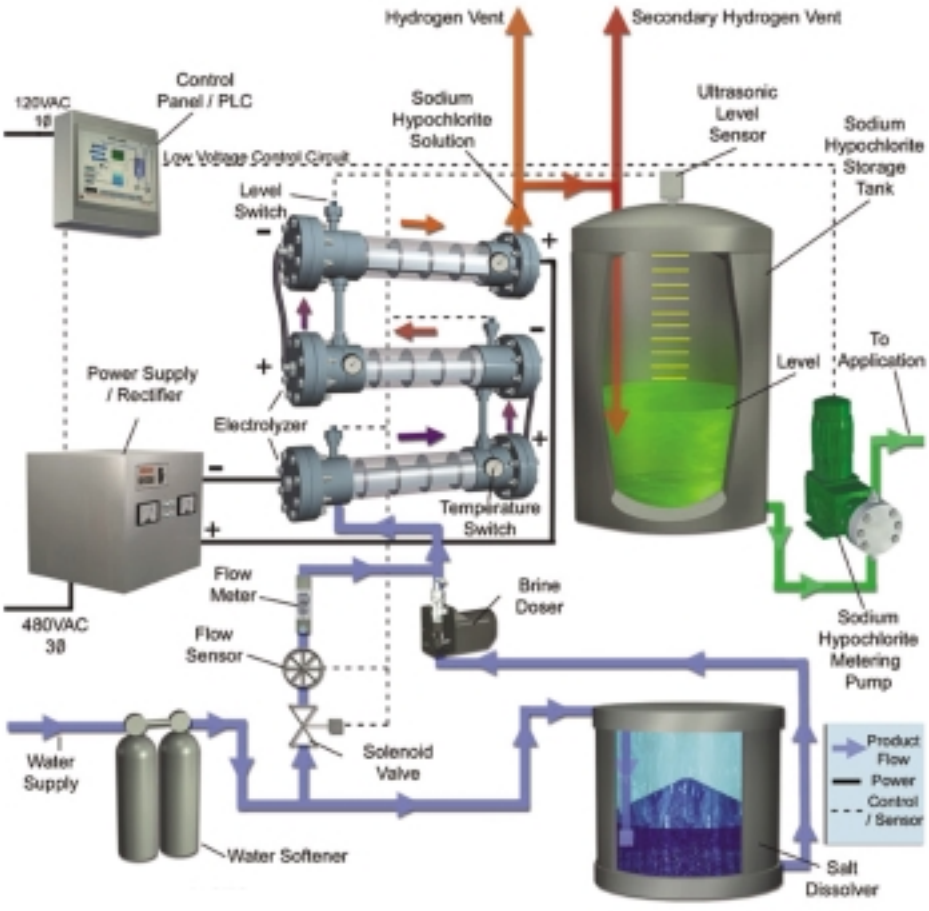
By Randy Walsh

Upgrading Well Water Disinfection Systems

The City of Albuquerque depends on groundwater from 93 deep aquifer wells to supply drinking water to more than 400,000 users. The city is fortunate to have this source of water relatively free of bacteria. However, it must use disinfection systems to meet EPA and local regulations for water quality in its extensive storage and distribution facilities. The total production capacity of all wells is 294 million gallons a day (mgd), but conservation measures resulted in peak usage last year of only 169 mgd.

Disinfection takes place at reservoirs that receive water from well fields containing from one to eight wells. Until recently, chlorine gas from 150-lb containers was being used for disinfection. Because of the inherent hazards of handling chlorine gas, plus more stringent regulations on its use, the Albuquerque Water Utility Division (AWUD) undertook an investigation of viable alternative disinfection technologies. The conclusion was to switch to on-site generation of sodium hypochlorite (NaOCl). (See sidebar.)

Figure 1: Standard ClorTec On-Site Hypochlorite Generating System



Site Conversions

For practical and economic reasons, AWUD set up a program to convert stations over about three fiscal years. After a pilot test, the program started in September 1999. As of March 2001, the systems have been installed at 11 stations that draw water from 28 wells. Of these converted sites, the largest well field handled by one station contains five wells.

At each site, treated water is stored in large steel or concrete reservoirs. These reservoirs have capacities from 3 to 11 million gallons. In the overall system, there are 110 booster pumps sending treated water to 46 reservoirs that have a combined capacity of 211 million gallons.

The Coronado pump station is typical of the disinfection sites. As shown in Figure 1, the basic components of the standard ClorTec on-site hypochlorite generating system consist of an electrolytic cell with its power supply/rectifier, a brine dilution device or "brine doser" and a water softener. A salt dissolver as a source of concentrated (30 percent) brine and a storage tank for the generated 0.8 percent sodium hypochlorite solution (also referred to as the day tank) are set up by AWUD, as is the metering pump that controls dosage rate.

AWUD standardized on 70-lb cells, and multiples of 70, meaning that a one cell system can produce up to 70 pounds of chlorine per day (ppd) and a system with two 70-lb cells can produce up to 140 ppd. The supplier offers higher or lower cell capacities, but AWUD chose this standardized approach for simplicity in operation and maintenance.

The dosage rate for treating the City of Albuquerque well water at each site is 1.0 to 1.2 parts per million (ppm) of free chlorine. This rate is relatively low because of the high quality of the water. The primary pur-

pose of the treatment is to provide residual chlorine in the reservoirs and distribution system, as EPA and local regulations mandate. Other cities using chlorine might be required to have higher dosage rates.

AWUD uses a magnetic flowmeter to measure the dosing of the sodium hypochlorite solution that flows from the discharge line on the hypo storage tank. A metering pump on the discharge line controls the dosing; the flowmeter as well as the calibration tubes can be used to adjust the set point of the pump.

Typically, the salt dissolver is loaded to supply brine for four days of operation. For simplicity, AWUD standardized on obtaining the salt in 50-lb bags.

System Selection

Faced with ever increasing regulations (federal, state and municipal) for the handling and storage of chlorine gas, AWUD set up a pilot installation, using a gas chlorination system that would meet foreseen restrictions in every aspect of its design. This test showed that compliance with such regulations would simply be too costly and that alternative methods should be explored.

In evaluating other options for providing chlorine disinfection, AWUD looked at capital, maintenance and chemical costs. One alternative is the purchase of bulk sodium hypochlorite liquid that is commercially available as a 12.5 percent solution. While this approach does not have the transporta-

Basic Operating Principles of the ClorTec System

The design and operation of the ClorTec system for on-site generation of sodium hypochlorite is straightforward.

- Using softened water, salt (NaCl) is dissolved in a tank to form a concentrated brine solution.
- The brine is diluted by a proportioner to a 3 percent solution that feeds an electrolytic cell. This cell is fed DC power from a rectifier.
- The cell electrolyzes the diluted brine into an 0.8 percent solution of sodium hypochlorite $NaCl + H_2O + 2e^- = NaOCl + H_2$.
  (salt) + (water) + (electric energy) = (sodium hypochlorite) + (hydrogen)
- The 0.8 percent hypochlorite solution flows into a storage tank by gravity.
- Hydrogen is safely vented to the atmosphere.
- A metering pump delivers the disinfectant to an ejection point in the well water treatment system.

The system was designed as a simple and safer means for a water utility to provide the effectiveness of a chlorine disinfectant. It avoids the problems of handling hazardous chemicals such as a bulk 12 to 15 percent hypochlorite solution or chlorine in 150-lb or larger containers. Since an initial installation in Hawaii in 1988, there have been more than 1,000 such systems of various sizes installed in mainland USA. A range of models is offered with capacities from 2 to 500 ppd of chlorine, allowing for system capacities in terms of hypo solution outputs up to 2,000 ppd.

The heart of the electrochlorination system is the electrolytic cell. This can be a single unit or stacked with up to four such assemblies. This is where the dilute brine solution (an electrolyte) reacts to the DC current and is converted to dilute (0.8 percent) sodium hydrochlorite and hydrogen. To carry out this electrolytic process, each cell contains an array of positively and negatively charged electrodes.

A programmable logic controller (PLC) monitors each aspect of the system and can be set up to automatically control selected conditions such as level in the hypochlorite storage tank. A CRT display with touchscreen is used to set up or change control settings. This technology processes and reports operating parameters, system status and alarm conditions. Such local controls are telemetry/SCADA compatible so that operations can be supervised from a remote location.

View of the Chlorine Room at AWUD's Gonzales station where a two-cell system was installed. A wall-mounted control panel is at the left, with the power supply/rectifier in the center and the electrolytic unit is at the right.

The metering pump (center) controls dosage of hypochlorite solution from bottom of storage tank at right. The set point for the pump comes from the control panel that receives a measurement signal from a magnetic flow meter (visible on horizontal line at left).

tion or storage hazards to the extent present with chlorine, there are safety factors to be considered such as corrosive vapors when using bulk sodium hypochlorite.

The bulk solution is subject to degradation in storage and the formation of chlorates that are EPA-regulated disinfection by-products (DBPs). Further complications from the degradation of commercial hypochlorite are the constant changes required in the dosage rate to maintain constant desired residuals in the finished water.

After careful evaluation and competitive bidding, AWUD chose the ClorTec On-Site Sodium Hypochlorite Generating System by Severn Trent Services, Inc. Geared to the extended conversion program, it orders groups of standard assemblies that are stored in trailers ready for transporting to the next conversion site. The systems are installed entirely by AWUD personnel. If a new building is needed or auxiliary equipment such as an electrical power system is required, AWUD contracts this work out. When the installation is complete, the supplier inspects the system before certifying the warranty.

Benefits

Operating advantages with on-site generation include

- Operates safely both for the public and operators,
- Generates 0.8 percent hypo, which is OSHA and EPA exempt,
- Produces sodium hypochlorite at the site, on demand,
- Avoids dependency on chemical suppliers,
- Eliminates handling of hazardous materials,
- Affords all of the benefits of chlorine as a disinfectant without the problems of using the gas,
- Eliminates bulk storage of hazardous chemicals,
- Resists degrading as a disinfectant, and
- Reduces DBPs.

To compare overall costs of on-site generation systems versus gas chlorinators, realize that the latter systems include such mandatory auxiliaries as scrubbers, back-up power and valves for automatic closure of cylinders as a safety measure. These additional items may make chlorinator systems more costly. Further, one cannot predict what additional requirements for gas chlorinators will come from city, state and federal government regulations.

Experience with the on-site systems has been relatively trouble-free and has consistently maintained the chlorine residuals in the treated water in storage and distribution at the desired level. AWUD manually checks chlorine levels daily in the field and also uses continuous monitoring at several sites.

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