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EFFECT OF THE UTILIZATION OF CHICKEN EGG SHELL WASTE AS A LIME MIXTURE ON PH PARAMETERS IN MINE ACID WATER

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ABSTRACT

Acid mine drainage (AMD) is a significant environmental impact of coal mining, particularly in open-pit mining systems. To neutralize AMD acidity, the commonly used method involves adding quicklime (CaO). This study aims to evaluate the effectiveness of using eggshells, which contain calcium carbonate (CaCO3), as an additive to quicklime in AMD treatment. Experiments were conducted with varying doses of ground and calcined eggshells at 150°C and 300°C. The results indicate that calcining eggshells at higher temperatures enhances their effectiveness in increasing AMD pH. Without calcination, the pH increased by 1.87%, while calcination at 150°C and 300°C resulted in pH increases of 1.87% and 8.6%, respectively. However, excessive doses of eggshells may decrease pH. Therefore, using calcined eggshells as an additive to quicklime offers a more economical and environmentally friendly solution for AMD treatment.

KEYWORDS *Acid, Mine, Egg shell*

INTRODUCTION

Mine acid water (AAT) is an environmental impact that is often found in the coal mining industry from the past to the present. Coal mining activities cause sulfide minerals such as pyrite (FeS2) to be exposed and eventually react with water and air. The reaction between water and minerals will produce acidic wastewater (Acid Mine Drainage/Acid Rock Drainage) (Faisal & Syarifudin, 2014).

The coal mining location carried out in this study is in South Sumatra. The mining system used at the location is an open pit mining system (surface mining).

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The mining method produces mine acid water (AAT). Mine acid water (AAT), which is formed when water passes through a layer of rock containing sulfide minerals, can result in a decrease in the pH of the water and will bind to the heavy metals it passes through. (picture 1) Efforts to neutralize mine acid water can be carried out in various ways through chemical and biological mechanisms (Sani, 2015).

Figure 1. Mine Acid Water at the Research Site

AAT management requires an effective strategy to neutralize water acidity. The process of treating mine acid water or AAT can be carried out by 2 methods, namely active and passive. One of the most important ways to treat mine acid water with an active method is to add lime. Tohor lime or commonly called (CaO) is a result of burning raw lime. The use of tahor lime has been widely applied in various companies and has been tested to be effective in neutralizing the pH of mine acid water. (Onwardana, et al., 2020)

The research on the neutralization of mine acid water was carried out by taking samples of acid water from the location of the mining front in one of the companies located in South Sumatra. Based on observations in the field, an average pH value of 2.8 was obtained. The PH value is less than the environmental quality standard (BML) based on the Decree of the Minister of Environment Number 1. 113 of 2003 concerning Wastewater Quality Standards for Coal Mining Businesses and or Activities. Based on previous research, it shows that extinguished lime is efficient in raising the pH of water. In recent years, research has explored more environmentally friendly and economical alternatives to treat AAT.

The increase in the population in Indonesia has made the need for foodstuffs also increase, one of which is eggs. The increase in egg consumption will also have an impact on the increase in the number of eggshells that will be discarded. Therefore, a large amount of eggshells will be disposed of as waste. So it is necessary to find an event to turn egg shells into valuable goods to overcome environmental challenges. (Anthony M. Muliwaa, et al. 2018)

Chicken egg shell waste, which contains calcium carbonate (CaCO3) is approximately 94%, then magnesium carbonate (MgCO3) and calcium phosphate (Ca3(PO4)2) are 1% each and the last is organic matter at 4% (Rivera, et al., 1999). Chicken egg shells are a waste from the food industry that has the potential to be used as a lime mixture in handling AAT.

The purpose of this study is to obtain the right mixed dose of lime and eggshell in the process of treating mine acid water so that it can increase the mine acid water to be in accordance with the quality standards of coal mining wastewater. It is hoped that by getting the right dose of the composition of lime and eggshells can be applied in the field so that it can reduce the cost of treating mine acid water.

RESEARCH METHODS

The research conducted was an experimental research (Experimental Research) with the experiment of adding various variations in dosage mixtures of eggshells and lime. Samples of mine acid water were obtained from the mining front at a coal mining company located in South Sumatra. Eggshell waste is obtained from food business waste which is then prepared so that the eggshells are ready to be used as a mixture with lime. The eggshells are mashed and then sifted with a sieve with a size of 100 mesh/flour size (0.149 mm) (picture 2). After that, heating/calcination is carried out with temperatures of 150 0 C and 300 0 C for 1 hour. After calcination, XRF testing was carried out in the BRIN Batan laboratory.

Preparation and testing at the Yogyakarta veteran UPN laboratory. The data needed by the researcher consists of primary data collected by making observations or measurements directly in the field and the results of the test. Experiments are carried out in the laboratory using a pH meter to measure pH

Figure 2. Eggshell Sifting Activity in Preparation

In this study, the researcher used a 100 ml sample of mine acid water with the addition of a mixture of eggshells and lime as many as 6 variations of the dosage mixture, namely constant egg cang, 0.05 grams and lime 0.05; 0,1; 0,2; 0,4; 0,8; 1 gr and the composition is the opposite with constant lime. Laboratory testing with titration procedures. The titration procedure is one of the chemical procedures used to ensure the concentration of a solution by reacting several volumes of solution to several volumes of other solutions whose concentration is known.

Then an analysis was carried out with the analysis method used in this study including the linear regression analysis method. The multiple linear regression method in this study is useful to analyze and find a correlation between the effect of calcination and the treatment of varying doses of calcination results from eggshell waste and lime on pH.

RESULT AND DISCUSSION

The research process began by collecting eggshell waste from food business products around the location where the researcher lived. Then the eggshell waste is crushed using a mill in the laboratory of the Mining Engineering Department of UPN Veteran Yogyakarta. The crushed eggshell waste is then sifted until it gets a size of 100 mesh (0.149 mm) The crushed eggshell is then calcined. This calcination process is a process that is carried out with the aim of removing certain contents or impurities in a material, especially water. The calcination process was carried out at temperatures of 150 0 C and 300 0 C

The results of calcination that have been carried out contain physical differences due to the influence of changes in calcination temperature. Samples of eggshell waste without calcination treatment did not change anything or it can be said that it is still physically the same. The results of calcination at 150ºC also produce product results that have not changed too significantly. The result of the 300ºC temperature calcination results in a product with a slightly older color than all the samples.

At a temperature of 150ºC, there is a process of evaporation of water so that the water content in the eggshell has evaporated, because at a temperature of 100ºC this is the boiling point of the water. The color of the eggshell has not changed in this sample with a temperature of 150ºC. Furthermore, at 300ºC, the color changes to be somewhat darker compared to the previous temperature. In this process, damage to organic matter begins to occur in the eggshell which is characterized by a change in color to become darker. Organic compounds in eggshells are easily damaged and lost at temperatures above 100ºC (Razali, et al., 2021).

The eggshell was then subjected to an XRF laboratory test conducted at the BRIN Batan Babarsari laboratory to determine its compound content. This aims to determine the chemical compound changes that will occur in the eggshell if calcination is carried out. Based on previous research conducted by Annas Alfandi Rifai (2023) [7], an increase in temperature in calcination has an effect on increasing CaO compounds in egg shells. This is also in line with the results of the tests carried out in this study as shown in table 1.

Table 1. XRF test results contain eggshells

Chemical Compound/ Sample Code	Without calcination	Calcination temperature 150 ^{0}C	Calcination temperature 300 ^{0} C
MgO	692, 299 ppm	150, 233 ppm	425,494 ppm
Al2O3	0,109 %	0,484 %	0,107 %
SiO2	0,464 %	0,52 %	0,409 %

SO3	332,877 ppm	962, 92 ppm	0,114 %
Tall	82,297 %	83,142 %	84,518 %
TiO2	94,081 ppm	113,931 ppm	198,337 ppm
MnO	27,115 ppm	26,728 ppm	25, 437 ppm
Fe2O3	0,663 %	0,691 %	0,725 %
Fe2O3	0,663 %	0,691 %	0,725 %
ZnO	11,328 ppm	17,925 ppm	14,689 ppm
SrO	510,647 ppm	494,8 ppm	487,349 ppm

After the test was carried out, in this study a certain dose was mixed between eggshells and lime. Eggshells and lime that have been mixed with a certain dose are then put into a 100 ml of acid water but before that, the initial PH condition of the acid water was measured.

Figure 3. Initial pH Measurement

In this study, the egg shell was conditioned, namely by grinding it with a mill until it obtained a size of 100 mesh/0.149 mm. The eggshells were then calcined at temperatures of 1500 Celsius and 3000 Celsius. Eggshells with conditions without calcination and by calcining mixed with lime with acid water are then stirred and left for 24 hours/one day to measure the PH. (fig. 5)

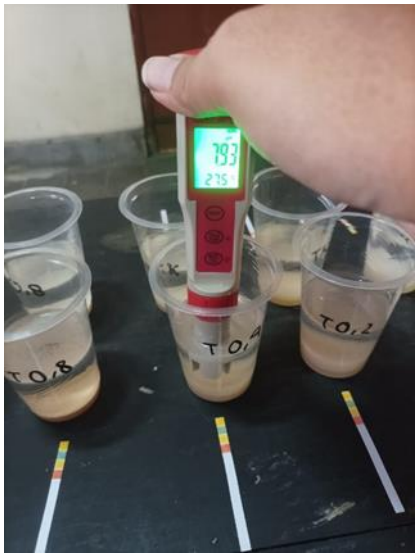

Figure 4. PH Measurement After 24 hours of sitting

PH measurements were carried out one by one on a mixture of mine acid water with egg shells and lime. The PH obtained from the measurement is recorded so that it produces a table as below. (Table 2 & Table 3)

Table 2. Experimental Results of Variation of Fixed Lime Dosage and Calcination Temperature at 100 ml of Mine Acid Water for pH Parameters

Temperature Calcination (degrees Celsius)	Dosage Mix Variation (grams)						
	0.00 lime & eggshell 0.00	Lime 0.05 & eggshell 0.05	Lime 0.05 & eggshell 0.1	Lime 0.05 & eggshell 0.2	Lime 0.05 & eggshell 0.4	Lime 0.05 & eggshell 0.8	0.05 lime & 1 eggshell
0	2,66	7,65	7,58	7,54	7,5	7,49	7,45
150	2,70	7,89	7,74	7,68	7,64	7,59	7,54
300	3,46	8,54	8,44	8,15	8,1	7,98	7,90

Table 3. Experimental Results of Variation of Fixed Eggshell Dosage and Calcination Temperature at 100 ml of Mine Acid Water for pH Parameters

Temperature Calcination (degrees Celsius)	Dosage Mix Variation (grams)						
	0.00 lime & eggshell 0.00	0.05 lime & eggshell 0.05	0.1 lime & eggshell 0.05	0.2 lime & eggshell 0.05	0.4 lime & eggshell 0.05	0.8 lime & eggshell 0.05	1 lime & eggshell 0.05
0	2,86	7,48	9,27	10,57	11,25	11,36	11,43
150	2,92	7,84	9,48	10,75	11,38	11,46	11,50
300	3,7	7,94	11,03	11,18	11,55	11,55	11,58

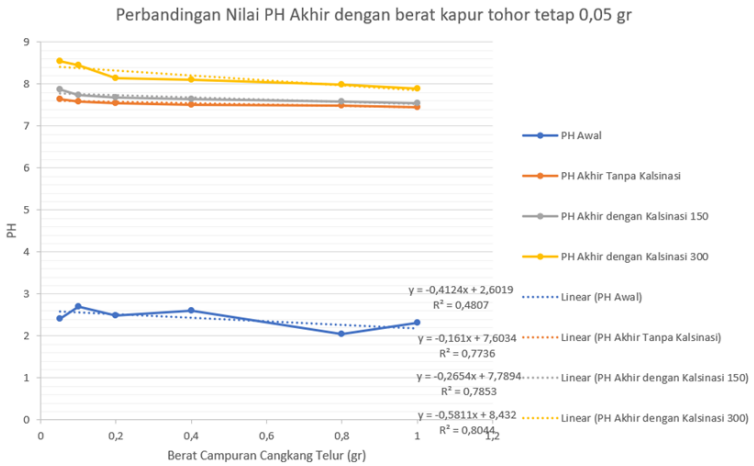

Figure 5. Comparison chart of Final PH value with fixed lime weight

While the egg shell with a fixed weight of 0.05 grams and in the state without calcination, calcined at a temperature of 1500 celsius, calcined at a temperature of 3000 celsius mixed with lime at varying weights has the following linear regression equations:

Conditions without calcination = Y = 3,0634 x + 8,9247
Conditions with calcination at 1500 celsius = Y = 2.8433x + 9.1933
Conditions with calcination at 3000 celsius = Y = 2.1785x + 9.8958

The results of the linear regression analysis, in a mixture of eggshells with a fixed weight of 0.05 grams and lime with varying weights, which shows that the number that does not have a variable x has a positive value. This shows that there is a unidirectional influence between the independent variable (eggshell weight) and the dependent (PH). A positive value in variable X indicates that along with the administration of the dose indicates that the pH value will increase.

The average p value in these conditions showed a > of 0.05, which means that the calcination temperature and the administration of treatment dose partially affected the increase in the pH value of the mine acid water. (fig. 7)

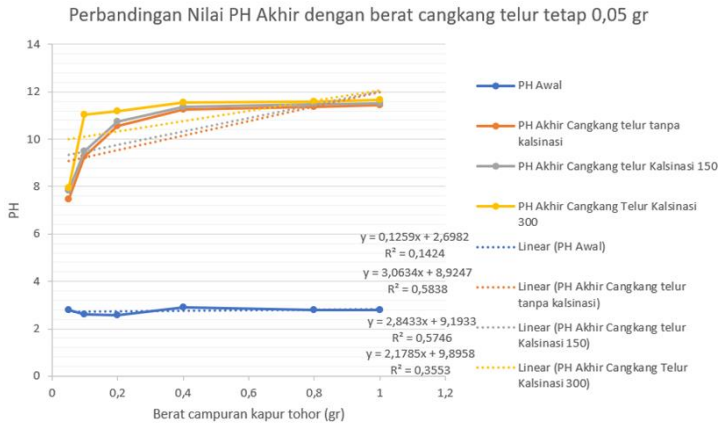

Figure 7. Comparison graph of Final PH value with fixed eggshell weight

From the graph above, the increase in pH occurs along with the higher temperature in the calcination treatment carried out on the eggs. This is because the higher the calcination temperature, the higher the percentage of metal oxides formed. This happens because the chalk material and the calcination results of eggshell waste have begun to approach the saturation point. The pH value that tends to be constant indicates that this material has reached the saturation point (Metboki, et al., 2018).

CONCLUSION

This study shows that egg shells can be used as a mixture of lime to neutralize mine acid water. However, calcination is needed first in the eggshell so that the results of the acidic water neutralization can run optimally. The higher the temperature used to calcinate, the more effective the eggshell can be used as a neutralizing mixture of mine acid water. This was proven during the experiment of neutralizing mine acid water using mixing lime with a fixed weight with egg shells in the condition that it can and has been calcined. The average PH increase using a mixture of fixed-weight lime and heavy eggshell varies without calcination using the same mixed dose composition but calcined at 1500 celsius is 1.87%. If you put an egg with the same dosage composition compared to an egg shell that is already at a temperature of 3000 celsius, the PH will increase by 8.6%. However, it is important to note that the composition of the number of eggshells is more ineffective and tends to lower PH.

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