aqua metrology systems

CASE STUDY

Use of Online THM Analyzer Helps Maintain Water Quality at a Scottish Water Drinking Plant

Over the past decade the more than 200 water treatment works (WTWs) sources managed by the Scottish Water Utility have been affected by deterioration in water quality caused by environmental factors including climate change. The deterioration has primarily been observed through increased water color and natural organic matter levels which pose a significant treatment challenge because of the resulting formation of disinfection by-products (DBPs). To ensure deteriorating source quality does not affect customer's drinking water, Scottish Water has used operational enhancements and online water quality analyzers to meet the strict trihalomethane (THM) discharge requirements needed to guarantee DBP regulatory compliance.

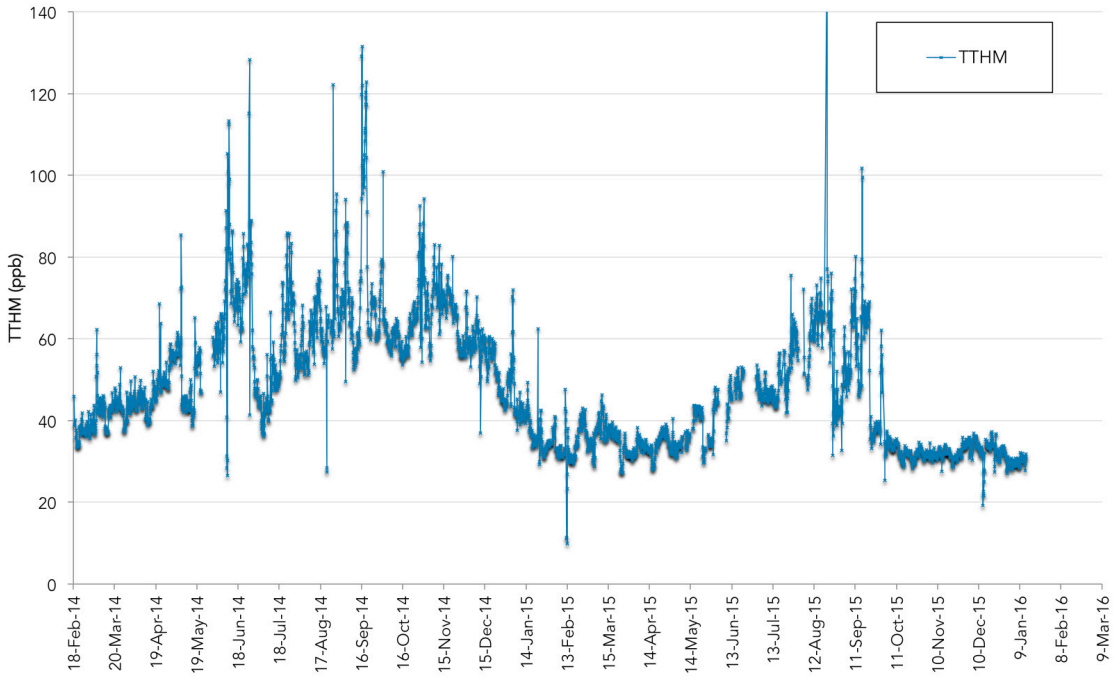
In 2010 Scottish Water began continuous online monitoring of THM levels with the THM-100™ manufactured by Aqua Metrology Systems (AMS). In total, three THM-100 units have been purchased and used to optimize a number of Scottish Water systems since 2010; one unit was installed at the Bradan WTWs, another at the Tullich WTWs, and one was transported throughout the region as needed at other Scottish Water facilities. Prior to the purchase of the online THM monitors Scottish Water relied on standard laboratory analysis. Analytical results could take up to a week to be returned, making it very difficult for operations staff to fully optimize the treatment processes at any given facility since they were working off THM results that were a week old. The THM-100 monitor enabled Scottish Water to have visibility of process improvement changes and their impact on DBP formation by providing the operational staff with immediate and accurate daily reports on THM levels. The THM-100 proved especially valuable at the Tullich WTWs when the facility tested and implemented an aeration system to further minimize THM formation.

Online THM Monitor Validates TRS Process

The Tullich Water Treatment Works in Oban, Scotland services the needs of approximately 13,000 inhabitants through a 2.64 MGD (11 MLD) plant consisting of pre-filtration using microstrainers, pre-ozonation, granular activated carbon and post-ozonation. Chlorine gas is used as the primary disinfectant. THMs are formed when natural organic matter present in the water reacts with the chlorine disinfectant during the water treatment process. When Tullich was built in 1970s it was a state-of-the-art WTWs designed to meet the challenges for that period. New water quality regulations introduced to protect and improve public health require Scottish Water to invest in a new WTW that will be commissioned by the end of 2017. Until then a concerted effort by staff is required to optimize treatment processes and keep the current facility in compliance with all quality standards.

A profile of the THM levels at the Tullich WTWs from February 2014 to December 2015 is detailed in Figure 1, data was provided by the online THM-100 monitor.

Figure 1: Tullich WTWs THM Levels (February 2014 - December 2015)



Having already optimized their existing process scheme, Scottish Water introduced aeration at the Tullich WTWs in 2015 to aid THM removal. As volatile organic compounds, THMs can be removed from water through volatilization given sufficient gas transfer opportunities. When water is exposed to and mixed with air inside a reservoir, the THMs are transferred into the air and can escape. There are four primary species of THMs; chloroform ($CHCl_3$), bromodichloromethane ($CHCl_2Br$), dibromochloromethane ($CHClBr_2$) and bromoform ($CHBr_3$). Chloroform is the most volatile of the primary THMs and is the most dominant THM speciation found in treated water at the Tullich WTWs, averaging approximately 70%.

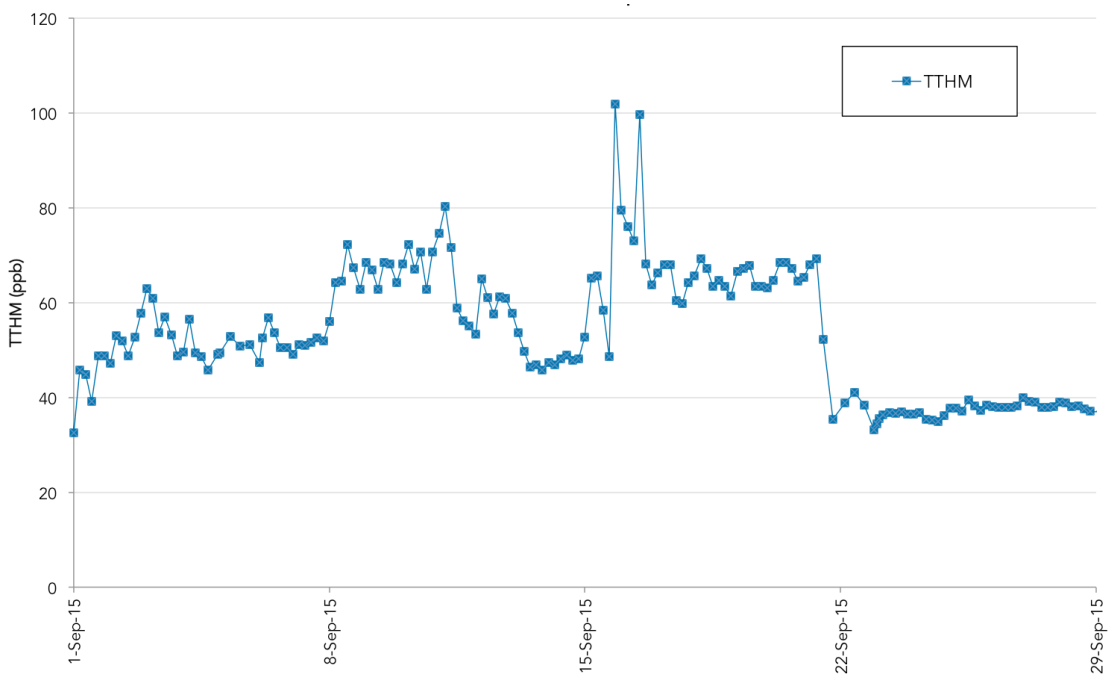
Treated water from the Tullich WTWs is stored in two water reservoirs before being distributed to the Town of Oban and the communities on the west coast of Argyll between Appin and Luing. Air stripping using a combination of mixing and spray nozzles is an aeration methodology best applied in distribution storage tanks/water reservoirs. To test the spray aeration concept Scottish Water installed the THM Removal System (TRS), developed by PAX Water, in one of their water reservoirs.

The TRS system draws water from the outlet of the reservoir and sprays it across the surface of the water inside the reservoir while submersible mixers inside the tank ensure the water is continuously circulated and exposed to aeration at the surface. The exchange and removal of THMs is facilitated with an active ventilation system that continuously delivers filtered air into the reservoir.

Installation was undertaken from May to August 2015 to ensure the pilot system was online and fully operational before the peak THM autumn season. Autumn brings stormy weather and higher organics loading, further exacerbating the formation of THMs. The online THM-100 analyzer was used in conjunction with the TRS system to provide real-time measurements of influent and effluent THM levels on both reservoirs. The continuous THM data Scottish Water obtained from the online analyzer enabled them to compare performance results of the TRS system against a known baseline from the control reservoir.

Scottish Water observed a 47% reduction in THM levels once the TRS system was installed; these values were inline with design parameters. Whereas THM levels in the reservoir ranged between 60-70 ppb prior to the installation of the TRS system, THM levels ranged between 30-40 ppb following the addition of aeration on 21 September 2015 (Figure 2). Using the THM-100 Scottish Water can maintain reservoir THM levels at or below 40 ppb to ensure compliance with the 100 ppb regulatory maximum in the distribution network.

Figure 2: Tullich WTWs THM Levels Pre- and Post-Implementation of TRS Aeration System



(Aeration Turned on 21-Sep-15)

Online THM-100™ Analyzer.

The THM-100 analyzer uses an approved "purge-and-trap" sampling method, followed by desorption into a chemical mixture that generates a colored product and time-resolved spectrophotometric analysis for detection and determination of THM levels. The online sampling method is automatic and does not require manual intervention.

THM levels are measured every four hours (six daily measurements); however, more frequent measurements could be programmed if necessary. The throughput for each THM analysis is approximately two hours. The self-calibrating instrument uses three reagents and two on-board calibration standards. System performance is also remotely monitored, 24/7, by AMS to ensure the instrument is operating within pre-determined parameters; enabling the factory to notify operational staff of deviations if required.

What's Next

Since its installation, the aeration system remains in constant operation. The high frequency and reliable data provided by the THM-100 allows Scottish Water to optimize perform and make additional process changes (e.g., ozone dose rate, adjust pH levels) to ensure water quality continues to meet the highest of standards and is safe for human consumption.

The new Tullich WTWs is scheduled for commissioning in the fall of 2017. The new facility will use coagulation, filtration and chloramination to ensure management of THM formation. The THM-100 will serve as a commissioning tool at the new facility, aiding Scottish Water with their validation of the process design.

For more than five years Scottish Water has relied on the reliability and accuracy of the online THM-100 monitor at a number of their facilities. The online THM monitors have allowed Scottish Water to consistently monitor, maintain, optimize and respond to any on-going THM concerns in a very timely fashion.

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