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Kinetics, thermodynamics and metal separation studies of transition (co^{2+}, ni^{2+}, cu^{2+}, zn^{2+}) and heavy metal ions (cd^{2+}, hg^{2+}, pb^{2+}) using novel hybrid ion exchanger—zirconium amino tris methylene phosphonic acid

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Abstract

Zirconium amino tris(methylenephosphonic acid) (Zr-ATMP)—a novel hybrid ion-exchange material of the class of tetravalent metal acid (TMA) salts—has been synthesized *via* the sol–gel route using inexpensive and easily available chemicals. In the present endeavour, we hereby report various kinetic [(D_0), (E_a) (ΔS^*) and thermodynamic parameters [(K), ($\Delta G°$), ($\Delta H°$) ($\Delta S°$) in the temperature range (30–60 °C)] for transition metal ions (Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+}) and heavy metal ions (Cd^{2+}, Hg^{2+}, Pb^{2+}). Metal ion adsorption with varying concentrations and temperatures has been studied using Langmuir and Fruendlich adsorption isotherms. Sorption behaviour of the metal ions mentioned above towards Zr-ATMP has been studied by evaluating K_d (distribution coefficient) under different conditions. Based on K_d ($mL.g^{-1}$), the selectivity order for metal ions towards Zr-ATMP is found to be Cu^{2+} (C.S)>Ni^{2+} (2980)>Zn^{2+}(1810)>Co^{2+}(1250) amongst transition metal ions and Pb^{2+}(3612)>Cd^{2+}(1601)>Hg^{2+}(125) amongst heavy metal ions. Elution behaviour of these metal ions has been studied using acids and electrolytes. Based on α separation factor, a few binary and ternary metal ion separations have been carried out successfully. Regeneration and reuse of the ion exchanger have also been studied. It is observed that the ion exchanger is effective up to four cycles without much decline in performance. The study indicates that Zr-ATMP has good potential to be used as a cation exchanger..

Keywords: Zirconium Amino Tries (methylenephosphonic Acid)**;** Hybrid IonExchanger**;** Zirconium Phosphonate**;** Metal Aminophosphonate**;** Cation Exchanger

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