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ADVANCED SUSTAINABLE WASTEWATER TREATMENT: A COMPREHENSIVE EVALUATION OF PROMISING ADSORBENTS THROUGH OPTIMIZATION OF COLUMN STUDIES

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Abstract

This research explores innovative wastewater treatment using agricultural waste materials as adsorbents, focusing on rice husk ash (RHA), sugarcane bagasse (SB), and ferric oxide-coated sand (Fe-S) to address water pollution and meet irrigation water quality standards. Comprehensive analysis was conducted using column studies, Response Surface Methodology (RSM), and Fourier Transform Infrared (FTIR) spectroscopy. Initial evaluations indicated that untreated sewage water contained contaminant levels exceeding permissible limits for irrigation. RSM optimization of bed depth, contact time, and sample load in column studies demonstrated high desirability values: 0.865 for RHA, 0.919 for SB, and 0.825 for Fe-S, with significant coefficients and R-squared values above 0.86 validating the models' reliability. FTIR analysis revealed RHA's high adsorption capacity due to siloxane groups, while SB showed significant structural and chemical modifications post-treatment, and Fe-S displayed adaptability through changes in Si-O and Fe-O vibrations. RHA and SB treatment effectively reduced fecal coliform contamination by 80-90%. This study elucidates the structural properties and optimized operational conditions of these adsorbents, presenting them as promising, sustainable, and cost-effective solutions for wastewater treatment.

Key words: adsorbents, column study, RSM, FTIR, E-coli, wastewater treatment

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