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