Surface modification of multi-walled carbon nanotubes for dye removal aqueous solutions based on the response surface modeling

Yousef Alinezhad*,

Abstract In this research work, response surface method was used to optimize malachite green (MG) removal aqueous solutions using magnetic nanocomposite of multi-walled carbon nanotube (SMNC). Synthesize of the nanocomposite of the carbon nanotubes was done during two steps including formation of iron oxide nanoparticles and then, covering them by silica nanoparticles. Characterization of the synthesized nanocomposite was performed by field emission scanning electron microscopy (FESEM), Fourier transform infrared spectrometry (FTIR), X-ray diffraction (XRD) and enery dispersive X-ray spectroscopy (EDX). The experiments were carried out based on a Box-Behnken design with four input variables including adsorbent dosage (0.08-0.2 g L-1), contact time (20-30 min), pH (3–9) and ionic strength (0.02-01 mol L-1) and dye concentration of 5 mg L-1 was taken as a fixed factor. Regression analysis of the experimental data resulted in a second-order polynomial model with coefficient of determination (R2) of 0.974 and Fisher ratio of 36.78. Quality of the developed model was validated by analysis of variance, lack of fit test and residual analysis. The second-order model predicted the optimum conditions of MG removal by SMNC as adsorbent dosage of 0.192 g L-1, pH=6.26, contact time of 25.1 minutes and ionic strength of 0.03 mol L-1 with a response of 100.18%. Experimental test in this conditions resulted in dye removal of 98.42% which showed high accuracy of the response surface method in modeling and optimizing MV removal aqueous solutions using SMNC nanocomposite. Moreover, the studies indicated that MG adsorption onto the synthesized nanocomposite followed the Freundlich isotherm and pseudo second-order kinetic model. Keywords: Dye removal; Response surface method; Multi-walled carbon nanotube; Magnetic nanocomposite; Malachite green

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