Demystifying Cooling Water Online Monitoring and Control Platforms

(A User's Guide for the Water Treatment Industry)

Background

The speed at which technology is overtaking our lives is growing exponentially each year. Technology has even made its way into the relatively stable and unchanging universe of Cooling Water Treatment. The increased use of technology in the water treatment industry is being driven by a need to respond to several important trends. These include increased regulations, a need for greater access to information, and tightening resources.

In response to these trends, users of water treatment technology are continually trying to do more with less. Many end users need to manage multiple systems across multiple locations without being bogged down running too many water tests. They prefer to operate from their PC or cell phone, but in doing so, cannot afford to sacrifice confidence, data integrity, or program quality. This document will help our members support their clients in navigating the required balance.

Project Introduction

AWT's Cooling Water Subcommittee took on this project in early 2019 as a response to an expressed need for clarification of the subject matter by member companies. Our workgroup's approach involved two brainstorming sessions to clarify the need and scope, followed by generating subheader content and ultimately by populating the document with user-appropriate information. The paper aims to provide AWT member firms with information necessary to expedite selection, specification, setup, commissioning, startup, and ongoing maintenance of an online monitoring and control package.

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DATA ACCESSIBILITY

The Internet of Things is the concept of everyday objects—from industrial machines to wearable devices—using built-in sensors to gather data and act on that data across a network. So, it's a building that uses sensors to automatically adjust heating and lighting. Or production equipment alerting maintenance personnel to an impending failure. Simply put, the Internet of Things is the future of technology that can make our lives more efficient.

Why is the Internet of Things important?

You might be surprised to learn how many things are connected to the Internet and how much economic benefit we can derive from analyzing the resulting data streams. Here are some examples of the impact the Internet of Things has on industries:

- Intelligent transport solutions speed up traffic flows, reduce fuel consumption, prioritize vehicle repair schedules, and save lives.
- Smart electric grids more efficiently connect renewable resources, improve system reliability, and charge customers based on smaller usage increments.
- Machine monitoring sensors diagnose—and predict—pending maintenance issues and near-term part stock outs and even prioritize maintenance crew schedules for repair equipment and regional needs.
- Data-driven systems are being built into the infrastructure of "smart cities," making it easier for municipalities to run waste management, law enforcement, and other programs more efficiently.

But how does the Internet of Things help water treaters?

A microprocessor-based controller designed to control cooling tower or boiler water parameters through online measurements of inputs and activation of outputs has many advantages for the water treaters.

Key benefits include the following:

1) Saves time traveling to a site to make a change in the treatment program.
2) Saves money in preventing potential system upsets since sites are monitored remotely in real time.
3) Allows for intervention of alarm conditions that customer may have otherwise been unaware of.
4) Easy report generation based on the data collected by the device locally and on the cloud. The data helps support evidence of control for water treaters for their customers.
5) Support for regulatory compliance, e.g., in regions such as New York City.

How does a remote connected/ "smart" controller help the water treater do their daily job?

1) Ability to connect to devices remotely and securely at customers' locations and view the status and operations on their computers, phones, or tablets.
2) Remote viewing of sensor readings and system status in real time.

3) Remote changes to device program settings, such as control set points and alarm parameters.
4) Ability to receive remote alarm notifications.
5) Ability to store data from the site and create charts and reports of the data remotely.

How does a remote connected/ "smart" controller help the building manager/end user?

1) Provides peace of mind, as it helps to ensure that the water treatment programs are running effectively and assures that the chemical contracts are providing excellent ROI.
2) Ensures timely maintenance of the towers to avoid expensive downtime and cleaning efforts to remove scale buildup.
3) Tracks water consumption and keeps it under control, ensuring efficient usage to maximize cycles of concentration and claim evaporation credits, where applicable.
4) Helps to keep energy bills under control through efficient use of the heat transfer system and ensures comfort of the building inhabitants.
5) Helps prevent outbreak of any serious respiratory illnesses, like Legionnaires' disease, by ensuring that effective water treatment programs are in place.

Considerations for selecting a "smart" controller:

1) Define business goals…how to use the devices in day-to-day job.
2) Prepare the data points and metrics aligned with the outcome…every installation is different as it has its own unique characteristics. So, ensure that the device operating parameters are configured properly.
3) Define the device connectivity and data format… how will the data from controllers be shared? Through a direct ethernet connection, Wi-Fi bridge, or modems? These decisions have a bearing on the running costs.
4) Ensure security, governance, and access rights across each layer…who has access rights to which controller? Define the tiered access rights for the organization and escalation matrix. Plus, define who has what rights…just view data or also change parameters? Also, the water treater might need to conform to the building IT's security infrastructure; so, choose connection options accordingly.
5) Decide on data transfer rates—what's critical and requires real time information and what can be "batch processed"? Balance data transfer running costs vs. the criticality of the application/information required.
6) Ensure and choose solution with an intuitive user experience—on the hardware, on the web, or through the app…ease of access, ease of data retrieval, ease of analysis, ease of reporting. Usage should not become a chore.
7) Finally, data security…data privacy is extremely key, as hackers are looking for that one "soft spot" to hack into building infrastructure. Ensure that the chosen solution has the right levels of industry security and encryption standards.

There is little doubt that the Internet of Things and remote connectivity have the potential to transform our business models. But to fully realize the Internet of Thing's potential, organizations would require simultaneous changes in thinking and in culture. The process of gaining insight from data, including Internet of Things data, is by its nature iterative. It takes a mixture of analytics capability and domain expertise, combined with vision and imagination, to achieve success. But when this happens, organizations see a valuable opportunity to operate more efficiently, serve their customers more successfully, and establish true competitive differentiation in their markets.

HARDWARE SELECTION (MODES OF CONTROL)

An early and essential step in establishing an effective online monitoring and control platform is to decide which variables are to be controlled and to decide on desired mode of control, including any remote communications and data communications methods. This section provides some insight into the preliminary decisions that the water treatment firm must make.

Blowdown Options

1) Control blowdown proportional to makeup. Hardware needed includes a contacting makeup water meter, timer, blowdown line flow control, and electrically operated blowdown valve. This option is low cost and low maintenance but can only be used when the makeup water supply quality is consistent. Pretreatment of the makeup water by reverse osmosis or softening also permits use of this mode of blowdown control.

2) Control blowdown by monitoring cooling water conductivity. Hardware needed includes a conductivity monitor/controller, conductivity probe, and electrically operated blowdown valve. A blowdown flow control may also be needed to prevent loss of water from the cooling system due to excessive blowdown flow rate. This option is typically used when the makeup water quality is known to vary. Initial cost is higher than makeup proportional control, and standard conductivity probes must be cleaned and calibrated on a routine basis. Conductivity probes are either electrode or toroidal. The toroidal units are more costly but do not require routine cleaning, as they are non-contact.

3) Other possible modes to control blowdown include various online monitors for total alkalinity, hardness, silica, and chloride. None of these methods are in common use.

Chemical Inhibitor Feed Options

1) Chemical feed based on lapsed time uses a timer to activate a chemical feed pump. Hardware consists of a timer and chemical feed pump. It is the lowest cost chemical feed mode but lacks any means of automatically adjusting chemical feed based on cooling system operation or changing makeup water quality.

2) Bleed-feed is a feed method where a blowdown event activates a timer, which then operates a chemical feed pump. In some cases, the chemical pump is activated at the same time as the blowdown valve. This method cannot compensate for changes in makeup water quality, which effects cycles of concentration and is also defeated by both in and out system water leaks. Hardware needed in addition to the conductivity controller consists of a chemical pump.

3) Control chemical feed proportional to makeup. Hardware needed includes a contacting makeup water meter, timer, and chemical pump. This option is low cost and low maintenance, often used with blowdown control proportional to makeup. It can be used with any makeup water supply but will require feed rate adjustment if the water quality varies over a wide range, changing cooling water cycles of concentration.

4) Tracer controlled chemical feed using online tracer sensors to control operation of a chemical feed pump. Hardware needed includes the online tracer sensor with appropriate controller and chemical feed pump. This can provide excellent control with varying makeup water quality and system in and out leaks. Downsides include unit cost, sensor cleaning, and calibration requirements.

5) Where corrosion is the main concern, an online corrosion rate monitor/controller can be used to control chemical feed to obtain a set corrosion rate by operating a chemical feed pump. Hardware needed includes a corrosion rate monitor/controller and chemical feed pump. At present, not in common use.

Biocide Feed Options

1) Biocide feed based on lapsed time uses a timer to activate a chemical feed pump. Hardware consists of a timer and chemical feed pump. Low-cost biocide feed mode but lacks any means of automatically adjusting biocide feed based on cooling system operation. Most common biocide feed method and generally the only one considered for use with nonoxidizing biocides.

2) Biocide feed based on online measurement of ORP for oxidizing biocides or specific parameters such as chlorine. Hardware consists of a sensor/controller and chemical feed pump. ORP is the more common method while the specific parameter monitor/controllers are costly and require routine maintenance and calibration.

3) Online biological activity monitoring has been used for control of biocide feed. Hardware needed consists of a biological activity monitor/controller and chemical feed pump. Equipment needed is both costly and proprietary.

Acid Feed Options (pH Control)

1) Acid feed for pH adjustment can be accomplished proportional to makeup. Hardware needed includes a contacting makeup water meter, timer, makeup line flow control, and chemical feed pump. This option is low cost and low maintenance but can only be used when the makeup water supply quality is consistent.

2) A pH monitor/controller is commonly used for pH adjustment of cooling water. Equipment needed consists of a pH monitor/controller, pH probe, and chemical feed pump. The pH probe must be cleaned and calibrated on a routine basis.

The parameters shown above are taken from the typical design approach currently offered by most companies. A standard design approach often uses PTSA for inhibitor, ORP for the oxidizing biocide, timers for dosing of nonoxidizing biocides, and conductivity to control bleed. These base level selections are essential; however, the list and level of complexity could grow depending upon the client's goals. The client may wish to add features such as container inventory control, pump "dosing" confirmation, corrosion rate monitoring, or bleed lock-out.

USER INTERFACE PLATFORMS

A user interface is any method that allows a user to connect to, monitor, control, or otherwise interact with a controller, system, or device. This is usually referred to as the HMI (human-machine interface), although other terms are used. This can also refer to a graphical user interface (GUI) such as a dashboard that can graphically display a system or components for a user.

An HMI can come in a variety of forms, from a simple meter indication to built-in display screens, or even a portable communication device such as a smartphone or tablet. HMIs are used in Supervisory Control and Data Acquisition (SCADA) systems. A SCADA system includes the hardware and software elements that are used to control processes or devices locally or remotely, monitor real-time data, and record system data into a type of database.

A basic SCADA system consists of the sensors, controllers or PLCs (programmable logic controllers), control devices such as pumps and valves, the communications network, the HMIs, and the software used to process and display the data. A SCADA system can have multiple HMIs, and the software will reside in the supervisory computers and not in the controllers or PLCs.

The controllers or PLCs accept the inputs from the sensors and provides the outputs to the control devices and the communications network. The communications to the network devices can be by several different methods, such as Ethernet, cellular communications, Bluetooth, or direct connect and can go over a local network or the internet.

The network devices can be local or remotely located. For local network devices, typically an industry standard or manufacturer proprietary protocol such as Modbus, BACnet, Profibus, LonTalk, or any of the Common Industrial Protocols (CIP) are used. Most of the building automation systems will use one or more of these protocols, and each has different requirements. These protocols can quickly become complicated and will require the services of a local integrator to implement.

Most of the controllers in our industry will have the ability to communicate via one or more of the above protocols, or they will have the ability to convert from one protocol to another even if they need to use an external secondary device.

For remote network devices, most controllers will use the local Ethernet or cellular communications to access the internet. Each of these methods has their own advantages and disadvantages. Using the local Ethernet is the least expensive method but requires the cooperation of the local IT professionals, and sometimes they can be reluctant to allow access to their network or make changes to their system, which could affect communications with the controller. Cellular communication has the benefit of not having to deal with the local IT department, but it will have a monthly or yearly fee, and the cellular reception can be quite limited in an industrial environment.

The manufacturers of controllers for cooling water all have different methods or programs to communicate with their controllers. Some communicate directly with the controller and display live readings, some access a web-based or cloud-based summary of the controller readings, and some do both. All manufacturers have the ability to send emails or notifications from their controllers once remote communications are established. Regardless of the manufacturer, the user will be able to remotely access the controller and make changes to the configuration or download the data if they have permission to do so.
There are several cloud-based software services that allow the water treatment professional to save wet test and controller data and integrate that data to create graphs and service reports. Some of the manufacturers have their own software service for this purpose. There are also apps that allow the water treater to enter data on site or remotely to be included in any reports that are generated.

The major benefit to remote communications with a cooling water controller is that it allows the water treater to verify that the controller is operating within specifications and make changes to the configuration without having to visit the site in person. This can greatly improve efficiency and time management and allows the water treater to be proactive in servicing the account.

INSTALLATION, COMMISSIONING, AND MAINTENANCE

Background
The purpose of this section is to provide AWT members with useful insights from the field and industry best practice for the installation, commissioning, and ongoing maintenance of the online monitoring and control technology described in previous sections.

Installation
1) Upon receipt of equipment from vendor, confirm that all components shipped match what was ordered, as these units are available with a myriad of options from probes and sensors.
2) Of critical importance is the configuration and installation of probes. Depending on the probe type, specific configuration and alignment will be required. A PTSA probe, for example, needs to be installed on a vertical at a 90-degree angle and always be flooded. Before beginning installation, map out the installation location of all required probes.
3) The connectivity of the unit also needs to be taken into consideration. If connecting to the internet thru Wi-Fi or cellular connection, the modem should be located to maximize proximity to the available signal (typically as high as possible for cellular). If hardwired thru ethernet connection, coordination may be needed with the end user’s personnel to make an ethernet cable available in proximity to the installed controller location.
4) Take the same considerations for mounting and power supply as you would for traditional feed and control equipment, with an eye toward giving yourself a bit more space, 1–2 square feet, than normal.

Commissioning

1) Of course, one of the key benefits of utilizing online monitoring and control technology is to enable the water treater to remotely control a treatment program based on key parameters such as PTSA or ORP measured in real time. It is desirable to take advantage of this capability immediately upon installation; however, it has been observed that not jumping into this practice can be helpful in dialing in a program and dosages.
2) Initially, instead of controlling dosages based on parameter readings, dosages can be set with timers. Observe the performance and readings over a period of 2–3 weeks.
1) When you've got the program performing where you want it, turn it over to full automated control with tightly configured alarms to give you warning of any potential issue during the initial probationary period.
2) Once you've got the program completely dialed in with fully automated control based on key parameters, adjust your alarms to appropriate levels.
3) Probe Calibration – This process ensures accuracy of the input data necessary for the controllers to function as designed. Calibration aligns probe functionality to solutions of known concentrations to achieve accurate program control, or depending upon the parameter, calibration within the system may be more appropriate. Refer to manufacturer's O&Ms.

Maintenance

1) There are two key points to the ongoing maintenance of online monitoring and control technology. The first is verification of the accuracy of probes. It is best practice to frequently confirm probe readings with onsite field tests. If bad data is being collected remotely, there is no way to ensure a successful treatment program.
2) Probe Maintenance – Beyond startup calibrations, certain measurement probes require special attention to ensure continued performance. Tasks may include periodic calibration, proper offline storage, or other. Periodic probe cleaning is essential. Refer to manufacturer's O&Ms.
3) Data Maintenance – The client must make decisions as to how they wish to receive and store the data generated by the online monitoring and control process. Decisions also include security, format, distribution, and modes of reporting.
4) An important consideration is to understand and accommodate the health and life cycle of the probes. Each probe type will have different requirements for maintenance and service life, so the equipment manufacturer should be consulted.

PROJECT SUMMARY

This collaborative document was intended to provide a preliminary overview of a movement that is gaining momentum within the water treatment industry. The authors recognize that change is forthcoming, but also that a portion of the AWT membership may not be fully prepared to participate or may require additional insight to get started. We hope this paper serves the expressed purpose, and we encourage additional dialogue within the AWT community and beyond.