

Behavior of Ions and Water in Weak Amphoteric Polymer Membranes

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Summary

Ion exchange membrane continues to be the object of intensive research in the fields of physical and polymer chemistry, biology, medicine, and physiology. Moreover it is being applied to the production of salt, sodium hydroxide, and pure water from sea water. The membranes which are charged negatively and positively are called as cation and anion exchange membranes, respectively.

Usually almost all of the studies of ion exchange membranes are concentrated to the anion or cation exchange membrane which is charged on one side. However, examining the chemical structure of major biological membranes, it is proved to be composed of amino acid including both negatively and positively charged groups at the same time. Such a membrane is called as the amphoteric ion exchange membrane which is available for the piezodialysis to concentrate the ion under the hydraulic pressure. Transport phenomena of amphoteric polymer membranes possessing strong acid and base have been already analysed using nonequilibrium thermodynamics. On the other hand those consisting of weak acid and base have not been studied systematically. In this study transport phenomena of N-succinylchitosan, CM chitosan, and silk fibroin membrane are discussed.

Membrane potentials of those samples were measured as a function of external solute concentration. Teorell-Meyer-Sievers' (TMS) theory was applied on their experimental results to estimate the effective charge densities (QC_x) and ion mobilities (ω_+ and ω_-). Q are calculated from QC_x and C_x which are determined by pH titration or calculation from contents of charged groups. Q were about 1/100 for N-succinylchitosan and CM chitosan membranes, and 1/20 for silk fibroin membrane. Usually Q is nearly equal to 0.2 for almost all of the monopolar ion exchange membranes. It indicates that the effect of charged groups are reduced if the anion and cation group are distributed in the same membrane. Bivalent anion mobilities in the membrane were much affected by the fixed charge groups in the membrane.