Developing a Hydrazine Seawater-based Hydrogen Production System Using a Highly Efficient Pd-Ni(OH)2 Catalyst

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Electrolysis, one of the most efficient methods for hydrogen production, consumes around 40 billion liters of freshwater annually, thus limiting its scalability due to freshwater scarcity. Seawater is an abundant alternative; however, it faces complex challenges, such as toxic hypochlorite release when used directly without desalination. The purpose of this project is to use a novel approach that incorporates hydrazine hydrate with a Pd-Ni(OH)2/NF catalyst and test its electrochemical performance for evaluation as a seawater-based hydrogen production system. The Pd-Ni(OH)2/NF catalyst was synthesized using the hot plate-assisted impregnation method and was prepared at least five times to ensure the accuracy of the results. Hydrazine hydrate was added to the electrolyte, replacing the oxygen evolution reaction with the hydrazine oxidation reaction, which has a lower overpotential than the chlorine evolution reaction, thereby preventing hypochlorite release. LSV tests on the system in seawater with hydrazine demonstrated improved performance. Without hydrazine, the system reached 8 mA/cm² at 1 V, whereas with hydrazine, it increased to 1030 mA/cm², making the system 129-fold more efficient than without hydrazine and 99-fold more efficient than the anodic benchmark RuO2, while being 39% less expensive. This system requires only 0.6 V to achieve the industrial benchmark current density of 500 mA/cm², one-third of the 1.8 V typically needed by current commercial systems. The system remained stable at 500 mA/cm² for 20 hours, indicating high durability. These results highlight the potential of using abundant seawater as a resource for large-scale hydrogen production, contributing to a sustainable energy future.

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