A mechanistic approach to evaluate the effectiveness of red soil as a natural adsorbent for phosphate removal from wastewater

Prangya Ranjan Rout, Puspendu Bhunia*, Rajesh Roshan Dash

Department of Civil Engineering, School of Infrastructure, Indian Institute of Technology Bhubaneswar, Bhubaneswar, Odisha 751 013, India
Tel. +91 674 2306355; Fax: +91 674 2301983; email: pbhunia@iitbbs.ac.in
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ABSTRACT

The present study was conducted to investigate the efficacy of red soil (RS), as a natural adsorbent, for phosphate removal from wastewater. The chemical composition of the adsorbent was determined by proton-induced X-ray emission and proton-induced \( \gamma \)-ray emission methods. Apart from evaluating the influence of major experimental parameters, the equilibrium data were analyzed by different isotherm models and kinetic models. Experimentally obtained values, such as separation factor (\( R_L \)), 0.0297, Freundlich exponent (\( n \)), 2.994, and Gibb’s free energy change (\( \Delta G^\circ \)), \(-1.279\) kJ mol\(^{-1}\), suggest that the phosphate adsorption by RS was a favorable and spontaneous process. The presence of coexisting anions showed no competing effects on phosphate removal efficiency. For synthetic initial phosphate concentration of 20 mg L\(^{-1}\) and contact time of 90 min, phosphate removal efficiency was 96.47% in batch mode and 19 h of breakthrough time in column mode. Whereas with real domestic wastewater having 5.62 mg L\(^{-1}\) of initial phosphate concentration, removal efficiency was as high as 99.8% in batch mode and 70 h breakthrough time in column mode. The results of this study suggested that RS can be used as a low-cost and highly efficient adsorbent for phosphate removal from wastewater.

Keywords: Red soil; Phosphate removal; Real domestic wastewater; Adsorption isotherm; Adsorption kinetics

*Corresponding author.

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