The Use of Peracetic Acid as a “Pre-Oxidant” for Drinking Water Applications

BACKGROUND

Chlorination as a technology for drinking water disinfection has significantly reduced the incidence of human disease and is one of the most significant contributions to the improvement of human health over the past century. Chlorine’s ability to provide a stable residual concentration makes it suitable as a drinking water disinfectant at the point of use. However, natural organic matter in the raw water being treated and disinfected at the drinking water treatment plant may interact with the residual chlorine to form compounds classified as disinfection by-products (DBPs). The most commonly employed disinfectants are chlorine, chlorine dioxide and ozone – each of which can generate a variety of DBPs. Many DBPs have been identified as potential cancer-causing agents, and include trihalomethanes (THMs) and haloacetic acids (HAAs). Examples of THMS and HAAs include: chloroform, dibromochloromethane, bromoform, trichloracetic acid, monchloracetic acid and monobromoacetic acid.

Peracetic acid (PAA) has gained momentum in the United States as a primary wastewater disinfection technology and alternative to chlorine. PAA has low residual toxicity, does not form harmful DBPs and has minimal impact on the environment. While the lack of a stable residual reduces its environmental impact post wastewater treatment, this characteristic decreases its values as a terminal drinking water disinfection technology – PAA residual at the point of use would be impractical to maintain. However, PAA may potentially be used in a disinfection treatment train approach as an early stage disinfection chemistry coupled with other methods such as membrane filtration, ozone and UV. In this scenario, PAA may provide “log reduction” credits to an overall multi-barrier disinfection scheme.

In addition to its disinfecting capabilities, PAA is a strong oxidant – which provides the engine to its disinfectant behavior – as shown in Table 1.

Oxidant	**Standard Potential (V)**
Hydroxyl Radical	2.80
Ozone	2.07
Peracetic Acid	1.81
Hydrogen Peroxide	1.78
Potassium Permanganate	1.68
Chlorine Dioxide	1.57
Chlorine	1.36

Table 1: Standard Electrode Potentials for Common Water Treatment Oxidants

This strong oxidizing potential indicates that PAA can oxidize a variety of organic species. Thus, PAA may be utilized as a “pre-disinfection” agent in drinking water applications to reduce the amount of oxidizable organics in the raw water prior to final chlorination. Therefore, PAA can be used to reduce the formation of trihalomethanes and haloacetic acids after chlorine disinfection of drinking water by reducing the level of precursors through oxidation.

EXAMPLE

A sample of untreated, raw water was obtained from a plant in Texas. Four, two-liter aliquots of the sample were placed in cleaned and disinfected beakers and set on a jar tester apparatus. The stirrers were set to 100 rpm for the duration of the test. PeroxyChem’s VigorOx® WWT II PAA was utilized for this test. One beaker was used for a control, and no PAA was added to this beaker. To the remaining three beakers, peracetic acid concentrations of 1, 5 and 10 mg PAA / L of raw water were added. After sixty minutes, a stoichiometric amount of a sodium thiosulfate was added to each beaker containing peracetic acid in order to quench the reaction. The neutralized samples and the control were then sent to a third-party laboratory for analytical testing. Analytical testing included measurement of THM Formation Potential (THMFP) and the HAA Formation Potential (HAAFP). The THMFP and HAAFP were performed via the standard test method 5710B, and detection of THM and HAA were measured by standard test method 524.2 and 552.2, respectively.

Figure 1 shows the impact of the addition of PAA prior to the final chlorine disinfection on the DBP formation potential.

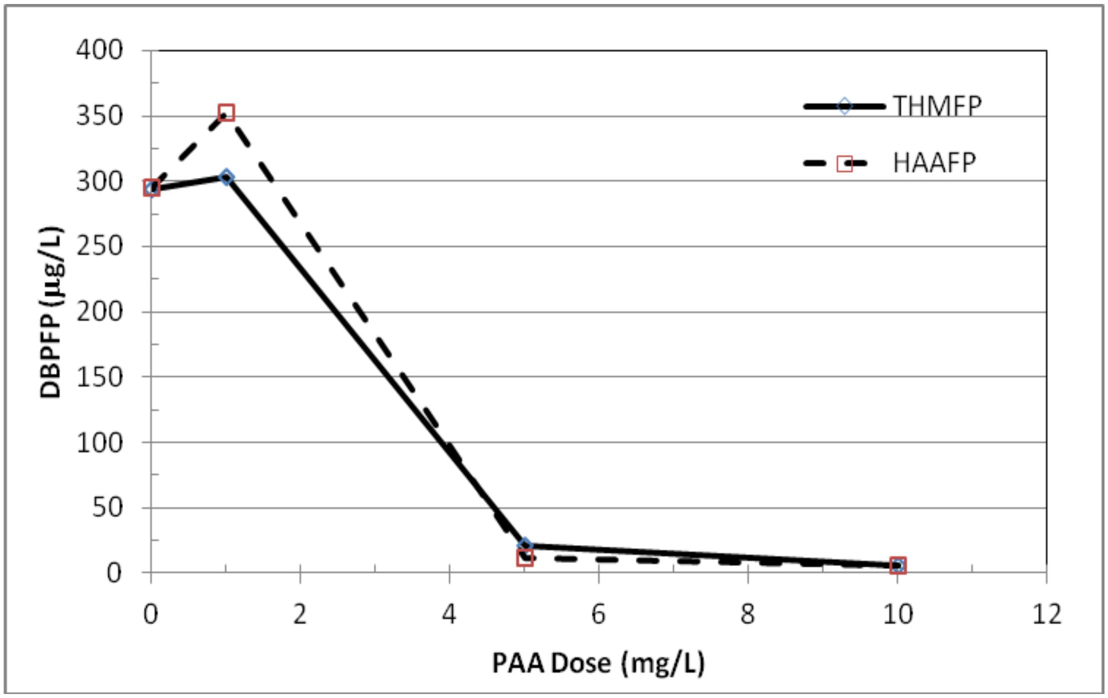

Figure 1: Reduction of THMs and HAAs as a Function of PAA Dose Concentration

In this example, a PAA dose of 5 mg / L and a contact time of sixty minutes reduced the THM formation potential by 93% post chlorination and the HAA formation potential by 97%.

CONCLUSION

The addition of PAA to the influent raw water of a drinking water facility can significantly reduce the formation of harmful DBPs, such as THMs and HAAs. In addition, adding PAA to the raw water stream may allow for inclusion of PAA as a multi-barrier approach to drinking water disinfection, providing disinfection log-reduction "credits" to the overall disinfection process.