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Synthesized multi-walled carbon nanotubes as a potential adsorbent for the removal of methylene blue dye: kinetics, isotherms, and thermodynamics

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ABSTRACT

Multi-walled carbon nanotubes (MWCNTs) are a highly effective adsorbent of methylene blue (MB), and they can be used to remove MB from aqueous solutions. In this study, we used MWCNTs that were synthesized by chemical vapor deposition method. The physico-chemical properties of MWCNTs were characterized by Brunauer-Emmett-Teller (BET) surface area, surface functional group analysis by fourier transform infrared (FTIR) analysis, zero point charge (pH_{zpc}), X-ray diffraction (XRD), and transmission electron microscopy (TEM). The factors that affected the adsorption properties of MB onto MWCNTs were investigated, including initial pH, contact time, dosage, initial concentration, and temperature. The equilibrium adsorption data were analyzed using two common adsorption models, i.e. the Langmuir and Freundlich models. The results indicated that the Langmuir isotherm fits the experimental results well. The maximum adsorption capacity obtained from the equation of the Langmuir isotherm at 323 K was 95.30 mg/g, indicating that the MWCNTs adsorbed MB effectively. The kinetic study illustrated that the adsorption of MB onto MWCNTs fits the pseudo-second-order kinetic model. The thermodynamic parameters indicated that the adsorption of MB onto MWCNTs was a spontaneous, endothermic process.

Keywords: Multi-walled carbon nanotubes (MWCNTs); Methylene blue (MB); Adsorption; Kinetics; Thermodynamic parameters

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