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## Small Communities

### Membrane Systems

*Tzahi Y. Cath*

Developed countries are not immune to water and wastewater problems. Water scarcity can result from unprecedented population growth, lifestyle changes, water pollution, climate change, and a shift in energy sources and demand. In cities, we witness growing need for investment in the improvement and expansion of water and wastewater infrastructure. We measure new contaminants in water sources, especially in reclaimed waters. Large metropolitan areas struggle to secure future water supply, while states battle over current water resources.

To meet increased demand, some water authorities are developing infrastructure to deliver reclaimed water to large customers, such as city properties, business parks, cooling towers, and golf courses. These customers' use of reclaimed water reduces demand on valuable potable surface water and groundwater. For example, Denver is in the process of building a water-recycling system (treatment facility and distribution system) that, when completed in 2013, will be able to deliver more than 21.5 million m<sup>3</sup> (17,440 ac-ft) of water per year.

Many small communities are also susceptible to water shortages, because they rely on local water supplies. Using reclaimed water can help communities increase supply and save money. For example, by employing multiple treatment systems in a distributed mode, thus eliminating the need to carry wastewater to a centralized treatment facility and return reclaimed water from a reclamation facility, communities can save significantly on infrastructure development. Other benefits include energy savings and potable water conservation.

Yet, better methods are needed for treating and reclaiming waste streams. Moreover, as water conservation in contaminants and the pollutant levels, wastewaters are becoming more concentrated in containers and homes. Residuals and brines from point-of-entry and point-of-use water treatment systems — for example, adsorption media, ion exchange, and reverse osmosis (RO) — can further impact the quality of wastewater streams and make it more difficult to treat them to meet reuse criteria. This may require adjustment of existing processes and introduction of advanced wastewater treatment systems.

As their costs decrease and their potential multiple benefits are considered, membrane processes are becoming a preferred solution for treating both water and wastewater. Implementing various membrane processes in small communities can substantially improve both the quantity and quality of local water supplies. RO membranes can remove a broad range of contaminants from water, including microorganisms, organic and inorganic compounds, and pesticides and herbicides. Newer pressure-driven membrane processes, such as nanofiltration (NF), can remove many of these same contaminants with greater productivity, lower pressure, smaller reject stream, and lower energy demand.

Recent advancements in membrane technology facilitated the incorporation of membranes in biological processes. One successful example is the membrane bioreactor (MBR). MBRs use ultrafiltration membranes that typically have a pore diameter in the range of 0.01 to 0.10 μm, smaller than most bacteria and within the size range of viruses. MBRs combine biological oxidation of many organic and inorganic compounds with efficient filtration of suspended solids, macromolecules, and most micro-organisms.

As with membrane systems for water treatment, relatively simple automation and operation of MBRs make them an attractive solution for wastewater treatment in small communities. The high-quality and partially disinfected effluent can be used onsite for beneficial purposes, such as irrigation. Use for toilet flushing will be dependent upon individual state requirements.

The Advanced Water Technology Center (AQWATEC; [www.aqwatec.com](http://www.aqwatec.com)) of the Colorado School of Mines (Golden) is investigating new hybrid systems that combine sequencing batch reactors (SBRs) and MBRs. One such hybrid system treats most of the wastewater generated at Mines Park, the school's student housing complex of several hundred apartments.

An MBR system or a hybrid SBR–MBR system can be installed in a small building in harsh climates and can be built and delivered to a small community as a packaged system that can be connected easily to an existing system. Research indicates that solids handling may be minimized and easier to manage by increasing solids retention time significantly, while maintaining effluent quality. Further combinations of MBR systems with RO or NF processes can produce higher-quality water that may be used for additional direct or indirect reuse purposes, which is important because different reuse options require different qualities of water.

On the water treatment side, small or isolated communities can take advantage of membranes to improve water quality significantly. For example, many groundwater resources in the western United States contain radionuclides. Many small western U.S. communities depend on this groundwater for domestic and agricultural uses and for their livestock. AQWATEC recently tested various technologies and found that NF membranes can effectively remove radionuclides from water with a high rate of water recovery and relatively low energy demand. An added benefit is that they also soften the water.

As the future unfolds for decentralized (and in some cases, onsite) water and wastewater treatment systems, membrane processes will become a more attractive option. More robust and reliable membrane systems should provide high-quality drinking water and the potential

of reusing the majority of reclaimed wastewater generated either at or close to the source.

**Tzahi Y. Cath** is an assistant professor of environmental science and engineering at the Colorado School of Mines (Golden) and associate director of the school's Advanced Water Technology Center.

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