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Comparative studies on removal of methyl orange and sunset yellow dyes using ZnS:Cu–NPs–AC: optimization, equilibrium, kinetic and thermodynamic studies

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ABSTRACT

Copper- doping zinc sulfide nanoparticles (ZnS:Cu–NPs) were synthesized and subsequently in the presence of ultrasound waves were immobilized on activated carbon (ZnS:Cu–NPs–AC). This nanocomposite was characterized by scanning electron microscopy and X-ray diffraction techniques. This material was used for ultrasound-assisted adsorption of methyl orange (MO) and sunset yellow (SY) dyes in single solution, and obtained results were compared with each other. It has been demonstrated that the removal percentage can be improved by the combination of ultrasonication and adsorption processes. The best pH searched via one factor-at-a-time method was found to be 5.0 for each dye. Subsequently, initial concentration of dyes (mg L^{-1}), amount of ZnS:Cu–NPs–AC (g) and sonication time (min) influence on dyes' removal percentage were studied by central composite design combined with desirability function. Desirability scores of 0.9086 and 0.9441 correspond to maximum removal percentage of 97.37% and 86.54% was found for MO and SY respectively. These predictive models were attained at 6.64 and 12 mg L^{-1} of MO and SY concentration, 0.018 and 0.029 g of ZnS:Cu–AC and 4.0 and 4.5 min of sonication time for MO and SY, respectively. The adsorption rate well fitted by pseudo-second order for two dyes, while adsorption capacity according to the Langmuir model as best equilibrium isotherm for MO and SY was found to be 44.65 and 50.54 mg g^{-1}, respectively. The comparison of obtained results shows that ZnS:Cu–NPs–AC has better performance for SY toward MO adsorption.

Keywords: Methyl orange; Sunset yellow; Copper-doping zinc sulfide nanoparticles; Activated carbon; Desirability function

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