

## Anion Exchange Characteristics of Stannic Tellurite

S K SRIVASTAVA\*, A K SINGH & RENU KHANNA

Department of Chemistry, University of Roorkee, Roorkee 247 667

Received 28 July 1986; revised and accepted 3 October 1986

Stannic tellurite, prepared under specified conditions behaves as an anion exchanger. It is stable in acids (1-5 *M*), bases (1-2 *M*) and salt solutions (upto ~ 5 *M*) and shows anion uptake capacity of 1.12 meq/g. Distribution coefficients determined for various anions show that the exchanger material has high affinity for sulphate ion.

In continuation of our investigations on some inorganic gels<sup>1-4</sup>, we report in this note our findings on the preparation, properties and ion exchange behaviour of stannic tellurite.

Stannic chloride (E merck), potassium tellurite (BDH) and other chemicals used were of AR grade. All solutions were prepared in doubly distilled water. pH measurements were made with ELICO pH meter model LI 10 and colorimetric estimation of some ions was carried out using a Unicam SP 500 spectrophotometer. Stanton-Redcroft TG 750 thermobalance was used for TG studies and Beckmann IR 20 spectrophotometer for recording IR spectra in KBr matrix. A Phillips X-ray diffractometer was employed for X-ray diffraction studies. Beta counting of <sup>36</sup>Cl was performed on a GM counter.

### Preparation, ion exchange capacity and analysis of exchanger material

A solution of stannic chloride (0.05 *M*) was added slowly to potassium tellurite (0.1 *M*), prepared in highly acidic medium<sup>5</sup> (pH ~ 0); equal volumes of the two solutions were used. The precipitate obtained was digested with mother liquor for 20 hr at 60°C, filtered, washed with distilled water to remove adhering electrolyte and dried in an air oven at 60°C for 6-8 hr.

Ion exchange capacity was determined by batch method. Since reproducible results could not be obtained for anion release capacity, the anion uptake capacity was measured by observing the uptake of <sup>36</sup>Cl\* radiometrically.

Tin in the exchanger material (0.2 g) was precipitated as hydroxide by adding conc. sodium hydroxide, the precipitate dissolved in hydrochloric acid and tin estimated spectrophotometrically at 530 nm using dithiol as reagent<sup>6</sup>. Filtrate was made upto 100 ml with distilled water and tellurite estimated as thiourea complex of tellurium at 360 nm spectrophotometrically<sup>7</sup>.

### Distribution coefficients

Distribution coefficients (*K<sub>d</sub>*) for different anions were determined by the batch equilibration method by shaking the exchanger (0.1 g) with anion solution (10 ml, 0.002 *M*) for 48 hr, Cl<sup>-</sup> ion was estimated by radiometric method, SO<sub>4</sub><sup>2-</sup>, PO<sub>4</sub><sup>3-</sup>, AsO<sub>4</sub><sup>3-</sup> and Br<sup>-</sup> by volumetric method and SCN<sup>-</sup>, Fe(CN)<sub>6</sub><sup>4-</sup>, VO<sub>3</sub><sup>-</sup>, CrO<sub>4</sub><sup>2-</sup> and MoO<sub>4</sub><sup>2-</sup> spectrophotometrically.

### Column operation

A glass column (30 × 0.5 cm) having lg of the exchanger material (100-200 mesh) was loaded with a mixture of pair of ions till these were completely adsorbed. Elution was started after 15 min at a flow rate of 0.2 cm<sup>3</sup>/min. Eluted ions were determined in fraction of the column effluent (2 ml each).

The optimum conditions described for the preparation of exchanger gives the product having maximum anion exchange capacity (1.12 meq g<sup>-1</sup>). The material is amorphous and is quite stable in water, acids (1-5 *M*), alkali (1-2 *M*) and in salt solutions (upto ~ 5 *M*).

Stannic tellurite exchanger synthesised and analysed for Sn(TeO<sub>3</sub>)<sub>2</sub>·3H<sub>2</sub>O (Found: Te, 53.8; Sn, 24.6; H<sub>2</sub>O, 10.6. Req'd: Te, 54.3; Sn, 25.2; H<sub>2</sub>O, 10.9%). The number of water molecules has been calculated by the method of Alberti *et al.*<sup>8</sup>. The IR spectrum of stannic tellurite exhibits bands at 3400 and 1620 cm<sup>-1</sup> assignable to stretching and deformation modes of coordinated water respectively. The broad band in the region 700-760 cm<sup>-1</sup> is characteristic of tellurite ion<sup>9</sup>.

Time and concentration of solution required for maximum uptake of ions have also been determined and it is observed that an equilibration time of 36 hr and 0.9-1.0 *M* concentration of bathing solution are necessary for saturation.

The mechanism of anion uptake on this product was observed by studying the exchange of <sup>36</sup>Cl\* as a function of NO<sub>3</sub><sup>-</sup> ion concentration. Although the plot was linear, the value of slope was less than one, indicating non-stoichiometric exchange of anions on this compound.

The distribution coefficient values for various anions [Br<sup>-</sup> = 49; Cl<sup>-</sup> = 78; VO<sub>3</sub><sup>-</sup> = 84; SCN<sup>-</sup> = 95; AsO<sub>4</sub><sup>3-</sup> = 108; CrO<sub>4</sub><sup>2-</sup> = 138; MoO<sub>4</sub><sup>2-</sup> = 187; Fe(CN)<sub>6</sub><sup>4-</sup> = 338; PO<sub>4</sub><sup>3-</sup> = 530; SO<sub>4</sub><sup>2-</sup> = 806 cm<sup>3</sup>g<sup>-1</sup>] reveal that the product has a significant affinity for sulphate ions, the order of affinities being Br<sup>-</sup> < Cl<sup>-</sup> < VO<sub>3</sub><sup>-</sup> < SCN<sup>-</sup> < AsO<sub>4</sub><sup>3-</sup> < CrO<sub>4</sub><sup>2-</sup> < MoO<sub>4</sub><sup>2-</sup> < Fe(CN)<sub>6</sub><sup>4-</sup> < PO<sub>4</sub><sup>3-</sup> < SO<sub>4</sub><sup>2-</sup>. The uptake of some cations have also been observed and the distribution

coefficient values for  $\text{Rb}^+$ ,  $\text{Cs}^+$ ,  $\text{Tl}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Th}^{4+}$  etc. range between 0-20.

The potential of sodium tellurite for the separation of sulphate ions from  $\text{CrO}_4^{2-}$ ,  $\text{MoO}_4^{2-}$ ,  $\text{SCN}^-$  and  $\text{Br}^-$  in synthetic mixtures provides sufficient evidence that a large number of binary separations can be achieved on sodium tellurite column. Sulphate was eluted with  $2 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl}$  (12 ml) and other anions with  $0.05\text{--}0.1 \text{ mol dm}^{-3} \text{ NH}_4\text{Cl}$ . The recovery of sulphate in all cases was about 95%. All the separations were clean and no cross contamination occurred. One column can be used for four to six cycles without any loss in separation efficiency.

Work on the estimation and removal of  $\text{SO}_4^{2-}$  ions in tannery and plating wastes, using sodium tellurite columns, is in progress.

The award of a senior research fellowship by the

UGC, New Delhi to one of the authors (RK) is gratefully acknowledged.

### References

- 1 Malik W U, Srivastava S K, Khanna Renu & Vidyarthi Amla, *Annal Chim*, **75** (1985) 171.
- 2 Malik W U, Srivastava S K & Bansal Amla, *Analyt Chem*, **54** (1982) 1399.
- 3 Srivastava S K, Singh A K & Khanna Renu, *Indian J Chem*, **24A** (1985) 254.
- 4 Srivastava S K, Singh A K & Khanna Renu, *Microchim Acta* (In press).
- 5 Nabi S A & Khan Rao R A, *J Indian chem Soc*, **58** (1981) 1030.
- 6 Charlot G, *Colorimetric determination of elements* (Elsevier, New York) 1964, 405.
- 7 Snell F D & Snell T C, *Colorimetric method of analysis* (D Van Nostrand, New York) 1959, 335.
- 8 Alberti G, Constantino U & Zsinka L, *J inorg nucl Chem*, **34** (1972) 3549.
- 9 Nakamoto K, *Infrared spectra of inorganic & coordination compounds* (Wiley-Interscience, New York) 1970, 94, 109.