The Effect of Carbon on Iron Nickel Bimetallic Nanoparticle Degradation of Orange G

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Textile azo dyes are a significant pollution source worldwide. Azo dyes can be toxic and carcinogenic, and their contamination adversely impacts human and aquatic ecosystem health. Metal nanoparticles can degrade azo dyes, but aggregation and oxidation reduce reactive surface area and catalytic ability. Here, we aimed to improve iron/nickel nanoparticle catalysts through deposition on high surface area and novel surface-functionalized carbons. We compared degradation at two nanoparticle iron to carbon ratios and for three novel surface-functionalized carbons, two non-functionalized carbons, and non-immobilized nanoparticles. Aqueous nanoparticle synthesis utilized sodium borohydride reduction of iron sulfate heptahydrate salt and nickel chloride hexahydrate salt. Samples were taken at regular time intervals from a solution of nanoparticles and aqueous azo dye Orange G. Concentration was determined with a UV-Vis spectrophotometer. Percent dye remaining after one hour quantified removal magnitude. First-order rate constants quantified degradation speed. Catalytic ability improvement resulted from increasing reactive surface area, for which dye degradation is pseudo-first order. Carbon nanoparticle immobilization prevented aggregative and oxidative reactive site reduction, increasing percent removal by 94% over non-immobilized nanoparticles. Electron transfer through novel carbons surface-functionalized with specific polyoxometalates further increased reactive surface area by allowing Orange G degradation on both the carbon and nanoparticle surfaces, increasing the rate constant by 433% over non-immobilized nanoparticles. Carbon immobilized iron/nickel nanoparticles show significant improvement over current technologies and promise for wastewater treatment.

Awards Won:

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