

Investigation of the Extraction of Tellurium Complexes with Basic Dye Reagents

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Comparison of some organic solvents as extractants of the tellurium complexes with basic dyes has been carried out spectrophotometrically. Absorbance of the coloured extracts of the tellurium ion associates depends on the nature of the extractant. Individual extractants and the mixture of various organic solvents have been tested. The best results were reached by using individual organic solvents as extractants. The rules for the correct choice of organic solvent have been formulated.

Application of preconcentration and separation techniques before the determination step allows improvement of analytical characteristics of the determination. For example, preconcentration, frequently, enables detection limit, it may increase the accuracy and precision of determination because of elimination of interferences, and widens the range of materials that may be analyzed by a chosen method [1]. One of these techniques is extraction. The method is widely used and characterized by versatility, simplicity, and rapidity [1]. The efficiency of the extraction procedure depends on the correct choice of extractant. Thus, the study of influence of the nature of organic solvent on the extraction of an element is very important.

The tellurium forms complexes with some organic reagents such as tetramethylthiourea [2], bizmutol II [3], and diantipyrylmethane [4]. In this work, the extraction of tellurium complexes with Cationic Red-Violet (CRV) and Astrasone Red 3G (AR3G) basic dyes has been investigated. The optimum conditions for the determination of tellurium with CRV are presented in [5–7]. The aim of this work was to compare and to demonstrate the advantages and insufficiencies of the investigated extractants, and to formulate rules for correct choice of organic solvent.

Spectrophotometric method was used for investigation of the extraction efficiency since the tellurium complexes with basic dyes are coloured. The extractant should answer the requirement of the highest absorbance of the complex and the minimum absorbance of the blank. The best extractants appeared to be the aromatic hydrocarbons (benzene, toluene) and some

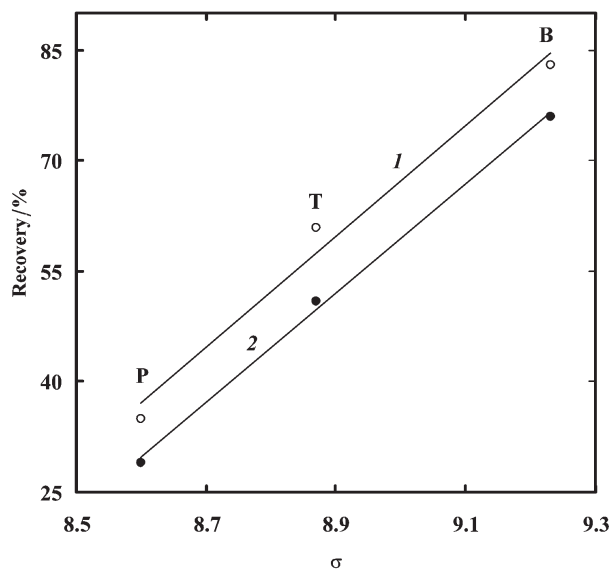


Fig. 1. Dependence of the extraction recovery of tellurium ion associates on the Hildebrand's solubility parameter of organic solvents. B – benzene, T – toluene, P – isopropylbenzene; $2 \times 10^{-5} \text{ mol dm}^{-3} \text{ Te(IV)}$; $l = 0.5 \text{ cm}$; 1. Te-Cl-CRV, $3.6 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$, $1.0 \text{ mol dm}^{-3} \text{ NaCl}$, $\lambda = 564 \text{ nm}$; 2. Te-Br-CRV, $5.8 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$, $0.04 \text{ mol dm}^{-3} \text{ NaBr}$, $\lambda = 572 \text{ nm}$.

acetic esters (pentyl acetate and isopentyl acetate) with very good extraction of the ion associates under minimum extraction of the simple dye salt. The recovery of extraction was calculated from the difference of absorbance between sample and blank.

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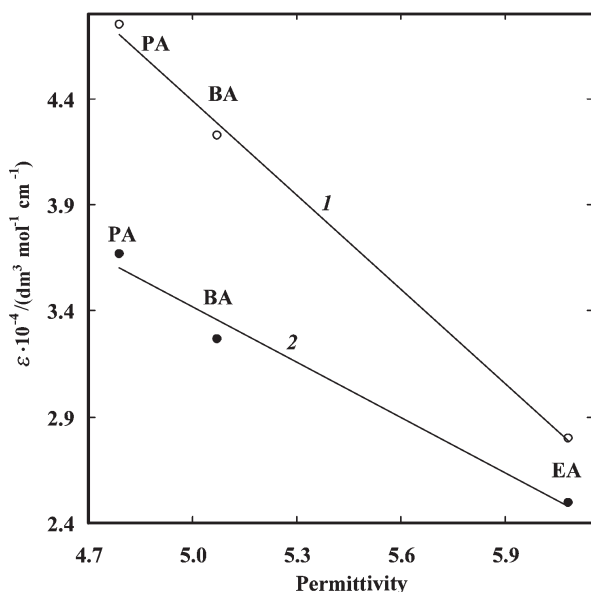


Fig. 2. Dependence of the molar absorptivity of tellurium ion associates on the permittivity of organic solvents. PA – pentyl acetate, BA – butyl acetate, EA – ethyl acetate; $2 \times 10^{-5} \text{ mol dm}^{-3} \text{ Te(IV)}$; $l = 0.5 \text{ cm}$; 1. Te-Cl-CRV, $3.6 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$, $1.0 \text{ mol dm}^{-3} \text{ NaCl}$, $\lambda = 564 \text{ nm}$; 2. Te-Br-CRV, $5.8 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$, $0.04 \text{ mol dm}^{-3} \text{ NaBr}$, $\lambda = 572 \text{ nm}$.

The decrease of extraction (Fig. 1 with trend lines) by benzene derivatives in the order benzene, toluene, and isopropylbenzene correlates with the decreases of the Hildebrand's solubility parameter [8, 9]. In spite of the higher value of recovery for benzene in comparison with toluene, the latter one was advised for practical use due to its lower toxicity. Extraction of complex also depends on the permittivity (dielectric constants) (Fig. 2). It follows from these results that the best extractant is an organic solvent with higher value of Hildebrand's solubility parameter and lower value of dielectric constant.

Some ion associates of tellurium have been extracted slightly by individual organic solvents. Thus, the study of extraction of the ion associates of tellurium by mixture of organic solvents appeared to be of interest. The mixtures of inert (IS) and donor-active organic solvents (AS) have been used. The difference of absorbance of the coloured extracts and blank depends on the nature and concentration of AS (Fig. 3). The best results were reached by using the cyclohexanone as active addition. The decrease of the absorbance in the order cyclohexanone (CHN), methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK) correlates with the decreases in the alkalinity.

The determination of the solvation number is based on the graphical solution of the following logarithmic dependence between the absorbance and the

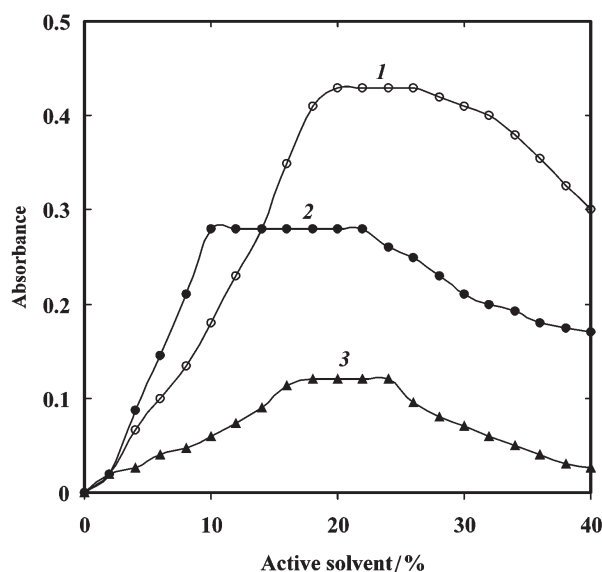


Fig. 3. Influence of the nature and concentration of AS on the absorbance of the tellurium ion associates with AR3G. 1. CHN; 2. MEK; 3. MIBK, inert solvent is toluene, $V(\text{org}) = 5 \text{ cm}^3$; $2 \times 10^{-5} \text{ mol dm}^{-3} \text{ Te(IV)}$; $3.8 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$, $0.8 \text{ mol dm}^{-3} \text{ NaCl}$, $\lambda = 504 \text{ nm}$; $l = 0.5 \text{ cm}$.

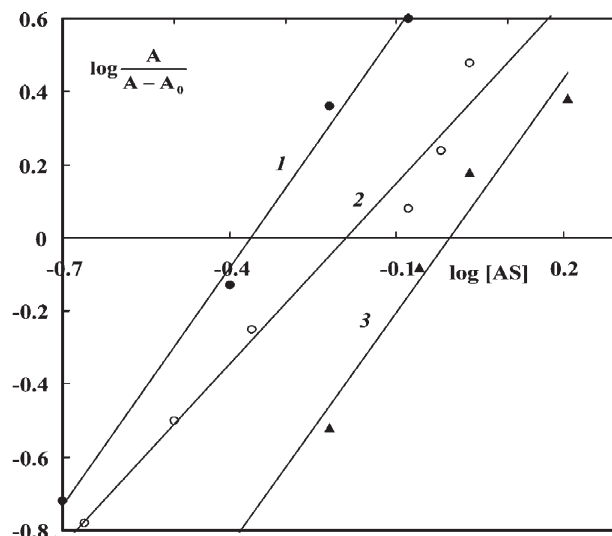


Fig. 4. Determination of solvation number for the Te-Cl-AR3G system. Active additions (solvents) are CHN (1); MIBK (2); MEK (3).

concentration of active solvent.

$$\log \frac{A}{A - A_0} = f(\log[\text{AS}])$$

where A is the absorbance of the coloured extract, A_0 is the absorbance of the blank test, and $[\text{AS}]$ is the concentration of the active solvent. Solvation number is 2 ± 0.2 (Fig. 4).

EXPERIMENTAL

The aqueous 10^{-3} mol dm $^{-3}$ solutions of dyes were prepared from their halide salts. A stock 0.01 mol dm $^{-3}$ solution of tellurium(IV) was prepared by dissolution of Na $_2$ TeO $_3$ salt in water. The working 10^{-4} mol dm $^{-3}$ solution was prepared by diluting the stock solution before the use. Derivatives of benzene and acetates were tested as extractants. The mixtures of various organic solvents as extractants have also been examined. The change of the volume was neglected. The extraction conditions (medium acidity, concentration of ligand) are presented in the figure legends. The extraction was carried out in the test tube at room temperature (18–22°C). The volumes of phases were 5 cm 3 . The time of extraction was 1 min. After the extraction, the organic phase was separated and the absorbance was measured against the blank. The absorbance of the organic phases was measured by spectrophotometer KFK-2MP. The complete absorption spectra were recorded by Unicam 400 double-beam spectrophotometer.

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