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Title of Thesis: **Utilization of Cost Effective and Efficient Adsorbents for Wastewater Treatment.**

Abstract

Many industries such as paper pulp, cosmetic, textile, leather, electroplating, metal finishing, etc. release their effluents into the nearby water bodies. The discharge of these industrial effluents into the water bodies has resulted in large scale water pollution. These industrial wastes may include dyes and heavy metals. These pollutants pose a serious threat to aquatic flora and fauna directly and indirectly to other terrestrial organisms through food chain. It, therefore, becomes imperative to devise methods to remove these pollutants from wastewater before it is let into the water bodies.

CHAPTER 1. This chapter deals with the introduction of the proposed work. Various aspects of the work have been explained. To illustrate the work being carried out in this field, an up to date literature survey has been presented.

CHAPTER 2. Materials and experimental methods, which have been used in the present study, are presented in this chapter. The quantitative analysis of adsorbates using U-V visible spectrophotometer has been given. Optimisation of various process variables like contact time, adsorbent dose, initial concentration of adsorbate and pH have been discussed. An account of adsorption isotherms viz Langmuir, Freundlich, Redlich Peterson, Temkin and Dubinin-Kaganer-Radushkevich has been given. Thermodynamic, kinetic and column studies of the adsorption processes have also been described.

CHAPTER 3. This chapter describes the synthesis and characterization of guar gum-nano zinc oxide (GG/nZnO) biocomposite adsorbent and its use for the removal of Chromium(VI) from aqueous solution. GG/nZnO biocomposite removed hazardous Cr(VI) from aqueous solution rapidly, economically, eco-friendly and effectively. At pH 7, 98.63% Cr(VI) was removed with a contact time of 50 min. and an adsorbent dose of 1.0 g/L. The adsorption data fitted best into Freundlich adsorption isotherm. Langmuir adsorption capacity of 63.69 mg/g was obtained. Pseudo-second order kinetics was followed with mechanism being controlled by both liquid film and intra-particle diffusion. The adsorption process came out to be spontaneous and endothermic in nature.

CHAPTER 4. This chapter deals with the synthesis and characterization of magnetic Fe_2O_3/chitosan cross-linked bamboo sawdust (FeCBSD) adsorbent and its use for the removal of an acidic dye bromothymol blue from aqueous solution. The higher Langmuir adsorption capacity ($q_{m=}$217.39 mg/g; 94.5% removal) at pH 7 together with low contact time (30 min.) and adsorbent dose (0.5g/L) implied that magnetic Fe_2O_3/chitosan cross-linked bamboo sawdust (FeCBSD) can remove bromothymol blue efficiently and rapidly. The adsorbent can be easily recovered under the influence of a magnetic field due to its magnetic nature. The adsorption process best followed the Langmuir isotherm model. The practical applicability of the present adsorption system was established by fixed bed column

experiments, fitting well into Thomas model with an adsorption capacity of 225.13 mg/g. The adsorption system obeyed pseudo-second order kinetics better than the pseudo-first order. The mechanism of adsorption was controlled by both intra-particle and liquid-film diffusion models. Thermodynamic parameters suggested that the removal of bromothymol blue from aqueous solution was spontaneous and endothermic in nature.

CHAPTER 5. Multiwalled carbon nanotube-polyurethane (MWCNT/PU) composite was synthesized and characterized. MWCNT/PU was used for the removal of safranin T dye and Pb(II) from aqueous solution. Various process parameters affecting the uptake of safranin T and Pb(II) onto the adsorbent were optimized using batch method. The optimum adsorption of safranin T and Pb(II) occurred at low adsorbent dose (0.075g/L, 0.1g/L) and contact time (60 min., 90 min.) at pH 7, with 99.16% and 97.11% removal of Safranin T and Pb(II), respectively. The adsorption capacity was 500 mg/g for safranin T and 270.27 mg/g for Pb(II). Langmuir adsorption isotherm was found to give a better fit than Freundlich isotherm model for both Safranin T and Pb(II) suggesting monolayer adsorption. Fixed bed column studies gave a breakthrough capacity of 425.5 and 239.05 mg/g for safranin T and Pb(II), respectively. The adsorption process followed pseudo-second order rate kinetics with both intra particle and liquid film diffusion controlling the overall mechanism for both dye and metal. Thermodynamically, the process was spontaneous and endothermic in nature.

CHAPTER 6. This chapter deals with the synthesis and characterization of ferrofluid magnetised multiwalled carbon nanotubes (MMWCNT) and its use for the adsorptive removal of bismarck brown R and Cd(II) from aqueous solution. Batch and column study of the adsorption process was carried out. Langmuir adsorption isotherm was found to give a better fit than Freundlich isotherm for both the dye and the metal suggesting the current adsorption process to be homogenous and monolayer in nature. The current adsorption system was found to be efficient due to a high adsorption efficiency of 76.92 mg/g and 38.17 mg/g for bismack brown R and Cd(II), respectively. A successful column study was carried out which gave a breakthrough capacity of 75.2 and 31.37 mg/g for bismack brown R and Cd(II), respectively. Kinetically, the adsorption system followed Pseudo-second order rate kinetics for both dye and metal removal and the process was found to be intra particle and liquid film diffusion controlled. Thermodynamically, the process was spontaneous and endothermic in nature.

CHAPTER 7. All the references that have been cited are given in this chapter.