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A BRIGHT FUTURE FOR WIRELESS TECHNOLOGY

Industry has a watchdog that can save costs, provide reliability and allow more confidence that our valves are in good health and operating at peak capacity. The technology can also work toward a safer work environment and provide more information for improving processes.

BY KURTIS JENSEN

Wireless technology is a game changer, especially when it comes to process control. Wireless lowers implementation costs, expands access to information and allows control in areas previously held back by technical or economic barriers. Inevitably, approaches to process monitoring and operations will change when proven wireless technologies are used. In fact, wireless operations will reinvent traditional approaches to valve monitoring and control strategies and offer many compelling uses for remote and hard-to-reach locations, which is particularly useful in the area of automating manual valves.

The technology and the information it provides is already used to eliminate three common headaches: the time and effort it takes for manual audits; the amount of occasions in which someone is sent into undesirable conditions; and product variances, which when reduced can improve product quality. This article is focused not just on the current value of wireless valves but on what the future holds and where this technology can make changes in the approach to controls.

Today, manually operated valves generally are not used in control situations where access is restricted; however, knowing the state of those valves is important—especially after they have been used (e.g., a clean-out valve on a chemical reactor). Manual valves in control valve applications are used when adjustment periods are long (oil and gas production, transmission, etc.). Increased position feedback information can provide early indication that a valve is not moving as expected or is stuck before the situation affects the process or final product.

Wireless will connect manual valve feedback to an increasing number of automated controls. The result will be improved operations and safety; one example is adding a manual clean-out valve to an interlock where filling the chemical reactor will not occur unless the valve is closed. This simple change does three things to improve process reliability: it protects product quality, it protects against scrap or rework, and it protects against clean-up actions. The end result is a more reliable process and greater confidence that all is well.

Wireless also enables reduced resources needed to verify a valve's state. Many mistakes are made in batch processes where valves are left in the wrong state. Therefore, increasing the amount of valve information leads to greater assurance, providing proof to management that operations and safety improvement actions are achieving desired results. Using wireless to improve awareness has already proven itself in the chemical industry.

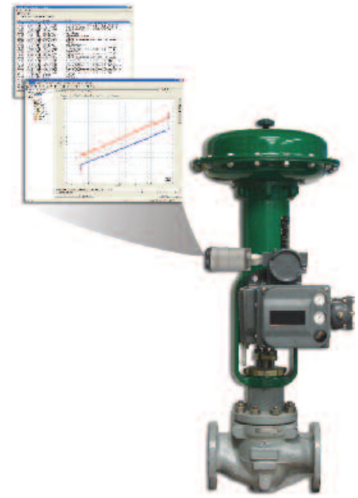
Early successes in wireless lead the way in addressing other operational pain points, as well. The industry-wide need and desire to increase safety means the percentage of manually operated blind valves will decline while valves equipped with feedback will increase.

ADVANTAGES OF VALVE AUTOMATION

Manually operated valves are automated for three primary reasons. First, moving the valve may require too much manual effort. Second, it may be desirable to eliminate having personnel in dangerous conditions such as precarious heights or hazardous environments. Third, it might be necessary to reduce complexity and time needed to coordinate valve adjustments during plant operations.

Valve uses are divided into two uses or categories: on/off or control. On/off valves are generally used for bypass, sampling and batching, as well as used in series with a control valve for shutdown or tight shutoff.

A large number of operations have some on/off valves that are not monitored for position—they are equipped solely with a solenoid to move the valve. About half of these semi-automated valves have no position feedback because of cost or practicality of obtaining the position feedback information. Obtaining feedback for an on/off valve has required the use of two sets of wires, one for open and another set for closed;



these wires are connected to simple discrete inputs at the control system.

Applications using control valves have process feedback called "process variables," which include pressure, temperature, level and flow. Without a process variable, the control loop is called "blind." Control loops are not typically blind—a valve is moved and a process variable changes. However, the valves themselves may be blind, in which case a command is sent to change valve position and the process variable is used for feedback. (No valve position feedback is used.) These valves are equipped solely with an I/P (current to pneumatic) transducer, pneumatic or electro-pneumatic positioner. Again, position feedback can affect cost or practicality of the operation. A single set of wires is used for feedback (which means less wiring expense as compared to on/off valves), but is connected to an analog input at the control system, which is typically more expensive than discrete inputs used for on/off feedback.

Until now, targeting existing valves for improvements has been rare because it has been a hassle and headache to make changes to wiring infrastructure as well as control I/O. Wireless is already changing approaches to new projects and installations because it eliminates wiring and creates simplicity. But the largest opportunity for improvement is with valves already installed. Knowing more about a valves' health enables better decisions and faster maintenance. It is just as simple and easy to achieve significant improvements on these old valves as with new projects. Facilities that implement wireless feedback have the competitive advantages of operating cost reductions, improved product quality, increased production volumes and increased levels of safety.

ADVANTAGES OF WIRELESS

In places where valve position monitoring does not currently exist, wireless monitoring provides a way to use monitoring technology with minimum risk.

Other compelling advantages of wireless over wired monitoring include:

- Wireless is easier to install because there are no wires. The devices can be battery-powered and operate for 5 to 10 years in process environments. WirelessHART position feedback devices, for example, are very energy efficient and update rates of 4 seconds will still provide 10 years of service without changing the power module.
- Wireless devices can be implemented at 10% to 20% of the cost of wired. An on-going cost of battery-powered devices exists; however, with life expectancies of 7 to 10 years, that burden is reduced considerably.
- Wireless instruments can be implemented in a matter of minutes and require fewer people for the process. Remember, battery-powered devices have no conduits or wiring at all—they are simply mounted to the valve. Feedback from a manual valve has incredible value, especially for safety. This is why retrofitting existing valves makes sense.
- Wireless devices often require fewer changes to drawings and less engineering resources. Fewer review meetings result in faster project completions with less people involved.
- Wireless can be installed in locations where wired devices cannot—in hard-to-reach locations, areas hazardous to plant personnel or where power doesn't exist, running wires is not allowed or is prohibitively expensive. These

wireless devices have features similar to intrinsically safe (IS) instruments and PDAs that are already in use in these locations.

- Hazardous area approvals and certifications are less complicated, especially in locations that require explosion-proof ratings. Because wiring and conduits into the device are eliminated, IS certifications are superior; they are by their very nature energy-limited and will not be a source of ignition. No source of ignition means no containment is required as well.
- Wireless devices operate on low voltage and low current, can easily be adapted to external power and can eliminate battery maintenance concerns. These power sources can also be IS certified. Installing to use local power is significantly less costly than running I/O wiring back to a control room. Another option for power sought by some customers, especially in remote locations, is solar panels.

The speed of wireless is getting closer to wired; monitoring devices are available with one-second update rates. When choosing the appropriate update rate for the device, battery life must be considered. The transmission of data is getting smarter through sampling the position and only sending updates when the valve position actually changes, which speeds up the process and lowers overall energy consumption.

RELIABILITY

An early concern with wireless technologies was that they were not as reliable as wired technologies. This was because early wireless technology was strictly point-to-point; picture a couple of tin cans with a string between them. If you did not have a straight line, also called line-of-sight, between the two devices, the chances of solid communications were eliminated. Also, line-of-site solutions require costly site surveys. Those problems have been addressed.

Today's technology—mesh networking—provides 99.9% reliability (for WirelessHART technology). With the advent of mesh networking, the tin can scenario was replaced by a spider-web-like network for communication that eliminates the need for site surveys. The distances between instruments in a WirelessHART mesh network is 200 meters, for example.

Every device is connected to other devices to form this mesh, which greatly increases the number of paths of communication as well as eliminating the requirement that a device be within a certain distance of the gateway. If one path fails from something such as a temporary construction project blocking a communication path, another path is automatically used without intervention. The result is very high reliability that in many aspects exceeds wired I/O.

For wired, a single set of wires runs between the input and output channel in the cabinet room to the conduit tray to the transmitter or valve. On the other hand, wireless is not subject to problems such as a broken cable from a situation such as when a fork lift runs into a cable tray.

Understanding Wireless Standards

Wireless valve communication offers many advantages, but can sometimes be confusing. There are many ways to set up a system, and they are governed by different standards. How do you choose? Here's a brief summary.

The layout or topology of a wireless network defines which nodes talk to which other nodes. Any wireless system has to have both end devices (mounted on valves, actuators or sensors) and a gateway to connect to a control system or an operator display. The end devices are generally very low power battery-operated units that spend most of their time asleep to save energy. The gateway to the rest of the world is generally powered by the AC mains. A system in which the end devices talk only to the gateway is called a "star" (think of the gateway as the center and the end devices as the points). Since the end devices have fairly short transmitting range, this tends to limit the physical size of the system.

If the end devices can hear each other and pass along any messages they get to the next node in the system until they reach the gateway (in other words, they can act as routers), the system is called a "mesh." A mesh can be much larger geographically than a star because end devices only have to be heard by the nearest other end device, not by the gateway. In addition, a message can take any path it must to get to its destination; if one node fails or its signal is blocked, the message automatically finds a new route.

Some systems have what amounts to a mesh of routers, with each router acting as the center of its own star; this is called a "hybrid" or "star cluster" network.

Wireless systems are governed by a number of different standards, with varying topologies and other characteristics and with support from different groups of vendors. At the lowest level, where such things as operating frequencies and methods of transmission are decided, most of them follow the IEEE 802.15.4 standard. But not all do, and even those that follow IEEE 802.15.4 aren't necessarily compatible. There are systems that follow ISA 100 (specifically ISA 100.11a). There are WirelessHART systems. There are ZigBee systems. All of them work, but not with each other.

One system that doesn't comply with IEEE 802.15.4 is Bluetooth. This is used a lot for things like cell phone earpieces and laptop computer mice, but there are industrial uses for it as well, including setting up and configuring smart valve actuators.

When considering wireless it's important to ask a few questions: Will the wireless system connect to an existing Profibus, Foundation fieldbus or Modbus network? Will it connect to Ethernet? Would a mesh, star or hybrid layout be best? How much area will it cover?

For more detail on wireless standards and topologies, take a look at the article "Sorting out wireless standards for smart valves and actuators" on ValveMagazine.com.

—Peter Cleaveland, Contributing Editor

SAFE OPERATIONS

Security is critical to data reliability. Wireless network standards employ security measures similar to those used for IT (information technology) systems.

Several important elements come into play with wireless transmission security. The first is encryption, which is a method of using seemingly random symbols that surround each transmission.

With wireless transmissions, encryption keys are adjustable to match security requirements that are designed to change before the transmission data can be intercepted. The IT systems can set how often these encryption keys are changed. In addition, each transmission must be authenticated, meaning that the sending and receiving devices must recognize each other. If those devices do not recognize each other, the transmission is ignored. The data is also verified by the receiving device.

Specific authentication and verification rules are built into each transmitter so no foreign devices can intercept a transmission or send bogus information to the receiving station.

Another advantage of wireless mesh networks is channel-hopping, which protects against frequency jamming by intentional or unintentional sources. If a channel or frequency does not work, the devices automatically make use of 15 different frequencies without user intervention. The wireless transmitters communicate their data to a network access device, also called a gateway. End users also may choose to install redundant gateways to eliminate the unlikely event that a particular gateway fails in critical applications. Channel-hopping coupled with the multipath networks, as well as redundant gateways, provide a solid infrastructure to move forward safely and securely with complete wireless operations, including critical and control applications.

USING THE DATA

The first uses with the new wireless data will be with interlock systems. In this case, actions will not be taken unless a piece of equipment is in the correct state. Referring back to our earlier example of a manual clean-out valve where filling the reactor will not occur unless the valve is closed—an interlock system would not allow the process to move to the next stage unless the valve is closed. Today, such action is sometimes completed manually by sending someone to the valve and verifying its position before transitioning the process. Along with requiring human resources, this can slow down a process while automation could improve throughput and increase consistency by reducing the possibility of transitioning the process without actually checking valve position.

New information can also be stored in repositories where it is analyzed and used to make improvements in processes. These improvements lead to greater confidence in operations. An example of this would be with forensics such as situations in which equipment state is needed to understand what happened just before an incident or when faulty or out-of-specification product is produced. Added information can reveal corrective actions that can improve safety and reduce accidents. An example is a valve not completely closed on a chemical reactor during a specific phase—when a vacuum is pulled on the reactor, air could be allowed into the vessel, which could negatively affect the product.

Such improved data on processes historically has been associated with high-end control systems. However, it is possible to store information in generic SQL (Structured Query Language) databases, so that common office applications can interface with the data easily and without expensive control system software. More frequently, data mining (database queries) would result in greater awareness of the state of processing equipment.

Internal and external regulations are increasingly asking for information about equipment health. The information gathered from wireless devices can be used for audit purposes and may demonstrate regulatory compliance.

A WINNING SITUATION

Automated valves can be coordinated with simple interlock controls, such as PLCs (programmable logic controllers), while PID (proportional integral derivative) control can be interfaced easily with control systems. Gateways are generic in design—they connect the wireless field devices' control systems and databases and can communicate with many types of equipment that use different communication languages. The result is easy integration with whatever control package is in use. The automated valves and control loops of the future will leverage open standards such as WirelessHART so designers can choose from a variety of suppliers and replace devices without replacing the entire network or control system.

Wireless makes valve monitoring more feasible and encourages more valve automation. Because of this, many plant operations are already embracing position monitoring and looking toward wireless valve automation and control in the near future. Designers of control strategies will take advantage of wireless valves to enable greater control as well as greater process and equipment health awareness, all of which results in greater confidence in operations and processes. Designers going forward will be well equipped to go to management with new wireless projects armed with a proven track record. **VM**

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