INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: Multi Heavy Metal Cyclic Adsorption-Desorption Characteristics of Commercial Resins and Chitosan Derivatives

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SHORT ABSTRACT

Considering the lacunae in the field of commercial resin and chitosan derivatives based multi-heavy metal sorptive removal from complex adsorbate systems, the PhD thesis involved the realization of five major objectives. These are as follows: (a) Efficacy of commercial resins (Amberlite IR 120H and Lewatit TP 260) for multi-heavy metal removal and resin regeneration from Cu and Zn dominant complex adsorbate systems. (b) Synthesis, characterization, batch adsorption and desorption studies of polyvinyl grafted chitosan variant derivatives (low CSPVA, medium CSPVA and high CSPVA) for multi-heavy metal removal and resin regeneration from Cu and Zn dominant complex adsorbate systems. (c) Synthesis, characterization, batch adsorption and desorption studies of citric acid grafted glutaraldehyde crosslinked chitosan variant derivatives (low Cit-CS, medium Cit-CS and high Cit-CS) for multi-heavy metal removal and resin regeneration from Cu and Zn dominant complex adsorbate systems. (d) Synthesis, characterization, batch adsorption and desorption studies of carboxymethyl grafted glutaraldehyde crosslinked chitosan variant derivatives (low CMCS, medium CMCS and high CMCS) for multi-heavy metal removal and resin regeneration from Cu and Zn dominant complex adsorbate systems. (e) Conceptual cost analysis for the multi-heavy metal ion removal from complex adsorbate systems.

For commercial and synthesized chitosan-based derivatives, characterization studies such as FTIR, BET, XRD, TGA and FESEM-EDX analyses were conducted. For all adsorbents

(Amberlite IR 120H, Lewatit TP 260, CSPVA, Cit-CS, and CMCS) and for complex adsorbate system (Cu, Pb, Fe, Zn, Mg, Na, K and Al in Cu dominant adsorbate system and Zn, Pb, Fe, Cu, Mg, Na, K and Al in Zn dominant adsorbate system), batch adsorption studies were carried for a variation in batch adsorption process parameters as 0.2-2.0 g L^{-1} adsorbent dosage, 5-720 min contact time and initial solution concentration (187.7-563.1 mg L^{-1} for Cu, 61.85-185.55 mg L^{-1} for Fe, and 5.2-15.6 mg L^{-1} for Pb in Cu dominant solution and 194.9-584.7 mg L^{-1} for Zn, 104.8-314.4 mg L^{-1} for Fe, and 2.65-7.95 mg L^{-1} for Pb in Zn dominant solution). For comparative assessment, the adsorptive and desorptive performance of all resins was evaluated for Cu and Zn dominant adsorbate systems at corresponding optimized batch process parameter values.

For the considered resin-adsorbate system combinations, experimentally determined batch equilibrium and kinetics data (Cu, Fe and Pb adsorption data in Cu dominant solution and Zn, Fe and Pb adsorption data in Zn dominant solution) were evaluated for their fitness with suitable equilibrium (Langmuir and Freundlich models) and kinetic (Pseudo-first-order, and Pseudo-second-order models) models. The desorption efficiencies of all adsorbents were carried out with simple and cheaper eluents (acid or base dilute solutions in the concentration range of 0.1 - 2M) and spent adsorbents realized with the initial solution concentration of 375.5 mg L^{-1} Cu, 123.7 mg L^{-1} Fe and 10.4 mg L^{-1} Pb in Cu dominant solution and 389.8 mg L^{-1} Zn, 209.6 mg L^{-1} Fe and 5.3 mg L^{-1} Pb in Zn dominant solution.

Among all adsorbents, commercial Amberlite IR 120H resin and medium CMCS synthesized derivative can be inferred to have excellent performance characteristics from adsorption, desorption and cost perspectives. Besides these, the carried-out investigations enabled useful insights into the irrelevance of HSAB theory as a generalized rule of thumb to screen and scope potential adsorbents for multi-heavy metal removal and resin regeneration. The mentioned findings of the thesis ascertain technical and economic benchmarks for the realization of low cost chitosan derivatives based cyclic desorption technology for multi-heavy metal complex adsorbate systems. Accordingly, sustainable technologies for real world situations can commissioned for multi-heavy metal removal from adsorbate systems.