The Solvent Extraction of Metal Ions in the Presence of Two Different Chelating Agents

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(Received September 27, 1965)

In the study of 2-thenoyltrifluoroacetone (TTA) solvent extraction, synergic effects were observed in the extraction of some metals in the presence of 8-quinolinol. Many studies of the synergic effects have been carried out. Most of these extraction systems contain complexing acids and other neutral ligands which form adduct compounds. The synergic effects in the presence of two different chelating agents are interesting,[1,2] because these agents can react as both chelate-forming and adduct-forming agents. In this paper, the extraction of uranyl and europium ions will be studied in the presence of TTA and 8-quinolinol and the stabilization factor will be calculated. It is well known that these metal ions are extracted into the organic phase as TTA[3] or 8-quinolinol[4] complexes under the present conditions.

Experimental

Reagents and Apparatus.—Uranium-237 was prepared by the (γ, n) reactions of natural uranium in a 20 MeV-electron linear accelerator of the Japan Atomic Energy Research Institute.[5] Europium-152+154 was supplied by the Radiochemical Centre, Amersham. Appropriate amounts of TTA and 8-quinolinol were dissolved in distilled benzene and were stored in a refrigerator. Radioactivity measurements were made with a Kobe Kogyo SA-230 scintillation counter.

The Determination of the Distribution Ratio.—Five ml. of an acetic acid - sodium acetate buffer solution (pH 3.5) and 1 ml. of the standard metal solution were transferred into a separatory funnel. Appropriate amounts of sodium perchlorate solution were then added to keep the ionic strength of the aqueous phase at 1 M. After the aqueous phase had been diluted to 10 ml. with water, TTA and 8-quinolinol solutions were added and the organic phase was diluted to 10 ml. with benzene. The system was then shaken for 5 min. at 25±2°C. The distribution ratio (D) was determined by the γ-counting of each phase. D was defined as the ratio of counts from the organic to those from the aqueous phase.

Results and Discussion

Determinations of D were carried out in the presence of TTA, 8-quinolinol, and a combination of the two. The results are shown in Tables I, II and III, respectively. $(D_M)_{TTA}$, $(D_M)_{OX}$ and $(D_M)_{TTA+OX}$ represent the distribution ratios of the elements in the presence of TTA, 8-quinolinol, and a combination of the two. β, the stabilization factors, $(D_M)_{TTA+OX}/((D_M)_{TTA}+(D_M)_{OX})$, are given in Tables II and III. The distribution ratio increases remarkably in the presence of two chelating agents. The extraction mechanism was not studied in this paper. Both agents (HA and HB) are able to form adduct compounds such as $MA_n(HA)_m$ with their acid forms as is shown in the extraction

Table I. Distribution ratio of uranium in the presenece of TTA and 8-quinolinol, respectively
(7.2×10^{-5} mol. U, 0.1 M AcO^-)

TTA, M	$(D_U)_{TTA}$	8-Quinolinol, M	$(D_U)_{OX}$
1.0×10^{-2}	1.44	1.0×10^{-2}	0.061
6.0×10^{-3}	0.52	8.0×10^{-3}	0.034
4.0×10^{-3}	0.23	7.0×10^{-3}	0.025
3.0×10^{-3}	0.13	6.0×10^{-3}	0.018
2.0×10^{-3}	0.061	4.0×10^{-3}	0.007

Table II. Stabilization factor
(7.2×10^{-5} mol. U, 0.1 M AcO^-)

Concn. of reagents, M TTA	8-Quinolinol	$(D_U)_{TTA+OX}$	β*
6.0×10^{-3}	4.0×10^{-3}	8.08	15.3
4.0×10^{-3}	6.0×10^{-3}	8.52	34.4
3.0×10^{-3}	7.0×10^{-3}	7.24	46.2
2.0×10^{-3}	8.0×10^{-3}	5.58	58.7

* $\beta = (D_U)_{TTA+OX}/((D_U)_{OX}+(D_U)_{TTA})$

Table III. Distribution ratio of europium and stabilization factor
(10^{-3} mol. Eu, 1.0 M AcO^-)

Concn. of reagents, M TTA	8-Quinolinol	$(D_{Eu})_{TTA}$ or $(D_{Eu})_{OX}$	$(D_{Eu})_{TTA+OX}$	β*
0.20	—	6.55**	—	—
0.16	0.04	3.24**	21.35	6.6
0.12	0.08	1.38**	19.98	14.5
0.08	0.12	0.43**	11.87	27.6
0.04	0.16	0.052**	2.74	52.7
—	0.20	$<10^{-3}$***	—	—

* $\beta = (D_{Eu})_{TTA+OX}/((D_{Eu})_{TTA}+(D_{Eu})_{OX})$
** $(D_{Eu})_{TTA}$
*** $(D_{Eu})_{OX}$

1) T. Sekine and D. Dyrssen, *J. Inorg. Nuclear Chem.*, **26**, 1727 (1964).
2) T. Sekine and D. Dyrssen, ibid., **26**, 2013 (1964).
3) A. M. Poskanzer and B. M. Foreman, Jr., ibid., **16**, 323 (1961).
4) J. Stary, *Anal. Chim. Acta*, **28**, 132 (1963).
5) E. Akatsu, Private communication.

of uranium[3,6] with TTA or in the extraction of strontium with 8-quinolinol.[7] The synergic effects observed may be due to the mixed-ligand-complex formation of TTA and 8-quinolinol or to such adduct-compound formation as $MA_n(HB)_m$ or $MB_n(HA)_m$.

6) S. Peterson, *J. Inorg. Nuclear Chem.*, **14**, 126 (1960).
7) D. Dyrssen, *Svnesk Kem. Tidskr.*, **67**, 311 (1955).

The author is indebted to Mr. Hiroshi Okashita for his help in preparing the manuscript.