Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Supplementary Information

Thermodynamic Limits of Extractable Energy by Pressure Retarded Osmosis

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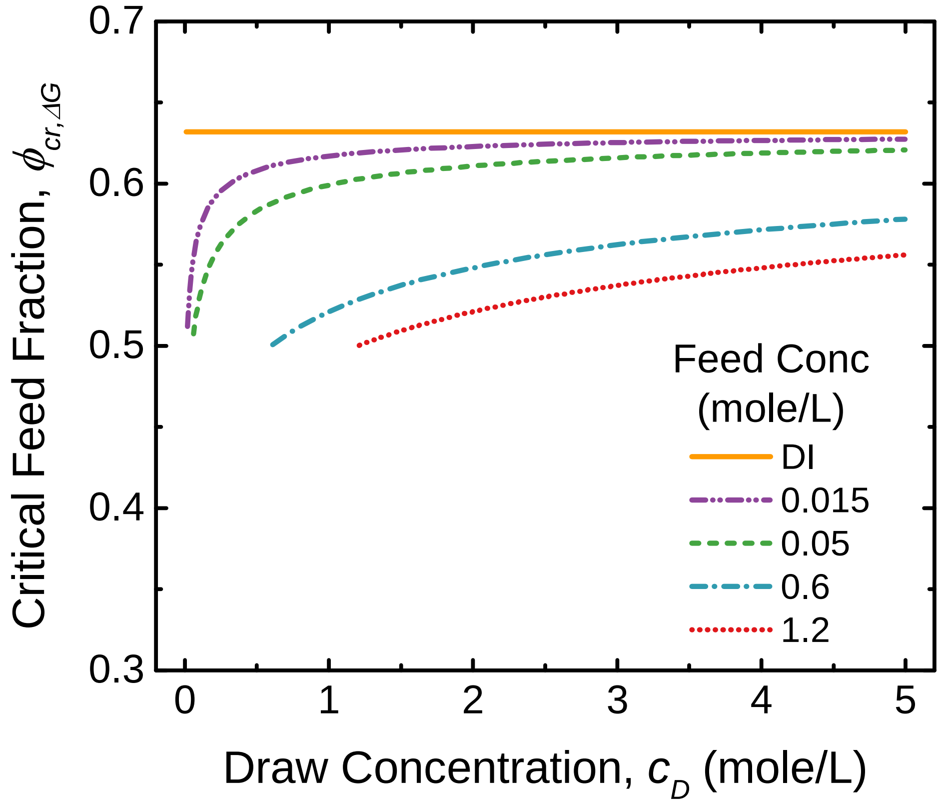

Fig. S1. The critical feed fraction, $\phi_{cr,\Delta G}$, (i.e. the feed fraction that maximizes the Gibbs free energy of mixing) as a function of draw solution NaCl concentration. The 0.015, 0.05, 0.6, and 1.2 M NaCl feed concentrations correspond to river water or waste water, brackish water, seawater, and brine, respectively. Deionized water (DI) is also shown as a potential feed solution.

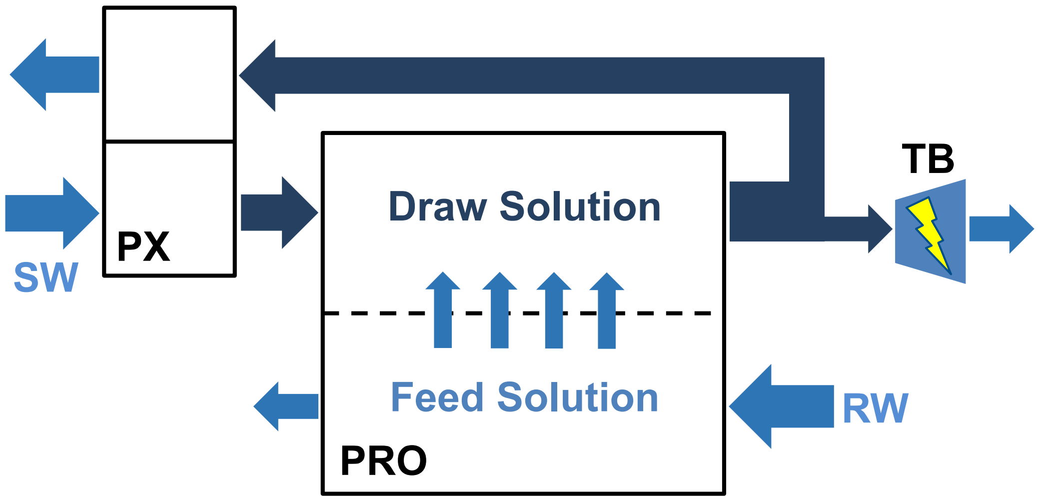

Fig. S2. Schematic diagram of a typical pressure retarded osmosis (PRO) system using seawater (SW) as the draw solution and river water (RW) as the feed solution. The streams in dark blue are pressured with an applied hydraulic pressure, ΔP, that is smaller than the osmotic pressure difference between the feed and draw solutions. The streams in light blue are unpressurized (except for the small applied pressure required to drive the circulation). A pressure exchanger (PX) is employed to pressurize the incoming SW for a continuous operation. The energy is extracted by depressurizing a portion of the draw solution effluent via the hydro-turbine (TB). Note that the flow rate of the stream passing through the TB is the same as the cross-membrane flow rate in the PRO module.