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Application of powdered activated carbon coated with zinc oxide nanoparticles prepared using a green synthesis in removal of Reactive Blue 19 and Reactive Black-5: adsorption isotherm and kinetic models

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ABSTRACT

Dyes considered as a main environmental pollutant are present in various effluents released from different industries like textiles. Dyes cause problems such as reduced light penetration, allergies, and cancer when they are entered into the environment. The purpose of this study was to compare the efficiency of the activated carbon coated with the zinc oxide (ZnO) nanoparticles prepared by walnut shell in removing two dyes from aqueous environments. The study used a floating method to prepare the AC-ZnO composite. The composite structure and morphology were studied using Fourier transform infrared spectroscopy, Brunauer–Emmett–Teller (BET), X-ray diffraction and field emission scanning electron microscopy techniques. The results confirmed the accuracy of the composite structure. Moreover, the study examined reaction time, solution pH, composite volume, and initial dye concentration and AC-ZnO composite recovery. The removal efficiencies under the optimal conditions for Reactive Blue 19 (RB-19) and Reactive Black-5 (RB-5) (dye concentrations 100 mg L^{-1}, composite dose 1.5 g L^{-1}, reaction time 45 min and pH 3) were 97.36% and 73.36%, respectively. The results of the experimental data were fitted well to the Langmuir isotherm, indicating monolayer adsorption of both metal ions onto the AC-ZnO composite and an estimated adsorptive capacity of 71.42 (RB-5) and 94.33 mg g^{-1} (RB-19). However, the kinetic data agreed well with the pseudo-second-order model. The S_{BET} and total pure volume for the AC-ZnO composite and AC were 728.17 m^2 g^{-1}, 687.95 m^2 g^{-1} and 0.684 cm^3 g^{-1}, 0.612 cm^3 g^{-1}, respectively. It can be concluded that AC-ZnO composite as an effective and environmentally friendly adsorbent had a high ability in removing dye from aqueous solutions.

Keywords: Walnut shell; Scrap tires; Green synthesis; ZnO nanoparticle; Dye

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