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Analysis of malachite green adsorption on multiple coated graphite oxide/ sand (M-GO/S) composite by incorporating isotherm and kinetic studies

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The increasing discharge of toxic dyes from industrial effluents into aquatic environments poses a severe threat to ecosystems and public health due to the non-biodegradable and carcinogenic nature. This research focuses to investigate the potential suitability of multi-coated graphene oxide–sand (M-GO/S) composite material for removal of malachite green (MG). This composite material was synthesized by 5-time coating of graphene oxide layers on purified river sand using a thermal annealing process. Synthesized composite was characterized by Scanning Electron Microscopy (SEM) and Fourier-Transform Infrared Spectroscopy (FT-IR). In this study, the effects of experimental parameters such as initial MG concentration, pH, composite dosage, and shaking time on MG adsorption were evaluated at room temperature *via* batch adsorption experiments. Then utilizing these optimized conditions, isotherm and kinetic studies were conducted on MG adsorption by the adsorbent and experimental analysis were triplicated. Post-shaking, dye concentration in the supernatant was measured using a UV-Vis spectrophotometer at 617 nm, enabling the determination of MG removal percentages. According to the SEM results, composite appeared as irregularly shaped granules with non-uniform GO coating on the sand surface, while FT-IR outcomes revealed presence of oxygenated functional groups on the surface. Adsorption results indicated the highest MG removal percentage with initial MG concentration (3 mg/L), pH (5), M-GO/S dose (0.09 g), and shaking time (40 min). Among the two isotherm models, the Langmuir isotherm (R^2 =0.9404) is better fitted with data having a maximum adsorption capacity (Q_{max}) of 0.4840 mg/g. Furthermore, kinetic studies revealed the better match with pseudo second order kinetics (R^2=0.9218). These findings revealed that the adsorption mechanism primarily comprises monolayer adsorption by means of a chemical sorption process. Ultimately, these findings suggest that the novel composite could be a promising solution for the removal of positively charged dye molecules such as MG from contaminated water.

Keywords:
Adsorption; graphene oxide; isotherm; kinetics