

Photochemical Hydrogen Production Using Tea Leaf Residue and Iron Ions

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H₂ is important as a promising green energy source. Conventional H₂ production methods include the steam reforming of fossil resources, water electrolysis, biomass fermentation, and photocatalysis. However, these methods have downsides such as the emission of CO₂ and high cost. In this study, a low-cost and eco-friendly H₂ production method was developed using the polyphenol contained in tea leaf residue, an iron ion, and sunlight. We clarified the mechanism by which H₂ is generated, namely, the reduction of H⁺ resulting from the excited state, Fe²⁺*, generated by the photoreduction of PP-Fe³⁺ complex and the accumulation of PP-Fe²⁺ complex. It was found that H₂ generation was promoted under the following conditions: (1) pH of PP-Fe complex solution was 4.0; (2) Fe³⁺ concentration was 0.01 - 0.3 mol/L; (3) light having wavelengths in the visible, ultraviolet, and near-infrared regions was provided. It was clarified that all of the above-mentioned conditions were fulfilled by incorporating CO₂ and installing a battery with metallic iron as the cathode and carbon as the anode in the H₂ production tank. Using this device, in addition to the H₂ generated photochemically, H₂ and electric power generated by the iron-carbon battery could be collected simultaneously. Furthermore, CO₂ was precipitated out as iron carbonate. The proposed method provides close to the current cheapest production unit price for H₂, which makes the introduction and low-cost operation of H₂ stations in many cities more attractive.

Awards Won:

Edison International : First Award of \$1,500