JPPIPA 10(1) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effectiveness of Acid Mine Water Testing Using Sparing at PT. Bara Alam Utama

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Received: October 24, 2023
Revised: November 29, 2023
Accepted: January 25, 2024
Published: January 31, 2024

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DOI: 10.29303/jppipa.v10i1.5803

Abstract: Sparing is a remote monitoring tool (telemetry) and is carried out in real-time via various different devices, as well as storing and displaying it on many device options. This research uses a quantitative descriptive method, which aims to present data related to the research object. The data sources used in this research consist of primary and secondary data sources. Where primary data is obtained from direct observation and measurements regarding pH values, Total Suspended Solid (TSS), Iron (Fe) and Manganese (Mn) metal content. Secondary data was obtained through literature relevant to the research and documentation during the research. The results obtained in May 2022 were 31.0 and 32.2 mg/l, in November 2022 upstream and downstream, namely 19 and 26.8 mg/l. Meanwhile, the pH value of the water in May 2022 in the upstream river still met The quality book is 6.03, while the pH value in the upstream and downstream rivers is 7.3 and 7.1, while in November 2022 the upstream and downstream pH will be 6.43 and 7.11. The iron (Fe) and manganese content is also relatively small both upstream and downstream, namely in May 0.323 and 0.284 mg/l and in November 2022 0.612 and 0.124. Meanwhile, the results of the river pollution capacity are TSS on the Kungkilan River, namely (28.89 - 36.13 mg/L) and the Lematang River, namely (27.00 - 30.25 mg/L).

Keywords: Acid water; Sparing; Water pollution

Introduction

The concept and application of human ecology, activities in the mining sector are included in the extractive industry, where this industry uses raw materials taken directly from the environment (Barlian et al., 2022). This mining activity certainly causes changes in the area where mining activities are carried out, the most obvious changes are changes in local morphology, especially mining carried out using an open pit mining pattern (Putri et al., 2023). Environmental conditions are influenced by excavation activities and the accumulation of overburden or waste rock material which has a direct influence on the properties of water due to physical and chemical changes in water resource areas in rocks (Gobel et al., 2018).

From various mines throughout the world, experience shows that once Acid Mine Water (AAT) is formed, it is difficult to stop the AAT formation. Many factors influence the speed of the oxidation reaction of sulfide minerals, including the type of sulfide mineral and the conditions that support the oxidation process (Puteri et al., 2023). In theory, the process will stop if one of the materials involved in the formation reaction has been completely used up or is no longer available (Mamede et al., 2023; Widodo et al., 2019).

Sulfide minerals are a source of acid which may be used up after a certain time or other AAT forming components, namely oxygen and water may no longer be available, either for a certain time or continuously, because the flow path towards the sulfide minerals is blocked (Nurbaiti et al., 2022; Said et al., 2020). However, when and how these conditions occur at sources of AAT formation, such as overburden deposits, is difficult to identify. The best management of AAT is that the oxidation process of sulfide minerals does not occur by preventing interactions between sulfide minerals with oxygen and water (Chandra et al., 2009; Maulida et al., 2023). This is the principle of the preventive method in managing AAT which is considered the most reliable,

How to Cite:
Herfien, Barlian, E., Dewata, I., Gusman, M., & Efendi, N. (2024). Effectiveness of Acid Mine Water Testing Using Sparing at PT. Bara Alam Utama. *Jurnal Penelitian Pendidikan IPA*, *10*(1), 100–107. https://doi.org/10.29303/jppipa.v10i1.5803

especially over a long period of time (Rahmatullah et al., 2023).

Law no. 3 of 2020 amendments to Law no. 4 of 2009 concerning Mineral and Coal Mining in article 95, namely that IUP and IUPK holders are required to apply good mining engineering principles and comply with environmental carrying capacity tolerance limits. As well as Minister of Energy and Mineral Resources Regulation No. 26 of 2018 concerning the Implementation of Good Mining Principles in article 20, namely handling and restoring the environment if environmental pollution and/or damage occurs, where arrangements for dealing with pollution and/or environmental damage are regulated in the Decree of the Minister of Energy and Mineral Resources No. 1827.K/30/MEM/2018 (Desianda, 2021).

Results from coal mining activities by PT. Bara Alam Utama (PT. BAU) produces piles of excavated soil which can react with acidic rocks or soil and an oxidation reaction occurs when it rains. If rocks or soil contain sulfide minerals and an oxidation reaction occurs, acidic leachate will form if the water is in contact with the rock for a long time (Purnama, 2020). For example, in situations where water is stagnant or trapped in a sump, the low pH in acid-contaminated water will flow into rivers or surface water sources. This can cause discomfort and health problems for workers and communities who use the water, as well as have a negative impact on aquatic biota. If we look at this situation, it can be concluded that the effect of the emergence of AAT can be categorized as an important detrimental impact (Adiansyah, 2021).

Measurement of surface water quality in connection with PT's Coal Mining Activities. BAU is carried out at 6 (six) observation stations in the form of water bodies or rivers which ecologically function as recipients of impacts from coal mining activities. The six observation stations are: observation stations at the upper reaches of the Lematang River (A1), the lower reaches of the Lematang River (A2), the upper reaches of the Kungkilan River (A3), the lower reaches of the Kungkilan River (A4), the upper reaches of the Sandaran River (A5), and the mouth of the Sandara River (A6).

The Industrial Revolution 5.0 is currently unavoidable due to the rapid progress of internet data, large data transmission capacity, and industrial trends that encourage switching from paper use to digitalization becoming a necessity (Haqqi et al., 2019). One way to implement the Industrial Revolution 5.0 in the environmental sector is by continuously monitoring and connecting to the internet the quality of waste water for certain businesses or activities. KEMEN-LHK Ministerial Regulation No. 1236, 2018 concerning Monitoring Wastewater Quality Continuously and in Networks for Businesses and/or Activities (SPARING) and Ministerial Regulation Number P.80/MENLHK/SETJEN/KUM.1/10/2019, Regarding Amendments to Ministerial Regulation No. 1236, 2018 KEMEN-LHK Monitoring Wastewater Quality Continuously and in Networks for Businesses and/or Activities (SPARING) where all companies included in the classification are required to implement this SPARING no later than 2 years from PERMEN No. 1236 of 2018 which was released by the government (Handayani, 2021; Paryanto et al., 2020).

Sparing is a remote monitoring tool (telemetry) and is carried out in real-time via various different devices, as well as storing and displaying it on a wide selection of devices (Nais, 2022; Simatupang et al., 2022). Remote monitoring (telemetry) has been accepted by company management as a more strategic alternative to replace monitoring systems that still use conventional or manual methods which can reduce dependence on labor so that costs can be reduced and supervision from stakeholders can be effective (Amane et al., 2023). By using real-time sparing, companies can quickly take immediate corrective steps (Suparno et al., 2022). From the description above, researchers are interested in seeing the effectiveness of acid mine drainage management using sparing carried out at PT. Bara Alam Utama, Lahat Regency, South Sumatra Province.

Method

This research uses a quantitative descriptive method, which aims to present data related to the research object. The quantitative descriptive research method is a method that aims to create a picture or description of a situation objectively using numbers, starting from data collection, interpretation of the data as well as the appearance and results (Arikunto, 2019).

The data sources used in this research consist of primary and secondary data sources. Where primary data is obtained from direct observation and measurements regarding pH values, Total Suspended Solid (TSS), Iron (Fe) and Manganese (Mn) metal content. Secondary data was obtained through literature relevant to the research and documentation during the research. The time and place of the research was carried out in the period May-July 2022, located at PT. Bara Alam Utama is located in Lahat Regency, South Sumatra Province.

Results and Discussion

Research Place

The research was carried out at the PT Mining Business License (IUP) location. Bara Alam Utama is geographically located between 103° 4200 39°30 - 103 East Longitude and 03° 50 46 74°40 - 03 South Lintang which is administratively included in the Merapi District, Lahat Regency, South Sumatra Province. The area of IUP PT. Bara Alam Utama is 799.6 Ha.

Figure 1. Location of research area (Source: TUKS PT. Bara Alam Utama)

River Water Quality Standards

The water quality standard values for the Kungkilan River and Lematang River around the disposal area for the TSS, pH, Fe and Mn parameters show safe values or have not exceeded the threshold limits. So that the disposal of mine water waste does not have a real influence on changes in the water quality level of the Kungkilan River and Lematang River, therefore the disposal of mine water waste into water bodies is still permitted. Liquid waste in the disposal area for TSS, pH, Fe and Mn parameters still meets the quality standards set by the government in PP No. 22 of 2021 concerning the Implementation of Environmental Protection and Management as well as Minister of Environment Decree no. 113 of 2003 concerning Waste Water Quality Standards for Coal Mining Businesses and/or Activities. The results of water quality compared to water quality standards can be seen in table 1 below.

Table 1. West KPL Wastewater Characteristics

Parameter	Units	West KPL 1				Method	Quality standards
		IIA.1	IIA.2	Runoff	Outlets		
Physical Test:							
Totally SuspendedSolid (TSS)	mg/L	37.1	68.6	40.2	46	SNI 6989-3:2019	400
Chemical Tests							
pH	mg/L	6	6	6	6	SNI 6989-11:2019	6 - 9
Iron (Fe)	mg/L	1.52	1.40	1.60	0.762	SNI 6989-84:2019	7
Manganese (Mn)	mg/L	3.23	3.01	0.997	3.13	SNI 6989-84:2019	4

Source: UPTD Laboratory Research Sampling

Table 2. Results of Surface Water Quality Analysis May 2022

Analyzed Parameters	Unit	Analysis Results		PP No.22 Year 2021 Appendix VI class II	Method
		SK Hulu	Downstream SK		
pH	-	7.3	7.1	6-9	SNI. 06-6989.11-2019
BOD	mg/L	1.88	1.92	3	SNI-6989.72-2009
COD	mg/L	9.76	8.57	25	SNI-6989.2-2019
TSS	mg/L	31	32.2	50	SNI. 06-6989.3-2004
TDS	mg/L	90	94	1,000	SNI 6989.27.2019
Water Temperature	°C	29	30.3	Deviation 3	SNI. 06-6989.23-2004
Ammonia Free	mg/L	0.002	0.002	0.2	15.23/IK/LL/2015
MBAS	mg/L	0.0946	0.0878	0.2	SNI 06.6989.51-2005
Phosphate	mg/L	0.18	0.17	0.2	15.26/IK/LL/2015
Oils & Fats	mg/L	0.6	0.5	1	15.35/IK/LL/2018
Nitrate (NO›)	mg/L	1	0.7	10	SNI 06.6989.09-2004
Nitrite (NO2)	mg/L	0.007	0.006	0.06	SNI. 06-6989.09-2004
DO***)	mg/L	6.3	7.1	Minimum 4	Tool Manual
Phenol	mg/L	0.007	0.008	0.005	15.31/IK/LL/2015
Chlorine	mg/L	0.07	0.15	0.03	15.30/IK/LL/2015
Cr+6	mg/L	<0.015	<0.01S	-	SNI -6989.84-2019
Iron (Fe)	mg/L	0.323	0.284	-	SNI -6989.84-2019
Manganese (Mn)	mg/L	0.489	1.04	-	SNI. 06-6989.05-2004
Zinc (Zn)	mg/L	<0.008	0.015	0.05	SNI. 06-6989.07-2004
Cadmium {Cd)	mg/L	0.002	8.27x10-4	0.01	SNI. 06-6989.16-2004
Fluoride (F)	mg/L	0.15	0.17	1	15.29/IK/LL/2015
Chloride (CI)	mg/L	16.4	14.9	300	SNI. 06-6989.19-2004
Sulfate (SO4)	mg/L	10	31	300	15.27/IK/LL/2018
Arsen	mg/L	<1.9x10-3	<1.9x10-3	0.05	SNI. 06-6989.54-2005

Analyzed Parameters	Unit	Analysis Results		PP No.22 Year 2021 Appendix VI class II	Method
		SK Hulu	Downstream SK		
Selenium	mg/L	<1.77x10-3	<1.77x10	0.01	SNI-06-2475-1991
Cyanide	mg/L	0.009	0.01	0.02	15.32/IK/LL/2015
Cobalt	mg/L	<0.068	<0.068	0.2	SNI 6989.68 2009
Mercury (Hg)	mg/L	<2.58x10-4	4.20x10-4	0.002	SNI 6989.78-2011
Barium	mg/L	<0.242	<0.242	-	SNI 6989.84-2019
Sulfur (H2S)	mg/L	0.01	0.007	0.002	15.28/IK/LL/2015
Black Lead (Pb)	mg/L	<1.98x10-3	<1.98x10-3	0.03	SNI-69B9.08-2009
Copper (Cu)	mg/L	<0.016	<0.016	0.02	SNI -6989.84-2019
Fecal Coliforms	MPN/100 ml	25	33	1,000	15.5/IK-MB/LL/202 1
Total Coliforms	MPN/100 ml	195	350	5,000	15.5/IK-MB/LL/202 1

Source: Laboratory UPTD Sampling

From the results of the analysis of the surface water quality of the Kungkilan River in May and November 2022, it shows that liquid coal waste has characteristics such as total suspended solids (TSS) content which still meets quality standards both upstream and downstream of the river, where in May 2022, it is 31.0 and 32.2 mg/l, in November 2022 in the upstream and downstream, namely 19 and 26.8 mg/l. Meanwhile, the pH value of the water in May 2022 in the upstream river still meets the quality book, namely 6.03, while the pH value in the upstream and downstream of the river 7.3 and 7.1 while in November 2022 the upstream and downstream pH will be 6.43 and 7.11. The iron (Fe) and manganese content is also relatively small both upstream and downstream, namely in May 0.323 and 0.284 mg/l and in November 2022 0.612 and 0.124. For Manganese (Mn) in May upstream and downstream it was 0.489 and 1.04 mg/l and Manganese (Mn) in November 0.489 and 1.04 and manganese in November 0.033 and <0.015 mg/l. Based on the quality standards set by the government in Government Regulation Number 22 of 2021, the pH and TSS parameters are still below the set quality standards.

If the analysis results from the water quality test are above the quality standard, then acid mine water management is carried out. One method used to reduce the high test value of acid mine drainage is using Active Treatment and Passive Treatment (Johnson et al., 2005; Neculita et al., 2007). Active Treatment is a system for treating acid mine water by applying chemicals to neutralize the acid mine water (Skousen et al., 2017). Neutralizing acid mine water can use chemicals such as limestone (Calcium Carbonate), Hydrated Lime (Calcium Hydroxide), Caustic Soda (Sodium Hydroxides), Soda Ash Briquettes (Sodium Carbonate), Anhyrous Ammonia (Skousen, 2014). These chemicals can neutralize the pH and heavy metals contained in acid mine water. Passive processing no longer uses continuous addition of chemicals (Orden et al., 2021). This will reduce equipment operations and maintenance. Passive processing relies on the occurrence of bio-geochemical processes, which take place naturally in increasing pH and binding and deposition of dissolved metals (Benjamin et al., 1992). So the passive system is considered the most effective and efficient. In passive processing, there are two main processes that cause an increase in pH, namely the dissolution of limestone and biological sulfate reduction. These two processes produce alkalinity in the form of bicarbonate (HCO3-) as a neutralizing compound (Rambabu et al., 2020; Virginia et al., 2020).

River Capacity

The capacity to carry the pollution load of a river can be known, where the capacity to carry the pollution load of a river is the ability of the water in a water source (for example a river), to receive pollution load input that can still be neutralized naturally without causing the river water to become polluted (Djoharam et al., 2018; Fan et al., 2021; Setiawan et al., 2018). Actions that trigger pollution loads are caused by industrial operations and community activities that dispose of waste along rivers where there are large concentrations of pollutant elements found in the wastewater or water (Mitsch et al., 2000; Rajaram et al., 2008). The capacity of the volume of river capacity for pollution loads in the form of determining a value if an aquatic environment is affected by pollutants from various sources does not give rise to a pollution process (Tchobanoglous et al., 2014). It can be seen that in May 2022 the upstream discharge of the Kungkilan River was 5.16 m3/second and the downstream Kungkilan River was 4.14 m3/second, so the capacity to carry the pollution load can be calculated as in table 3 using the mass balance method (Minister of Environment Decree No. 110 2003) as follows:

Table 3. Capacity of Kungkilan River Pollutant Load in May and November 2022

Month	May	Nov	May	Nov	May	Nov	May	Nov	May	Nov
Point	Debit		TSS		pH		Fe		M N	
Upstream	5.16	5.16	31	19	7.3	6.43	0.323	0.612	0.489	0.033
Downstream	4.14	4.14	32.2	26.8	7.1	7.11	0.284	0.124	1.04	0.015
CR	9.30	9.30	21.11	13.87	5.26	4.78	0.65	0.80	0.83	0.47
BM			50	50	6-9	6-9	-	-	-	-
Capacity				Enough		Not enough		Enough		Enough

Table 4. Capacity of Lematang River Pollutant Load in May and November 2022

Month	May	Nov	May	Nov	May	Nov	May	Nov	May	Nov
Point	Debit		TSS		pH		Fe		M N	
Upstream	29.86	29.86	33.1	38.8	7.1	6.64	0.168	0.144	0.015	0.021
Downstream	23.23	23.23	37.1	39.3	6.5	6.73	0.156	0.208	10,015	0.021
CR	53.09	23.23	19.75	23.00	4.55	4.30	0.53	0.52	0.45	0.45
BM		53.09	50	50	6-9	6-9	-	-	-	-
Capacity				Enough		Not enough		Enough		Enough

From data on the TSS pollutant load capacity of the Kungkilan River and Lematang River in May and November 2022 according to the monitoring/monitoring time per semester for the TSS capacity of the Kungkilan River, namely (28.89 – 36.13 mg/L) and the Lematang River, namely (27.00 – 30.25 mg/L). The data above also shows that the test results have experienced increases and decreases. This is because in the field the weather conditions are uncertain, causing differences in test results (Sahabuddin et al., 2014).

Data Analysis Using Sparing

Sparing sensor placement was carried out at West KPL 1 by adjusting the conditions at the existing compliance points. Sparing sensors are grouped into 2, based on their placement, namely: pH, TSS, NH3-N (Ammonia), COD sensors placed in 1 sensor probe/pipe and Discharge placed in the flow for the Doppler type, pipe for the Flowmeter type sensor and for the outlet flow with v-notch for ultrasonic type sensor. In the use of sparing, there are technical specifications regarding its use, while these specifications are regulated in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.80/MENLHK/SETJEN/KUM.1/10/2019 concerning Monitoring Wastewater Quality Continuously and in Networks for Businesses and/ Or Activities. As for monitoring data using Sparing at PT. Main Natural Bara can be seen in table 5.

Table 5. Test results using Sparing at PT. Bara Alam Utama

Parameter	Unit	Analysis results			Quality standards	Method
		L802- 09.30.22	L803- 09.30.22	L804- 09.30.22		
pH	Units	7.06	6.52	7.81	6 - 9	SNI 6989 11 2019
Suspended Residue	mg/L	3.40	24.1	13.3	300	SNI 6989 3 2019
Iron (Fe) Total	mg/L	0.720	0.806	1.02	7	SNI 6989 84 2019
Manganese (Mn) Total	mg/L	0.672	0.897	1.05	4	SNI 6989 84 2019

Source: SHU PT. Bara Alam Utama

From test data using Sparing carried out at PT. Bara Alam Utama obtained a pH value ranging from an average of 6.98, this is still below the established quality standard threshold. The test results from the data above use Sparing which can monitor wastewater quality continuously and in the network, monitoring, recording and reporting parameters and levels of wastewater discharge automatically, continuously and in the network. This online industrial wastewater quality monitoring activity uses an integrated system to collect data, process it in real time, and distribute it quickly to several users according to their tasks, principals and functions, such as the Regional Environmental Management Agency (BPLHD). Ministry of Environment and Forestry (KLHK), and BPPT as a research institution. Central stations that handle wastewater quality monitoring data require adequate computer servers and trained operators and maintainers. The central station can continuously check water quality at all substations and identify wastewater pollution using excellent equipment (Hendarto, 2023; Yudo, 2018). With the sparing monitoring method, samples are identified by a sensor based on the level of turbidity. Sensors monitor industrial wastewater discharged at disposal sites, and the efficient system continuously sends monitoring results directly to users (Mahbub, 2020; Padma et al., 2017).

Conclusion

Based on the results obtained in May 2022, namely 31.0 and 32.2 mg/l, in November 2022 in the upstream and downstream areas, namely 19 and 26.8 mg/l. Meanwhile, the pH value of the water in May 2022 in the upstream river was still meets the quality book, namely 6.03, while the pH value in the upstream and downstream rivers is 7.3 and 7.1, while in November 2022 the upstream and downstream pH will be 6.43 and 7.11. The iron (Fe) and manganese content is also relatively small both upstream and downstream, namely in May 0.323 and 0.284 mg/l and in November 2022 0.612 and 0.124. Meanwhile, the results of the river pollution capacity are TSS on the Kungkilan River, namely (28.89 - 36.13 mg/L) and the Lematang River, namely (27.00 - 30.25 mg/L).

Acknowledgments
During the research, the author received a lot of support, guidance, direction and input from various parties, for this reason, on this occasion the author would like to thank the supervisors and lecturers at Padang State University.

Auhor Contributions
H: preparation of original draft, results, discussion, methodology, conclusions; E. B, I. D, M. G, and N. E: analysis, review, proofreading and editing.

Funding
This research did not receive external funding.

Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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