

REMOVAL OF URANYL IONS UO_2^{2+} FROM DILUTE SOLUTIONS BY ELM TECHNIQUE. II. TRANSPORT MECHANISM OF URANYL IONS WITH FATTY PRIMARY AMINES AS CARRIERS AND EMULSIFIER

Cristina Măruță*, I. Mândru, Daniela Rață, Mihaela Sandu,
Georgeta Popescu and Ana Mariana Urmenyi

abstract: The separations of uranyl ions (UO_2^{2+}) from dilute aqueous solution can be achieved by ELM technique using primary fatty amines $\text{C}_{14} - \text{C}_{18}$ as carrier and emulsifier in the same time. Uranyl ions are transported across a membrane formed of kerosene to the receiving solution composed of NaHCO_3 1M. By these techniques, residual concentrations under 0.4 mg/L are obtained.

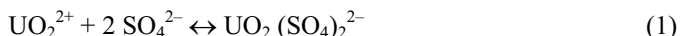
Introduction

The use of liquid membrane in the separations processes has become of interest in the last time for recovery of valuable materials or as means of depoluting wastewaters.

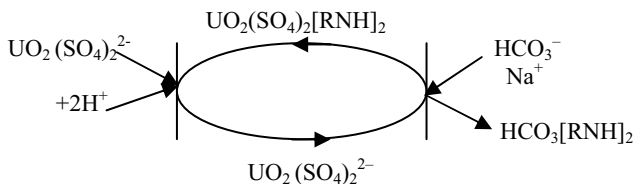
As a rule, in this technique, the liquid membrane consisting is an insoluble organic liquid containing both the emulsifier and carrier are used in order to obtain an inverted w/o emulsion.

This paper demonstrates the possibility to use a single compound, fatty primary amine, both as emulsifier and carrier for uranyl ions from dilute aqueous solutions to receiving solutions.

Like in the case previously presented (1), extraction of uranyl ions UO_2^{2+} is based on formation in the phase source of uranyl-sulfate anion:



The mechanism of separation is illustrated in the following scheme:



* Research Center for Macromolecular Materials and Membranes, Spl. Independentei 202B,
RO – 79611, Bucharest

The separation process is based on protonation of primary amine at the phase source / membrane interface to form $\text{UO}_2(\text{SO}_4)_2[\text{RNH}_3]_2$ complex. This complex is soluble in organic phase and transported to the receiving phase where interacts with HCO_3^- to form an insoluble inorganic phase complex $\text{UO}_2(\text{HCO}_3)_4^{2-}$.

This way, a transport against the concentration gradient takes place, uranyl ion being accumulated in the receiving solution.

The solution of uranyl ions were obtained by dissolving uranium octoxid (U_3O_8) in concentrated nitric acid and dilution with distilled water to concentration between 4÷10 mg/L.

Materials and Methods

The organic membrane was composed of kerosene (Merck) having dissolved the carrier, primary fatty amines (Akzo Nobel). Extraction of uranyl ions from dilute aqueous solution is achieved using for the first time a single compound as emulsifier and carrier in the same time. Equal volumes of organic phase and receiving solutions (NaHCO_3 1 M) were stirred using a Cole & Parmer high-speed stirrer to obtain the inverted emulsions.

The extraction of uranyl ions from dilute solutions was realized by dispersing the inverted emulsion in the source phase (at 1:15 ratio) for times between 5÷15 min.

The yield of extractions was expressed as the ratio of uranyl ions extracted to initial quantity in system.

The residual uranyl ions remained in the source solution were determined photometrically using the Arsenazo III as indicator [1].

Results and Discussions

As in the case of using the ammonium quaternary compounds [2], the extraction yield is strongly dependent on pH of the source phase (Fig. 1).

As a particularity, in this case, the yield of extraction reaches a maximum under pH 5, with a sensible decrease above this value.

Extending the contact time between source phase and inverted emulsion a maximum in extraction yield is reached after 5 min and than the yield drops very likely due to emulsion breaking (Fig. 2).

The extraction yield is affected by the emulsion / source phase ratio (Fig. 3).

The transfer process is very fast. The high values of the yield are obtained for 5 min. of contact time. Extending the contact time is detrimental for extraction. The emulsion / source phase ratio does not change sensible the extraction yield in contrast with the case when an ammonium salt is used as carrier [3,4].

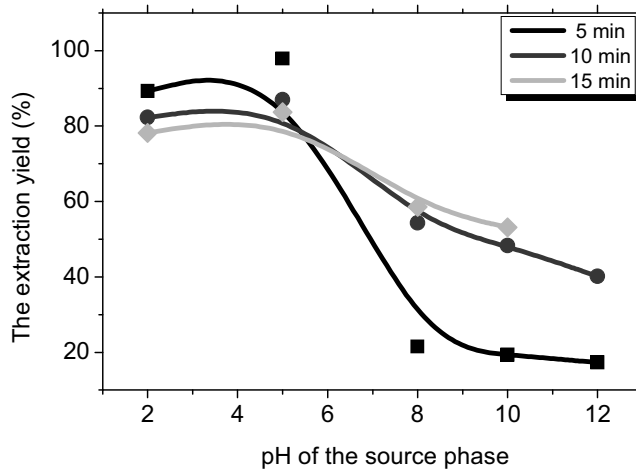


Fig. 1: The influence of phase source's pH on the extraction yield.

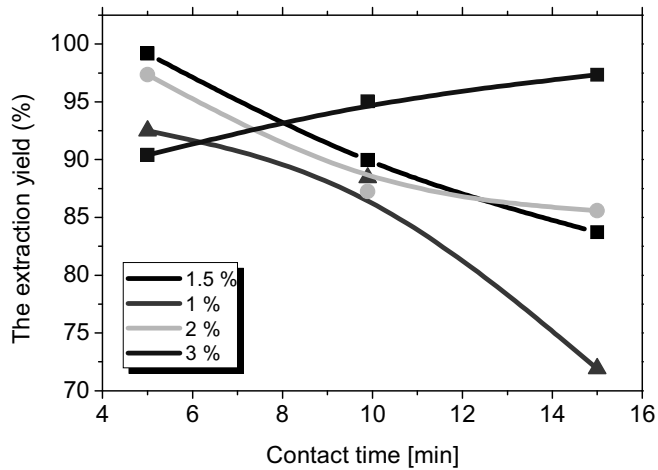


Fig. 2: The influence of the contact time on the yield extraction.

Besides the yield of extraction versus carrier and emulsifier nature as well as the characteristics of emulsion formulation, the speed of transport from source phase to receiving solution can be characterized by the flux of uranyl ion defined by:

$$\gamma_{\text{net}} = \frac{C_{\text{RP}}}{M \cdot S \cdot t} \quad \left[\text{mol}/\text{cm}^2 \cdot \text{s} \right] \quad (2)$$

where: C_{RP} is the concentration of uranyl ions in the receiving phase after time t , S – area of separation between two phases and M – molecular weight of transported species.

For dispersions of inverted emulsion in source phase the mean diameter of spherical particles was $d = 0.05$ cm and the specific surfaces of 1 ml emulsion is given by:

$$S = \frac{6}{d} \quad (3)$$

The C_{RP} after time t in receiving solution is given by:

$$C_{RP} = (C_0 - C_t) \frac{V_{SP}}{V_{RP}} \quad [\text{mol/L}] \quad (4)$$

where: C_0 and C_t are the concentration of uranyl ions in the source phase.

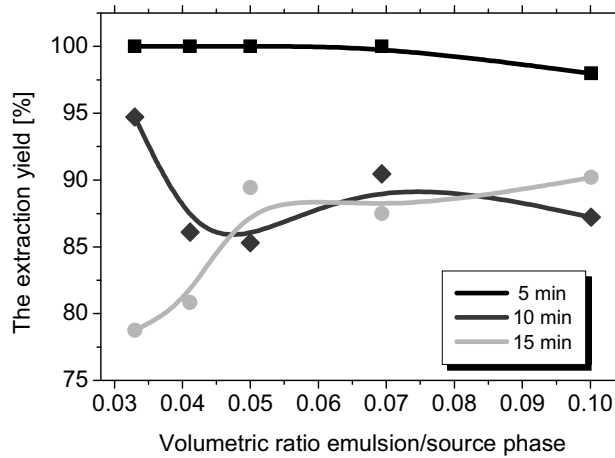


Fig. 3: The influence of volumetric ratio emulsion/ source phase on the extraction yield.

The net flux vs. time is presented in Fig. 4.

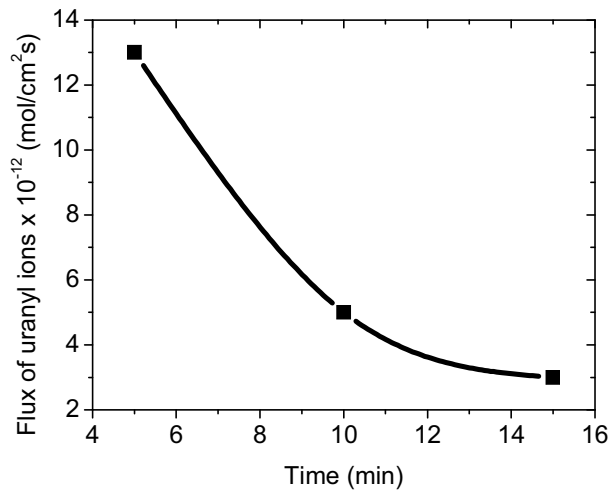


Fig. 4: The influence of the time on the uranyl ions's flux.

Conclusion

The removal of uranyl ions from waste waters by ELM technique has been realized by using for the first time a primary fatty amines with double role: as carrier and emulsifier.

The best results were obtained with these fatty amines (the extraction yield is about 95%).

REFERENCES

1. ***STAS 12849/1-90.
2. Maruta, C., Mandru, I., Rata, D., Popescu, G. and Urmenyi, A.M. (2002) *J. Colloid and Surf. Chem.*, in press.
3. Noble, R.D. and Stern, S.A. (1995) **Membrane Separation Technology: Principles and Applications**, Elsevier, Amsterdam.
4. Ramkumar, J., Nayak, S.K. and Maiti, B. (2002) *J. Membr. Sci.* **196**, 203-10.