LORAINE A. HUCHLER, CONTRIBUTING EDITOR

Huchler@martechsystems.com

Update on water treatment for ethanol plants

Several refiners have recently purchased ethanol plants; here are some insights into the water treatment issues in these plants. The unit operation with the most stringent water requirement is the low-pressure boiler (~ 150 psig) that provides steam to the fermentation unit, distillation unit and/or the evaporators: permeate from a reverse osmosis (RO) unit is suitable. These plants also require cooling water and will have a cooling tower.

In most cases, ethanol plants are located near their feedstock source. In the US, over 95% of these plants use corn and are located in the central and northern Midwest. Most facilities use well water, although some plant owners may have a withdrawal permit from a nearby surface-water source. Finally, most ethanol plants are zero- discharge or have extremely stringent discharge volume and quality limits.

The central water treatment strategies in ethanol plants are: water reuse, wastewater minimization and conformance to discharge permit limits. Here are some common practices and design issues for ethanol facility wastewater processes.

> **■ Failure to identify and quantify needs of process and cooling water will have negative and very costly impacts on ethanol facility operations.**

Mismanagement of RO units. Process engineers often place RO units in series to minimize concentrate (wastewater) volume, but fail to properly specify the recovery rate. One possible explanation for this design error is the requirement for empirical data to accurately predict scaling risk. Designers should use data generated by field measurements of the raw water's LSI (Langelier scaling index) to specify the correct recovery rate. Consequently, the secondary RO unit often has higher-than-expected operating costs and performs poorly, with severe scaling, unexpectedly high feedrates of anti-scalant chemicals and premature replacement membrane replacement.

Difficult soluble contaminant removal. Precipitation of dissolved contaminants is the lowest-cost option; a cold lime softeners is also a good option. Lime and soda ash will precipitate the carbonate and non-carbonate hardness, but high concentrations of sulfates and chlorides remaining in the effluent can exceed the National Pollutant Discharge Elimination System (NPDES) permit limits. If the discharge permit requires silica removal, then cold-lime softening can remove a significant portion by adsorption. However, warm or hot-lime softening is required for more complete silica removal. An evaporator is an energy-intensive option to concentrate contaminants in a liquid waste stream and to reduce or eliminate wastewater volume.

Modulating impacts of dynamic operation. Treatment steps, including filter backwash, softener backwash and softener regeneration, are batch operations. Tanks receiving these waste streams must be large enough to avoid hydraulic disruptions to downstream units and allow blending with the other wastewater streams to modulate chemistry changes.

Poor water reuse decisions. Process designers should evaluate the optimal destination for each wastewater stream and characterize consequences on the ion balance for all operating conditions. For example, boiler and cooling tower blowdown streams are considered "clean" or low in contaminant concentration as compared to RO concentrate. Boiler blowdown is a small volume, but cooling tower blowdown volumes can be equal to 20% to 50% of the RO concentrate stream. Diversion of the dilute cooling tower blowdown to the cold-lime softener can increase the size and cost of the softener with little or no return on investment. Blowndown return has no impact on the softener's performance or effluent quality, especially during peak cooling season when the cooling tower blowdown volume is high. Constructing an ion mass balance will allow process designers to determine the optimal configuration and treatment of *ALL* wastewater streams.

Unintended consequences of discharge permit limits. Plant owners must work with their process designers to properly characterize effluent quality as part of the discharge permit application. Process designers can construct the ion balances and predict the effluent concentrations. But, sometimes, such mass balances overlook the impacts of water-treatment chemicals on the effluent quality. In one case, process designers neglected to anticipate the need for an oxidizing biocide in the cooling tower and greensand filter. The chloride concentration in the discharge permit was so low that the plant routinely violated the parameter despite using more expensive alternatives such as hydrogen peroxide and bromine.

Options to consider. Ethanol plants involve some unique challenges for water treatment, including water reuse, wastewater minimization and conformance to discharge permit limits. Process designers can avoid errors by understanding water treatment technology and gathering information from personnel at other plants regarding "lessons learned." **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.