A New DIRECTION

Newport News Waterworks switches from chlorine to ozone for its primary disinfection process

Newport News used the Emerson Rosemount Analytical 499 sensor to monitor ozone residual in the contact chamber.

John Volbeda & Randy Hawkins

Maintaining a quality water supply is the top priority for municipal drinking water treatment plants across the U.S. Both surface water and some groundwater sources can contain many different pathogens (bacteria, viruses and parasitic protozoa), some of which are potentially lethal. Water treatment plants use various treatment processes to render these pathogens inactive, but disinfection is integral to ensuring water quality and safety.

Large-scale use of chlorine for water disinfection began in the U.S. in 1908, and chlorine is now used in both primary and secondary disinfection steps at many water treatment plants. However, the U.S. EPA and others have reported that trihalomethanes and haloacetic acids are produced as byproducts of the chlorination process, and that these byproducts could be hazardous.

In response to these reports, many water utilities have begun examining alternatives to chlorine for primary water disinfection.

Ozone option

Ozone has been used extensively in Europe for water treatment since 1886. Today, some U.S. water plants are moving to ozone for primary disinfection to address more stringent drinking water regulations. One water utility that is taking this direction is Newport News Waterworks, located in southeast Virginia.

Eight years ago, Newport News constructed a pilot plant that uses ozone as the primary disinfectant. For this pilot plant, the utility selected Rosemount Analytical ozone measurement systems from Emerson Process Management. These analyzers were used for continuous measurement of aqueous ozone in the ozone contact basin.

Based on the success of the pilot plant, the Harwoods Mill plant at Newport News switched from chlorine to ozone for its primary disinfection process in March 2002.

"Our pilot plant processes 50,000 gal of water per day, where the main plant processes an annual average of 24 mgd. The success of this pilot plant testing prompted us to also convert our Lee Hall plant to ozone. It will be completed in about six months. Upon completion, the total system will serve over 400,000 people," said Randy Hawkins, pilot plant engineer, Newport News Waterworks. "With that many people in our community relying on us, it is important we provide the best quality water possible."

According to Hawkins, making the switch from chlorine to ozone for primary disinfection was a critical step, and using ozone analysis instrumentation from Emerson allowed for continuous monitoring of the ozone process.

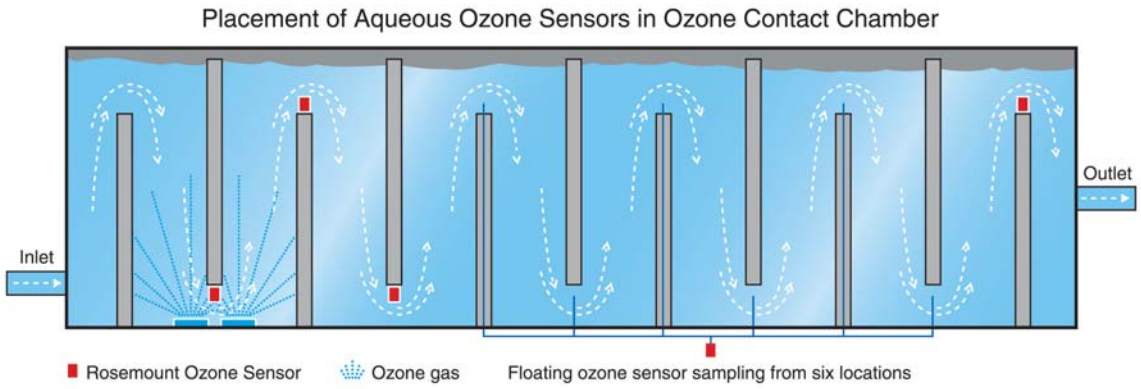
"We chose to use ozone because ozone does not form the hazardous byproducts that chlorine produces, and it effectively oxidizes organic compounds while improving the taste and odor of the water," Hawkins said. "Ozone is the most powerful and fastest of the oxidants currently used in the water treatment industry. Also, it disinfects in less time than is required with chlorine."

Ozone attacks pathogens in the water; oxidizes organic material, iron, manganese and sulfur; and reduces taste and odor problems. The effectiveness of ozone disinfection is measured by the amount of residual ozone remaining after application and the effective contact time. The presence of a small residual implies that the organic compounds have already been oxidized.

Despite ozone's success in primary disinfection, chlorine still plays a very important role in the secondary disinfection process. Ozone has little residual and cannot be used for secondary disinfection. Chlorine, on the other hand, has more residual and continues to protect the distribution system from further contamination. Chlorine continues to be used at Newport News as a secondary disinfection method, and therefore, rigorous safety standards are maintained.

Ozone generation

The ozone molecule consists of three oxygen atoms and degrades back to oxygen, forming a free oxygen radical



that survives less than 30 minutes. The rate of degradation depends on the water chemistry, pH and temperature. Because ozone is unstable, it is generated on site. Ozone is bubbled up through the water in contact chambers. By the time the water reaches the end of the contact chambers, primary disinfection is complete and the ozone has converted back to oxygen.

Ozone gas is produced by electrical discharge in gaseous oxygen. The gas is injected into a contact chamber via diffusers to distribute the gas evenly. The ozone concentration in the contact chamber, where the reactions are still occurring, can therefore be much higher than in the final effluent.

Continuous measurement

"We've found that it is most effective to install several ozone monitors in key points for continuous measurement, so we have five sensors in each of our two contact basins," Hawkins said. "Because we measure ozone continuously throughout the process, rather than at only one location, we have improved process control by better understanding the reaction through the ozone contactor. Also, by maintaining an ozone residual of 0.3 mg/L at the first analyzer, a 0.5-log *Giardia* inactivation credit for disinfection is achieved. If future regulations require additional disinfection credit for *Cryptosporidium*, greater disinfection credit can be achieved by calculating the CT through the entire contactor using the downstream ozone analyzers."

Newport News installed the Rosemount Analytical ozone analyzer Model 54eA and the ozone sensor Model 499A OZ to monitor ozone residual in the contact chamber. The ozone sensor is covered with a gas-permeable membrane specifically for ozone that eliminates interference from chlorine, bromine and peroxide, and their byproducts.

"The advantage of continuously measuring ozone is remarkable," Hawkins explained. "Continuous online analyzers give a greater understanding of the process with data collection and trending abilities, while grab samples will only reveal snapshots of the process. Grab samples of aqueous ozone can be difficult and labor intensive when trying to achieve accuracy and repeatability. Also, by continuously monitoring ozone residuals at several points, we can determine if upstream water quality changes are occurring through changes in ozone residuals.

"We knew we needed continuous online measurement," Hawkins said. "The analyzers are accurate and cost-competitive; they integrate easily with our digital communications system; and they are easy to use. The instruments are standardized so that once plant personnel knows one instrument, they can easily work with any other. Also, Emerson provides a single source for us for instrumentation, and their customer support has been great." WWD

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