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.

The relationship between potential and current by theoretical analyses confirms that the rate of water-splitting in a bipolar membrane is $10^6 \sim 10^7$ times higher than that of bulk water. It is estimated that the thickness of boundary layer between an anion- and a cation-selective portion is about 0.6nm and a potential gradient over 10^9 V/m is applied to this layer. This result leads to a model in which about three molecules of water are arranged along the high potential gradient in this layer and this orientation of water molecules makes extensively dissociation feasible. The oberved results could be explained by this model.