A Fundamental Study on an Acid-base Production Process by Water Splitting in Bipolar Membranes

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Summary

A bipolar membrane is a composite membrane consisting of an anion-exchange membrane and a cation -exchange membrane in series. A potential difference higher than a critical one, negative to the cation-selective side and positive to the anion-selective side, causes water splitting at an intramembrane interface and flows of H^+ and OH^- ions in directions opposite to one another. It could be estimated that the water splitting takes place at a very high rate compared to the case of bulk water. In this study, we analyzed theoretically ion and potential distribution in a membrane and lead a theoretical equation for current-voltage curves, and confirmed a very high rate of water dissociation at the intramembrane interface, where a very high potential difference is applied. Moreover, the effect of accerelation of water dissociation owing to the existence of metal hydroxide is clearly noticed. The catalytic effect of metal hydroxides is investigated in detail.

The method of investigation is as follows; Bipolar membranes were prepared of pretreated cation and anion exchange membranes in a suspended solution of metal hydroxide, and the catalytic effect is analyzed with the potential-current curves measued under various conditions. Especially, the effect of treatment with aluminum hydroxide is investigated in detail.

The bipolar membrane prepared of pretreated cation and anion exchange membranes in a aluminum hydroxide suspension shows an accerelation effect of water dissociation depending on the preparation conditions, that is, the molar ratio of Al^{3+} and OH^- in the aluminum hydroxide suspension. With an increasing molar ratio of OH^-, the current density increases until the molar ratio of about 1:1 and then decreases to a minimum at the molar ratio of about 1:2.5. Water splitting is supposed to be catalyzed by aquo complexes of Al^{3+}, and the relation of current density *vs.* molar ratio could be explained by considering the olation process of aluminum salt.