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$MgFe_2O_4$@SiO_2 Core-Shell Composite For The Adsorptive Removal Of Pb(II) And Ni(II) Ions

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Extended Abstract

Contamination of water with heavy metals is a global concern and is posing significant threat to the environment and public health [1]. Magnetic core-shell composites have an outstanding potential for the remediation of pollutants from water. In this context, the novel core-shell $MgFe_2O_4$@SiO_2 composite was synthesized having hollow mesoporous silica (SiO_2) as core over which magnesium ferrite nanoparticles ($MgFe_2O_4$ NPs) were coated. Hollow mesoporous SiO_2 was prepared using polyethylene glycol and cetyl trimethyl ammonium bromide as templates. Coating of $MgFe_2O_4$ NPs over SiO_2 was done sequentially by using Sodium dodecyl sulphate (SDS) binder in order to synthesize dual core composite. XRD of composite displayed peak at 21.0° for SiO_2 along with the characteristic peaks of spinel $MgFe_2O_4$ NPs. Mössbauer studies revealed the presence of sextet and paramagnetic doublet in the composite, the later was ascribed to the presence of NPs with size less than 20nm. SAED patterns of SiO_2 confirmed its amorphous nature, whereas the composite exhibited crystalline nature due to the presence of $MgFe_2O_4$ NPs. Presence of $MgFe_2O_4$ layer over hollow mesoporous SiO_2 reduced the agglomeration of NPs and afforded larger surface area (41.5 m^2g^{-1}) for the adsorption of Pb(II) and Ni(II) ions as compared to pristine $MgFe_2O_4$ NPs (38.4 m^2g^{-1}). SiO_2 core supported $MgFe_2O_4$ NPs on its surface in $MgFe_2O_4$@SiO_2 resulted in enhanced adsorptive efficiency. The pristine NPs and composites were comparatively studied for adsorptive removal of two inorganic pollutants viz. Pb(II) and Ni(II). Effect of adsorbent dose, initial metal ion concentration and temperature on the percentage removal of Pb(II) and Ni(II) ions (at optimized pH) using synthesized pristine NPs and composite as adsorbents was studied. Adsorption followed the Langmuir model, suggesting the monolayer adsorption. Core-shell composite displayed Langmuir adsorption capacity (q_m) of 1000mg/g for Pb(II) and 333.3mg/g for Ni(II) ions which were significantly higher than that of pristine $MgFe_2O_4$ NPs and SiO_2 nanospheres. Adsorption mechanism was explained on the basis of zeta potential, XPS and surface area studies. The effect of coexisting anions revealed that sulphate ions were potential competitors of Pb(II) and Ni(II). Whereas, effect of coexisting cations showed that the Pb(II) ions were preferentially adsorbed in the presence of Cd(II), Zn(II) and Ni(II) ions. Adsorption studies using real electroplating effluent revealed the effectiveness of nanocomposite in treating wastewater over pristine NPs. This study unveils the effective strategy for enhancing adsorption potential of core-shell nanocomposite for the remediation of contaminated water.

References

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