Granular laterite for batch and column studies of phosphate removal and its modification with iron for enhancing the adsorption property

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ABSTRACT

An aluminum iron-rich laterite with granular shape was developed as a phosphate absorbent candidate. Batch tests showed that phosphate sorption on the granular laterite (GL) was fitted well with the Langmuir and Freundlich models. The kinetics was the pseudo-second-order reaction. The physical characterization suggests that the adsorption and precipitation are responsible for P removal. Moreover, the adsorption of phosphate was highly pH dependent as high P removal amount was observed in the acidic solution. The presence of concomitant anions inhibited phosphate adsorption onto GL in the descending order of extent NO$_3^-$ > SO$_4^{2-}$ > Cl$^-$. Column experiments were carried out under a constant bed depth at different influent concentrations, which demonstrated that the capacities of the exhaustion point decreased with the increase of the influent concentration. Based on the results above, GL doped with iron was prepared. According to the response surface methodology, a Box–Behnken design (BBD) was applied to give the optimized preparation conditions (quality percentage concentration of 43%, activation time of 2.13 h, and impregnation time of 0.5 h). The estimated phosphorus sorption capacity under the optimized conditions was 1.542 mg P/g, which was much higher than that using GL without modification.

Keywords: Phosphate removal; Granular laterite (GL); Column adsorption; Granular laterite doped with iron (GL-Fe); Response surface methodology (RSM)

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