World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:19, No:01, 2025

Response Surface Methodology for the Optimization of Radioactive Wastewater Treatment with Chitosan-Argan Nutshell Beads

Authors : Fatima Zahra Falah, Touria El. Ghailassi, Samia Yousfi, Ahmed Moussaif, Hasna Hamdane, Mouna Latifa Bouamrani

Abstract : The management and treatment of radioactive wastewater pose significant challenges to environmental safety and public health. This study presents an innovative approach to optimizing radioactive wastewater treatment using a novel biosorbent: chitosan-argan nutshell beads. By employing Response Surface Methodology (RSM), we aimed to determine the optimal conditions for maximum removal efficiency of radioactive contaminants. Chitosan, a biodegradable and non-toxic biopolymer, was combined with argan nutshell powder to create composite beads. The argan nutshell, a waste product from argan oil production, provides additional adsorption sites and mechanical stability to the biosorbent. The beads were characterized using Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and X-ray Diffraction (XRD) to confirm their structure and composition. A three-factor, three-level Box-Behnken design was utilized to investigate the effects of pH (3-9), contact time (30-150 minutes), and adsorbent dosage (0.5-2.5 g/L) on the removal efficiency of radioactive isotopes, primarily focusing on cesium-137. Batch adsorption experiments were conducted using synthetic radioactive wastewater with known concentrations of these isotopes. The RSM analysis revealed that all three factors significantly influenced the adsorption process. A quadratic model was developed to describe the relationship between the factors and the removal efficiency. The model's adequacy was confirmed through analysis of variance (ANOVA) and various diagnostic plots. Optimal conditions for maximum removal efficiency were pH 6.8, a contact time of 120 minutes, and an adsorbent dosage of 0.8 g/L. Under these conditions, the experimental removal efficiency for cesium-137 was 94.7%, closely matching the model's predictions. Adsorption isotherms and kinetics were also investigated to elucidate the mechanism of the process. The Langmuir isotherm and pseudo-second-order kinetic model best described the adsorption behavior, indicating a monolayer adsorption process on a homogeneous surface. This study demonstrates the potential of chitosan-argan nutshell beads as an effective and sustainable biosorbent for radioactive wastewater treatment. The use of RSM allowed for the efficient optimization of the process parameters, potentially reducing the time and resources required for large-scale implementation. Future work will focus on testing the biosorbent's performance with real radioactive wastewater samples and investigating its regeneration and reusability for long-term applications.

Keywords : adsorption, argan nutshell, beads, chitosan, mechanism, optimization, radioactive wastewater, response surface methodology
Conference Title : ICC 2025 : International Conference on Chemistry
Conference Location : New York, United States
Conference Dates : January 30-31, 2025