Most industrial plants are controlled by a basic process control system (BPCS) (**FIG. 1**). Should the BPCS fail to function, or if an unsafe condition occurs, then a safety instrumented system (SIS) acts to isolate the process and move it into a safe state. The SIS uses its own instruments to independently monitor the process, and the system has its own means of tripping the unit by shutting down pumps, stopping feeds, venting high-pressure gases and/or taking other actions.

While every device in the SIS loop is critical, shutdown valves are the heart of the interlock system and are usually responsible for more than 50% of reliability problems. SIS sensors can easily be made redundant; they can usually be tested while the plant is running and they employ a host of diagnostics, so they tend to be very reliable. The logic solver is often housed in a conditioned environment and includes multiple levels of redundancy and digital diagnostics, so it rarely fails in normal operation.

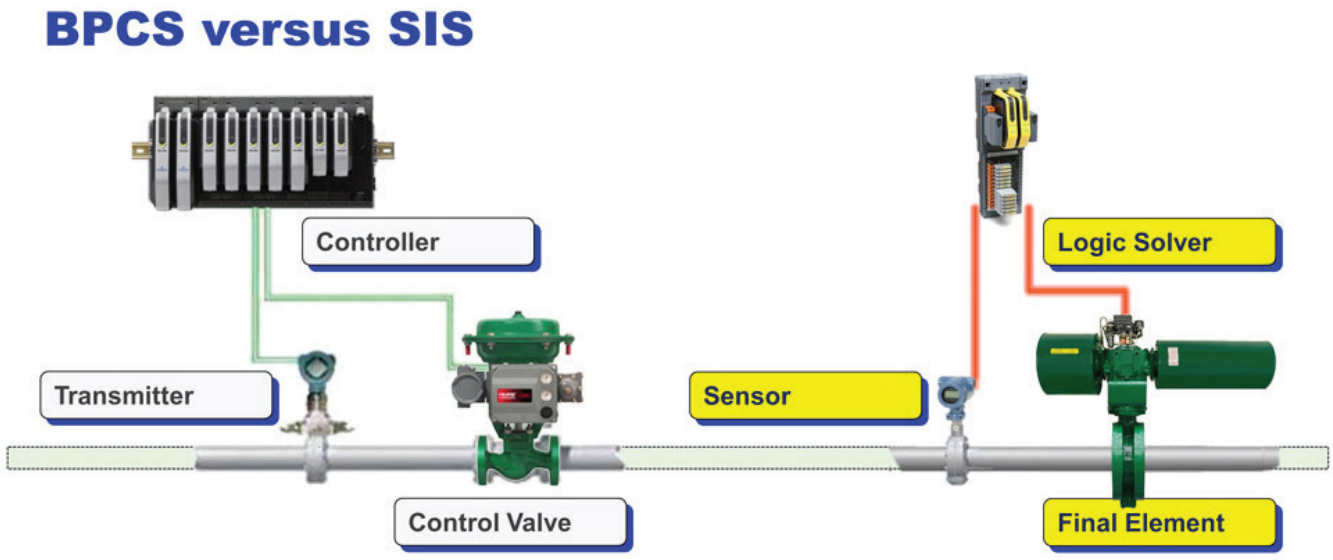

FIG. 1. An SIS uses its own sensors, logic solver and final elements—independent of the BPCS—to detect unsafe conditions and protect the plant.

Unlike the sensor and logic solver, the safety shutdown valve must employ moving parts, each of which are subjected to process conditions, and these valves often cannot be tested while the plant is running. A typical SIS valve lacks diagnostic sensors and may go years without actuating—however, when necessary, it must instantly respond to move the process to a safe state. For these reasons, safety shutdown valves are often the weakest link of the SIS loop and are therefore an area where significant improvements can be made to enhance the performance of the entire SIS.

Valve design improvements. A typical on/off safety valve includes a solenoid to command the valve state and an actuator to physically move the valve itself. Larger valves require some type of pneumatic booster to move the valve faster, and they may also include mufflers to reduce noise as the valve moves. Such a valve assembly has several inherent limitations, including:

- The solenoid and the actuator lack any kind of diagnostics.
- There are no means to determine the position of the valve and to confirm that it has moved.
- Unless a bypass is installed, testing the valve while the plant is running is not possible.
- Many parts must be included in the SIS reliability calculations, with each an additional potential source of failure.

To address these concerns, many users are replacing the solenoid, booster and muffler with a single SIS-rated, high-capacity digital valve controller (**FIG. 2**). These devices create dramatic improvements in reliability, while reducing maintenance and support costs.

Digital valve controllers have long been used to improve safety shutdown valve reliability. These devices provide diagnostic information on air supply, valve stroke time, actuator internal components, packing performance and more (**FIG. 3**). They also provide feedback on the actual valve position, which can be used to take credit for a valve proof test should the plant unexpectedly trip.

While all these features improve reliability, recent enhancements allow the digital valve controller to do much more. Larger valves have much larger actuators, so a standard digital valve controller is often unable to move the valve fast enough to satisfy the stroke time requirements. In these cases, pneumatic boosters are employed to amplify the valve controller signal and move the valve faster. Boosters tend to be loud when they stroke, so mufflers are also employed to reduce the sound to acceptable levels. Unfortunately, all these added devices are perceived to reduce reliability, complicate the design and increase the form factor of each valve assembly.

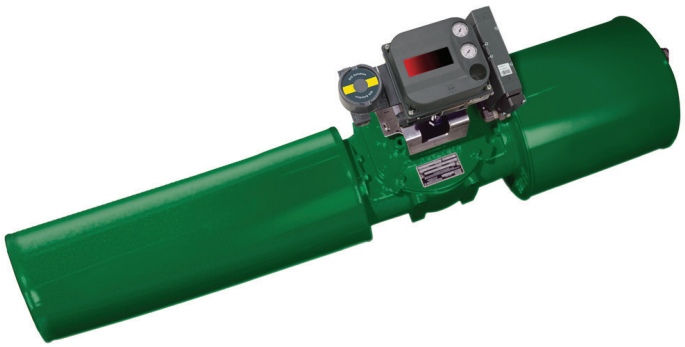

FIG. 2. Very high-capacity digital valve controllers, like the one shown[a], replace the solenoid, volume booster and muffler. The overall package is simpler and more reliable than previous models and enables partial stroke testing.

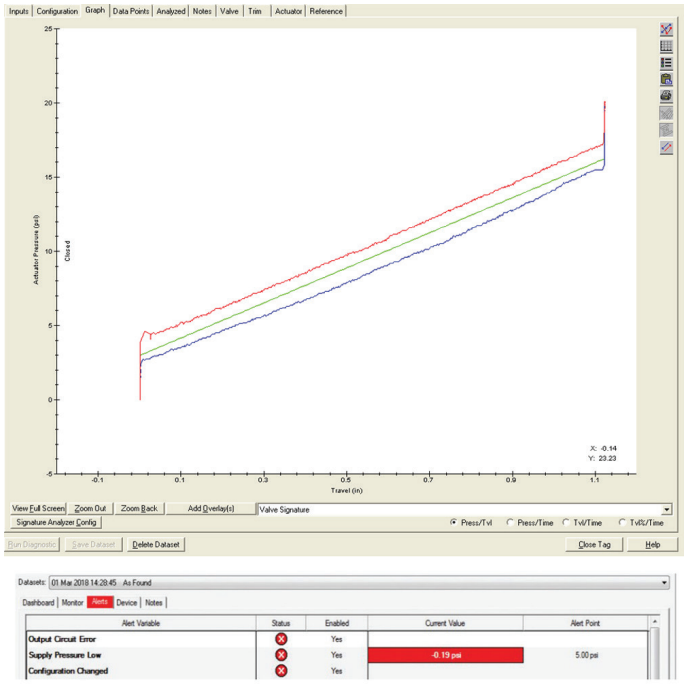

FIG. 3. Digital valve controllers incorporate many diagnostics to detect issues with air supply, packing, actuator dynamics and other factors. They also detect actual valve positions.

Recently introduced high-capacity digital valve controllers incorporate several design features that eliminate both the booster and the muffler. A single valve controller can now provide all diagnostics and reliability improvements, while providing enough air capacity to move very large valves quickly. They also include specially designed mufflers that deaden the sound without adversely impacting air capacity, and thus, stroke speed. Internal spools are made of ceramic materials to minimize wear and combat corrosive environments. The single unit is simpler, has a reduced footprint and is much more reliable. Because the booster is an integral part of the valve and is included with the unit's safety integrity level (SIL) rating, it does not have to be considered as a separate component for SIS calculations.

Additionally, an enhanced SIS-rated digital valve controller enables partial stroke testing. One of the most common failures of a safety shutdown valve is that it fails to move at all. Because the valve may not have moved for years, it can become stuck in a position due to process buildup, corrosion or other factors, and then fail to actuate when called into service. While a partial stroke test does not prove 100% of valve functionality, it does cover most valve failure modes and can be used to extend proof testing intervals.

Digital valve controllers can execute these tests and capture valve performance data as the partial stroke test is performed (**FIG. 4**). Unlike more mechanical means of partial stroke test execution, the digital valve controller can monitor valve position and control actuator pressure, thus greatly reducing the likelihood of over-stroking the valve and impacting plant operations.

The test can be commanded from the control system, or valve accessories are available that allow a partial stroke test to be executed and controlled at the valve, where performance can be closely monitored and quickly overridden, if necessary.

Improved reliability. An enhanced high-volume, SIS-rated digital valve controller provides significant improvements in safety valve reliability vs. the typical solenoid/booster/muffler design. This single device replaces three components and provides a wealth of diagnostic data that can flag developing problems in advance of outright failure. The controller also enables partial stroke testing, yet guards against excessive valve movement, avoiding process upsets or accidental plant trips. Unlike the solenoid/booster solution, the digital valve controller provides continuous valve position feedback so that, in the event of a trip, valve performance will be captured and documented, allowing plant staff to take credit for a full proof test.

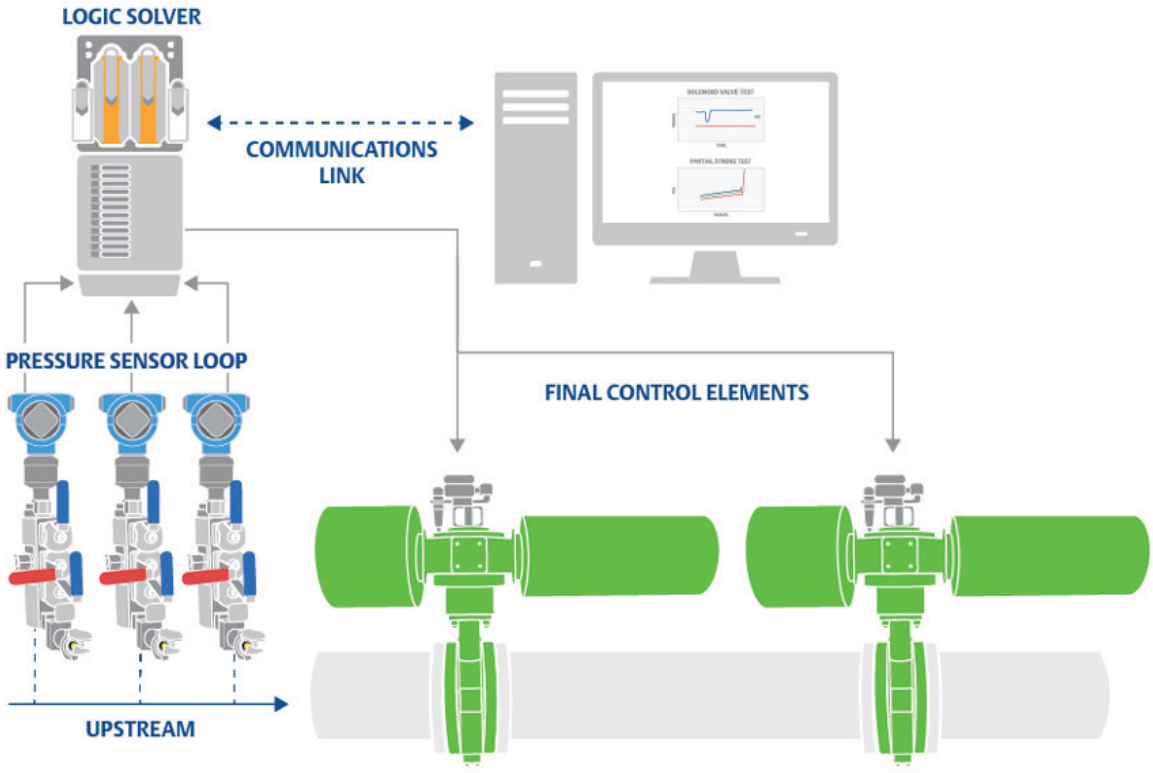

FIG. 4. A partial stroke test allows a safety valve to be tested during plant operations. A digital valve controller can safely execute this test, capturing diagnostic data and protecting against inadvertent shutdowns.

The unit can be installed as a retrofit on existing valves or specified as the control component on new safety shutdown valve installations. Optionally, the entire valve assembly (digital valve controller, actuator and valve) can be purchased as a single engineered assembly, which further improves reliability ratings and extends proof testing intervals.

Takeaway. When specifying a new SIS-rated shutdown valve or retrofitting an existing valve, end users should investigate the available digital valve controller options. New designs are simpler than previous models, and provide a significantly improved level of reliability, while reducing installation and maintenance support costs. While specifically designed for safety shutdown valve applications, these same digital valve controllers are often the best choice for any critical on/off process valve where high performance and reliability are required, along with a smaller form factor. HP

NOTE

a. Fisher™ FIELDVUE™ DVC6200 SIS digital valve controller

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