INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Urbanization and industrialization activities release large amount of hazardous pollutants in water stream and turn it non-potable form. Among the several pollutants, heavy metals found in water are needed special attention for many reasons; they are non biodegradable and their high toxicity causes adverse affect to living organisms even at very low concentrations. Among the heavy metals found in the water, Cr(VI) is one of the top toxic heavy metals by virtue of more carcinogenic and recalcitrant nature. Chromium has a wide range of applications in several industries such as paints, electroplating, cooling towers, dyes, metal finishing and largely used in tannery industry. Therefore, effluent discharge from these industries in water stream causes a serious threat to aquatic and humane life. Long exposure to Cr(VI) results in adverse effects such as lung cancer, skin irritation, kidney and liver damage. Therefore, for a long time, decontamination of Cr(VI) from wastewater has been become a challenging task. Numerous scientific methods have been used in this regards such as adsorption, reverse osmosis, precipitation, ion exchange, electrochemical treatments and membrane filtration processes. However, these conventional methods have some disadvantages due to generation of toxic

sludge, high reagent and energy consumption, and incomplete metal removal. Among these methods, adsorption technology based on natural agriculture waste is a suitable choice due to inexpensive use of adsorbent and easy to operate.

In this framework, the present study was aimed to evaluate the potential of locally available biosorbents (water caltrop (*Trapa Natans*) shell and Datura *(Datura Stramonium) fruit*) and activated carbon developed from it towards the hexavalent chromium removal from waste water through batch and continuous system.

Several characterization techniques such as FESEM, EDX, TGA, FTIR and BET were employed to study physical and chemical properties of the adsorbents before and after biosorption.

Batch system was applied to study the effect of various influence parameters such as biosorbents dosage, particle size, initial metal ion concentration, contact time, temperature and pH of solution. Several adsorption isotherm and kinetic models were used to test the equilibrium data obtained from biosorbents on the basis of regression coefficient and chi square values determination.

The removal of Cr(VI) on water caltrop shell was well explained by Langmuir isotherm (R^2 = 0.989) and pseudo-second-order (R^2 = 0.998) compared to that of other models with separation factor (R_L) observed between 0.11 and 0.37. The monolayer adsorption capacity of waste caltrop shell was found to be 98.04 mg g^{-1}.

Using linear and non-linear regression analysis with high R^2 and low χ^2 value, Langmuir and pseudo-second order models were employed to explain the equilibrium data of Cr(VI) adsorption on PDSF (phosphoric activated Datura *(Datura Stramonium)* fruit), SDSF (sulphuric activated Datura *(Datura Stramonium)* fruit) and RDSF (raw Datura *(Datura Stramonium)* fruit) biosorbents. The monolayer adsorption capacity of developed adsorbents RDSF, SDSF and PDSF was found to be 85.916, 119.632, and 138.074 mg g^{-1} respectively towards the adsorption of Cr(VI) at pH 2 of solution.

Thermodynamic results of batch investigation revealed that the adsorption of Cr(VI) on adsorbents was spontaneous, endothermic and randomness in nature. The studied adsorbents were regenerated using 0.1 m HCl as an eluent.

Adsorptive performance of phosphoric treated water caltrop shell (*Trapa Natans*) was investigated in fixed bed column for the removal of Cr(VI) from waste water. Characteristics of breakthrough curve were obtained by investigating the effect of several operating parameters viz. inlet flow rate (2 - 6 mL min^{-1}), initial metal ion concentration (50 - 150 mg L^{-1}) and bed height (1 - 3 cm). The breakthrough curves of column experiment were well described by the Thomas model, Yoon-Nelson and BDST model based on regression equation and the maximum adsorption capacity was found to be 87.31 mg g^{-1}.

Research carried out in this thesis provide an insight that the developed adsorbent can be serve as alternative efficient, eco-friendly and low cost adsorbent for removal of Cr(VI) from waste water in order to meet the regulatory limits of Cr(VI) release in effluent.

Keywords: Water caltrop (*Trapa Natans*); Datura (*Dataura Staramonium);* Activated carbon; Low cost adsorbent; Cr(VI); Biosorption; Isotherm; Kinetics; Column studies; Breakthrough curve; Model.