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Covalent bonding synthesis of magnetic graphene oxide nanocomposites for Cr(III) removal

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ABSTRACT

A covalent bonding technique to obtain magnetic graphene oxide nanocomposites (Fe_3O_4/SiO_2–GO) decorated with core/shell nanoparticles is reported. Fe_3O_4/SiO_2–GO was characterized by transmission electron microscopy, energy dispersive X-ray spectrometer, X-ray diffraction, Fourier transform infrared, Raman, and thermogravimetric analysis techniques. Through covalent synthesis method, magnetic core/shell particles in size of 20–40 nm were homogeneously dispersed onto graphene oxide. The characteristic Si–O–Si peak (1091, 468 cm^{-1}), Fe–O (576 cm^{-1}), and aromatic C=C (1621 cm^{-1}) were the direct evidences to consolidate the formation of the Fe_3O_4/SiO_2–GO. The DTG curve showed about 54.45 wt% of metal oxide deposited on the surface of GO. The adsorption behaviors, including adsorption kinetics and isotherms parameters, effect factors, and mechanisms of chromium adsorption on Fe_3O_4/SiO_2–GO were studied. Fe_3O_4/SiO_2–GO demonstrated an extremely fast Cr(III) removal from the wastewater within 5 min and could be separated faster by using a permanent magnet. The adsorption kinetics followed the pseudo-second-order model and Fe_3O_4/SiO_2–GO exhibited better Cr(III) removal efficiency in solutions with high pH (>3). The adsorption of Cr(III) fits the Freundlich equation well. Based on abundant oxygen functional groups and negative surface charge on Fe_3O_4/SiO_2–GO, the adsorption mechanisms could be explained as electrostatic interactions and ion exchange. The significantly reduced treatment time required to remove the Cr(III) and the applicability in treating the solutions with high pH made Fe_3O_4/SiO_2–GO promise for the efficient removal of heavy metals from the leather industry wastewater.

Keywords: Graphene oxide; Fe_3O_4/SiO_2–GO; Covalent synthesis; Adsorption; Cr(III) removal

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