Speaker Name: Mayara Arnold

Affiliation: Trussell Technologies

Coauthors: Daniel Gerrity

Coauthor Affiliations: University of Nevada, Las Vegas

Abstract Title: Use of ozone-biofiltration for bulk organic removal and disinfection byproduct mitigation in potable reuse applications

Abstract: Potable reuse is an emerging alternative to water supply augmentation or even replacement in areas experiencing water shortages. Although the United States Environmental Protection Agency (USEPA) has not yet regulated potable reuse, several states (e.g., Florida, California, Nevada) have individually established regulatory requirements for such practice. For example, the California Department of Drinking Water (DDW) requires a treatment train composed by reverse osmosis (RO) and advanced oxidation (AOP), a combination now known as full advanced treatment (FAT), to be employed for direct injection of recycled water into aquifers and surface water augmentation. DDW has also required a maximum concentration of 0.5 mg/L of wastewater-derived total organic carbon (TOC), which appears conservative if compared to typical average TOC concentrations in surface water (~3 mg/L). Even though FAT is capable of achieving TOC levels as low as required by DDW, costs associated with this technology are very high due to energy demand and brine management. The combination of ozonation and biofiltration has been evaluated as an alternative technology to RO, due to its capability of considerably reducing TOC levels (15-30%) as well as demanding less energy in its operation. However, compliance with the DDW TOC requirement is not achievable without a polishing treatment or applying significant blending ratios. This issue may be overcome by optimizing operational parameters (e.g., ozone dose and empty bed contact time) or by developing an alternative regulatory framework for bulk organic matter.

When considering potable reuse application, disinfection byproducts (DBPs) also poses a great concern due to its carcinogenicity potential. Free chlorine is a common disinfectant used in conventional drinking water treatment and when undergo contact with organic matter, it forms, among other chemicals, trihalomethanes (TTHMs) and haloacetic acids (HAA5), which are both regulated by USEPA in drinking water with a maximum contaminant level (MCL) of 0.080 and 0.060 mg/L, respectively. In order to control DBP formation and ensure MCL compliance in conventional drinking water treatment, the USEPA's Stage 1 Disinfectant and Disinfection Byproducts Rule (D/DBPR) mandates certain levels of TOC removal based on source water TOC and alkalinity. It may be possible to regulate bulk organic matter in potable reuse applications using a similar approach. The purpose of this research was to investigate the impacts of ozone dose and empty bed contact time (EBCT) on DBP formation upon final chlorination, and a secondary objective was to evaluate the possibility of using DBP formation potential as an alternative regulatory framework for TOC removal.

A 1-liter per minute pilot-scale ozone-biofiltration system was built with biofiltration columns containing anthracite or exhausted granular activated carbon (BAC). The system was operated with ozone/TOC ratios ranging from 0.1-2.5 and EBCTs ranging from 1-20 minutes. The Bench-scale chlorination was performed using the uniform formation conditions (UFC) approach, and quenched samples were analyzed for TTHMs

and HAA5. The data demonstrated that ozone-biofiltration achieved TOC removals ranging from ~10 to 30%, depending on operational conditions, but biofiltration without ozone generally achieved <10% TOC removal. UFC testing demonstrated that ozone alone was efficient in transforming bulk organic matter and reducing DBP formation potential by 10 to 30%. Ozone-biofiltration achieved average overall reductions of 26% and 51% in TTHM and HAA5 formation potential, respectively. As conclusion, a maximum TOC concentration of 2.0 mg/L was identified as a recommended treatment target for reliable compliance with TTHM and HAA5 regulations for potable reuse systems in the United States.