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Equilibrium modeling for adsorptive removal of Indosol Black NF dye by low-cost agro-industrial waste: batch and continuous study

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ABSTRACT

In the present study, a low-cost agricultural waste, peanut husk, has been used as a potential biosorbent in native, pretreated and sodium-alginate immobilized form for the adsorptive removal of Indosol Black NF dye from aqueous solutions. Pretreatment of peanut husk with a chelating agent, polyethyleneimine, significantly enhanced its biosorption capacity. Different important process parameters like pH, contact time, biosorbent dose, initial dye concentration, and temperature were optimized during the study. The biosorption process was found to be feasible at acidic pH and was exothermic in nature. An agitation time of 15–30 min was sufficient to get equilibrium with native and pretreated biomass while immobilized biomass took 1 h for attainment of equilibrium. Maximum biosorption capacity (89.6 mg/g) was with pretreated biomass. Dye biosorption process followed pseudo-second-order kinetic model and equilibrium data fitted well to Langmuir isotherm model. Thermodynamic study indicated the spontaneity of biosorption process at lower temperatures. Continuous mode study was carried out to optimize the important parameters like bed height, flow rate, and initial dye concentration. Thomas and bed depth service time models were applied to the column study data. Maximum biosorption capacity in continuous mode study was 40.32 mg/g. Surface analysis of peanut husk biomass was carried out using Fourier transform infrared (FTIR) and scanning electron microscopy (SEM). FTIR analysis showed the involvement of hydroxyl, carbonyl, and carboxyl groups in the biosorption process. The results indicated that peanut husk could be used for treatment of wastewater containing dyes.

Keywords: Indosol Black NF; Biosorption; Batch studies; Kinetics; Thermodynamics

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