Performance Analysis of Reverse Electrodialysis (RED) Cell Stacks Utilizing Equivalent Circuit Model (ECM)

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Reverse electrodialysis is a direct way to convert salinity-gradient energy to electricity using ion exchange membranes (IEMs). The power characteristics are considerably well related to the membrane resistance, selectivity, the number of cell stack, channel structure, and concentrations of fresh water and sea water. In a previous study on REDCS, we assumed that the concentration polarization can be neglected when the flow rates are high enough. However, the concentration polarization should be considered for practical operation conditions of low flow rates. In this study, a more sophisticated version of the equivalent circuit model (ECM) was developed to include the concentration polarization by correlating internal resistance as a function of flow rate. The relationship between the internal resistance and flow rate was obtained from numerical simulations using finite differential method (FDM) based on Nernst-Plank and diffusion-convection equations. We estimated open-circuit voltage and short-circuit current of REDCSs, which are used for evaluating the optimum flowrate and stack number.