world water

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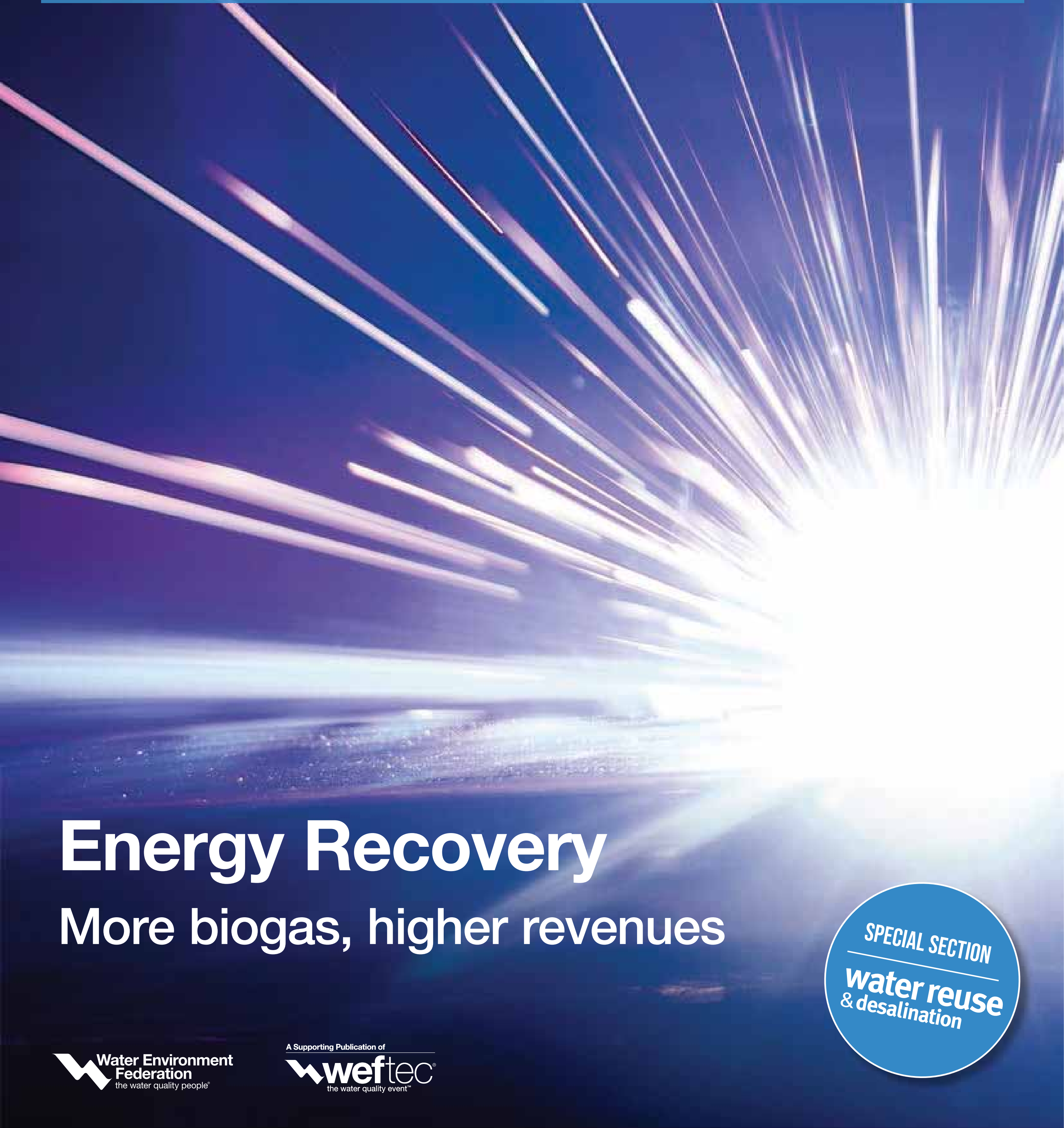

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Advancing use of membranes in industrial water reuse

Improvements in membrane technology are expanding their applications in treating difficult industrial wastewater for reuse. **Anna Jawor** explains how the PolyCera Titan membrane – with the material advantages of both ceramic and polymer – is changing expectations.

In recent years, water reuse has become an increasingly important part of water resource management programs around the world. From 2009–2017, the global contracted water reuse capacity nearly doubled. According to a report in the *2018-2019 IDA Water Security Handbook*, cumulative contracted water reuse capacity reached 118 million cubic meters per day (m^3/d) in 2017, up from 59.7.7 million m^3/d in 2009. Industrial users represent a growing part of this market, as industrial water demand becomes a key driver of the wastewater reuse market amid growing stress on existing water resources and increasing regulatory requirements.

Globally, an estimated 80 percent of industrial wastewater is discharged into the environment untreated, contaminating the world's finite water resources. One of the reasons is that industrial wastewaters contain oils, solids, and other pollutants that can make treatment – and reuse – challenging and costly.

At present, membrane technology dominates water treatment technology in all other sectors. For example, membrane technologies such as microfiltration (MF), ultrafiltration (UF), and reverse osmosis (RO) have been used successfully for treatment of municipal wastewater effluent for indirect potable reuse for nearly three decades. However, the use of membrane technologies for treatment of industrial wastewaters and reuse of industrial effluent has lagged far behind. Membrane technology is used to treat only an estimated 2 percent of these waters.

UF and MF membrane technology generally can offer effective removal of particles and dispersed and emulsified oil, offering a small footprint, low weight and low energy requirements, and high throughput rates – but a large part of membrane technology has not ideally been suited to more challenging wastewater applications.

One of the challenges has been that the choice of membranes was traditionally an either-or decision between polymeric or ceramic membranes. Polymeric membranes are widely used in a variety of applications, and they are less costly than ceramics, but they lack the robustness needed to treat challenging and often highly variable industrial wastewaters. For example, they are susceptible to fouling, which decreases throughput, increases cleaning frequency, decreases membrane life, and ultimately increases operating expenditures.

On the other hand, ceramic membranes are engineered to handle difficult wastewaters. They are highly durable and widely available, but their high capital and operating costs limit their applicability.

Fortunately, advancements in membrane technology have overcome barriers that precluded its widespread adoption by industrial users. For example, PolyCera, Inc. has developed and successfully commercialized organic metal membranes that are being used for an array of treatment requirements in a wide range of projects. These hydrophilic and oleophobic microfiltration, ultrafiltration and nanofiltration membranes offer robust performance comparable with ceramic membranes but at a price comparable with that of polymeric membranes. Now being used in more than 100 installations on six continents, they are becoming widely embraced. Available in a highly differentiated portfolio to address specific needs, they are known for their reliability and effectiveness in handling difficult waters for a variety of industries and applications from upstream oil and gas (including produced water treatment for reuse) to refineries, power generation, mining, automotive, chemicals, textiles, oily wastewater treatment, and anaerobic digestate.

Following are some examples of how these membranes are being used.

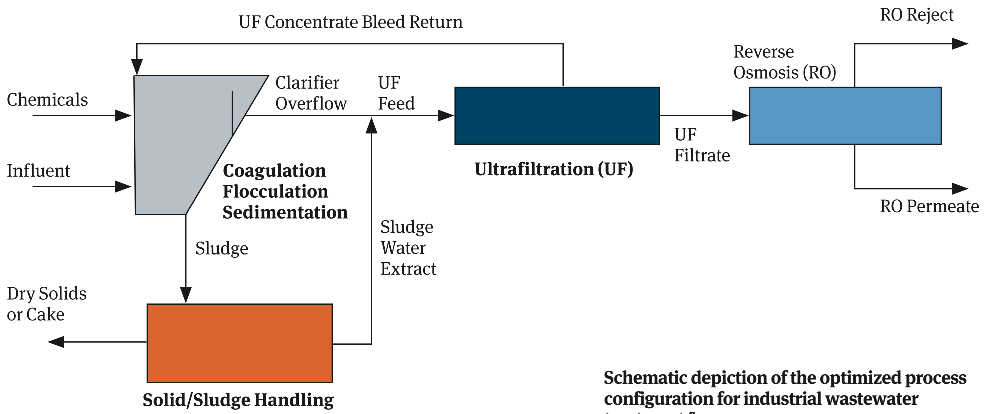
Treating produced water for reuse

PolyCera Titan UF membranes have been a key part of a produced water treatment system at a facility located in the state of California, United States (US), that took produced water from nearby oilfields, treated it to a high quality for reuse, and then sold it back to oil producers as well as other industrial users to recycle it in their plants. Because this facility received produced water from many sources, it needed a technology that could effectively handle numerous disturbances in water quality while maintaining performance and producing a consistent water quality after treatment. Operating at 795,000 liters (210,000 gallons) per day – which translated into hundreds of millions liters of water over 180 days – the plant provided a rigorous and successful proving ground for this membrane technology.

Tertiary filtration for reuse of biologically treated wastewater

PolyCera Hydro UF membranes have been in use for over two years by an operator of mobile wastewater treatment systems for use in such industries as oil field, construction, and emergency management. The membranes are used as a tertiary filtration step in wastewater processing to recycle water with the highest quality standard for reuse in human contact, delivering the stability, robustness, and performance of

Figure 1



Schematic depiction of the optimized process configuration for industrial wastewater treatment for reuse.

Part of an industrial wastewater treatment system for reuse using PolyCera membranes. Photo by PolyCera

ceramic membranes at a lower cost. Using PolyCera in more than 60 of its mobile wastewater treatment systems, the company has recycled more than 189 million liters (50 million gallons) of water, representing almost 1 million truck miles taken off the road.

Treatment of blowdown water for reuse

Blowdown water from power plant cooling towers can present very challenging geochemistry, with super-saturated concentrations of minerals that must be removed before reapplying the water for cooling. A pilot-scale evaluation system for a power plant (Figure 1), consisting of chemical softening followed by PolyCera Hydro UF, was implemented to prove the ability to treat waters with varying qualities and make the filtrate suitable for reuse. The pilot test proved the ability of PolyCera Hydro UF membranes to remove precipitated silica, hardness, and other suspended solids, thus, providing a very high quality, consistent feed to the high-recovery RO unit targeting total dissolved solids removal.

Throughout the evaluation period, the system consistently produced a high quality of filtrate with average turbidity and scaling ions removal efficiencies of 96.4 percent and 82 percent, respectively. All of the key performance indicators were met or exceeded during the evaluation with an attractive return on investment for the owner allowing discussions to commence on scale-up and plant expansion.

Food and beverage process separation

In February 2019, PolyCera's Hydro MF/UF line of membranes received approval from the US Food and Drug Administration (FDA) for use in food processing applications. These applications include dairy processing, fat and casein removal, whey concentration, and lactose isolation. They have also been certified to NSF/ANSI 61, which covers all products with drinking water contact from source to tap. These approvals open up significant opportunities in the food and beverage process separations as well as drinking water purification, offering more robust and durable membranes for such applications.

The impact of drivers ranging from water scarcity to increasingly stringent environmental regulations portends continued growth in industrial wastewater treatment and reuse. PolyCera's advancements in organic metal membrane technology overcome traditional barriers to use of membranes in industrial applications; hence, there is a new, low-cost option to apply membranes to recover difficult to treat industrial effluents and challenging process separations.

Author's Note

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