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POROUS STRUCTURE OF ION EXCHANGE MEMBRANES INVESTIGATED BY VARIOUS TECHNIQUES

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Abstract

A comparative review of various techniques is provided: mercury intrusion porosimetry, nitrogen sorption porosimetry, differential scanning calorimetry (DSC)-based thermoporosimetry, and standard contact porosimetry (SCP), which allows determining pore volume distribution *versus* pore radius/water binding energy in ion-exchange membranes (IEMs). IEMs in the swollen state have a labile structure involving micro-, meso- and macropores, whose size is a function of the external water vapor pressure. For such materials, the most appropriate methods for quantifying their porosity are DSC and SCP. Especially significant information is given by the SCP method allowing measuring porosimetric curves in a very large pore size range from 1 to 10^5 nm. Experimental results of water distribution in homogeneous and heterogeneous commercial and modified IEMs are presented. The effect of various factors on water distribution is reviewed, *i.e.* nature of polymeric matrix and functional groups, method for membrane preparation, membrane ageing. A special attention is given to the effect of membrane modification by embedding nanoparticles in their structure. The porosimetric curves are considered along with the results of electrochemical characterization involving the measurements of membrane conductivity, as well as diffusion and electroosmotic permeability. It is shown that addition of nanoparticles may lead to either increase or decrease of water content in IEMs, different ranges of pore size being affected. Hybrid membranes modified with hydrated zirconium dioxide exhibit much higher permselectivity in comparison with the pristine membranes. The diversity of the responses of membrane properties to their modification allows for formation of membranes suitable for fuel cells, electrodialysis or other applications.

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