

DESALINATING SEAWATER AND RECOVERING WASTE WATER USING HYBRID FORWARD AND REVERSE OSMOSIS AT THE PILOT LEVEL

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With the advantage of having low fouling propensity and requiring low hydraulic pressure to operate, forward osmosis (FO) has captured attention as an alternative technology which is capable of treating and desalinating highly fouling and saline water sources respectably. Established technologies such as reverse osmosis (RO) is capable of performing the aforementioned tasks at high efficiency. However, RO often requires extensive pretreatment to reduce membrane fouling which increases cost. In this work, a pilot scale FO-RO system was built using commercially available membrane modules. A combined hybrid FO-RO system where FO acts as a pre-treatment system to downstream RO system and RO acts as a recovery step for FO draw solution offers a multitude of benefits. Reduction in fouling, and fast and low cost cleanability is achievable. In addition, having similar membrane selectivity, both FO and RO provides a dual barrier protection to trace contaminants such as boron, low molecular weight organics, and metals. The pilot system includes a PLC-HMI based data acquisition system with process control and monitoring capability of flowrates, pressures, temperatures, and electricity usage. Initially, using DI water as a benchmark for evaluating the fundamental operating parameters that are critical to FORO, the system was optimized. Using a Dow SW30-4040 spiral wound module and Porifera FOMEM plate and frame module, the system was operated at 40%-45% recovery. During this recovery, the feed concentration in the RO changed from 4000 TDS to 12000 TDS with a rejection of 93%-97% at a pH of 6.5. For a 0.25M NaCl draw solution in FO, a 10-12 $\text{Lm}^{-2}\text{hr}^{-1}$ water flux was observed with a reverse salt flux of 11-13 $\text{gm}^{-2}\text{hr}^{-1}$. The total peak current used was found to be 4.0-4.5 amps at a maximum feed and draw flowrate of 1.25 GPM. We anticipate an automated process control through mass transport between the FO and RO module in closed loop. Our future work include investigation of different types of feed sources to observe and record the operating parameters as well as to investigate the double barrier concept and the automated process control feature of the FO-RO hybrid system.



Figure 1 – A pilot scale FORO plant (top image) with a PLC based data acquisition system (bottom image)