Studies on the partitioning of plutonium from 30% TBP by ion-exchange absorption on macroporous cation exchanger Amberlyst-15 have been described. Detailed loading experiments indicate that the resin absorbs plutonium in preference to uranium from loaded organic phase at low organic phase acidities (around 0.2M). Absorption behaviour of some fission products on the resin in 30% TBP is also reported. Possibility of using this procedure as an alternate method for plutonium partitioning from IAP stream of Purex process has been discussed.

Introduction

In Purex process, plutonium(IV) and uranium(VI) are extracted with a solution of 30% tri-n-butylphosphate in an inert diluent from nitric acid solutions. Pu(IV) is later separated from uranium by reducing it to Pu(III) and stripping in dilute nitric acid solutions. The principal reductants used for this purpose are ferrous sulphamate, hydroxylamine sulphate, hydroxyl amine nitrate and U(IV)-hydrazine mixture. A discussion on the advantages and limitations of these reductants is beyond the scope of this report and is available in the literature.1,2 However, it may be pointed out that these reductants have certain disadvantages.2 Investigations for alternate methods for the preferential stripping of plutonium from loaded TBP are still being pursued in several laboratories.3-5

In the course of our studies on the absorption of the metals of interest in fuel reprocessing by macroporous ion-exchange resins from 30% TBP-Shell Sol T solutions it was observed that thorium, plutonium and some fission products have high affinity for macroporous cation exchanger Amberlyst-15, while uranium remains practically unabsorbed.6 Based on these observations, two separation schemes were tested earlier: (1) Separation of traces of thorium from uranium by directly treating 5% TBP-Shell Sol T solutions containing both, on Amberlyst-15,7 (2) Purification of tail-end uranium product solution from fuel reprocessing plant from traces of...
impurities like plutonium and fission products by passing the metal-bearing 30% TBP-Shell Sol T through Amberlyst-15. While the former has relevance to Thorex process the latter has applicability in Purex process.

From the high affinity shown by Amerlyst-15 for solvent-extracted plutonium, in comparison to poor uptake of uranium under similar feed conditions, it was considered possible to absorb large amounts of plutonium on this resin from 30% TBP and separate it from uranium. This could be treated as an interesting alternate method for partitioning of plutonium from loaded TBP in Purex process. A similar attempt was made earlier by Swedish workers by directly absorbing plutonium from 30% TBP on silica gel absorbents. But because of the low capacity of silica gel, the amount of plutonium that could be separated was small. Later, Japanese investigators attempted to separate plutonium and uranium on conventional, gel type cation and anion exchangers from TBP medium. Due to the inability of these exchangers to swell in non-polar solvents like TBP this effort also did not succeed. Macroporous resins absorb solvents irrespective of their polarity and are best suited for ion exchange separations in organic media.

The present paper describes the separation of plutonium from uranium using macroporous cation exchanger Amberlyst-15 in 30% TBP-Shell Sol T medium. Breakthrough capacities were determined as a function of organic phase acidity and flow rates. Elutions of plutonium and fission products from the loaded resin were also studied. Finally, separation of plutonium from uranium on Amberlyst-15 was demonstrated through several model runs using synthetic mixtures of plutonium and uranium in 30% TBP-Shell Sol T.

**Experimental**

**Chemicals and reagents**

Tri-n-butyl phosphate and Shell Sol T were obtained from Bayer Chemicals and Shell, Netherlands, respectively, and were used as such without further purification. 30% TBP was prepared by mixing three parts by volume of TBP with seven parts by volume of Shell Sol T. Organic feed solutions for resin-loading experiments were prepared by extracting the required metal from nitric acid solutions of appropriate concentrations. Organic acidity was adjusted either by controlling the aqueous acidity before extraction or by mixing calculated volumes of 30% TBP having different acidities. $^{239}$Pu, $^{95}$Zr/$^{95}$Nb, $^{103}$Ru, $^{141}$Ce and natural uranium, all in nitrate forms, were used for the studies.

The resin used was Amberlyst-15, a strong acid, macroporous cation exchanger, manufactured by Rohm and Haas Company. All other chemicals and reagents used were of AR quality.