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Effective removal of methylene blue from aqueous solution by adsorptioonto gasification char: isotherm, kinetic and thermodynamics studies

Abstract

This study presents the preparation of oil palm empty fruit bunch (OPEFB) activated char from gas-ification plant residues via phosphoric acid chemical treatment for adsorption of methylene blue (MB) in aqueous solution. The Fourier-transform infrared (FTIR), scanning electron microscopy (SEM) and Brunauer–Emmett–Teller (BET) analysis were conducted to identify the characteristic of OPEFB. Adsorption experiments were carried out to determine the effects of initial dye concentration 100–300 mg/L, contact time, pH 2–10 and temperature 30°C–60°C. The optimum conditions were achieved at adsorbent dosage, pH, initial dye concentration and temperature of 0.2 g/200 mL, 6, 100 mg/L and 60°C, respectively with 91.44% of MB removal. From isotherm study, the Freundlich isotherm model fitted the adsorption data very well owing to its higher value of correlation factor (R2 = 0.9352), compared to Langmuir model (R2 = 0.8682). The Langmuir maximum monolayer capac-ity, qm was estimated at 167.2 mg/g. The results from the kinetic study showed that the MB adsorp-tion followed a pseudo-second-order kinetic model (R2 = 0.9216–0.9581). The adsorption of the MB dye onto OPEFB activated char was an endothermic and spontaneous process with ΔH°, ΔG° and ΔS° values of 58.379 kJ/mol, –0.70505 kJ/mol and 194.955 J/mol·K, respectively. The obtained results suggest that the OPEFB char could be a promising candidate as an adsorbent for MB removal.

Keywords

Activated carbon; Adsorption; Chemical activation; Gasification char; Methylene blue; Oil palm empty fruit bunch