ABSTRACT

Metal pollution of water and its sources has been receiving considerable attention in recent times due to the increasing amounts of industrial effluents discharged into the environment. Heavy metals like nickel, chromium, copper, cobalt, mercury, lead, cadmium and zinc in their common oxidation states are reported to cause several physiological disorders and pose hazardous threat to the environment. Several reclamation technologies have been developed to reduce their concentrations. A number of low-cost and indigenous materials are identified as successful adsorbents, to remove metal ions through the process of adsorption. In this context, acid-base treated, phosphate modified and nanomodified adsorbent materials, which have been prepared from *Terminalia catappa* nut shell and *Azaridachta indica* nut shell are employed to reduce the concentrations of the three selected metal ions. Adsorption studies of Ni(II), Co(II) and Cr(VI) employing the chosen sorbents have been investigated by batch equilibration method. The characteristics of the treated sorbents are determined and the adsorptions of metal ions onto the surface of the adsorbents are confirmed by Microscopic, AFM, BET, BJH, SEM, FT-IR and EDAX analytical techniques. The optimum conditions for achieving maximum adsorption of metal ions are established. Phosphate modified and Nano modified sorbents are subjected to the optimized conditions of parameters study. The factors influencing the adsorption rate and the dynamics of adsorption processes are studied in order to verify the adsorption behaviour. The nature of adsorption equilibrium and kinetic behaviour are explained by different isothermal and kinetic models respectively. A comparative assessment of the sorption ability of the treated adsorbents along with the order of preferential adsorption among the metal ions is made on the basis of the valid conclusions drawn from the experimental results. The efficiency of the adsorbent materials is tested with industrial effluents.

LIST OF ABBREVIATIONS AND NOTATIONS

WHO	World Health Organization
USEPA	United States Environmental Protection Agency
IARC	International Agency for Research on Cancer
IAEA	International Atomic Energy Agency
DRI	Dietary Reference Intake
TUL	Tolerable Upper Intake Level
TTCNS	Treated *Terminalia catappa* nut shell
TAINS	Treated *Azaridachta indica* nut shell
MTCNS	Modified *Terminalia catappa* nut shell
MAINS	Modified *Azaridachta indica* nut shell
NAINSC	Nanomodified *Azaridachta indica* nut shell composite
SEM	Scanning Electron Microscope
FT-IR	Fourier Transform Infra-Red spectrophotometer
EDAX	Energy Dispersive X-ray spectrometer
AAS	Atomic Absorption Spectrophotometer
AFM	Atomic Force Microscope
Conc.	Concentration
ppm	parts per million (or) mg/L
pH_{ZPC}	pH at which the surface charge of the adsorbent is zero
q	Amount of metal ions adsorbed per gram of the adsorbent(mg/g)
C_i	Initial metal ion concentration (ppm)
C_e	Equilibrium metal ion concentration in solution (ppm)
R^2	Correlation Co- efficient

q_e	Amount of metal ions adsorbed per gram of adsorbent at equilibrium (mg/g)
q_t	Amount of metal ions adsorbed per gram of adsorbent at time 't' (mg/g)
q_m	Maximum monolayer adsorption capacity (mg/g)
b	Langmuir adsorption constant (L/mg)
K_F	Freundlich adsorption capacity (mg/g)
n	Freundlich isotherm constant
A_T	Tempkin equilibrium binding constant (L/g)
b_T	Tempkin heat of adsorption
R	Gas constant (8.314 J/mol K)
β_{DR}	Mean free energy of sorption per mole of adsorbate (mol^2/J^2)
ε	Polanyi Potential
E	Mean free energy (kJ/mol)
k_1	Pseudo-first-order adsorption rate constant (min^{-1})
k_2	Pseudo-second-order adsorption rate constant (g/mg min)
SSE	Sum of Error Squares
α	Elovich initial adsorption rate (mg/g min)
β	Elovich adsorption constant (g/mg)
K_i	Intraparticle rate constant (g/mg $min^{1/2}$)
$\Delta G°$	Gibb's free energy change of adsorption (kJ/mol)
$\Delta H°$	Enthalpy change of adsorption (kJ/mol)
$\Delta S°$	Entropy change of adsorption (J/mol K)