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Valve diagnostics

Past, present and future

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What the future holds for a control valve is on-line/in-service/in-situ diagnostics of the entire valve/actuator/positioner assembly. These diagnostics will tell you if or when you are going to have a problem, what the problem is and how to fix it. This technology will extend itself to the current method of diagnostics that require a control valve assembly to be blocked and isolated from the process. Digital valve controller manufacturers are moving rapidly in the direction of developing diagnostic software to minimize, and make more efficient, plant valve maintenance.

A typical control valve assembly consists of a valve, an actuator and a positioner. Many control valve assemblies also include accessories, such as solenoids, volume boosters, quick exhausts and trip valves. Each directly affects control valve assembly reliability—and performance.

Because they are usually the final process control element, control valve assemblies are one of the most critical elements in the loop. If it's inoperative, the whole loop is shut down. If it's operating, but poorly, loop performance is sub-par. Both situations can cost thousands of dollars per hour in lost revenue.

A logical goal is to keep the assembly in operation and performing optimally for as long as possible. The ideal situation includes a reliability and performance diagnostic indicator so that preventive maintenance could be performed predictably. This has not always been possible, but great advances are being made in this direction.

Past valve diagnostic and maintenance technology

Early valve maintenance philosophy was to keep the valves in operation for as long as possible. When something failed, the plant was shut down and the equipment was repaired to its like-new condition. This involved removing and disassembling each valve, and repairing or replacing the worn or damaged parts. This reactive maintenance approach used no diagnostic technology and was time consuming and costly.

Plant management eventually realized that shutting down because of an unexpected failure was costly. Unplanned shutdowns are the worst kind because there is no opportunity to develop a strategy for dealing with the emergency. They often last longer than planned ones because it's necessary to locate the problem, determine the cause, obtain repair parts (especially if they're not in stock), and locate skilled personnel.

About 15 years ago, we introduced a major improvement—the FlowScanner, a suitcase-sized instrumentation package to test the valve assembly while it's operating in the field (see Figure 1). This allows a skilled valve analyst to determine whether the valve can be left in the line or whether it needs to be removed, disassembled and repaired. While the device required the valve assembly to be isolated from the process, it still reduced

the resources needed to perform a planned maintenance program.

Present diagnostic technology

Many plants today run on a two- to three-year maintenance cycle. Instead of rebuilding every control valve assembly, however, only those with a maintenance history are rebuilt, along with a percentage of the rest. The latter category is rotated into the maintenance cycle every three to five cycles. This is known in the industry as a preventive maintenance cycle.

In 1999, ARC (formerly known as the Automation Research Council) published the results of a study that concluded as many as 60 percent of scheduled process valves preventive maintenance checks are unnecessary. The problem is that no one knows for certain which of the remaining valves need attention. The only reasonable action left is either to perform on-line electronic diagnostics or tear them down for maintenance checks.

With the introduction of the digital valve positioner, diagnostic technology migrated from the suitcase to the valve positioner. This means that the digital positioner (see Figure 2) is becoming the heart of a diagnostic-based maintenance system. Because of its expanded capability, valve manufacturers have renamed them digital valve controllers (DVCs). They allow users to change configuration, calibration and tuning quickly. Any valve assembly in the plant can be subjected to diagnostics initiated directly from the control room or maintenance shop. Unfortunately, most DVCs still require the valve assembly to be isolated from the process during testing.

Figure 1. Flowscanner.

DVC diagnostics requires proprietary software. Valve positioner manufacturers offer a range of capabilities among the DVCs and software packages. Many merely provide information about basic DVC parameters—not the entire assembly. Others offer true diagnostic testing capabilities that can measure, store and provide trends, valve signatures, valve performance and other variables for judging valve assembly condition. To ensure the total package meets their needs, users must evaluate the DVC and the accompanying software when purchasing a new DVC. Table 1 highlights the more advanced features available across the many diagnostic software packages.

Most of these features that provide true valve diagnostic information still require the control valve assembly to be isolated from the process during testing. There is one test, however, that actually provides valve condition information while the assembly is actively in the process.

Performance diagnostics test

This test determines the valve assembly's friction and dead band while the valve is on-line/in-service/in-situ. It gathers information without interrupting the process or by injecting a signal. The test also trends friction and dead band over time and can alert the operator if friction moves outside pre-configured limits. An observer standing near the valve in the field would be unaware that testing and monitoring are being performed.

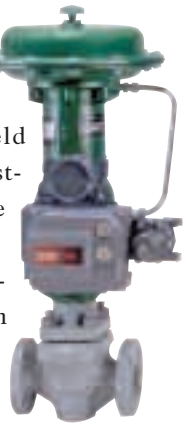

Figure 2. Digital positioner.

Plants can now determine specifically which valve assemblies need maintenance. This allows them to:

- Minimize total downtime during a turnaround. Knowing what to do before the turnaround occurs is an essential part of reducing downtime.
- Maximize the elapsed time between turnarounds. This directly affects process up-time and profitability.
- Sustain reliable performance. Reducing or eliminating unscheduled downtime enhances reliability and prof itability.

The plant now can move into a predictive maintenance program. Savings generated from predictive maintenance programs include:

- Productivity increases ranging from two percent to 40 percent.
- Maintenance expense reduced from seven percent to 60 percent.
- Product quality improved (rework and scrap rates reduced by five percent to 90 percent).
- Equipment life extended from one to 10 times.
- Spares inventory reduced by 10 percent to 60 percent.
- Inventory turns increased as much as 75 percent.
- Energy consumption reduced by five percent to 15 percent.
- Process downtime reduced by as much as 70 percent.

Future diagnostic technology

Throughout industry—whether it's pulp and paper, hydrocarbon, chemical or power—production is para-

mount. In many industries with continuous production, a process operates in excess of 95 percent of the time. Inherent physical limitations, such as catalyst degradation and heat exchanger fouling, prevent plants from operating 100 percent of the time. However, every fraction of a percent of increased availability often translates into millions of dollars in production. As such, valve diagnostics are most important during the 95 percent time frame when the process is running. In the remaining five percent time frame, the goal is to turn the plant around as quickly as possible.

While DVCs will continue to undergo many future improvements, the most immediate gains in valve diagnostics will occur in the software. What more should we expect from these powerful software tools? With economics of the process pushing the 95-percent uptime ever upward, it would not be a stretch to say that most future diagnostic development will be around on-line/in-service/in-situ diagnostics. Furthermore, because diagnostic software provides a wealth of diagnostic data but tells little about the effect on the user, it's obvious that development also will involve smart interpretation.

Leading valve manufacturers have made the commitment and are already developing software that works with DVCs. The next software advance is the ability to analyze valve assembly data and trends, and then determine the root cause of performance deviations. If the root cause is deterioration of the valve's operational health, for example, the software will establish an alert and inform the user what is wrong, the severity of the problem and what is needed to fix it. Software with this capability will appear in the very near future.

As valve assembly diagnostic technology continues to advance, users will receive more useful and descriptive information. Diagnostic packages will be able to:

- Indicate approximately how long the valve will continue to oper ate without serious performance degradation.
- Provide documentation of exact ly what needs to be fixed, a list of parts, tools, drawings and instructions needed, a list of qualified repair personnel, and any other information needed to perform the task quickly and reliably.
- Assist the repair personnel in generating the necessary logging information and repair documen tation.

Advanced features available on many diagnostic software packages.

User security
Audit log
Auto tuner
Batching capability
E-mail alert notification
Valve signature with analysis (friction, benchset and linearity)
Step response with analysis (overshoot, T63 and T86, error, gain)
Positioner signature
Performance diagnostics
Trending (with histogram)
Dead band analysis
Hart communications (modem and multiplexer)
Fieldbus communications
Modbus communications
Positioner electronics alerts
Internet/intranet access to valves
Actuator load factor
Positioner internal drive signal

Table 1

It's clear that the DVC industry is moving rapidly in the direction of developing diagnostic software to minimize, and make more efficient, plant valve maintenance.

With the diagnostic capability currently available, as well as the capability that will be available in the near future, emergency plant shutdowns caused by valve-related problems should begin to decrease. Having an up-to-date picture of each valve's operational health should begin to lengthen the interval between valve shutdowns, producing more operational revenue.

Using DVCs and associated diagnostic software to establish a viable predictive maintenance program can be a highly productive and profitable experience. The key is not only to implement valve diagnostic technology physically, but to incorporate it into a maintenance or reliability program effectively. Effective use of predictive diagnostic technology reduces the need for continuous preventive maintenance operations at a plant. Predictive valve diagnostics should replace PM, not augment it.

Process plants that have already begun incorporating this new technology into their maintenance and management culture are pleased with the results, and they feel that predictive maintenance with on-line/in-service/in-situ monitoring and testing is the wave of the future. You owe it to yourself to check it out.

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Figures: Fisher Controls International, Inc.

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