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Synthesis and performance of pomegranate peel-supported zero-valent iron nanoparticles for adsorption of malachite green

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ABSTRACT

Nanoscale zero-valent iron (NZVI) supported by carbonized pomegranate peel (CPP) was synthesized by liquid-phase chemical reduction and characterization of the composites was carried out with Fourier transform infrared spectroscopy, scanning electron microscopy, X-ray diffraction, pH_{zpc} (zero point of charge) and Brunauer–Emmett–Teller. NZVI/CPP composites were tested as adsorbents in the disposal of malachite green (MG) with certain parameters. The maximum adsorption value of MG was obtained as 99.7% for the adsorbent dose of 0.15 g in 30 min of equilibration time. The most suitable isotherm was obtained as the Langmuir isotherm (R^2 = 0.98) with the analysis of equilibrium data, and the maximum adsorption capacity (q_m) was found as 32.47 mg/g. The pseudo-second-order kinetic model ($R^2 \geq 0.994$) was found to be the best fit to the experimental data in comparison with the other models. The experimental results obtained at different temperatures were analyzed and adsorption was determined to occur endothermically and spontaneously due to the $\Delta H°$ value of 110.27 kJ/mol and $\Delta G° \leq -0.89$ kJ/mol, respectively. The positive values of $\Delta S°$ indicated that the irregularity in the interface between the NZVI/CPP adsorbent and the MG solution increased. NZVI/CPP may be used instead of active carbon for dye removal in industrial wastes due to its low cost and good performance.

Keywords: Malachite green; Pomegranate peel; Nano zero-valent iron; Isotherm; Kinetics; Thermodynamics

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