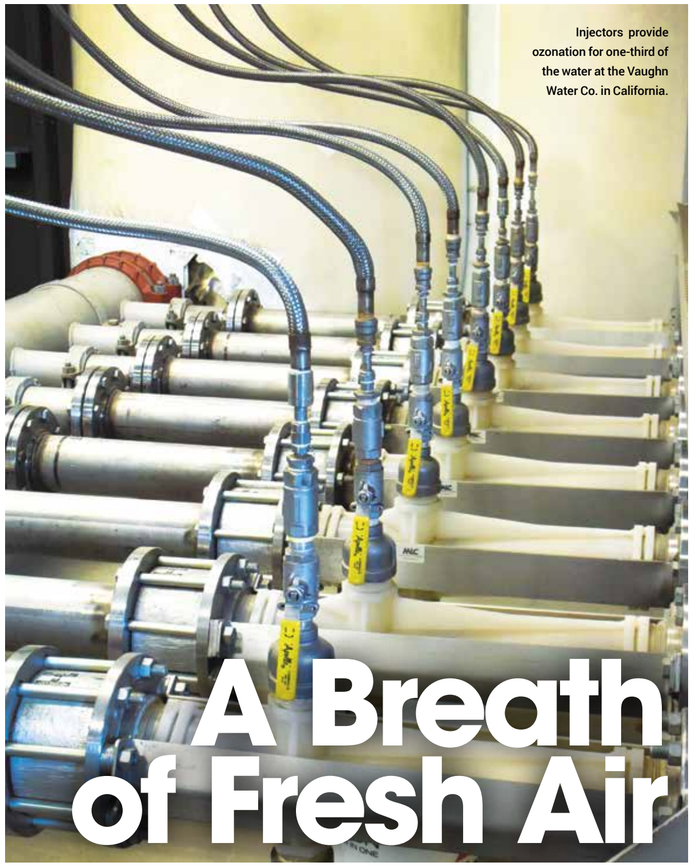

Injectors provide ozonation for one-third of the water at the Vaughn Water Co. in California.

A Breath of Fresh Air

By Jim Lauria

Ozonation helps small water systems manage odor, taste & color

Small water districts face huge challenges, grappling with the same water quality regulations, ratepayer demands and environmental strictures as larger utilities, but with smaller budgets, limited staff and no economy of scale.

Adding to the challenge, it is estimated that 91% of the nation's small water systems—more than 130,000 water utilities across the U.S.—rely on groundwater for their potable water supply. Compared to surface water supplies, groundwater often has a greater need for special treatment for radon, arsenic, nitrate and metals before distribution as drinking water.

Ozonation has emerged as an attractive option for small water systems seeking efficient management of odor, taste and color. Ozone, a highly aggressive oxidizer comprising three oxygen atoms, also can be used as a disinfectant. Ozone typically is created onsite 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 beverage production, and regulators have established standards and procedures for its use in drinking water plants.

Minimizing DBPs

Ozone provides an alternative to chlorine and, unlike chlorine, does not yield notorious disinfection byproducts (DBPs), such as trihalomethanes (THMs) or haloacetic acids (HAAs), which are strictly regulated by the U.S. Environmental Protection Agency. 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 with a mass transfer rate in the range of about 10%. Contrast this with sidestream systems using Venturi injection, in which mass transfer rates of 90% or more are achieved rapidly in a small footprint.

The geometry of these injectors causes ozone to be drawn in when there is a pressure differential from the inlet to the outlet by using the Venturi effect. This treated sidestream then is released and mixed rapidly with the bulk water, with minimal contact time.

Smaller in Texas

When the Four Way Special Utility District drilled a 750-gal-per-minute well in Angelina County, Texas, in the summer of 2013, color and odor management immediately became a priority. The well water was tinted to 30 platinum-cobalt units (pcu) by tannic acid at a concentration of 3 mg/L, contained 0.4 mg/L hydrogen sulfide and was also contaminated with sulfur-reducing bacteria.

Regulations on THMs eliminated chlorination from the district's list of options, 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. Goodwin-Lasiter of Lufkin, Texas, with the help of Clark Water Treatment of Nacogdoches, Texas, determined that a precisely delivered dose of no more than 3 mg/L of ozone through a Mazzei 3090 GDT ozone transfer system would provide the ozone mass transfer needed to remove color and odor while minimizing the production of bromates.

The Mazzei GDT skid-mounted ozonation system includes a Venturi injector for mixing ozone with water, an off-gas separator with a gas destruction 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 programmable logic controller proportional, integral and derivative 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 2.8 mg/L of ozone. Pathogen control from the ozone has allowed Four Way to reduce its dosage of chlorine, and the district even has decommissioned the energy-intensive air stripping process it formerly used for volative organic compound removal.

Ozonation does not yield THMs or HAAs, but can form bromate with long contact time.

The skid-mounted ozonation system for Texas' Four Way Special Utility District has diminished the need for chlorine.

Eliminating Odor & Maintenance

Near Bakersfield, Calif., the Vaughn Water Co. also encountered high levels of hydrogen sulfide in well water. The company installed Venturi injectors and an ozonation system. Vaughn now uses Mazzei injectors for ozonation on one-third of its water—the quantity that needs hydrogen sulfide reduction.

The GDT system, first installed in 1997, is operating today virtually maintenance free. The Venturi injector, degas separator and PFR have no moving parts, so the company's maintenance staff keep the ozone generator and pump in order to keep the whole system working seamlessly.

Iron & Manganese Removal

Ozonation or aeration through Venturi injectors are also highly effective at removing soluble iron and manganese from water supplies. A Mazzei GDT skid in Ladysmith, Wis., injects ozone into well water to precipitate manganese, which could otherwise foul pumps and pipe throughout the utility's delivery system.

Operators of another rural water system found that soluble iron was fouling the costly ion exchange resin they were using to remove radon from groundwater. The interference of the iron was making radon removal economically unsustainable. Aerating the water with a Mazzei Venturi injection and PFR system allows the company to remove iron in particulate form through a media filtration system without breaking pipeline pressure.

The system is not entirely chemical free—iron and manganese removal requires pH control of the source water in order to efficiently oxidize the soluble forms of the metals into filterable particles. However, using air or ozone to remove iron or manganese is efficient in both space and cost, and minimizes the need for chemicals.

Field-Testing Systems

Rural water providers, who number their connections in the hundreds or low thousands, 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 confident that the systems will work for their source water.

Mazzei has responded to this need in two key ways. First, computational fluid dynamics (CFD) modeling allows the company's designers to optimize all aspects of a system, from the plumbing in the water treatment facility to the sizing and positioning of the nozzles in the PFR, for top performance.

On a physical level, the portability and small footprint of the GDT ozone transfer 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 performance, reliability and low-maintenance operation to rural water systems. w&wd

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