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Rice Husk Char-Clay Composite for the Adsorption of Methylene Blue Dye

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Abstract

Contamination of water bodies due to the release of wastewater containing dyes is a worldwide environmental problem and hence treatment before discharging is particularly important. In this study, adsorption of Methylene Blue dye from aqueous solutions onto a novel adsorbent; rice husk char-clay composite; was studied. Rice husk was burnt at 300° C at a heating rate of 10^0 C increase per minute with the total residence time of 45 minutes. Rice husk char thus obtained was grounded and the composite was prepared by mixing rice husk char and clay to the weight ratio of 9:16 and extruding to approximately 0.5 cm diameter pellets. Two types of adsorbents were prepared with clay burnt at 450° C for 1 hour and with unburnt clay. A series of batch adsorption experiments were performed to determine the factors affecting adsorption. For both types of composites, maximum removal of dye was observed at an initial dye concentration of 20 mg/l. In particular, an extensive analysis was made on solution pH variation during the adsorption process. Batch experiments at various initial pH values were carried out, and solution pH profiles with the adsorption time were also evaluated. The pH values considered for the experiment were 6, 7, 8, 9 and 10. Optimum pH values for the maximum dye removal were obtained for burnt clay at 7 and for the unburnt clay at 10. Composite made of burnt clay showed higher dye removal compared to unburnt clay composite. Experimental data were fitted to pseudo first order and second order kinetic models and related parameters, initial adsorption rate (h) and rate constant (k_2) were estimated. The results showed that kinetic data of the system best fits the pseudo second order model for burnt clay composite with initial adsorption rate (h) as 12.937 mg g^{-1} min^{-1} and rate constant (k_2) 0.136 g mg^{-1} min^{-1}. The highest initial dye uptake of 12.9 mg/g was observed for burnt clay composite. Langmuir and Freundlich isotherms were used to fit the equilibrium data successfully and constants were calculated. Accordingly, for burnt clay these values were obtained adsorption coefficient (b) as 1.28, constant related to adsorption capacity (k) as 4.96, constant related to adsorption intensity (n) as 2.42 and amount of solute adsorbed per unit weight of adsorbent corresponding to complete coverage of available sites (qo) as 10.21 mg g^{-1}. Results revealed that Freundlich isotherm fits the burnt clay composite and Langmuir model fits the unburnt clay composite. Based on these experimental results, application of rice husk char burnt clay composite in removal of dye from wastewater is suggested.

Keywords: Rice husk char, Adsorption, Methylene-blue