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Smart Water

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During the time when most water and wastewater treatment plants were built, automation was very costly. Therefore, many treatment plants only have a bare minimum of instrumentation and still rely on manual data collection. However, with ever more stringent directives, availability requirements, and operator workload considerations, manual operation becomes impractical. Hence, treatment plants, pumping stations and et cetera are being modernised with a second layer of automation to become smarter. Just like many other industries, the water and wastewater industry has discovered that wireless instruments are an easy way to modernise an existing plant.

The Smart Water Treatment Plant

When many water and wastewater treatment plants were built, they were only fitted with basic instrumentation due to the high cost of running many wires for 4-20 mA and on-off signals and the system I/O cards for any additional instruments. Some plants still rely on manual data collection for vibration of pumps, compressors, and blowers, power consumption, as well as valve line-up and et cetera. In many cases, there is no data collection at all.

Pump Vibration

Water and wastewater plants use pumps to move the water around the various treatment stages and to discharge the treated water out of the plant. As for all pumps, bearings are checked periodically with a portable vibration tester. An infrared temperature gun is used to check for overheating. However, portable data collection is infrequent so developing vibration issues may be missed. Manual data collection is not productive, particularly for the remote locations of pumping stations. WirelessHART vibration transmitters can be used instead to provide bearing condition once an hour, capturing weak signals early. As a result, repairs can be scheduled based on actual conditions. Since vibration sensors are non-intrusive, pumps can be modernised while in operation. Manual checks and data collection are eliminated, reducing cost. Issues like strainer plugging and high discharge pressure are also detected.

Compressor and Blower

Similarly, compressors or blowers used for air supply to the aeration basins have also traditionally been inspected and tested manually on a periodic basis. Wireless transmitters enable continuous monitoring of vibration and temperature for bearings, motors, manifolds and et cetera.

Valve Position

There have been a number of incidents caused by manual valves not being in the correct position. Incorrect lineup of a manual valve has led to mistakes in transfer of treatment chemicals. Manual valves, which are opened and closed regularly, can be fitted with WirelessHART position transmitters to provide feedback to operators on actual valve position for better situational awareness to reduce mistakes. This information can also be incorporated into interlocks to prevent pumps from starting. Operators also benefit from position feedback on sluice gates.

Manual Data Collection

Vibration, temperature, pressure, and fluid level transmitters reduce the data collection burden on maintenance personnel. One of the steps in a plant modernisation audit is to review the log sheets used on clipboard rounds to see which points should be automated.

Similarly, water quality must be reported to the local authorities. For drinking water, this may include pH, chlorine, ozone, turbidity and et cetera. For wastewater, this also includes biological activity of the microorganisms. If any of these measurements are missing or done by grab sampling in a lab, the plant can automate this by deploying wired transmitters using local power, but with wireless signal transmission through WirelessHART adapters. This eliminates the need for signal wiring and system input cards.

Emergency Safety Shower and Eyewash Station

Water and wastewater treatment plants have areas where hazardous chemicals are stored and handled, where they will be equipped with emergency safety showers and eyewash stations. However, in many plants, these safety showers and eyewash stations are not wired to the control system so there is no alarm when they are activated. A person in distress may or may not be able to call for help on a walkie-talkie, the radio set may or may not work when wet, and the person may or may not be able to describe which shower they are using. Plants across all industries are therefore installing proximity switches and wireless discrete transmitters on the safety showers and eyewash stations which are not yet monitored. This alarm enables operators to quickly discover if and where a safety shower is activated, so they can immediately notify first aiders and nearby personnel.

Energy Management

When electrical equipment like motors that are not in use are left running or run faster than required, energy is wasted. Leaking aeration systems and valves left open – when not producing – waste the electricity that is consumed to blow

the air. Most plants today only monitor the power consumption from the single meter at the battery limits where electricity enters the plant. Power consumption of individual equipment may be checked manually on a periodic basis using a clamp meter. The data is typically manually compiled in an Excel spreadsheet. Therefore there is no visibility to whether consumption is higher than normal in some plant unit, or if some equipment is running when not needed. By only looking at overall plant energy consumption, problems cannot be pinpointed so there is little or nothing that can be done to improve and sustain. Thus those responsible for energy consumption at most sites do not have the information they need in order to drive energy management practices to reduce energy consumption.

Plants across many industries are adopting ISO 50001 energy management practices. This entails monitoring the energy flows within the plant with much finer granularity than before. For instance, electric power consumption is monitored for each plant area, unit, and even down to each piece of equipment in the case of heavy loads, such as large electric motors for pumps, air compressors, blowers, and sludge dewatering centrifuges. Existing plants that do not have such power measurement in place can easily add it using wireless power meters.

Other energy steams to monitor include chlorine gas. Modernising with additional electric power meters and flow meters at the plant area, unit, and equipment levels together with an energy management information system (EMIS) gives plant operators the ability to manage consumption and loss of energy around the plant with much finer granularity. Energy consumption can be rolled-up for each processing stage and compared to plant throughput to detect abnormal consumption.

Modernising Valve Automation

Treatment plants have many electric actuators / motor operated valves (MOV). Each MOV has 16 or more control and feedback signals that need to be integrated with the control system to fully utilise the capability of the MOV. However, due to the high cost of hardwiring as well as 4-20 mA and on-off I/O cards, only part of the signals are wired. As a result, treatment plants only enjoy part of the capability of the MOV. Because of the limitations of 4-20 mA and on-off signals, treatment plants were among the first to abandon hardwired signals and instead started using digital communication to unleash the full functionality of MOV. While proprietary networks were used decades ago, standard PROFIBUS or FOUNDATION fieldbus™ are used.

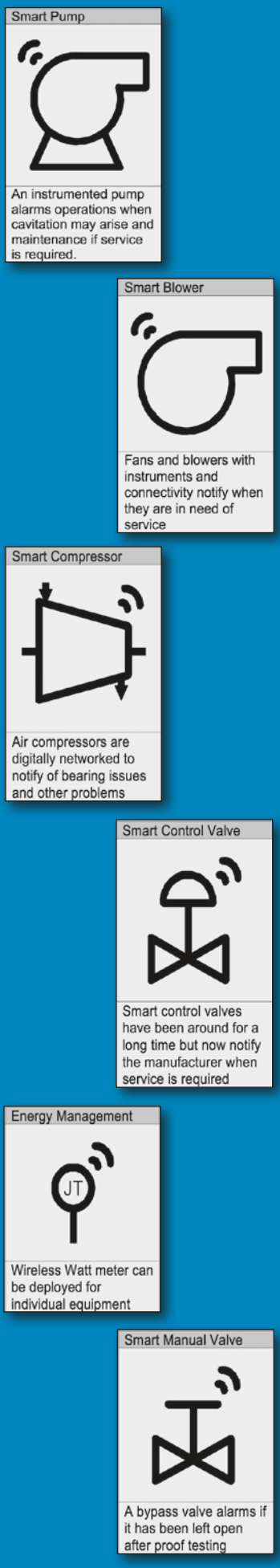
Some treatment plants still have MOV integrated using proprietary networks. However, integration of proprietary solutions to the control system is more complex, using gateways, intermediate networks, interfaces, and drivers. Moreover, proprietary technology causes single vendor dependency preventing the use of MOV from other suppliers.

Treatment plants are now modernising using standard networking for MOVs instead of hardwiring or proprietary protocols. This gives the treatment plants MOVs with full functionality and the plant is liberated from proprietary protocols. The instrument and control engineers can centrally access MOV diagnostics, such as torque, motor temperature, etc.

The same two-wire fieldbus which is used to integrate the MOV can also be used to connect flow meters and analysers used for the controls. The same intelligent device management (IDM) software used to manage radar level transmitters and control valves can also be used to manage MOV and two-wire intelligent on-off valves.

Industrial Internet of Things

Once a pump, compressor, or blower has been instrumented, its condition can be monitored by the personnel working in the plant "on premise." By



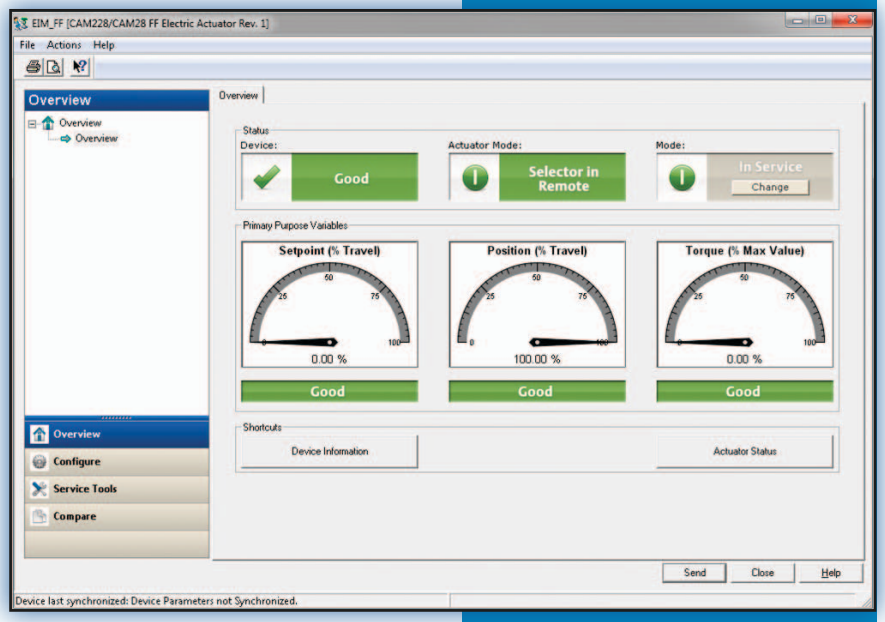


Figure 1 IDM software dashboard for fieldbus MOV rendered from EDDL

also providing an Internet connection new possibilities open up since the equipment health can be monitored from outside the plant. For instance, equipment in multiple plants in a municipality or even across a country can be monitored from a central engineering office specialising in equipment health. Another business model is that each equipment manufacturer or a third-party service provider monitors equipment in plants for a monthly subscription fee. Such services are already in operation for improving energy efficiency and reliability of plants. It can also be done for control valves, MOVs, and analysers. This type of arrangement where "things" like sensors and actuators are accessed remotely across the Internet is referred to as the Internet of Things (IoT), and in an industrial setting as the Industrial IoT (IIoT). It should be noted that the sensors involved in such remote monitoring services can be either physically or logically separated from the plant's control system. Also, since it is an asset monitoring system not related to control or safety, system downtime does not affect the safety or quality of the water. Lastly, the data collected through the system is the same, which was traditionally collected manually for service purposes, often by third-parties. That is, this type of data has been leaving the plant in the past as well.

Balancing the ins and outs of the water supply network is a way to detect leaks while ensuring the integrity of the distribution network. Flow is measured at the point of production, in every branch of the network, and at each consumer. By reading water meters once a month and tallying up the numbers, it could take a long time to detect a leak. Also, unless measurements are done for individual branches of the network, the leak is hard to pinpoint. In order to detect and pinpoint leaks quickly more flow meters should be deployed along the network and at the consumers to monitor and balance the flow in real-time. Additional sensors can monitor the water quality. Large consumers of water in Singapore, such as industrial plants, are already required to report their water consumption. In the future, this reporting will be common in other nations as well and likely have to be ever more frequent and eventually measured in real time, and will also apply to medium and relatively small consumers. It will not be practical to do such reporting manually. It has to be automated with sensors and networking. In the years ahead, IIoT will drive the deployment of more of these kinds of sensors, enabling better water network management.

Water Management 4.0

Existing water and wastewater treatment plants can be modernised with wireless and fieldbus to meet today's demands, and to be ready to meet future demands. Start with a modernisation audit to uncover missing measurements that need to be updated to make the plant smarter, ready for the IIoT and Industry 4.0. A smarter plant is a safer and more efficient plant. WWA