Power Generation

Perspectives in Pure Water Analytics

10 News

THORNTON

Leading Pure Water Analytics

TOC Analysis in Boiler Condensate – Fine if You Have the Know-how!

A large-scale power plant in Germany successfully relies on the THORNTON 5000TOC measurement system to monitor TOC levels in the condensate of a cooling circuit.

TOC measurement in condensate is imperative

Determination of the total organic carbon (TOC) level is a highly relevant measurement in power plant chemistry. The presence of halogenated hydrocarbons in condensate can lead to substantial damage to pipework and turbines. For instance, thermal cracking of chlorinated hydrocarbons creates aggressive hydrogen chloride (Hcl) which, as an aqueous solution, is hydrochloric acid. Hydrochloric acid acts as an oxidant, and its presence must be avoided, since through corrosive attack on piping and turbine blades, it can cause pitting and dynamic unbalance.

On-line measurement of TOC in purified water

For the above mentioned reason, this large power plant employs an on-line TOC measurement system in the condensate to detect the presence of any organic contamination. The 5000TOC from THORNTON is the only TOC instrument on the market which actually carries out continuous, online measurement of TOC in purified water. It is outstanding for the following features:

- Real-time data: one measurement value per second
- The quickest TOC measurement for purified water: the actual measured value is displayed after approximately one minute
- The only true on-line TOC measurement system: no batch measurement

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cycle with analysis times of between 7 and 15 minutes, but continuous, on-line measurement

- Low maintenance requirement: no moving parts, no chemicals, no membranes. UV lamp exchange twice a year only.
- Rapid startup: automatic recognition of the instrument and configuration thanks to THORNTON Smart sensor technology.
- Lowest cost per TOC measuring point: 2 TOC sensors can be connected to the multiparameter, multichannel transmitter 770MAX, reducing the overall cost per measuring point substantially.
- Extensible: additionally, the 770MAX has 2 more inputs which can be used for conductivity / resistivity, ozone, pH/ORP or oxygen, as well as 2 inputs for flow measurement.
- The complete solution: the 770MAX offers THE platform for comprehensive pure water analytics.

Ion exchange supports the 5000TOC

The 5000TOC works according to the principle of dynamic UV oxidation and detection of the development of CO_2 (end product of oxidation) via differential conductivity measurement.

Since iron(II) ions are dissolved in the condensate and these readily oxidize to iron(III) ions by the UV radiation, this results in the formation of iron(III) hydroxide which precipitates as rust on the components of the analytic instrument (quartz coil, tubing). To overcome this problem, the application engineers at Mettler-Toledo Thornton advised the installation of a cation exchanger in the sample flow stream in advance of the analysis equipment.

$$Fe^{2+} + \text{UV light} \rightarrow Fe^{3+}$$
$$Fe^{3+} + 3\ H_2O \rightarrow Fe(OH)_3 + 3\ H^+$$
$$2\ Fe(OH)_3 \rightarrow Fe_2O_3 + 3\ H_2O$$

All's well that ends well, thanks to THORNTON competence!

What at first sounds so simple can in actual practice be a real teaser! Even the very best measuring system will function poorly if it is inappropriately employed. Initial installation of the 5000TOC by the customer brought disappointing results, for after only two weeks in operation, rust deposits began to appear, making it necessary to carry out an overhaul of the system. Our experts recognized the root of the problem, and introduced an ion exchanger into the flow path upstream of the measurement equipment. Since then the power plant operator is fully satisfied with the performance of our 5000TOC analytic system.

Fig. 1: 5000TOC sensor (right) with transmitter 770MAX (left).

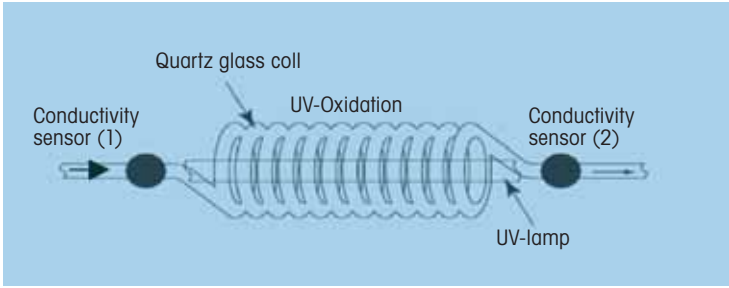

Fig. 2: Measurement principle of the 5000TOC.

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Instrument Predicts
Deionization System Exhaustion

The exchange capacity of a deionization system is the total load of ionic materials that can be removed before regeneration is required. Instrumentation can monitor this accumulated load and accurately predict resin exhaustion.

In operation, deionization resins eventually reach their capacity and need to be regenerated. The costs of regeneration including acid, caustic, rinse water and labor are very substantial. Anything that can be done to extend run cycles, regenerate more efficiently, or accurately determine the need for resin treatment or replacement can bring significant operating savings.

Detecting resin exhaustion

When exchange capacity is reached, the resin begins to leak the most weakly held ions. Conventional monitoring for resin exhaustion uses sodium measurement at the outlet of a cation exchanger and uses conductivity and/or silica at anion and mixed bed exchanger outlets. An accurate and precisely temperature compensated conductivity measurement provides reliable, low cost, fast responding and continuous means of detecting exhaustion.

These are all sensitive measurements but detect exhaustion only after breakthrough has occurred. The process downstream begins receiving contamination at the same time the measurement detects it. In many situations it is desirable to predict when exhaustion will occur beforehand to allow coming off-line and regenerating before breakthrough, but not so much ahead of time that a large portion of exchange capacity is wasted.

Predicting resin exhaustion

Predicting resin exhaustion has a number of benefits. It can help avoid reaching capacity during an inadequately staffed shift or weekend. It can allow more reliable scheduling of operations. In some situations this can reduce overtime labor costs or wasted chemicals. With more confidence in the amount of exchange capacity remaining, it can allow running longer and can avoid premature regeneration. Early regeneration wastes time, system capacity, and most importantly, expensive caustic and acid used for regeneration, plus the additional chemicals needed to neutralize the wastewater produced by the unneeded regenerations.

Without the means for monitoring resin capacity remaining, it is much like operating a car without a fuel gage. You must be constantly vigilant to avoid running out of fuel and even then, there is no real assurance. Extra, precautionary stops for fuel are needed.

Common methods for predicting exhaustion are to monitor elapsed time or totalized flow. If the flowrate is nearly constant over the run cycle, then a consistent run time before regeneration should give adequate prediction, but only if the water composition is also constant. If the flowrate varies through the run of the exchanger, then a total flow measurement can accurately account for this, but again, only if the feedwater composition is constant.

In the missing fuel gage analogy above, using total flow as the criteria for regeneration is like using the odometer of the car to monitor mileage to determine when to refuel. It can be used. However, if the driving involves mountainous terrain, strong headwinds or long waits in heavy traffic, the odometer reading will not correlate well with the amount of fuel consumed. Likewise, if the water composition changes for any reason, then a total flow value will not be a good predictor of the time to regenerate.

In today's environment of scarcer water supplies, raw water comes from multiple sources, recycled and reclaimed water, and with variable pretreatment processes ahead of deionization. Seasonal variations also are significant. As a result, variable composition in deionization feedwater is becoming commonplace. There really is a need to account for the varying ionic load on a deionization bed due to both flowrate and composition.

More accurate prediction of exhaustion

The capability to predict exhaustion that accounts for variations in both flowrate and composition has been implemented in the THORNTON 770MAX multiparameter analyzer/transmitter. It includes the unique Di-Cap™ deionization capacity monitoring algorithm. The accompanying figure illustrates how this method is implemented. Feedwater conductivity is measured and converted to TDS (total dis-

solved solids). Flowrate is also measured and multiplied by the TDS value. The product of these is integrated over time to produce a measure of ionic load entering the deionization system as illustrated by the accompanying equation. The direct readout allows a choice of units of equivalents, grains or ppm-gallons.

$$\text{Ionic load} = \int \text{Flow} \times \text{TDS}\, dt$$

With this system, an accounting is made for both variable flowrate and variable water composition to give a very close measure of ion loading. Display, output signals, setpoints and relays can be assigned to this computed parameter to enable continuous monitoring and control. The total ionic load measurement can be reset manually or automatically by a remote contact closure at the beginning of each run. The 770MAX has additional channels that allow it to measure, alarm and provide output signal for effluent conductivity as well as other measurements.

Assessing resin health

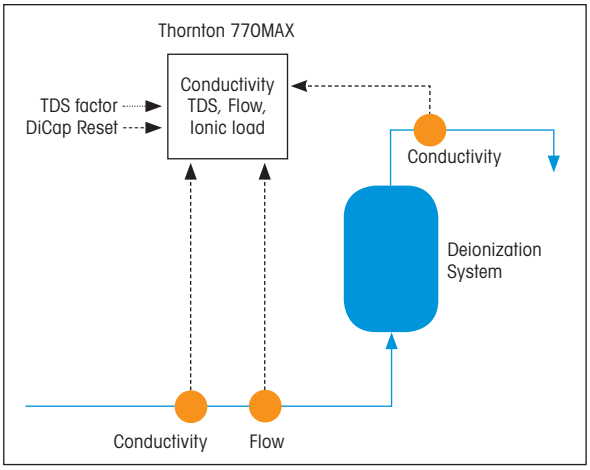
Another benefit from deionization capacity monitoring is to track resin bed working capacity over the long term to warn of capacity loss. Lowered working capacity can be due to incomplete regeneration, loss of resin, channeling, fouling with organics or silica, etc. which leaves many areas to examine when a problem occurs. If a DI bed is run to exhaustion as detected by effluent conductivity or other means and the total ionic load for each run cycle are logged, a good historical record of performance can be developed. This record will be much more useful than a record of just total gallons since it will be corrected for changing feedwater composition.

With this technique, even a gradual deterioration in performance can be detected and corrective action can be taken before a major loss of efficiency occurs. This represents a real improvement in DI system troubleshooting and maintenance since the first loss of capacity will be more visible and will allow more timely diagnosing of the problem. Problems that continue undetected become harder to pinpoint and more damage and inefficient operation can result.

Conclusion

Deionization capacity monitoring with the THORNTON 770MAX provides a significant contribution to the efficient operation and troubleshooting of large DI systems. Whether deionizing raw water, reverse osmosis permeate, or condensate, most systems can benefit from this water treatment monitoring tool.

Deionization capacity monitoring.



THORNTON 770MAX displaying influent to a deionization system with parameters of conductivity, TDS, flowrate, and accumulated deionization load. More parameters are displayed on additional screens.

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Self-Contained Controller – a Problem Solver

When a water or wastewater treatment system is widely separated from other process controls, a pH transmitter with built-in PID control capability can provide a very efficient solution.

When a remote location requires high resolution control but does not have a control system available, a pH transmitter with internal proportional control capability, such as the THORNTON M300, can greatly simplify the installation.

On-off control

Simple on-off control at a setpoint turns reagent flow on or off. For pH control in most applications, on-off control produces significant over and under treatment which is unacceptable.

PID control action

"Proportional, Integral and Derivative control" can provide smooth regulation of a process. Instead of abrupt on-off action, PID provides a more continuous and gradual change in reagent feed rate and accounts for changing demand while minimizing over or under treatment. It does this using the three standard modes of control action.

Proportional control action responds to the amount of pH deviation from the setpoint. It adjusts the reagent feed rate in direct proportion to the difference between the measured pH and the setpoint. The proportional GAIN tuning parameter adjusts the sensitivity of this action.

Integral control action responds to a combination of the amount of the pH deviation and the length of time it continues: it integrates the deviation over time. Integral action (also called reset) is needed to bring a continuous process all the way to the setpoint.

Derivative control action responds to the speed and direction of pH change. It minimizes over treatment by "heading-off" a growing deviation of pH as an operator would do instinctively by anticipating the need for additional corrective action.

Control output types

Various reagent feeders require various types of control signals: Pulse metering pumps, require a relay pulse frequency, solenoid valves require a relay pulse length, and proportioning valves require an analog signal. All THORNTON M300 transmitters include the hardware and software for all three control output types.

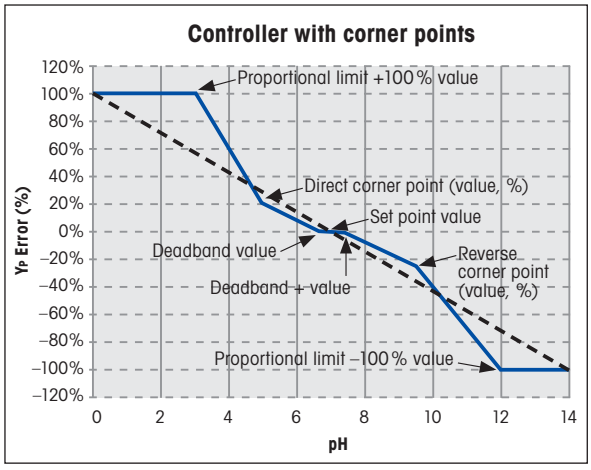
Pulse frequency control output provides short rapid relay contact closures, suitable for pulse-type electronic metering pumps.

Pulse length control output provides switching of relay contact(s) to control acid and/or base solenoid valves.

Analog control output provides a 4 to 20 mA (or 0 to 20 mA) control signal for acid and/or base feeders.

Convenient operation

For routine operation of PID control, the THORNTON M300 uses the bottom display line to provide the control status: manual or automatic control, % output, and whether feeding acid or base, if both reagent feeders are configured.
For a stand-alone transmitter/controller, the M300 provides outstanding value.



Enhanced nonlinear pH control is available in the THORNTON M300 transmitter by setting deadband, corner points and proportional limits.

THORNTON M300 Transmitter with PID control activated.

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New Developments
in Process Analytics

METTLER TOLEDO delivers powerful solutions to optimize your processes and reduce maintenance costs. Recently, we introduced new intelligent technologies that allow you to improve handling and optimize maintenance thus addressing your most pressing needs.

ISM – the next generation of intelligent process analytics!

With the groundbreaking ISM technology METTLER TOLEDO provides another milestone in process analytics measurement!
Dissolved oxygen sensors and pH electrodes with integrated preamplifier are using a new technology with "Plug and Measure" and intelligent diagnostics functionalities. The Intelligent Sensor Management (ISM) technology simplifies all maintenance operations of the sensor. Process interruptions are shorter or even avoided, leading to enhanced productivity.

iSense – the key to maximize the benefits of the ISM technology

iSense ISM Asset Suite allows efficient and easy verification and calibration of METTLER TOLEDO digital ISM pH and DO sensors in an instant with an intuitive software application that includes advanced analysis and documentation functionalities to support your sensor management.

Digital transmitter line M300

The digital M300 transmitter represents an easy-to-use version of the M300 transmitter line. Its unique "Plug and Measure" features enable a fast start-up and robust measurements for digital pH/ORP and dissolved oxygen sensors. Its versatility and reliability make this instrument the ideal choice for a wide range of applications.

If you want to take advantage of these advanced products ask your local METTLER TOLEDO representative or visit **www.mt.com/ISM.**

Mettler-Toledo AG
Process Analytics
Im Hackacker 15
CH-8902 Urdorf, Switzerland

Your METTLER TOLEDO contact:

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