Preparation and characterization of Fe3O4/SiO2/TiO2 composite for methylene blue removal in water

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Abstrak

The main problem with the slurry process is the difficulty in recovering the photocatalyst nanoparticle from water following purification. An alternative solution proposed the photocatalyst be immobilized on magnetic carriers, which would allow them to be recollected from the water suspension following treatment using an external magnetic field. Magnetically photocatalyst composites were prepared using simple heteroagglomeration by applying attractive electrostatic forces between the nanoparticles with an opposite surface charge. The Fe3O4/SiO2/TiO2 photocatalysts were synthesized in an aqueous slurry solution containing Fe3O4/SiO2 and TiO2 nanoparticles under pH 5 conditions. Meanwhile, Fe3O4/SiO2 was prepared by a simple procedure via a coprecipitation of iron(II) and iron(III) ion mixtures in ammonium hydroxide and was leached by sodium silicate. The synthesized samples were investigated to determine the phase structure, the magnetic properties, and the morphology of the composites by X-ray diffraction (XRD), vibrating sample magnetometer (VSM), and transmission electron microscopy (TEM), respectively. The results indicated that the composites contained anatase and rutile phases and exhibited a superparamagnetic behavior. Fe3O4/SiO2 particles, which were of the aggregation spherical form at 20 nm in size, were successfully attached onto the TiO2 surface. The catalytic activity of Fe3O4/SiO2/TiO2 composites was evaluated for the degradation of methylene blue under ultraviolet (UV) irradiation. The presence of SiO2 as a barrier between Fe3O4 and TiO2 is not only improves the photocatalytic properties but also provides the ability to adsorb the properties on the composite. The Fe3O4/SiO2/TiO2 (50% containing TiO2 in composite) were able to eliminate 87.3% of methylene blue in water through the adsorption and photocatalytic processes. This result is slightly below pure TiO2, which is able to degrade 96% of methylene blue. The resulting Fe3O4/SiO2/TiO2 composite exhibited an excellent ability to remove dye from water and it is easily recollected using a magnetic bar from the water. Therefore, they have high potency as an efficient and simple implementation for the dye effluent decolorization of textile waste in slurry reactor processes.