
# 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 are rapidly becoming global issues that RTI International is working to address. RTI is developing novel technologies to lower the cost and energy required for water treatment, covering such application areas as desalination, oil & 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

This 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 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 total dissolved solids (TDS). Electrically conductive membrane distillation (ECMD) as a novel, 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: minimum 50% reuse of treated effluent for produced water at 180,000 mg/L, 80% reduction in water management costs compared to deep well injection costs, and reduce cost associated with water treatment/disposal of 35% to > 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 novel, energy-saving solutions for water treatment and reuse.

## 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 up 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 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. From the prototype operational data collected, 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 cannot handle and waters with high oil and grease concentrations that cannot be treated by thermal processes.

The mobile water treatment system is available to be deployed to various test sites.



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