

Extractive-spectrophotometric Determination of Uranium with Dibenzylidimethylammonium Chloride

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A simple and rapid extractive spectrophotometric method has been developed for determination of uranium in microquantities using dibenzylidimethylammonium chloride and bromopyrogallol red as reagents and isobutanol as extractant.

A number of quaternary ammonium salts find application in the determination of metal ions in microquantities: benzylidimethylphenylammonium chloride¹, benzyltriethylammonium chloride², tetrabutylammonium perchlorate³.

The present communication reports a method of determination of U using dibenzylidimethylammonium chloride (DDAC) and bromopyrogallol red (BPR).

Results and Discussion

When bromopyrogallol red solution is added to a solution containing microquantities of uranium in the pH range 4.6–5.2, a violet coloured complex is formed which is not extractable into isobutanol. To it, when an aqueous solution of dibenzylidimethylammonium chloride is added, a violet precipitate of DDA-U^{VI}-BPR complex system is formed which being an ion-association complex is easily extractable into isobutanol, and is found stable for more than 24 h. The λ_{\max} of the extract is 618 nm and Beer's law is obeyed over the range 0.59–10 ppm. The molar absorptivity and Sandell's sensitivity are $1.27 \times 10^4 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ and $0.0185 \mu\text{g cm}^{-2}$ respectively.

Uranium can be extracted quantitatively in isobutanol from an aqueous solution containing BPR and DDAC solutions at pH 4.6–5.2. The absorbance is constant in the BPR concentration range 0.055–0.065%. As regards DDAC concentration, 3 ml of 0.5% solution is adequate for quantitative extraction of 5.9–100 μg of U^{VI} from 10 ml of aqueous solution in the pH range 4.6–5.2. Increased concentration of DDAC does not produce any significant change in the color intensity. A single extraction with 10 ml of isobutanol is sufficient to extract the complex quantitatively.

An ion was considered to interfere if the recovery of uranium differed by more than $\pm 3\%$ from the actual amount (47.58 μg) taken in each case. The upper concentration limit of foreign ions investigated was restricted to 50-fold (w/w) ratio to uranium. The tolerance limit for some of the interfering species could be improved by use of masking agents, e.g. Pd with iodide and Fe^{II} with oxalate ion. The foreign ion to uranium weight ratio at which no interference is caused is for Zn^{II}, Ni^{II}, Hg^{II}, Cd^{II}, Mn^{II}, CN⁻, F⁻, Br⁻, I⁻, SO₃²⁻, ClO₄⁻, PO₄³⁻, C₂O₄²⁻, SCN⁻, thiourea, tartrate ≥ 20 ; Sn^{IV}, Sb^{III}, Ag^I, Co^{II}, Bi^{III}, Fe^{II}, Pd^{II}, Rh^{III} ≥ 2 ;

Sn^{II} > 1 ; and Cr^{III}, Cr^{VI}, Fe^{III}, Cu^{II}, Mo^{VI}, W^{VI} ≥ 0.1 .

The method was applied to determine uranium from a number of synthetic mixtures comprising of Zn^{II}, Ni^{II}, Mn^{II}, Cd^{II}, I⁻ in four-fold excess of uranium taken and a good recovery of uranium (within 3% error) was achieved. Thus the present method is simple, rapid and sensitive and compares well with standard methods of determination of uranium⁴.

Experimental

A Hitachi U-3210 spectrophotometer and an Elico LI-10 pH meter were used. All chemicals and solvents used were of A.R. grade.

A stock solution of uranium (0.002 M) was prepared by dissolving UO₂(NO₃)₂·6H₂O in distilled water and solutions of lower concentration were prepared by appropriate dilution. Dibenzylidimethylammonium chloride was prepared by mixing equimolar amounts of benzyl chloride and *N*-benzylidimethylamine, allowing the mixture to stand and the resulting solid after washing with benzene was crystallized from alcohol. A 0.5% solution of DDAC and a freshly prepared 0.06% (w/v) solution of BPR in 1 : 1 alcohol were used. Solutions of 0.2 M acetic acid and 0.2 M sodium acetate were prepared to constitute the required buffer. Standard solutions of diverse ions were prepared.

Procedure : To an aliquot of uranium solution containing from 5.9–100 μg of U^{VI} set at pH ~4.8 with acetic acid-sodium acetate buffer, BPR solution (1 ml) followed by DDAC solution (3 ml) were added and the volume was made upto 10 ml without altering the pH. Then after adding isobutanol (10 ml), the mixture was shaken for 3 min and the organic layer was separated. The absorbance of the extract was measured at 618 nm against the reagent blank, and amount of uranium in unknown solutions was calculated from the standard calibration curve prepared similarly.

References

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