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ADSORPTIVE REMOVAL OF RHODAMINE B DYE FROM MAGNETIC $MnFe_2O_4$-MONTMORILLONITE NANOCOMPOSITE

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The presence of rhodamine B in water has been connected to several environmental issues and risks to human and animal health. Therefore, effective remediation techniques must be used to remove dyes to prevent contaminating water bodies. Adsorption is one of the most often used and well-liked therapy modalities since it is affordable, straightforward, adaptable, and simple to administer. In this study, manganese ferrite ($MnFe_2O_4$) nanoparticles were co-precipitated chemically with montmorillonite clay (MMT) to combine the increased surface area with the magnetic property. The prepared nanocomposite ($MnFe_2O_4$-MMT) was employed as a magnetic adsorbent to eliminate rhodamine B from aqueous solutions. The successful nanocomposite formation was confirmed by powder X-ray diffractometry (PXRD), Fourier transform infrared spectroscopy (FT-IR), and scanning electron microscopy (SEM) characterizations. The size of manganese ferrite was found to be 50-60 nm. The obtained results from adsorptional experiments indicated an optimal rhodamine B adsorption capacity of 49.97 mg g^{-1} for the $MnFe_2O_4$-MMT composite at pH = 4, an initial dye concentration of 50 mg L^{-1}, an adsorbent dose of 0.10 g, and a contact time of 1 h at room temperature. Pseudo-first-order (correlation coefficients, R^2 = 0.81) and pseudo-second-order models (R^2 = 0.99, calculated adsorption capacity: $q_{e(cal)}$ = 49.26 mg g^{-1}, and experimental adsorption capacity: $q_{e(exp)}$ = 49.16 mg g^{-1}) were used to analyze the kinetic investigation, and the dye adsorption was best characterized by the pseudo-second-order kinetic model. Therefore, compared to the Freundlich isotherm model (R^2 = 0.63), the Langmuir isotherm model (R^2 = 0.98) better represented the adsorption behaviour. The thermodynamic study revealed that the main parameters, including ($\Delta G°$ = -11.53 kJ mol^{-1} @333 K, $\Delta H°$ = 3.70 kJ mol^{-1}, and $\Delta S°$ = 0.05 kJ mol^{-1}), indicated that the adsorption of rhodamine B onto the $MnFe_2O_4$-MMT composite was an endothermic and spontaneous process. High removal efficiency, high dye adsorption capacity, and a low-cost magnetic adsorbent were significant features of the $MnFe_2O_4$-MMT composite for removing rhodamine B.

Keywords: Adsorption, Industrial wastewater, Low cost, Magnetic separation, Nanocomposite