Leveraging Smart Valve Positioners

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Smart valve positioners offer a range of diagnostics, but the volume of information they can provide can be daunting. Establish a program to deal with alerts and analyze data to help you benefit from the information without getting overwhelmed.

Most of us interact with our personal devices — smartphones, tablets, e-readers, laptops, etc. — frequently throughout the day, everyday. We have incorporated these smart devices into our lives, but are we taking full advantage of all their functionalities? Because the power of these technologies can be overwhelming, some of us do not enable all of our devices' functions or might be totally unaware an option is available.

As more smart devices are incorporated into process equipment, this tendency to underutilize them has extended into the industrial environment. The smart valve positioner has become the standard across the chemical process industries (CPI), but are you leveraging all of the functionality of your valve positioner? Like the smartphone in your pocket, you probably are not.

Nearly every corporate or site control valve specification requires a smart positioner for all or most new valves and for replacements of existing valves. Many plants are being asked to do more on a tighter budget, and smart positioners can help meet this demand. Smart positioners offer diagnostics that can be used for predictive maintenance programs, which can save time and money.

Valve positioners

A valve positioner is the interpreter between the control valve assembly and the control system. It translates output signals from the control system and adjusts the air to the actuator, which moves the valve to the position requested by the control system (Figure 1). The positioner may also take position feedback from the valve stem/shaft and send that information back to the control system.

Valve positioners can help to overcome high valve friction, as well as reduce deadband (during which there is no valve movement) and hysteresis. The higher the friction, the more deadband associated with the control valve. Mechanical feedback from the valve assembly to the positioner enables the positioner to vary its output to overcome the friction and provide accurate control. For example, if the positioner receives a 50% input signal, it will provide whatever air output is required to move the valve to the midpoint of its range of travel. A positioner must be used with a piston actuator (with or without springs) to provide throttling control.

Smart (*i.e,* intelligent, digital) valve positioners perform the same basic functions as a traditional valve positioner, but they have expanded functionalities. The International Society of Automation (ISA) does not differentiate between traditional and smart positioners in its standards. Like any "smart" device, a smart positioner includes a small computer that enables additional capabilities. A smart positioner is analogous to a smartphone, while a traditional positioner is like your landline — both can make calls, but one can do considerably more.

The capabilities beyond positioning are what make smart positioners unique and valuable, but also what can make them intimidating. Smart positioners make the basic positioning functionality across your plant more accurate and reliable. Every positioner can be calibrated exactly the same and that calibration can be maintained, which provides more accurate control to setpoint and thus optimum process control.

Smart positioners enable accurate calibration. Users often specify an input signal with a larger range than necessary to compensate for inaccurate positioner calibration. In the case of analog 4–20-mA inputs, users will drop the input to well below 4 mA and then adjust it to exceed 20 mA to ensure the valve shuts off and travels from 0% to 100%.

The autocalibration feature of a smart positioner eliminates the need to rely on the skill of the technician adjusting the mechanical parts. The typical calibration of a smart positioner allows a 4-mA signal to be sent to a positioner enabled for highway addressable remote transducer (HART) communication (sidebar); at that point no air would go to the actuator. If the input signal is increased to 4.12 mA, the valve would start to travel. When the signal reaches 19.92 mA, the valve would go to full 100% valve travel.

Plant Communication Protocols

Plant automation requires communication between the control system and the process equipment. The type of protocol used at a facility affects how data are transferred.

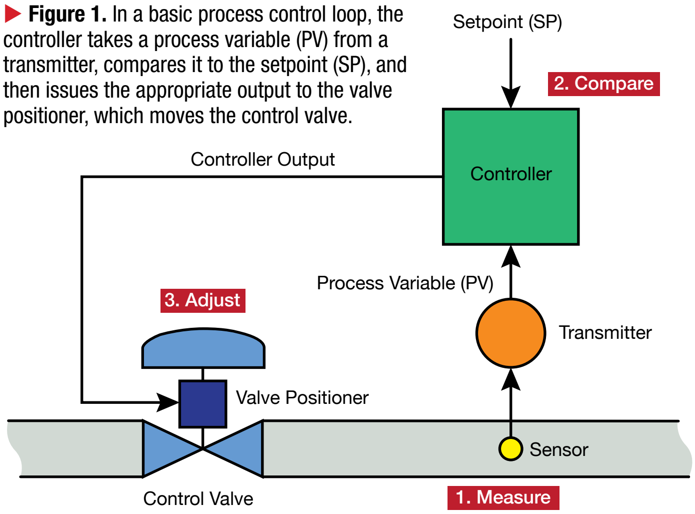
Highway addressable remote transducer (HART) protocols use the Bell 202 audio frequency-shift keying (AFSK) standard to superimpose digital communication signals on top of a 4–20-mA analog signal.

FOUNDATION Fieldbus is an all-digital, serial, two-way communication protocol used for communications among field devices and control systems.

Process Fieldbus (PROFIBUS) is an international fieldbus communication standard for linking process control and field devices.

HART is a question/response type of control communication and can only transmit a limited number of variables. FOUNDATION fieldbus and PROFIBUS allow for two-way communication, but they operate at different speeds. FOUNDATION fieldbus and PROFIBUS communications provide constant feedback of digital data.

Figure 1. In a basic process control loop, the controller takes a process variable (PV) from a transmitter, compares it to the setpoint (SP), and then issues the appropriate output to the valve positioner, which moves the control valve.



Positioning functions, on average, use only about 10% of the microprocessor's capabilities, which leaves most of the electronics available for diagnostics that provide insight into the valve's performance. Most smart positioners have a range of diagnostic capabilities that include both in-service and out-of-service diagnostics.

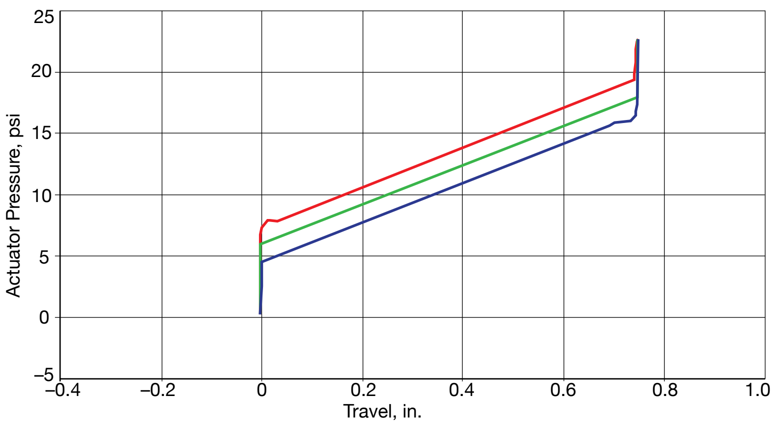
Typical in-service diagnostics include monitoring, friction analysis, troubleshooting, and air consumption tests. Monitoring diagnostics indicate important parameters such as air pressure, input setpoint, valve travel, and other values critical to operation. A friction analysis can be done while the valve is in operation to determine the amount of friction present in the valve assembly; excessive friction can make the valve more difficult to control. Air consumption tests can be conducted to determine whether the valve assembly is using an excessive amount of air. Excessive air usage can be caused by wear or damage to the pressure-retaining portions of the actuator assembly and/or to the instrument tubing. All of these non-intrusive in-service diagnostics can highlight a failure or performance degradation and alert the operator that it is time to schedule maintenance on the assembly.

Out-of-service diagnostics include valve signatures and step-response tests. The valve signature (Figure 2) is a graphical representation of the relationship between the actuator pressure input and valve position while the valve is slowly opened and closed. The data can be used to calculate spring settings, spring rate, valve friction, and valve closure forces. Step-response tests (Figure 3) move the valve in predetermined increments and measure the actual valve travel in response to the input, which helps to evaluate valve performance, calibration accuracy, positioner tuning, and stroking speed.

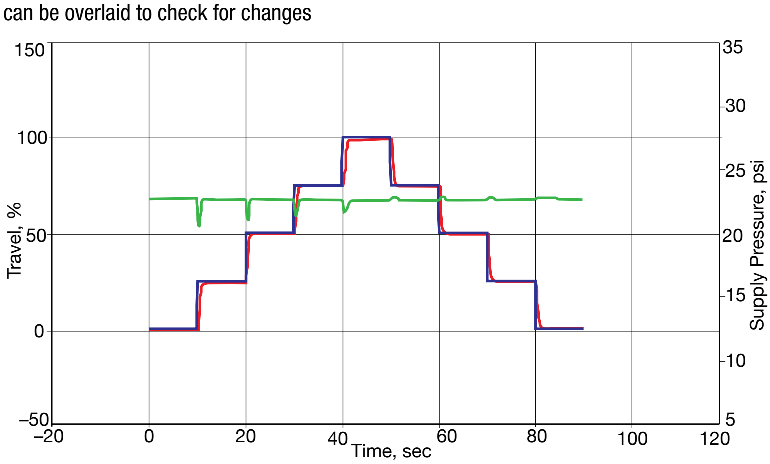
Out-of-service diagnostic tests should be conducted prior to control valve installation, as well as before or at the start of a turnaround to aid planning efforts. When done in combination, they can detect abnormalities in a valve assembly, which can be used to determine whether work needs to be done on the valve and, if so, what kind of work. Knowing the type and extent of work that needs to be done on the valve ahead of a turnaround can save time and money and, hopefully, eliminate any surprises or unnecessary work.

Establish a valve monitoring program

You may already be aware of your smart positioner's capabilities, but like many of your smartphone's functions, you choose not to leverage them. The typical excuses for this are lack of time, personnel, and/or procedures to deal with the many diagnostic alerts, which can be overwhelming.



▲ **Figure 2.** A valve signature indicates the integrity of the valve body and the actuator. The red line represents the recorded travel as output pressure increases until the valve is 100% open. The blue line is the recorded travel once the positioner releases the pressure and the valve travels to the closed position. The green line is the best-fit line; the distance between the green line and red or blue lines can be used to calculate valve friction. Valve signatures should be recorded when the valve is brand new so that future valve signatures can be overlaid to check for changes



▲ **Figure 3.** A step-response test checks the response of the entire valve assembly and indicates the effectiveness of the instrumentation tuning and accessories. The blue line is the input signal to the positioner that directs the valve to move to a certain travel point. The red line is the actual valve travel as it attempts to reach the setpoint. The blue and red lines should follow a similar path to indicate good operation. The green line records supply pressure as the valve moves to the setpoints.

A process to leverage diagnostic information is essential to starting a control valve monitoring program. Follow these seven steps to get a program off the ground at your plant.

Step 1. Determine who will own the process. Great ideas without an owner stay just that — great ideas. An owner who leads the program might be from the maintenance, instrumentation and electrical, or reliability department. If you have staffing challenges or other priorities, consider outsourcing the responsibility.

The ownership plan should be for the long term. Many programs get started and have some success, then the owner moves on to another role, leaving an ownership void and the program fades.

Step 2. Establish a route for gathering data. The positioner can provide much valuable diagnostic information, but you first need to get that information from the positioner to a point where you can use and analyze the data.

The communication protocol (*e.g.,* HART, FOUNDATION Fieldbus, Process Fieldbus, etc.) that you use in your plant impacts your options. Software tools can transfer diagnostics through your control system network. These tools may already be implemented at your plant and simply need to be leveraged for this new application. If your plant does not already have such software, consider sending the information wirelessly, or use a route-based process in which an operator manually pulls diagnostic information directly from the valve positioner.

Step 3. Create a list of valves to be monitored. To get your valve monitoring program up and running, start small. Do not try to start the program with every control valve in your facility. Turning on all the alerts in all your smart positioners at once is a good way to overwhelm your operations and program teams. Instead, make a list of a handful of critical valves to be monitored. It is easier to work out the process on a few valves and then expand the program slowly.

Plant assets have varying levels of criticality. A criticality assessment will help you to identify the most important valves that should be part of the initial monitoring program.

A simple A-, B-, C-rating scheme works well. A-rated assets are the most critical and have the biggest impact on plant operations; these assets require more monitoring and receive the highest work order priority. An example of an A-rated asset is a compressor antisurge valve. B-rated assets, such as valves in applications that also have a bypass valve, are of medium criticality. C-rated assets are of the lowest importance, and include such equipment as general service water or instrument air valves. Once you have assessed and rated your valves, start incorporating your A-rated valves into your diagnostic monitoring program.

Step 4. Identify the parameters to be monitored and the diagnostic alerts to be issued. To avoid information overload, start small with three key alerts. We suggest starting with travel deviation, drive signal (*i.e.,* how hard the positioner is working to maintain or go to its intended position), and supply pressure.

A typical A-rated asset is a throttling control valve. For this type of valve, the travel target (where it is told to be) and the actual travel (where it actually is) should be very close. The difference between these two values is the travel deviation. Travel deviation, which indicates that the valve is not following setpoint, is commonly caused by increased friction, broken components, low air supply volume, internal part galling, or calibration issues.

The travel deviation alert usually has two other components: percent of allowable deviation and time of deviation. These can be adjusted to prevent nuisance alerts, such as for very large actuators that move very slowly; typical throttling of the valve should not trigger a travel deviation alert.

The drive signal is the output current to the I/P converter, typically shown as a percentage, which provides the air output value necessary to correctly position the valve. The standard drive signal range is 55–85% when the valve is in its throttling range. An alert is triggered if the drive signal is too low or too high when the valve is not on the seat or in the wide-open position. High drive signal values can indicate sticking, internal plugging by debris from the air supply, or pneumatic leakage. Low drive signal values may indicate low supply pressure, internal blockage, damage to the positioner, or mechanical failure of the valve. Run additional diagnostic tests if this alert is active.

A low supply pressure alert indicates that the valve does not have enough force to operate correctly. If the supply pressure is lost or too low, the valve may move very slowly or not reach full travel. Low supply pressure could also trigger a travel deviation alert because the supply may not be high enough to move the valve to its set location, as well as a drive signal alert because the positioner is working as hard as it can and the supply is not adequate to move the valve. If all three alerts are active, low (or lack of) supply pressure likely triggered them.

Setting and monitoring these three critical alerts should give adequate warning of an impending issue with your control valve without triggering nuisance alarms or alerts.

Step 5. Devise a process for handling the information. Pilot the program in one area of your plant. This will allow you to work through the process details, such as who will generate a work order in response to an alert. Personnel should be trained on the process so that they can react to alerts with the proper tools and methods. Once the alert is addressed, you can use the diagnostics to decide whether the valve should be returned to service, repaired, or replaced.

After the alert has been addressed, conduct a review. The discussion should cover potential repair parts that need to be ordered and work scheduling. Major repairs are usually scheduled during shutdowns, but if a shutdown is not in the near future, personnel may need to be advised to closely monitor the equipment until the work can be done.

Step 6. Keep track of your costs. Maintaining asset reliability comes at a cost, and your management team will want to know how the extra money and time are being spent.

The monitoring program will save money in the long term. Celebrate any successes and pass that information on to management. Document efforts that prevent a shutdown or downtime to establish an argument for continuing and expanding the program.

Step 7. Give it a try. Once you have your plan, try it out. As with most new things, everything will not go as planned. Do not be discouraged. Starting small will help you to better handle any issues that might arise. Challenges are an opportunity to go back and review the program, refine it, and try again. After you get the program running smoothly, consider expanding it to other control valves.

An industrial success story

The HART Communication Foundation named Monsanto 2012 HART Plant of the Year for leveraging its smart input/output (I/O) infrastructure. Monsanto implemented an asset reliability optimization strategy to prioritize, plan, and schedule downtime. To gather data, they used both handheld and remote office-based systems (a combination of the options suggested in Step 2). They conducted an asset criticality review (Step 3), and assigned ratings to more than 14,000 pieces of equipment, including control valves, transmitters, vapor sensors, and other equipment. The monitoring program saves the plant an estimated $800,000 to $1.6 million per year in avoided costs. CEP

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