By Brian S. Fraser

improving

membrane performance with pretreatment

Phillipsburg, Kan., facility uses pretreatment to maintain high-quality feedwater

Those who depend on membrane filtration as a part of their water treatment process understand that the life and performance of membranes is unavoidably linked to the quality of feedwater. Poor feedwater quality can lead to unexpected costs and possibly damage membranes. Fortunately, pretreatment can prevent these potential problems. In fact, properly implemented pretreatment can significantly improve the performance and extend the life of reverse osmosis (RO) membranes.

The consideration of the cost of pretreatment versus the benefits of a membrane system has long been a debate. From a purely technical point of view, pretreatment would be incorporated in the design scheme of most membrane plants from the beginning. Capital costs have been and will always be a major driving force in the design decisions of plants. Most new plants now look more closely at the life cycle cost and try to put some weight on service and maintenance costs, which can be hard to quantify.

New plants are closely examining different pretreatment options and how they affect their bottom line. For those with existing systems, a retrofit may be just what is needed to extend the service life of existing membranes, reduce energy costs, protect the warranty and improve overall plant operating costs.

Importance of Pretreatment

A new ethanol plant in Phillipsburg, Kan., highlights the importance of pretreatment for RO membrane feedwater. The 40 million gal-per-year ethanol plant is owned by Prairie Horizon Agri-Energy and was designed and built by ICM, Inc. The RO system and its associated pretreatment system were designed and built by the membrane division of Layne Christensen Co. The goal of the ethanol facility is to produce product for the lowest cost; this goal was specifically directed toward the design and implementation of the water treatment facility.

Water for the ethanol plant is drawn directly from the city of Phillipsburg drinking water facility wet well and eventually treated with a 400-gal per minute (gpm) RO system. The permeate is then delivered to the ethanol plant via a two-mile-long pipeline, while the reject water is recovered by blending with the feedwater destined for the city's lime softeners.

The RO system provides high-quality water for use in the ethanol plant's boiler, cooling towers and refining process. Investigating the feedwater quality showed that the membranes in the RO system must be protected from potential fouling contaminants of iron and manganese. Iron levels ranged between 0.6 and 0.8 mg/L, and manganese levels were 0.3 mg/L. Membrane manufacturers typically prefer iron and manganese to be less than 0.05 mg/L. If left unchecked, these contaminants could have quickly fouled the RO membranes.

Pretreatment was needed to reduce contaminants to acceptable levels. After careful consideration, a LayneOx system was selected for its iron and manganese removal capabilities and highly efficient design. The final design of the prefiltration skid was comprised of three 66-in. diameter pressure vessels. The pressure filters were designed to take advantage of LayneOx, a manganese dioxide filter media with unique physical characteristics. In the presence of chlorine as an oxidant, the LayneOx media achieves highly efficient iron and manganese contaminant removal through a combination of oxidation, precipitation and adsorption. Manganese can, in some cases, be difficult to precipitate efficiently, particularly with chlorine. The LayneOx media's catalytic oxidation capability facilitates an extremely quick oxidation reaction, which translates into savings from smaller vessels and lower oxidant requirements. LayneOx filters typically run at filtration rates of 6 to 15 gpm/sq ft. An additional benefit is that the pressure filters can be reconditioned indefinitely through backwash while maintaining filtration cycle times in excess of 24 hours.

Immediately before entering the pressure filters, free chlorine is added to the raw

Completed RO units provide 400 gpm of treated water for the Phillipsburg ethanol plant's boiler, cooling towers and refining process.

water. The chlorine serves to oxidize the iron, which is removed through filtration, while the manganese is mainly removed through adsorption. Permeate from the pressure filters contains a chlorine residual. Because most RO membranes are chlorine intolerant, the Phillipsburg plant dechlorinates with sodium bisulfite to prevent oxidation of the membranes.

In operation, the pressure filters easily satisfy the pretreatment requirements, providing excellent iron and manganese removal with up to 533 gpm throughput. The system utilizes a high filtration rate of 7.7 gpm/sq ft. Onsite pilot tests demonstrated that iron and manganese contaminants had been reduced to an average of 0.025 mg/L for iron and 0.016 mg/L for manganese, and these same levels were achieved in the full-scale system.

Overall, the filtration system provides consistent and simple operation with low maintenance requirements. The system serves to protect the vital and costly downstream RO membranes while keeping energy requirements down by reducing the pressure needed to provide treated water.

Measuring Success

Because suspended solids—in this case, precipitated iron and manganese—can have a severe negative effect on RO membrane performance, the nanofiltration/RO membrane industry uses a standardized method to measure potential membrane particulate fouling. This method is a measurement called the silt density index (SDI). For RO feedwater, an SDI of 5 is typically considered acceptable and 3 is considered a good design, with lower numbers being more desirable.

The benefits of the Phillipsburg prefiltration system are impressive. The untreated raw water for this facility had a nonmeasurable SDI, which would have certainly clogged cartridge filters and potentially fouled the RO membranes. This pushed the design to consider pretreatment. The LayneOx filters provide pretreated water to the RO membranes with an SDI of 1.3. Maintaining high-quality feedwater assures the Phillipsburg facility that it will benefit from optimum performance of its RO system while avoiding unnecessary maintenance and operating costs.

All aspects of securing an ample water supply to the Phillipsburg ethanol plant were carried out by a single source, Layne Christensen Co., including system design, permitting, filter manufacturing and system and pipeline installation. By contracting with a single company, the entire water supply and treatment system was completed in only eight months.

Layne is also in the final startup phase of an integrated membrane system, which treats municipal wastewater for reuse where ultrafiltration is being used as pretreatment to RO. MT

Brian S. Fraser is eastern region sales, membrane technology group, for Layne Christensen Co. Fraser can be reached at 413.253.7473 or by e-mail at bsfraser@laynechristensen.com.

For more information, write in 1105 on this issue's Reader Service Card.

LEARN MORE

For additional articles on this topic, visit:
www.wwdmag.com/lm.cfm/mt030805