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Analysis of Quicklime and Organic Chemical Coagulant Doses in Acid Mine Water Management at PT Lematang Coal Lestari (LCL), Gunung Raja, Muara Enim, South Sumatra

Suhardiman Gumanti[1], Rodiyah Nursani[2]
Universitas Prabumulih, Indonesia
Email: suhardiman.sgc@gmail.com
*Correspondence

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ABSTRACT

Mine acid water (AAT) is one of the liquid wastes produced by coal mining activities. The existence of this liquid waste can hurt the environment, so it needs to be managed. This management aims to minimize the negative impact that will be caused. This study aims to determine the stages of AAT management and analyze the need for lime and chemical organic coagulants for coal mining at PT Lematang Coal Lestari (LCL). The method used in this study is by field observation, interview methods, and documentation as supporting data. The result of this study is that the stages of AAT management carried out by PT LCL are known, starting from AAT pumping, mixing chemical organic coagulant, measuring the pH of the inlet channel, liming the inlet channel, checking the color and pH of the outlet line water, mixing the chemical organic coagulant and liming the outlet channel if necessary, as well as settling. The lime dosage required by PT LCL is 0.32 gr/l, and the chemical organic coagulant requirement is 0.11 ml/l in one AAT water management.

Introduction

Production activities in an industrial activity will produce wastewater. (Dwisaputra & Wahyudin, 2023; Tumpu et al., 2023)Wastewater is the remaining production that is not used and must be disposed of. It can come from households, industries, or other public places. It contains substances that can harm human health, affect living activities, and damage the environment. (Zulkifli & Suslia, 2017).

One of the industries that produces wastewater is the coal mining industry. (Maulida & Purwanti, 2023). In its activities, the coal industry produces a dangerous liquid called mine acid water (AAT). This AAT has a significant negative influence if its existence is not managed correctly. As with the nature of water, this mining waste will reach a large area, even to residential areas where water continues to rise. Coal mining generally uses the open pit mining method, where in mining activities, the overburden layer is stripped using heavy equipment or by blasting. These activities can produce AAT if they are related to rocks and minerals that cause the formation of AAT. (Husni et al., 2022).

PT Lematang Coal Lestari (LCL) is one of the companies engaged in the coal mining industry. In its operations, it uses the open pit mining method in its mining

activities. The use of this method has the potential to produce mineral acid water (AAT). This is because the open pit mining method in its mining activities involves stripping the cover soil layer. This allows the exposure of rocks containing sulfide minerals to the surface and can be oxidized due to the presence of water and oxygen. AAT can cause negative impacts on the environment, so it is necessary to manage it, to minimize the negative impact it will cause. One of the methods of managing AAT is the active treatment method, where this method uses alkaline chemicals to increase the pH of the water and precipitate the metals contained in the AAT (Assyakiri et al., 2022; Sitorus et al., 2024).

PT LCL in neutralizing AAT uses an active treatment method, which uses lime as an ingredient to increase the pH of water and chemical organic coagulant as a material to precipitate suspended solids and dissolved iron in AAT. PT LCL in the use of active methods, of course, has stages and the need for specific doses of lime and chemical organic coagulant in the neutralization of AAT, so that AAT can be by the water quality standards that have been set in the Decree of the State Minister of Environment Number 113 of 2003 concerning wastewater quality standards for mining businesses and activities. (Imani et al., 2021; Tuheteru et al., 2021).

According to Matofani et al., (2025) This study concludes that the management of AAT using lime on the site is technically adequate in neutralizing pH according to quality standards and needs further analysis of its economic efficiency. Seeing the importance of the influence of AAT on the environment, the author of the study conducted a study entitled Analysis of Tohor Lime Dosir and Chemical Organic Coagulant in the Management of Mine Acid Water at Pt Lematang Coal Lestari, Gunung Raja, Muara Enim The research objectives of writing this final project are as follows: knowing the stages of neutralization of mine acid water (AAT) at PT Lematang Coal Lestari (LCL), analyzing the dosage of tahor lime used by PT LCL in AAT neutralization and analyzing the dose of chemical organic coagulant used by PT LCL in AAT neutralization.

The research benefits of writing this final project are divided into two types of benefits, namely theoretical benefits and practical benefits. The theoretical benefit is to be able to increase knowledge about the process of neutralizing mine acid water (AAT), as well as to be able to find out the dosage requirements of lime and chemical organic coagulant used at PT Lematang Coal Lestari (LCL) and practical benefits The research benefits of writing this final project, which are helpful, are as follows, a) if factors are found that affect the AAT neutralization process caused by poor AAT management practices, so that the use of lime and chemical organic coagulant used is not practical or maximum. b) It can provide information for readers about the AAT neutralization process and the calculation of the dosage needs of the tohor lime and chemical organic coagulant used at PT LCL.

Method

This study uses a quantitative approach with a descriptive research design. It aims to analyze the dosage of lime (tohor) and organic chemical coagulants in the management

of mine acid water (AAT) at PT Lematang Coal Lestari (LCL). The data sources used consist of primary and secondary data.

Data Collection Techniques

The following is the data collection technique used by the author, in this final project research.

1. Observation

This technique was carried out to collect the data needed for this final project research, which consisted of the stages of AAT management, water pH, chemical organic coagulant discharge, time or duration of pumping and mixing of chemical organic coagulant, and total lime used by PT LCL.

2. Interview

This technique is carried out by asking employees who work or are involved in mining acid water (AAT) management activities at PT Lematang Coal Lestari (LCL), to collect the data needed in this study, which consists of the stages of AAT management.

3. Documentation

This technique is carried out to complement interview and observation techniques. This technique can be shaped, imaged, sketched, and others.

Types of Data Sources

In this final project research, the types of data sources used are divided into two types, namely:

1. Data Primer

Primary data used by the author in this study.

a. pH of water at inlets and outlets
b. Mine acid water volume (AAT)
c. Total lime used
d. Volume of chemical organic coagulant used

2. Data Seconds

Secondary data used by the author in this final project research.

a. Company history
b. Organization and workforce
   Regional arrival location
   Geological and stratigraphic location
   Suggestions
c. Rainfall
d. Pump capacity

Data Analysis

Data analysis is divided into two stages in this final project research: analysis before and during the field.

1. Analysis Before Going

The analysis before the field was carried out to learn information about this research topic, which was obtained through a second party or in the form of secondary data before the field (Saprida & Umari, 2021; Wahidmurni, 2017). This analysis aims to determine

the researcher's focus. It is temporary and can still develop after the researcher goes directly to the field. The analysis before the field was carried out in this research was to study information related to the research title obtained from books and the Internet.

2. Analysis in the Field

The author conducted the field analysis using interview, observation, and documentation methods. The data needed for this analysis are here.

a. Measure the pH of the water using litmus paper.
b. Calculate the pumped discharge used by PT Lematang Coal Lestari (LCL) in liters/second. This activity aims to determine the volume of AAT that will be neutralized in the sludge settling pond (KPL.
c. Calculate the total lime used. This activity was carried out to compare the dose of lime and the volume of AAT in the gr/l unit used by PT LCL.
d. Calculate the discharge of chemical organic coagulant from the reservoir in ml/l. This activity compares the chemical organic coagulant dose, the AAT volume in ml/l units, and the PT LCL uses.

Data Processing

Data processing is the last stage of the author's completion of this research. (Pradana & Idris, 2021; Wulandari, 2021)The method used is data obtained from the field in the form of stages of mine acid water (AAT) management, water pH, pump capacity, discharge of chemical organic coagulant, time (duration of pumping and mixing of chemical organic coagulant), and total lime used. Next, data interpretation was carried out to obtain a conclusion from this study. The following are the formulas used by the author in this final project research.

Results and Discussion

Stages of Mine Acid Water Management

PT Lematang Coal Lestari (LCL) is one of the companies that uses the Active Treatment method, in minimizing the negative impact caused by mine acid water (AAT), where PT LCL uses tohor lime as an ingredient to increase the pH value of AAT and chemical organic coagulant as a material to clear or precipitate suspended solids and dissolved metals in AAT. PT LCL in the main sump two sludge settling pond, has 10 sludge settling pond (KPL) compartments, where the KPL is connected in a zig-zag manner by a channel or ditch, which can be seen in the sketch of the primary sump 2 KPL Appendix A.

KPL main sump 2 has different dimensions or sizes and has functions as a mixing pool, reaction pool and stabilization (settling) pool. KPL 1 is a mixing place for chemical organic coagulant and AAT while the connecting channel or trench between KPL 1 and 2 is used as a mixing place for lime and AAT (inlet channel mixing place). KPL 2 functions as a place for the reaction between lime, chemical, and AAT (reaction pond 1). KPL 3,4,5 and 6 function as stabilization pond 1 (sedimentation pond 1). Pool 7 functions as reaction pond 2, where the process of mixing lime or chemical organic coagulant is

carried out in the connecting channel or trench between KPL 6 and KPL 7. KPL 8,9, and 10 function as the second stabilization pond (2nd sedimentation pond).

PT LCL performs KPL maintenance at least once every three months or as needed according to field conditions. KPL maintenance aims to maximize the AAT management mechanism carried out by PT LCL. The following are the stages of AAT management at PT LCL, which can be seen in Figure 4.1.

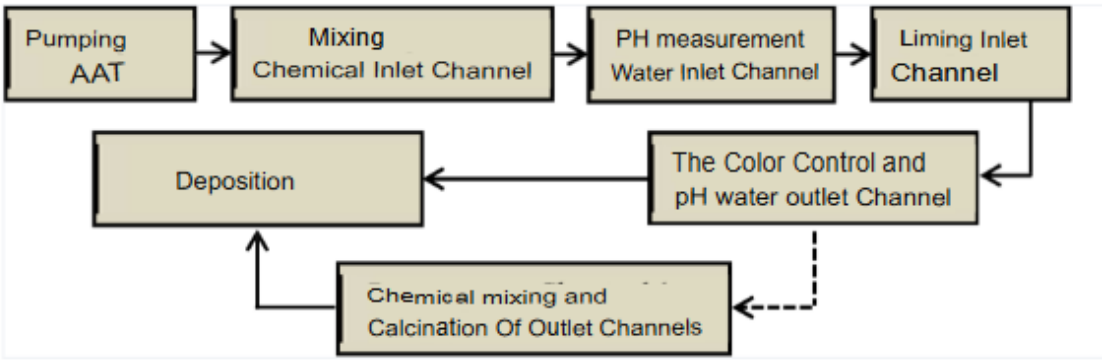

Figure 1. Stages of AAT Management at PT LCL
Source: Author's Research

The following is a detailed explanation of the stages of mine acid water (AAT) neutralization at PT LCL in Figure 1.

Mine Acid Water Pumping

The first process carried out by PT LCL is the pumping of AAT, which is carried out from within the mine or mining area (sump) into KPL main sump 2, using a pump with a capacity of 2200 m3/hour with a voltage of 6000 volts according to Mr. Rizal as the electric force of the pump (Figure 4.2). In pumping AAT into KPL, there is no fixed time duration or adjusted to the height of AAT at the last KPL.

Figure 2. Interview on Pump Formant
Source: Documentation, 2023

Chemical Mixing Inlet Channel

PT LCL uses chemical organic coagulant as a water tratment material in the management of AAT (Figure 4.3), to precipitate or precipitating total suspended solids and dissolved metals in AAT, to comply with effluent standards or wastewater quality standards that have been stipulated in the Decree of the Minister of Environment No. 113 of 2003 concerning Wastewater Quality Standards for Coal Mining Activities.

Figure 3. Chemical Organic Coagulants
Source: Documentation, 2023

The process of mixing chemical organic coagulant with AAT has the same time duration as the duration of pumping AAT into KPL, with an irregular dose of chemical organic coagulant or based on the level of turbidity in the AAT to be managed (the more turbid the AAT, the more doses of chemical organic coagulant are used). Mixing chemical organic coagulant with AAT at PT LCL uses a storage tank with a capacity of 520 liters, where the reservoir has a shell connected to a pipe, which goes directly into the 1st KPL. The shell in the reservoir is used to regulate the discharge of the chemical, and organic coagulant is to be used (Figure 4.4). This technique is expected to mix chemical organic coagulant with AAT evenly, so that suspended solids and heavy metals contained in AAT can be deposited optimally.

Figure 4. Chemical Organic Coagulant Reservoir
Source: Documentation, 2023

pH (Potential Hydrogen) Measurement of Inlet Line Water

The pH (potential hydrogen) measurement of water at PT LCL uses litmus paper, so the pH value of the water measured does not show a detailed number. The pH (potential hydrogen) measurement of inlet water is carried out in the connecting channel or ditch between KPL 1 and KPL 2 (after mixing chemical organic coagulant) by taking water samples on the channel, and followed by measuring the pH (potential hydrogen) of water using litmus paper (Figure 4.5). The measurement of water pH (potential hydrogen) in the inlet channel aims to find out whether the pH (potential hydrogen) of water is by the effluent standard or wastewater quality standard that has been stipulated in the Decree of the Minister of Environment No. 113 of 2003 or 6-9, if the pH value is still below the standard or <6, then liming activities will be carried out. (Said, 2014).

Figure 5. Water Sampling on Inlet Canal
Source: Documentation, 2023

Inlet Channel Liming

Liming is used in mixing activities between lime and AAT to increase AAT's pH (potential hydrogen) value (Figure 4.6). Calibration of the inlet channel will be carried out if the pH value of the water in the channel is below the standard set by the government or <6.

Figure 6. Limming Activities in Inlet Canals
Source: Documentation, 2023

Liming activities at PT LCL are carried out manually or by sprinkling lime directly on the connecting channel or ditch between KPL 1 and 2. The dose of lime used is not fixed or based on estimates in the field. Lime is soowed periodically during the AAT pumping process; this technique is expected to mix the lime used evenly.

Color and pH (Potential Hydrogen) Checking.

Outlet Line Water Checking the color and measurement of pH (potential hydrogen) of water in the outlet line at PT LCL, is carried out in the last sludge settling pond, by taking water samples on the pond body (Figure 7). This step is carried out to determine whether the water's color is good (clear) and the pH of the water has met the standards set, 6-9. If it does not meet the standards that have been set, then further management will be carried out (Pozo-Antonio et al., 2014).

Figure 7. Water Sampling at the Last Sludge Sedimentation Pool (Outlet)
Source: Documentation, 2023

Chemical Mixing and Outlet Line Mixing

Mixing of chemical organic coagulant and mixing in the outlet channel (addition of chemical and lime) will be carried out, if the color of the AAT is still brownish yellow (cloudy) and the pH value of the water in the last KPL (outlet) has not met the standard quality of wastewater for coal mining activities that has been set or <6, but in the process of taking data in the field the researcher did not find the activity of adding chemical organic coagulant and lime to the outlet channel, This is because the color of the water in the last sludge settling pond is quite good and the pH value of the water has met the standard, after mixing chemical organic coagulant and mixing in the inlet channel. (Shokouhi et al., 2014). Chemical organic coagulant mixing and mixing activities (addition of chemicals and lime) on the outlet channel, if needed, will be carried out on the outlet channel of the sixth sludge sedimentation pond or the connecting ditch between the 6th and 7th KPL manually (Figure 8).

Figure 8. Chemical Organic Coagulant Mixing and Mixing Place on Outlet Channels
Source: Documentation, 2023

Deposition

Sealing is the last stage in the mining acid water (AAT) management process carried out by PT Lematang Coal Lestari (LCL). Deposition aims to deposit water or precipitate suspended solids and dissolved metals at the AAT to the maximum, with a deposition duration that is not fixed or by the turbidity level at the AAT. After tapping, the next step is to dispose of it, provided that the AAT is clear enough in color and has a minimum water pH of 6. The disposal of the AAT is carried out by opening the sluice gate at the last settling pond of the last outlet (Figure 4.9).

Figure 9. Mine Acid Water (AAT) on the Last Outlet Line
Source: Documentation, 2023

Analysis of Tohor Lime Dosage Needs

Mining acid water (AAT) management activities using active methods require a specific dose of lime to increase the pH value of AAT. To determine the average dose of lime used by PT Lematang Coal Lestari (LCL) in the Main Sump 2 sludge settling pond (KPL) in gr/l, the researcher calculated the dose of lime for six samples (Appendix B), starting from April 3, 2023 to April 8, 2023. From the calculation results in samples 1-6, a comparison table between the volume of AAT and the total lime used and the change in the pH value of AAT after the calibration activity is carried out below (Table 1).

Table 1. Comparison Between Mine Acid Water Volume (AAT) and Total Tohor Lime

Sampel	Tanggal	Volume Air Asam Tambang (L)	Total Kapur Tohor (gr)	pH	Inlet pH Outlet
1	03-04-2023	1.649.700	450.000	5	6
2	04-04-2023	1.539.720	500.000	5	6
3	05-04-2023	1.576.380	500.000	5	6
4	06-04-2023	1.576.380	500.000	5	6
5	07-04-2023	1.649.700	600.000	5	6
6	08-04-2023	1.649.700	550.000	5	6

Source: Primary Data, 2023

The results of the calculation of 6 data samples in the table above show that the average pH of the AAT of the inlet channel is 5, while the average pH of the outlet channel is 6. The average volume of AAT in one management time is 1,606,930 L, and the average use of lime is 516,667 g. So, the dosage requirement of lime at PT LCL is 0.32 gr/L.

Analysis of Chemical Organic Coagulant Dosage Needs

Mining acid water (AAT) management activities using chemical organic coagulant as water treatment materials to precipitate suspended solids and dissolved metals in the AAT carried out by PT Lematang Coal Lestari (LCL), of course, have a specific dose ratio, so that the AAT can be deposited optimally. To find out the comparison between the volume of AAT and the volume of chemical organic coagulant used, a calculation of 6 samples was carried out starting from April 3, 2023 to April 8, 2023 (APPENDIX B). To calculate the volume of chemical organic coagulant released by the reservoir, the researcher used a 220 ml glass. The glass determines the discharge of chemical organic coagulant released by the shell in the reservoir in ml/second (Figure 10).

Figure 10. Chemical Organic Coagulant Discharge Measurement

Source: Documentation, 2023

From the calculation results of AAT volume and chemical organic coagulant volume carried out on samples 1-6 (APPENDIX B), a comparison table between AAT volume and chemical organic coagulant volume is obtained below (Table 4.2.)

Table 2. Comparison Between Mine Acid Water Volume (AAT) and Chemical Organic Coagulant Volume

Sampel	Tanggal	Volume Air Asam	Volume		
		Tambang (L)	Chemical (ml)	pH Inlet	pH Outlet
1	03-04-2023	1.649.700	90.720	5	6
2	04-04-2023	1.539.720	112.392	5	6
3	05-04-2023	1.576.380	128.432	5	6
4	06-04-2023	1.576.380	306.762	5	6
5	07-04-2023	1.649.700	154.980	5	6
6	08-04-2023	1.649.700	231.120	5	6
Rata-rata		1.606.930	170.734		

Source: Primary Data, 2023

The calculation results of 6 data samples in the table above show that the average pH of AAT in the inlet channel is 5, while the average pH in the outlet channel is 6. The average volume of AAT in one management is 1,606,930 L, with an average use of 170,734 ml of chemical organic coagulant. So, the dosage requirement of PT LCL's chemical organic coagulant is 0.11 ml/L.

Conclusion

From the results of the research conducted at PT Lematang Coal Lestari (LCL), it can be concluded as follows: a) PT Lematang Coal Lestari (LCL) in neutralizing AAT, carrying out the following stages, starting from pumping AAT, mixing chemical organic coagulant, measuring the pH of the inlet (using litmus paper), mixing the lime (liming), checking the color and pH of the water in the outlet line, mixing of chemical organic coagulant and capping in outlet channels and sedimentation. b) The comparison between the dose of lime and the volume of AAT used by LCL is 0.32 gr/l. The use of this dose is quite adequate, evidenced by the change in the pH value from 5 to 6 so that the AAT can comply with the standards set by the government. C) Comparison of chemical dose and AAT volume used by PT LCL is 0.11 ml/l. The use of this dose is quite adequate, as evidenced by the change in color in the water, which was previously brownish-yellow, to clear (transparent) after management.

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