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Fixed-bed column and batch reactors performance in removal of diazinon pesticide from aqueous solutions by using walnut shell-modified activated carbon

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Abstract

This paper evaluates adsorption of diazinon pesticide from aqueous solution onto walnut shell-modified activated carbon using fixed-bed column and batch system. Contact time, initial concentration, and pH were considered as variable parameters to obtain maximum adsorption capacity using batch technique. The pseudo-first-order, the pseudo-second-order, and Webber and Morris models were chosen to analyze adsorption kinetic data. The results indicated that adsorption process followed closely the pseudo-second-order kinetic model. The equilibrium adsorption data fitted the Freundlich isotherm well, with K_f = 53.82, n= 1.98, and R^2= 0.9966. For continuous fixed-bed column studies, the effect of inlet concentration (15-40 mg.lit^{-1}), flow rate (9.5-16.5 lit.h^{-1}), and bed height (10-30 cm) was investigated. Results showed that increase in inlet concentration and also bed height lead to increase of bed capacity. In addition, changes in flow rate from 9.5 to 14.5 lit.h^{-1} caused a decrease in bed capacity. However, a minor increase in bed capacity was observed via an increase in flow rate from 14.5 to 16.5 lit.h^{-1}. The highest bed capacities were 34.98 and 34.31 mg.g^{-1} for the same initial concentration of 40 mg.lit^{-1}, flow rates of 12 and 9.5 lit.h^{-1}, and bed heights of 30 and 20 cm, respectively. Dynamic behavior of column was investigated by Bohart-Adams and Yoon-Nelson models. According to obtained results, Yoon-Nelson model can describe well the adsorption process. The findings of the current study show that the walnut shell-modified activated carbon can be successfully applied to remove diazinon pesticide from aqueous solution.

Highlights

- Increase in surface area of commercial activated carbon with a simple modification.
- Significant removal of diazinon from aqueous solution in the pH ranges of 1.5-10.
- The pseudo-second-order model is the best to analyze adsorption kinetic.
- Flow rate, initial concentration, and bed height were the experimental conditions.
- The highest bed capacity was 34.98 mg.g^{-1} with flow rate of 12 lit.h^{-1}.

Keywords: Diazinon, Walnut shell, Adsorption, Fixed-bed column, Isotherms