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Conversion of Osmotic into Mechanical Energy in Systems with Charged Membranes*

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Abstract

Within the framework of irreversible thermodynamics the problem of osmotic to mechanical energy conversion in systems with charged membranes has been formulated. Using the numerical results for the conductance coefficients for the system Nafion 120 membrane/single salt and alkali solutions, the couplings between the volume and the water osmotic fluxes, q, and the efficiency of osmotic into mechanical energy conversion, η, have been computed. It has been stated that with charged membranes the osmotic pump can operate effectively with an electrolyte perfectly reflected by a membrane (e.g. sulphuric acid). If the diffusional flux reaches a few percent of the water flux, the energy conversion decreases strongly.

Introduction

The standard application of membrane systems is for the separation of suspensions and molecular mixtures, gaseous or liquid, into components on an expense of supplied energy. The mechanical, thermal or electric energy can be used. More than twenty membrane separation techniques are already known.

In each of these systems, however, the difference in concentration of components on both sides of a membrane presents the effective source of osmotic energy, generating the spontaneous osmotic flux affecting the separation. For example, in a technique like electrodialysis, the osmotic flow of water dilutes a brine, thus lowering the energetic efficiency of desalination. In some other techniques like reverse osmosis, the osmotic pressure is a powerful force to overcome. The osmotic energy is thereby a native energy of membrane systems affecting both the income of energy and the separation process itself.

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