PREFACE

A healthy life cannot be imagined without access to safe water. Anthropogenic contamination of water drastically declines the amount of safe water. One of the major sources of anthropogenic contaminations is heavy metal contamination. Heavy metals are peculiar as unlike; organic pollutants they are non-biodegradable. Heavy metals are accumulated in river body and find their way into biological organisms through ecological processes. Heavy metals' concentrations in various aqueous bodies in India are reported to be above the prescribed standards. Chromium and cadmium are toxic metals and their adverse effects on fauna, flora and human beings are well documented. Because of the toxic nature of these metallic contaminants, Present study deals with abatement of chromium and cadmium from aqueous solutions.

Maximum allowable concentration of chromium and cadmium in drinking water are 0.05 mg $L^{-1}$and 0.005 mg L^{-1}respectively. Chromium enters aquatic bodies through untreated discharges of several industries like from several industries like metallurgical industries, refractory, pigments, electroplating tanning, pulp production, milling and mining. Similarly, cadmium finds its way into aquatic bodies through discharge of untreated effluents from paints, electroplating, phosphate fertilizers, and alloy industries. Chromium causes cancer, skin rashes, abdominal pain, respiratory problems, weak immune system, kidney and liver damage and it's hexavalent form interacts with genetic material. Similarly, cadmium has numerous health effects. It causes renal dysfunction and neuropsychological impairments; it effects bone and causes its degradation. It also affects respiratory organs and causes renal failure. Ground water, lotic and lentic water system in India are reported to be contaminated by chromium. Chromium concentration has been reported to be above the permissible limit in many regions of Andhra Pradesh, Maharashtra, Uttar Pradesh, Punjab, Karnataka, Mumbai and Tamil Nadu. Cadmium is present in significant amount in various rivers and lakes of the country. The groundwater of Assam and Uttar Pradesh is also reported to be contaminated with cadmium.

There are several methods like precipitation, reverse osmosis, ion exchange, electrocoagulation, electrodialysis, reverse osmosis and nanofiltration for the removal of chromium and cadmium from aqueous solutions. Most of these methods in spite of benefits are associated with few demerits like high operational and maintenance cost and sludge generation. Reverse osmosis and nanofiltration are associated with membrane fouling and ion exchange cannot handle concentrated metal solutions. Hence, adsorption is used due to ease of operation, least energy sensitive and remove contaminant even at very low concentration.

A numerous number of adsorbents like low cost dolomite, modified corn stalk, activated carbon, chitosan, nano zerovalent iron, nano alumina and nano hyroxyapatite, functional mesoporous silica, activated carbon, cerium oxide and titanium oxide have been used as adsorbents for removal of chromium and cadmium from contaminated water. In current study, nano crystalline zirconia and iron oxide/hydroxide have been used for removal of chromium and cadmium from aqueous solutions.

Classically, experimentation is conducted to optimize the response by varying one parameter at a time and keeping other parameters constant. Classical method is time consuming and does not provide the correct picture of quantitative interactions between various parameters. To overcome these drawbacks, experimental response is optimized by varying variables collectively. One of the statistical methods of experimentation to optimize response is response surface methodology (RSM). The experiments for removal of chromium and cadmium were designed by response surface methodology.

The isotherm and kinetic parameters help in understanding mechanism of adsorption, surface property, adsorption capacity and rate of adsorption. Isotherm and kinetic parameters for adsorption are determined by linear and nonlinear curve fitting of the data. A comparative study is conducted via different methods to reach the optimum isotherm and kinetic parameter determination. Thermodynamic parameters like change in free energy, enthalpy and entropy give essential requisite for the design and management of adsorption plants. Langmuir constant method and partition method are widely used methods apart from others. The

differences in thermodynamic parameters obtained by aforementioned two methods were studied. The present study serves as the potential database to treat water contaminated with chromium and cadmium.