Donald Compton manages the Prestonsburg, Ky., water treatment plant.

Making a Business Case for Mixed Oxidants

On-site generation improves safety, reduces TTHM formation, and saves money.

BY DONALD COMPTON

FOR YEARS, Prestonsburg, Ky., treated its water with chlorine gas stored on-site in several 1-ton cylinders. Several times a year, a box truck or open trailer would drive through town to deliver chlorine gas cylinders to the treatment plant. The 3.5-mgd facility lies in a residential area next to a middle school and a quarter mile from a nursing home, so transporting and storing the hazardous chlorine gas was a big concern for such a populated area. Additionally, because of the large volume of chlorine used, the city had to comply with US Environmental Protection Agency requirements for a risk management plan. The plant also struggled to stay within the USEPA-compliance limits of 80 µg/L of total trihalomethanes (TTHMs) during periods of high heat and chlorine demand.

The desire to improve safety and to reduce formation of cancerous by-products led the city to explore the on-site generation of mixed oxidants as a disinfection alternative. Mixed oxidants are a dilute, chlorine-based, liquid disinfectant generated through the electrolysis of salt water. To determine if mixed oxidants would meet Prestonsburg's needs, plant personnel visited other utility operators in several states who had purchased mixed-oxidant generation equipment. Considering the tremendous safety advantages of on-site generation, as well as the ability of mixed oxidants to reduce TTHM formation, the city chose to go with this solution. While the plant was retrofitted for on-site generation, it used concentrated hypochlorite for the short term.

PRIMARY BENEFITS

Prestonsburg's mixed-oxidant generator was started in October 2006, with a total free available chlorine capacity of 1,000 lb/day. The mixed-oxidant disinfectant is injected primarily in the pretreatment stage, with a small amount added for final disinfection. Peak usage during the summer season with higher incoming turbidity levels equates to approximately 400 lb/per day of equivalent chlorine.

Safety has improved with the installation of the on-site generator. Chlorine gas is no longer transported or stored, eliminating the potential for a chlorine emission. In addition, the temporary use of bulk hypochlorite has been discontinued, so there's no potential for a spill during transport, nor is there concern over inadvertently forming a chlorine gas cloud from mixing reactive chemicals with the bulk hypochlorite. Chlorine gas has been increasingly targeted as a terrorist threat, and the community of Prestonsburg can now proudly claim that use of on-site generation at the water treatment facility has eliminated this threat. Now, only salt is transported to the plant to generate a dilute disinfectant on-site. By eliminating chlorine gas, the facility no longer has to prepare a Tab-Q-7 report, an evacuation plan, or train and equip a hazardous materials team.

REDUCED CHLORINE LEVELS, TTHMS

Beyond the safety and environmental advantages, the mixed-oxidant generator was also able to reduce the amount of disinfectant added to the water. With both chlorine gas and bulk hypochlorite, pretreatment dosage requirements were approximately 2.5 mg/L, with an additional 0.5 mg/L boost for final disinfection, for a total chlorine dose of 3 mg/L. This dose maintained a 1-mg/L residual at the farthest point in distribution, 18 mi from the treatment plant. After conversion to mixed oxidants, the pretreatment dosage was reduced approximately 40 percent to 1.5 mg/L. The dosage for final disinfection hasn't changed, bringing the total chlorine dose to 2 mg/L, a 33 percent reduction over the chlorine level required with both chlorine gas and bulk hypochlorite. In addition, the residual in the distribution system is still maintained at 1 to 1.5 mg/L, despite the reduced need for chlorine. The city also has a lower chlorine level for water exiting the facility, which benefits residents closer to the treatment plant.

Mixed-oxidant generating systems are sized based on requirements for pounds per day of free available chlorine.

PHOTOGRAPH: CITY OF PRESTONSBURG

Reducing the chlorine dose has led to an associated reduction in the formation of TTHMs. In 2005, with use of chlorine gas, TTHM measurements averaged 81 µg/L with excursions of 160 µg/L in the third quarter. The mixed-oxidant generator was installed in the fourth quarter of 2005, so the first TTHM measurements taken wholly with mixed-oxidant disinfection began in 2006. With the use of mixed oxidants, TTHMs in 2006 averaged only 54 µg/L, a 34 percent reduction over 2005 and a perfect correlation with the reduced chlorine added to the drinking water. More significantly, the third quarter of 2006, historically the greatest challenge period because of high heat and oxidant demand, as well as higher levels of organics, reflected a 54 percent reduction in TTHMs to 74 µg/L. The plant is now in compliance for every quarter, as well as for running averages. Because former excursions necessitated public notification, public relations have improved.

COST SAVINGS

Although the capital cost of on-site generation is higher than installing the tanks and pumps required for bulk hypochlorite, the long-term savings of on-site generation are clear. The cost of the 15 percent hypochlorite used during the conversion averaged $1/lb of chlorine equivalent. In contrast, the cost of mixed oxidants generated on-site is approximately $0.37/lb of chlorine equivalent, more than 2.5 times less expensive than bulk hypochlorite.

The operating cost of an on-site generation system is based on the cost of salt and electricity. Prestonsburg uses food-grade salt at a cost of $0.08–$0.09/lb of salt delivered. The salt is delivered in bulk via truck and then pneumatically blown into a bulk storage silo, so no handling is required. In addition, the low calcium level in the salt minimizes maintenance with the electrolytic cell by preventing calcium carbonate buildup in the cell. Prestonsburg pays $0.07 for power during peak use and $0.046 during off-peak hours. Thus, the city attempts to run its on-site generator during off-peak hours as much as possible to minimize electricity costs.

Although the cost of chlorine gas formerly used by Prestonsburg ranged up to only $0.26/lb of chlorine, this figure didn't consider the additional safety costs of hazardous materials training at $6,000 per year, Tab-Q-7 reports, cleaning and refilling self-contained breathing apparatus, chlorine alarm testing, chlorine cylinder repair kits, operation of chlorine ventilation fans, inspection of the chlorine hoist, and maintenance of a risk management plan. Prestonsburg is satisfied with the mixed-oxidant system, as the slightly higher chemical costs of on-site generation are offset by improvements in safety and TTHM levels, as well as by reductions in other costs associated with the use of chlorine gas.