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Advancements in multifunctional core-shell adsorbent comprising graphene oxide/ sand for adsorptive removal of water contaminants

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Our study introduces a novel approach to enhance the efficiency of water treatment by developing a porous material (M-GO/S) that combines graphite oxide (GO) with river sand overcoming the limitations of conventional granular media filtration. Synthesized M-GO/S was finally characterized by X-ray Photoelectron Spectroscopy (XPS) after primary characterization via X-ray diffraction (XRD), FT-IR, Ramen, and Scanning Electron Microscopic images (SEM). The adsorptive removal efficiency of M-GO/S on selected toxic metals (Pb, Cr, Cd, and Ni), calcium, and methylene blue dye was investigated under the optimum conditions. The findings reveal the presence of a non-uniform graphene oxide coating on the surface of the sand. The incorporation of oxygenated functional moieties within the structure observed according to the comprehensive analysis of the Carbon 1s (C 1s) spectra of the M-GO/S sample in XPS spectrums and revealed the existence of four distinct carbon species exhibiting binding energies at 284.8 eV, 287.05 eV, and 288.85 eV. These carbon species were identified as C-C/C-H, C-O, and COO (epoxy) functional groups, respectively. The adsorption capacities of Pb, Cr, Cd, and Ni were recorded as; 52.2 mg/g, 21.9 mg/g, 38.1 mg/g, and 21.9 mg/g respectively. Under the optimum conditions, the sand/GO nanocomposite demonstrated remarkable efficacy in removing 75% of calcium ions (elevated removal percentage than commercial coal powdered activated carbon) from simulated hard water. Apart from that, under the optimum conditions, M/GO-S was able to mitigate 95% of methylene blue which was identified as a toxic dye from the water. Therefore, based on its versatile characteristics as a multifunctional porous material, the synthesized graphene oxide-sand nanocomposite (M-GO/S) demonstrates significant potential as a viable solution for the treatment of contaminated water.

Keywords: Adsorption, Graphene oxide, Heavy metals, Methylene blue, Water hardness

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