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Chitosan-based composite beads for effective removal of heavy metals from aqueous solutions

Sabrina A. Shaikh & Hemlata Bagla

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ABSTRACT

This study introduces a novel composite material, composed of Dry Cowdung Powder (DCP), Humic Acid (HA), Chitosan (C), and Bentonite (B), developed for the efficient removal and recovery of metal ions from

enhance structural stability, maximize surface area, and minimize agglomeration in acidic media. Chitosan, a biopolymer with amino and hydroxyl groups, facilitates metal ion adsorption through chelation and electrostatic interactions, while bentonite enhances mechanical strength and cation exchange capacity. The inclusion of DCP and HA further improves the composite's biosorption capabilities. The prepared composite beads were characterized using Fourier Transform Infrared Spectroscopy (FTIR), Atomic Force Microscopy (AFM), Field Emission Scanning Electron Microscopy (FESEM), and Energy Dispersive X-ray Spectroscopy (EDS) to assess their structural and chemical properties. Adsorption experiments using radiotracer showed high efficiency in representative metal ions removal i.e. 88 ± 3% for Ag(I) and 92 ± 2% for Zn(II) in batch studies. The column studies also showed a similar trend with 93.77% for Ag(I) and 96.28% for Zn(II). The quantitative desorption of metal ions using HCl suggested the possibility of regeneration and reuse of the composite beads developed in the present work. The composite beads' reasonably good efficiency in continuous-flow systems highlights the scalability of the water treatment process based on the composite chitosan beads developed in the present work for industrial wastewater treatment applications. This research provides a sustainable and effective approach to environmental remediation, contributing to advancements in wastewater purification technologies.

KEYWORDS:

Chitosan composite beads metal ions adsorption column mode

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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