Lignin Assisted Water Electrolysis for Sustainable Hydrogen Production and Lignin Valorization

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Hydrogen is a promising green fuel that is being rapidly adapted for use as a secondary energy carrier- particularly due to its high calorific value of 142.3 MJ/kg, more than three times higher than that of oil, and its theoretical combustion products are only water. The two main methods of hydrogen production are natural gas/oil steam reforming, which produces excess greenhouse gasses and requires additional hydrogen purification, and water electrolysis, which generates clean green produced higher purity hydrogen. Thus, electrolysis, the process of splitting water, is a promising option for carbon-free hydrogen production. However, water electrolysis involves the oxygen evolution reaction (OER), which has high energy consumption and slow kinetics. Replacing OER with a more thermodynamically favorable reaction at the anode can reduce electric consumption. This work focused on utilizing an electron-rich biomass source- Bio-Oil (a low-cost waste product from the paper and pulp industry)- to lower the amount of energy needed to produce hydrogen. Additionally, this process generates useful carbon-based aromatic byproducts-such as quinone and other agricultural and pharmaceutical pre-products. Cyclic voltammetry was conducted to determine the reduction-oxidation behavior of lignosulfonate and determine peak anodic potential. Analysis was done on the effect of key reaction variables- temperature, salt type, and concentration of lignin used- on hydrogen production. It was found that at higher temperatures and lignin concentrations, increased hydrogen production efficiency, producing more hydrogen via a green method with less energy compared to conventional approaches.

Awards Won:
Third Award of $1,000