

Control of Chlorine/Oxygen Selectivity in Hydrogen Production Using Seawater Electrolysis

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Summary

To popularize natural energy, where a stable power supply is difficult, it is essential to develop a method for storing large amounts of electricity at low cost. Hydrogen energy can be converted between two sources by combining water electrolysis and fuel cells, and can be used for energy storage. In this study, we aimed to control the selectivity of chlorine and oxygen generation at the counter electrode in hydrogen production by seawater electrolysis through cell structure and operating conditions, and to examine an electrolysis cell that can control the amount of oxygen and chlorine produced according to demand.

A flow-type two-tank electrolytic cell with a thin plate-shaped flow channel was fabricated, and electrolysis was performed by passing a 3.5wt% NaCl solution as simulated seawater. Electrolysis was performed at a constant current, and the pH and chlorine concentration of the solution were measured, and the amount of O₂ and Cl₂ produced and the reaction selectivity were evaluated from the changes in these concentrations. The mechanism that affects the selectivity was examined from the viewpoint of mass balance, based on the effects on the reaction selectivity when the solution supply flow rate, applied current, and cell structure were changed.

In seawater, the concentration ratio that determines the selectivity of O₂ and Cl₂ is sufficiently $[Cl^-] \gg [OH^-]$, yet O₂ generation is considerably large. Based on the results of the current and flow rate changes, we believe this is due to diffusion rate control caused by an insufficient supply of OH⁻ and Cl⁻. The diffusion rate is $OH^- \gg Cl^-$, which is favorable for O₂ generation. For this to be true, the solutions near the electrode and in the flow path must be separate regions, and mass transfer between the regions must occur by diffusion. Also, in the mesh electrode, the solution inside does not flow in the same way as in the flow path, so it is thought that the solution stagnates, causing a change in concentration.