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Eco-friendly cost-effective approach for synthesis of ZnO nanoparticles and loaded on worn tire powdered activated carbon as a novel adsorbent to remove organic dyes from aqueous solutions: equilibrium, kinetic, regeneration and thermodynamic study

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ABSTRACT

In the present research, activated carbon (AC) was prepared from worn tire specimens and was coated with zinc oxide nanoparticles (ZnO) obtained from pomegranate peel extract. The prepared adsorbent (AC-ZnO) was characterized by field-emission scanning electron microscopy, Brunauer–Emmett–Teller, X-ray diffraction and Fourier-transform infrared spectroscopy analyses. The performance of the AC-ZnO was investigated to remove Acid Black 1 (AB1) dye from aqueous solutions. The results of the adsorption experiment indicated that the removal efficiency declined with increasing dye concentration and solution pH but a decrease in adsorbent dosage caused the efficiency to decline. The findings suggest that the adsorption of AB1 onto the AC-ZnO obeyed the pseudo-second-order model. Equilibrium data were analyzed using the Langmuir and Freundlich isotherm. The data were best described by the Freundlich isotherm model and the maximum adsorption capacity of the AC-ZnO was 93.46 mg/g. Based on the thermodynamic parameters, the adsorption process was non-spontaneous at all temperatures and also the process was endothermic. The AC-ZnO could be regenerated and reused for several cycles and also has high efficiency (71.21%) in removing AB1 dye in the actual wastewater sample. It was implied that AC-ZnO could be employed effectively as a cheap and environmentally friendly adsorbent for AB1 dye removal from wastewater-containing dyes.

Keywords: Green synthesis; Activated carbon; Zinc oxide nanoparticles; Acid Black 1; Adsorption

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