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Red-Earth Material as a Novel Adsorbent for the Removal of Phosphates from Aqueous Media

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Abstract

Phosphate removal is now a major environmental concern as many aquatic ecosystems are affected by cultural eutrophication. Harmful algae blooms arising from eutrophication are seen on the surface waters, making water resources less appealing for domestic, industrial, and other recreational activities. Adsorption is recognized as an effective method of removing excess phosphate from aqueous solutions. This preliminary study centres on investigating the feasibility of the adsorption of phosphates (PO_4^{3-}) onto Red Earth, commonly found in the Northcentral and North-western provinces of Sri Lanka. In this study, red earth-based adsorbents have been prepared via acid activation and acid-thermal activation methods. X-ray diffraction (XRD), X-ray fluorescence (XRF), and Fourier Transform Infrared Spectroscopy (FT-IR) were performed to characterize the prepared adsorbent materials. The adsorption capacities and the effect of the column parameters on phosphate removal were examined using column studies. The column study employed nonactivated and activated soil particles in the size range of 125-250 microns, packed in a 1 cm diameter and 20 cm length column. Experimental data suggested that sorption mainly depends on column parameters of bed height, flow rate, and inlet feed concentrations and is less dependent on pH, and co-existing anions. Breakthrough curves were analysed for different bed heights (4.5 cm, 6.0 cm, 7.5 cm), initial concentrations (50.0 mg/L, 75.0 mg/L, 100.0 mg/L), and flow rates (1.15 $mLmin^{-1}$,3.62 $mLmin^{-1}$). It has observed the highest adsorption capacity of 2.05 P mg/g at optimum conditions (7.5 cm, 100 mg/L, 1.15 $mLmin^{-1}$). Column Adsorption behaviours were evaluated with Thomas and Yoon-Nelson's mathematical models. Preliminary outcomes of sorption-desorption regeneration cycles depict that phosphate uptake is not entirely reversible. Since red-earth is still not utilized for any specific application, this study's results and outcomes magnify the red earth mineral's feasibility as an easily abundant, cost-effective, green sorbent to remove phosphate pollution from aqueous media.

Keywords: Red-earth, Phosphate, Adsorption, Column study, Breakthrough curves