LORAINE A. HUCHLER, CONTRIBUTING EDITOR

Huchler@martechsystems.com

Trouble with RO

Many refineries and chemical plants have replaced or supplemented sodium zeolite softeners with reverse osmosis (RO) membrane units to remove soluble contaminants from water used as boiler makeup. Benefits of RO systems include:

- Improved the boiler feedwater quality
- Eliminate using large volumes of acid and caustic as required by demineralizer systems
- Significantly reduce boiler blowdown flowrate
- Increased water, energy and chemical efficiencies.

However, these systems can fail because RO technology has different requirements for successful performance, especially for systems that purify surface water. Several key considerations for proper application of RO technology for boiler makeup water purification include:

RO design capacity. Calculation of the design capacity should include the efficiency of the RO unit at the lowest inlet water temperature and poorest inlet water quality. They should incorporate the degradation of efficiency as the membranes ages to avoid under-sizing the unit. A standard approximation for water temperature is a decrease of 1.5% of flow capacity per °C at a constant operating pressure. Over-sizing an RO system will result in intermittent operation that dramatically increases the risk of fouling by microbiological growth during idling, significantly reducing the system efficiency and increasing cleaning frequency. Continuous operation of RO systems is critical to ensure reliability and availablity.

■ Optimizing RO design and efficiencies balance lowest water quality and temperatures with anticipated degradation of unit, thus avoiding an undersized unit.

Permeate storage capacity. If there is no permeate storage tank, then the RO design capacity calculation must include the removal of one skid during routine cleaning at peak demand. The minimum size of a permeate storage tank should equal the volume of permeate produced by one skid for the duration of a routine cleaning. Designers typically size permeate storage tanks to accumulate several hours of makeup water volume to reduce the risk of curtailment or complete loss of steam production.

Inlet water pretreatment. RO manufacturers provide specifications for the inlet water quality, implying that designers must install sufficient inlet water pretreatment equipment to meet these specifications. Many pretreatment systems fail to continuously produce water that meets these specifications, especially with respect to the maximum silt density index (SDI) of treated surface water. RO operators often feed acid and anti-scalent chemicals and clean the membranes frequently to compensate for inadequate pretreatment systems. However, these practices are only partially effective and reduce membrane life.

Cleaning system equipment. The maximum cleaning interval is typically 12 months. However, RO systems that use surface water may require cleaning as frequently as every three weeks. Implementing the proper cleaning process is essential to maintaining optimal RO system reliability. Therefore, the cleaning skid should be a permanent installation with a variable speed recirculation pump and quick disconnect couplings on flexible cleaning hoses. RO operators should always clean one stage at a time to avoid moving foulants from membranes in one stage onto membranes in another stage.

Data management. Automated acquisition of temperature, flow and pressure data simplifies the monitoring process and speeds identification of non-conforming operating conditions. More importantly, the availability of trend data allows a determination of the optimal cleaning frequency and maximizes the reliability of the system.

Boiler blowdown equipment. Retrofit of RO into pretreatment systems that have sodium zeolite softeners increases the complexity of controlling boiler chemistry. Using RO for makeup will decrease the volume of blowdown flow by as much as 90% due to the higher purity of the feedwater. Accurately modulating blowdown with a valve designed for a much larger flow is very difficult, often resulting in poor control of boiler chemistry. Planned retrofit of smaller blowdown valves during turnarounds and outages is essential to optimize boiler efficiency.

Crises management. Membranes that are at the end of their service life may benefit from several short-term strategies to recover performance. Rotating each membrane 180° reverses the flow direction within the membrane and can flush out some foulants. This strategy is especially helpful if cleaning has been marginally effective; however, it rarely results in a long-term return for performance. Discarding the first element in a housing and installing a new element either in the first position or in the last position in the housing may recover performance for a longer period of time, especially if the fouling was irreversible and due to a short-term excursion.

Successful application of RO technology in refineries and petrochemical plants using surface water requires a thorough assessment of the system vulnerabilities and implementation of the appropriate design and operating procedures. **HP**

The author is president of MarTech Systems, Inc., an engineering consulting firm that provides technical services to optimize energy and water-related systems including steam, cooling and wastewater in refineries and petrochemical plants. She holds a BS degree in chemical engineering and is a licensed professional engineer. She can be reached at: huchler@martechsystems.com.