ABSTRACT

Copper, zinc and cadmium are among the most widely used heavy metals in various industries. These industries produce wastewater containing these metal-ions with different concentrations, which might have detrimental effect on the water environment. Various treatment techniques have been employed to treat the wastewater including precipitation, adsorption, ion exchange and reverse osmosis. Among these methods adsorption has already been established as the best available technology for the reduction of heavy metals and other non-biodegradable contaminants from the water. Activated carbon has been proved to be the most effective adsorbent but its manufacturing cost is quite high. Hence, significant efforts have been directed allover the world to use the low cost adsorbents for the removal of metal-ions.

Waste sludge collected from dumping yards of wastewater treatment plants and their metal uptake potentials were evaluated. Physical and chemical properties of waste sludge were examined, which indicated the presence of carbon, iron, calcium and magnesium, which were responsible for the simultaneous occurrence of physical and exchange adsorption. Batch kinetic studies were conducted with a series of parameters such as initial concentration, size. pH, ionic strength and with different anionic and cationic concentrations. Sorption capacity and equilibrium time were affected with these parameters. Increased metal sorption rate observed at a pH from 4.0-5.0 and lower initial concentration. The removal capacity for a single metal-ion was in the following descending order: Cu(II)=Cd(II)>Zn(II). Isotherm studies indicated that maximum adsorption capacity of metal-ions with waste sludge were comparable with other non- conventional adsorbents. The experimental data was analysed using five kinetic models. The best-fit model was identified using the normalized standard deviations. A New waste Sludge model was developed and was found to be the best-fit model among all the models. The rate-limiting step was determined using various methods and film diffusion was found to be rate limiting in case of all the metal-ions. Batch desorption and regeneration studies were also conducted and confirmed the suitability of this adsorbent.

BDST model was employed to analyse breakthrough data in fixed bed studies. Design parameters were calculated at different bed depths to obtain a maximum efficiency above 90% in case of all the metal-ions studied. The theoretical and experimental breakthrough curves were also compared. All these studies confirm that the industrial waste sludge met the selection criteria of USEPEA for the treatment of metal bearing wastewater. Therefore, it could be a viable and cost effective alternative for metal-ion removal for the wastewater.