Numerical Simulation on Electrical Energy Harvesting by Reverse Electro-Dialysis (RED)

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The free energy of mixing electrolyte solutions with different concentrations can be directly converted into electricity via RED process, the reverse operation of electrodialysis (ED) that increases the concentration gradient between two electrolyte solutions by consuming electrical energy. In this research, we first prepared RED stack cells by using commercial ion exchange membranes, then evaluated the power density under conditions that emulate mixing of seawater (35 g/L) and brackish water (0.5~3.0 g/L). The evaluation was based on current-voltage characteristics, and power outputs were measured as functions of flowrates, geometry of flow channels, feed concentrations and the number of stacks. Numerical simulations were conducted on the ion transport in various RED cell structures to develop a proper model describing RED cell behaviors. Power generation depending on flow conditions of sea and brackish water was analyzed from both experimental and numerical simulation results.
Keyword: Salinity-Gradient Energy, Reverse Electro-Dialysis, Ion Exchange Membrane, Numerical Analysis