A two-stage batch system for phosphate removal from wastewater by iron-coated waste mussel shell to assess the optimum adsorbent dosage

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ABSTRACT

High amounts of phosphate discharged in receiving water can lead to eutrophication. Once a water body is enriched with phosphate, it can prompt the growth of plants and cause algal blooms. The water body may also lose its important functions and cause adverse effects on the environment and human health. In this study, removal of phosphate from domestic wastewater treatment plant effluent was elucidated using iron-coated waste mussel shell. The phosphate adsorption by iron-coated waste mussel shell was examined with respect to initial phosphateconcentration (7 mg L–1), solution volume (0.2 L), adsorbent dosage (4–20 g), and contact time (1–5 day). The chemical composition of iron-coated waste mussel shell was analyzed using energy dispersive X-ray fluorescence spectrometer. The measurement of the specific surface area of iron-coated waste mussel shell was performed by multiple-point method according to the Brunauer, Emmett, and Teller theory. Several kinetic models (i.e., pseudo-first order and pseudo-second order) and isotherm models (i.e., Freundlich and Langmuir) were used to describe the adsorption behavior. The optimum removal efficiency of phosphate can reach at 95.7% after 120 h with the amount of iron-coated waste mussel shell used to run the experiment was 20 g and the treated effluent phosphate concentration of 0.3 mg L–1, was verified. Experimental data can be well described by pseudo-second order kinetic model (R2 > 0.99) and Freundlich isotherm model (R2 = 0.93), suggesting that chemisorption and multilayer adsorption occurred. Furthermore, a two-stage batch system was proposed to assess the optimum adsorbent dosage for phosphate removal. The two-stage system has contributed to reduce iron-coated waste mussel shell dosage by 56.94%, as compared to one-stage and thus reduced the operating cost of iron-coated waste mussel shell.

KEYWORDS

Adsorption; Eutrophication; Isotherm model; Kinetic model; Phosphate; Two-stage batch system; mussel shell

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