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Equilibrium and Kinetic Parameters Determination of Cr(VI) Adsorption by Hogla Leaves (Typha elephantina Roxb.)

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Abstract

Equilibrium and kinetic parameters of Cr(VI) adsorption on Hogla leaves (Typha Elephantina Roxb.) were determined during a batch process. Batch adsorption experiments were administered as a function of pH, adsorbent dosage and initial metal ion concentration. Maximum metal adsorption was found to occur at pH 2.0. The adsorption capacity of studied adsorbent was found to be 30.616 mg/g for initial Cr(VI) concentration of 400 ppm and optimum adsorbent dose of 10 g/L at 25°C. Compared to the Freundlich isotherm model, the Langmuir and Temkin model best fit the experimental data ($R2 > 0.995$). Batch adsorption models, supported the idea of the pseudo firstorder and pseudo second order mechanism were applied to look at the kinetics of the adsorption. The results of this study demonstrated that the pseudo-second order model was more suitable than pseudo-first order model for adsorption of Cr(VI) by Hogla leaves. At 25°C, with a contact time of 360 minutes and agitation rate of 180 rpm, the potential of Cr(VI) removal by Hogla leaves from industrial effluent was also investigated at optimized condition of pH 2.0, initial metal ion concentration of 400 ppm and adsorbent dose of 10 g/L and removal efficiency was found to be 44.8%.

Heavy metals like mercury, lead, cadmium, copper, chromium and nickel are extremely toxic even in minute quantities . Chromium is more abundant in earth's crust and is widely utilized in electroplating, leather tanning, metal finishing and chromate preparation. It exists in two stable oxidation states Cr(III) and Cr(VI). Cr(VI) is of particular concern as due to its high toxicity, it's going to cause many adverse effects on human health like epigastric pain, hemorrhage, severe diarrhea, vomiting, nausea, dermatitis by skin contact, ulcer, carcinoma and tissue necrosis. The allowable limit of Cr(VI) for the discharge of inland surface water is 0.1 ppm . Therefore, it's become an important to get rid of Cr(VI) from industrial waste water before discharging it into water body or on to land. Conventional technology for the removal of metal ions from solution includes chemical precipitation, natural process , chemical oxidation/reduction, reverse osmosis, electrodialysis, ultrafiltration, etc. which have their own inherent limitations such incomplete metal removal, requirements for expensive equipment and monitoring system, high reagent or energy requirements or generation of toxic sludge or other waste products that need disposal . Adsorption may be a physiochemical wastewater treatment process, which is gaining prominence as a way of manufacturing high-quality effluents, which are low in metal ion concentrations. Natural materials which are available in large quantities or certain waste products from industries or agriculture have drawn attentions to researchers to be used as inexpensive adsorbents. a number of these are tea factory waste , eucalyptus bark , Hevea brasilinesis sawdust , beech sawdust , the agricultural byproduct of shiitake , non-living microbial biomass , water algae , clay mineral , phosphate rock ,etc. Among these adsorbents the power of biological materials to adsorb metal ions has drawn considerable attention for the event of an efficient, clean and cheap technology for wastewater treatment .Hogla, local name for a bush-like small plant, Typha elephantina Roxb. of Typhaceae . The plants appear as if grasses and should attain heights from two to 5 meters. The leaf blades are flattened and composed of aerenchymatous spongy tissue . In Bangladesh Hogla is usually seen within the North-Eastern a part of the country especially along the banks of rivers and canals. Hogla grass is extensively wont to make mats, baskets, ropes and different sorts of handicrafts. Beside these house hold applications, anther application of Hogla leaves as low cost adsorbents are often explored. In many adsorption studies, activated charcoal derived from many agricultural sources are getting used as an adsorbent. Low cost and availability of Hogla leaves could be an appropriate alternative of activated carbons. the target of this study is to work out the equilibrium and kinetic parameters of Cr(VI) adsorption onto dried Hogla leaves by fitting the experimental data into various mathematical models like Langmuir's, Freundlich's and Temkin's models for sorption isotherms and pseudo first- and second- order rate equations for description of kinetics. And also to research the potential of Hogla leaves for removal of Cr(VI) from industrial effluents.

The adsorption of Cr(VI) by AWP Hogla was hooked in to pH, adsorbent dose, and initial metal ion concentration. The adsorption capacity was highest at pH 2.0. The optimum dosage for Cr(VI) adsorption by AWP Hogla was found to be 10 g/L. Using Langmuir, Freundlich and Temkin isotherm, the adsorption of Cr(VI) onto AWP Hogla were described. Langmuir and Temkin's model showed better coefficient of correlation than the opposite model within the studied concentration. Freundlich model also showed quite good coefficient of correlation . The pseudo first- order and pseudo second- order kinetic model were wont to analyze the info obtained for the adsorption of Cr(VI) onto AWP Hogla. The pseudo second- order equation was found to possess the simplest correlation for the adsorption data. The AWP Hogla was found quite not suitable for the removal of Cr(VI) from its industrial effluents. This adsorbent are often applied after appropriate dilution of the economic effluent for the removal of Cr(VI) or after removing the co-metals present within the effluent.

Keywords: Hogla leaves; Adsorption; Adsorbent; Cr(VI)