PREFACE

The thesis entitled *Studies on the removal of heavy metals from waste water using clarified sludge from basic oxygen furnace of steel industry* is submitted herewith. Out of the various methods available for removal of heavy metals from water and wastewater adsorption method using activated carbon seems to be a very powerful technique. However, the high cost factor associated with activated carbon limits its application as an adsorbent in most of the developing countries specially country like India and this forces the environmental scientists to identify natural or the low cost and readily available alternatives including industrial and agricultural wastes to substitutes activated carbon. Detailed literature survey on the removal of heavy metals from aqueous solutions was presented.

In the present investigations adsorption studies have been carried out using seven different low cost and readily available adsorbents collected from industrial, synthetic as well as from natural sources for removal of Zn(II), Cr(VI), Cd(II) and Pb(II) from aqueous solutions. Adsorbents used are clarified sludge, rice husk ash, activated alumina, fuller’s earth, fly ash, saw dust and neem bark.

Surface area analysis by BET method, Particle size distribution analysis, X Ray Diffraction (XRD), Scanning Electron microscope (SEM), Fourier Transform Infrared Spectrophotometer (FTIR), Thermogravimetric(TGA) analysis techniques were used for the characterization of the adsorbents used for adsorption studies.

Influence of different parameters effecting the adsorption process like pH, adsorbent type and concentration, contact time, initial metal ions concentration have been investigated using batch adsorption studies. Kinetics and adsorption isotherm models
were also investigated to understand the adsorption behavior. Mass transfer analysis was carried out for the different adsorbents for removal of metal ions from the aqueous solutions. Thermodynamic studies were carried out to determine the spontaneity of the adsorption process. The maximum adsorption capacity in terms of monolayer adsorption $q_{\text{max}}$ was determined for the different adsorbents and it is compared with those reported in literature. The clarified sludge was found to be most effective adsorbents for all the metal ions.

Detail batch adsorption studies were carried out at different initial metal ion concentrations using clarified sludge as metal adsorbent. The effect of pH, adsorbent dosage level, contact time, effect of particle size and effect of temperature were investigated. Effect of temperature studies was utilized to determine the changes in Gibbs free energy, enthalpy and entropy change of the adsorption process.

Desorption and column studies were studied using clarified sludge as adsorbent. Application studies were conducted using wastewater from different industrial sources containing aforesaid metal ions as contaminants to predict the commercial use of clarified sludge in wastewater treatment applications.