Numerical simulation of ionic transport processes through bilayer ion-exchange membranes in reverse electrodialysis stacks

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Numerical simulation of ionic transport processes through bilayer ion-exchange membranes in reverse electrodialysis stacks

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Abstract

The effect of the inhomogeneity degree in the fixed-charge distribution of a bilayer ion-exchange membrane under reverse electrodialysis conditions on the voltage-current characteristic and the power transferred to the load has been numerically studied on the basis of the Nernst-Planck-Donnan equations under electrical neutrality conditions in the Teorell-Meyer-Sievers model. The open circuit voltage, the internal resistance under short circuit current and the maximum power transferred to the load have been analysed for different values of the average fixed-charge concentration inside the membrane, the inhomogeneity degree of the membrane and the thickness of the DBLs. This thickness and the fluid flow velocity inside the intermembrane channels are related by numerically solving a 2D diffusion-convection problem, using a parabolic velocity profile, in the limiting current regime. The obtained results have been also related to those characterizing the permselectivity of the membranes by means of the current efficiency.

Keywords: Reverse electrodialysis / Renewable energy / Concentration polarization / Bilayer membranes / Ion-exchange membranes

1. Introduction

Nowadays, theoretical studies on selective transport of ions through membranes are