IMPROVING WATER QUALITY WITH RO

BIOFILTRATION AND REVERSE OSMOSIS SOLVE WATER TREATMENT PROBLEMS IN MINNESOTA

BY CRAIG R. GRANLUND

City officials in Hutchinson, Minn., were faced with a challenge when the city's aging water treatment plant no longer had enough capacity to handle future growth. In addition to the capacity problem, there were three other issues with the water in Hutchinson:

- Aggressive chemistry of the water caused high copper levels in the water distribution system and the wastewater plant's effluent and biosolids, which had been an ongoing issue for more than 20 years. In 2006, copper levels in Hutchinson's drinking water was 2.22 parts per million (ppm), well above the 1.3-ppm action level.
- The chemical used to minimize copper corrosion created increased phosphorus loading and caused concern for the city's high-tech manufacturing industries as well as some environmental issues.
- Ammonia was identified in significant concentrations in the source water and high alkalinity and hardness were also present.

Hutchinson is a town of about 14,000 people, located 55 miles west of Minneapolis. Although the city started as primarily an agricultural town, it is now home to some large manufacturing companies. The bulk of the manufacturing jobs are approximately 1,800 employees at Hutchinson Technology, which manufactures computers and peripheral equipment, and 1,300 employees at 3M, which manufactures adhesive tapes and other products.

Addressing the Issue

In 2006, the city decided to address the long-term capacity and corrosion issues at the treatment facility. Several technologies were considered to meet the unique water treatment needs of the city. These included conventional technologies, such as lime softening and ion exchange along with air stripping, but these were too costly and ineffective at removing ammonia. The solution the city chose was a new 6.5-mgd-capacity plant designed to solve the copper corrosion issue and lower hardness levels, as well as meet future growth needs while significantly reducing the amounts of phosphorous, copper and softener salts released to the environment.

The approach selected was a two-part process that uses a combination of reverse osmosis (RO) and biologically activated filtration for iron and ammonia treatment. The final water distributed throughout Hutchinson includes a blend of water from the biofiltration system and the RO system together. This process achieves hardness and alkalinity reduction through the RO process, as well as removal of iron and ammonia from the biofiltration process. Extensive pilot testing and water quality modeling were performed to confirm this treatment approach and to determine the required blending ratios of these two processes.

Biologically active filtration in a water treatment facility had never been used in Minnesota and has only been used sparingly in the U.S. Biofiltration can be used for iron, manganese or ammonia treatment without the need for chemicals, which are currently used in conventional treatment. Additionally, biofiltration can operate at significantly higher loading rates and longer run times, saving capital and operating costs as well as water.

Figure 1

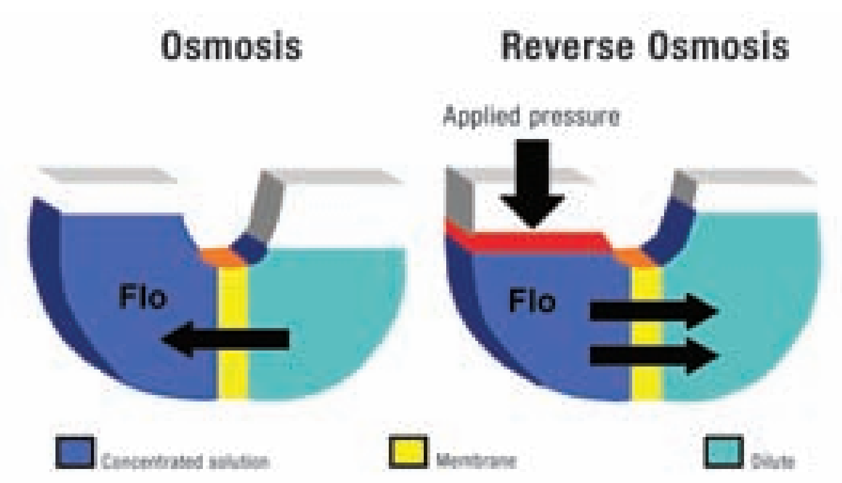
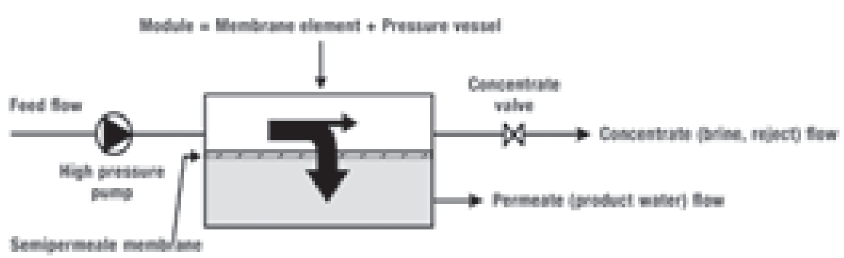


Figure 2



The RO Phenomenon

The RO system includes three trains containing a total of 630 Filmtec XLE-440 (440 sq ft of active area each) low-energy RO elements. Each train can be started up and shut down individually as demand dictates. The RO system operates at 75% recovery and removes about 98% of all the salts in the water.

While this water alone would be too aggressive to distribute directly to the city, the blended water from the biofiltration system still lowers the hardness and salt levels from previous levels and produces improved water quality that residents can readily observe.

The phenomenon of osmosis occurs when pure water flows from a dilute saline solution through a membrane into a higher concentrated saline solution. This is illustrated in Figure 1, as a semipermeable membrane is placed between two compartments. Semipermeable means the membrane is permeable to some species but not to others. Assume that this particular membrane is permeable to water but not to salt, then place a salt solution in one compartment and pure water in the other. The membrane will allow water to permeate through to either side, but salt cannot pass through the membrane.

As a rule of nature, the system shown on the left in Figure 1 will try to reach equilibrium.

LearnMore! For more information related to this article, visit www.wqpmag.com/lm.cfm/wq110806

For more information on this subject, write in 1016 on the reader service card.

That is, it will try to reach the same concentration on both sides of the membrane. The only possible way to reach equilibrium is for water to pass from the pure water compartment to the salt-containing compartment to dilute the salt solution.

Figure 1 also demonstrates that osmosis can cause a rise in the height of the salt solution. This height will increase until the pressure of the column of water (salt solution) is so high that the force of this water column stops the water flow. The equilibrium point of this water column height in terms of water pressure against the membrane is called osmotic pressure.

If a force is applied to this column of water, the direction of water flow through the membrane can be reversed. This is the basis of the term reverse osmosis. Note that this reversed flow produces pure water from the salt solution because the membrane is not permeable to salt.

In practice, RO is applied as a crossflow filtration process. The simplified process is shown in Figure 2.

With a high-pressure pump, feedwater is continuously pumped at an elevated pressure to the membrane system. Within the membrane system, the feedwater will be split into a purified or low-saline product called permeate, and a high-saline or concentrated brine called concentrate or reject. A flow-regulating valve—a concentrate valve—controls the percentage of feedwater that is going to the concentrate stream and the permeate, which will be obtained from the feed.

To increase the life and efficiency of RO systems, proper pretreatment is required. Proper pretreatment maximizes efficiency and membrane life by minimizing fouling, scaling and membrane degradation, while optimizing product flow, product quality (salt rejection), product recovery and operating and maintenance costs. It is important to note that the larger the RO system, the more care and detail should be used to plan out the pretreatment system.

In the case of Hutchinson's RO system, care is taken so that the feed water does not contact oxygen before being pumped to the RO membrane. This keeps the iron that is naturally occurring in the well water from converting from ferrous iron form (soluble) to the ferric form (insoluble) so that it will not precipitate out on the membrane surface.

Showing Results

As the new facility at Hutchinson started up, it demonstrated running at the designed 6.5-mgd capacity. In addition, distribution system monitoring has shown a significant reduction of about 75% in copper levels as reported in the 2008 Drinking Water Report, a required publication of the Minnesota Department of Health.

A byproduct of the plant's ability to lower the corrosiveness of the water was a softening of the water by about 75%, something many residents have noticed and appreciate. Routine monitoring continues to confirm the drop in copper levels as well as the reduced ammonia and hardness levels throughout the city.

One of the large manufacturers in town, Hutchinson Technology, has noticed the improved water quality by the improvement in the operation of their own water treatment equipment, used in their manufacturing process.

Overall, Hutchinson's new water treatment plant has been a successful application of new technologies applied to meet the needs of a growing community. *wqp*

Craig R. Granlund is senior account manager for Dow Water Solutions. Granlund can be reached at 952.233.1445 or by e-mail at craig@dow.com.