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Defluoridation Behaviour of Laterite under Different pH, Contact Time, Fluoride Loading and Co-existing ions

Lakmal Jayarathna, R.M.A.U. Rajapaksha and Meththika Vithanage

Chemical and Environmental Systems Modelling Laboratory,
Institute of Fundamental Studies, Kandy, Sri Lanka.
(*e-mail: lakmalipj@yahoo.co.uk*)

ABSTRACT

Fluoride contamination in water is a worldwide problem. In this study, the efficacy of laterite was tested on removing fluoride in drinking water. The particle morphology of laterite was characterized by XRF, XRD and FT-IR analysis. Diffused Double Layer (DDL) model was used to calculate surface reaction constants for >FeOH and >AlOH sites in laterite. Defluoridation of drinking water using laterite powder as an adsorbent was studied in batch process. Different parameters influencing adsorption, such as the pH, ionic strength, common cations and anions, dose and contact time were examined. Maximum fluoride uptake was 11.5 mg/g at pH 5.10. Freundlich model showed the best fit for the fluoride–laterite interaction indicating heterogeneous surfaces as well as multilayer adsorption. High adsorption of fluoride was observed at low pH levels (pH < 6.5) however, adsorption decreased with increasing pH. Fluoride adsorption did not show any variation with the ionic strength indicating inner-sphere bond formation with laterite surface sites. The impact of major anions on fluoride adsorption followed the order: PO_4^{3-} > HCO_3^- > SO_4^{2-} >Cl^-, reflecting the relative affinity of these anions for laterite. With the presence of PO_4^{3-} fluoride adsorption decreased and due to the inner-sphere complexation of PO_4^{3-} with laterite surface. However, Ca^{2+} and Mg^{2+} increased adsorption affinity of fluoride. Adsorption of fluoride resulted in changes such as disappearance of bands, shifts and decrease in the percentage of transmittance in the IR spectra of the solid surface. Continuous flow experiments showed the maximum removal efficiency at the initial stage where there are many free surface sites and the efficiency gradually decreased reaching equilibrium after 180 minutes. Therefore, laterite can be considered as an alternate material for defluoridation but further studies are necessary to determine efficiency and replacement time using different size fractions in flow through columns.