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INSIDE:

Field Diagnostics Improve Performance & Profitability

Certain diagnostic solutions can leverage the experience of the manufacturer to identify actionable maintenance advice to restore control valves to peak performance.

By Fabian C. Gonzalez, Flowserve Corp.

The demand on facilities to improve profitability has driven many plant managers to prioritize maintenance activities while striving to increase plant output. Historically, refineries, chemical plants and power plants have focused on achieving cost savings through capital and personnel reductions, and improving output by reducing unplanned downtime. While many plant managers struggle with the apparent paradox these two frequently conflicting goals create, improving control valve performance can help make both objectives a reality.

Traditionally, improving the availability (process uptime) of a control valve requires increasing planned and corrective maintenance in order to maintain peak performance. Many facilities try to reverse this problem by moving towards condition-based strategies that adjust maintenance workload in response to actual control valve health. This strategy is based on the assumption that such proactive maintenance is more cost-effective than reactive activities—a fact supported by a recent *Factory Maintenance* article, which states that emergency maintenance can cost “four to 10 times as much as proactive preventive maintenance.”

However, realizing the benefits of proactive maintenance for control valves also depends on another critical assumption—that plant operations and maintenance staff are able to obtain an accurate real-time picture of control valve health, which can be translated into tangible actions to keep the unit in peak performance. Diagnostics is a buzzword for solutions that provide this data, but often fall short of the ideal for two key reasons.

Conventional Diagnostic Methods

First, valve and instrumentation diagnostics have traditionally required off-line performance testing, which can be costly. Checking and maintaining each valve in a facility can also be a time-intensive process. In addition, the accuracy of the resulting data could vary due to both the equipment and the skill of the technician performing the test.

To understand the current level of technology used to evaluate the performance of control valves, it is important to look at how this testing has been performed historically. Equipment for performing valve and instrumentation testing in the past usually consisted of a high-resolution pressure regulator, a 0- to 30-PSIG pressure gauge with a 0.25 percent accuracy and a linear dial indicator (see Figure 1).

Typically, the equipment was precalibrated for the specific operating range (3 to 15 PSIG, for example), and the high-resolution pressure regulator was used to simulate the control command signal over the operating range, using the pressure gauge as a measurement point. The dial indicator then provided a valve position at the specified signal range.

This procedure was performed in both operating directions—signal to close and signal to open—starting at 50 percent of valve displacement. In order to report and calculate repeatability and hysteresis, as well as dead band, which is the maximum difference for the same input between the upscale and downscale output values during a full range, three consecutive full cycles were performed. The test data was then plotted and analyzed for performance. The resulting valve signature provided a fingerprint of the specific control valve, and its associated instruments and accessories. Data captured during these valve diagnostic tests offered useful information about valve performance degradation (see Figure 2).

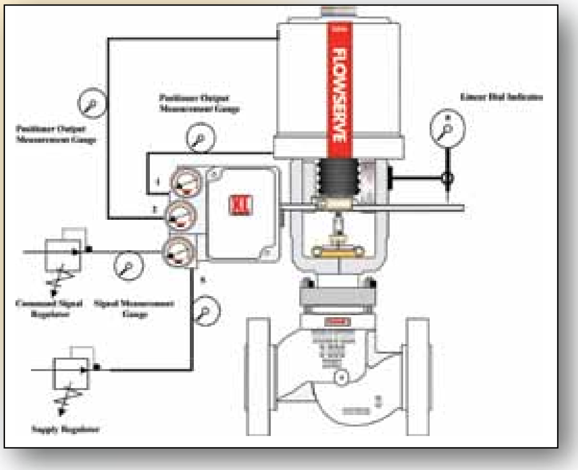

Figure 1: Conventional valve diagnostics equipment

However, this diagnostic procedure is time-consuming and requires that the valve be off-line, resulting in less output. Furthermore, the accuracy of the data results relies on the equipment and skill of the technician performing the test. Because of the complexity of mechanical components and instrumentation associated with different valve designs and accessories, the interpretation of diagnostic data into specific maintenance action is both a science and an art. It is therefore highly dependent on the experience and knowledge of the individual technician.

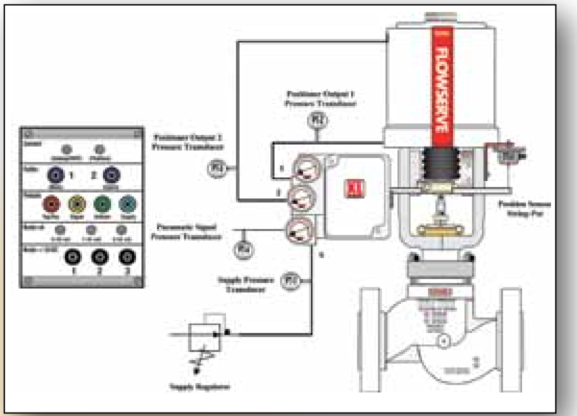

Figure 2: Typical application of valve field diagnostics equipment

The overall aim is to conduct proactive maintenance that is cheaper than corrective actions, while being more effective at preventing unplanned downtime. Translating diagnostic data into actionable maintenance advice that meets these goals frequently requires detailed knowledge about why the valve is designed the way it is, how it was built, how it should perform under specific process conditions and what behavior should be deemed normal as a result.

While the International Society of Automation (ISA) has played a role in defining standards for the performance of control valves and general instrumentation, plus providing fundamental guidelines in performing valve-related diagnostics, these directives can only grant part of the full picture of control valve health without the specific knowledge and experience of the original equipment manufacturer (OEM).

For example, field diagnostics have limitations in identifying nonconforming issues, such as whether the valve is leaking across the seat or why a particular valve may be high maintenance. Some of these areas can be quickly resolved, such as whether there is adequate seat force. Calculating seat load (Fs) is a function of force based on actuator-effective area (Af), multiplied by applied loading pressure (Ps), and spring final (Pf) and actuator spring rate in the other direction.

However, this analysis requires specific knowledge of the actual control valve hardware being used, such as the physical size of the valve actuator and the stiffness of springs installed. Additionally, a generic algorithm for seat load confirms only that force is being applied, while the actual physical surface finish and mating contact angle of the trim components determine whether the control valve provides a satisfactory shutoff under that seat load against process pressure. The physical design of the trim (plug orifice or pressure balanced) must also be considered.

The reality for many plant operations is that large amounts of experienced maintenance staff have been replaced by fewer personnel with less experience with the wide array of configurations, sizes and trim designs of modern control valves. In addition, many facilities have turned to asset management software to perform the arduous task of collecting, analyzing and archiving the vast amount of data that is generated from control valve diagnostic tools. While these tools perform a valuable function in helping plants plan and prepare for turnarounds, they are no substitute for the knowledge and experience of a control valve technician since they are frequently provided by a vendor other than the valve OEM, and therefore, are often of little help in day-to-day maintenance management.

Finding The Right Answers

Valve diagnostic and asset management has evolved to the point that it has become a useful ally to plant operations and maintenance staff. These tools capitalize on best practices of data management, valve identification, and online and off-line valve diagnostic techniques. In the best examples, these solutions are integrated into the control valve positioner and operate in real-time to constantly collect data, thus reducing the need to take the valve off-line to generate a signature (see Figure 3). These tools improve valve performance, leading to less downtime and costs.

More importantly, the latest generation of diagnostic tools obtained from a control valve OEM is based on the manufacturer's history in valve design, manufacture, operation and maintenance. In some cases, these tools can come close to capturing the art and science of control valve diagnostics. Without the information from these field diagnostics, facilities could spend time and money performing unnecessary preventive maintenance, while still suffering from high levels of unplanned downtime.

It is common for valves to require only simple mechanical adjustments or instrument recalibration (see Figure 4). For example, an average 3-inch globe valve can cost approximately $4,600. The cost of replacing the valve can be much higher than taking the old valve off-line, repacking it with new gaskets and packing rings, then reinstalling it. The trick becomes knowing when this is sufficient to maintain performance.

Because they are provided by the valve manufacturer, the new generation of diagnostic tools has the ability to analyze a valve-signature-response curve and identify any inconsistencies or pattern/trend deviations, such as excessive friction caused by packing or guiding components, high hysteresis and dead band, nonlinear response, mechanical maladjustments, low friction induced by packing wear, etc.

These analytical approaches improve field diagnostics accuracy while making the process less intrusive, thereby reducing the time it takes to perform diagnostics because the valve is kept in service. This process saves facilities the labor and productivity costs associated with downtime as the solutions give advanced notice of impending problems, offering plant operators time to take action to minimize or eliminate downtime.

Because they are provided by the valve OEM, next-generation control valve diagnostics can provide guidance and recommendations by identifying the potential root cause of the problem. This further saves facilities time and money by allowing operators to quickly address the cause of the issue, as well as understand the correct maintenance procedure, spare parts and special tools that may be required to correct the problem.

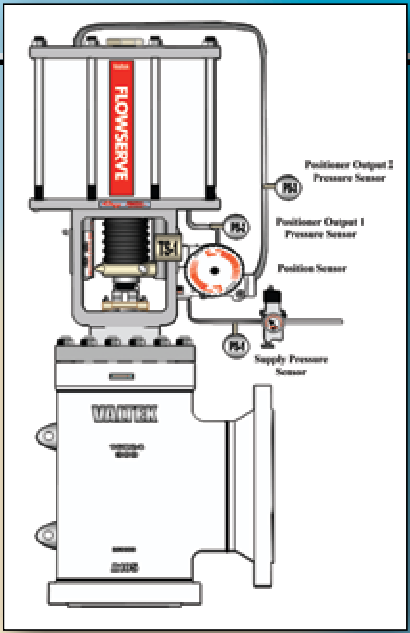

Figure 3: Flowserve Logix 3000 Series digital valve positioner sensors

Save Time & Money

In conclusion, while control valve diagnostic solutions have great potential for improving plant profitability, realizing the full potential benefits is frequently jeopardized by solutions that fail to collect meaningful real-time diagnostic data or translate it into actionable maintenance advice based on the combination of valve design and service conditions.

Best-in-class diagnostic solutions from valve OEMs overcome the traditional shortcomings of solutions from third-party software vendors by leveraging the experience of the valve manufacturer to enhance the analysis of control valve performance, as well as the resulting identification of actionable maintenance advice to restore the device to peak performance. In so doing, these solutions are better positioned to help plants realize the original promise of asset management strategies aimed at increasing process output without increasing maintenance costs or manpower. CI

Figure 4: Flowserve ValveSight® diagnostics software features an intuitive dashboard-inspired user interface.

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