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SOLVENT EXTRACTION STUDIES USING TETRACYCLINE AS COMPLEXING AGENT. PART 7. SEPARATION OF URANIUM FROM SCANDIUM AND RARE EARTHS WITH ETHYLENEDIAMINETETRAACETIC ACID AS MASKING AGENT

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Separation of uranium from rare-earth and scandium is accomplished by solvent extraction technique using tetracycline as a complexing agent and ethylenediaminetetraacetic acid as a masking agent for for scandium and rare-earths. Benzyl alcohol is used as the organic solvent and ionic strength in the aqueous phase is kept constant at 0.10M by addition of $NaClO_4$.

INTRODUCTION

In previous papers separation of uranium from thorium[1] and from neptunium[2] by solvent extraction with benzyl-alcohol-tetracycline solution, were presented. Diethylenetriaminepentaacetic acid (DTPA) was used as masking agent for thorium.

This work presents the separation of uranium from rare-earth elements as well as from scandium by solvent extraction using tetracycline hydrochloride (TC) as complexing agent and ethylenediaminetetraacetic acid (EDTA) as masking agent for the lanthanides and for scandium.

EXPERIMENTAL

The general experimental technique has been described in previous paper of this series[1,2]. The extraction was carried out at 25°C by shaking the phases for 30 min. The concentration of $NaClO_4$ in the aqueous solution was equal to 0.10M $NaClO_4$.

Radioisotopes (^{46}Sc, ^{140}La, $^{152-154}Eu$, ^{170}Tm) of the elements were obtained by the irradiation of oxides (Johnson Matthey) in a thermal neutron flux of $5x10^{12}$ n cm^{-2} sec^{-1} for 8 hours. After irradiation the scandium oxide was dissolved in a hot mixture of $HClO_4$ and HNO_3 and the rare earths oxides in hot $HClO_4$ and diluted to the desired concentration (10^{-4}M).

The masking agent EDTA was added to the aqueous phase to give a concentration of $2.5x10^{-3}$M. TC was dissolved in benzyl alcohol previously washed with distilled water. The concentration of TC in the alcohol was 0.010M.

After equilibration the phases were separated by centrifugation, the pH of aqueous phase was measured and aliquots of each phase were counted using a well-type NaI(Tl) scintillation coupled to a single channel γ-ray analyser or a Ge-Li detector and a 4096 channel analyser when counting mixtures of the radioisotopes.

Concentration of uranium in both phases was determined by activation analysis with epithermal neutrons.[3]

RESULTS

Previous experiments showed that in the absence of tetracycline, the uranyl, lanthanides and scandium ions, as well as the complexes scandium-EDTA and lanthanide-EDTA, were not extracted into benzyl alcohol.

Data for extraction of uranium, scandium, lanthanium, europium and thulium with benzyl alcohol-tetracycline and no masking agent are given in Table 1 and plotted in Fig. 1. From these data it is seen that separation of uranium from Sc, La, Eu and Tm would only be possible by using multistage technique, since the curves lie too close apart.

However, masking of Sc and the lanthanides with EDTA and forming the non-extractable complex Sc-EDTA and lanthanide-EDTA, gives an excellent separation of uranium from Sc and lanthanides, the EDTA com-

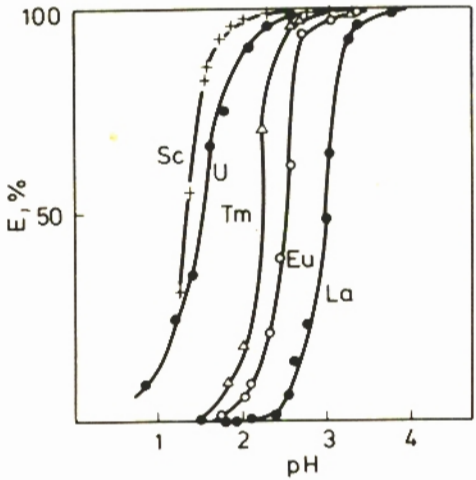

Fig. 1. Extraction curve for U, Sc and lanthanide elements without masking agent. Concentration of $NaClO_4$ 0.10M, uranium = 7.0×10^{-5}M TC=0.010M, Sc=1.0×10^{-5}M, lanthanides = $10^{-4} - 10^{-5}$M

TABLE 1

Percent extraction of Sc and lanthanides elements by TC-benzyl alcohol solutions without masking agent. Concentrations of $NaClO_4$ in the aqueous phase 0.1M

U		Sc		La		Eu		Tm	
pH	%E	pH	%E	pH	%E	pH	%E	pH	%E
0.85	8.7	1.30	31.5	1.80	0.2	1.50	0.4	1.50	0.6
1.20	22.6	1.40	55.1	1.90	0.4	1.75	1.7	1.55	1.6
1.40	34.8	1.60	83.3	2.10	1.0	2.00	5.4	1.80	9.4
1.60	65.6	1.60	86.1	2.40	1.7	2.10	8.1	2.00	18.8
1.80	74.9	1.75	92.8	2.55	6.2	2.30	21.9	2.25	71.0
2.10	91.1	1.90	96.1	2.60	14.4	2.45	39.8	2.60	95.7
2.30	96.8	2.00	98.1	2.80	23.6	2.60	62.3	2.70	97.1
2.60	98.2	2.30	99.0	3.00	48.4	2.70	93.7	3.35	99.6
		2.40	99.0	3.05	64.9	3.10	97.6		
		2.80	99.1	3.30	92.9	3.30	99.1		
		3.05	99.6	3.40	96.1				
				3.85	98.9				

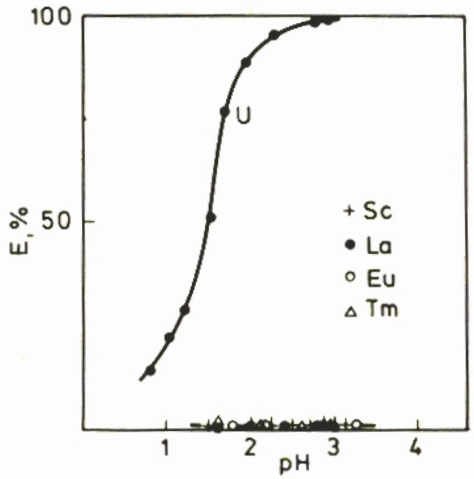

Fig. 2. Extraction curve for U, Sc and lanthanide elements using EDTA as masking agent. Concentration of $NaClO_4$ 0.1M, uranium = 8.0×10^{-5}M TC = 0.010 M. Sc = 1.0×10^{-5}M, lanthanides = 10^{-4}–10^{-5}M, EDTA = 2.5×10^{-3}M

TABLE 2

Percent extraction of Sc and lanthanides by TC-benzyl alcohol solution using EDTA (2.5×10^{-3}M) as masking agent. Concentration of $NaClO_4$ in the aqueous phase 0.1M

U		Sc		La		Eu		Tm	
pH	%E	pH	%E	pH	%E	pH	%E	pH	%E
0.80	14.1	1.50	0.6	1.60	0.1	1.80	0.9	1.60	1.2
1.05	21.9	2.00	0.5	2.00	0.8	2.20	1.0	2.10	0.5
1.20	29.3	2.25	0.6	2.40	0.9	2.85	1.4	2.60	0.7
1.50	50.8	2.50	0.8	2.80	0.9	3.25	1.7	2.95	0.8
1.70	77.5	2.50	0.6	3.00	1.0				
1.95	87.3	2.70	0.9						
2.30	95.9	2.85	1.0						
2.80	98.6	3.15	1.1						
2.90	99.3								

plexes with Sc and lanthanides remaining in the aqueous phase. Table 2 and Fig. 2 show the extraction data corresponding to the separation of uranium from Sc and the lanthanides.

The stability constants for the lanthanides-EDTA and Sc-EDTA complexes[4] are larger than the ones for the lanthanides-TC complexes[5] and there is no displacement of the lanthanides and of Sc, from their respective EDTA compounds, by TC.

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