The Electrometric Titration of Thorium with Tellurite

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Berzelius prepared tellurites of thorium, zirconium, berylium, aluminium, yttrium, etc. by mixing a solution of each of their salts with a sodium tellurite solution.[1] We ourselves have previously used tellurite for the estimation of zirconium by electrometric methods.[2] Results of similar investigations with thorium have been reported in the present communication.

Experimental

Solutions from thorium nitrate (99.0% pure) and potassium tellurite (97.0% pure) were prepared and standardized by gravimetric methods.

Conductometric Measurements.—Solutions prepared from conductivity water were used for the purpose of conductometric titrations.

When thorium nitrate solutions are taken into the cell, two breaks, at ratios of approximately 1 : 1 and 1 : 2, are obtained, whereas reverse titrations show only one break, at the 1 : 2 ratio. Results of direct as well as reverse titrations have been incorporated in Table I, while typical curves are shown in Fig. 1.

Table I

S. No.	Volume and strength of $Th(NO_3)_4$ soln.	Volume and strength of K_2TeO_3 soln.	Ratio Th : Te
	Direct titration		
1	20 ml., 0.0025 M	2.0 ml., 0.05 M	1 : 2
2	20 ml., 0.0020 M	1.6 ml., 0.05 M	1 : 2
3	20 ml., 0.00125 M	1.0 ml., 0.05 M	1 : 2
	Reverse titration		
4	2.0 ml., 0.05 M	20 ml., 0.01 M	1 : 2
5	1.6 ml., 0.05 M	20 ml., 0.008 M	1 : 2
6	1.0 ml., 0.05 M	20 ml., 0.005 M	1 : 2

Potentiometric Titration. — pH measurements were made with a battery-operated Cambridge pH meter. Direct and reverse titrations show a sharp break at the 1 : 2 (Th : Te) ratio. Results have been summarized in Table II, while typical curves are given in Fig. 2.

Direct Volumetric Titrations.—pH titrations show

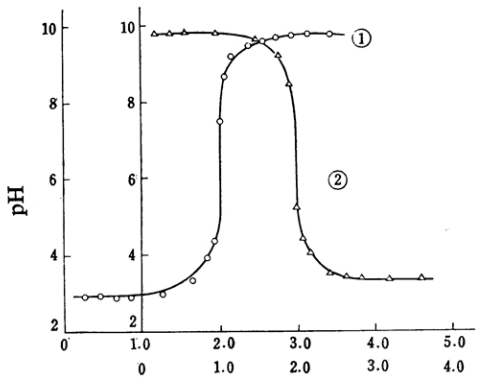

Fig. 2. Titration of (1) 10 ml., 005 M $Th(NO_3)_4$ with 0.05 M K_2TeO_3 and (2) 10 ml., 0.02 M K_2TeO_3 with 0.05 M $Th(NO_3)_4$.

Table II

S. No.	Volume and strength of $Th(NO_3)_4$ soln.	Volume and strength of K_2TeO_3 soln.	Ratio Th : Te
	Direct tirtration		
1	10 ml., 0.005 M	2.0 ml., 0.05 M	1 : 2
2	10 ml., 0.004 M	1.6 ml., 0.05 M	1 : 2
3	10 ml., 0.0025 M	1.0 ml., 0.05 M	1 : 2
	Reverse titration		
4	2.0 ml., 0.05 M	10 ml., 0.02 M	1 : 2
5	1.6 ml., 0.05 M	10 ml., 0.016 M	1 : 2
6	1.0 ml., 0.05 M	10 ml., 0.01 M	1 : 2

that there is a sharp change in pH from the acidic side to the alkaline side at the end point. Thus, the possibility of using phenolphthalein for the visual detection of the end point can not be ruled out. In was actually found that phenolphthalein gave reliable results, even in dilute solutions of thorium nitrate, and that hence potassium tellurite could be used for the direct volumetric estimation of the thorium nitrate solution. Results are summarized in Table III.

Table III

S. No.	Volume and strength of $Th(NO_3)_4$ soln.	Volume and strength of K_2TeO_3 soln.	Ratio Th : Te
1	10 ml., 0.005 M	2.0 ml., 0.05 M	1 : 2
2	10 ml., 0.004 M	1.6 ml., 0.05 M	1 : 2
3	10 ml., 0.0025 M	1.0 ml., 0.05 M	1 : 2

1) J. J. Berzelius, "Jahrez," 1833; *Pogg. Ann.*, **28**, 396 (1833). Handlinger 1833, 277; *Pogg. Ann.*, **32**, 1-577 (1834); *Ann. Chem. Physics (2)*, **58**, 225 (1835).

2) V. K. Sharma and J. N. Gaur, *J. Electroanal. Chem.*, **5**, 375 (1963).

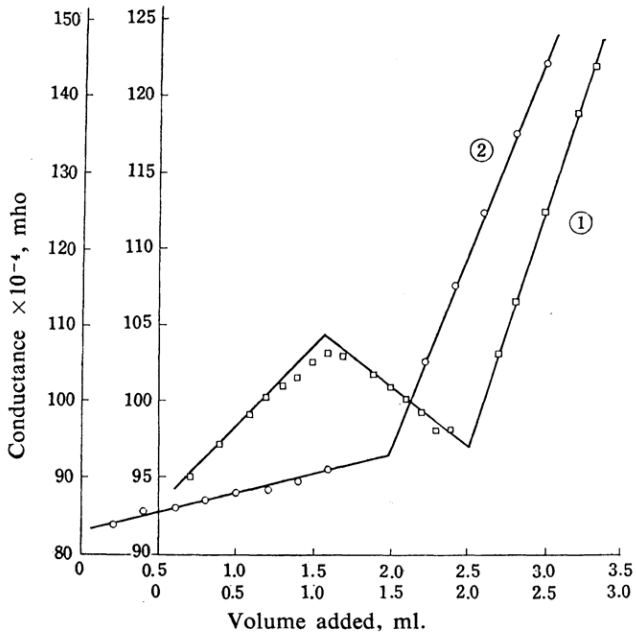

Fig. 1. Titration of (1) 20 ml. 0.0025 M $Th(NO_3)_4$ with 0.05 M K_2TeO_3 and (2) 20 ml. 0.01 M K_2TeO_3 with 0.05 M $Th(NO_3)_4$.

Discussion

Conductometric and potentiometric titrations show a sharp break at 1:2 (Th:Te) ratio; hence, thorium can be estimated using potassium tellurite by conductometric and potentiometric methods. A direct estimation of thorium can also be effected using phenolphthalein as an indicator, as is evident from the results of Table III. All these titrations show the formation of normal thorium tellurite.

Summary

Potentiometric and conductometric titrations of thorium nitrate solutions with tellurite show a sharp break at the 1:2 (Th:Te) ratio. Direct volumetric titrations using phenolphthalein as an indictator also show the 1:2 ratio, indicating the formation of normal tellurite. The estimation of thorium by potentiometric, conductometric and direct volumetric titrations using potassium tellurite has been suggested.

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