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The Effect of Aloe Vera Bioreagent as a Frother and Collector in the Gold Ore Flotation Process on Increasing Grade and Recovery

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Abstract

One of the concentration processes in processing sulfide gold ore is the flotation technique which takes advantage of differences in mineral surface properties by adding chemical reagents. The addition of chemical reagents to the flotation process can cause environmental problems. Therefore, efforts are needed to replace chemical reagents with more environmentally friendly materials. In this research, an attempt was made to replace chemical reagents with a commonly found plant extract, namely aloe vera, as a bioreagent. Bioflotation experiments on a laboratory scale were carried out using a Denver flotation cell with an aloe vera reagent as a frother. This gold mineral bioflotation experiment was carried out on a 150 mesh size fraction. The results of increasing concentrate levels by flotation indicate that the aloe vera reagent as a frother is able to produce biosurfactants which replace chemical reagents as a more environmentally friendly biofrother and biocollector. This can be concluded based on flotation experiment data with bioreagent which has been tested showing an Au content value of 10.09 and a recovery of 96.15%, while flotation using chemical reagents shows an Au content value of 10.50 and a recovery of 95.96%. So the use of aloe vera as an environmentally friendly bioreagent in the flotation process releasing low sulfidation gold is more effective than the use of chemical reagents because it is indicated that there is a biosurfactant content in aloe vera.

Keywords: Flotation, Bioreagent, Grade, Recovery, Biosurfactant, Mineral Processing

Introduction

Indonesia is an archipelagic country with considerable natural wealth. One of the assets that is quite highlighted is related to mining. One of the activities in an effort to increase the added value of minerals is by concentrating on mineral processing. One concentration method that is often used is flotation.

Gold ore processing technologies commonly used in the gold processing industry are cyanidation and amalgamation. This amalgamation method is quite easy to do because it is more practical, but the waste produced is not environmentally friendly. On the other hand, the cyanidation process is more complex and also has negative impacts on the environment. These two methods become less profitable if used to process low

grade gold and silver ore. For this reason, technology to increase the gold and silver content (ore beneficiation) is needed as an effort to prepare gold and silver concentrates that are ready for further processing, which is usually called a

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concentration process. Several factors that cause the concentration of gold ore to be carried out before proceeding with other processes such as cyanidation, amalgamation and smelting include low grade and grain size. Concentration is one of the important processes in a gold processing chain. Gravity concentration and flotation are widely used in gold processing (Wahyudi, 2004; Ferdana et al., 2018; Prasetya et al., 2018).

The flotation process is the most popular method in the field of mineral processing and has been widely applied in industry, especially in processing sulfide minerals (Otsuki A., 2016). The working principle of flotation is to separate a mineral from its ore by floating the mineral so that it can be separated from other minerals. There are several factors and parameters that determine the success of the flotation process. In order for flotation separation to occur, several things need to be considered, especially in the flotation cell, air must be injected to attach certain mineral grains and the addition of important reagents as feed modifying agents and is useful for adjusting the effective flotation environment. This flotation process can only be carried out for fine sized mineral particles. (Marsden & House, 1999).

Further development continues to be carried out to obtain methods and/or reagents more effective and selective flotation for complex and high grade ore processing low. Along with this development, there are demands for processing which is environmentally friendly is also a reference in selecting methods and reagents appropriate, so that the use of microorganisms as helpful agents develops mineral processing processes which are also called biotechnology (Pecina E. T., et al., 2009., Fazaelipoor et al., 2009). A very important part in the flotation process is the Reagent. The flotation process can take place optimally depending on the reagents used. The use of reagents also varies depending on the mineral you want to obtain. The use of this flotation reagent creates a flotation thermodynamic scheme where the scheme is between air bubbles, hydrophobic particles and hydrophilic particles. For the flotation scheme as shown in Figure 1.

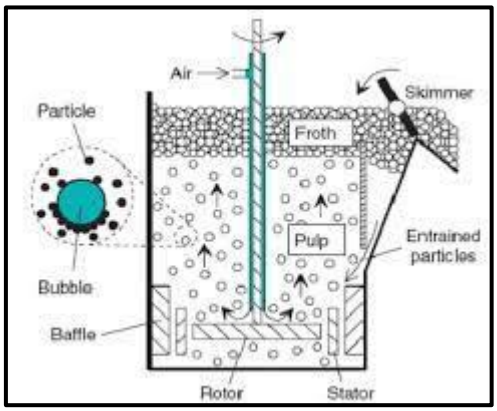

Figure 1. Flotation Scheme

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The use of chemical reagents has many negative impacts and is a major environmental problem. Therefore, currently biotechnology is being developed in various industries in the world, especially in the fields of biomining and biobeneficiation. (Axel Schippers, etc, 2013).

One interesting topic that has been widely discussed and developed is bioflotation in the last few decades. The aim of using this bioflotation method is to carry out environmentally friendly mineral processing. (Erlina Yustanti, etc, 2018). Bioflotation is the process of separating valuable minerals from mineral gangue using bioflotation reagents, such as biosurfactants. (Nelly Amelia, et al, 2021)

The application of iotechnology in mineral processing has opened up great possibilities to produce a cleaner concentrate that has higher grade and recovery acceptable. Bioflotation is a process of processing minerals to separate them valuable minerals from mineral impurities by exploiting the surface properties of the mineral by using bacteria as a flotation reagent that facilitates the separation of minerals selectively (Vasanthakumar B., et al., 2012). Use of bioreagents as collectors brings out several aspects of the interface of mutual biological and geological materials interact, namely the physicochemical properties of mineral surfaces, such as atomic structure and electronics, charge/potential, charge properties, acid-base properties and hydrophobicity of minerals (Vasanthakumar Be, et al., 2012).

Several studies show that the use of biosurfactants is a more environmentally friendly alternative to flotation reagents and continues to develop today. One study has also used biosurfactants from the bacteria Pseudoclavibacter sp. to increase the hydrophobicity of chalcopyrite so that it can separate chalcopyrite from sulfide seeds. (Sanwani, et al, 2017).

In the aloe vera plant there is an active component, namely stereoid saponin ($C_{27}H_{42}O_3$). Stereoid saponin which, when mixed with water and shaken, produces froth or foam. Therefore, saponin acts as a natural surfactant, namely as a collector and frother. The use of aloe vera gel as a surfactant is because aloe vera gel is environmentally friendly and the waste can be broken down by microorganisms. (Juhara Depipa, et al., 2021)

Apart from that, what is commonly used is the use of reagents made from organic materials, namely from aloe vera plant extracts as a substitute for chemical frother reagents. Therefore, based on this theory, research was carried out on the flotation process using reagents from aloe vera plant extracts as a substitute for frother reagents.

Research Methods

This research was carried out by testing gold ore samples from PT Antam in the laboratory. This test was carried out using the Denver type flotation method with sample preparation previously carried out to obtain a particle distribution size of up to 150 mesh.

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The data needed in this research is primary data from laboratory testing results. The comparative variables used in this research are the collector reagent using xylene, and the frother reagent using pine oil which is a chemical so that we can compare the effectiveness of reagents from natural and chemical materials in separating valuable minerals and impurities. Meanwhile, the bioreagent used in this experiment was aloe vera which was used as a frother. The ore sample used in this research was a gold ore sample which was first carried out by XRD and AAS testing to determine the initial grade of the ore sample used.

Samples that are still rough in size are crushed using a jaw crusher with an open setting of 0.5 and a close setting of 0.3. Then the crushing product will be ground using a rod mill. Next, the sample will be sifted using a hanging sieve until an ore size of -150 mesh to 600 grams is obtained.

The prepared samples will be divided into two to represent flotation schemes with chemical reagents and flotation schemes with natural reagents. Sample 1, weighing 300 grams, underwent flotation for 15 minutes with a dose of xylene as a collector of 5 mL and a dose of pine oil as a frother of 5 mL. Sample 2, weighing 300 grams, underwent flotation for 15 minutes with a dose of xylene as a collector of 5 mL and a dose of aloe vera extract as a frother of 30 mL.

Separation The concentrate is then separated by transferring it to a cup. The concentrate is at the top of the flotation cell (overflow) and the tailings are at the bottom where it also settles (underflow). After being transferred, the next step is to dry the concentrate and tailings obtained using an oven to remove the water content.

Result and Discussion

Based on visual observations in flotation testing, more bubbles or froth are produced in bioreagent samples compared to froth produced in chemical samples. Froth on chemical reagent samples and bioreagent samples. So, it can be hypothesized that bioreagents are more effective in the flotation process, but further review is carried out to calculate the levels produced from the two sample concentrates so that more precise conclusions and recommendations can be obtained (figure 2 and 3).

Both samples were subjected to AAS testing to obtain Au levels to calculate the recovery and weight of Au obtained from the flotation results for each sample. The AAS test results can be seen in tables 1 and 2.

On the samples from the flotation test, to determine the elements contained in the ore, XRD testing was carried out, with the test results of most of the ore samples containing 98.81% quartz and Enstatite and syn in the form of $MgSiO_3$ which can be seen based on the following graph (figure 4).

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Figure 2. Froth results from flotation of chemical reagent samples (xylene)

Figure 3. Froth results from flotation of aloe vera samples

Table 1. AAS Test Results for Chemical Reagent Samples

	Total Weight (gr)	Au Grade (ppm)
Feed (F)	300	4,00
Concentrate (C)	128,6	10,09
Tailing (T)	50,7	1,80

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Table 2. AAS Test Results for Aloe Vera Samples

	Total Weight (gr)	Au Grade (ppm)
Feed (F)	300	4,00
Concentrate (C)	230,8	10,50
Tailing (T)	28,5	0,91

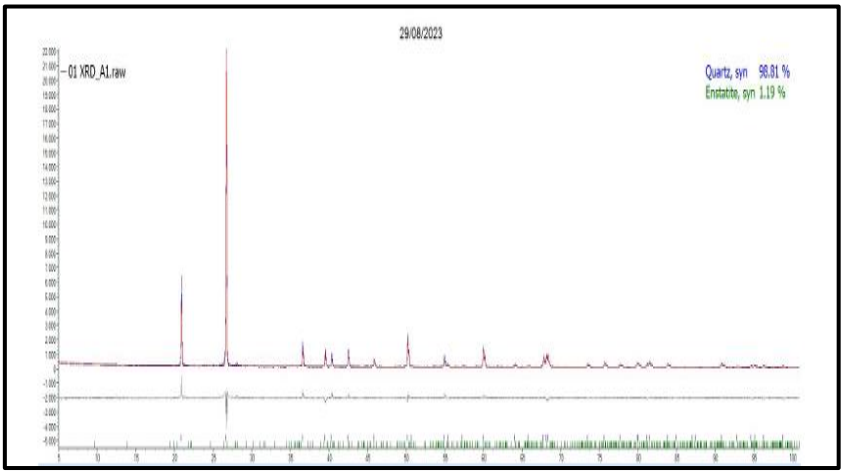

Figure 4. XRD Test Results

A. Calculation

Recovery

- Chemical Reagent Samples

$$\% R = \frac{C.c}{F.f} \times 100\%$$

$$\% R = \frac{128{,}6 \,.\, 10{,}09}{300 \,.\, 4{,}00} \times 100\%$$

% R = 95,96 %

- Aloe Vera Reagent Sample

$$\% R = \frac{C.c}{F.f} \times 100\%$$

$$\% R = \frac{230{,}8 \,.\, 10{,}50}{300 \,.\, 4{,}00} \times 100\%$$

% R = 96,15 %

B. Data Analysis

Samples that have undergone flotation are subjected to AAS (Atomic Absobtion Spectrophotometer) testing to determine the metal content and levels in the feed, concentrate and tailings of each sample. Based on the test results, the bioreagent sample

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had a higher Au content, namely 10.50 ppm, compared to the chemical reagent sample, namely 10.09 ppm.

The Au content value in each sample is also used to calculate the recovery or recovery of gold obtained from the flotation process. The bioreagent sample has a recovery value of 96.15%, which is higher than the recovery value of chemical reagents, namely 95.96%.

The use of bioreagent is considered more effective in increasing concentrate levels and increasing recovery from flotation results. This can be caused by the content of aloe vera extract which is used as a bioreagent which contains biosurfactants. The biosurfactant produced in aloe vera extract can increase the hydrophobicity of the gold ore used so that it can separate gold minerals from impurities.

Conclusions

From the research conducted, it can be concluded that the use of aloe vera as an environmentally friendly bioreagent in the low sulfidation gold ore flotation process can be carried out more effectively compared to the use of chemical reagents because the help of the biosurfactant content is indicated by the large amount of foam produced in the aloe vera extract. The ability of aloe vera to oxidize sulfur is able to produce biosurfactants which replace chemical reagents as a biofrother as well as a biocollector.

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