Bio-sorptive Removal of Cadmium, Copper, Lead and Zinc from Industrial Wastewater

Name of Candidate: **Amer Arif Mukhlif**
Name of Supervisor: **Prof. Tabrez Alam Khan**
Department of Chemistry
Faculty of Natural Sciences

ABSTRACT

The contamination of aqueous stream by industrial wastewater discharge containing heavy metals is of considerable environmental concern over their potential hazardous effects on human health and the environment. The various physico-chemical processes are available for aqueous wastes treatment, yet adsorption/biosorption is considered to be the most promising, efficient and cost effective technique for the removal of toxic metal ions from aqueous solution. The present thesis work deals with the studies on the bio-sorptive removal of lead, cadmium, copper, nickel and zinc from aqueous solution using cost effective green algal biomass and muskmelon peel biochar as bio-sorbents. Algal biomass is considered favorite biosorbent because of its widespread abundance and cost effectiveness. However, the raw algae have limited applicability in the treatment process because of leaching of alginate and other organic constituents from the biomass, which may cause secondary pollution and lower the stability of the biosorbents. The chemical surface modifications of algal biomass may prevent the leaching of its adsorptive components and increase the stability of the biosorbents. The fresh water green algal biomass has, therefore, been modified with epichlorohydrin, which may increase its stability and adsorption capacity due to introduction of extra hydroxyl groups. Similarly, Muskmelon peel has been chosen as the precursor for biochar preparation because of its low cost, easy availability and renewable resource. There are no reports of the utilization of biochar derived from muskmelon peel for the removal of heavy metal ions from aqueous solution. Raw and modified adsorbent including epichlorohydrin crosslinked algal biomass and muskmelon peel biochar were

characterized using FTIR, SEM and EDS techniques. The batch adsorption experiments in terms of contact time, initial metal concentration, adsorbent dose, initial solution pH and temperature have been described. The different isotherms (Langmuir, Freundlich, Temkin and D-R) and kinetic (pseudo-first order, pseudo-second order, intraparticle and film diffusion) models for evaluating the experimental data is presented. Various thermodynamic parameters for all adsorbent-adsorbate system have been discussed. The optimized parameters for epichlorohydrin crosslinked algal biomass are: biosorbent dose (0.75 g/L), initial metal concentrations (50 mg/L) for both the metal ions, contact time (80 min for Pb(II) and 60 min for Cd(II), initial solution pH (5 and 6 for Pb(II) and Cd(II), respectively) at 303 K. For Cu(II) and Ni(II) contact time (120 min), dose (0.6 g/L for Cu(II) and 0.8 g/L for Ni(II), initial metal concentration (50 mg/L for Cu(II) and 30 for Ni(II), initial pH of solution (6 for Cu(II) and 7 for Ni(II) and temperature (323 K) are 0ptimizied. The optimized parameters for muskmelon peel biochar with Cu(II) and Zn(II) are: contact time (120 min), initial metal concentration (60 mg/L), biochar dose (0.8 g/L), initial metal solution pH (7) and temperature (303 K). A strong correlation between the data and Langmuir model suggests that the adsorbent has homogeneous distribution of surface energy, thereby inducing monolayer adsorption. The maximum monolayer adsorption capacity of epichlorohydrin crosslinked algal biomass and muskmelon peel biochar was 100.00, 72.46, 60.6 and 116.3 mg/g for Pb(II) Cd(II), Ni(II) and Cu(II), respectively, and 78.74 mg/g for Cu(II) and 72.99 mg/g for Zn(II). The values of R_L between zero and unity support favorable adsorption process. Pseudo-second order kinetic model describes the adsorption kinetics of both the metal ions most suitably. The mechanism of biosorption of Pb(II) is controlled by film diffusion whereas intra-particle and film diffusion may be the rate controlling steps in case of Cd(II), Cu(II) and Zn(II) adsorption. The thermodynamic parameters suggest the adsorption process to be spontaneous, endothermic and entropy driven. Based on the results it may be reasonably be concluded that the epichlorohydrin crosslinked algal biomass and muskmelon peel biochar are quite efficient in removing Pb(II), Cd(II), Ni(II) and Cu(II) from aqueous wastes.