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SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH WITH POTASSIUM PROPYL XANTHATE IN WATER

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A spectrophotometric method for the determination of bismuth in water with potassium propyl xanthate is described. Bismuth in water is complexed with potassium propyl xanthate and the complex is extracted into carbon tetrachloride. The absorbance of the complex is maximum at 300 nm. The molar absorptivity of the complex is 2.92×10^3 l. mol^{-1} cm^{-1} and it obeys Beer's Law in the concentration range of 2 to 60 μg of bismuth in 10 ml of the sample.

INTRODUCTION

Bismuth occurs in its compounds in the +3 and +5 oxidation states. Bismuth (III) hydrolyses at pH 1–2 and shows no amphoteric properties. Though Bismuth is not employed industrially in large quantities it still has a number of applications. It is found in low concentrations in food and daily dietary intake is to the extent of 5 to 20 μg. Bismuth(III) ion forms an orange-brown coloured complex with dithizone, soluble in CCl_4 and $CHCl_3$; this complex formation forms the basis for the spectrophotometric method[1–3] and for the metal in natural waters and biological materials[4]. Tompsett[5] and Lacoste *et al.*[6] have been performed the extraction of bismuth with diethyldithiocarbamate into ethyl ether or chloroform and interference occurred during the analysis. Karadakov and Sakharieva[7] employed spectrophotometric method by extracting with DDTC. Complexes of W and Bi together into CCl_4 and bismuth were separated by re-extraction with 3M HBr. Dithiocarbamates were used for the determination of bismuth in water. Xanthates are also good reagents for spectrophotometric determination of bismuth in water after extracting into the organic layer. Here we report the spectrophotometric determination of bismuth in water with single extraction of the complex into the organic phase with potassium propyl xanthate.

EXPERIMENTAL

Potassium propyl xanthate solution (3×10^{-3} M): 0.104 g of potassium propyl xanthate was dissolved in 200 ml double distilled water.

Buffer solution pH 3: 50 ml of 0.1 M potassium hydrogen phthalate was added to 22.3 ml of 0.1 M HCl and diluted to 100 ml.

The potassium propyl xanthate was prepared[8] freshly and purified as described by Rao[9]. A standard stock bismuth solution was prepared by dissolving 2.32 g of analytical grade bismuth nitrate in water diluting to 1 litre and it was further diluted as required to give working solutions. Carbon tetrachloride (Glaxo Excellar India)

was used. U3400 UV visible NIR spectrophotometer with stoppered 10 mm quartz cells was used.

Procedure

4 ml bismuth solution and 0.3 ml buffer solution were taken in a 50 ml separating funnel and to this 2 ml of potassium propyl xanthate solution was added and shaken vigorously for 5 minutes. The bismuth potassium propyl xanthate complex formed was extracted into 10 ml of carbon tetrachloride. The spectrum of the complex was recorded and shown in Fig. 1. The complex is stable for 12 hrs.

0.3 ml of buffer solution and 2 ml of potassium propyl xanthate solution were added to varying amounts of bismuth solution and extracted into 10 ml of carbon tetrachloride measured at 300 nm. The calibration plot was constructed for absorbance versus concentration of bismuth.

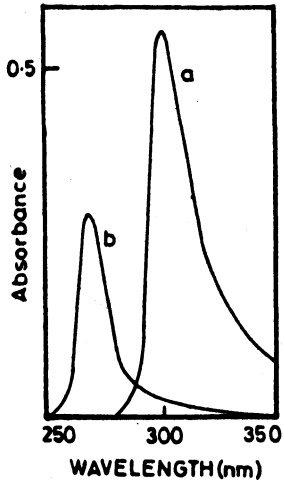

Fig. 1

(a) Absorption spectrum of Bi-PPX complex extracted into CCl_4
(b) Absorption spectrum of the reagent

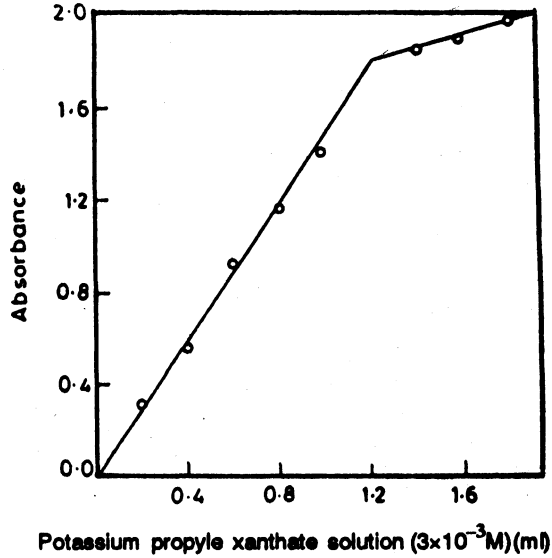

Fig. 2

RESULTS AND DISCUSSION

From the absorption spectrum shown in Fig. 1, it is evident that the maximum absorbance of bismuth potassium propyl xanthate complex is at 300 nm. Hence absorbance of complex is measured at 300 nm. The molar absorptivity of the complex is 2.92×10^3 l. $mole^{-1}$ cm^{-1} at the wavelength 300 nm and the minimum detection limit of this method is 0.2 μg of bismuth. The ratio of bismuth to potassium propyl xanthate complex is established by mole ratio method which is shown in Fig. 2. The results indicate that the bismuth to potassium propyl xanthate

ratio is 1 : 3. The calibration plot (Fig. 3) shows that it is linear upto 60 μg of bismuth. The system conforms to Beer's law over a concentration range of 2 to 60 μg of bismuth in 10 ml of the sample.

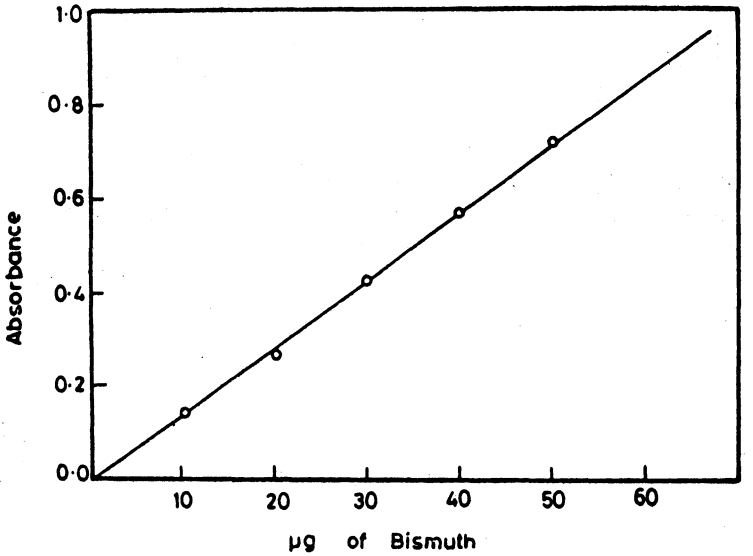

Fig. 3

Interference

The metal ions Fe(III), Cr(III), Cd(II) interfere slightly. Interference due to Ni(II) is avoided by carrying out the extraction in the presence of EDTA. The system tolerated Mo(VI) and Zn(II) at low concentrations.

The precision and accuracy of the proposed method are tested by analysing solutions containing a known amount of bismuth and the relative mean deviation is 0.28%.

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