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Synthesis and Characterization of Polymer Inclusion Membranes Containing Uranium-Selective Transporters

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ABSTRACT

Environmental contamination has become more serious with the rapid development of modern industry, where many wastes have cruelly polluted the natural environment. Among these wastes, radioactive effluents generated during nuclear operations which vary in chemical composition and radionuclides. Uranium is among the most dangerous radionuclides present in the effluents generated by the activities of the Draria nuclear research center due to its chemical toxicity and radioactivity. For the protection of the environment and human health, the elimination of uranium is necessary. Several techniques have been used for this purpose: chemical precipitation, solvent extraction, ion exchange, adsorption and membrane processes. Membrane processes have been used for the recovery of many metals of strategic and economic interest such as uranium, copper, molybdenum, cadmium, lead and zinc, etc. Polymer inclusion membranes so-called membranes of third generation have the advantage of being selective because they incorporate specific extractants in their structure which gives them great stability. In the present study, we developed inclusion polymer membranes based on cellulose triacetate (TAC) containing 2-diethyl hexyl phosphoric acid (D2EHPA), Tributyl phosphate (TBP) at different volumes and the mixture of Tributyl phosphate and kerosene (TBP/kerosene) as carrier. The physicochemical and the structural characterization of the synthesized membranes are made by Fourier transform infrared (FTIR), by scanning electron microscopy (SEM) and by differential thermal analysis (ATG/ATD). The performance of these membranes toward uranium are studied by determining the number of fixed complexing sites on each type of membrane using UV-Visible spectrophotometry for the determination of the fixed uranium by the Arsenazo III method . The results of the comparative study of the performance of the different membranes developed showed that the most selective membrane for uranium is that containing tributyl phosphates alone as a carrier (TAC-NPOE-TBP)

Keywords: membrane, uranium, D2EHPA, TBP, Kerosene, fixed complexing sites

1 Introduction

Environmental contamination has become more serious with the rapid development of modern industry, where many wastes have cruelly polluted the natural environment. Among these wastes, radioactive effluents generated during nuclear operations which vary in chemical composition and radionuclides [1,2]. Uranium is among the most dangerous radionuclides present in the effluents generated by the activities of the Draria nuclear research center due to its chemical toxicity and radioactivity [3]. For the protection of the environment and human health, the elimination of uranium is necessary. Several techniques have been used for this purpose: chemical precipitation, solvent extraction, ion exchange, adsorption and membrane processes [4]. Membrane processes have been used for the recovery of many metals of strategic and economic interest such as uranium, copper, molybdenum, cadmium, lead and zinc, etc[5-7]. Polymer inclusion membranes so-called membranes of third generation have the advantage of being selective because they incorporate specific extractants in their structure which gives them great stability [8].

2 Experimental

All used chemicals were of analytical reagent grade. The aqueous solutions were prepared in doubly distilled water. Uranyl nitrate (UO2 (NO3)2) used for the preparation of U(VI) aqueous solutions is declared in the

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framework of IAEA guarantees. The polymer inclusion membrane PIM is prepared as described in literature and our previous work [9] A chloroform solution (20 mL) of CTA (200 mg), the appropriate plasti-cizer NPOE (0.2 mL) and the above-listed D2EHPA,TBP and the mixture TBP/kerosene were placed in a 9.2 cm diameter flat bottom glass petri dish. The solvent was allowed to evaporate slowly overnight to obtain a polymer film with a smooth looking surface. The obtained film was then carefully peeled out from the dish and used in uranium performance experiments.

The uranium concentrations were determined by sampling aliquots of 0.5 mL and analysed with UV visible spectrophotometer: Optizen pop at 652 nm. IR spectra were recorded on with Perkin-Elmer (Spectrum One) spectrophotometer.The morphologies of the different membranes elaborated are determined by SEM analysis using a scanning electron microscope (Hitachi S4500).

3 Results and discussion

In the present study, we developed inclusion polymer membranes based on cellulose triacetate (TAC) containing 2-diethyl hexyl phosphoric acid (D2EHPA), Tributyl phosphate (TBP) at different volumes and the mixture of Tributyl phosphate and kerosene (TBP/kerosene) as carrier. The physicochemical characterization of the elaborated membranes are represented in Table 1.The structural characterization of the synthesized membranes are made by Fourier transform infrared (FTIR), by scanning electron microscopy (SEM) and by differential thermal analysis (ATG/ATD). The performance of these membranes toward uranium are studied by determining the number of fixed complexing sites on each type of membrane using UV-Visible spectrophotometry for the determination of the fixed uranium by the Arsenazo III method (Table 2).

4 Conclusion

The results of the comparative study of the performance of the different membranes developed showed that the most selective membrane for uranium is that containing tributyl phosphates alone as a carrier (TAC-NPOE-TBP) as shown in Table 2.

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