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STUDY OF THE COLOUR REACTION BETWEEN URANIUM AND SODIUM SALICYLATE USING THE WEISZ RING-OVEN TECHNIQUE

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A simple, precise and accurate method for the determination of U(VI) in μg amounts, through its reaction with sodium salicylate has been reported using Weisz ring-oven technique. The effect of foreign ions on this determination has also been studied.

INTRODUCTION

There is always a room for a suitable method for the determination of uranium. In the present work therefore a study on the colour reaction between uranium (VI) and sodium salicylate (1) has been carried out using the Weisz ring-oven technique. The reaction between uranium (VI) and sodium salicylate proceeds quantitatively and the same has been made the basis to standardise a suitable method which could be used for the routine analysis of uranium. Some of the results of this investigation have been reported in this communication.

EXPERIMENTAL

Reagents

Uranyl acetate. Uranyl acetate (BDH) 1.25 g was dissolved in 250 ml distilled water, 20 ml of this solution was diluted to 100 ml and the exact concentration of the final aqueous solution was determined using $\text{K}_2\text{Cr}_2\text{O}_7$ [2].

Sodium salicylate. A 10% solution of sodium salicylate (M & B) in distilled water was used during these experiments.

Solutions of the foreign ions including iron (II), lead (II), zinc (II), silver (I), cobalt (II), nickel (II), manganese (II), cadmium (II), magnesium (II), cerium (IV), copper (II), ruthenium (III), chromium (III), iodate, periodate, nitrate, nitrite, sulphate, iodide, chloride, ferrocyanide, ferricyanide, oxalate and citrate were prepared by dissolving appropriate amounts of their respective salts (A.R. Grade) in distilled water and were calibrated according to the conventional methods [3].

Synthetic mixtures of uranium with foreign ions. Synthetic mixtures of uranium (VI) were prepared which contained uranium (VI): zinc :: 1:9, uranium (VI): lead (II) :: 1:4, uranium (VI): magnesium (II) :: 1:8, uranium (VI): silver (II) :: 1:5, uranium (VI): cobalt (II) :: 1:8, uranium (VI): nickel (II) :: 1:5, uranium (VI) cadmium (II) :: 1:9, uranium (VI): iron (II) :: 1:0.5, uranium (VI): manganese (II) :: 1:2, uranium (VI): iodate :: 1:8, uranium (VI): nitrate :: 1:5, uranium (VI): sulphate :: 1:4, uranium (VI): nitrite :: 1:5, uranium (V): iodide : 1:4, and uranium (VI): chloride :: 1:8.

All other solutions used in the work were also made from the A.R. Grade chemicals.

Apparatus. The Weisz ring-oven with 110° working temperature, Whatman filter paper No. 41 and automatic capillary pipettes of 1 μl and 10 μl capacity (Karl Kolb Scientific and Technical Supplies, Buchschlag, Frankfurt) were used.

All glassware used were of calibrated A. Grade.

Procedure. One μl each of uranium (VI) and sodium salicylate solutions were transferred. The paper was put on the ring-oven and washed out completely the reaction products into the ring zone with 4.5 washings with distilled water. A standard scale was prepared by taking 1, 2, 4, 6, 8 and 10 μl of U(VI) standard solution using the above procedure. Similarly three other ring were prepared by taking different volumes of the U(VI) test solution and compared with the standard scale rings to calculate the results according to the usual prescribed method [4].

Interferences by foreign ions, mentioned in the preceding part of this paper, on the determination of uranium (VI) were checked according to the already described method [5].

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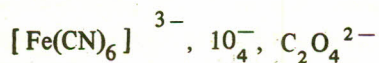
Table 1. The determination of uranium (VI) with sodium salicylate

Standard scale method			Segment technique method		
Uranium (VI) taken μg	Uranium (VI) found μg	Error %	Uranium (VI) taken μg	Uranium (VI) found μg	Error %
0.50	0.51	+ 2.00	0.50	0.51	+ 2.00
1.00	1.00	\pm 0.00	1.00	1.01	+ 1.00
2.00	2.00	\pm 0.00	2.00	2.06	+ 3.00
3.00	3.00	\pm 0.00	3.00	3.05	+ 1.66
4.00	4.00	\pm 0.00	3.50	3.54	+ 1.14
5.00	4.88	- 2.40	5.00	4.88	- 2.40
10.00	9.88	- 0.20	10.00	10.04	+ 0.40
25.00	25.05	+ 0.20	20.0	20.08	+ 0.40
30.00	30.10	+ 0.33	30.0	30.12	+ 0.40
40.00	40.20	+ 0.50	40.0	40.45	+ 1.12

RESULTS AND DISCUSSION

The reaction between uranium (VI) and sodium salicylate is so fast that full colour intensity is developed in a few sec. [1]. The end product is so easy to wash that only 4-5 washings with distilled water are sufficient to transfer it quantitatively to the ring-zone. As is apparent from the Table 1, uranium (VI) can be determined within the range from 0.5 to 40 μg with a maximum error of -2.4% with the standard scale method and with a maximum error of +3% for the segment technique. The standard scale is stable for a week at least. The orange red colour of the product is so bright that it can be discerned very easily. Cerium (IV) produces instantaneously a very intense colour when added to the reaction mixture of uranium (VI) and sodium salicylate; hence there is no question of its slightest tolerance for the determination of uranium in its presence.

Fe (III), Cu (II), Ru (III), Cr (III), $[\text{Fe}(\text{CN})_6]^{4-}$,



and citrate also interfere with the reaction and hence the determination of uranium (VI) is impossible in their presence.

As observed from Table 2, the ions described here up to the ratios as

U(VI): Zn^{2+} :: 1:9, U(VI): Pb^{2+} :: 1:4, U(VI): Mg^{2+} :: 1:3,
 U(VI): Ag^{1+} :: 1:5, U(VI): $\text{Co}(\text{II})$:: 1:8, U(VI): Ni^{2+} :: 1:5,
 U(VI): Cd^{2+} :: 1:9, U(VI): Mn^{2+} :: 1:2, U(VI): IO_3^- :: 1:8,
 U(VI): NO_3^- :: 1:5, U(VI): SO_4^{2-} :: 1:4, U(VI): NO_2^- :: 1:5,

U(VI): I $^-$:: 1:4 and U(VI): Cl^- :: 1:8 do not interfere with the determination of U(VI).

Table 2. The determination of uranium (VI) in the presence foreign ions

Uranium (VI) taken (μg)	Interfering ion (μg)	Uranium (VI) found (μg)	Error %
39.00	13.00	39.35	+ 0.89
39.00	78.00	39.00	\pm 0.00
39.00	273.00	40.00	+ 2.56
39.00	351.00	43.00	+ 10.25
39.00	429.00	46.00	+ 17.94
39.00	7.80	38.55	- 1.15
39.00	78.00	39.00	- 0.00
39.00	156.00	39.00	\pm 0.00
39.00	273.00	45.00	+ 15.38
39.00	468.00	50.00	+ 28.20
39.00	19.50	39.15	+ 0.38
39.00	39.00	38.50	- 1.28
39.00	117.00	39.00	\pm 0.00
39.00	234.00	50.00	+ 28.20
39.00	351.00	78.00	+100.00
39.00	10.00	39.15	+ 0.38
39.00	39.00	39.50	+ 1.28
39.00	117.00	39.00	\pm 0.00
39.00	195.00	39.00	\pm 0.00
39.00	273.00	78.00	+ 100.00
39.00	13.0	39.08	+ 0.20
39.00	39.00	39.50	+ 1.28
39.00	78.00	39.00	\pm 0.00
39.00	234.00	39.00	\pm 0.00
39.00	312.00	44.00	+ 12.82

Contd.

Contd.				
39.00	8.0		39.07	+ 0.18
39.00	39.00	Ni ²⁺	39.00	± 0.00
39.00	117.00		39.00	± 0.00
39.00	195.00		42.00	+ 7.69
39.00	273.00		45.00	+ 15.38
39.00	10.00			38.95
39.00	170.00	Cd ²⁺	39.00	± 0.00
39.00	273.00		39.00	± 0.00
39.00	351.00		42.00	+ 7.69
39.00	390.00		50.00	+ 28.20
39.00	10.00			40.00
39.00	20.00	Fe ²⁺	42.00	+ 5.12
39.00	40.00		50.00	+ 28.20
39.00	60.00		78.00	+ 100.00
39.00	100.00		312.00	+ 700.00
39.00	10.00			40.00
39.00	39.00	Mn ²⁺	39.00	± 0.00
39.00	78.00		42.00	+ 7.69
39.00	312.00		50.00	+ 28.20
39.00	319.00		70.00	+ 79.48
39.00	10.00			38.55
39.00	117.00	10 ₃	38.50	- 1.28
39.00	195.00		39.00	± 0.00
39.00	312.00		42.50	+ 8.97
39.00	390.00		47.00	+ 20.51
39.00	13.00			38.85
39.00	78.00	NO ₃	39.00	± 0.00
39.00	195.00		39.00	± 0.00
39.00	273.00		60.00	+ 53.84
39.00	312.00		107.00	+ 174.35
39.00	13.00			39.05
39.00	39.00	SO ₄ ²⁻	40.00	+ 2.56
39.00	78.00		39.00	± 0.00
39.00	156.00		39.00	± 0.00
39.00	234.00		50.00	+ 28.00
39.00	10.00			39.03
39.00	117.00	NO ₂ ⁻	39.00	± 0.00
39.00	195.00		39.50	+ 1.25
39.00	234.00		78.00	+100.00
39.00	13.00			38.85
39.00	39.00	I ⁻	38.00	- 2.56
39.00	78.00		39.00	± 0.00
39.00	156.00		39.00	± 0.00
39.00	234.00		60.00	+ 53.00
39.00	13.00			39.50
39.00	39.00	Cl ⁻	40.00	+ 2.56
39.00	239.00		39.00	± 0.00
39.00	312.00		42.00	+ 7.69
39.00	390.00		44.00	+ 12.82

The synthetic mixture containing U(VI) and all the above mentioned ions was also analysed and as should be evident from Table 3, it can also be determined in the solution in their presence with a maximum error of + 2.56% for 39 μ g of its amounts taken.

The reaction proceeds quite smoothly and no laborious and lengthy procedure or special and stringent conditions are required to be followed for the determination of U(VI) and hence the method is recommended for routine analysis.

Table 3. Determination of uranium (VI) in a synthetic mixture

S.No.	Uranium (VI)		
	(in synthetic mixture)		
	taken (μ g)	found (μ g)	Error (%)
1.	39.00	40.00	+ 2.56
2.	39.00	39.00	± 0.00
3.	39.00	38.50	- 1.28
4.	39.00	39.03	+ 0.08
5.	39.00	38.85	- 0.38

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