RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Research Update

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Bottom Line

This research project reviewed the current state of forward osmosis membranes, draw solutions, and potential forward osmosis applications. It also identified niches where forward osmosis has the greatest potential to improve water recovery for beneficial uses.

Better, Faster, Cheaper

Although forward osmosis does not directly produce potable water, in select cases, waste minimization and improved treatment may be possible. Applied properly, forward osmosis can be a low energy component of a larger treatment process.

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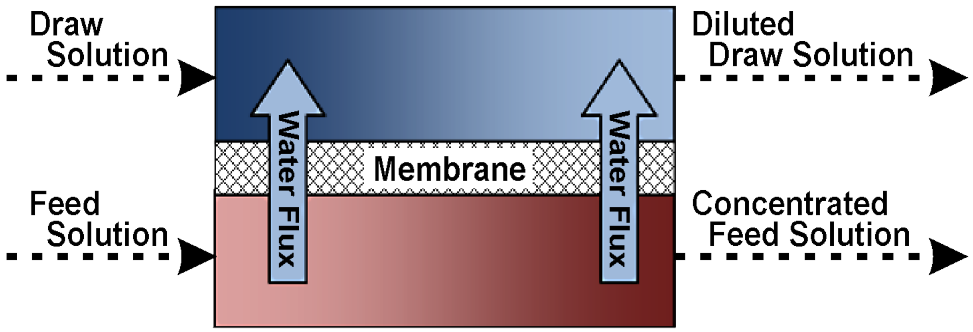
Can Reclamation Benefit From Forward Osmosis?

Evaluating potential applications for forward osmosis

Problem

Forward osmosis has generated a lot of interest lately in the water treatment industry. These processes have seen rapid technological advances in recent years, with an aggressive pursuit of potential applications. Understanding where forward osmosis can be applied in a cost-effective, environmentally sound manner may help meet Reclamation's mission.

Forward osmosis uses two sources of water: a draw solution that has higher concentrations of solutes and feed solution, which could be a local source of brackish water, wastewater effluent, or other industrial stream. Forward osmosis may be a low energy separation method with a range of potential applications, depending on how the draw solution is recycled or used. In forward osmosis, two water sources are separated by a membrane, and water permeates across the membrane from the lower concentration feed solution to the higher concentration draw solution. Questions include how much water can be extracted from impaired water sources for beneficial uses and how forward osmosis can enhance existing treatment processes.



Forward osmosis process.

Solution

This Reclamation Science and Technology Program research project examined current literature to answer:

What configurations and applications of forward osmosis have the greatest potential to compete with other water treatment technologies for solving Reclamation's water supply challenges?

Application and Results

Researchers concluded that forward osmosis is *most* viable when used:

- **To dilute a high salinity feed stream with a low salinity waste stream.** Using forward osmosis, water can be recovered from wastewater discharges by diluting a feed stream to a desalination process, which reduces the energy requirements of desalination and adds an additional microbial barrier (with the forward osmosis membrane).

- **To recover water from wastewaters prone to fouling (i.e., clogging) membranes.** Although more membranes would be required, forward osmosis processes are less susceptible to membrane fouling, which reduces the cleaning frequency.

- **To recover water from highly saline solutions when other treatment methods are not practical.** When pressure driven membrane processes (e.g., reverse osmosis) are not suitable to recover water from saline wastes, forward osmosis can further concentrate waste streams and reduce disposal costs.

Researchers concluded that forward osmosis is *not* viable when used:

- **For fertigation applications.** Fertigation uses a brackish groundwater as the feed solution and concentrated fertilizer solution as the draw solution. This approach is not viable, because another desalination method is needed to supply 85 to 97 percent of the water needed for typical agricultural applications.

- **To pretreat water for conventional desalination processes (e.g., reverse osmosis).** Due to the large membrane area requirements needed to meet water production needs, forward osmosis is better suited for process streams where lower fluxes are practical.

- **To produce potable water in emergencies.** Commercially available products use a sugar-electrolyte mix as a draw solution to treat impaired or saline waters. The resulting product, a high sugar beverage, should be supplemented by other means of producing potable water.

Future Plans

Hybrid processes combining forward osmosis with other commercially developed water treatment processes to improve water recovery is a promising area that warrants further investigation.

"There has been extensive research conducted on forward osmosis touting the minimization of fouling and low energy requirements of the process—yet there is seldom such a thing as a free lunch. Where forward osmosis is most applicable must be scrutinized and tested, and this literature survey will help guide research areas that Reclamation believes are best suited for this technology."

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More Information

www.usbr.gov/research/projects/detail.cfm?id=7911

For printable version see: www.usbr.gov/research/docs/updates/2016-25-forward-osmosis.pdf