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Efficient adsorption of phosphate by a kaolin-alginate composite

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Water bodies and waterways are increasingly contaminated by phosphates, from fertilizer run-off in agriculture and effluents from human and animal waste, and consumer products causing eutrophication.

In this study, we prepared a novel adsorbent from readily available kaolin and alginate, cross linked with Al^{3+} for phosphate adsorption.

Kaolin was added to 2.5% alginate solution and stirred for 24 hours to obtain a homogeneous mixture. The mixture was added dropwise to a 5% Al^{3+} solution and the resulting beads kept in Al^{3+} solution for 48 h to complete the solidification process of the composite. It was then washed with deionized water, dried at 70 °C, ground and sieved to obtain 250-350 µm particles. All the experiments were conducted using 0.25 g of the composite in 25 mL of 5 mg L^{-1} phosphate solution, which were shaken at 100 rpm. Experiments were conducted to determine the optimum time for maximum adsorption, optimum pH, kinetic, isotherm and thermodynamic modeling of the composite.

The maximum adsorption of 91.83% was observed at 90 minutes. The optimum pH range was 3-9 where the composite is more attractive towards $H_2PO_4^-$ ion. The kinetic data fitted well to the pseudo 2nd order model with 0.2352 g mg^{-1} min^{-1} rate constant. The rate of the adsorption was controlled by intraparticle and liquid film diffusion models. Adsorption isotherm data agreed with Langmuir, Dubinin-Radushkevich and Langmuir-Freundlich models. According to the Langmuir model the maximum adsorption capacity was 6.77 mg g^{-1}. The thermodynamic study indicated the adsorption was spontaneous and endothermic process.

Our study suggests that the kaolin-alginate composite is an environmentally friendly and cost-effective green material to remediate phosphate from aqueous environments.

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