

Increasing amounts of copper from mineralogical with stripping method

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As a mineral product, copper has been widely used by human being since the early stage of civilization up to the modern time of today. Due to its characteristics and wide range of uses, copper is much used for household articles, electric machineries and equipments, non electric machineries, construction, transportation and others. Usually copper ores containing low copper amount between 0.5-0.8% Cu. Increasing amounts of copper can be done hydrometallurgy process. Stripping is another process to increased amount of copper with organic phase contracting with aqueous phase to drive the metal into the aqueous phase. From the experiment have been done, the high increasing amount of copper are with 25% of % H₂SO₄, volume compare are 1/8 and shaker time is 60 minute. From AAS analyzed, copper ionic results are 82.3 mg in 50 mL organic phase and increased amount of copper are 9 times. Result of % stripping is 90.0%.

Introduction

Copper is one of non-iron metal types which since thousands years before Christ has been largely used by human beings. The discovery and use of copper metal and its integrated metals, primarily bronze, is also an historical milestone in human civilization on the earth planet.

Since 1973 Indonesia began to be known as one of copper producing countries, but it is still in the form of copper concentrate, containing: 32-44% Cu, 10-20 gram Au/ton and 100-200 gram Ag/ton. The entire production of Indonesian copper concentrate is still exported to Japan, Europe and United States of America and several countries in Pacific region (Simatupang M., 1992).

In order to make the copper metal from the mineral it can be done by a *pyrometallurgical* process (a high-temperature process) or by *hydrometallurgical* process (a dissolving process), the two processes individually have the different advantages and disadvantages, depending on their mineral characteristics. The *pyrometallurgical* process is more advantageous for metal mineral having a high content, while for copper mineral having low content will be more advantageous when using a path of the *pyrometallurgical* process. Unfortunately, the most of coppers founded have occasionally had only low content such that it is highly not advantageous as used as industrial basic material. In order to tackle this the stress put on the *pyrometallurgical* process is very essential in the light of this process the low-content copper can be improved so that it can be used for the next need. The copper making with the path of the *pyrometallurgical* process principally consists of several process phases: floatation process, dissolving process and electrolytic process constituting the copper depositing from the copper solution. (N. Erlinda et al., 1982).

The orders of the dissolving occurring here are the dissolving using sulphate acid (*leaching*) and then it will be continued by the dissolving using extractant (*solvent extraction*) and before electrowinning it can be done a dissolving by acid according to its metal type (*stripping*). The stripping is the taking-up of metal ion extracted to the organic phase conducted by contacting it to the organic solution with a solution of acidic water, where the metal ion will return to water solution phase at higher and pure concentration such that it met the conditions for the electrowinning process. In order to identify the effects of various factors on the stripping process, so we have carried out this research.

Based on the background mentioned above, it can be identified several problems as follows:

1. How much the optimum condition of each individually variable %H₂SO₄, volume ratio and the stirring time such that it can be obtained an increase of copper in the solution satisfying the condition for electro winning.
2. How much the effects of each individually variable %H₂SO₄, volume ratio and the stirring time on the increase of copper volume in the stripping solution.

This research has been carried out to look for the optimum condition of the variables having highly effects on the stripping process, among of them are variable %H₂SO₄, volume ratio and the stirring time.

This research is useful for obtaining the optimum condition of variable %H₂SO₄, volume ratio and the stirring time, so that it can be used by a domestic copper industry to increase the outcome of the copper mine being in operation currently.

Materials and Methods

The experiment of looking for the optimum condition of the variables having an influence on the stripping process began by making the *Solvent Extraction* solution as a solution whose the organic phase will be used in the stripping stage. In the stripping process the influential variables are among other things: variable %H₂SO₄, volume ratio and the stirring time. In this research it will be also conducted a characterization according to SNI standards, that is the Cu content analysis in the copper sulphate solution by means of AAS (*Atomic Absorption Spectrophotometer*)

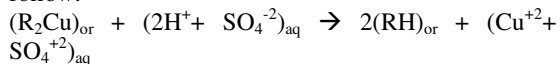
Stripping

Stripping is a taking-up process of the metal ion extracted to the organic phase. This process is a continued process of solvent extraction where the copper in the leaching-outcome solution is bound by the organic solvent for increasing its content. The copper that has been in the organic phase will further passed through the stripping stage. This process is done by contacting the organic solution to an acidic water solution where the metal ion return to the water solution phase with higher and pure concentration such that it meets the condition for the electro wining process, that is about 20-30 g/L, whereas the organic solution is used again as extractant. (Rosenqvist T., 1983).

In the stripping stage two points has occurred, those are:

- The taking-up of the copper metal ion from the organic solution by contacting it to a solution possessing a adequately high acidity.
- Regression of LIX extractant. (Habashi F., 1969).

The reaction occurring in the stripping process is as follow:



where:

RH = organic solvent (LIX)

()_{aq} = in the water solution phase

()_{or} = in the organic solution phase

R₂Cu_{or} = complex copper compound in the organic phase.

Stripping needs to use an acidic solution with a adequately high concentration into the water solution. With ion association and solving system, where acids or salts at high concentration are required for the metal extraction. The stability of extractant type will determine the type and concentration of the stripping solution needed. For example, it has been clear that the low pH when the metal extraction occurring, then the stripping solution must possess high acid concentration. (Ritcey G.M., 1984).

A moving process of metal ion from water solution phase to organic phase is offset also by a moving process of hydrogen ion from organic phase to water solution phase. This results in high solution acidity, as the solution acidity has reached at a certain

limit it begins to occur a direction change of reaction, where the extracted copper ion in the form of organic complex will return to water solution phase in the form of ion. The higher the acidity used in the stripping process, the more number of Cu⁺² ions carried into the water solution phase. (Biswas A.K., 1994)

Formation of Solvent extraction solution

Weighed CuSO₄.5H₂O (crystal) as many as 13.26 g, and then dissolved by distilled water as many as 22.5 L. The solution is stirred such that it is homogenous. After is has been homogenous the solution is added by several drops of H₂SO₄ until at pH 4. The metal ion concentration is analyzed. LIX984N is diluted as many as 120 mL by petroleum as many as 1380 mL (volume ratio = 1/15) so that it can be obtained extractant solution. And then the extractant solution is mixed into copper sulphate solution and stirred for 60 minutes. The mixture is put into a separating funnel and separated between Solvent Extraction (upper phase) solution and water solution (lower phase). Taken up the Solvent Extraction solution for process in the stripping stage. The final concentration of copper ion is analyzed in the water solution (lower phase). The initial and final concentrations of copper ion are analyzed by AAS (*Atomic Absorption Spectrophotometer*) model Shimadzu AA630-01.

The concentration of copper ion in the Solvent Extraction solution = initial concentration of copper ion – final concentration of copper ion in the solution.

Stripping Process

Determination of optimum %H₂SO₄ (stirring by shaker)

As 50 mL of *Solvent Extraction* solution is put into 100-mL Erlenmeyer, added by H₂SO₄ and distilled water by % H₂SO₄ and the fixed volume ratio. The mixture is shaken by using a shaker for 10 minutes. After stirred, the mixture is put into a separating funnel and separated between *stripping* (upper phase) solution and copper sulphate solution (lower phase). The concentration of copper ion in the copper sulphate solution is analyzed (lower phase) by AAS.

Determination of optimum %H₂SO₄ (stirring by magnetic shaker at temperatures T = 25°C and T = 100°C)

As 50 mL of *Solvent Extraction* solution is put into two 150-mL beaker glasses, added by H₂SO₄ and distilled water by % H₂SO₄ and the fixed volume ratio. Each mixture is individually stirred by using a magnetic shaker for 60 minutes. One beaker glass the stirring is at temperature 25°C, and another beaker glass the stirring is at 100°C. After stirred, each

mixture is individually put into a separating funnel and separated between *stripping* (upper phase) solution and copper sulphate solution (lower phase). The concentration of copper ion in the copper sulphate solution is analyzed (lower phase) by AAS.

Determination of Optimum Volume Ratio

As 50 mL of *Solvent Extraction* solution is put into a 150-mL beaker glasses, added by H₂SO₄ and distilled water by optimum % H₂SO₄ and the variation of fixed volume ratio. The mixture is stirred by using a magnetic shaker for 60 minutes at temperature 25°C. After stirred, each mixture is individually put into a separating funnel and separated between *stripping* (upper phase) solution and copper sulphate solution (lower phase). The concentration of copper ion in the copper sulphate solution is analyzed (lower phase) by AAS.

Determination of Optimum Stirring Time

As 50 mL of *Solvent Extraction* solution is put into two 150-mL beaker glasses, added by H₂SO₄ and distilled water by % H₂SO₄ and the optimum volume ratio. The mixture is stirred by using a magnetic shaker with the variation of time that has been set at temperature 25°C. After stirred, each mixture is individually put into a separating funnel and separated between *stripping* (upper phase) solution and copper sulphate solution (lower phase). The concentration of copper ion in the copper sulphate solution is analyzed (lower phase) by AAS.

Results and Discussion

Determination of Optimum H₂SO₄ (Stirring by shaker)

The determination of H₂SO₄ is done to identify the effects of the sulphate acid number added for binding Cu²⁺ tied to the extractant in the organic phase solution. The duration of the stirring conducted in this experiment is 10 minutes by using a low-speed shaker. From the result of the experiment conducted, it can be obtained some outcomes as shown in the following table. % Stripping yielded is not high. This is possibly due to the speed of shaker is low.

Table 1 Determination of Optimum H₂SO₄ (Stirring by shaker)

% H ₂ SO ₄	Volume Ratio	Stirring Time	Cu taken-up	% Stripping
1.86 %	1/8	10'	6.215 g	7.5 %
9 %	1/8	10'	6.866 g	8.3 %
21 %	1/8	10'	7.743 g	9.3 %
25 %	1/8	10'	9.120 g	11 %

Determination of Optimum (Stirring by magnetic shaker at temperatures T = 25°C and T = 100°C)

The determination of H₂SO₄ in the second experiment simply uses the largest value of H₂SO₄ in the previous experiment, that is 25%, the stirring time is 60 minutes, volume ratio is 1/8. The operating temperatures used in this experiment are 25°C and 100°C. The application of the two temperature variables has an objective to identify what is the cause of low % stripping. The stirring is done for 60 minutes. It is expected with the change of the two variables that % stripping yielded will be increased. From the result of analysis, it is obtained a high increase of % stripping. The high increase of % stripping is obtained at temperature 25°C and conducted for 60 minutes using a magnetic shaker. The duration of stirring and the type of shaker have also significant influence. This is perhaps due to the releasing process of strong bind between LIX-Cu such that Cu⁺² can be bound by SO₄⁻² to form the bind of CuSO₄.

Table 2 Determination of Optimum (Stirring by magnetic shaker at temperatures T = 25°C and T = 100°C)

% H ₂ SO ₄	Volume Ratio	Stirring Time	Temperature	Cu taken-up	% Stripping
25 %	1/8	60'	25°C	82.3 g	99.0 %
25 %	1/8	60'	100°C	78.42g	94.4 %

Determination of Optimum Volume Ratio

Volume ratio is a ratio of organic phase solution volume to be stripped to the water phase solution volume. The water phase solution volume is slightly more than the organic phase solution volume. This is caused such that the number of H₂SO₄ applied is not too high but strong concentrated in the water such that the binding of Cu⁺² ion of LIX-Cu binding is more maximal such that the increasing of Cu⁺² number can be consistent with the expected. The volume ratio also determines how times of the increasing of Cu⁺² number before stripping. The result of analysis is obtained the volume ratio of 1/8 the increase level of Cu⁺² number by 9 times with % stripping of 99.0%. With the volume ratio of 1/2 increase level of Cu⁺² number at 13 times with % stripping of 98.4%. But the volume ratios of 1/16 and 1/20 of the increase yielded are not consistent with the value of volume ratio. This is possibly caused by too little comparison of organic phase solution and water phase solution. So the reaction occurring didn't take place perfectly and the volume of water phase solution is inadequate to do an increase to Cu⁺²⁺ ion.

Table 3 Determination of Optimum Volume Ratio

% H ₂ SO ₄	Volume Ratio	Stirring Time	Cu taken-up mg	Cu taken-up x	% Stirring
25 %	1/8	60'	82.30 mg	9x	99.0 %
25 %	1/12	60'	81.83 mg	13x	98.4 %
25 %	1/16	60'	58.50 mg	14x	70.4 %
25 %	1/20	60'	46.82 mg	14x	56.3 %

Determination of Optimum Stirring Time

The last variable observed in this experiment is the stirring time. The stirring times used in this experiment are 30; 45; 60; 75 minutes. From the result of analysis, it is obtained high % stripping yielded with the stirring time for 75 minutes is by 99.2%. But the stirring time applied as the optimum stirring time is the stirring time for 60 minutes with % stripping by 99.0% because with earlier time for 15 minutes, % stripping yielded is not too far so that is it selected the stirring time for 60 minutes. This is associated with work time coefficient.

Table 4 Determination of Optimum Stirring Time

% H ₂ SO ₄	Volume Ratio	Stirring Time	Cu taken-up mg	% Stirring
25 %	1/8	30'	79.77 mg	96 %
25 %	1/8	45'	81.52 mg	98 %
25 %	1/8	60'	82.30 mg	99.0 %
25 %	1/8	75'	82,43 mg	99.2 %

Conclusions

From the experiment conducted in this research it can be drawn some conclusions as follows:

1. For the stripping process, it has been obtained an optimum condition from the variation of several variables considered to be large influential, that is % H₂SO₄ by 25%, volume ratio by 1/8 and the stirring time for 60 minutes.
2. The variables used in this research have large effects on the increasing of copper number.

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