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Flow Battery Based on Reverse Electrodialysis with Bipolar Membranes: Single Cell Experiments

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Abstract

The efficient storage of electrical energy is a key issue for a sustainable electrical energy supply from fluctuating sources such as windmills or photovoltaic devices. In addition to traditional electrical energy storage devices, flow batteries have become a subject of intensive research and development activities. This publication is concentrated on a flow battery type, based on the neutralization of an acid and a base by reverse electrodialysis with bipolar membranes. The fundamental aspects of the process will be discussed and experiments at laboratory scale in a single repeating cell unit will be presented, using HCl as acid, NaOH as base and NaCl as neutral salt solution. The components and process parameters which determine the performance of this battery, such as the monopolar and bipolar membranes, the concentrations of acid and base, and the operating temperature, have been investigated and their effect on the overall efficiency of the battery will be discussed. In a following second part, experimental results for stacks with 5 to 20 repeating cell units will be presented [15]. Key issues for a successful implementation of a flow battery based on acid/base neutralization are the membrane permselectivities, depending on the fixed charge density, the ionic resistances of the mono- and bipolar ion-exchange membranes and the water permeability of the bipolar membrane.

Graphical Abstract