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Forward Osmosis Water Purification

Improvements to FO membranes and process can significantly reduce capital and energy costs for membrane separation plants

What Is The Problem?

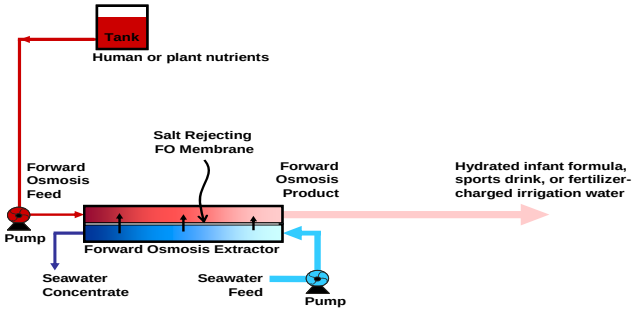
Commercial desalination technologies used to desalinate seawater and inland brackish waters -- including electrodialysis, reverse osmosis (RO), multistage flash distillation (MSF), and vapor compression -- can be cost-prohibitive due to high capital and energy costs.

Desalinization using forward (direct) osmosis (FO) has the potential to significantly reduce both capital and energy costs.

What Is The Solution?

Traditional RO uses high-pressure pumps to force seawater (or other contaminated water) thru a semi-permeable membrane. The membrane allows only pure water to pass thru as the salt and other contaminants are held back by the membrane.

FO employs a membrane similar to RO, but the saltwater is not pressurized to force it through the membrane. If two solutions are placed on either side of a semi-permeable membrane, water will move toward the side with the higher concentration of solutes. Thus, if a concentrated solution of water and fertilizer (the "driving solution") is placed opposite a volume of seawater (the "source water") the natural force of osmosis will pull pure water out of the seawater and thru the membrane, resulting in a larger volume of fertilizer-charged irrigation water ("the FO product"). Similarly, baby formula powder or liquid concentrate can extract fresh water from a contaminated source water, producing a large diluted volume of liquid baby formula. In FO, selecting the proper driving solute determines the end use of the

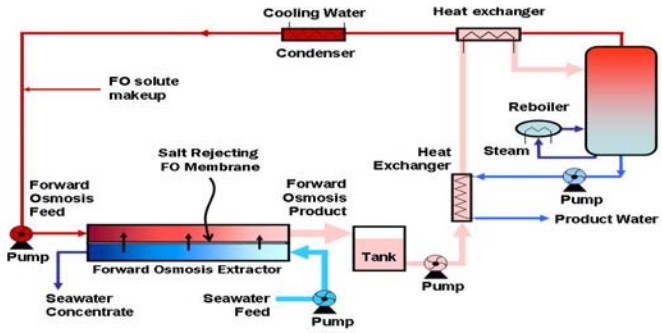


FO product and the salinity of the source water determines its maximum dilution .

FO production of drinks and fertilizer-charged irrigation water

Advantages of using FO compared to pressure-driven membrane processes like RO include:
1) operates at low pressures that translates to less energy used, 2) can reject a wide range of contaminants, and 3) may lower membrane fouling propensity.

FO's primary energy consumption occurs if the feed water must ultimately be separated from the FO product. For example, to produce drinkable water from saltwater, a concentrated driving solution is formulated using water and a chemical that can be efficiently extracted from the resulting FO product, thus leaving just water. Reclamation has developed a 2-stage process that removes and recycles the driving solution back to the FO extractor producing potable water that is free of salt and the driving solute. Reclamation is working with Separations Systems Technologies (SST) to improve the performance of FO membranes and develop low cost pumps and piping that may have significant capital and energy cost advantages over RO.



2-stage FO process for production of potable water from saltwater

Who Can Benefit?

Efficient membranes and an engineered 2-stage FO process offer the potential for low-cost seawater desalination. As desalination plants become more affordable, FO may be a new alternative to the drinking-water shortages in many areas.

Future Development Plans

The next steps consist of developing improved FO membranes and integrating and pilot testing the 2-stage FO process at Reclamation's Water Quality Improvement Center (WQIC) in Yuma, AZ.

Reclamation is currently seeking a qualified industry partner to cooperate in further testing and commercialization. Interested parties should contact Reclamation to learn about required qualifications and explore partnership opportunities.

More Information

Information on Reclamation's Desalination and Water Purification Research Program, including the WQIC, is available at http://www.usbr.gov/pmts/water/research/DWPR/index.html

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