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New anion-exchange membranes for the selective transport of platinum

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Introduction

Platinum is a metal of high interest due to its extensive anthropogenic uses. The large demand of this metal next to its high price has led to a further impetus for techniques to allow its separation and recovery. Among the different separation methods described in the literature, supported liquid membranes (SLMs) have shown to effectively recover this precious metal [1]. However, it is well known that SLMs suffer of a lack of mechanical and even chemical stability. Thus, development of stable and cost effective ion-exchange membranes with good physicochemical is highly desired.

This study is aimed at developing new stabilized membranes for the transport of Pt(IV) based on *in situ* anchoring anion-exchange groups to the pores of the host poly(propylene) membranes by photo-polymerization of the monomers along with a crosslinker [2].

Methods

The microporous poly(propylene) flat sheet membrane (Accurel^{R} 1E R/P from Membrana) having nominal pore size of 0.1 μm and thickness of 92.5 μm was used as the host membranes. The polymerizing solution was prepared by dissolving monomer 3-Acrylamidopropyl)trimethylammonium chloride (APTMA), (with or without 10-undecenoic acid (UDA)) and cross-linker MBA (5 mol % of monomer) in 1:1 mixture of N,N'-dimethylformamide (DMF) and methanol. The UV-initiator α,α'-dimethoxy-α'-phenyl acetophenone (DMPA) was added to this solution. The different membranes tested are shown in Table 1 with the proportions of APTMA and UDA used in the polymerizing. Besides, the amount of cross-linked microgel anchored in the host membrane (determined gravimetrically) is also indicated

Table 1. Membrane composition

Membrane	APMTA:UDA (moles)	Grafting (wt %)
M1	1:1	102.5
M2	1:1	31.9
M3	2:1	90.2
M4	1:2	169

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Extraction experiments were done using 100 mL solution containing 10 mg L^{-1} Pt(IV) in 10^{-2}M HCl and contacted with a small piece of the membrane under study (aprox. 0.04 g) in continuous agitation. After 24 h, the membrane segments were removed from the solution, blotted dry, and used for the elution studies. In this case also 100 mL of the tested solutions was used. The permeation experiments were carried out by using a two compartment membrane cell provided with a circular window, 3.8 cm diameter, where the membrane was placed. Samples were analyzed by ICP-OES.

Results

Among the different membranes tested, membrane M1, consisting of APTMA and UDA (1:1 mole proportion) and prepared by using a polymerizing solution having higher concentrations of monomers than M2, was the most efficient in terms of Pt uptake, as can be seen in Fig. 1. Elution studies were conducted using Pt-loaded M1 membranes, and the use of both 0.5 M thiourea and 0.5 M NaCl quantitatively recovered Pt extracted, while 0.5M $NaClO_4$ and 0.5 M NaSCN solutions were less effective. However, when using thiourea as stripping agent in transport studies, poor Pt recovery was achieved, and thus, a 0.5 M NaCl solution was used. As can be seen in Fig.2, where the transient concentration of Pt is shown, the metal was successfully transported through M1, showing this membrane as a promising separation technique to recover Pt from scraps.

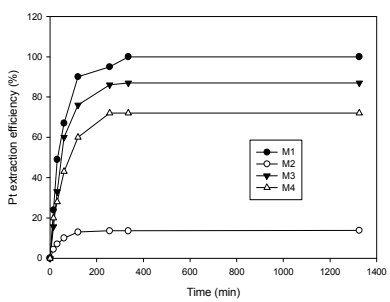

Fig.1. Pt extraction efficiency vs. time

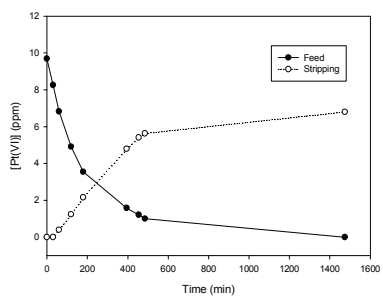

Fig 2. Pt transport profile using M1 and 0.5M NaCl as stripping solution

Discussion

The novel membranes here developed have shown to effectively transport Pt. Moreover, the extraction of Pd has been also investigated with M1-M4, and Pd was extracted but in a less extent. Thus, we expect that M1 will allow Pt and Pd separation from spent automotive catalyst solutions, and thus, facilitating the recycle of these expensive metals.

References

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