

Their distinct qualities make them appropriate options for a range of utilizes, including the treatment of wastewater. This chapter covers the key findings due to the experimental work. This study outlines the modification of adsorbent utilized for the removal of organic and inorganic pollutants.

The thesis is presented into seven chapters, which are outlined as follows in the concluding remarks:

In **Chapter I** of the thesis deals with the Introduction:

Introduces to water pollutants (organic and inorganic) and it's affected on living organisms. Utilize the ion exchange and adsorption techniques outlined to remove these pollutants. Applied to adsorbents for removal of water pollutants. This chapter includes a brief description of adsorbents (Ion exchange resin and Tetravalent metal acid salt) for removal of organic and inorganic pollutants an exploration of its properties and advantages.

In **Chapter II** of the thesis deals with the materials, methods and characterizations:

Amberlite IRA-400(Cl⁻) resin, MCR, Ce-ATMP and Sn-ATMP were characterized by means of instrumental, ion exchange, and physical approaches. The material's ion-exchange, physicochemical, and chemical stability in a range of organic solvent media, acids, and bases were evaluated. Modified adsorbent via Sol-gel method was described. Instrumental methods of analysis include elemental analysis (ICP-AES) and CHN analysis, spectral analysis [Fourier transform infrared (FTIR spectroscopy)], X-ray diffraction (XRD), scanning electron microscopy (SEM) energy-dispersive X-ray (EDX) spectroscopy and UV-vis adsorption spectroscopy (UV-vis) and thermogravimetric analysis (TGA) is a type of thermal analysis.

In **Chapter III** of the thesis deals with the removal of transition and heavy metal ions by using modified chelating resin (MCR) as an adsorbent:

Amberlite IRA-400(Cl⁻) resin (polymeric resin) was modified with disodium salt of ethylenediaminetetraacetic acid (Na₂EDTA). The modified chelating resin (MCR) has been characterized by FTIR, SEM and EDX. The distribution coefficients (K_d) for a variety of metal ions (Co²⁺, Ni²⁺, Cu²⁺, Zn²⁺, Cd²⁺, Hg²⁺, Pb²⁺) has been calculated using MCR, and K_d data was examined utilizing the adsorption isotherms of Freundlich and Langmuir.

Kinetic study, for exchange of metal ion, was performed to obtain information related to mode of kinetic exchange. Changes in thermodynamic parameters include the equilibrium constant (K), standard Gibbs free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS°) have been estimated by performing metal ion exchange at different temperatures (299, 309, 319 and 329 K). Distinct electrolytes (NH_4NO_3 , HNO_3 , HClO_4 , CH_3COOH) have been used to study the elution characteristics of the above metal ions. It has been found that exchange process follows Langmuir adsorption isotherm together with second order kinetic model.

In **Chapter IV** of the thesis deals with the adsorption of acid yellow 49 and Reactive Orange 12 by using Amberlite IRA-400(Cl^-) resin:

Acid and reactive dyes are easily adsorbed by anion-exchange resin through electrostatic attraction bound to the matrix material, making adsorption easy and possible. It was therefore thought of interest to use Amberlite IRA-400(Cl^-) resin as sorbents for wastewater treatment containing dyes. Sorption of dyes (AY 49 and RO 12) has been studied in pH, dosage, concentration, contact time, varying temperature (303, 313, 323 and 333 K). Adsorption isotherms [Langmuir and Freundlich] have been studied and kinetic and thermodynamic parameters evaluated. It has been saw that multilayer adsorption.

In **Chapter V** of the thesis covers with the separation of transition and heavy metal ions by using cerium amino tris-(methylene phosphonic acid) (Ce-ATMP):

An amorphous Ce-ATMP (where, ATMP = amino tris-(methylene phosphonic acid), metal phosphonate with a significant CEC value occurred via sol-gel route. Distribution coefficient (K_d) and breakthrough capacity (BTC) values have been utilized to investigate the ion exchange behavior of Ce-ATMP toward transition and heavy metal ions. The described works have been compared with the ion exchange efficiency obtained by applying different kinetic models, including pseudo-first-order, and pseudo-second-order and intra-particle diffusion. Ce-ATMP was consequently determined to be an effective ion exchange material in terms of having a very short equilibrium period for a metal ion to be present an exchange site. A number of thermodynamic attributes were assessed, including the standard Gibbs free energy (ΔG°), enthalpy (ΔH°), entropy (ΔS°), and equilibrium constant (K).

These metal ions' elution behavior has been investigated through separation studies with different media containing acids and electrolytes. Consideration has also been provided to K_d values in some binary and ternary metal ion separations. Material can be recycled without losing its ability to perform in terms of cation exchange capacity, according to a study on regeneration. Ce-ATMP is a useful cation exchange material that may be used to effectively remove of water pollutants in environmental cleaning applications, as demonstrated by the current work.

In **Chapter VI** of the thesis cover with the adsorption of cationic dyes by using Tin amino tris-(methylene phosphonic acid) (Sn-ATMP) as adsorbent:

The presence of structural hydroxyl groups in Sn-ATMP, it is predicted that the dye could either be bound to the matrix material (Sn-ATMP) by hydrogen bonds or weak van der Waals forces, making sorption and desorption easy and possible. It was therefore thought of interest to use Sn-ATMP as sorbents for wastewater treatment containing dyes. The sorption behaviour of cationic dyes namely, Methylene Blue (MB), Malachite green (MG), Crystal Violet (CV) and Rhodamine B (RHB) using (Sn-ATMP). In each instance, sorption of dyes has been investigated in pH, dosage, concentration, contact time, varying temperature (298, 313, 323 and 333 K). Langmuir and Freundlich adsorption isotherms have been examined. Various kinetic models and thermodynamic parameters evaluated. Desorption study of dyes have also been investigated and discussed. This investigation shown that sorption process follows monolayer sorption with pseudo-second-order kinetic model. Sn-ATMP have greater chemical and thermal stability.

In **Chapter VII** of the thesis covers with the all over conclusion. Concise outline of the investigation, focusing significant insights and results.