Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

Gold Extraction Process with Pre-Ox Sample and Aachen Assisted Leaching (AAL) Using Running Aachen

Dedi Pangestu[1*], Tri Wahyuningsih[1]
[1]Universitas Pembangunan Nasional "Veteran" Yogyakarta, Indonesia.
*Corresponding author: 116200007@student.upnyk.ac.id

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 reducing the effectiveness of gold leaching is that there are minerals that are still included in the associated minerals, therefore a pre-treatment process is needed to remove these associated minerals. The Aachen reactor will help 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 processes ore into metal using liquid media. Solvents that can be used in hydrometallurgical extraction include aqua regia and sodium metabisulfite solvents. Aqua regia used for and sodium metabisulfite used for Apart from the types of solvents mentioned above, cyanide solvents are also usually used, the process is called cyanidation. Cyanidation is for leaching gold. (Sarempa, 2015)

The gold leaching process is usually carried out using a cyanidation process. The selection of leaching methode involving cyanide is determined by the impact of cyanide on gold. Cyanide will produce the most thermodynamically stable reaction compared to using other reagents. When cyanide reacts with gold, it forms a highly stable Aurosyanide [Au (CN)2] bond.

In the cyanidation process, the gold ore is crushed and then ground to a size of 200 mesh using a ball mill. The ground ore is subjected to a cyanidation process by adding air and stirring in a tank for 48 hours. The final stage is the adsorption process using activated carbon. After binding with activated carbon, the following process is the combustion process. After that, borax is added and melted at a temperature of 1000 – 1200 °C.

The concentration of cyanide added is an important determinant in attaining gold recovery. The concentration value used usually ranges from 400 – 600 ppm. The more cyanide concentration added, the higher the recovery value. (Sabari, 2017)

In addition to addressing the dissolution procedure also considers the oxygen

Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

utilization. Oxygen is added to enchance the leaching process. Furthermore, the oxidizing agent, namely H_2O_2, is introduced into the solution. Experimental assessments of of H_2O_2 in solution Have yielded promising outcomes, demonstrating that gold can be effectively separated. (Sabari, 2017)

During the leaching of refractory gold ore, a treatment procedure is implemented to enhance the leaching kinetics of refractory ore and augment the recovery of gold. Various pre-treatment methodologies can be employed preceding the leaching stage. These pre-treatment techniques encompass roasting, biological methods, pressure oxidation, and Albion and Leachox processes.

The Leachox process comprises a sequence of both established and novel unit process steps, such as Imhoflit flotation, extremely fine milling of the flotation concentrate and subsequent partial sulfide oxidation followed by in-column leaching to replace conventional leaching which is susceptible to the atmosphere exposure. A high-shear reactor known as the Aachen Reactor is central to these processes. (Maelgwyn, 2009)

In this instance, an apparatus known as called the Aachen Reactor has been innovated to enchance the leaching kinetics of refractory ore by through augmentation of oxygen mass transfer within the slurry. The Aachen reactor is used as the initial stage in pre-oxidation preceding the cyanidation process. (P. Lotz, J. van der Merwe, 2015)

The leaching process using the Aachen reactor has been substantiated to enchance the leaching kinetics of free milled gold ore. Even with the availability of published outcomes related to its efficacy in free-milling gold ore, there is a discernible absence of subsequent publications detailing its application to refractory gold ore. (Fajri, 2022)

This study tried to analyze the pre-treatment process using the Aachen Reactor by varying the Pre- Ox sample with the Aachen Assisted Leaching (AAL) sample.

Research Methods

The primary aim of this study is to assess the efficiency of the leaching procedure facilitated by the Aachen Reactor. This assessment entails a comparative analysis of extraction outcomes between samples subjected to pre-oxidation and those undergoing Aachen Assissted Leaching (AAL).

The evaluation was conducted at the Metallurgical Laboratory of the tekMIRA Mineral and Coal Testing Center using a refractory gold sample possessing a gld content of 1.84 ppm subsequently which was then carried out a pre-treatment process employing the Aachen Reactor wa executed over a 4 hour pre-treatment process to obtain the Pre-Ox sample. The pre-treatment process parameters using the Aachen reactor can be seen in Table 1 as follows.

Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

Table 1. Operational Data for the Running Aachen Process

Pressure	1 bar
Temperature	30-40 °C
Cycle	12 *pass*
Feed Weight	20 kg
% *Solid*	40%
Rate NaCN	700 ppm
Rate DO	20-30 ppm
Time	180 menit per sample (*pre-ox*, *Aachen assisted leaching* (AAL)
Leaching Type	*Agitation Leaching*
pH	9-11

The leaching process employs a bottle roller is executed to replicate real-world. The leaching conditions to attain conservative results closely aligned with. Within the bottle roller procedure, a sampling process is systematically conducted for subsequent analysis employing the fire assay methode.

Following the completion of the fire assay analysis process, assay data is acquired. Subsequently an assessment of the percent extraction value was conducted. Determined by the application of the following formula:

$$\% \, Ext = \frac{Au\, Total\, Rem.\; in\; sample}{Au\, Total} \; x\; 100\%$$

Upon calculating the percent extraction results, a subsequent analytical process was undertaken involving a comparative assessment between the percent extraction outcomes of the pre-ox sample and the Aachen Assisted Leaching (AAL) sample.

Result and Discussion

1. Sieve Analysis Results

Sieve analysis is conducted to obtain grain size values aligning with the specified leaching parameters to be implemented. This process specifiacally aim to obtain P80 analysis. The outcomes of the sieve analysis are as follows.

Table 2. Data from SieveAnalysis Results

No.	Fraction	Weight
1.	+ 200	13.0 gr
2.	- 200 + 270	23.5 gr
3.	- 325 + 400	17.0 gr
4.	- 400	432.0 gr
Amount		485.5 gr

Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

From theassessment conducted, the following P80-400 mesh sieve analysis was obtained:

$$P80 = \frac{Bera\ lolos\ ayakan\ 400\ mesh}{Berat\ feed}\ x\ 100\%$$

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

$$P80 = 97.38\%$$

The analysis results indicate a P80 value of 97.38%. Signifying that the ore size has passed through the 400 mesh sieve. However, this value of 97.38% suggests an instance of overgrinding, leading to excessively fine ore particles, which means that during the leaching process the viscosity of the solution will become too high, causing the reagent to not leach the gold ore optimally.

2. NaCN Consumption Analysis

NaCN analysis is carried out through an argentometry titration methode. The titration methode involves using silver nitrate ($AgNO_3$) and Rhodanine indicator. The outcomes of the titrimetric analysis are presented in Table 3 and Table 4 as below.

Table 3. NaCN levels in Pre-Ox samples

Time (Hour)	Volume $AgNO_3$ (mL)	Volume Sample (mL)	Rate NaCN (ppm)
0	10	5	935.9
2	9	5	842.31
4	7.85	5	734.68
8	6.6	5	617.69
24	5.1	5	477.31
48	3.1	5	290.13

Table 4. NaCN Levels in Aachen Assisted Leaching (AAL)

Time (Hour)	Volume $AgNO_3$ (mL)	Volume Sample (mL)	Rate NaCN (ppm)
0	10	5	935.9
2	9	5	842.31
4	79	5	739.36

Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

8	6.7	5	627.05
24	5.15	5	481.99
48	3.15	5	294.81

The obtain results reveal that the final cyanide content in the Pre-Ox sample was 290.13 ppm, where as in the Aachen Assisted Leaching (AAL) sample, it amounted to 294.81 ppm. This discrepancy suggest that the cyanide consumption in the Pre-Ox sample surpasses that in the Aachen Assisted Leaching (AAL) sample. This can be attributed to implementing the Aachen running process in the AAL sample , leading to enhanced kinetics in the leaching process compared to the Pre-Ox sample.

3. Analysis Of Extraction Percentage

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

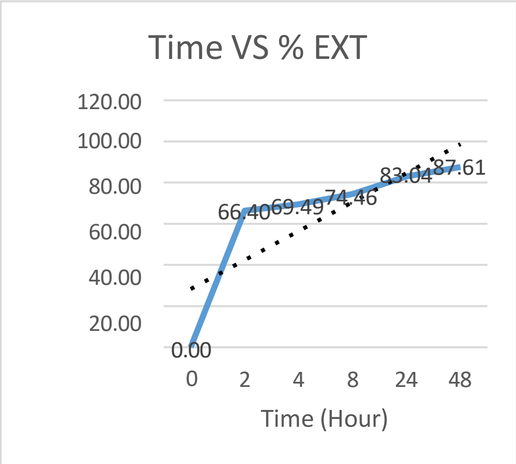

Figure 1. Percentage of gold extraction in Pre-Oxidation sample as a function of residence time after 48 hours

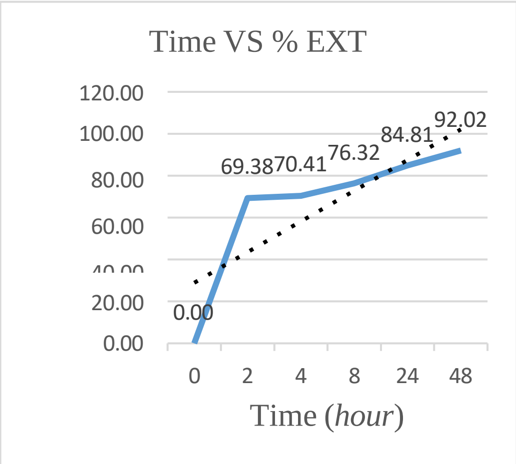

Figure 2. Percentage of gold extraction in AAL sample as a function of residence time after 48 hours

The graphical representation illustrates that the Pre-Ox sample yields an extraction percentage of 87.61%, whereas the Aachen Assisted Leaching (AAL) sample attains a higher extraction percentage of 92.02%. Consequently, it can be concluded from the AAL samples that employing the Aachen Reactor in the leaching process enchances the extraction efficiency compare to the conventional process without Aachen pre-treatment. This enchancement is attributed to heightened kinetics of the leaching process. The elevation of Dissolve Oxygen levels to 20-30 ppm within the AAL method induced thinning of the fluid film layer on associated minerals and impurities such as sulfide and silica facilitating a more efficient leaching process.

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 Dissolve Oxygen levels up to 20-30 ppm in one Aachen run. The increased presence of Dissolve 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 the Pre-Ox sample produces an extraction percent of 87.67%, while the Aachen Assisted Leaching (AAL) sample produces an extraction percent of 92.02%.

Acknowledgement

The author would like to thank the Mineral Processing and Refining Testing Division, especially the Kalimasada Team, for the opportunity to provide guidance and direction in the research entitled ‘Gold Extraction Process with Pre-Ox Sample and Aachen Assisted Leaching (Aal) Using Running Aachen’. We would like to thank the Management and Employees of BBPMB tekMIRA Bandung West Java who have provided the opportunity to use company facilities in completing this research.

References

Fajri, Dwi Latifatul. (2022). 6 Daerah Penghasil Tambang Emas Terbesar di Indonesia

Jimansyah. (2016). *Ekstraksi Logam Emas dan Perak dari Larutan Bijih dengan Sistem Penyerapan Menggunaan Karbon Aktif Batubara Sub-Bituminus (Coalite)*. Universitas Islam Bandung: Jawa Barat

Maelgwyn, (2009). Imhoflot Pneumatic Flotation Technology

Nastiti, Hani. (2022). Pengertian Emas, Jenis, Manfaat, dan Cara Membedakan Emas Asli.

Prokhorov, Konstantin. (2018). *Influence Of Agitation Leaching Conditions to The Behavior Of Gold in Solution*. Mining Institute of Far Branch of Russin Academy Of Sciences: Russia

Journal of Metallurgical Engineering and Processing Technology, Vol. 4, No. 2
February, 2024
P-ISSN: 2723-6854, E-ISSN: 2798-1037, page 60-66
DOI: https://doi.org/10.31315/jmept

P. Lotz, J. van der Merwe dkk. (2015) Aachen Reactors^{TM}, a proven system to realize hidden economic potentials, *The Southern African Institute of Mining and Metallurgy Word Gold Conference 2015*.

Reza, Muhammad. (2022). *Kajian Teknis Pengolahan Emas Menggunakan Metode Heap Leaching di PT DEF Kecamatan Simpenan, Kabupaten Sukabumi, Provinsi Jawa Barat*. Bandung Conference Series Mining Engineering: Jawa Barat

Riandini, Ananda. (2023) ANALISISI KESTABILAN *HEAP LEACH PAD* BERDASARKAN JUMLAH MATERIAL YANG DAPAT DITAMPUNG PADA PROJEK TAMBANG XX, JAWA BARAT. Universitas Islam Negeri Syarif Hidayatullah: Jakarta

Rindu, Maharani. (20170. *Perbandingan Hasil Logam Emas pada Pengolahan Bijih Emas dengan Metode Sianida (Heap Leaching) Berdasarkan Perbedaan Ukuran Butir Umpan*. UPN “Veteran” Yogyakarta

Sabara, Zakir, dkk. (2017). EKSTRAKSI EMAS DARI BIJI EMAS DENGAN SIANIDA DAN OKSIGEN DENGAN METODE EKSTRAKSI PADAT-CAIR. Journal Of Chemical Process Engineering. Vol. 02, No. 02. Universitas Muslim Indonesia: Makassar

Sarempa, apriani dkk. (2017) OPTIMASI RECOVERY EMAS DAN PERAK DENGAN SIANIDASI PADA DEPOSIT BIJIH EMAS KADAR RENDAH DI PT. NUSA HALMAHERA MINERAL DAERAH GOSOWONG KABUPATEN HALMAHERA UTARA, PROVINSI MALUKU UTARA

Suci, Ferlia. (2016). *Efektifitas Larutan Leaching Tiourea dan Tiosulfat dengan Bantuan Oksidator dalam Proses Ekstraksi Emas (Au).*Universitas Jember: Jawa Timur

Sudesno, Nurhakim. (2019). *Peningkatan Recovery Emas di Carbon in Leach Plant PT. Antam tbk. Unit Bisnis Pertambangan Emas Pongkor, Jawa Barat (Studi Kasus Kadar Bijih 3.5 – 4.5 gp di Plant 1)*. PROSDIDING TPT XXVIII PERHAPI 2019

Sulistiyono, Eko. (2016). *Potensi Pemanfaatan Limbah Pengolahan Emas Proses Heap Leaching*. Semninar Nasional Sains dan Teknologi 2016. Universitas Muhammadiyah Jakarta: Jakarta

S. Orgul. U. Atalay. (2002). *Reaction Chemistry Of Gold Leaching in Thiourea Solution For A Turkish Gold Ore*. Hydrometallurgy, Vol. 67. No. 71-77. Elsevier

Tangkuman, Herling. (2008). *Pengaruh Konsentrasi Sianida terhadap Produksi Emas*. Universitas Sam Ratulangi: Sulawesi Utara

Tang, Yuan. (2020). *Enhancement Of Gold Agitation Leaching by HPGR Comminution Via Microstructural Modification Of Gold Ore Particles*. Vol 159. Minerals Engineering. Elsevier