Electrocoagulation With Aluminum, Copper, and Zinc for Aqueous Methylene Blue Remediation and Sustainable Energy Production

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Global water pollution and unsustainable energy production are growing and harmful issues. This study aimed to create a solution to these problems, allowing them to abet each other through electrocoagulation, for dual water remediation and sustainable energy production. Methylene blue was used as a model textile dye while hydrogen gas (by-product of electrocoagulation) was harnessed for energy production. Methylene blue (5ppm) was treated with three aluminum, zinc, and copper electrodes connected to a DC power supply (0.5 amperage) for dye remediation via flocculation. Lids were designed and 3D-printed to hold the electrodes in place and assist in hydrogen gas collection. Treatment was run for 5 hours (samples taken at 10, 20, 30 minutes, 1, 2, 3, 4, 5 hours) while being stirred (200 or 300 rpm) to determine the optimal treatment conditions. The alternate hypothesis stated that aluminum electrodes at 5 hours and 300 rpm would have the highest dye removal. However, copper electrodes performed best (5 hours and 300 rpm): 100% dye removal, 1.00V hydrogen gas production (11.62% of energy required to offset energy expenditure). Statistical significance was found between almost all groups via One-Way ANOVA with a post-hoc Scheffe ($p<0.05$). Aluminum and zinc electrodes formed the thickest flocs, which covered the electrodes and decreased anode dissolution for remediation. The 300 rpm was optimal, as the faster stir rate increased the efficiency of electron flow, water remediation, and hydrogen gas production. Electrocoagulation has potential for efficient, cost-effective, and accessible water remediation and energy production.