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Catalytic Reduction of Methylene Blue by Magnetite - Silica Composite

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Iron oxide nanoparticle-based nanomaterials have well-known catalytic activity for the degradation of organic dyes in the water remediation process. The objective of this research was to synthesize iron oxide silica composite by sol-gel method and assess their applicability in wastewater treatment as a catalyst. Synthesized catalysts were characterized by FT-IR spectroscopy, X-ray diffractometry (XRD) and scanning electron microscopy (SEM). Vibration modes in FT-IR spectra show the presence of SiO_2 and Fe-O bonds. Formation of $Fe_3O_4$is shown by the XRD patterns. SEM images indicate that iron oxide particles and flakes are distributed in the silica matrix. The effects of catalyst dosage, temperature, initial concentration of methylene blue (MB), $NaBH_4$ concentration, foreign salts, and ionic strength on MB degradation were studied. Maximum degradation of MB (99.89%) was obtained with an initial MB concentration of 20 mg/dm^3, catalyst dose of 1.0 g/dm^3, $NaBH_4$ concentration of 6.25 mmol/dm^3, and a temperature of 50^{0}C. Common salts found in industrial wastewater such as NaCl, KCl, $CaCl_2$ and $MgCl_2$ inhibit the degradation of MB, while Na_2SO_4 enhanced the degradation rate. Iron oxide helps in electron relay from BH_4^- to MB and silica tends to adsorb MB molecules and provide the proximity required for the catalytic reaction.

Keywords: *iron oxide nanoparticle, silica, methylene blue, wastewater treatment*