THE CHEMICAL REACTIONS OF TRIBUTYL PHOSPHATE IN THE SOLVENT EXTRACTION OF METALS

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Recent investigations concerning applications of tributyl phosphate to separation and recovery of metals are reviewed. Potential applications that may be commercially developed in the future are discussed along with existing processes that have been tested on a pilot plant scale or put into industrial practice. Emphasis has been placed on metals and process media of particular interest to hydrometallurgists. Developments occurring in the past 10 years are stressed. Although to date the greatest success of TBP in hydrometallurgy has been in multistage separation of rare earths, the great versatility of this reagent, combined with its relatively low cost and desirable physical properties, suggests that it may be much more widely applied to metal recovery in the future. Based on the fundamental and developmental work that has been recently carried out, commercial hydrometallurgical applications of TBP appear most likely for recovery of refractory and rare metals.

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INTRODUCTION

Tributyl phosphate is an extremely versatile reagent. To varying degrees, it extracts most of the elements of the periodic table. Careful selection of process conditions is therefore necessary to effect good separations and many stages are often required. In spite of these difficulties, hydrometallurgical applications of TBP are increasing and new processes continue to be developed. The literature on the physical chemistry of extraction by TBP suggests that the potential of this reagent has not yet been fully exploited.

Since the subject of hydrometallurgical uses of TBP has been reviewed before, we have concentrated our attention on the developments of the past 10 years. In cases where the original papers or patents may be difficult to obtain, we have cited Chemical Abstracts in addition to the original source. The chapter is organized in six sections following the customary terminology of extractive metallurgists. First is a section on alkali metals and alkaline earths. This is followed by a section on the base metals Mn, Fe, Co, Ni, Cu, Zn, In, Sn and Al. Sc, Ti, V, Cr, Nb, Mo, Ta and W are discussed under refractory metals. In the rare metals section, Ga, Tl, As, Sb, Te, Cd and Hg are considered. Ag, Au, Ru, Rh, Pd, Re, Os, Ir and Pt are covered in the section on precious metals and the platinum group. In the final section, rare earths are discussed.

ALKALI METALS AND ALKALINE EARTHS

Alkali Metals

Extraction of alkali metals by TBP has received only limited study and there appear to be no industrial-scale applications aimed at separating these elements. However, alkali metal extraction can be significant in certain systems and concern must sometimes be given to coextraction.

Hasegawa et al.[1] reported that the sodium distribution ratio in the aqueous $NaClO_4$-TBP system had a maximum value of about 0.2 near initial aqueous $NaClO_4$ concentrations of 1 M. The lithium distribution coefficient has been reported to depend strongly on the anion; for extraction from 2.5 M aqueous solutions, the distribution coefficients were 0.003, 0.044 and 0.270 for LiCl, LiBr