

Application of Response Surface Methodology in Optimizing Chitosan-Argan Nutshell Beads for Radioactive Wastewater Treatment

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Abstract : The presence of radioactive contaminants in wastewater poses a significant environmental and health risk, necessitating effective treatment solutions. This study investigates the optimization of chitosan-Argan nutshell beads for the removal of radioactive elements from wastewater, utilizing Response Surface Methodology (RSM) to enhance the treatment efficiency. Chitosan, known for its biocompatibility and adsorption properties, was combined with Argan nutshell powder to form composite beads. These beads were then evaluated for their capacity to remove radioactive contaminants from synthetic wastewater. The Box-Behnken design (BBD) under RSM was employed to analyze the influence of key operational parameters, including initial contaminant concentration, pH, bead dosage, and contact time, on the removal efficiency. Experimental results indicated that all tested parameters significantly affected the removal efficiency, with initial contaminant concentration and pH showing the most substantial impact. The optimized conditions, as determined by RSM, were found to be an initial contaminant concentration of 50 mg/L, a pH of 6, a bead dosage of 0.5 g/L, and a contact time of 120 minutes. Under these conditions, the removal efficiency reached up to 95%, demonstrating the potential of chitosan-Argan nutshell beads as a viable solution for radioactive wastewater treatment. Furthermore, the adsorption process was characterized by fitting the experimental data to various isotherm and kinetic models. The adsorption isotherms conformed well to the Langmuir model, indicating monolayer adsorption, while the kinetic data were best described by the pseudo-second-order model, suggesting chemisorption as the primary mechanism. This study highlights the efficacy of chitosan-Argan nutshell beads in removing radioactive contaminants from wastewater and underscores the importance of optimizing treatment parameters using RSM. The findings provide a foundation for developing cost-effective and environmentally friendly treatment technologies for radioactive wastewater.

Keywords : adsorption, argan nutshell, beads, chitosan, mechanism, optimization, radioactive wastewater, response surface methodology

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