Platinum Electrode for Green Hydrogen Production via Electrocatalytic Conversion of Ion-Rich Agricultural Fertilizer Runoff

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This project investigated using fertilizer-rich agricultural runoff, mainly ammonia, for green hydrogen production. Instead of artificial setups, a system with soil, seeds, and urea solutions was tested with real runoff. The hypothesis proposed that nanomaterial-based electrodes would enhance hydrogen production during ammonia electrolysis. It was also expected that electrolysis would remain effective in the first hour despite the complex composition of runoff. Two key research questions guided the study: How do fertilizer runoff ions affect ammonia electrochemical oxidation? How can high electrode overpotential, which lowers efficiency, be improved? The simulated runoff solution was tested on Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and showed a high concentration of calcium, magnesium, sodium, and potassium ions. Then solutions of these ions were made and tested on eight platinum (Pt) electrodes designed with titanium mesh. Results showed that 77% of electrical current was effectively used for hydrogen production in calcium- and magnesium-rich solutions. Switching electrode polarity every 30 seconds prevented surface poisoning, improving longevity. While fertilizer solutions posed challenges due to competing reactions, adding hydroxide improved equilibrium and reduced ammonia concentration, enhancing hydrogen formation. This research tackles water pollution and clean energy simultaneously. The electrode design proved effective in ion-rich water, demonstrating its potential for real-world applications in sustainable hydrogen production from wastewater electrolysis.

Awards Won: