

Facilitated Transport of Zn²⁺, Ni²⁺ and Co²⁺ by Liquid Membrane Using a Tertiary Amine as Carrier

F. Hassaine-Sadi¹, M. Graiche² and A. Boudaa³

¹Laboratory of Electrochemistry-Corrosion, Metallurgy and Inorganic Chemistry. Chemistry Faculty. University of Sciences and Technology Houari Boumediene. USTHB.. Algiers. ALGERIA. sadifatma4444@yahoo.fr

²Laboratory of Electrochemistry-Corrosion, Metallurgy and Inorganic Chemistry. Chemistry Faculty. University of Sciences and Technology Houari Boumediene. USTHB.. Algiers. ALGERIA. guivache@gmail.com

³Laboratory of Electrochemistry-Corrosion, Metallurgy and Inorganic Chemistry. Chemistry Faculty. University of Sciences and Technology Houari Boumediene. USTHB.. Algiers. ALGERIA. boudaaa@yahoo.fr

Abstract. The environmental impact of the emissions of heavy metals (Zn²⁺, Ni²⁺, Co²⁺) present in the industrial effluents become extensive more and more. The discharge of toxic metals into environment is a serious problem facing numerous industries. So the search for extraction techniques to remove those heavy metals are increasing interest. Liquid membranes have shown great potential in this way especially in cases where metal concentrations are relatively low and other techniques cannot be applied efficiently. The fundamental parameters influencing the transport of the zinc (II), nickel (II) and cobalt (II) through the liquid membrane have been examined (the acidity, the time of transport). The coupling that makes itself thanks to the membrane (extractant + diluent) permits to define the different phases of transfer and to determine the mechanisms of transportation membranaires. In this study of the facilitated transport of zinc, nickel, cobalt ions by liquid membranes containing Tri-n-octyl amine as carrier. The chemical variable exam permitted to determine the parameters giving the extraction efficiency and reextraction optimum. Some performances have been gotten so much to the level of the extraction that of the reextraction. A chemical modelization has allowed to identify the extraction mechanism and transport. The coupling required a real optimization of the set of the parameters. The symmetrical behavior of the two compartments showed that the extraction - reextraction association permits to achieve a transportation, one counter - transportation and a positive coupling. This lets predict an applications as well in the field of metalliferous processing liquid waste not very in charge as in that of the industrial wastes. This also allows an effective protection of the environment while being profitable.

Key words: Zinc, nickel, cobalt, transport, liquid membrane, heavy metal.

Introduction

The treatment and the industrial sewage valorization is at a time therefore a theme carrier and unifier for the future a larger research offer and more varied. The valorization of the dismissals became an important axis these last years, because of the regimentations and instructions that get in place in the world for the protection of the environment [1, 2]. For this doing we have developed a liquid-liquid extraction technique associating extraction to reextraction.

The integration of these main preoccupations, drove us to fix us like objective the exam of the systems of extraction [3-6] of the Zn(II), Ni(II), Co(II) by tri-n-octylamine (TOA). The chemical variable survey (acidity, pH, concentration of the extractant, concentration of metal...) permitted us to determine

optimum outputs, to understand the processes reactionnels and the phenomena of transfer put in game.

Materials and Methods

We have engineered and realized [7-10] a combined comprising two liquid-liquid extraction tubs. A scheme of the extraction-reextraction combined is drawn on figure 1 where the organic phase is the light phase. The great interest is to avoid the regeneration of the solvent which is intact at the end of operations. The organic phase (membrane) consists of extractant dissolved in the kerosene. The stirring velocity is of 280 turns per minute and the volume of the cells is 200 ml.

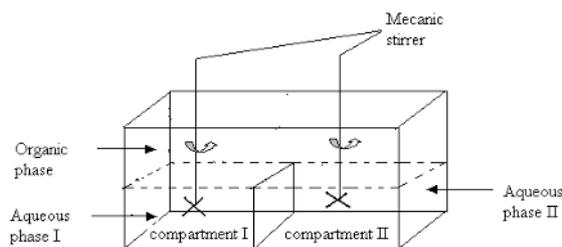
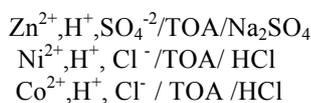


Fig. 1. Scheme of extraction -reextraction combined.

Results and Discussion

We applied the process purification-concentration to these systems:



The parameters of the feeding phase and the parameters bound to the membrane have been examined such that: the time of transport.

Transport of the Zn(II) by tri-n-octylamine (TOA)

Compartment extraction: $[\text{Zn}(\text{II})]_0 = 100 \text{ ppm}$, and $[\text{H}_2\text{SO}_4] = 0,5\text{M}$

Membrane: $[\text{TOA}] = 0.01\text{M}$ / kerosene

Compartment reextraction: $[\text{Na}_2\text{SO}_4] = 1\text{M}$

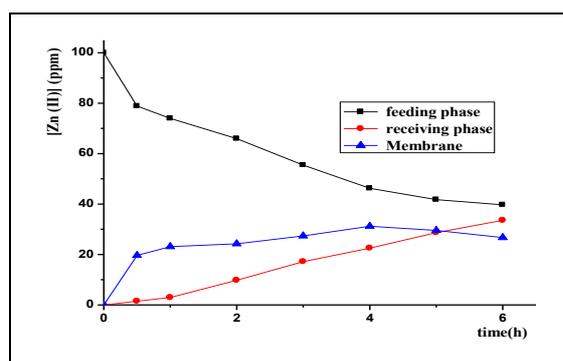


Fig. 2. Variation of the quantities extracted and reextracted of Zn(II) in function the time.

We examined the transport of ions Zn^{2+} through the liquid membrane by TOA. The transferred quantity of Zn(II) is higher at the time than the receiving phase is Na_2SO_4 thus a quantity reextraite of the order of 33 ppm is an output of 33% at the end of 6 hours.

Transport of the Ni(II) by tri-n-octylamine (TOA)

Compartment extraction: $[\text{Ni}(\text{II})]_0 = 100 \text{ ppm}$, and $[\text{HCl}] = 0,5\text{M}$

Membrane: $[\text{TOA}] = 0.1\text{M}$ / kerosene

Compartment reextraction: $[\text{HCl}] = 3\text{M}$

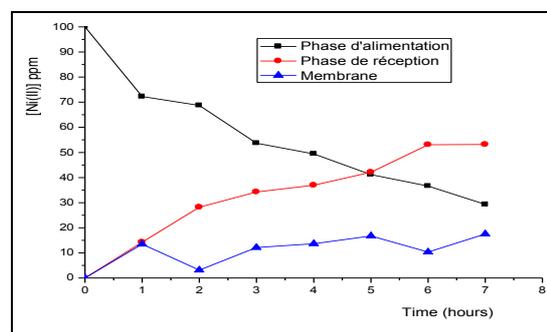


Fig. 3. Variation of the quantities extracted and reextracted of Ni(II) in function the time.

The amount of nickel (II) in the receiving phase increases over time. We obtain an amount of about reextracted 53.17 ppm is a percentage of 53.17% for a time of 7:00. We have a transfer between these two compartments.

Transport of the Co(II) by tri-n-octylamine (TOA)

Compartment extraction: $[\text{Co}(\text{II})]_0 = 100 \text{ ppm}$, and $[\text{HCl}] = 0,5\text{M}$

Membrane: $[\text{TOA}] = 0.1\text{M}$ / kerosene

Compartment reextraction: $[\text{HCl}] = 3\text{M}$

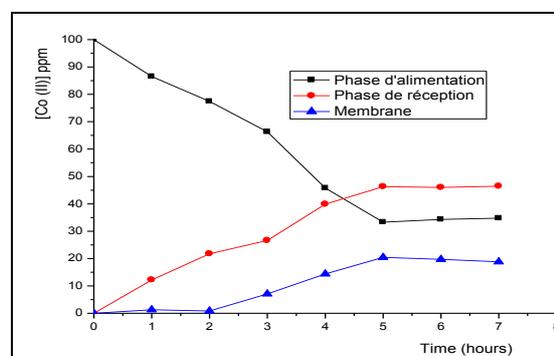


Fig. 4. Variation of the quantities extracted and reextracted of Co(II) in function the time.

The amount of cobalt transferred to the stripping phase increases until a concentration of 46.42 ppm is a quantity of 46.42% for a time of seven hours. We note that the behavior of the two compartments are symmetric, we have a good transfer across the membrane.

Conclusion

This work had been fixed like objective to develop a process treatment of the diluted solutions. It was reached thanks to the application of a process using association extraction-reextraction liquid-liquid, where the two

compartments are coupled thanks to the membrane constituted of an extractant + diluent. We examined the transport of Zn^{2+} , Ni^{2+} and Co^{2+} ions through the liquid membrane by TOA. We note that transport of ions Zn^{2+} through the liquid membrane by TOA. The transferred quantity of Zn(II) is higher at the time than the receiving phase is Na_2SO_4 thus a quantity reextraite of the order of 33 ppm is an output of 33% at the end of 6 hours.

The amount of Nickel (II) in the receiving phase increases over time. We obtain an amount of about reextracted 53.17 ppm is a percentage of 53.17% for a time of 7h. The amount of Cobalt (II) transferred to the stripping phase increases until a concentration of 46.42 ppm is a quantity of 46.42% for a time of seven hours. The symmetrical behavior of the two compartments extraction and reextraction shows that we have a transfer well through the membrane and it showed that the coupling makes it possible to carry out a transport, a against-transport and a positive coupling.

The results obtained highlighted the feasibility of the liquid membrane process and the performances of the coupling. This lets predict and to hope for broad applications in the field of the treatment and valorization of the industrial effluents containing of heavy metals. It also allows an effective protection of the environment while being profitable.

References

- [1]: A.M. Urtiaga, A.Alonso, J.A. Daoud, S.A. El-Reefy, S., Perez of Ortiz, T., Gallego . Newspaper of Membrane Science 2000;164; p229.
- [2]:G.Hanrahan, Tina Mr. Salmassi, Crist., Khachikian, Krishna L, F. Talanta 2005,66, p437.
- [3]: J.P.Brun, «Process of separation by membrane», Ed Masson, 1989
- [4]:Y.MARCUS, A.S.Kertes,«ion exchange and solvent extraction of metal complexes»,Wiley Interscience, 1969.
- [5]:G. M. RITCEY and A. W. ASHBROOK, Tome I , Ed. Elsevier, 1984.
- [6]: G. M. RITCEY and A. W. ASHBROOK., Part II, Elsevier edit. 1979.
- [7]: F. Hassaine-sadi, A., Benhassaïne and H.Aït Amar . Entropy, 2001;230;31.
- [8]: F. Hassaine-Sadi, L.Sadoun, Desalination 2005 ;185 ;335-340. Elsevier
- [9]: F. Hassaine-Sadi, H. Bouchabou, Desalination 2007 ;206 ; p 554. Elsevier
- [10]: F. Hassaine-Sadi, M.Graiche, 15th ICHMET 2010, Gdansk, Poland.