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Microwave induced activated carbon for the removal of metal ions in fixed-bed column study: modeling and mechanisms

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ABSTRACT

The continuous discharge of metal-containing wastes into the aquatic system leads to a hazardous impact onto the environment and human health. This study investigated the preparation of activated carbon derived from palm-date stone using H_2SO_4 and KOH impregnation followed by microwave-induced irradiation for the adsorption of Fe^{3+}, Cd^{2+}, and Cu^{2+} from solution onto the fixed-bed column. The characterization of prepared adsorbents using scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy showed changes in the structure functional groups between adsorbents according to the used activating agent. Factors that characterize the breakthrough curves and influence the adsorption capacity including bed depth, flow rate, and initial ion concentration were studied. The maximum adsorption capacity is from 11.45 for Cd^{2+} to 85.12 mg/g for Cu^{2+} onto H_2SO_4 impregnated activated carbon (AC1). Adsorption kinetics were analyzed using Thomas, Adam–Bohart, and Yoon–Nelson models at a flow rate of 1 mL/min, bed depth of 3 cm, and initial concentrations of 12.5, 1.5, and 3.3 mg/L for Fe^{3+}, Cd^{2+}, and Cu^{2+}, respectively. Models exhibited good agreement with results experimentally obtained. Statistics showed that both KOH impregnation obtained adsorbent (AC2) and AC1 have similar ($p > 0.05$) fixed-bed adsorption performance.

Keywords: Metal ions; Activated carbon; Adsorption capacity; Breakthrough curve; Fixed-bed column

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