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Separation of Uranium with Benzo-substituted Crown Ethers using Solvent Extraction and Adsorption Chromatographic Techniques

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Abstract - A very simple method has been developed for the column chromatographic separation of uranium(VI) using poly(dibenzo-18-crown-6). The adsorption studies were carried out from hydrochloric acid medium in the concentration range of 0.5 10.0 mol dm-3. The adsorption of uranium(VI) started from 3.0 mol dm-3 hydrochloric acid and was quantitative from 5.5-10.0 mol dm-3 hydrochloric acid. Various eluting agents such as hydrobromic acid, perchloric acid, sulfuric acid, acetic acid were used for the elution of uranium(VI). The capacity of poly(dibenzo-18-crown-6) for uranium(VI) was found to be 2.5 mmol g-1 of crown polymer. Uranium(VI) was separated from a large number of elements from the binary as well as from multicomponent mixtures. The method was applied to the analysis of uranium from real samples.

Uranium(VI) was quantitatively extracted with 0.01M DB-24-crown-8 in nitrobenzene from 6 to 10M hydrochloric acid. From the organic phase uranium was stripped with 2M nitric acid and determined spectrophotometrically with PAR at 530 nm. Uranium(VI) was separated from a large number of elements in binary mixtures as well as from multicomponent mixtures. The method was extended to the analysis of uranium in geological samples and animal bone.

Key Words: Uranium, Crown Ethers, Adsorption - Chromatography,

1. INTRODUCTION

A very simple method has been developed for the column chromatographic separation of uranium(VI) using poly(dibenzo-18-crown-6). The adsorption studies were carried out from hydrochloric acid medium in the concentration range of 0.5 10.0 mol dm-3. The adsorption of uranium(VI) started from 3.0 mol dm-3 hydrochloric acid and was quantitative from 5.5-10.0 mol dm-3 hydrochloric acid. Various eluting agents such as hydrobromic acid, perchloric acid, sulfuric acid, acetic acid were used for the elution of uranium(VI). The capacity of poly(dibenzo-18-crown-6) for uranium(VI) was found to be 2.5 mmol g-1 of crown polymer. Uranium(VI) was separated from a large number of elements from the binary as well as from multicomponent mixtures. The method was applied to the analysis of uranium from real samples.

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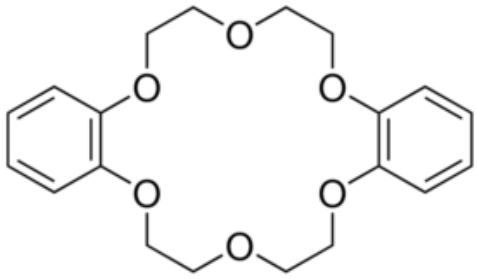
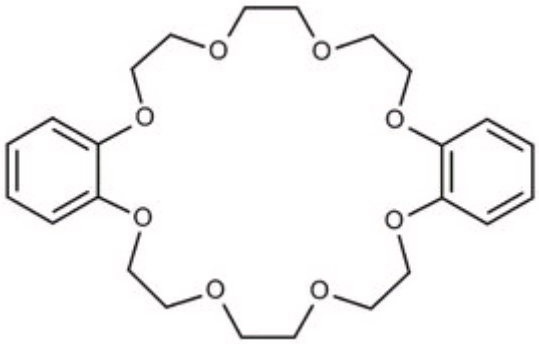


Dibenzo-18-crown-6



Dibenzo-24-crown-8

General Procedure for solvent extraction separation of uranium:

An aliquot of solution containing uranium (VI) hydrochloric acid was added so as to have its concentration of 7M in a total volume of 10 ml. The solution was then transferred to a separating funnel and was equilibrated with 10 ml of 0.01 M suitable crown ether with nitro benzene as the diluent for 10 minutes on a wrist action flask shaker. The two phases were allowed to settle and separate. Uranium (VI) was stripped from the organic phase with 10 ml of 2 molar nitric acid. After evaporating the acid , uranium (VI) was extracted with water and it was then determined spectrophotometrically with PAR at 530 nm(3). The concentration of uranium was calculated from the calibration curve.

Results:

The optimum results obtained are as follows:

Parameters	Uranium(VI)
Crown ether	DB-24-C-8(0.01M)
Solvent	Nitrobenzene
Counter anion	Chloride
	6-10M HCL
Stripping agents	0.001-2 M HCl
	1-2 M HNO_3
	4-8 M H_2SO_4
Separated from	Ba,Th,Rb,Sr
	Ce(III), La,Ru,
	Rh,Cr(III)
Applications	U from geological
	Samples and animal
	Bone samples

Conclusion:

The important future of the method described is that it permits the separation of uranium from thorium, cerium, barium, rubidium, strontium, lanthanum, yttrium, chromium which are usually present in nuclear fission products. The method was used for the analysis of uranium in geological samples and animal bone samples(4). The extractant dibenzo-24-crown-8 in nitrobenzene can be reused. The method is simple, rapid, selective and reproducible.

General procedure for separation of uranium (VI) by adsorption chromatographic technique:

An aliquot of solution containing 50 microgram of uranium (VI) was mixed with hydrochloric acid in the concentration range of 0.5 to 10 M(5). The solution was then passed through the column preconditioned with hydrochloric acid of the same acidity as that of the sample solution at a flow rate of 0.5 ml per minute. The column was washed subsequently with hydrochloric acid of the same acidity. The adsorbed uranium was then eluted with different eluting agents at a flow rate of 0.5 ml per minute. 2 ml fractions were collected, after evaporating the acid it was extracted with water and the uranium (VI) content was determined spectrophotometrically with PAR at 530 nm(6). The concentration of uranium (VI) was calculated from the calibration curve.

Results:

The optimum results obtained are as follows:

Parameters	Uranium
Crown ether	Poly-(DB-18-c-6)
Adsorbing condition	6.0-10.0 M HCl
Eluants	0.5-2.0 M HCL,HBr
	1.0-7.0 M $Hclo_4$
	4.0 M HAC
Capacity	2.52 m.mol/gm
Separated	K,Pb,Mo,Th,La,
	Ce(III),Cr(III),
	V(V).Co(II).Cs
Applications	U from geological
	Sample and animal
	Bone sample.

Conclusion:

The important feature of this method is that the adsorption chromatographic separation of uranium (VI) from hydrochloric acid medium on poly-(DB-18-C-6) has been achieved. The separation of uranium has been carried out from K,Rb,Pb,Mo and other elements such as thorium, cerium, chromium, lanthanum, vanadium, cobalt, cesium.

The separation of uranium from thorium, cesium, lead, molybdenum is of great significance because these elements are usually associated with nuclear fission products(6). The method has been used for the analysis of uranium in real samples. The method is very simple, rapid, selective and reproducible.

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