Investigating the Effect of Concentration and stirring time on Copper Extraction Process from Pregnant Liquid Solution (PLS), Case study: Sungun Copper Mine

Amirhossein Soeezi[1], Esmaeil Rahimi[2], and Neda Mohaghegh[3]

***Abstract*----**Solvent extraction is regarded as one of the most applicable methods of extracting copper from pregnant liquid solution. The amount and quality of copper extraction are depend on various parameters including: the type of extractant, concentration and the stirring time. The current essay considers the amount of copper extraction from the pregnant liquid solution of Sungun copper mine in an approxiate concentration of 3% by chemorex cp150 as an extractant in 10% and 20% concentrations. In addition, the concentration of sulfuric acid in Sungun PLS is determined 4 gr/lit. eventually, the stripping process is done by sulfuric acid in 180 gr/lit concentration. the results indicate as the extractant concentration is increased, the amount of copper recovery from Sungun PLS gets more, while the long time of strring decreased the recovery.

***Keywords*----**Solvent extraction, Pregnant liquid solution, concentration, Stirring time, Sungun copper mine

I. Introduction

ABOUT 20% of the mines hold deposits of oxide ores. Hydrometallurgical method is applied to exploit metal from its liquid solution[3-1]. According to statistics in 2010,approximately 4.5 million tons of copper metal is yearly extracted from its ore by hydrometallurgical methods[7-1].

Considering parameters like pressure in leaching (hydrometallurgy), Ting-sheng QIU, Gung-hua NIE, Jun-feng WANG, Li-feng CUI observed that the increase of this parameter enhances copper metal separation[4].

Extracting by solvent is identified as one of the methods of recovering copper metal with low grade[5-6]. Extracting by a chemical solvent is a chemical process in which copper metal is stirred with an inorganic substance in solution phase. In fact, a complex with anorganic complicated composite is formed[8-13]. In this case, the copper metal leaves the liquid phase and is transmitted into inorganic phase [7-8]. It is very important to detect the rate of separation of all types of solution extractors (lix) because they show different reactions to various elements [14-17].

[1.] Mining engineering student, Islamic Azad university, south Tehran branch. Email:Amirhossein.soeezi1@gmail.com
[2]. Department of mining engineering, Islamic Azad university, South Tehran branch. Email: SE_rahimi@azad.ac.ir
[3]. Department of Chemistery, Sharif university of Technology.
Email: Mohaghegh@ch.Sharif.edu

The presence of extra ions like permanganate in ppm measurement is very harmful in the liquid solution because this ion can oxidize the solution extracter (lix) and it reduces its recovery rate[18-20]. Moreover,Dalton Raymond has searched in this regard and has got the same conclusions as other researchers[8]. The increase of the solution of extractor concentration accelerates the recovery rate of the liquid solution[18-21]. Considerably, the concentration of sulfuric acid highly affects the separation of copper from inorganic phase. This has been scrutinized by Manish K. Sinha , S. K. Sahu , Pratima Meshram , B. D. Pandey , V. Kumar[21]. The circulation speed of the mixer is also regarded as one of the parameters influencing the separation of metal from liquid solution. F.Valenzuela, C. Araneda, F.Vargas, C. Basualto, J. sapag has studied this issue [1-11]. The current essay analyzes the amount of copper separation from the liquid solution of Sungun copper mine by a solution extractor (chemorex cp150). The concentrations of chemorex cp 150 is considered as %10 and %20. The stirring time of the liquid solution with chemorex cp 150 is recognized as one of the parameters provided in this essay.The increase of chemorex cp 150 concentration can move up the recovery of copper metal from its liquid solution. As the stirring time of the liquid solution with the chemorex cp 150 gets longer, copper recovery will be more.

II. Text

2.1. Sungun

Sungun mine is located in The Eastern Azerbaijan province, 100 km away from the north east of Tabriz and 25 km further from the north of Varzaghan. From mineralogical point of view, the ores present in this mine include: chalcocite, chalcopyrite, bornite and covolite. The pregnant liquid solution (PLS) obtained from Sungun heap leach contains 4.106gr/lit of copper and 1.5 gr/lit of ferrous. This essay aims at raising the recovery rate of copper metal from liquid solution and figuring out the effects of effective parameters on liquid solution.

2.2 Materials

The Kerosene is practiced to dilute chemorex c.p 150 in %10 and %20 concentrations(figure 1). Diluted sulfuric acid purifies copper out from the inorganic solution. The concentration of sulfuric acid is measured 180 gr/lit. Eventually, the recovery amount of copper metal is measured and recorded through iodic-meter and atomic absorption methods. Chemicals applied to determine the concentration of ferrous and the copper of the liquid solution of sungun copper included: iodide potassium(KI),Iodate potassium (KIO_3), concentrate sulfuric acid(H_2SO_4), Tio sulfate sodium($Na_2S_2O_3$), Tio Cianate potassium (KSCN) and Permanganate potassium($KMnO_4$).

Fig. 1: The Kerosene and extracted copper from PLS

Fig. 2: The Mixing equipment and Plastic container

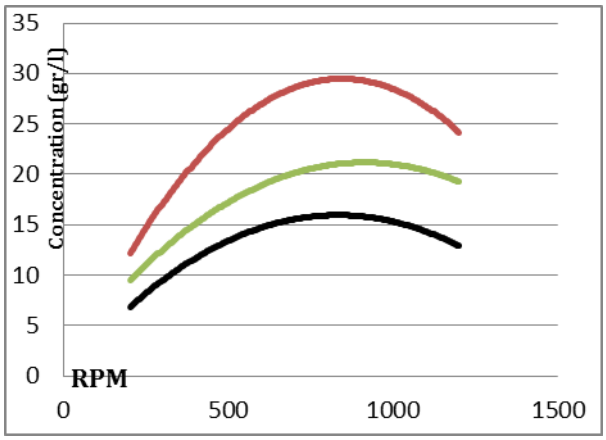
2.3 Methodology

The way of producing Sulfuric acid in 180 gr/lit concentration is as below: $C_1 .V_1 = C_2 .V_2$ $C = \frac{10ad}{M}$ a,d,M respectively indicate molecular mass, purity percentage and sulfuric density. V1 which is unknown is identified by the data obtained from the formula. The mixer used in this experiment belongs to Danesh Faravaran Company by 87110 serial number.

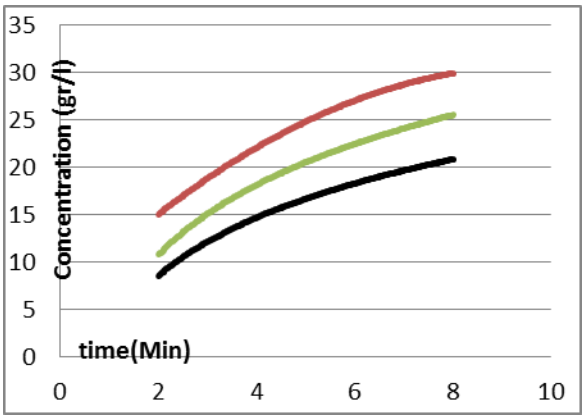
All separating steps are done by a plastic container having on a steel leg and offloading tap (Figure2). The srirring rate is fixed at 200,405,605 and 900 RPM and its mixing time is set 2,3,4,6 and 8 min. the color of these two solutions(liquid solution with inorganic solution) are changed. So, the color of the liquid solution is changed from dark green to light green and the inorganic one(chemorex cp 150), from light brown to dark brown (Figure2).

III. Results

The effect of stirring rate on the amount of recovering copper from liquid solution, in different concentrations of inorganic solution, B: the influence of stirring time on the amount of recovering copper from liquid solution is specified in various concentrations of the inorganic solution.

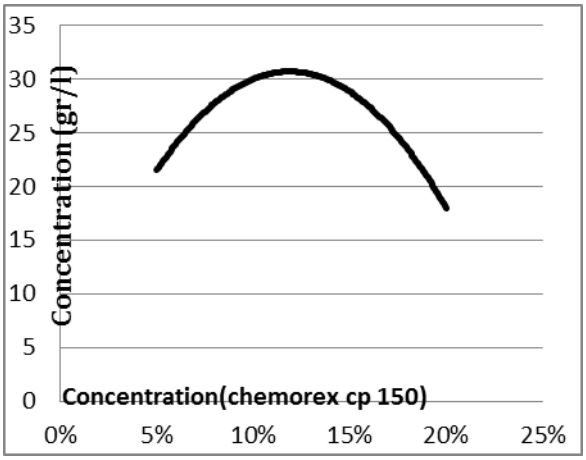


A: Effect of different RPM on the extraction of copper. Vertical column indicative of separation of the copper, during different stirring rates. The red, green and black color in the chart are showing the chemorex cp 150 in 10%, 5% and 20% concentrations



B: Separation of the copper at different times. Vertical column indicative of separation of the copper, at different stirring times. The red, green and black color in the chart are showing the chemorex cp 150 in 10%, 5% and 20% concentrations

Graph (2): The effect of different concentrations of inorganic solution on the recovery amount of copper from liquid solution is determined.



Graph (2): Effect of different Chemorex cp 150 concentrations on recovering of the copper concentrate

IV. Conclusion

Studies demonstrate that different parameters such as temperature, the concentration of the inorganic solution, sulfuric acid concentration and, etc are very essential in extracting copper metal from liquid solution. The present essay attempted to assess the amount of recovering copper from the pregnant liquid solution of Sungun heap leaching under various conditions like the concentration of the liquid solution, the stirring time and the speed of the mixer circulation. In fact, it is specified that 1000 RPM is the most optimum circulation speed and the highest amount of extraction is marked at this speed. Furthermore, the stirring time is also regarded one of the parameters considered in this essay. Analyses on these parameters illustrate that as the stirring time gets increased, the amount of copper recovery is enhanced, too. Like other parameters, time has a point indicating the maximum rate of copper recovery. Graph 2 shows that %10 concentration of the inorganic solution (chemorex cp150) scores the highest amount of copper recovery than other concentrations (%5 and %20).

V. Acknowledgments

The authors are grateful to Mr. Ilkhani at the South Tehran laboratory manager for providing samples.

References

[1] Mark E. Schlesinger, Mattew J. King, Kathryn C. Sole, William G. Davenport, “Extractive Metallurgy of Copper”.
[2] Demergasso, C., Galleguillos, F., Soto, P., Seron, M., & Iturriaga, V. “Microbial succession during a heap bioleaching cycle of low grade copper sulfides”.
[3] Cordoba, E. M., Mun˜oz, J. A., Bla´zquez, M. L., Gonza´lez, F., & Ballester, A. “Leaching of chalcopyrite with ferric ion. Part I: general aspects. Hydrometallurgy”
[4] Ting-sheng QIU, Gung-hua NIE, Jun-feng WANG, Li-feng CUI, “Kinetic process of oxidative leaching of chalcopyrite under low oxygen pressure and low temperature”.
[5] LIU Qing-ming, YURun-lan, QIU Guan-zhou, FAnG Zheng, CHEN Ai-Liang, ZHAO Zhong-wei, “Optimization of separation processing of copper and iron of dump solution in dexing Copper Mine”.
[6] Barid, Lo.T., Hanson M.E; 1983; “Handbook of solvent extraction”; GSA.
[7] Cordoba, E. M., Mun˜oz, J. A., Bla´zquez, M. L., Gonza´lez, F., & Ballester, A. “Leaching of chalcopyrite with ferric ion. Part I: general aspects. Hydrometallurgy”
[8] Dalton, Raymond; 1998; “CORGA ZNX50 Novel reagent for the selective solvent extraction of zinc from aqueous chloride solutions”.
[9] Kordosky, G. A. (2008). “Development of solvent-extraction processes for metal recovery – finding the best fit between the metallurgy and the reagent”. In B. A. Moyer (Ed). Solvent extrction: fundamentals to industrial applications.
[10] F. Valenzuela, C. Basualto, c. Tapia, J. Sapag, C. Paratori, “Recovery of copper from leaching residual solutions by means of a hollow-fiber membrane extractor”.
[11] F. Valenzuela, C. Araneda, F.Vargas, C. Basualto, J. sapag, “Liquid membrance emulsion process for recovering the copper content of a mine drainage”.
[12] 12 Bishop, M. D.,Gray,L. A., Greene, M. G., Bauer, K., Young, T.L, May, J., Evans, K. E., & Amerson-Treat,I. (1999). “Investigation of evaporative losses in solvent extraction circuits”.
[13] Dudley K.A.(2000), “Impurity transfer in copper solvent extraction plants understanding and managing the problem”, ALTA2000
[14] LAN Zhuo-yue, HU Yue-hua, LIU Jian-she, WANG Jun; “Solvent extraction of copper and zinc from bioleaching solutions with LIX984 and D2EHPA”.
[15] YANG XJ, FANE AG, “Performance and stability of supported liquid membranes using LIX 984N for copper transport”.
[16] SAN MIGUEL E R, AGUILAR J C, BERNAL J P, BALLINAS M L, RODRIGUEZ M T J, deGYVES J, SCHIMMEL K. “Extraction of Cu2+, Fe3+, Ca2+, Ni2+, In3+, Co2+, Zn2+ and Pb2+ with Lix984 dissolved in n-heptane [J]. Hydrometallurgy”
[17] George O; “selective extraction of Zn and Cd from Zn-Cd-Co-Ni sulphate solution using di-2- ethylhexyl phosphoric acid extraction”.
[18] Barnard H.C.,Cheng C.Y.,Larcombe K.,(2000), “The role of contaminants in phase sepration during copper solvent extraction”, ALTA200019 Dudley K.A.(2000), “Impurity transfer in copper solvent extraction plants understanding and managing the problem”, ALTA2000
[19] Miller G, “The problem of manganese and it's effects on copper solvent extraction- electrowining”.
[20] Anderson, C.G, Giralico, M. A., Post, T.A.,Robinson,T. G., & Tinkler, O. S. (2002).”Selection and sizing of copper solvent extraction and electrowinning equipment and circuits”.
[21] Manish K. Sinha , S. K. Sahu , Pratima Meshram , B. D. Pandey , V. Kumar, "Solvent Extraction and Separation of Copper and Zinc from a Pickling Solution”
[22] Mohan, D. and Chander, S, “Removal and recovery of metal ions from acid mine drainage using lignite—a low cost sorbent”.
[23] Lazarova, Z. and Boyadzhiev, L, “Kinetic aspects of copper (II) transport across liquid membrane containing LIX-860 as a carrier”.