The adsorption of thorium on a strong base anion exchange resin from nitrate media

The adsorption of thorium on strong base anion exchange resins from HNO_3 solutions has been examined by various workers[1-3]. Thorium is strongly adsorbed in concentrated HNO_3 (distribution coefficient K_D* reaches a maximum value of 200 in 7–8 M HNO_3), shows rapid decrease of K_D with decreasing HNO_3 concentration below 6 M HNO_3 and has negligible adsorption at low HNO_3 concentrations. Since the distribution coefficients of several elements (uranium[4,5], rare earths[6,7] and bismuth[8]) are significantly higher in nitrate solutions of low acidity (*e.g.* $LiNO_3$, NH_4NO_3, $Mg(NO_3)_2$ and $Fe(NO_3)_3$ solutions) than in HNO_3 solution, the adsorption of thorium from nitrate solutions of low acidity has been examined. Since the author was concerned with the processing of Al–Th, Ca–Th and Li–Th mixtures, aluminium, calcium and lithium nitrate solutions were selected for study.

A strongly basic anion exchanger of the polystyrene–divinylbenzene type (Deacidite FF, mesh size 100 to 200) with moderate cross-linkage (7–9 % D.V.B.) was used. Initially in the chloride form, it was converted to the nitrate form by treatment in a column with 2 M NH_4NO_3 solution until the silver nitrate test for chloride was negative. The resin was then washed with deionised water and air dried.

All reagents were C.P. or reagent grade.

Adsorbabilities were determined at room temperature (23 to 25°) by the batch equilibrium method. Weighed amounts of resin were shaken with a known volume of solution for 12 h. (Example: 0.25 g resin + 20 ml 0.2 M $LiNO_3$ solution containing 40 μg Th.) All solutions were maintained at pH 1.9 by the addition of a small amount of 1.0 M HNO_3 to avoid complications by possible hydrolytic reactions. From analysis of the thorium contents of the solution phase before and after equilibration, distribution coefficients K_D were computed. Thorium was determined spectrophotometrically with thoron[9].

The adsorption of thorium on Deacidite FF (NO_3 form) from $Al(NO_3)_3$, $Ca(NO_3)_2$ and $LiNO_3$ solutions of pH 1.9 at 23–25° is shown in Fig. 1. For comparison, CARSWELL's[2] anion exchange data of thorium in HNO_3 are included in Fig. 1.

It is seen from Fig. 1 that the distribution coefficient of thorium is increased if HNO_3 is replaced by nitrate solutions of low acidity. Adsorption was found to increase with the nature of the cation of supporting nitrate solution in the order

$$H < Ca < Li < Al$$

DANON[10] recently measured the adsorbability of thorium on Dowex-1 (NO_3 form) from 1.55–8.44 M $LiNO_3$. All solutions were 0.07 M in HNO_3. Thorium adsorbability (K_D) increased from 13 in 1.5 M $LiNO_3$ to 20,000 in 8.4 M $LiNO_3$.

Interestingly, the extraction of thorium, uranium and rare earths by tributyl phosphate and ether from nitric acid solution is favoured by the presence of inorganic

* $K_D = \frac{\text{Concentration of element/g resin}}{\text{Concentration of element/ml solution.}}$

nitrates[11-15]. In the case of tributyl phosphate extraction of uranium[12], the salting out effect of inorganic nitrates was most marked at low acidities.

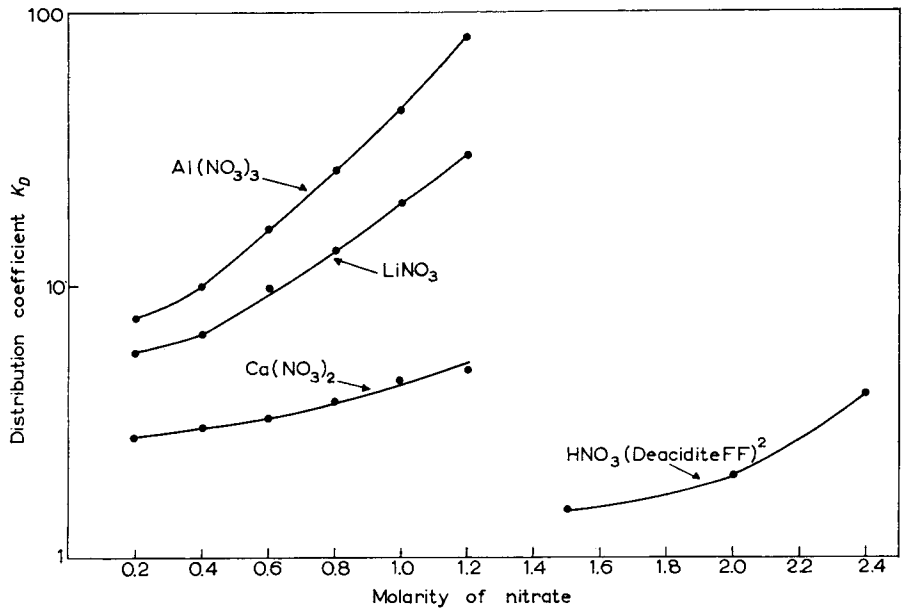

Fig. 1. Distribution coefficient of thorium as a function of concentration of various inorganic nitrate solutions.

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