

Short Communication

Spectrophotometric determination of cerium (IV) with solo chrome black 6B

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Abstract

A simple, rapid and sensitive method for the determination of cerium(IV) in microgram quantities, based on the proportional discharge of the reddish violet colour of solo chrome black 6B reagent at pH 2 with the metal ion is described. The method allows the determination of cerium(IV) in the range 1-20 ppm at 530 nm. The effect of various foreign ions on the reaction system is also studied.

Key words: Spectrophotometry, oxidation, cerium(IV), solo chrome black 6B.

1. Introduction

Determination of cerium(IV) in microgram amounts is important since it is present as a minor constituent in many complex materials. Usually cerium(IV) is determined colorimetrically either by complexing the metal ion with the reagent or by utilizing its oxidizing ability of some of the organic compounds¹⁻⁴. However, there are only a few rapid colorimetric methods for the determination of cerium(IV) making use of either of the properties of the metal ion. A method for the spectrophotometric determination of cerium(IV) in microgram quantities is described here using solo chrome black 6B as reagent. The reddish-violet coloured reagent solution which is stable for several hours is found oxidised easily by cerium(IV) in the pH range 1-4. A decrease in the absorbance of the dye proportionate to the amount of cerium(IV) is noticed in the oxidation process. The authors have therefore carried out a detailed study on the reaction at pH 2.0 for the possible spectrophotometric determination of small amounts of cerium(IV). The results are communicated in this paper.

2. Experimental

2.1. Reagents

Ammonium ceric sulphate (0.1 M) solution was prepared in 1 NH₂SO₄ and standardised with standard ferrous ammonium sulphate solution and is diluted suitably with distilled water for lower concentrations.

0.025% solo chrome black 6B solution was prepared in 5% aqueous methanol.

Sodium acetate-hydrochloric acid buffer solution of pH 2.0 was used in the studies.

2.2. Apparatus

ECIL Junior Spectrophotometer Model GS 866B and ELICO Digital pH Meter LI-120 were used for optical and pH measurements.

3. Recommended procedure

To 2 ml of the reagent solution, 12 ml of the buffer solution (pH 2.0) and various aliquots of cerium(IV) were added in different 25 ml volumetric flasks and the contents were made up to the mark with distilled water. Ten minutes after the reaction mixture is prepared, the absorbance measurements were made at 530 nm against water as blank. A linear plot was obtained between the absorbance and the amount of metal ion in the range of 1-20 ppm of cerium(IV). This shows that the reaction is quite suitable for the determination of micro amounts of cerium(IV).

4. Results and discussion

The method described allows determination of cerium(IV) in the range 1-20 ppm. A study of the effect of pH on the redox process revealed that the metal can be determined with good precision in the pH range 1-4 indicating that the critical control of pH is not necessary in this range of study.

4.1. Effect of diverse ions

In order to assess the possible analytical applications of the reaction, the interference, if any, of various ions which usually accompany cerium was studied. The tolerance limit of different ions in the determination of 2.7 ppm of cerium was established by the procedure outlined earlier. The maximum amount of the foreign ion that can be added (in ppm) to the test solution without changing the absorbance by more than ± 0.03 was taken as the tolerance limit. La(III) 2000, Th(IV) 2000, Pr(III) 2000, Nd(III) 2000, Gd(III) 2000, Er(III) 2000, Dy(III) 2000, Y(III) 2000, Mn(II) 1000, Co(II) 470, Ni(II) 470, Pb(II) 4150, Cd(II) 3000, W(VI) 1100, V(V) 1.2, Cr(VI) 50,

Mo(VI) 19, Cu(II) 250, Zn(II) 2000, As(V) 2600, Zr(IV) 300, fluoride 2000, bromide 3000, phosphate 2000, oxalate 1800, chloride 8000, citrate 3000, tartrate 2300, bromate 3000, EDTA 3500, nitrate 3000 and sulphate 3000 can be tolerable. The interferences of iron(III) and uranium(VI) can be eliminated by masking with fluoride.

The method is advantageous over those reported in the literature as it eliminates the extraction steps.

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