Effective Disinfection with Ozonation **Using Venturi Injection**

Ozonation has emerged as an attractive option for small water systems seeking efficient management of odor, taste and color. Ozone, a highly aggressive oxidizer comprised of three oxygen atoms, can also be used as a disinfectant. Ozone is typically created on-site in a compact generator and is produced on demand eliminating the need for storage and handling of large amounts of chemicals such as chlorine, chlorine dioxide or permanganate. Bottled water companies have used ozone for decades in the production of premium, clean-tasting beverages, and regulators have established standards and procedures for its use in drinking water plants.

Minimizing DBPs

Ozone provides an excellent alternative to chlorine and, unlike chlorine, does not yield notorious disinfection byproducts (DBPs), such as trihalomethanes (THMs) or haloacetic acids (HAAs). However, if ozone has a substantially long contact time with bromine in water, the reaction can yield bromate, an undesirable DBP. To prevent the formation of bromate—and simultaneously improve the energy efficiency of ozone systems while maximizing taste, odor and color control—water treatment professionals must optimize the mass transfer of ozone into the water source and minimize contact time. Early ozone systems relied on bubble diffusers to mix ozone with water—a laborious, large footprint process. Contrast this with today's side stream Venturi injection systems which require a very small footprint … and, in addition, side stream Venturi injection systems have a mass transfer rate of 90 percent and above which outperforms bubble diffusers. The unique geometry of Venturi injectors causes ozone to be drawn in when there is a pressure differential from the inlet to the outlet by means of the Venturi effect. This treated side stream is then released and mixed rapidly with the bulk water, with minimal contact time.

Problem in Texas

When the **Four Way Special Utility District** (**SUD**) drilled a 750-gallon-per-minute (gpm) well in Angelina County, Texas, USA in the summer of 2013, color and odor management immediately became a priority—the utility district faced aesthetic issues. At the time, Well Number 3 flowed at 750 gpm and served over 2,000 rural customers. The well water was tinted to 30 pcu (platinum-cobalt units) by tannic acid at a concentration of 3.0 mg/l, contained 4.0 mg/l hydrogen sulfide, and was also contaminated with sulfur-reducing bacteria. While the presence of these contaminants is not uncommon, the conventional treatment methods being used—aeration and chlorine injection—were ineffective at color, taste and odor control and held the potential for exceeding regulated disinfection by-products Trihalomethanes (THMs) and Haloacetic Acids (HAA5) formation, so managers turned to ozone. However, they were concerned that long contact time and excess ozone in the contact tower could allow bromates to form.

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Developing a Solution

The Four Way SUD contacted *Mike Walker*, PE, of **Goodwin-Lasiter, Inc.** in Lufkin, Texas, to evaluate the water concerns. Goodwin-Lasiter, with the help of **Clark Water Treatment** in Nacogdoches, Texas, determined that a precisely delivered dose of no more than 3.0 mg/l of ozone through a **Mazzei**® 3090 GDT™ Ozone sidestream Venturi injection system would provide the ozone mass transfer needed to remove color and odor while minimizing the production of bromates. Working together, the team submitted a design proposal to the Texas Commission on Environmental Quality (TCEQ) which detailed solutions to the problems facing the SUD. After a few months of technical data exchange with the commission, little progress had been made, so Mazzei engineers joined the efforts to answer the commission's questions and concerns on the benefits of ozone to meet the application needs and protect public health. The packaged ozone system design presented incorporating a highly efficient ozone contacting sidestream Venturi injection system was shown to allow tight control of the dissolved ozone levels to reduce color, taste and odor concerns while avoiding the formation of regulated disinfection by-products including THMs, HAA5 and bromate. The process design presentation was supported by laboratory testing which confirmed that there would be no excessive disinfection by-product formation. This resulted in the commission's approval. In addition to color, taste and odor control that ozone treatment provides, the treatment process enhancement allowed for reduced chlorine dosage and discontinuation of the high energy demand air stripping process that was currently being used. The new ozone system installed included on-site oxygen and ozone generation, a GDT-3090 Ozone sidestream injection skid and dissolved ozone measurement and control by a PLC PID loop. The GDT skid-mounted ozonation system included a Venturi injector for mixing ozone with water, an off-gas separator with a gas destruct system to eliminate undissolved ozone, and a set of carefully designed nozzles in a spool of pipe, called a Pipeline Flash Reactor™ (PFR), to inject the ozonated water sidestream into the main pipeline and ensure thorough mixing with the bulk flow. A dissolved ozone sensor and PLC PID loop govern the process, ensuring efficacy, safety and efficiency. With an ozone generator producing 730 grams of ozone per hour, the system achieves its performance objectives with a rate of just 2.8 mg/l of ozone. In fact, pathogen control from the ozone has allowed Four Way to reduce its dosage of chlorine for disinfection, and the district has even decommissioned the energy-intensive air stripping process it formerly used for VOC removal. The utility, their customers and the Texas Water Commission are very pleased that the negative well water quality parameters could be addressed so effectively by ozone treatment.

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Others Face Same Problem

Like Four Way, most small water providers who number their connections in the hundreds or a few thousand, must be extremely prudent with their infrastructure investments. In addition to seeking out proven technologies that have low cost of ownership and minimal maintenance demands, they must be comfortable that the system will work for their source water—sidestream Venturi injection responds to this need. On a physical level, the portability and small footprint of the ozone sidestream Ventguri injection skid enables it to function as a pilot system for in-situ testing. Several small utilities have utilized pilot systems to prove to themselves and local stakeholders that ozonation with Venturi injection delivers the performance, reliability and low-maintenance operation that are vitally important to rural water systems. ■

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