Electrochemical Water Treatment and Hydrogen Production Using a PEM Electrolysis Cell

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ABSTRACT

Water electrolysis is an electrochemical process that utilizes electrical energy to decompose water into hydrogen and oxygen. Among various electrolysis methods, polymer electrolyte membrane (PEM) electrolysis exhibits high current density and produces high-purity hydrogen. When recalcitrant organic compounds, which are not effectively treated by conventional water treatment processes, are used as influent in a PEM electrolysis system, direct oxidation reaction occurs under the applied electrical energy, leading to the decomposition of these compounds. Additionally, when sodium chloride is added to the organic matter, oxidizing agents such as hypochlorous acid are generated, which induce indirect oxidation reactions of the organic compounds. Therefore, this study aimed to decompose representative reference organic substances, humic acid and bovine serum albumin (BSA), using a PEM electrolysis system and to quantify the amount of hydrogen produced as a by-product. The degradation efficiencies of humic acid and BSA were evaluated by analyzing total organic carbon (TOC) and the average molecular weight distribution using size-exclusion chromatography (SEC).

The minimum voltage required for hydrogen productions determined using deionized (DI) water. The optimal conditions for generating chlorine-based oxidants were derived by adjusting the concentration of sodium chloride and the flow rate of the influent. Subsequently, direct oxidation reaction of humic acid and BSA was confirmed, and the reduction in TOC and average molecular weight of the decomposed organic matter was observed following the addition of sodium chloride, indicating the effects of both direct and indirect oxidation reactions.

Keyword: Water electrolysis/PEM/Electrochemical water treatment/Hydrogen Production

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