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, and 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 intra-membrane interface and flows of H^+ and OH^- ions in opposite directions to one another. It could be estimated that the water-splitting is taken place at a very high rate compared to bulk water. The objective of this study is to elucidate a mechanism of the water-splitting in bipolar membranes.

The method of investigation is as follows;

1) Bipolar membranes were prepared and the potential-current curves were measued under various conditions.

2) Theoretical analyses on the ion and potential distributions in bipolar membranes gave potential-current curves, which were compared to the observed results.

3) From the results of (1) and (2), the mechanism of water-splitting was discussed.

Cr (III)-doped anion and cation exchange membranes were pressed in series to make a bipolar membrane, where the current density caused by water splitting in the intra-membrane interface was about 10^3 times larger compared to the case of membrane prepared without Cr (III). This suggests catalytic action of Cr (III) on the water dissociation reaction. On the other hand, it is suggested by theoretical analyses that the potential gradient is over 10^9 V/m, which is sufficiently strong to arrange water molecules in the intra-membrane interface along the potential gradient direction, making the water dissociation feasible. Based on these considerations, a series of theoretical equations were derived and experimental results were analyzed.