Water for the future - Water reclamation and reuse maximize freshwater resources

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During the last decade, water reclamation and reuse have increased in popularity as more communities and industries realize that water reuse is a reliable, economically feasible, and environmentally sensitive solution when faced with drought or water resource issues. Water reclamation and reuse effectively conserve our limited, high-quality freshwater supplies by using treated wastewater effluent for non-potable uses such as irrigating parks and golf courses, and washing vehicles. The result: Communities are protecting our limited freshwater supplies for future generations.

Today, highly treated wastewater is valued as an important resource. Per capita, an additional 120,000 people could have drinking water if just one municipality or industrial site treated and reused 12 million gallons of wastewater each day. Reclaimed water is used to recharge local aquifers and to prevent seawater intrusion. Industrial facilities purchase reclaimed water for use in cooling towers, boiler feed, and manufacturing processes.

The United States produces the most reclaimed water in the world, averaging more than 2.6 billion gallons daily. "New" water is not easily created, but some communities are doing just that by using high-tech water treatment systems that make it possible to successfully and safely reuse water. Many water reuse projects are located in Arizona, California, Colorado, Florida, Nevada, New Mexico, and Texas. However, even areas that appear to be water rich, including the Carolinas, Georgia, Virginia, Washington, and the Northeast, are adopting water reuse programs.

Research and guidelines

There is a growing inventory of water reuse projects in the United States. Practicability is evaluated in research projects sponsored by the Water Environment Research Foundation (WERF), the American Water Works Association Research Foundation (AWWARF), and the WateReuse Foundation.

Dozens of research experts contributed to the U.S. Environmental Protection Agency's (EPA) Guidelines for Water Reuse document. This document, which summarizes industry demonstration projects, research, and development, includes the following:

- types of reuse applications;
- technical issues in planning;
- state reuse regulations and guidelines; and
- public involvement programs.

Available on the EPA website (www.epa.gov), the guidelines also address various market-advancing treatment technologies used in water reuse applications.

Proven technologies

There are a number of proven technologies for water reuse applications to satisfy the needs facing municipal plants today. These include media filtration, carbon adsorption, deionization, ion exchange, microfiltration, ultrafiltration, reverse osmosis (RO), and disinfection. The use of multiple treatment processes, also referred to as the multiple-barrier approach, is most effective for removing pathogens. In this article, we will discuss two filtration processes - membrane filtration and membrane bioreactors.

Membrane filtration - Membrane filtration is a proven, costeffective treatment option for a wide variety of feed streams, including municipal wastewater reuse. Both membrane filtration and traditional treatment systems remove suspended solids, although the removal methods differ. Membrane filtration units remove solids at their surface to form a filter cake, irrespective of the type of solids. Traditional processes (media filtration and clarification) rely on attractive forces, chemical addition, and gravitational settling to achieve solids removal. One effective use of membrane filtration for reuse applications is the combination of membrane filtration and RO. By using membrane filtration as pretreatment to RO, facilities can achieve a very stable, consistent quality effluent for reuse.

RO is used to achieve the purity required for industrial and other non-potable uses. RO membranes are well suited for removing dissolved solids but are adversely affected by suspended solids, colloidal matter, organics, and bacteria. Membrane fouling from these constituents is a major reason for RO system failure. Membrane replacement comprises approximately 25 percent of an RO system's annual operating cost. For this reason, appropriate pretreatment is critical to the RO system's long-term, stable performance.

Membrane filtration as pretreatment can significantly reduce RO membrane fouling and provide a stable, predictable performance that other conventional pretreatment technologies cannot match. Additionally, when membrane filtration is used to treat the RO feedwater, the RO membranes require less frequent cleanings, for example, quarterly cleanings instead of weekly. Municipal wastewater is treated by membranes for a variety of uses, including industrial process water, irrigation, and deep-well injection for coastal communities or other areas where groundwater requires replenishment.

Membrane bioreactors - An emerging technology in the municipal reuse market, the membrane bioreactor (MBR) system, uses a combination of an aerobic biological process and an integrated, immersed membrane filtration system that meets the most stringent state reuse standards. The system captures minute particles, bacteria, and viruses as water passes through the membranes. Solids from the biological process are removed and returned to the sewer system where they continue on to the main wastewater treatment plant for further treatment. The biological process and membrane operating systems are located in separate tanks to optimize performance of the overall process and to simplify operation and maintenance. This form of filtration also eliminates the need for clarifiers and other peripheral equipment, and for process control and maintenance normally associated with a conventional clarification process. This reduces the overall footprint by more than 50 percent compared with a conventional biological process. Replacing clarifiers with microfilters allows the biological process to be designed and operated as a high-rate wastewater treatment process. The system can provide advanced nitrogen and phosphorus removal to meet the most stringent effluent requirements.

Advancements in membrane filtration have fostered a new generation of compact MBR systems. These systems offer costeffective water and wastewater treatment solutions to small communities, municipalities, developers, and industrial clients that require high-quality treatment with a small footprint, minimal installation costs, and reliable performance.

MBR systems also can be designed for use in remote or satellite locations. A current trend in communities and municipalities, satellite treatment allows wastewater to be treated remotely, eliminating the need to expand old, centralized wastewater systems in an urban location where it can be disruptive and costly. Treatment involves taking raw sewage and treating it locally through a miniature version of a wastewater treatment plant. Installing a number of separate, satellite systems instead of a single reuse facility eliminates the possibility that a plant failure will disrupt delivery of reclaimed water to all customers. It also eliminates the redundancy inherent in a large-scale wastewater treatment plant located at the end of the line. If the satellite plant should shut down, there will be no environmental impact because the untreated water can simply be left in the collection system to continue its journey to the main treatment plant downstream. In addition, the satellite plant takes the load off the main treatment facility, delaying costly expansions or permitting. Moreover, state environmental regulators view systems that recycle water as a good way to keep wastes out of streams and rivers. MBR systems are highly suited for satellite treatment. Their small footprint allows them to be sited easily, and they provide a high-quality effluent and reliable operation with minimal operator intervention.

Satellite treatment system: Olympia, Wash

One municipality that has already taken advantage of the benefits of satellite treatment is Olympia, Wash., where the Hawks Prairie Reclaimed Water Satellite Plant reclaims wastewater from four communities. This is expected to save 78,000 customers hundreds of millions of gallons of drinking water annually. The Hawks Prairie satellite plant is the first of three, planned reclaimed water satellites that are part of the community's 20-year wastewater resource management plan.

The Hawks Prairie location was chosen first because it offers several potential uses of the reclaimed water for irrigation, and commercial and institutional purposes. A portion of the treated wastewater filters through the ground to replenish groundwater supplies.

As part of the plan, each satellite plant will intercept existing regional sewer lines and extract municipal wastewater for local use. At the Hawks Prairie site, the clean water will travel three miles through a pipeline from the plant to wetland ponds and an 8-acre groundwater recharge site. Along the way, some of the water will be drawn off for irrigation or other beneficial uses.

MBR technology was chosen for its reliability in producing quality reuse water and its ability to be integrated into remote sites. Currently, the plant treats 2 million gallons per day (MGD) of wastewater, and over time, the plant will be expandable to 5 MGD. The reclaimed water meets Washington State "Class A" reclaimed water standards, which is the highest quality of water as defined by the Washington State Departments of Health and Ecology.

Sustainability case study: Scottsdale, Ariz

Located in the middle of the Arizona desert, Scottsdale, Ariz., had been planning for the possibility of drought for many years. When a drought occurred, along with the increasing cost of wastewater disposal, the city decided to implement a water reuse program. To treat its reclaimed water, the Scottsdale Water Campus facility uses membrane technology as pretreatment to RO. This solution produces high-quality processed water suitable for landscape irrigation and groundwater recharge.

The Water Campus contains a 50-MGD water treatment plant, a 12-MGD water reclamation plant, and an advanced water treatment (AWT) facility. The AWT consists of membrane filtration, RO, and recharge systems. Reclaimed effluent not used for irrigation is treated by membrane filtration and RO, and then recharged. Colorado River water treated by membrane filtration alone is also recharged.
The membrane filtration system consists of polypropylene hollow fibers (0.2 micron pore size) installed in nylon housings, manifolded together into 90, skid-mounted module assemblies. Raw water is pumped through the membranes, removing pathogens and turbidity. During backwash, high-pressure air is used to blow solids off the membranes, while raw water simultaneously flows along the outside of the fibers. The high-energy backwash efficiently removes solids, resulting in long filter runs before chemical cleaning is required. The membrane filtration system is arranged in three trains of eight units. Two trains treat effluent

that has been tertiary filtered and nitrified/denitrified. The effluent is chlorinated upstream of the tertiary filters for algae control. Additionally, ammonia is added upstream of the systems to ensure a combined residual. The third train treats Colorado River water. System valves ensure that any train can treat any feedwater. The RO system is arranged in 10 trains, each designed for a feed flow of 1 MGD at 85 percent recovery. Hardness and alkalinity is treated by adding sulfuric acid and anti-sealant to the RO feed.

Since its implementation, Scottsdale's reuse program has saved 25 billion gallons of potable water. The Scottsdale Water Campus is recognized as one of the largest municipal facilities in the world that treats raw wastewater to potable quality for aquifer recharge. It does so by injecting highly treated reclaimed water directly into an underground aquifer via wells. Recharging excess effluent allows the city to water bank, or store, accumulated withdrawal credits until needed during peak periods. This reduces the city's demand on water from the Colorado River, as well as its water treatment requirements.

Scottsdale currently draws more than 65 percent of its drinking water from the Colorado River and pumps another 30 percent from city wells. The rest of the city's drinking water comes from other surface water sources. According to the city, its goal is to replace any pumped groundwater with groundwater recharge. Groundwater supplies are the ultimate drought protection. The city will only use them if surface water supplies are unavailable.

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