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The Study of Effectiveness Gold Exytaction Process with Base-Case Sample and Aachen Assisted Leaching (AAL) using Running Aachen

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Abstract

The Center for Mineral and Coal Testing is an institution that works in the field of research services on mining and mineral processing. In the mineral processing research currently being carried out there is a research project related to increasing the efficiency of the leaching process using the Aachen Reactor. The samples used in this research were refractory gold samples. The problem of decreasing the effectiveness of gold leaching is caused by the presence of minerals that are still included in the associated minerals. Therefore, a pre-treatment process is needed to remove the associated minerals. In this research, we studied increasing the efficiency of refractory gold using an Achen reactor which is expected to increase the efficiency of the leaching process by increasing Dissolve Oxygen levels to 30 ppm.In this study, two samples were used for comparison, namely the Pre-Ox sample and the Aachen Assisted Leaching (AAL) sample.
Keywords : Minerals, Aachen, Leaching, Extractive Metallurgy

Introduction

Hydrometallurgy is an extraction process that includes purifying and recycling metal using an aqueous solution at a temperature < 200 º C. Hydrometallurgy developed after acid and base solutions were discovered. The basic principle of hydrometallurgy is to take the metal we want from ore, by dissolving it in a solvent or liquid. Then, the solution formed is then purified to get the metal we want. (Sarempa, 2015)

The solvent or liquid used in this process depends on the type of metal you want to obtain. To extract gold from ore, mercury (Hg) can be used as a solvent, because the process of obtaining gold (Au) from ore is very easy, gold immediately reacts with Hg. However, because it is very dangerous for the environment and health, this method has long been abandoned.

Leaching is a selective dissolution process where only certain metals can dissolve and separate them from impurity minerals using an aqueous solution, either acid, base, or salt. Mineral impurities will remain in solid form and are referred to as residue. The choice of leaching method depends on the valuable metal content in the ore and the characteristics of the ore, especially whether or not certain chemical reagents easily leach the ore.

In the cyanidation process, the gold ore is broken down and then ground to a size of 200 mesh. The equipment used is a ball mill. The crushed ore is subjected to a cyanidation

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process by adding air and stirring in a tank for 48 hours. The final stage is the adsorption process using activated carbon. After that, borax is added and melted at a temperature of 1000-1200 ^{o}C. The process of adding cyanide in the cyanidation process must consider its concentration. The added concentration greatly influences the recovery value that will be obtained later. Basically, the more cyanide concentration added, the higher the recovery rate. Concentration values usually range between 400 – 600 ppm. Sudesno, Nurhakim. (2019)

Apart from the cyanide concentration, the dissolution process also considers the proper use of oxygen. Oxygen is added with the intention of improving the leaching process. Apart from that, H_2O_2 is also added as an oxidizer. The use of H_2O_2 in solution has been tested and shows results where gold can be separated quickly.

In the process of leaching refractory gold ore, a treatment process is carried out. This treatment process is carried out with the aim of increasing the leaching kinetics of refractory ore and increasing gold recovery. Pretreatment techniques are used before the leaching process. Pre treatment techniques include roasting, biological and pressure oxidation, Albion and Leachox processes. (Sabari, 2017)

The Leachox process is essentially a series of existing and new unit process steps, such as Imhoflot flotation, very fine grinding of the flotation concentrate and then partial oxidation of the sulfide followed by in-column leaching to replace conventional leaching which is exposed to the atmosphere. At the heart of all these processes is the high shear reactor, the Aachen Reactor. (Maelgwyn, 2009)

In this case a device called the Aachen Reactor has been developed to improve the leaching kinetics of refractory ore by increasing the mass transfer of oxygen in the slurry. The Aachen reactor is used as the first step in pre-oxidation before the cyanidation process.

The leaching process using the Aachen reactor has been proven to increase the leaching kinetics of free-milled gold ore. However, apart from the results obtained in the application process for free milling gold ore, it seems that there has been no further development regarding research regarding its application to refractory gold ore.

In this research the author tried to analyze the pre-treatment process using the Aachen reactor by varying the method between the Pre-ox sample and the Aachen Assisted Leaching (AAL) sample.

Research Methods

This research has the main objective, namely to determine the effectiveness of the leaching process using a tool in the form of an Aachen Reactor and then comparing the % extraction results obtained between the base-case sample and the Aachen Assisted Leaching (AAL) sample.

The testing process was carried out at the Metallurgical Laboratory of the TekMIRA Mineral and Coal Testing Center using refractory-type gold samples with an initial gold content of 1.84 ppm. A pre-treatment process was carried out using equipment

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in the form of an Aachen Reactor on July 31, 2023, for a 4-hour process: pre-treatment to obtain base-case samples and Aachen Assisted Leaching (AAL) samples. Then, the bottle roller process was carried out for two days with time intervals of 2, 4, 8, 24, and 48 hours; after that, a sampling process was carried out to analyze the levels.

The parameters of the pre-treatment process using the Aachen reactor can be seen in table 1.1 as follows:

Tabel 1 Operational Data for the Running Aachen Process

Pressure	1 bar
Temperature	30 – 40 ^{o}C
Cycle	12 *pass*
Feed Weight	20 kg
Solid Percent	40%
NaCN levels	700 ppm
DO levels	20 – 30 ppm
Waiting time	30 minutes per sample (*base case, Aachen assisted leaching* (AAL))
Leaching Types	*Agitation Leaching*
pH	9 – 11

The leaching process using a bottle roller is carried out to simulate the leaching process to get the lowest results. This is done in order to get results that are close to industry parameters. In the bottle roller process, a sampling process is carried out to be later analyzed using the fire assay method.

After obtaining the assay data from the fire assay analysis process carried out, an analysis of the percent extraction value was then carried out. The percent extractionvalue is obtained from the formula:

$$\%\,Ext = \frac{Au\,Total\,Rem.in\,sample}{Au\,Total}\,x\,100\,\% \quad (1)$$

From the results of calculating the percent extraction, an analysis process was then carried out by comparing the results of the percent extraction of the base-case sample with the AAL sample.

Result and Discussion

1. Sift Analysis Result

Sift analysis is carried out to obtain grain sizes that are in accordance with the provisions of the leaching parameters that will be carried out. This sieve analysis was

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carried out to obtain P80 analysis. The results of the sieve analysis are as follows Table 2.

Table 2 Data from Sift Analysis Result

No.	Fraksi	Berat
1.	+ 200	13.0 gr
2.	- 200 + 270	23.5 gr
3.	- 325 + 400	17.0 gr
4.	- 400	432.0 gr
Jumlah		485.5 gr

From the analysis carried out, the following P80-400 mesh sieve analysis was obtained:
P80 =

$$\frac{The\ weight\ passing\ through\ the\ sieve\ is\ 400\ mesh}{Weight\ feed}\ x\ 100\%$$

$$P80 = \frac{485\ gr}{498\ gr}\ x\ 100\%$$

$$P80 = 97{,}38\%$$

From the results of the analysis carried out, the P80 value was 97.38%. This shows that the size of the ore has passed the 400-mesh sieve. However, on the other hand, a value of 97.38% indicates that the sample has experienced overgrinding so that the ore becomes too small, which causes the solution viscosity to be too high during the leaching process. This causes the reagent to be unable to leach the gold ore optimally.

2. NaCN Consumption Analysis

NaCN analysis is carried out through an argentometry titration process. The titration process is carried out using silver nitrate (AgNO3) and Rhodanine indicator. The results of the titration analysis can be seen in table 3 and table 4 as follows:

Table 3. NaCN levels in Base-case samples

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Hour	Volume AgNO3 (mL)	Volume Sample (ppm)	Rate NaCN (ppm)
0	10	5	935,9
2	8,5	5	795,515
4	7,35	5	687,8865
8	6	5	561,54
24	4,25	5	397,7575

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48	2,2	5	205,898

Table 4. NaCN levels in Aachen Assisted Leaching

Hour	Volume AgNO3 (mL)	Volume Sample (ppm)	Rate NaCN (ppm)
0	10	5	935,9
2	9	5	842,31
4	7,9	5	739,361
8	6,7	5	627,053
24	5,15	5	481,9885
48	3,15	5	294,8085

From the results displayed in Tables 3 and 4, it can be seen that in the base case sample, the final cyanide content was 205,898 ppm, while in the Aachen Assisted Leaching (AAL) sample, the final cyanide content was 294.81 ppm. This indicates that cyanide consumption in the base case sample is higher than in the Aachen Assisted Leaching (AAL) sample. The AAL sample given the Aachen running process resulted in better leaching process kinetics than the Base case sample.

From the calculation analysis that has been carried out, the results of the percent extraction for each sample are as follows which can be seen in Figure 1 and 2.

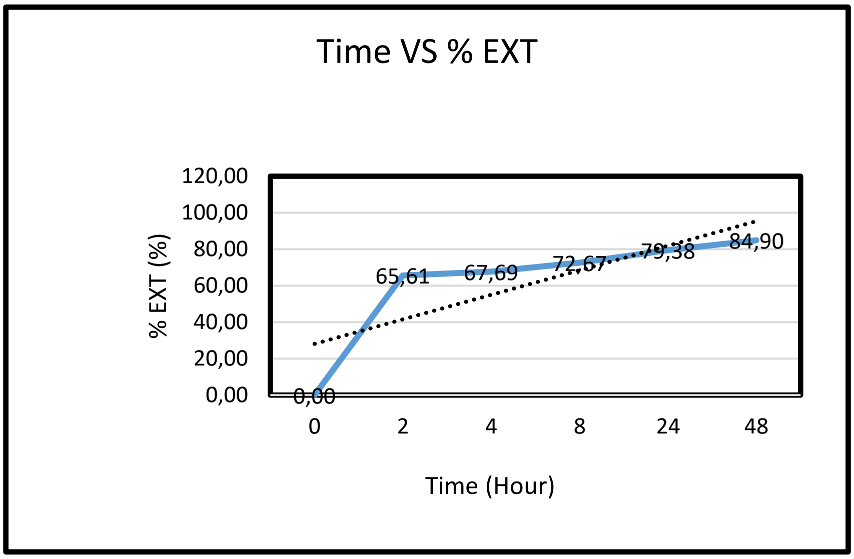

Figure 1 Graph of Time vs % Base-case Sample Extraction

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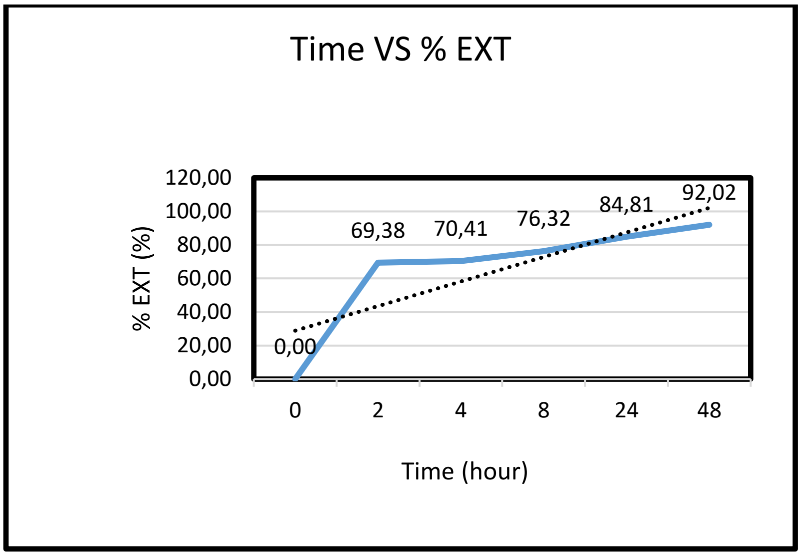

Figure 2 Graph of Time vs % AAL Sample Extraction

From this graph on figure 1 and 2 it can be seen that the Base case sample produces an extraction percentage of 84.90%, while the Aachen Assisted Leaching (AAL) sample produces an extraction percentages of 92.02%. Thus, it can be concluded from the AAL samples that the leaching process with the help of the Aachen reactor will produce a better extraction percentage than the normal process without pre-treatment using Aachen. This is caused by an increase in the kinetics of the leaching process. In this AAL method there will be an increase in dissolved oxygen levels to 20-30 ppm so that the fluid film layer on associated minerals and impurities such as sulfide and silica will thin and the leaching process can run more effectively.

Conclusions

The leaching process using the Aachen Reactor as a pre-treatment method will help speed up the gold leaching kinetics reaction. This can occur due to an increase in Dissolved Oxygen levels up to 20-30 ppm in one Aachen run. As is the increased dissolved oxygen will cause thinning of the fluid film layer on associated minerals and impurities such as silica and sulfide, thereby maximizing the gold leaching process. This is reinforced by the results of the analysis of the percent extraction that has been carried out, that in the Base case sample the extraction percent was 84.90%, while in the Aachen Assisted sample *Leaching* (AAL) produces an extraction percentage of 92.02%

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