Redefining Flow Control

Overview

Wireless monitoring and control offers a great opportunity for many facilities, in a wide variety of applications and industries, to gain significant benefits over the traditional hard-wired methods of achieving valve actuator connectivity.

While the benefits of wireless monitoring and control are extremely attractive, there are many factors that need to be seriously considered before making the decision to employ wireless technology for either new installations or when retrofitting and upgrading existing applications. The ideas presented in this white paper about wireless connectivity, as it pertains to valve actuator monitoring and control, are based on years of experience with site trials and successful installations in various industries and applications.

Based on this experience, this white paper offers some thoughts to help separate wishful thinking from the realities of wireless control. There’s no doubt that the concept of “wire free” has great appeal, but like any change of philosophy, it requires prudent planning before throwing the switch.

Principal benefits

Wireless monitoring and control provide many benefits for new installations or retrofit projects. Typically, the most obvious benefits are significant cost and labour savings that result from the elimination of cables, conduits, and the work required to install and maintain them. Other advantages include the ease and convenience of wireless technology, which enable better monitoring and ready access to important valve performance data. There are other more subtle benefits as well, such as quick start-up.

For example, Rotork recently participated in a relatively straightforward fast track installation. It involved the installation of 16 wirelessly controlled actuators for a liquids storage facility.

When completed, the end-user commented that the actuators were ready for remote control as soon as the power was applied to the actuators. To accomplish this, the integrator received a wireless test set for software development purposes weeks in advance of commissioning, so that control via the PLC was ready once the equipment was installed and powered up.
So, not only were there substantial cost savings due to the elimination of the field control cable and conduit installation, but the labour and delays associated with proving the field control cable installation at the time of start-up were eliminated.

**Wireless connectivity for monitoring valve performance**

Unfortunately, not all applications are good candidates for wireless control. In fact, there are situations where distances between devices are too great, obstructions too many, or concerns about security too crucial. However, while wireless control may not be an option in some cases, wireless monitoring is viable for most field instrumentation applications.

One such example of a monitoring-only application is for the valves at a refinery’s coker process. There, obtaining diagnostic information about critical service valves is extremely important, and it’s much more productive if it can be done without having to send operations personnel to the valves.

Today’s typical valve actuators are intelligent and can provide information regarding torque loading changes that can be used for preventive maintenance purposes, and this information can be accessed and monitored wirelessly with ease and convenience.

**Conducting a site survey – a necessity?**

When considering wireless for either monitoring-only or for monitoring and control, it’s recommended that a site survey be conducted to set the stage for a successful installation. A “plug and play” approach, as attractive as it first may sound, really isn’t a recommended methodology when considering wireless monitoring and/or control.

Conducting a professional site survey is a necessity, because in real-life situations, there can be too many unknowns that can cause potential problems. That is why Rotork recommends a site survey and has site-survey teams of skilled technicians available to inspect a potential site for possible problems and drawbacks.

One of the most important things they check is the viability of reliable wireless communication between field units. Special equipment is used to examine available radio frequencies, and once unoccupied frequencies are identified, the technicians thoroughly examine signal paths from the control room to MOV locations.

To date, we’ve found each site survey to be an extremely important element for the successful implementation of the wireless system. For example, on one occasion, we discovered that a newly constructed building blocked the line of sight between some MOVs, so we added repeaters to by-pass the obstruction.

On another occasion, at a loading jetty application, the original site and satellite photos failed to indicate that the height of ships at the dock would block radio transmissions to the valves. Freely available satellite imagery is very useful for obtaining an overall idea of distances.
and some obstructions, but it does little to help define signal-blocking topology. In this circumstance, the obstacles were circumvented by remote mounting of the wireless module and by strategically locating the wireless gateway.

Unlike cell phones and computers, MOVs are generally not very flexible in terms of location. In some cases, we need to add signal repeaters to get around obstacles or increase transmission distances in order to maintain redundant paths of communication. Where an actuator might not be in an acceptable location in terms of signal reception (such as in a pit), we can locate the transceiver remotely from the actuator.

Site trials to assess difficult situations

Some situations may not only require a site survey, but also a site trial for a certain period of time to make sure wireless technology can meet the special demands. Rotork has conducted site trials internationally and in the USA.

One of the site trials we performed was at a water treatment plant in the Northeast part of the USA. The site was chosen due the presence of significant local radio traffic, line of sight distances, and because the cost-effective alternate solution to traditional control wiring was substantial.

At this location, all the valves designated for wireless control are located outdoors and exposed to rain, snow, and the typical temperature variations expected in the Northeast part of the USA. Average line of sight distances between the control room and the individual nodes are approximately 350-400 feet with distances between nodes averaging about 100 feet.

Site trials are an effective means to gain real world experience in a known environment where the application conditions can be stretched past the expected norms. For this application, we were able to locate equipment at distances greater than the intended designs, intentionally create barriers in signal paths, and monitor interference over greater periods of time and weather conditions than one might normally expect.

Basic system elements

There are three main components of the wireless system, the field nodes in the actuator which are powered by the actuator (no batteries required), the wireless gateway device which is powered by the network controller, and the network controller itself. In our case, the network controller is the Rotork Wireless Enabled P3 Pakscan Master Station. Control communication between the Master Station and higher-level control is via Modbus TCP or Modbus RTU protocol. The P3 Pakscan Master Station also has embedded web pages for configuration and diagnostic purposes.

Fig 1: System Elements: Field nodes, Wireless Gateway, Network Host
Mesh networking

The mesh network concept is fairly simple. All nodes act as signal repeaters to other nodes and create a self-healing meshed network. The Rotork system does not utilise non-repeating end devices. To prevent node overload and reduce unnecessary traffic, Rotork limits the number of neighbouring connections each node will maintain in the meshed scenario. Part of the site survey includes an examination of potential bottlenecking, and gateway and repeater locations are planned accordingly.

Fig 2: Image of site survey testing

Fig 3: Image of signal measurements node to node and gateway
Security, an important consideration

Security for the networked devices is extremely important. Therefore, in wireless monitoring and control applications, a variety of sophisticated security methods are employed. They include:

- 128-bit AES command encryption;
- Anti-spoofing technology to prevent unauthorised joining and denial of service scenarios;
- Private protocol to obscure unauthorised monitoring.

Furthermore, if a facility’s management isn’t totally comfortable with wireless control as a stand-alone technology, wireless can be combined with a two-wire control system with some valves controlled via wire and others controlled and/or monitored wirelessly.

Coexistence with other devices

A real concern can be the potential interference from other wireless devices such as 802.11b/g/n networks, cordless phones, tablet computers, and other equipment.

A primary reason for a site survey is to measure RF activity and to select an unused or lightly used band to avoid the potential for overlapping frequencies. The relatively high data rate of 250Kbps means short transmission times, therefore less chance of “collisions,” and the Carrier Sense Multiple Access (CSMA) technology employed ensures a device will listen before it talks in order to check that the channel is clear for communication.

In addition to this, acknowledged transmission and retry techniques are used along with dynamic routing of communication paths to minimise the potential for lost packets of data.

Configuration

Wireless configuration of the field devices is relatively straightforward. The standard setting tool that comes with the valve actuator can be used to configure the wireless node parameters.

The embedded Web pages in the P3 Pakscan Master Station allow users to access parameters for both the P3 Pakscan Master Station and the field nodes.

Information

In addition to the typical MOV status information you would expect with a digital control network, the wireless network has the ability to upload a stored datalogger file within the actuator that contains information about torque loading, motor starts, and other valuable statistical information.

This data can be viewed and analyzed when needed offline with Rotork’s PC based Insight2 software programme.

Today’s wireless realities

To date, site surveys and installations have been performed successfully for a variety of new and retrofit applications including liquids storage facilities, a loading jetty, water treatment plants, coker facilities, a mining tailings processing application and more.

Wireless technology advances have proven themselves to be reliable, secure, and cost effective. While it is true that some applications aren’t suitable for wireless control, nonetheless, virtually every hardwired installation should become familiar with the technology and carefully consider its validity when it comes time for a major upgrade, new installation, or just to
add a wireless monitoring capability to the existing system.

Incorporating wireless technology into the valve actuator control and monitoring arena is no longer wishful thinking. It works well and can result in substantial cost savings and productivity benefits. In summary, the installed cost benefit of wireless technology is too appealing to be ignored whenever considering a new or retrofit installation.

Schematic of typical wireless Pakscan P3 control network
The schematic illustrates how different actuator designs as well as instrumentation such as flow sensors can be monitored and controlled on the same wireless network.

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