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Performance of zinc hydroxide coated activated carbon in the removal of methylene blue from aqueous solutions

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ABSTRACT

This study aimed to develop and characterize acorn shell-based activated carbon (AC) as a low-cost, abundantly available, highly efficient, and eco-friendly adsorbent. AC was modified ultrasonically using zinc hydroxide, $Zn(OH)_2$, and used effectively for the removal of methylene blue (MB) from aqueous solutions. MB is one of the most commonly used dyestuffs in the textile industry. The resulting products were characterized via analytical methods such as scanning electron microscopy, scanning electron microscopy/energy-dispersive X-ray spectroscopy, X-ray diffraction, and Fourier-transform infrared spectroscopy (SEM, SEM/EDS, XRD, and FTIR, respectively). The influence of different batch parameters, such as initial pH (3–10), adsorbent dosage (0.1–0.3 g/100 mL), temperature (298–318 K), initial dyestuff concentration (25–150 mg L^{-1}), and contact time (0–180 min), on the adsorption process, was examined. The highest maximum adsorption capacity was found to be 117.65 mg g^{-1} at 318 K from the Langmuir isotherm model for $AC/Zn(OH)_2$. The pseudo-second-order model determined the kinetics of MB dyestuff adsorption ($R^2 > 0.99$). According to the results of the thermodynamic parameters, standard negative values of Gibbs free energy, standard enthalpy, and standard entropy values were positive. These results revealed the endothermic nature of the adsorption process. After considering all the results, it was concluded that $AC/Zn(OH)_2$ adsorbent shows promise due to its manufacturability from a cheap source, high adsorption capacity, and short production time in addition to possessing eco-friendly characteristics, for removing MB dyestuff from aqueous solutions.

Keywords: Methylene blue; Activated carbon; synthesis; Ultrasonic support; Kinetic and isotherm

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