

FACTORIAL DESIGN AND RSM FOR OPTIMIZATION OF DYES ADSORPTION FROM WASTEWATER BY MAGNETIC NANOCOMPOSITE

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Abstract

The textile industry consumes large amounts of water during technological processes, thus generating large amounts of wastewater, which contain polluting dyes [1]. The treatment of textile wastewaters has become a worldwide concern in order to protect the aquatic environment [2]. Factorial design and Response Surface Methodology (RSM) are powerful tools in optimizing conditions for dyes removal by adsorption [3]. The paper presents a factorial design experiment carried out in order to establish the optimal conditions for removal of dyes by adsorption with maximum yields and reduced resources. A magnetic nanocomposite based on activated carbon and iron oxide (magnetite) was synthesized by the combustion method [4], characterized, and applied as adsorbent material for the removal of dyes from wastewater by adsorption. The adsorption experiments of dyes were design based on three factors: solution pH, initial dye concentrations (C_{AO7} , C_{MB} and C_{ChS}), and adsorbent dosage (D_S). Using the experimental design matrix, a regression analysis was performed in order to find the best empirical model that evidences the maximum removal efficiency for investigated dyes. Optimal working conditions were established using the contour maps and 3D representations for each pair of factors present in the model. High removal efficiencies of over 92% for AO7, 99% for MB and 60% for Ch-S were obtained, even working under normal conditions: natural solution pH, and room temperature (25°C).

The study was extended to the simultaneous adsorption of dyes from bicomponent systems. Very good removal efficiencies, up to 98%, were obtained for the removal of the investigated dyes from bicomponent systems.

The kinetic studies indicated that the model that best describes the adsorption process for the investigated dyes was the pseudo-second order kinetic model. The equilibrium data were best fitted by the Sips isotherm model and a maximum adsorption capacity of 136.36 mg/g, 132.59 mg/g and 146.26 mg/g was obtained for AO7, MB and Ch-S respectively.

Six consecutive adsorption-desorption cycles were performed, and the high regeneration and reusability of the nanocomposite was demonstrated by the high removal efficiency of over 75% for AO7 and MB dyes and over 59% for Ch-S dye after the sixth use as adsorbent.

The obtained results demonstrate that the synthesized magnetic nanocomposite is a promising adsorbent material for the removal of dyes from single and binary systems. Optimization of the adsorption process using Factorial design and RSM proved to be an efficient method to determine the optimal working conditions that predict the highest dye removal yields.

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References

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