

BAYPURE CX 100 AS A NEW GENERATION COMPLEXING AGENT USED IN REMOVAL OF HEAVY METAL IONS FROM WASTEWATERS

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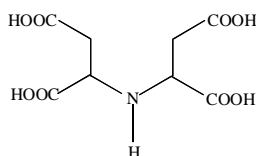
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Abstract

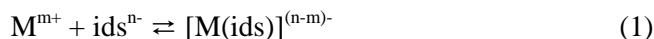
In the presented paper the sorption of heavy metal ions in the presence of iminodisuccinic acid (IDS) on polyacrylate anion exchangers from aqueous solutions was studied. It is a complexing agent of new generation as it undergoes biodegradation thus being an alternative for the reagents of the EDTA or NTA type. Based on the research, the applicability of gel and macroporous polyacrylate anion exchangers with different functional active groups was determined by the dynamic technique. Batch experiments were also carried out to determine the factors affecting sorption and kinetics of the sorption process.

1. INTRODUCTION

Tetrasodium salt of N-(1,2-dicarboxyethylene)-D,L-aspartic acid (sodium iminodisuccinate) produced since 1998 by the Lanxess (Bayer AG Leverkusen, Germany) as a Baypure CX 100 (IDS), is a synthetic compound readily biodegradable, which is made from maleic anhydride, ammonia and sodium hydroxide solution. In water equal amounts of the four possible stereoisomers: two identical meso forms RS'-IDS and SR'-IDS and two forms RR'-IDS, SS'-IDS are found [1,2]. The structure of IDS can be described as follows:



It forms chelates of octahedral structure with many metal ions. The reaction between the metal ion and the anion of IDS acid is reversible and occurs with the ratio 1:1 [3]:



IDS is characterized by low remobilization of heavy metal ions and is superior to the conventional complexing agents because of its excellent ability as complex iron(III), Cu(II) and Ca(II) ions and its very good biodegradability. For these reasons sodium iminodisuccinate seems to be an important alternative soon for the traditional agents of the EDTA type.

The aim of the presented paper was to examine the possibility of using polyacrylate anion exchangers for removal of heavy metal ions such as Cu(II), Co(II) and Ni(II) from aqueous solutions in the presence of IDS.

2. EXPERIMENTAL

The following polyacrylate anion exchangers were used in the investigations: Amberlite IRA 458, Amberlite IRA 958 and Amberlite IRA 67. Prior to the use they were washed with 1 M NaOH, 1 M HCl and deionized water. The resin was finally converted to the appropriate forms. The following heavy metal ions were selected - copper(II), cobalt(II) and nickel(II) in the nitrates form. The initial concentration of metals ions was 0.1 M. The aqueous solutions of each heavy metal ions in the presence of IDS were prepared by dissolving the stock solutions.

In order to measure affinity of Cu(II)-IDS, Co(II)-IDS and Ni(II)-IDS complexes the breakthrough curves were determined. The frontal analysis process was carried out in glass columns. The prepared solutions were passed continuously downward through the resin beds keeping the flow rate at 0.8 mL/cm²-min and the effluent was collected in fractions. The weight (D_g) and bed (D_v) distribution coefficients as well as the working ion exchange capacities (C_w) of M(II) were calculated. The recovery factors (%R) were determined by means of the static method (0.5 g of appropriate dry anion exchanger was placed in a 100 mL stoppered conical flask containing 50 mL of solution and shaken at the constant temperature in the three parallel series). pH was measured with a Radiometer pH meter (Model PHM 82). The concentrations of Cl⁻/NO₃⁻ ions were not determined. The contents of each metal in the raffinate and eluate were determined by the AAS method (Varian SpectrAA- 880).

3. RESULT AND DISCUSION

The sorption process of cobalt(II) and nickel(II) from the single-metal ion solutions in the presence of IDS was conducted by the dynamic method on Amberlite IRA 458, Amberlite IRA 67 and Amberlite IRA 958. As follows from the obtained breakthrough curves (Fig.1) and the calculated weight (D_g) and bed (D_v) distribution coefficients the nickel(II) complexes with IDS exhibit higher affinity for these anion exchangers than that for the cobalt(II) complexes.

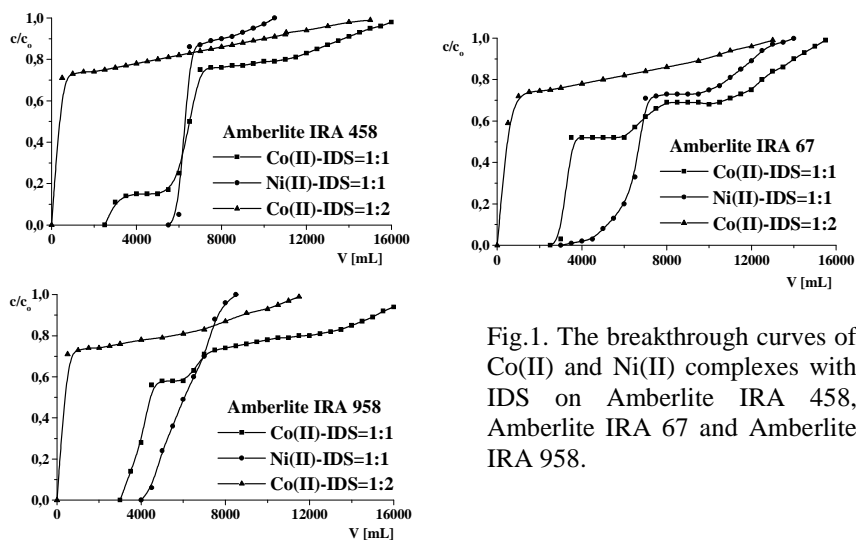


Fig.1. The breakthrough curves of Co(II) and Ni(II) complexes with IDS on Amberlite IRA 458, Amberlite IRA 67 and Amberlite IRA 958.

It can be also stated that the sorption effectiveness depends on the M(II):L molar ratio and the form in which these anion exchangers were used (data not presented). As follows from the studies in the pH range from 2.0 to 6.0 using the static method, at the constant phase contact time equal 6 h, the values of recovery factor (%R) of metal ions on Amberlite IRA 458 and Amberlite IRA 958 increase and reach the plateau at pH above 5. In the case of weakly basic Amberlite IRA 67 these values slightly decrease. Therefore in the next stage, the investigations of sorption by the static method depending on the phase contact time were carried out in the M(II):IDS=1:1 and 1:2 systems at pH without adjustments. The values of anion exchangers capacities (q_t) determined for the Cu(II), Co(II) and Ni(II) complexes with IDS are presented in Fig. 2.

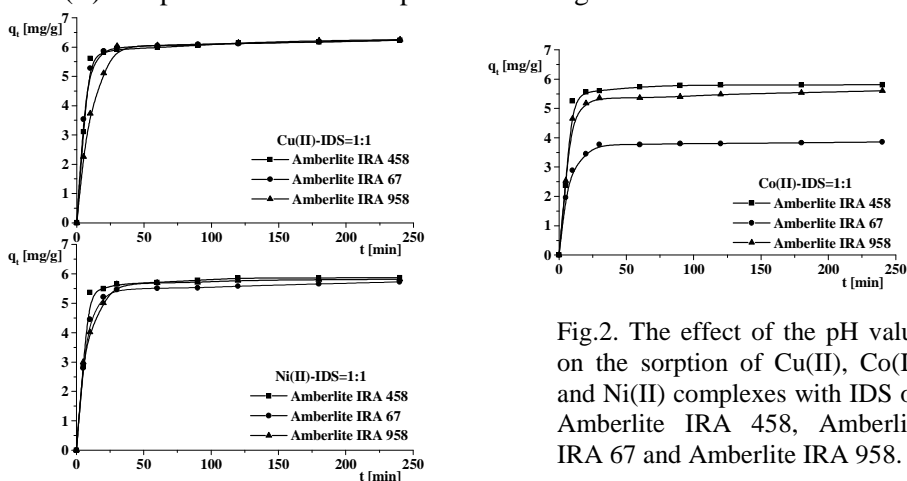


Fig.2. The effect of the pH value on the sorption of Cu(II), Co(II) and Ni(II) complexes with IDS on Amberlite IRA 458, Amberlite IRA 67 and Amberlite IRA 958.

As follows from the comparison of the obtained results, the recovery factors assume the values in the range from 60 % to 100% and they are much more differentiated for the Co(II) complexes than for Cu(II) and Ni(II) ones. The adsorption data for a wide range of adsorbate concentrations are most accurately described by the adsorption isotherms, such as those of Langmuir or Freundlich, which relate adsorption amount to the equilibrium adsorbate concentration in the resin phase. As in Table 1, evaluation of the equilibrium adsorption constant and the maximum sorption capacity was readily obtained from the experimental data by plotting the reciprocal amount of adsorbed metal ions. The highest amounts of metal ions adsorbed per unit weight (mg/g) of the anion exchanger are for the Cu(II) and Co(II) complexes on Amberlite IRA 458 and Amberlite IRA 958.

Table 1. Comparison of Cu(II), Co(II) and Ni(II) complexes with the IDS amount adsorbed per unit of weight of anion exchanger (mg/g) in the M(II)-IDS=1:1 system.

	Cu(II)	Co(II)	Ni(II)
<i>Amberlite IRA 458</i>	65.88	60.65	23.96
<i>Amberlite IRA 67</i>	15.98	12.45	14.16
<i>Amberlite IRA 958</i>	56.78	51.00	33.33

As follows from the research the polyacrylate anion exchangers, according to their applicability for sorption of Cu(II), Co(II) and Ni(II) complexes in the presence of IDS in the 1:1 system can be put in the order:

Cu(II) Amberlite IRA 458 > Amberlite IRA 958 > Amberlite IRA 67,
Co(II) Amberlite IRA 458 > Amberlite IRA 958 > Amberlite IRA 67,
Ni(II) Amberlite IRA 958 > Amberlite IRA 67 > Amberlite IRA 458.

3. CONCLUSIONS

The goal of this study was the assessment of the performance of commercial polyacrylate anion exchange resins, in order to recover the copper(II), cobalt(II) and nickel(II) in the presence of IDS from industrial effluents. The selected resins were Amberlite IRA 458 and Amberlite IRA 958 and the experimental results showed that both are effective in the removal of these heavy metal ions from aqueous solutions. The experimental data were well fitted by the Langmuir model.

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