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Removal of phosphate from aqueous solutions using modified activated carbon prepared from agricultural waste (*Populous caspica*): optimization, kinetic, isotherm, and thermodynamic studies

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ABSTRACT

Activated carbon was successfully prepared from *Populous caspica* wood by a thermochemical reduction method and modified by grafting amine groups. In the batch tests, pH, initial phosphate concentration, reaction time, and adsorbent dose were evaluated to remove phosphate (PO_4^{3-}) from the aqueous phase. The response surface method was chosen to study the composition effect of independent input factors and one dependent output response (removal efficiency). The *p*-value (2.2×10^{-16}), *F*-value (116.6), R^2 (multiple: 0.9774, adjusted: 0.97), and lack of fit (0.167) indicated that the reduced quadratic model is highly significant for the phosphate removal using aminated activated carbon. The maximum efficiency removal of phosphate (92.76%) was obtained at pH, initial phosphate concentrations, contact time, and adsorbent dose of 3, 10 mg L^{-1}, 60 min, and 90 mg L^{-1}, respectively. The adsorption data fitted well with the Freundlich isotherm and pseudo-second-order kinetic model. Therefore, the intraparticle diffusion was the dominant adsorption mechanism but it was not the sole rate controlling step. In addition, regeneration process with five repetitions of regeneration cycles showed high desorption efficiencies and slight loss of spent adsorbent initial adsorption capacity. Thus, the results recommended that modified activated carbon prepared from agricultural waste (*P. caspica*) could properly remove phosphate from aqueous solution.

Keywords: Agricultural waste; Amination; Phosphate; Optimization; Kinetic; Isotherm

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