



## *Copper Extraction From Aqueous Solution By Organic Solvents Of TBP And D2EHPA In Buffer Solution*

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### **ABSTRACT**

Organic solvents of TBP and D2EHPA were used to extract copper from aqueous phase in the buffer solution. This study was performed in order to obtain optimized conditions for copper extraction from low grade copper oxide ores by hydrometallurgical processes. In this regard, the following parameters were studied: the effect of organic solvents synergism, the ratio of TBP:MIBK, the buffer solution pH, the concentration of buffer solution agent (sodium acetate) and the ratio of aqueous to organic phase (A:O). The results showed that under conditions of: synergism of TBP (Tri-n-Butyl Phosphate), MIBK (Methyl Iso-Butyl ketone) and D2EHPA (D-2-Ethyl Hexyl phosphoric acid), TBP:MIBK= 7:3, pH=5, concentration of sodium acetate= 1 milli mole and A:O= 1:1; more than 99% of copper could be extracted.

### **KEYWORDS**

Copper, Solvent Extraction, TBP, D2EHPA, MIBK, Sodium Acetate.

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## 1- INTRODUCTION

Solvent extraction is an impressive technique in hydrometallurgy that is used to extract copper, iron, zinc, cadmium, nickel, cobalt, etc. from aqueous solutions. Recently, limitation of metallic resources have caused interest in scientists to extract useful metals from low grade and reusable resources using new methods in hydrometallurgy. Copper is one of the important elements of non-ferrous metals. Owing to its unique physical and chemical properties such as high electrical conductivity and heat (only silver is rated higher than copper), malleability resulting in good formability, and resistance against corrosion, the applications of pure copper are consequential characteristics. Copper alloys, especially brass have great operational importance [1].

Although, protection of environment limits usage of some organic solvents, economic and industrial significance of copper resulting in recovery and separation of this metal from solutions have been performed by various solvents such as oxim, phosphonic acid, and organophosphorus reagents in solvent extraction [2- 4].

Researchers have examined recovery of copper from aqueous solutions with a variety of commercial extractants, for example, LIX (oxime compounds), Tri-n-butyl phosphate (TBP), Di-2-Ethyl Hexyl Phosphoric Acid (D2EHPA), and Cyanex (organophosphorus compounds) [2- 3]. In recent years, some new extractants and synergistic effect of solvents have attracted attention [4- 6].

Jianming Lu and David Dreisinger was conducted as part of the development of a novel process for copper recovery from copper sulfide concentrates by chloride leaching, simultaneous cuprous oxidation and cupric solvent extraction to transfer copper to a conventional sulfate electrowinning circuit, and hematite precipitation to reject iron [7].

Fouad [8] studied the extraction of copper (II) with Cyanex301, LIX984N, and their mixtures. The extraction efficiency of the mixture was higher than those of both Cyanex301 and LIX984N for more acidic solutions.

TBP is one of the organophosphorus reagents that has been used in the removal of iron and copper solutions.

D2EHPA reagent is an organic solvent that has few destructive impacts on the environment in comparison with other commercial solvents, and is an economical solvent. Recovery of copper using D2EHPA was not very effective, but adding anionic ligands can improve it [9, 10]. Ren et al. [11] studied separation of copper(II) from aqueous acetate buffer solutions with di-(2-ethylhexyl) phosphoric acid (D2EHPA) and observed that acetate ions can greatly improve the extraction efficiency.

The aim of this paper is to study the complete separation of copper (II) from aqueous acetate buffer solutions by solvent extraction using TBP, D2EHPA extractant diluted in kerosene and pure MIBK. The effects of TBP to MIBK ratio, addition of HCl, aqueous to organic phase ratio, acetate ion concentration, pH, D2EHPA concentration, and influence of synergism

D2EHPA-TBP on the copper extraction were investigated.

## 2- REAGENTS AND APPARATUS

Tri-n-butyl phosphate (TBP), Methyl iso-butyl ketone (MIBK), hydrous copper sulfate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ), kerosene, hydrochloric acid (HCl), acetic acid ( $\text{CH}_3\text{COOH}$ ), sodium hydroxide (NaOH), and hydrous sodium acetate ( $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ ) were purchased from Merck. Di-(2-ethylhexyl) phosphoric acid (D2EHPA), from the Sandong Chemical, Chengdu, China, was of solvent quality with a purity > 95%. Other chemicals and reagents of analytical grade were used directly without further purification. A Unicam 939 Atomic Absorption Spectrometer (AAS) was used for the measurement of copper concentration. Shaker IKA type H 5501 was used to agitate of solutions. A Shimifan MTT65 pH meter with a calibrated glass combination electrode assembly was used for pH measurement.

## 3- PROCEDURE

The aqueous phase containing  $1000 \text{ mg.L}^{-1}$  of copper was prepared by dissolving a weighed amount of copper(II) sulfate in distilled water. The TBP, MIBK, and D2EHPA were used as extractants. Commercial kerosene was used as organic diluents for the extractants TBP and D2EHPA; and MIBK was used pure.

All the extraction experiments were conducted with 150 mL reactor at ambient temperature. The desired volumes of organic solvents containing extractants were added to the desired volume of aqueous solution. The reactor was placed in a shaker, and the mixture was agitated for about 20 min to equilibrate. It was observed that this time was sufficient to establish the equilibrium between the two phases. There was no significant difference in the percentage extracted when the shaking time was longer than 20 min. The mixture was then conducted to a separating funnel of suitable capacity, after two phase disengagement, the concentration of copper in the aqueous phase was analyzed by the Atomic Absorption Spectrometer (AAS) and then the distribution coefficient,  $D$ , or percentage of extraction,  $E_{\text{pct}}$ , was calculated. All extraction experiments were performed at room temperature. For the investigation of each parameter affect, in each test, all other parameters were constant and the experiments described were repeated with changing any parameters.

## 4- CONCLUSIONS

These studies explain the capability of the mixture of organic solvent TBP, MIBK, and D2EHPA on copper solvent extraction from aqueous solution. The overall results of this study are as follows:

- The mixture of TBP, MIBK, and D2EHPA solvents has caused their synergistic effect on copper extraction and could be prepared for recovery of more than 99% copper from aqueous solutions.

- The usage of D2EHPA in buffer solution plays an important role in copper extraction, and the recovery of copper became maximum.
- To consider that increasing the extraction can be due to the intermediate formation of Cu(II)- acetate with TBP and D2EHPA.
- Optimum conditions of extraction are dependent on the other factors such as pH, so that the precise settings of pH balance are effective on the extraction efficiency.
- The optimum mixing ratio of TBP: MIBK was equal to 7:3 for the copper extraction.
- The usage of HCl caused a reduction in the extraction percentage due to instability of TBP complex with copper in presence of HCl.
- The mixing of aqueous and organic phases with the ratio of 1:1 produced the higher percentage of copper extraction.

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