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Topic: “Syntheses and Analyses of Promising Biopolymer Based Adsorbents for Removal of Heavy Metals from Wastewater”
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My thesis titled “**Syntheses and Analyses of Promising Biopolymer Based Adsorbents for Removal of Heavy Metals from Wastewater**” itself depicts that it is about synthesis of novel adsorbents for the removal of toxic heavy metals from wastewater. A large number of greener ways as well as methods and reactions have been discussed throughout Chapter 1 to give brief idea to the researchers working in the field for the possible modification of natural polysaccharides to transform them into highly efficient adsorbents in a sustainable and environmentally friendly approach. Furthermore, various models both thermodynamic as well as kinetic have been discussed together with batch adsorption method to obtain and process the data for evaluation of the synthesized material. The introduction has been composed to summarise the scattered information on the research works carried out on remediation of heavy metal ion containing wastewater.

In Chapter 2, one pot approach has been explored to synthesize the crosslinked beads from chitosan (CS) and carboxymethyl cellulose (CM) using arginine (ag) as crosslinker. Different kinetic and thermodynamic models were used to check the best fit of the adsorption data. The results revealed that the kinetics data of the adsorption of Pb(II) and Cd(II) ions shows best fit with the Pseudo second order model whereas the thermodynamics data shows the best fit with the Langmuir isotherm with maximum adsorption capacities of 182.5mg/g and 168.5mg/g. for Pb(II) ions Cd(II) ions, respectively. For the recovery and the regeneration after the one use of the beads, several adsorption-desorption cycles were carried out to check the reusability and recovery of both the metal ion and the adsorbent without the loss of maximum adsorption efficiency.

In Chapter 3, a new adsorbent derived from the naturally occurring biopolymers chitosan(CS) and carboxymethyl cellulose(CMC) was prepared by cross-linking them through EDTA. The kinetic model’s pseudo first order, pseudo second order and intraparticle diffusion model were

applied for studying the kinetics of adsorption process whereas Langmuir, Freundlich, Temkin and D-R models were applied to evaluate the thermodynamics of adsorption process. The kinetic adsorption parameters were in best agreement with pseudo second order model with R2 values corresponding to 0.999, 0.999, 0.989, while thermodynamic parameters best fitted to the Langmuir isotherm with R^2 values corresponding to 0.990, 0.999, 0.993 at temperatures 303K, 313K and 323K respectively, for adsorption of Cu(II) ions from aqueous solution with a maximum adsorption capacity of 142.95 mg/g at pH 5.5. CS-E-CMC showed excellent regeneration and recovery of the Cu(II) ion upto the five cycles without the loss of the adsorption efficiency, which is the best characteristic to select the appropriate choice of the adsorbent.

In Chapter 4, a novel magnetic carboxymethyl cellulose(CMC) nanocomposite is synthesized by the chemical co-precipitation of Fe^{2+}/Fe^{3+} in presence of CMC by NaOH followed by hydrothermal method. The synthesized nanocomposite was characterised by FTIR, XRD, SEM, TEM and magnetic susceptibility. The adsorption of Cr(VI), Cr(III), Cu(II) and Hg(II) metal ins by the magnetic nanocomposite was evaluated by batch adsorption method and was found to be 207.34, 232.24, 198.42 and 180.0 mg/g respectively. The regeneration and reusability of the nanocomposite was evaluated by subjecting the metal containing adsorbent to various adsorption-desorption cycles in 0.01N HCl, and it was observed that the nanocomposite was regenerated ≈93 - 95 % after 5 adsorption-desorption cycles.

Chapter 5 gives the brief comparison of the adsorption kinetics, adsorption thermodynamics and adsorption efficiencies of all the three synthesized adsorbents. On comparing the rate of adsorption of the synthesized adsorbents for Pseud second order (followed by all the adsorbents, it was observed that adsorption of Cu(II) in was much faster on CSEM than on the magnetic CMC nanocomposite. Moreover, the rate of adsorption of different heavy metal ions was much faster on CSECM followed by CS-ag-CM and magnetic CMC nanocomposite.