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Journal of Chemical and Pharmaceutical Research

ISSN No: 0975-7384
CODEN(USA): JCPRC5

J. Chem. Pharm. Res., 2011, 3(3):271-276

Removal of Ni(II) from Hydrometallurgy effluent of Gujarat state Region Using Dowex M-4195

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ABSTRACT

Water is essencitial factor to survive in nature, in the era of progressing and developing stage of industries there is lots of adverse effect of it. Industrial waste effluent directly dumped into water sources like river ,ponds and canals which is drink by human beings and invite dangerous and incurable disease like asthama,cancer of skin, particularly excess level of nickel in drinking water responsible for cancer of skin. Dowex M 4195 resin , Bis(2-pyridylmethyl) amine functional group have capacity to remove heavy metal ions from aqueous solutions. Physical, chemical and liquid-phase adsorption characterizations of the Resin was done following standard procedures. Studies on the removal of Ni(II) ion was attempted by varying pH of the metal ion solution, initial concentration of solution in batch mode. .

Keywords: Resin, Metallurgy, pH, Desorption, Metal ions removal, ion exchange

INTRODUCTION

Nickel is the heavy metals which have been widely used in electroplating industry. If wastewater contaminated with divalent copper and nickel is discharged to waterways without adequate treatment, soil and water resources become polluted. Electroplating operations form part of large scale manufacturing plants (e.g. automobile, cycle, engineering and numerous other industries) or performed as job-work by small and tiny units They are spread across the entire country with significant concentration in several states like Punjab, Haryana, part of U.P., Maharashtra, Karnataka, Andhra Pradesh, Gujarat and West Bengal. Electroplating is considered a major polluting industry because it discharges toxic materials and heavy metals through wastewater (effluents), air emissions and solid wastes into the recipient environment. It is harmful to humans and other living organisms. Inhalation of divalent copper and nickel causes an increase in the incidence of lung cancer. Moreover, soluble nickel compounds are carcinogenic, giving rise to cancers of the nasal cavities, lungs and other organs such as stomach kidney. [1-3]

Several environmental and health problems, associated with the metal contamination of the natural systems (soil and water) are arising from mining industries, smelting, brass, metal coating, silver refineries, electroplating and several other industrial activities[1-2]. The main symptoms of nickel causes headache, dizziness, nausea and vomiting, chest pain, tightness of the chest, dry cough and shortness of breath, rapid respiration, cyanosis and extreme weakness[3].

Among the methods such as precipitation, oxidation, ultrafiltration, reverse osmosis and elcetrodialysis, ion exchange on natural zeolites seems to be more attractive method. Dowex M 4195 resin have been intensively studied recently because of their applicability in removing trace quantities of heavy metal ions from aqueous solution by utilizing the ion exchange phenomenon[4-7]. Different methods available for metal ions removal, namely, electrolytic reduction, precipitation, oxidation, ultra filtration, ion exchange, adsorption, *etc*, ion exchange appears to have the least adverse effects. It includes high degree of porosity and large surface area[8] and finds use for the removal of Nickel(II), biodegradable and non-biodegradable substances from waste effluent. It is attractive as it can treat waste water to acceptable quality suitable for reuse.

The removal Performance of Dowex M 4195 resin towards nickel(II), was attempted in the present study. The effects of adsorbate dose, pH, Contact time were studied.[9]

EXPERIMETAL SECTION

Characterization of CC

preparation of calibration curve by preparing different concentration from nickel solution. Then by the use of spectrophotometer (UV-VIS),Measured absorbance of solution and plot standard Calibration curve ,which was almost linear and obeyed Lambart-beers law.

p-nitro phenol titrations were performed to find out the amounts of surface functional groups[10]. Also percentage of moisture in resin was also find out by titration method. [11]

Analysis of metal ions

All the metals were estimated following a suitable spectrophotometry method. Nickel(II) was estimated by the dimethylglyoxime method[12-14]

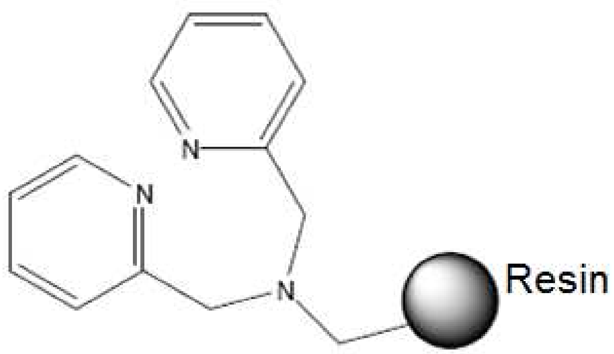
Isotherm procedure

Prior to isotherm studies, minimum contact times for adsorption equilibria to become established were estimated. Each experiment comprised six replicate 100mL glass-stoppered bottles containing appropriate amount of adsorbent and 50mL of adsorbate solutions of selected concentrations. Mixtures were maintained in a rotary shaker (orbitek) at constant temperature (30). After the attainment of equilibrium the contents of each flask were filtered through Whatmann No.41 filter paper, with the first 10mL discarded. The filtered samples were then analyzed for unadsorbed metal ions. The equilibrium adsorption data were then fitted to Freundlich, Langmuir isotherm equations:[15-17]

Dowex M 4195

Given the potential applications of Dowex M-4195 for separating Nickel and other metals from industrial waste solutions, it is important to understand the effect of pH on metal uptake, to allow optimization of the separation. The effect of pH on the uptake of nickel, by the resin in solutions containing 1000mg/L of Nickel chloride. In view of the uncertainty over the behavior of Dowex M-4195 at high chloride concentrations, the present study was undertaken to examine the uptake of copper, nickel, cobalt, iron (III), lead, and manganese at different pH values from chloride solutions more concentrated than those studied hitherto.

The copper, nickel, cobalt, were at trace concentrations (50 mg/L),The study was made under conditions that provided an excess resin capacity for copper, nickel, cobalt, and lead, but an undercapacity for iron and manganese. The rationale for this was to gauge the ability of resin to scavenge trace metals from a process solution flowing through a resin column, and assess the extent of iron and manganese uptake that might be expected. The behavior of the resin is discussed in terms of the chemistry of the bis(2-pyridylmethyl) aminefunctional group.



Bispicolylamine functional group present on Dowex 4195

adsorption of Ni(II) and Cu(II) from Aqueous Solutions

Freundlich: $q_e=K_LC_e/(1 + bC_e)$

Langmuir: $q_e=K_RCe/(1 + b_RCe\beta)$e

q_e is the adsorption capacity in mg/g; C_e is the equilibrium concentration of adsorbate (mg/L); K_F and n are Freundlich constants; K_L and b are Langmuir constants; q_m is the Langmuir monolayer adsorption capacity and K_R, b_R and β are Redlich-Peterson Isotherm constants.

Effect of initial Concentration

Ni (II) concentrations was selected in the range of 05 to 50 mg L^{-1} for Dowex M 4195 resin (at pH: 6). Experiments were done using 500 mg of resin with different metal concentrations (05-50 mg L^{-1}). It was found that the metal amounts retained were almost stable in this concentration range for Dowex M 4195 resin . Adsorption of nickel was a bit higher in Dowex M 4195 . The maximum adsorption was obtained as 81 % for 10 mg L^{-1} concentration.[18-19]

pH variation studies

In order to find out the optimum pH for maximum removal of adsorbate, experiments were carried out with solutions of same metal ion concentration but adjusted to different initial *pH* values (with HNO3 or NaOH). Measurements were carried out below which chemical precipitation of metal hydroxides do not occur.[20]

Desorption Studies

Some desorption experiments were also conducted in order to explore the feasibility of recovering both the adsorbed species and the adsorbent and to elucidate the nature of adsorption processes. They were carried out as follows. After adsorption experiments using the selected adsorbent and adsorbate doses, the adsorbate loaded adsorbents were separated and washed gently with several portions of distilled water to remove any unadsorbed species. The samples were then air-dried and agitated with 0.1M solutions of HCl, AcOH or water for a period of 10 hours and the amounts of desorbed species were determined in the usual way.[21]

RESULTS AND DISCUSSION

Characterization of the Resins

The parameters evaluated are listed in Table 1.

Table 1. Characteristics of Dowex M-4195 Resin

	Dowex M-4195
Physical form	opaque beads
Ionic form as supplied	free base
Moisture holding capacity	40-60%
Particle size	20/50 US Mesh
Uniformity coefficient	1.7 max
Total exchange capacity	1.0 meq/ mL
pH range	0 – 7

Adsorption Isotherms: Adsorption Models

The assumptions associated with the Langmuir isotherm are well known; Adsorption can not proceed beyond a monolayer coverage and all adsorption sites are equivalent. The Freundlich model, on the other hand, assumes a heterogeneous adsorption surface with sites that have different energies of adsorption and are not equally available. The Redlich-Peterson model is described as a combination of both the other models and is often used to describe equilibrium data over a wide range of concentration. For each and every individual adsorption system, the data were fitted to the three isotherm equations and the results are given in Table 2 [Conditions: adsorbent dose 0.1g/50mL of adsorbate solution; initial concentration of metal ion solutions, Q = 15-100mg/L for Ni; 20-100mg/L for Cu]. All the curves were of L type under Giles classification[21-22]

According to Treybal [23] it has been shown using mathematical equations that n values between 0 and 1 represent beneficial adsorption. Indeed, the n values found for all the adsorption systems fall in this range. The Langmuir constant b is a measure of adsorption intensity and the parameter q_m is a measure of adsorption capacity. Adsorption capacity of the adsorbents toward metal ions decrease in the order Ni(II) [values in Table 2], whereas the adsorption intensity decrease in the opposite order. The b values found indicate stronger interaction forces between carbon surface and Fe(III) ions compared to Ni(II) and Cu(II) Adsorption of Ni(II) and Cu(II) from Aqueous Solutions

In all the systems studied, R_L values were comprised between 0 and 1 (values not listed) indicating favourable adsorption of all the metal ions on the resin[24].

Table 2. Isotherm parameters for the adsorption of metal ions
Model parameters

Metal ion	Model	K_F			
		mmol/g	mg/g 1/ *n*	*n*	R^2
Ni (II)	Freundlich	0.2654	1.4173 0.5065 Model parameters	1.9743	0.9556
		K_L	*b*	q_m	R^2
Ni (II)	Langmuir	0.5272	0.4110 1.2827 Model parameters		0.9849

Effect of pH
The effects of *pH* in external solutions on Resin extent are presented in Figure 2 (adsorbent doses: 0.1g/50mL, *Ci*= 50mg/L).

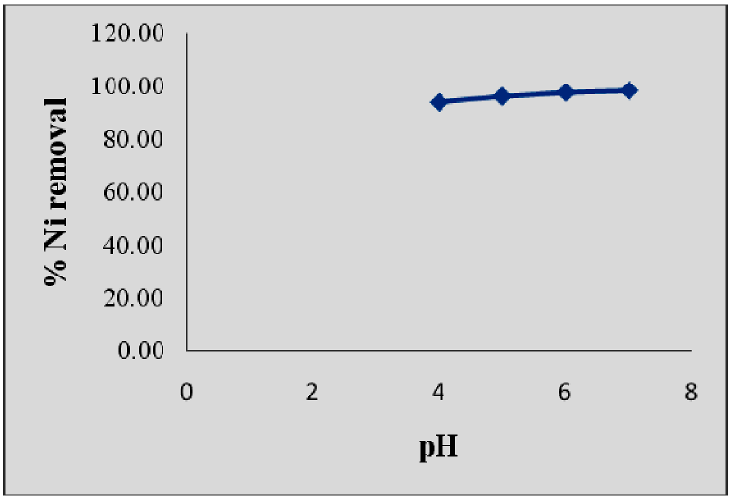


Figure 1. Adsorption of Effect of pH on adsorption of Nickel

Desorption Studies
Attempts were made to regenerate the adsorbed metal ions with water, 1 M NaoH and 1 M hydrochloric acid as regenerating agents.

These results indicate that the metal ions are adsorbed by ion-exchange mechanism by the surface groups present on the Resin surface.

CONCLUSION

The work described has shown that the bis(2-pyridylmethyl) aminefunctional group contain resin can be successfully used for the adsorptive removal of metal ions from solution. Bispicolyl amine have possessed good textural and chemical properties. Ni(II) was found to be superior than Freundlich and Langmuir models. Increase in solution pH result in greater retention of metal ions on CC ,results shown that as metal ion concentration was increase there was increase in resin absorbance or ion –exchange capacity, and resin have good performance at pH 6 in of nickel contain solution

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