“Synthesis and characterization of graphene oxide based materials and their application in water purification”

ABSTRACT

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Abstract

The adsorption performances of graphene oxide based materials are considered as auspicious technology for remediation of various water contaminants due to its outstanding removal efficiency. Graphene and its derivatives structure is the new generation of nano carbon based materials because of unique physicochemical features and discovered the various type of water contamination like heavy metals, synthetic dyes, and microorganisms for their prospective applications in water treatment.

The synthesis, characterization, and water treatment application of reduced graphene oxide-manganese oxide-black cumin hybrid composite, rGO-MnO_2/BC, has been reported. The rGO-MnO_2/BC was synthesized by incorporating MnO_2 particles into reduced graphene oxide functionalized with functional groups of black cumin seeds. The prepared rGO-MnO_2/BC was highly amorphous, having large numbers of functional sites, and was evaluated for adsorptive removal of arsenic and methylene blue from their respective aqueous solutions. Adsorption capacities of rGO-MnO_2/BC for methylene blue and arsenite were evaluated in batch manner under optimum conditions. 1.0 g/L dosage of rGO-MnO_2/BC could remove approximately 99 % of methylene blue and arsenite from initial concentration of 10.0 and 1.0 mg/L, respectively, after 75 min at 7.0 pH, and 27 °C temperature. The Freundlich isotherm was most suitable for arsenite sorption and both Langmuir and Freundlich isotherms were suitable for methylene blue sorption data. The sorption kinetics followed pseudo-second order relationship for both adsorbates. The Langmuir sorption capacity of rGO-MnO_2/BC for methylene blue and arsenite were found to be 232.5 and 14.7 mg/g, respectively, at 27 °C.

The multifunctional nanocomposite BC-GO@Fe_3O_4 was prepared by incorporating magnetic Fe_3O_4 nanoparticles in cellulosic Black cumin seed powder which was functionalized with graphene oxide following co-precipitation method. The prepared BC-GO@Fe_3O_4 was characterized by employing thermal, spectroscopic and microscopic techniques that showed high thermal stability, magnetic behavior, and the presence of large numbers of hydroxyl and carbonyl functional groups at the surface. The in vitro investigation has shown that BC-GO@Fe_3O_4 possesses significant antibacterial activities against Gram-negative and Gram-positive bacterial strains, and antioxidant capability. Thus the prepared nanocomposite is biologically safe and beneficial; therefore was tested for adsorptive removal of both cationic and anionic representative water pollutants, namely, methylene blue and arsenic from their aqueous solutions. Therefore, BC-GO@Fe_3O_4, a biologically safe and beneficial material, can be employed for adsorptive removal of dyes and arsenic from water while controlling the bacterial growth and acting as antioxidant.

We appearance that the manganese ferrite magnetic nanoparticles incorporating into the reduced graphene oxide and black cumin seeds have the excellent properties of adsorption for effectual elimination of methylene blue (MB) dye and As(III) from polluted water. The rGO-BC@$MnFe_2O_4$ nanohybrid composite was prepared by simply co-precipitation. The rGO-BC@$MnFe_2O_4$ nanohybrid was tested for various linear isotherms such as Langmuir, Freundlich, Temkin, and Dubinin-Radushkevich for removal of MB dye and As(III) from polluted water. For MB dye and As(III) ions, the Freundlich isotherm was best-fitted model which proved that the adsorption is multilayer adsorption. The adsorption kinetics followed the pseudo second-order for MB dye and

As(III), and recommended that chemical interaction between the adsorbate and nanohybrid composite was responsible for the adsorption. Temperature-dependent studies of adsorption have been completed to estimate the free energy and enthalpy of adsorption.

Reduce graphene oxide-BC/zirconium oxide nano hybrid composite (rGO-BC@ZrO_2) by employing a simply co-precipitation method. X-ray diffraction, Fourier transform infrared spectroscopy, Transmittance electron microscopy and scanning electron microscopic analysis was done to study the effect of Zr substitution on structural properties and surface morphology of nanohybrid composite. The characterization data confirmed that the zirconium nanoparticles (ZrO_2-NPs) were successfully incorporated into the reduce graphene oxide and black cumin seed surface. X-ray diffraction analysis ensured that the rGO-BC@ZrO_2 have amorphous structure. The rGO-BC@ZrO_2 have also used for the remediation of a Methylene Blue (MB) dye under aqueous environment. The present study could open up promising avenues for substitution of toxic reducing agents for the production of rGO-BC@ZrO_2 and their potential environmental applications.

Keywords: graphene oxide based materials, nanoparticles, adsorption, heavy metals, dye.