Separation of Uranium from Fission Products Using Cellulose

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It has been previously known[1] that cellulose has the property of adsorbing metals such as rare earths from impure uranyl nitrate in ether-nitric acid mixture. We could separate uranium from fission products by dissolving uranyl nitrate in organic solvent and percolating the solution through a column of cellulose pulp. Almost all parts of fission products (99% or more) were retained on the cellulose, while uranyl nitrate passed unadsorbed.

Experimental procedure was as follows. A glass tube, 18 mm. in diameter and 10 cm. long, was packed with 1 g. of activated cellulose (100~200 mesh). Uranyl nitrate (1 g.) which includes fission products (about 10^6~10^8 cpm) was dissolved in 5 ml. of the solvent and was transferred to the top of the column. After washing out uranium with further 25 ml. of the solvent, 30 ml. of 0.2 M nitric acid was passed to elute fission products. The activity of the combined organic solvent, nitric acid and the remained cellulose were analyzed by a γ-scintillation spectrometer.

Organic solvents suitable for this procedure were oxygen-containing compounds which dissolve uranyl nitrate but have small water-insolubility, perhaps less than 2%. Tri-*n*-butylphosphate was found to elute fission products.

The organic solvent was preferably used without nitric acid. Presence of nitric acid enhanced the elution of fission products, especially ruthenium. For example, from 1-month-cooled irradiated uranium, 1% of fission products were eluted by ethyl ether, while 4.5 and 6.6% were eluted by ethyl ether containing 3 and 5% nitric acid, respectively. In this case the ratio of eluted ruthenium was 1 : 18 : 27.

As regards the influence of water in this procedure, it was shown that fission products were eluted more by decreasing the water content of the system. For example, in the case of uranyl dihydrate, fission products were eluted about twice as much as that of uranyl trihydrate. This fact seems to indicate that this separation method resembles to ordinary liquid-liquid extraction. The cellulose seems to act as the water layer.

Behavior of various nuclides in this separation were as follows. Nuclides which were found to contaminate the organic solvent were mainly iodine, ruthenium and cesium. From these, ruthenium is most troublesome. It was eluted 1% by ethyl ether, 4% by *n*-butyl acetateand 20% by methyl isobutyl ketone. Elution of cesium ceases by lowering the initial uranium concentration. Result of the batch method showed that distribution ratio of cesium-137 between *n*-butyl acetate and the cellulose were 2.1 (1.0 M), 9.5 (0.5 M), 450 (0.1 M), and 6300 (0.0 M) in each uranium concentration written in the parentheses. Zirconium and niobium were eluted only to a small extent. Rare earths remained on cellulose.

Example of treatment of 1 g. of 100 days-cooled irradiated uranium are shown in the table. These results may also be improved by lengthening the column or lowering the initial uranium concentration in the solvent.

It seems that this method is also interesting for handling large amounts of irradiated uranium. In this method mass transfer of

1) F. H. Burstall and R. A. Wells, *Analyst*, **76**, 396 (1951).

uranium between two different phases is not performed, so that the contamination of fission products is rather small. Moreover uranium can be easily recovered and fission products are condensed on the small amounts of cellulose.

TABLE

	The amounts of γ-activity eluted, %
Ethyl ether	0.42
n-Butyl acetate	0.68
Isoamyl acetate	0.89
Isopropyl acetate	1.1
Methyl isobutyl ketone	3.1
Total activity	about 10^7 γ cpm

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