

TOC Analysis for Dow's Control of Condensed Steam and Cooling Water

Problem

Dow Chemical's have a requirement to closely monitor conductivity, pH, and TOC on their cooling water and return condensate application. A high percentage of Dow facilities will need to measure TOC in order to have full transparency of their condensate or cooling water to avoid contamination risks.

Solution

Hach® BioTector B3500c TOC Analyser offers accurate, reliable TOC measurement with maximum uptime and an alarm system that helps operators with process control and risk avoidance. In combination with Hach's pH and conductivity probes, operators can cover the key risks of contamination.

Benefits

Dow grades BioTector as the Most Effective Technology (MET) for facilities required to measure TOC. The B3500c allows operators to avoid product loss, reduces waste treatment costs, and helps improve operational efficiency.

Background

Dow Chemical Company is a global chemical and technological manufacturer operating in agricultural sciences, infrastructure solutions, performance materials and chemicals, performance plastics, and consumer markets. Dow maintains a set of guidelines and rules to globally share best practices and set standard work and equipment. The goal of these guidelines is to monitor key parameters in plants that return condensed steam or cooling water to collection or distribution systems. Those key parameters include conductivity, pH, and total organic carbon (TOC) analysis.

Importance of condensate control

The highest priority for Dow is safety. If facilities are reusing condensate, the condensate must meet the Dow compliance standards. Contamination of steam, condensate, and cooling water can cause environmental and safety hazards, including water discharge, plant downtime/shutdown, and even explosions.

Many industrial plants waste the condensate from the steam system and do not return condensate to the boiler plant. If condensate isn't returned to the boiler, the steam system must make up the loss with cold, untreated water that has to be prepared for boiler operation. If the condensate/cooling water is contaminated, it will need costly treatment prior to discharge. Any uncontrolled discharge can lead to damage to the environment and violation of laws. The new "make-up" water must be heated using additional energy and this increases operational costs. One of highest return on investments is to return condensate to the boiler. Returned condensate contains expensive boiler treatment chemicals and includes energy transferred during combustion. Condensate, therefore, needs to be returned to the boiler to:

- Improve energy efficiency
- Reduce chemical cost
- Reduce make-up water costs
- Reduce product loss
- Reduce waste treatment costs

Recommendations for controlling condensed steam

Best industry practice of the use of return condensate:

- Measure pH and conductivity online:
 - Conductivity: it is recommended to have two probes in the system in order to enable alarms triggered by differential conductivity
 - pH: two sensors are recommended in the system for differential pH to detect analyser drift
 - For pH and conductivity different alarm set points are recommended, including a high peak alarm triggering closure of the return valve to avoid further contamination
- Measure TOC online to detect substances in the condensate or cooling water which would not be picked up by pH or conductivity monitoring
 - Different alarm set points are recommended for the measuring of TOC, including a high peak alarm triggering closure of the return valve to avoid further contamination
- Make all conductivity, pH, and TOC data available from a central control room in order to facilitate fast and sound decision making
- Regularly utilise grab samples and execute lab analysis to check against analysers
- Utilise grab samples and lab analysis as a backup for out of service times on the online analyser/sensor system

Solution and Improvements

The B3500c analyser is designed to measure TOC, volatile organic compounds (VOCs), total inorganic carbon (TIC), total carbon (TC), biochemical oxygen demand (BOD), and chemical oxygen demand (COD). The analyser has a six-month preventative maintenance cycle; its reagent set lasts six months, and there's no need for calibration during this period. Further, the B3500c can be installed at convenient monitoring points in the cooling system. The long maintenance cycle was designed to deliver operational benefits in expenditures and manpower allocation.

Due to its patented Two-Stage Advanced Oxidation (TSAO) technology, the analyser provides superior oxidation power compared to other technologies. The B3500c self-cleans reliably after each measuring cycle, which prevents costly service interventions, and delivers unsurpassed reliability, accuracy, and system uptime (certified for 99.86%).

Emphasizing safety and quick response to any alarms, the B3500c offers close to real-time analysis and sends alerts for potential risk events. This helps operators address potential issues before compliance is in jeopardy. This is critical for the timely detection of VOC contamination – what is vital to the safety of condensate/cooling water systems as VOC contamination can cause explosion risk.

The BioTector family is the standard instrumentation for TOC measurement of Dow Chemical. BioTectors are listed on Dow's MET list and the installed base within Dow Chemical counts nearly 300 instruments worldwide.

Why not HT combustion in TOC cooling water applications?

BioTector has a much higher sample volume compared to high temperature (HT) oxidation TOC methods. Small sample volumes provide a low signal-to-noise ratio, and thus poor precision and accuracy on low-level TOC analysis. Using a small sample volume carries the risk that the target substance is overlooked. Also, HT TOC systems are known for drifting, shifting, and noisy baselines in each measurement. With the B3500c's higher sample volume, there's no drifting, shifting, or noisy baseline; this eliminates risk, and due to the high signal-to-noise ratio, the highest accuracy and precision.

Compared to BioTector – which cleans automatically between every measurement cycle – HT systems need to be cleaned manually or cleaned with additional cleaning reagent. This has a severe impact on system uptime and the utilisation of an operator's manpower. Because there may only be a small amount of target substance in cooling water samples, a high level of cleanliness in the measuring system is crucial. Otherwise, pollution might accumulate and result in inaccurate or wrong measurements due to high system blank and a continuously shifting baseline.

HT oxidation TOC systems don't use hermetically sealed IR detectors, so the atmospheric air will influence the stability of the system and its IR measurements. Measuring in a very low TOC range will be affected by atmospheric air (e.g. CO₂, CxHy, etc). The B3500c uses an industrial Hastelloy and hermetically sealed IR detector, resulting in TOC measurement that can't be affected by atmospheric air.

Why is BioTector more reliable in VOC measurement?

VOC is the volatile part of organic carbon of the sample. By definition you lose the volatile part to the atmosphere if measurements are taken in an open reactor TOC system. The B3500c measures in a completely sealed mixer reactor system. As competitive TOC systems are not sealed, the measurement might be inaccurate, and some of the VOC might be lost before oxidised and measured.

VOC is a calculated measurement. Due to low sample size and the consequential inaccuracy in low measuring ranges on HT oxidation TOC systems, the calculation of two inaccurate measurements lead to low reliability of the calculations. Also, most VOC and hydrocarbons are often difficult to oxidise, therefore UV/persulfate systems struggle to provide reliable recovery rates, and they also tend to lose the VOC in open UV/reactors before being able to oxidise it. The oxidation performance of BT is very powerful using patented TSAO technology.

Conclusion

As the application of pH, conductivity, and TOC analysis is probably valid for approximately 50% of the chemical production plants worldwide, all operators should be aware of the BioTector's ability to accurately measure TOC and keep facilities operating efficiently while requiring minimal maintenance and reagent exchange. Thanks to accurate measurement and alarm capabilities, the B3500c could easily become the solution in Dow plants where BioTector is not used for this application to ensure safety, improve costs, and help achieve greater process control. In combination with Hach's powerful portfolio of pH and conductivity probes, Dow can source complete monitoring solutions from a single partner. In order to provide a maximum benefit to each Dow plant, Hach maintains one of the biggest qualified field service forces in the market.

Key Takeaways/Summary:

- It's best practice to measure conductivity, pH, and TOC for safety and facility efficiency in returned condensate and cooling water. Many organisations are constantly auditing the control of parameters that are vital to plant safety.
- All chemical production sites need to measure conductivity and pH in their condensate and cooling water; approximately 50% also need to measure TOC. About half of them have to consider new solutions to meet standards of controlling key parameters to ensure plant safety.
- The BioTector family is graded by Dow Headquarters as Most Efficient Technology (MET), making it the standard TOC online analyser for the whole Dow organisation. Nearly 300 instruments already in operation at Dow worldwide.
- With a cycle of six months, the B3500c requires minimal effort for regular maintenance and provides a maximum (certified) uptime of 99.86%. This provides unique benefits in operational efficiency to Dow.
- BioTector B3500c meets all requirements for facilities looking to measure TOC. Hach can also provide the necessary solutions for pH and conductivity measurement.
- Safety is the primary concern of Dow – Hach helps to meet the highest standards.
- Operator's business case for a B3500c is very competitive compared to any other TOC competitive technology (HT or UV/Persulfate). Total cost of ownership including reagents and preventive maintenance will easily offset the increased investment of a BioTector.