Tewksbury Water Treatment Plant Demonstrates Aeration System and Online THM Monitor

The Town of Tewksbury, Massachusetts, provides water to more than 30,000 residents through a 7 million gallons per day (mgd) conventional water treatment plant located on the banks of the Merrimack River. The Merrimack River, the primary water source for the Tewksbury Water Treatment Plant (WTP), is a dynamic body of water experiencing frequent flunctuations in organic loading and ammonia levels due to the effluent from the upstream Lowell wastewater treatment plant (WWTP) and the inflow from the Concord River.

The Concord River contributes less than 10% of the total water volume to the Tewksbury WTP and is characterized by its slow flow, high color, and the presence of trihalomethane (THM) precursors. A combination of chlorine dioxide and hypochlorite is used at the Tewksbury WTP to tackle ammonia, as well as taste and odor issues, while minimizing the formation of disinfection by-products (DBPs).

THMs are the most significant DBPs generated and cause the greatest concern for the Tewksbury WTP as low bromide levels in the source water favor the formation of chlorinated DBPs. Chloroform, one of the regulated THMs, is the most prevalent THM speciation found in the town's treated water due to its faster formation compared to other chlorinated DBPs.

While the plant's staff has been satisfied with the effectiveness of their current process regime, an engineering evaluation completed by AECOM and issued in December 2012, identified two potential modifications to improve disinfection efficiency. The first recommendation was an automated dosing control loop to help the plant quickly adjust to changing raw water conditions and chlorine demands while preventing DBP formation. The second recommendation was to test an aeration system for enhanced THM removal.

Minimize THM Formation

THMs, as volatile organic compounds, can be removed from water through volatilization when sufficient gas transfer occurs. 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.

THM removal through air stripping can be achieved using packed towers, spray aeration, diffused aeration, or tray aeration, each with its own cost and gas transfer efficiency. Air stripping using a combination of mixing and spray nozzles was the most applicable aeration approach to test at the Tewksbury WTP since the methodology is best applied in clearwells and/or distribution storage tanks.

AECOM managed the aeration demonstration from September to November 2014. The three-month testing program included a detailed study of the effectiveness of an air-stripping aeration system in minimizing THM levels at the Tewksbury WTP. Influent and effluent THM values were measured for the duration of the study. In addition to traditional third-party laboratory analysis, an online THM monitor manufactured by AMS was also demonstrated for the duration of the study to measure THM values. Split sampling was used to compare the online THM-100™ monitor's accuracy against certified third-party laboratory analysis.

The validation of the THM-100 analyzer found the instrument to be consistent and highly reproducible with a standard error of deviation of five percent. The automated online THM 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. Manually collected "grab" samples from other locations can be analyzed alongside samples taken automatically by the monitor in its online mode; allowing for multi-point analysis.

The THM-100 monitor was installed near the plant and used to analyze eight daily samples. The instrument gave plant operators real-time results for Total THM and chloroform specie measurements at the Tewksbury WTP. Prior to using the online THM monitor, plant operators waited to receive analytical results from external analysis, often conservatively operating the facility since real-time THM values were not known.

The real-time data provided by the online monitor made THM formation within the WTP and distribution system easy to identify. The baseline and predictive data available through the THM-100 allowed process changes to be readily implemented to ever-changing water quality conditions at Tewksbury WTP.

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