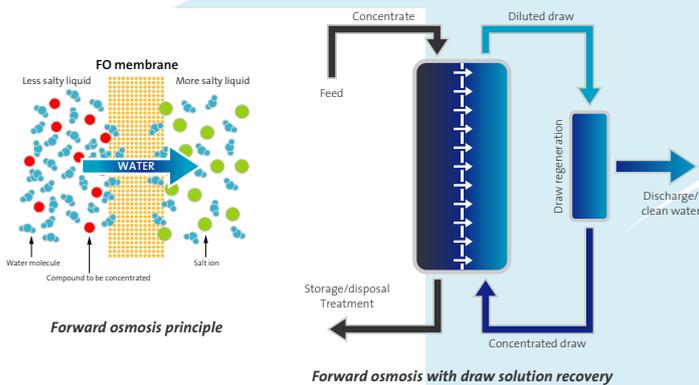


Early Adapter Project: Forward Osmosis

Concentration of liquids and recovery of clean water and/or raw materials

PROJECT DESCRIPTION

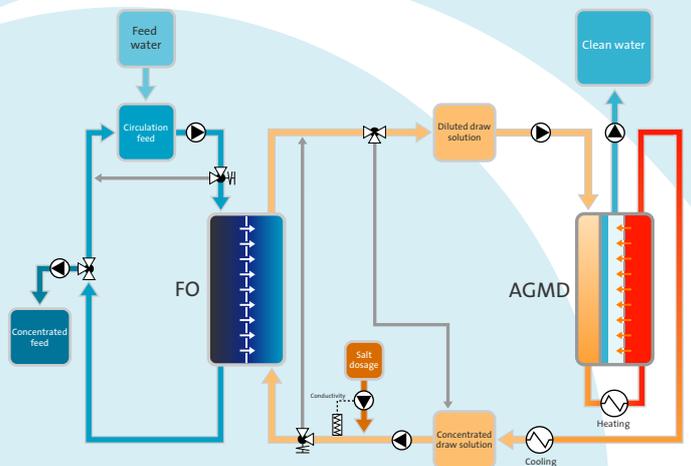
The project is focused on developing the commercial use of forward osmosis to concentrate highly fouling streams. Forward osmosis differs from traditional membrane filtration technology in its resistance to fouling and it doesn't use any mechanical pressure or heat for the separation. This opens concentration possibilities where classical technologies fail, such as reverse osmosis or evaporation.



BACKGROUNDS FORWARD OSMOSIS

Forward Osmosis (FO) is based on the principle that water permeates from a liquid with low osmotic pressure to a liquid with high osmotic pressure, separated by a semi permeable membrane. This process doesn't require energy or pressure. FO is a low fouling separation process. FO membranes rejects organics, minerals and other solids, similar to RO, but doesn't have the typical fouling problems.

The high osmotic solution is called draw solution. During the FO process the draw solution gets diluted by the extracted water from the feed. Further treatment is needed in order to recover the draw solution. In this project Reverse Osmosis and Membrane Distillation are applied for this.



Forward Osmosis with Air Gap Membrane Distillation flow diagram

FO-RO AND FO-MD PILOT PLANT

BLUE-tec has constructed a pilot plant testing the feasibility of forward osmosis for these different applications, after which the results will be evaluated for use in scale-up calculations.

The pilot plant has a 1 to 7 m² FO membrane. For the recovery of the draw solution reverse osmosis (osmotic pressure till 60 bar) and membrane distillation (osmotic pressure till 200 bar) are used.



FO-MD pilot unit

RESULTS

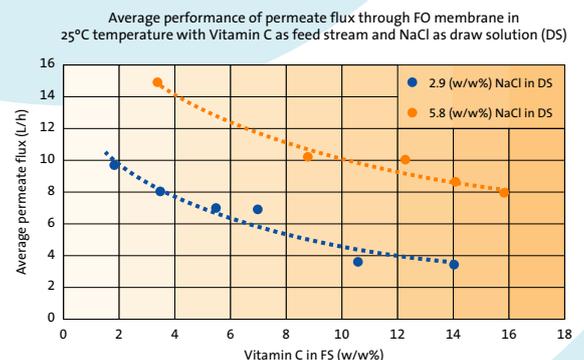
The pilot tests confirm the low sensitivity for fouling of the FO membranes. By simple osmotic backwash without chemical cleaning the original flux of the membrane could be restored easily.

Tests are performed with different feed solutions having different concentration factors and for the draw solution recovery either RO or MD are used.

PILOT TEST

Four different types of industrial feed streams are tested for up concentration using FO:

- The concentration of Vitamin C for DSM.
- The concentration of whey for FrieslandCampina.
- The concentration of food industry wastewater, whereby opportunities to reuse the purified water and to extract biogas from the concentrate will be explored for Marfo.
- The concentration of the produced water released during oil extraction for Shell and Gaz de France.



Membrane flux in relation to the feed concentration at different draw solution concentrations