COPPER IONS CONCENTRATION USING ION EXCHANGE RESINS

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Abstract: *The paper present the recovery process of copper ions adsorbed onto Purolite S930 chelating resin. The recovery process was investigated using hydrochloric acid, sulfuric acid and disodium salt of ethylenediaminetetraacetic acid solutions. Experiments were carrying out using different resin dose in the range 1 - 25 g dried exhausted resin/L and varying the concentration of regeneration solution in the range 0.1 - 2 eq./L for hydrochloric and sulfuric acid, and in the range 0.1 - 0.2 eq/L for disodium salt of ethylenediaminetetraacetic acid.*

Keywords: *recovery, concentration, ion exchange resins*

1. Introduction

The heavy metals are non-biodegradable in the nature, present bioaccumulation tendency in environment and toxicity to most of life forms [1,2]. When they are found in water in soluble form, heavy metal ions present a high mobility increasing the risk of contamination of large adjacent areas. Therefore the presence of heavy metals in the environment is still a major concern for nature health. The most important source of heavy metals for environmental is the industrial wastewater [3]. To remove the heavy metals from wastewater can be used different treatment techniques such as chemical precipitation, coagulation–flocculation, flotation, membrane filtration processes (ultrafiltration, nanofiltration and reverse osmosis), electrochemical treatment techniques (electro-dialysis, membrane electrolysis, electroextraction and electrochemical precipitation) and sorption treatment techniques (ion exchange, adsorption and biosorption) [1, 3-7]. All these methods have been studied extensively and can be successfully applied in industry. Despite of these possibilities, the industry still uses mainly precipitation. By using precipitation process does not completely eliminate the problem of heavy metals from wastewater. The sludges that result in heavy metals precipitation process need to be treated and stored under special conditions. Recovery of the precipitated metal ions is laborious and expensive. Instead ion exchange methods are ecological as purification methods and may be used both for organic and inorganic compounds [6].

Retention of metal ions from wastewater by ion exchange resin process has a number of advantages over other methods. One of these advantage is the easiness in recovery process. Recovery of metal ion retained on resin can be concentrated and recovered in the form of various salts according to the substance used for regeneration of resin: acids (HCl, H_2SO_4, HNO3), bases (NaOH) or salts (NaCl, disodium salt of EDTA). Another

advantage is the purity of the solution obtained from regeneration. This solution may contains metal salt and acids, bases or salts, depending on regeneration solution used. These solutions can be reused in process, or used to obtain solid metal by electrochemical methods or other products.

2. Materials and methods

The chelating resin used in the experiments was S930 obtained from Purolite International Limited (Hounslow, UK). Table 1 presents the main physical and chemical properties of the resin.

Table 1.
Proprieties of the chelating resin *

Polymer matrix structure	Macroporous styrene divinylbenzene
Functional groups	Iminodiacetic acid
Ionic Form (as shipped)	Na^+
pH range (operating): H^+ form, Na^+ form	2 - 6; 6 - 11
Maximum operating temperature	70ºC
Particle size range	+ 1.0mm <10%, -0.3mm <1%
Total exchange capacity	≥ 1.9 meq/mL

* Manufacturer supplied.

The conversion of the sodium form of the resin into hydrogen form was done with 10% HCl solution, followed by washing with distilled water until the pH of the effluent dropped to neutrality. Then, the resin has been dried at 60 ºC using an oven.

Exhausted resin was obtained using 50.0 ml of Cu^{2+} with initial concentration C_0 = 300 mg Cu^{2+}/l that were added to Erlenmeyer flask already containing 0.05 g of dry resin in H form. The initial pH_i = 5 of the solution was adjusted by using diluted solutions of H_2SO_4. The flasks where mechanically shacked at several fixed temperatures and at the rate of 120 cycles min−1 using Orbital Shaking Incubator GFL 3031. After equilibrium (24 hours), the resin and solution were separated by filtration and the copper content of the solution was measured. The resin was washed with distilled water and then dried using an oven. Further the resin was used in the regeneration and desorption experience

Concentration of Cu (II) in solution was determined by spectrophotometric method with rubeanic acid (λ=395 nm, linear range 1-4 mg Cu /L) using a Hach DR/2000 spectrophotometer.

Concentration ratio was calculated using Equation *1*.

$$C_r = \frac{C_o}{C_d} \quad (1)$$

where,

C_r - is concentration ratio,

C_0 - is copper concentration in solution used in the resin exhausted process (eq./L) and

C_d - is copper concentration in regeneration solution after resin regeneration process.

Recovery percent meaning the percent of copper recovery in the regeneration solution from the copper retained onto ion exchange resin was calculated using Equation *2*.

$$R_p = \frac{a * q}{C_d * V} * 100 \quad (2)$$

where,

R_p - is recovery percent in %,

a - the resin dose, g/L,

q - amount of Cu (II) retained on resin, mg/g,

C_d - is copper concentration in regeneration solution after resin regeneration process, and

V - the volume of regeneration solution.

3. Results and discussion

3.1. Desorption using hydrochloric acid

To study the resin regeneration process a range of resin dose from 1 to 25 g dried exhausted resin/L. In the regeneration experiments the concentration hydrochloric acid solutions were varying in the range 0.1 - 2 eq./L. Figure 1 present Copper concentration ratio using hydrochloric acid solution for regeneration. Using a concentration regeneration solution of 1eq HCl/L Concentration ratio increase from 0.54 for o resin dose of 1 g dried exhausted resin/L to 12.21 for a resin dose of 25 dried exhausted resin/L. Using a concentration of 2eq. HCl/L the concentration ratio increase from 0.54 for o resin dose of 1 g dried exhausted resin/L to 13.40 for a resin dose of 25 dried exhausted resin/L.

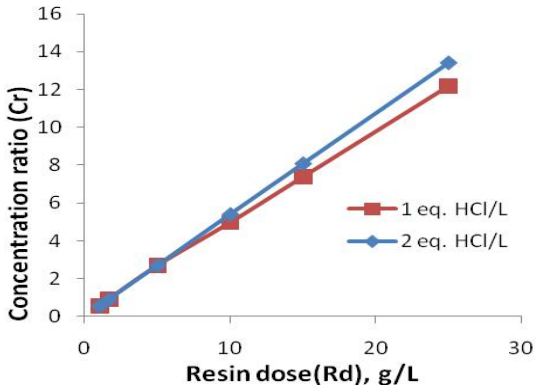

Figure 1. Copper concentration ratio varying dried exhausted resin dose

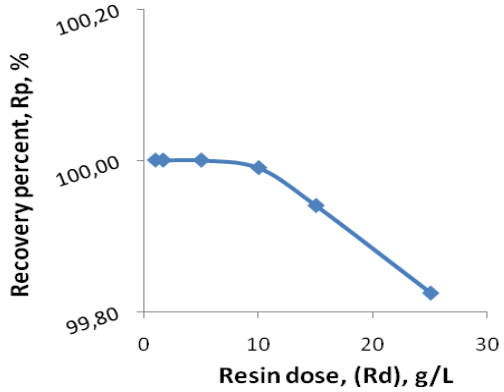

Figure 2. Copper recovery percent using a regeneration solution of 2eq HCl/L and varying dried exhausted resin dose

Figure 2 illustrate the influence of dried exhausted resin dose onto copper recovery percent using a regeneration solution of 2eq HCl/L. Using the same volume of regeneration solution and the same concentration of hydrochloric acid the percent of recovered copper decrease 100% for a dry exhausted resin above 5 g/L.

3.2. Desorption using sulfuric acid

In the regeneration experiments using sulfuric acid the concentration of regeneration solution was varying in the range 0.1 to 2 eq H2SO4/L and the dry exhausted resin was varying in the range 1 to 25 g/L. Figure 3 present the influence of dry exhausted resin dose onto copper concentration ratio using sulfuric acid solution for regeneration.

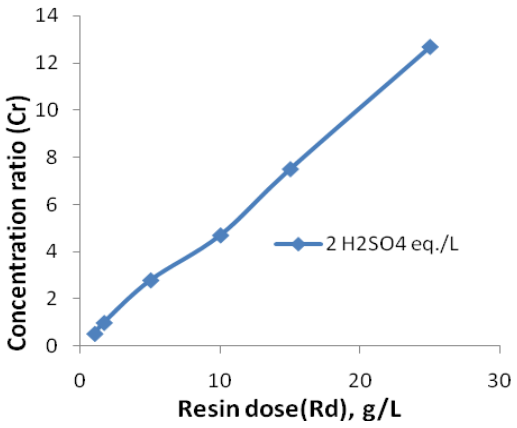

Figure 3. Copper concentration ratio using a regeneration solution of H_2SO_4 and varying dried exhausted resin dose

Using a concentration of 2eq. HCl/L the concentration ratio increase from 0.53 for o resin dose of 1 g dried exhausted resin/L to 12.67 for a resin dose of 25 dried exhausted resin/L. The concentration ratios obtained using hydrochloric acid solution for regeneration were higher up to 6 percents by values obtained using sulfuric acid solution with the same concentration for regeneration. Figure 2 illustrate the influence of dried exhausted resin dose

onto copper recovery percent using a regeneration solution of 2eq H_2SO_4/L.

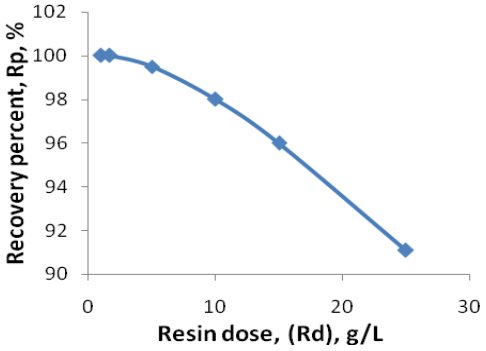

Figure 4. Copper recovery percent using a regeneration solution of 2eq H_2SO_4/L and varying dried exhausted resin dose

Using the same volume of regeneration solution and the same concentration of sulfuric acid, 2eq./L, the percent of recovered copper decrease for a dry exhausted resin above 3 g/L.

3.2. Desorption using disodium EDTA

In the regeneration experiments using disodium EDTA, the concentration of regeneration solution was varying in the range 0.1 to 0.2 meq.disodium EDTA/L and the dry exhausted resin was varying in the range 12.5 to 37.5 g/L (Figure 5).

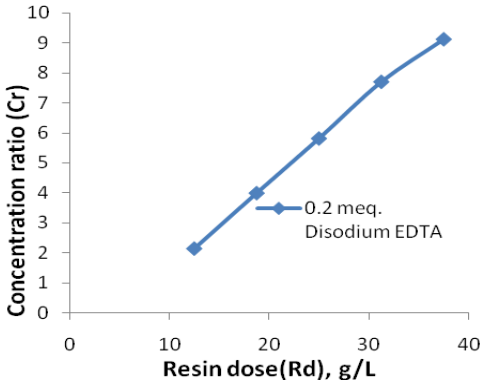

Figure 5. Copper concentration ratio using a regeneration solution of disodium EDTA and varying dried exhausted resin dose

Using a concentration of 0.2 meq. disodium EDTA/L the concentration ratio increase from 2.15 for o resin dose of 12.5 g dried exhausted resin/L to 9.11 for a resin dose of 25 dried exhausted resin/L.

4. Conclusion

The highest rate of regeneration, 13,40, was obtained using hydrochloric acid solution of 2eq/L and a high dose of dried exhausted resin. Good rates of regeneration was also obtained using sulfuric acid solution of 2eq/L or 0.2meq disodium salt of ethylenediaminetetraacetic acid/L and a high dose of dried exhausted resin.

5. References

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