



LEACHING BASALT ROCK USING AVERRHOA BILIMBI EXTRACT

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ABSTRACT

This research was conducted to determine the effect of solid/liquid ratio (s/v), temperature, and stirring Speed on per cent extraction of iron using oxalic acid from Averrhoa bilimbi. The variation of the solid/liquid (s/v) is 10%, 15% and 20 (%), the temperature variations used are 30, 60 and 90 °C, while the variation of the stirring Speed uses 200, 400 and 600 rpm. Some basalt rock samples are put into the reactor and leached using an oxalic acid solution from Averrhoa bilimbi. Within a certain period of time, the filtrate was taken and analyzed for Fe content using Atomic Absorption Spectroscopy. The residue was analyzed using XRF and XRD. The results showed that the highest percentage of iron extraction for basalt rock leaching experiments using oxalic acid from Averrhoa bilimbi was achieved at a temperature of 90°C, 10% of solid/liquid ratio, 400 rpm stirring speed and 120 minutes of leaching time with a percent iron extraction of 65.90%. XRD analysis results showed that the compounds formed in the residual leaching were Anorthite, Ferrosilite, Cristobalite and quartz low.

Keywords: Basalt rock, Averrhoa bilimbi, Solid percentage, temperature, leaching

INTRODUCTION

Basalt rock reserves in Indonesia reach more than 1 billion tons. Widespread from Sumatra, Java, Kalimantan, Sulawesi to Papua. In Lampung Province, basalt rocks can be found in East Lampung, scattered in several areas including Mataram Baru, Jabung, Bumi Agung, Marga Tiga, Sukadana, and Labuhan Maringgai. The total resources in the area are more than 10 million m³ [1]. So far, basalt is only used as a foundation stone for building houses. Along with the development of technology and science, basalt rock can be processed into

basalt fibers [2,3], basalt castings [4], and ceramics [5,6]. The basis for the determination can be processed into basalt fiber, foundry basalt or basalt rock by calculating the acidity modulus (Ma) or acidity coefficient (Ka) and or metal silicate index (Nx) [7]. In the basal smelting process, the viscosity value is related to the melting process. The content of iron and aluminum affects the basal smelting process. Elemental iron affects the crystallization process, viscosity, and resistance to acid. At the same time, the aluminum element affects the water resistance [8].

Elements incorporated into gabbro–basalt raw materials influence these properties in different ways. Thus, alkaline earth metals reduce the melting temperature. Aluminum (within a specific concentration interval), silicon, and titanium increase the viscosity of a melt and decrease its crystallization ability. Magnesium, calcium, manganese, sodium, and potassium reduce the viscosity to varying degrees. Iron also decreases the viscosity and expands the casting range of a melt. At the same time, low ferrous castings manufactured from gabbro–basalts have a high compression strength. [9]

Basalt is also used in the foundry process for the manufacture of tiles and slabs for architectural applications, and in tubing. Cast basalt has been used in industrial applications because of its high abrasion resistance, the properties of basalt fibers resemble those of glass fibres. However, basalt fiber has the advantage of being workable at higher temperatures than glass fiber, and is more stable in highly alkaline liquids. CBF production is a fledgling industry, with many leading manufacturing companies less than 20 years old and technological advances rapidly [10,11,12,13]

The high iron content in basalt rock needs to be reduced to obtain an appropriate acidity coefficient (K_a). One way is by leaching the basalt rock. Leaching is a solid-liquid extraction process. Liquid solid extraction is separating the solute contained in a solid by bringing the solid into contact with the solvent. The solid and the solvent mix, then the solute dissolves in the solvent [14]. Several researchers have leached basalt stones

using orthoboric acid [15], hydrochloric acid, and oxalic acid [16], as well as leaching using bacteria[17]. The leaching process in this study used an oxalic acid reagent derived from *Averrhoa bilimbi*. Unfortunately, *Averrhoa bilimbi* is very limited in use, so much of it is left to waste. This research will discuss the effect of solid percent, temperature, and stirring Speed in basalt rock leaching using oxalic acid from *Averrhoa bilimbi* as the leaching reagent. Basalt rock characterization before leaching was carried out using XRF and XRD, and the leaching solution was analyzed for Fe elements using AAS. At the same time, the residues of the research results were characterized using XRF and XRD. were characterized using XRF and XRD.

METHODS

Material

The material used in this study was basalt rock from East Lampung, with the results of the XRF analysis shown in Table 1.

Table 1. Results of analysis of basalt stones in East Lampung using X-Ray Fluorescence (Panalytical Epsilon 3 XLE)

No	Compound	Percentage (%)
1	Na ₂ O	1.806
2	Al ₂ O ₃	17.345
3	SiO ₂	47.588
4	K ₂ O	0.684
5	CaO	11.105
6	Fe ₂ O ₃	15.957
7	MnO	0.27
8	Cr ₂ O ₃	0.102
9	Ag ₂ O	0.137

Extraction of basalt rock

The experimental stage was initiated by reducing the size of the basalt rock using a jaw crusher and milling to obtain a size of 74 microns. The basalt powder was then

dried at a temperature of 105-110°C for 2 hours. Finally, basalt powder before leaching was analyzed using XRF and XRD.

The next step is the extraction of oxalic acid from *Averrhoa bilimbi*. Several *Averrhoa bilimbi* were blended and filtered until a solution of starfruit was obtained. Then the NaOH solution was added to the *Averrhoa bilimbi* solution and heated at 90°C for 150 minutes. Then CaCl₂ 1 N is added to form a white precipitate. The solution is filtered. The precipitate formed is dried in an oven and then added with sulfuric acid to get the oxalic acid filtrate.

The last stage is the leaching process. Leaching was carried out by varying the solid/liquid ratio (s/v), namely 10%, 15%, and 20%, temperature variations of 60 °C and 90°C and stirring Speed of 200 rpm, 400 rpm, and 600 rpm for 2 hours. Every particular time the leaching result of the filtrate was taken and analyzed using AAS Shimadzu AA-7000 to determine the dissolved metal. While the residue was analyzed using XRF and XRD.

RESULTS AND DISCUSSION

Effect of Solid/liquid ratio (s/v) on the percent of Iron extraction in basalt leaching

In this leaching experiment, one of the variables studied was the solid/liquid ratio (s/v), where the solid/liquid ratio (s/v) was varied in the range of 10%, 15%, and 20%. The fixed conditions of the experiment were a temperature of 30°C and a stirring speed of 400 rpm. The experimental results on the effect of solid/liquid ratio (s/v) on percent extraction of iron in basalt leaching are shown in Figure 1.

From the experimental results shown in Figure 1, it can be seen that the greater the solid/liquid ratio (s/v), the smaller the percent extraction of iron dissolved in the leachate solution. For example, in the experiment with 20 solid/liquid ratio (s/v) percent, it was seen that the percent iron extraction obtained reached 44%. However, when the experiment was carried out by reducing the solid percent to 15 percent, an increase in the percent extraction of Fe was 56% at 120 minutes. This is because, at a higher solid percent, the slurry density is higher. Therefore, the mobility of oxalate ions will decrease, and transport of Fe²⁺ ions to in bulk of the solution becomes slow. Therefore, the decrease in solid percent will increase the ratio of the leachate solution concentration to the weight of the basalt rock provided. In general, the higher the reagent concentration, the faster the reaction rate will be so that the iron extraction obtained will be higher[15].

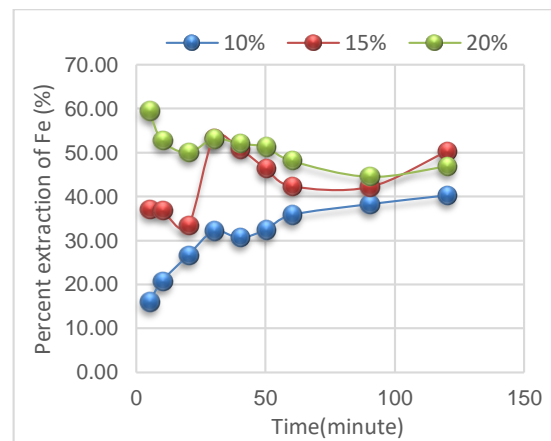


Figure 1. Effect of solid/liquid ratio (s/v) on basalt ore leaching on percent iron extraction

Effect of temperature on the percent of iron extraction in basalt leaching

The percentage of Fe extraction as a function of time at various leaching temperatures in this study is shown in Figure 2. In

general, temperature greatly affects the reaction rate. According to Arrhenius, an increase in temperature will increase the rate of the leaching reaction so that with the same leaching time with a higher temperature, the percentage of metal extraction will be higher.

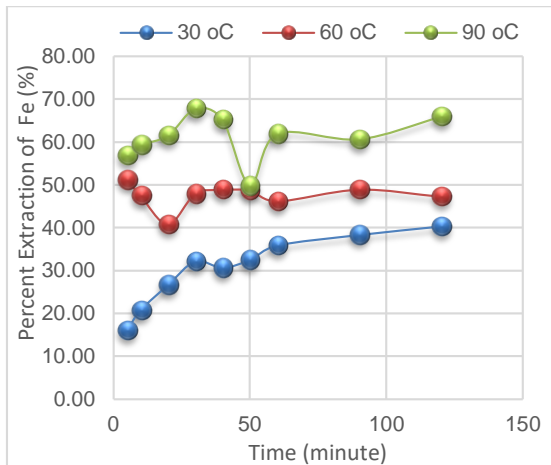


Figure 2. Effect of solid/liquid ratio (s/v) on basalt ore leaching on percent iron extraction

At this higher temperature, the activation energy of the Fe dissolving process will decrease so that in the same leaching time, more Fe can be dissolved. The experimental results show that the temperature increase from 30°C to 60°C only slightly increases the percent extraction of Fe, which is about 2% after 120 minutes. However, a significant increase occurred from 60°C to 90°C. The extraction percentage that can be achieved at this temperature is 65%. Because high temperatures will increase the diffusion of oxalate ion species to be higher, in addition, at high temperatures, it will cause the solution to become increasingly dilute. Thus the mobilization of Fe^{2+} ions in the bulk of the solution becomes faster[13].

Effect of Stirring Speed on the Percent of Iron extraction in basalt leaching

In addition to variations in solid/liquid ratio (s/v) and temperature, this experiment studied the effect of stirring Speed on percent extraction of Fe. The experimental fixed conditions were solid/liquid ratio (s/v) 10%, temperature 90°C. The experiment results on the effect of stirring Speed on percent extraction of iron in basalt leaching are shown in Figure 3.

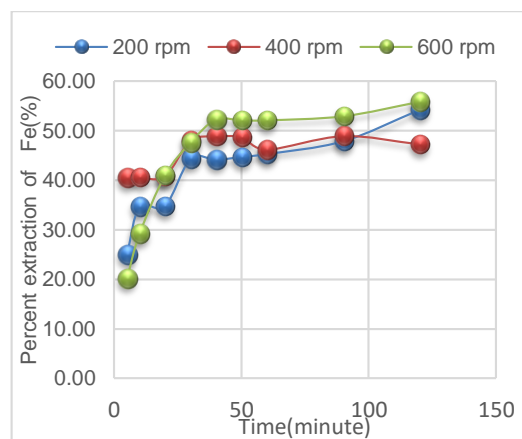


Figure 3. Effect of stirring Speed on basalt ore leaching on percent iron extraction

Figure 3 shows the leaching process with various stirring speeds, 200 rpm, 400 rpm, and 600 rpm. At a stirring speed of 400 rpm, the iron element dissolved in the reagent was the highest at 56% when taking the sample in the 120th minute. The stirring Speed affected the physical contact between the sample surface and the leachate solution: the faster the stirring causes, the more frequent contact with the ore to dissolve Fe metal[11].

XRF and XRD analysis of basalt before and after leaching using oxalic acid from starfruit

The residue that produced the highest percent extraction was analyzed using XRF and XRD. The results of the

analysis of compound content can be shown in Table 2.

Table 2. XRF results of basalt rock leaching residue using starfruit extract

No.	Compound	Before leaching (%)	After leaching (%)
1	Na ₂ O	1.806	0
2	Al ₂ O ₃	17.345	14.947
3	SiO ₂	47.588	46.437
4	K ₂ O	0.684	0.800
5	CaO	11.105	12.630
6	Fe ₂ O ₃	15.953	8.180
7	Ag ₂ O	0.137	0
8	MgO	3.107	1.536
9	TiO ₂	1.572	1.592

Based on Table 2, the highest oxide compounds are SiO₂ of 46.437%, Fe₂O₃ of 8.180%, CaO of 12.630%, Al₂O₃ of 14.947%. Other compounds are present in very small amounts in ppm. From the data above, it can be seen that the iron content has decreased by almost half. Based on that data, the acidity coefficient (Ka) can also be calculated with the following calculations [18]

$$Ka = \frac{(SiO_2 + Al_2O_3 + TiO_2)}{(CaO + MgO + FeO + Fe_2O_3 + Na_2O + K_2O)} \dots\dots(1)$$

The stoichiometric FeO formed was calculated to obtain 2.863 so that the coefficient of acidity (Ka) in this experiment was 2.42. Meanwhile, to produce basalt casting, the required Ka value is in the range of 1.5-1.8[18].

The results of XRD analysis on basalt powder before leaching and residue after leaching for 120 minutes at 90°C are shown in Figure 4.

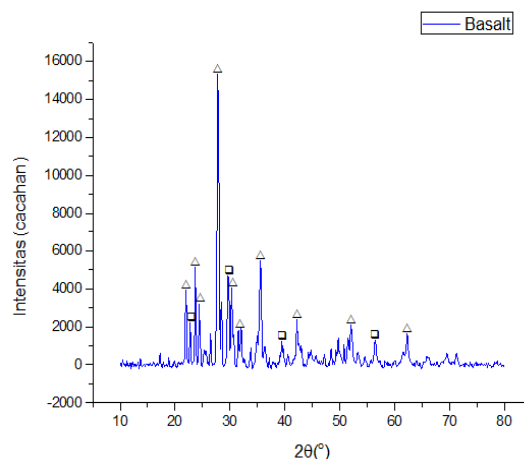


Figure 4. XRD diffractogram pattern of basalt sample before leaching (symbol: Δ =Anorthite, \square =Iron Silicate)

Based on Figure 4, the characteristics of the basalt sample before leaching are dominated by the peaks of the phases, namely the Anorthite and Iron Silicate phases. Figure 5 shows that the diffractogram pattern is dominated by phase peaks such as Anorthite, Ferrosilite, Cristobalite, and low quart according to XRF analysis results showing a decrease in iron content so that SiO₂ compounds appear at their peak after leaching[17].

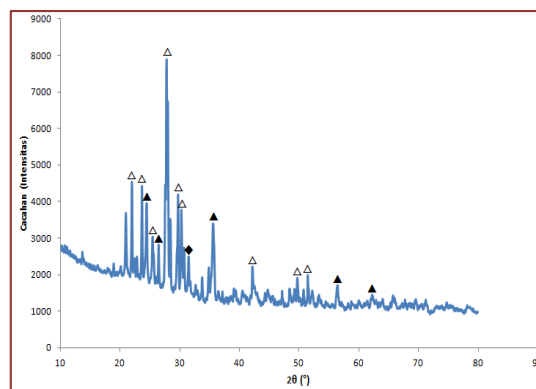


Figure 5. XRD pattern of basalt sample after leaching temperature variation of 90°C (symbol: Δ = Anorthite, \bullet = Anhydrite, \square =Quartz low, \diamond =Ferrosilite, ∇ =Cristobalite)

CONCLUSION

Based on the results of the experiment, analysis, and discussion that have been carried out, Iron extraction from East Lampung basalt stones can be done by leaching using oxalic acid made from Averrhoa bilimbi. The highest percentage of iron extraction for basalt rock leaching experiments using oxalic acid from Averrhoa bilimbi was achieved at a temperature of 90°C, 10% solid percent, a stirring speed of 400 rpm, a leaching time of 120 minutes with a percent iron extraction of 65.90%.- Acidity coefficient (Ka) in the basalt rock leaching experiment using oxalic acid from Averrhoa bilimbi was obtained 2.42. XRD analysis results show that the compounds formed in the leach residue are different from Anorthite, Ferrosilite, Cristobalite, and low quartz

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