Equivalent Circuit Modeling of Reverse Electrodialysis for Harvesting Salinity-Gradient Energy

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Reverse electrodialysis (RED) is a direct process to convert salinity-gradient energy to electricity utilizing ion exchange membranes. 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 order to optimize the efficiency of energy harvesting, equivalent circuit models are developed for given structures of RED cell stacks. Input parameters are resistances of membranes and electrodes, structure of flow channels, stack number, and salt concentration. The electrical potential across a membrane is calculated from Nernest equation and also used as an input parameter. Output such as power density, short-circuit current, and open-circuit voltage can be estimated by the model. The internal resistance, which is most affected by fresh water concentration, is the critical parameter influencing the power efficiency. Parasitic currents that degrade power output were also considered. Those effects evaluated by the model agreed with experimental measurements with varying the concentration and the thickness of water channels.