Adsorption of dye onto raw and surface modified tamarind seeds: isotherms, process design, kinetics and mechanism

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ABSTRACT

This paper describes the adsorption of basic dye, methylene blue (MB) dye, from aqueous solution using raw tamarind seeds (RTS) and surface modified tamarind seeds (SMTS). The adsorbents (RTS and SMTS) were characterized by using the Fourier Transform Infrared spectroscopy and Scanning Electron Microscopy analysis. The operating parameters such as pH, adsorbent dose, time, initial dye concentration, and temperature that influence the adsorption of MB dye onto adsorbents were investigated. The adsorption equilibrium data were tested by the Langmuir and Freundlich adsorption isotherm model. The results indicated that the adsorption of MB dye onto RTS and SMTS were best fit by the Langmuir and Freundlich model, respectively. The maximum monolayer adsorption capacity for the RTS and SMTS was found to be 16.611 and 34.483 mg/g, respectively. The best described adsorption isotherm model was used to design a single-stage batch reactor. Adsorption kinetics was well described by the pseudo-second-order kinetic model. Adsorption mechanism was explained with the intraparticle diffusion and Boyd kinetic model. The thermodynamic analysis revealed the exothermic and spontaneous nature of adsorption. The results indicated that the tamarind seeds have great potential to remove MB dye from aqueous solution.

Keywords: Adsorption; Isotherms; Kinetics; Methylene blue; Tamarind seeds; Thermodynamics