



Industrial Water Treatment

Drivers

- Reduce energy consumption in water treatment and desalination
- Provide clean water sources for industrial processes
- Recover energy from water production from gas and oil power processes
- Expand and realize water reuse opportunities

The security of water quality and supply is rapidly becoming a global issue. RTI International is developing innovative technologies to lower the cost and energy required for water treatment for such applications as desalination, oil and gas production, and biomass conversion. We can bring together multidisciplinary teams of chemists, engineers, environmental scientists, economists, and social scientists to work in this emerging area.

Integrated Forward Osmosis and Membrane Distillation

One new hybrid system synergistically combines a forward osmosis (FO) system with membrane distillation (MD) technology using minimal energy and waste heat to provide water quality comparable to reverse osmosis. Minimally treated wastewater is sent to the FO system containing a salt-draw solution on the membrane's permeate side. The resulting permeated water is then passed through the MD system, where the low-grade heat drives water vapor across the MD membrane for collection by condensation. The remaining solution, containing salt and other nonvolatile solutes, is sent back to the FO system as draw solution. This technology is particularly suitable for high-salinity water streams that otherwise could only be treated with evaporators.

Solvent-Based Desalination

The use of non-aqueous solvents is a promising approach to recover water from brine found in deep aquifers. This novel approach is expected to significantly lower the cost of treatment of water with high levels of total dissolved solids (TDS), especially on a large scale. Non-aqueous solvents can also be applied to treatment of concentrated brines generated from CO₂ subsurface storage, unconventional fossil fuel extraction, treatment of high-TDS mining process waters, wastewater volume reduction, and dewatering.

Electrically Conductive Membranes Addressing Biofouling

Produced waters generated from fossil fuel extraction have high levels of TDS. Electrically conductive membrane distillation (ECMD) is a cost-effective water treatment process for concentrated brines. Benefits of fouling-resistant membranes for water reuse could be applied to industrial operations, agricultural operations, and municipal water uses. Through bench-scale testing, our engineers and scientists have the following goals to validate the advantages of this low-cost, novel water treatment process: reusing at least 50% of treated effluent for produced water at 180,000 mg/L, 80% reducing water treatment costs by 80% compared to deep well injection costs, and reducing water treatment/disposal costs by 35–90%.



Carbon Nanotubes

RTI's anti-fouling membrane technology platform is based on incorporating carbon nanotubes (CNTs) into the surface layer of existing, commercially available MD membranes. The CNTs confer electrical conductivity to the membrane surface so that an electrical potential can be applied to remove and prevent membrane scaling and fouling, thereby reducing the need for external chemicals/cleaning. This work builds off ongoing efforts within RTI's Energy Technology Division to develop innovative energy-saving solutions for water treatment and reuse.

For more information,
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Mobile Water Treatment Lab

RTI has constructed and tested a pilot-scale, integrated FO/MD prototype system with a nominal water production capacity of 500 gallons per day for the treatment of brine concentrate derived from the RO treatment of raw, oil-field produced water. Because of the concentrations of organics, oil, and grease in the RO brine, no further water recovery could be done on this wastewater by conventional treatment technologies. The prototype unit had six commercial-sized FO membrane modules and three commercial-sized MD membrane modules that were tested at different process operating conditions. Aqueous FO draw solutions of NaCl and $MgCl_2$, provided by Veolia Water Technologies, were tested to compare the reverse draw-salt fluxes of these salts in the pilot-scale FO membrane modules. The draw-salt concentration was increased to as high as 4.5 M to ensure adequate osmotic-pressure driving force in the FO process section of the prototype.

Real produced-water RO brine having roughly 14,000 ppm TDS was shipped from an oil production site to RTI's campus for pilot testing. The FO/MD prototype was used to first pre-concentrate this brine to higher TDS levels in the range of 30,000 ppm up to 180,000 ppm. The prototype was then operated for several days to weeks with the resulting pre-concentrated, higher-TDS brine as feed to determine system performance as well as the maximum water recovery achievable and the maximum TDS level to which the FO/MD system could concentrate the industrial oil-field-generated brine. The hybrid FO/MD process was found to be particularly suited to treat waters having high TDS content (i.e., 50,000-200,000 ppm) that state-of-the-art RO systems cannot handle and waters with high oil and grease concentrations that cannot be treated by thermal processes.

RTI's mobile water treatment system is available to be deployed to various test sites.

RTI International is an independent, nonprofit research institute dedicated to improving the human condition. Clients rely on us to answer questions that demand an objective and multidisciplinary approach—one that integrates expertise across the social and laboratory sciences, engineering, and international development. We believe in the promise of science, and we are inspired every day to deliver on that promise for the good of people, communities, and businesses around the world. For more information, visit www.rti.org.

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RTI 10802R1 1118

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