Softening Up

Wisconsin utility implements new RO system for softening

By Peter Waldron

Replacing the aging water softening facility in Waupun, Wis., gave Waupun Utilities the opportunity to find a technology that would provide much-needed equipment redundancy, offer easy expansion for future population growth and help meet existing and future state regulatory requirements. Located in south central Wisconsin, the city of Waupun has nearly 11,000 residents. Its central water treatment facility receives water from five municipal wells. Normal flow is about 1.1 million gal per day (mgd), with a maximum flow of about 2.9 mgd. Water demand is 80% residential and 20% industrial.

Waupun's raw water is also relatively hard—about 320 ppm (mg/L) of hardness, or 19 grains of hardness—due to the presence of dissolved calcium and magnesium. In addition to providing poor soap lathering, leaving a salty residue in hair after shampooing and coating tea and coffee pots, hard water can have a significant adverse effect on community infrastructure.

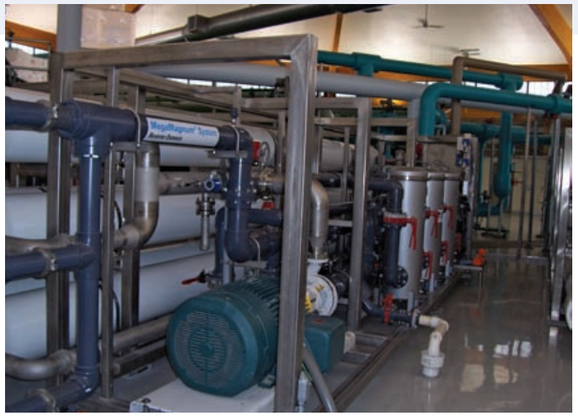
For example, hard water causes scaling that can clog pipes and decrease the lifespan of water heaters and toilet-flushing units. Water hardness can also have a negative effect on industry, causing boiler breakdowns and problems with cooling towers or other equipment that comes in contact with water. After softening, Waupun's water hardness was reduced to about 80 mg/L, or about five grains of hardness.

Treatment Facility Options

Concerned about the rising costs associated with this aging facility, as well as the quality of the town's water supply, Waupun Utilities began researching improved lime softening technologies, zeolite lime softening and reverse osmosis (RO) as possible alternatives for the central facility. The utility's goal was to give the public equal, if not better, water quality. Steve Schramm, treatment facilities supervisor for Waupun Utilities, led the search for a replacement for the existing central water softening facility.

"The water softening facility was quite outdated and had reached the end of its useful life," Schramm said. "In addition, we had no equipment redundancy, causing repair and reliability issues."

The city of Waupun, Wis. needed to replace its outdated central water softening facility and turned to a pre-engineered, packaged RO system.



The new system's 18-in.-diameter elements process water in a smaller footprint, which allowed the city to spend $1 million less on a smaller building.

The first option Schramm researched was to replace the existing lime softening plant, which had performed adequately over the years. Capital costs for a replacement lime system would be high, and the plant was already operating using two labor shifts that required three full-time treatment facility operators, resulting in considerable annual operating costs.

A second option considered was the use of natural or synthetic zeolites, which are hydrated aluminosilicate minerals with a microporous structure. Zeolites have positive ions that are loosely held and can readily be exchanged for others in a contact solution. Waupun rejected zeolite softening because the process involves adding large quantities of salts to the water. The salts would then ultimately flow through the wastewater treatment plant and to the river, exceeding the community's allowable chloride discharge limit.

The third option—and the one ultimately selected—was the MegaMagnum Water Treatment System, an RO system manufactured by Koch Membrane Systems (KMS), Wilmington, Mass. The RO system uses pressure to force a solution (in this case, water) through a membrane that retains most of the dissolved ions on the concentrate side and allows the treated water or permeate to pass to the other side.

How the RO System Works

The MegaMagnum system installed at the Waupun treatment facility is a pre-engineered, packaged RO system that uses 18-in.-diameter membrane elements rather than the industry-standard 8-in. membranes. The system processes more water in a smaller footprint and greatly reduces treatment system maintenance costs.

Using these elements allowed the city to construct a smaller building, which cost approximately $1 million less than the capital costs for a replacement lime softening system. Plus, the system requires only one operator—roughly two hours per day, seven days per week—considerably reducing annual operating costs and routine maintenance.

Another key feature that drew Schramm to the system was its expandability. "If a major water customer moves into the city or if the city grows rapidly, we can just plug in another RO skid rather than add on to a building or build extra tanks," Schramm said. "The reduced capital and operating costs, plus the ability to expand the system easily, sealed the deal for us."

The new water treatment system at Waupun consists of pretreatment, RO and post-treatment. When raw water from the five existing wells reaches the plant, booster pumps increase the raw water pressure to provide proper operating pressure for the pretreatment system. Pretreatment is provided by disposable cartridge filters and multi-cell greensand filter media to remove iron and manganese. Pretreatment prolongs RO membrane life and helps meet recommended standards for iron and manganese removal in drinking water.

After water passes through the filters, it then moves to the RO system. Waupun's system consists of two pre-engineered packaged skids called "trains" that operate on alternate days. The dual-skid configuration provides system redundancy, which facilitates maintenance. If for any reason increased capacity is needed due to fire protection needs or another large water demand, the city could run both trains at the same time to increase capacity.

continues on page 88 ▶

◀ *continued from page 86*

The RO system's pressure is increased to force water through semipermeable membranes to separate impurities. About 80% of the pretreated water from the greensand filters flows through the RO system. The remaining 20% is bypassed around the RO system and then mixed back in with the permeate to raise the water hardness to the desired level of approximately 80 ppm. About 20% of the water sent through the RO system does not pass through the membrane. This is called concentrate or reject and is discharged to the sewer.

After the permeate and RO bypass waters are mixed, they are sent through a forced-draft degasifier. As water passes through the degasifier, carbon dioxide is removed by forcing air through the water flow. Stripping carbon dioxide raises the pH in the finished water product, which prevents the water from corroding the distribution pipes and valves.

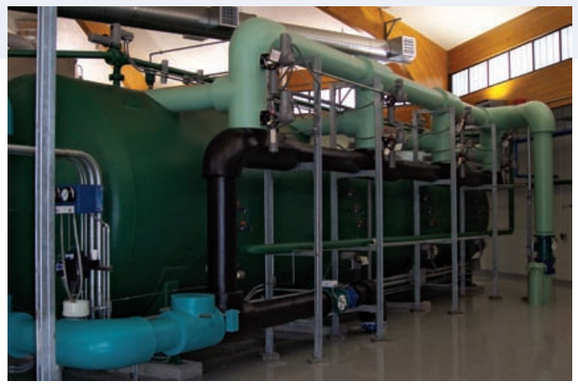
After carbon dioxide stripping, fluoride and chlorine are added to the water to meet drinking water standards prior to distribution. The final step is pumping the water to towers by high-lift pumps. Water in the towers is maintained at a specific level to provide sufficient volume for fire protection and to pressurize the distribution system.

Process Performance

The new water softening process is working well, according to Schramm. KMS installed a pilot unit that ran for about seven weeks. Officials tried a variety of pretreatment options before settling on the present horizontal pressure filters with manganese greensand and potassium permanganate feed systems. The entire water softening system went online in December 2007 and has been working smoothly since, with a noticeable improvement in water consistency.

"There is not a lot of maintenance on the RO system," Schramm said. "We change the cartridge filters about once every three months and conduct clean-in-place (CIP) of the membranes about once every six months. RO membrane elements are projected to last three to five years, but we've talked to other operators of RO systems that have seen elements last as long as seven or eight years depending on the level of pretreatment and how well the CIP operations are conducted."

A final benefit is a measure of security in the face of potential changes to water quality regulatory requirements. "We meet and exceed all our state regulatory requirements and are confident that this system will allow us to meet any changes that make water quality requirements more stringent in future," Schramm said. WWD



The new RO system requires minimal maintenance and the facility operator expects it will last at least three to five years.

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