

Experimental investigation and thermodynamic and kinetic study of cobalt removal aqueous solutions using rice waste

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The presence of toxic heavy metals such as cobalt in the effluent of the industrial wastewater treatment plants and subsequent contamination of water resources is of a serious concern in many countries. Adsorption process is one of the most efficient and widely used water and wastewater treatment technologies in the world. So far valuable efforts have been made to develop low-cost adsorbents using agricultural, industrial and municipal waste. Rice husk as an organic solid waste has a high ability to remove heavy metal ions wastewater and can be very effective in the treatment of industrial effluents, which are the main sources of water and soil infection to heavy metals. In this thesis, removal of cobalt heavy metal aqueous solutions by crude and modified rice husk through adsorption was investigated. In adsorption experiments the effect of important parameters such as contact time, adsorbent dosage, pH, temperature and concentration were examined. The equilibrium time for the raw and modified sorbent was obtained to be 20 minutes. Examination of the pH effect pH=3 to pH=6 showed that the maximum adsorption occurs at pH=6. Investigation of the effect of temperature changes (10, 25 and 35 °C) showed that increasing of the temperature has a negligible positive effect on the process. The percentage of adsorption and adsorption capacity of cobalt in the optimum condition by the raw adsorbent were 54.19% and 20.53 mg/g, respectively. Three different modification methods were applied to the adsorbent and adsorption experiments using the modified adsorbents were performed under the achieved optimum conditions for the raw adsorbent. Modified adsorbent with 0.1 M hydrochloric acid, 0.1 M sodium hydroxide and 0.5 M sodium hydrogen carbonate resulted removal percentages of respectively 93.84%, 99.37% and 92.55%. In addition, adsorption capacities of these modified adsorbents were 37.54, 39.75 and 37.02 mg/g,

respectively. Two Langmuir and Freundlich adsorption isotherms were considered for analyzing the attained equilibrium data at 25 °C and a good agreement between experimental results and the Langmuir isotherm was observed. In order to describe the adsorption kinetics, pseudo-first-order and pseudo-second-order kinetic models were examined and the pseudo-second-order model was most consistent with the experimental data. Thermodynamic parameters such as standard Gibbs free energy changes (ΔG^0), standard adsorption enthalpy changes (ΔH^0) and standard adsorption entropy changes (ΔS^0) were calculated using equilibrium data at different temperatures. Negative ΔG^0 values at all temperatures indicated that adsorption of Cobalt on the rice husk is a spontaneous process. Moreover, positive ΔH^0 values indicated that this adsorption process is endothermic.

Keywords : Thermodynamic study, Kinetic study, Cobalt removal, Rice waste.

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