Options for Industrial Water Reuse

By Jared Galligan

Every day in the U.S., more than 355 billion gallons of water are withdrawn from surface and groundwater sources to serve industry and the public, according to a 2010 report from the U.S. Geological Survey. As the strain on water sources steadily increases, it is critical for all water users to work toward water conservation.

The primary drivers towards water recycling and reuse practices are environmental compliance and water availability. Every five years, a facility that discharges to a public body of water must apply for and renew its National Pollutant Discharge Elimination System (NPDES) permit. During the renewal process, the local regulating authority may choose to impose tighter discharge restrictions on specific constituents. In states like Iowa, iron and sulfate are targeted, while in Minnesota and Wisconsin, phosphorus is under greater scrutiny. The ongoing permitting costs, costs to comply with new discharge restrictions, or the threat of not being granted a permit are driving more facilities toward minimal or Zero Liquid Discharge (ZLD) operations.

For those facilities that receive municipal water or discharge to a Publically Owned Treatment Works (POTW), water availability may become an issue. As infrastructure continues to age and the costs to replace approach the hundreds of billions of dollars, according to a 2012 *Washington Post* article, communities may not be able to supply facilities and may be forced to choose between supplying residents or supplying industry.

Cold Lime Softening Clarifier at a Western dry grind ethanol facility where a ZLD system was implemented. CLS is this decade's old technology that is making a comeback as it is common in ZLD systems.

Those plants that are still served may face double-digit increases in water or sewer costs to maintain their services. It is these costs that have companies looking at alternative water sources, installing their own intake systems (surface or well), or evaluating reuse options within the facility.

Water reuse and recycling projects can be one of the most difficult water treatment processes to design and implement. These treatment processes often require a combination of chemical and mechanical solutions to be successful. They must also be designed by someone familiar with water quality requirements, air and water permitting, and the nature of plant operational cycles.

While it is easiest to design a greenfield plant to operate with a water reuse, or ZLD system, any plant in operation today must look to retrofit existing equipment. Generally speaking, the simplest and

Graywater reuse solutions have used a combination of: filtration, microfiltration, ultrafiltration (shown above), and reverse osmosis.

lowest cost option is to install equipment at the front end (raw water intake) of the plant to minimize waste water generation at the back end of the plant (i.e., cooling tower blowdown).

Because there is no single design that works for all applications, it is important to find the best integrated solution for each individual plant. In order to create a successful water treatment system design for a plant, it is necessary to have a thorough understanding of the chemistry and equipment aspects and plant conditions, such as: plant design, operating conditions, available water quality and quantity, available personnel and training, capital and operating budgets, and environmental restrictions.

Most water reuse and ZLD systems use one or multiple of the following water treatment technologies, in order of capital costs: chemical feed systems, membrane filtration, reverse osmosis, evaporation ponds (if climate allowable), cold lime softening, and evaporation/crystallization. While evaporation/crystallization may seem like the simplest solution, its initial capital investment and ongoing energy costs greatly exceed all other technologies combined.

As groundwater sources become more limited, facilities old and new are looking at alternative water sources to supply their plant. One of the most common sources today is municipally treated waste water, called graywater. This low cost, or sometimes free, water source is abundant and does not strain local water sources. While at first attractive from a financial perspective, graywater carries many concerns in designing a water treatment system. The most common concerns in using graywater center around its variability from hour to hour and day to day, and its nutrient content.

Constituents like phosphorus and ammonia, which are common and abundant in graywater, can be costly to remove, and if left untreated can lead to scale formation on heat exchange surfaces, corrosion, and other biological-based concerns. The suspended solids content is usually much higher than most groundwater sources and requires its own method of treatment.

A Midwestern United States ethanol facility implemented a graywater reuse system that eliminated their need for freshwater. While first designed to operate on potable water completely, during construction the facility learned the municipality could not supply the quantity of water required by the ethanol producer. Forced to find another water source, the municipality offered to supplement their potable water with graywater to meet their demands. The alternative water source changed the facility's planned water treatment system to include microfiltration, a membrane-based filtration system excellent at removing suspended solids and other organics common to graywater, and additional reverse osmosis capacity. The plant has been operating successfully since system integration almost ten years ago. This facility was the first of its kind to use the technologies of microfiltration and reverse osmosis together for graywater reuse.

As water reuse and recycling projects continue to take center stage in a facility's long-term environmental plan, water-related projects will become even more common. Creative engineering and treatment technologies will continue to drive their advancement and further water conservation.

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