On-site Hypochlorite Generation as a Chemical Disinfection Alternative

Alberto Garibi and Leo A. Kazanowski

Water treatment plants have three main choices when selecting a chlorination method for water disinfection: gaseous chlorine, high-strength commercial hypochlorite solutions or low-strength on-site generated hypochlorite solutions. In selecting the right alternative, plant operators must take into account safety, reliability and economic aspects associated with each of the three alternatives.

Chlorine gas has been used for almost a century and has proven to be economical and reliable. Its use requires chlorine to be stored as a liquefied gas in pressurized containers and a feed system to measure and inject the gas into the water main. In the last decade, increasing safety concerns associated with a potential release of this chemical and the burden of compliance with regulations like the USEPA Risk Management Program rule have prompted many utilities to evaluate other chlorination methods.

Commercial hypochlorite is available in concentrations ranging from 12% to 15%. The use of this chemical requires only storage tanks and dosing equipment, simplifying installation requirements. However, high-concentration solutions experience fast hypochlorite degradation during storage, resulting in loss of available chlorine and generation of byproducts such as chlorates. Corrosion and operator safety can be a concern when handling this highly caustic solution. In addition, the chemical can cost significantly more than chlorine gas, resulting in higher operating costs.

On-site generation of hypochlorite is achieved through the electrolysis of brine, consuming only water, salt and power. The system eliminates safety concerns associated with transportation and storage of chlorine gas. Since it produces a low-strength hypochlorite solution, this method minimizes the degradation, corrosion and handling issues typical of commercial hypochlorite. Although the capital cost of this system is higher than that required for the use of commercial hypochlorite, the operating cost is much lower, resulting in lower life cycle costs.

Why Use On-site Generated Hypochlorite?

Safety, lower operating costs, reliability and greater environmental friendliness are convincing more water treatment plants to use on-site hypochlorite generation. The city of Vallejo, Calif., for instance, installed two 55-lb On-site Electrocatalytic Chlorination (OSEC®) systems from USFilter (now Siemens Water Technologies) at two of its plants: the 1-mgd Green Valley Water Treatment Plant and the 7-mgd Swanzy Post-Chlorination Facility. The former's original design had called for commercial hypochlorite to be used; the latter had used gaseous chlorine until state and federal codes mandated they be retrofit or replaced.

"Our maintenance staff didn't like [the idea] of working with 12.5% sodium hypochlorite, due to safety and handling concerns," recalls Franz Nestlerode, deputy water superintendent of operations.

Likewise, Phoenix City, Ala., also made the switch from chlorine gas to on-site generated hypochlorite for safety reasons in 2004. The city installed three 750-lb OSEC systems at its 13-mgd Phoenix Water Treatment Plant, which is located in the middle of a residential area.

"The system is cost-effective and is actually less expensive than using chlorine," says Susie Smith, chief operator. "The OSEC system has not affected our power consumption, and it's really easy to use."

Equally important to selecting the right system is choosing the right supplier. Smith confesses that price factored into her decision to install the OSEC systems, as did the system's technical complexity. But she had not bargained for the customer service.

"The technical support from USFilter (now Siemens Water Technologies) and its local representative has been phenomenal," Smith says. "They've been like mother hens taking care of the systems."

The OSEC Process

The OSEC electrolyzer cell includes a series of flat plate anode/cathode pairs, which are energized with DC power. The titanium anodes are coated with a precious metal oxide that acts as a reaction catalyst. The electrolyte solution is a 3% concentration of brine solution made from solar salt and softened water. Sodium hydroxide is formed at the cathode, and chlorine gas is formed at the anode. Through a series of intermediate reactions, sodium hypochlorite is created and discharged to the treatment process. The hydrogen byproduct is gathered in the product storage tank and disposed of through dilution with forced air, using blowers. For each pound of equivalent chlorine formed, 3 lbs of salt and 2 kWh of power are required. The resultant hypochlorite solution has a concentration of 0.8%. (Refer to Figure 1 for the chemistry of the process involved.)

A metering pump is used to feed the hypochlorite solution to the point of application. The metering pump can be controlled through conventional plant flow and chlorine residual signals. The entire process is automatically controlled and is suitable for use at unmanned stations. (Refer to Figure 2 for a depiction of the generation process.)

A broad range of systems are available, with individual generator capacities ranging from 12 lbs per day to 2000 lbs per day. The lower capacity units are typically wall-mounted in small pump stations. The equipment components are easily arranged within existing pump stations or treatment plants. All systems use the same cell technology, automatic operation and positive hydrogen removal.

Back-up arrangements can be handled in various ways. A single generator can be provided that is backed up, if necessary, by bringing in commercial hypochlorite. Alternatively, two 50% capacity generators can be provided to handle average plant flows with the other unit standing by; both units would need to be brought into operation

for peak plant flows. Alternatively, two 100% capacity units could provide maximum standby capability.

Over Two Decades of Operating Experience

The OSEC system's popularity has been on the rise in the United States during the last few years. Hundreds more installations have been operating in other areas of the world for more than 25 years.

OSEC systems are easy to install and start up. They are designed to optimize power and salt use efficiencies. The anodes are dimensionally stable to assure long life. Once these systems are installed and operating, they require minimal maintenance and exhibit very low downtime.

In addition to potable water treatment, OSEC systems can also be found in a wide variety of applications, including well pump stations, wastewater treatment, industrial applications (such as cooling water in power plants), and commercial swimming pools.

About the Authors

Alberto Garibi is the OSEC product manager at USFilter (now Siemens Water Technologies). Located in Miami, Fla., Alberto has five years of experience in water and wastewater disinfection. He holds a BS degree in Chemical Engineering from the Instituto Tecnologico y de Estudios Superiores de Occidente in Guadalajara, Mexico and a MS degree in Environmental Engineering from Drexel University in Philadelphia, Pa. Alberto can be contacted at 305-567-0596 or at alberto.garibi@siemens.com.

Leo A. Kazanowski is a senior applications engineer at USFilter (now Siemens Water Technologies). Located in Union, N.J., Leo has been with the company for 39 years. He holds a BSME degree from the New Jersey Institute of Technology in Newark. Leo can be reached at 908-851-6951 or at leo.kazanowski@siemens.com.