Study on Water Transport and Highly Concentrating Sea Water through Ion-exchange Membrane

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Summary

In order to produce the salt from sea water the concentration is increased by about 5 times through ion-exchange membrane before evaporation. Recently it is desired that the sea water is concentrated by 8 or 9 times to obtain the salt in the higher efficiency. Reduction of the water content in the ion-exchange membrane is one of the solutions for this process. However, it decreases the effective fixed charge density (effective ion capacity) and increase the membrane resistance. In this study, the effect of ion pairing between fixed charge groups and counterions on the effective charge density and the ionic mobility was studied, theoretically and experimentally, in order to develop the ion-exchange membrane for highly concentrating sea water.

Cation exchange membranes which were composed of PAN mixed with PSSNa and poly(divinylbenzene-co-styrene) containing sulfonic acid group in a polymer matrix, and anion exchange membranes which were composed of poly(butadiene-co-styrene) containing quaternary amine groups and PVA grafted with quaternary amine groups, were used for the measurements. The membrane potentials across cation- and anion-exchange membranes were measured for salt-aqueous and organic solutions. The experimental data were analyzed on the basis of the Donnan equilibrium and the Nernst-Planck equation of ion flux. The effective charge densities (QC_X) and the mobility ratios of cation to anion ($r=\omega_+/\omega_-$) in the membranes were determined. It was evidenced that the counter-ions prefer to make ion pairs with the fixed charge groups in the low water content since the dielectric constant in the membrane is smaller than water. From those results it was suggested the introduction of OH group in the ion-exchange membrane reduces the effect of ion pairing.