The Analysis of The Effect of Deposition Time on TSS Content Level and pH Mine Water at Mud Settling Ponds of East Pit 3 West Bangko Coal Mine

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Abstract: The experimental results obtained in laboratory conditions where the pH optimum was 7.3 at the best ratio of lime dose of 0.8 g / l to 50 minutes operating time. With the optimum conditions, subsequently measured the effectiveness of the deposition time on the water content of TSS and further improve the performance of lime in the water pH. From the test results and the measurements can be seen that the longer the settling time, the lower the TSS with the condition is the most influential on the fourth day. The measurement of the performance of lime in raising the pH of the mine water under conditions was known to remain effective in improving the conditions of pH. The most influential on the first day and the fourth day in which the pH of the mine water was on environmental quality standards.

Keywords: mine water, lime dosing, TSS, deposition time, pH, sludge settling ponds

I. INTRODUCTION

One of the important problems faced by the coal industry is water pollution by coal mine (*Acid Mine Drainage* = AMD). The AMD is a liquid that is formed by the oxidation of sulfide minerals, mainly pyrite (FeS_2), which produces sulfuric acid [1] [2]. With a high level of acidity, coal mine water can dissolve minerals and release of other cations such as Fe, Mn, Al, Cu, Zn, Cd, Ni and Hg. If carried to the water source, it can degrade the biological productivity of aquatic systems. In severe conditions, the water becomes unsafe for consumption and other uses [3]. Therefore, part of the concern is about Coal Mine Water, where the volume of water in the mine area are sourced from rainwater on the front mine produces water that can be generated through the exploration and mine production. Accumulation of the mine water pollution as a result of allowing mining activities which bring pollutants mining materials.

Some Factors that became the source or be input factors in generating mine water mainly from climate, wind that brings dust mine material, rainfall, catchment basins and slope and it's all that will be a factors and a water reservoir or material which directly will brought by mining activity. Furthermore, the water from the front mine is the result of excavation and exploration.

Therefore, identification of system draining and sewage treatment plants in the area of the mine should be reflected in the presence of monitoring and evaluation to determine the condition of the mining environment under controlled conditions whether or not in relation to environmental pollution.

To minimize and mitigate pollution in uncontrolled conditions, it is necessary to analyze the factors that support and affect pollution in mining areas by basing the above conditions by observing, measuring the quality and pollution levels are indicated by the parameters defined either in relation to pH and the content of heavy metal minerals.

Then, as the potential for environmental contamination is indicated, then the next step can be done in the form of application of mine water treatment technique is a way to overcome or neutralize and minimize the environmental impact, which in turn can be a mine water management model. So expect the output of the mine water management provide ideal conditions on the water main which parameters can be measured against the ideal materials such as pollutants, pH, content of Manganese, Iron and TSS. [4]

Mining activities in the coal mines of West Pit 3 East Bangko using open pit methods, such mining activities will have a direct impact to the formation of a reaction between the material mines, air and water so that either directly or indirectly to form acid mine drainage [5].

The reaction between pyrite, oxygen and water to form sulfuric acid and iron hydroxide precipitate. General reaction In acid mine drainage formation, occurring in four pyrite reaction that produces hydrogen ions when binding to negative ions can form acid.
Based on the chemical equation it can be seen the process as follows:

Eq. 1: $FeS_2 + 7/2\ O_2 + H_2O \longrightarrow Fe^{+2} + 2SO_4^{-2} + 2H^+$

Eq. 2: $Fe^{+2} + 1/4\ O_2 + H^+ \longrightarrow Fe^{+3} + 1/2\ H_2O$

Eq. 3: $Fe^{+3} + 3\ H_2O \longrightarrow Fe\ (OH) + 3H^+$

Eq. 4: $FeS_2 + 14\ Fe^{+3} + 8^{+2}\ H_2O^{+} \longrightarrow 15\ Fe_2SO_4^{-2} + 16\ H^+$

The explanation of the above equation:

Equation 1, *the iron sulfide* is oxidized to release *ferrous iron, sulfate* and *acid*

Equation 2, *the ferrous iron* in the two equations will be oxidized to *ferric iron*

Equation 3 can be hydrolyzed *ferric iron* and forming *ferric hydroxide* and *acid.*

Equation 4, *ferric iron* directly react with *pyrite* and act as a catalyst that causes a very large *ferrous iron, sulfate* and *acid* .. [6].

The efforts made by the management of an integrated manner using lime. Than the water with the condition that it meets environmental standards can be streamed back to the rivers there and to soak into the ground without causing environmental problems.

Several previous studies have concluded that the use of lime has been effective in raising the pH of the water to achieve environmental quality standards [7] [8], but has not been clearly illustrated the influence of mud settling ponds in the water to precipitate the mine in relation to the decreased levels of TSS. Furthermore, with the deposition time, the performance of lime in increasing pH is also not clearly observed in addition to the volume factor and rainfall will also give effect to the pH of the water in the mine area. It thus becomes important to investigate the environmental characteristics of the mine, the mine water management with calcification by considering indicators such as TSS indicator, time of deposition, precipitation and time of operation.

Thus expected to generate an ideal environmental conditions at the mine, where the existing mines still consider the environment by promoting efforts to cope with the damage and minimize the contamination most likely occurred in the mine area. Based on the above, this study is to analyze the management of environmental pollution and mining areas to provide an accurate identification of the level of pollution in mining areas as well as countermeasures good start from the front to the quarry mud settling pool installation.

Based on the issues to be discussed, the purpose of this study was to determine the effect of deposition time on levels of TSS and its influence on the performance of lime increases the pH of the water in the mine .. While the expected benefits of this research in order to know the method of deposition and the amount of MPA and calcification of the effective and efficient which can be adopted by companies for environmental management of mining.

2. METHOD

1. Laboratory Studies

To determine the effect of deposition time on levels of TSS and its relationship to the performance of lime in raising the pH of the mine water was tested in the laboratory using a sample of mine water settling ponds sludge to reach the limits of environmental quality standards.

2. Variables research

a. mine water samples
b. calcium oxide (0.8 g / liter)
c. operating time (50 minutes)

3. Influence of deposition time on the performance of TSS and lime in water pH ningkatkan mine.

Measurement of the effect of deposition time on levels of TSS conducted to determine the influence of the independent variable (time of deposition) of the TSS (the dependent variable). Besides, it also can be seen the correlation (relationship) between variables whether negative or positive.

The treatment is done by varying the deposition time (days) ie from day 1 to 4 and made three (3) replications.

The next measurement is to determine the effect of deposition time are made to raise the performance of lime in mine water pH.

The treatment is done by varying the deposition time (days) ie from day 1 to 4 and made three (3) replications.

To take measurements of the two conditions mentioned above are used by the statistical method ANOVA test methods. Next will be measured with a further test of least significant difference test and Tukey test to determine which one is the most optimum variation and effect between variables. Looking at the condition of significance, it will be known variations where the most significant effect. [9]

3. RESULTS AND DISCUSSION

1. **Variation of deposition time and TSS**

The results of laboratory tests conducted to determine the effect of deposition time on levels of TSS is as following table.

Table 1. Influence of Deposition Time on TSS

No.	**Deposition time (days)**	**TSS**		
		U1	**U2**	**U3**
1	**1**	**9.00**	**8, 70**	**8.90**
2	**2**	**8.50**	**8.40**	**8.40**
3	**3**	**7.2 0**	**7.2 0**	**7.0 0**
4	**4**	**6, 80**	**6, 50**	**6, 50**

From the above table it can be seen that there is an inverse relationship between the time of deposition with TSS levels where the longer the settling time will be more down the mine water TSS levels.

Effect of deposition time on the following graph of TSS as a treatment for replications 1 through to 3 replications.

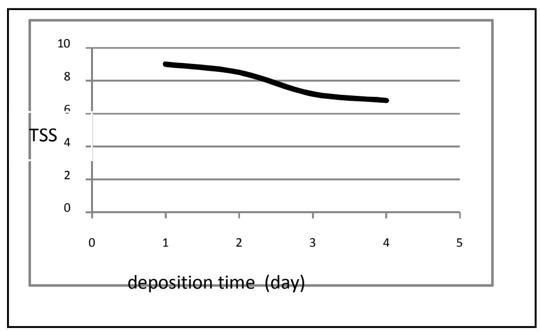

Fig 1. Influence of deposition time on TSS replicates 1

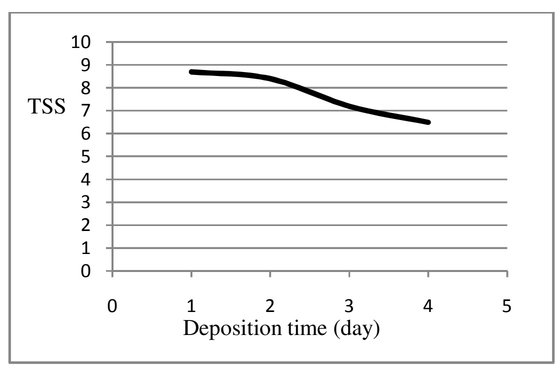

Fig 2. Influence of deposition time on TSS replicates 1.

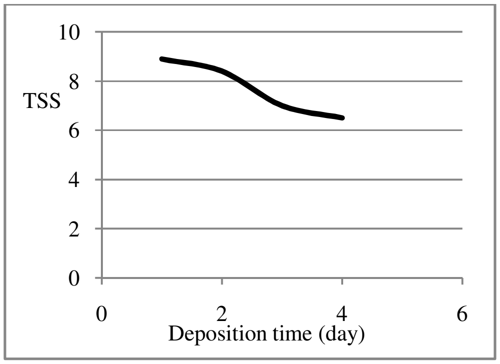

Fig 3. Influence of deposition time on TSS 3 replications.

2. **Variation of deposition time and pH of the mine water.**

The results of laboratory tests conducted to determine the effect of deposition time on the pH of the mine water with liming is done as the following table.

Table 2. Influence of deposition time on the pH

No.	Deposition time (days)	TSS		
		U1	U2	U3
1	1	8.24	8.11	7.82
2	2	7.80	7.80	7.50
3	3	7.40	7.30	7.30
4	4	7.25	7.15	7.0

From the above table it can be seen that the longer the time penegendapan still will raise the pH of the mine water level by liming is done is still meeting environmental standards between 6-9. [10]

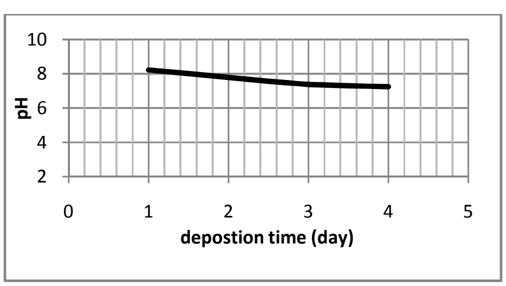

Fig 4. Influence of deposition time on the pH replicates 1.

Effect of deposition time on the following graph of pH as a treatment for replications 1 through to 3 replications.
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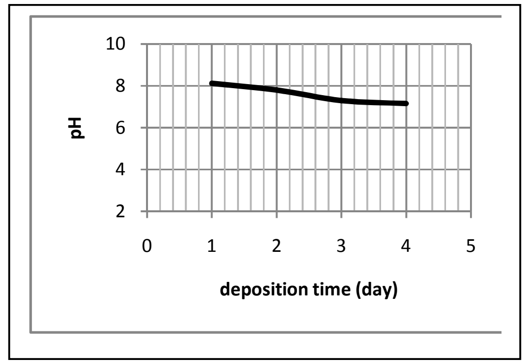

Fig 5. Influence of deposition time on the second TSS replications

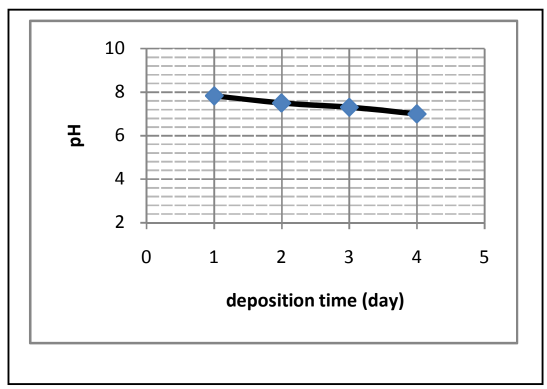

Fig 6. Influence of deposition time on TSS 3 replications

3. **Effect of deposition time on levels of TSS**

From the analysis of the calculation results calculated F value of 351 400 and a sig that midnight can be said that there is a significant effect for the value of F is greater than F table and sig is smaller than 0.05 means a significant difference between the time of deposition of the TSS level.

On the table there is a difference comparing the difference between the real test of a significant distance between the settling time with TSS levels. While the results of univariate tests to variable deposition time showed a significant difference between the time of deposition is used to levels where sig 12:00 error value is smaller than 0:05

Significantly different from the results of further tests using the Tukey method known that each time sneaking provide significant results for TSS levels. With each show that the longer it will creep even lower levels of TSS. The difference between the highest difference was on day 4.

4. Influence of deposition time on the performance of lime increases the pH of the water in the mine.

From the analysis of the calculation results calculated F value of 73 686 and a sig that midnight can be said that there is a significant effect because the calculated F value is greater than the value of F table and standard sig smaller than 0.05 means a significant difference between the performance of calcification deposition time for increasing the pH.

On the table there is a difference comparing the difference between the real test of a significant distance between the time of deposition with increasing pH. While the results of univariate tests to variable deposition time showed a significant difference between the levels of sedimentation is used where the value is smaller niilai sig error 12:00 00:05

Significantly different from the results of further tests using the Tukey method known that each time sneaking provide significant results for pH levels. With each show that the longer it will creep even lower levels of TSS and increasing pH tends to be lower where the highest value of the difference is on the first day of the fourth day of treatment with the most significant difference.

Calcification of the test results in optimum condition it is known that the longer time creep, the lower the levels of TSS and turbidity of the water on the wane and minimize the use of lime for pH levels remain above the environmental quality standards ie 6-9

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

From the foregoing discussion, it can be drawn some conclusions, namely:

1. Statistical test results showed that a significant difference between the time of deposition with TSS levels where the longer the settling time, the more it will reduce levels of TSS
2. Statistical test results showed that a significant difference between the time of deposition to improve the performance of lime in Ph mine water which showed a positive means, increasing the settling time will still increase the pH.
3. The most significant condition of the settling time is the fourth day that showed the greatest difference in both the TSS and pH.

B. Recommendations

Based on the observations that have been made in the field, then there are some suggestions that can give Authors include:

1. The necessity of settling time applications by way of adding mud settling ponds that can be effective in lowering the levels of TSS.
2. In order to maximize the results of calcification should be stirring the mud settling ponds that really quicklime reacts with acidic water that is at the pool.

Appendix

Effect of deposition time against TSS

Tests of Between-Subjects Effects

Dependent Variable: Hasil_TSS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10 331 [a]	5	2,066	212 520	.000
Intercept	722 301	1	722 301	74293.800	.000
K elompok	10 249	3	3,416	351 400	.000
P threat of physical	.082	2	.041	4,200	.072
Error	.058	6	.010		
Total	732 690	12			
Corrected Total	10,389	11			

a. R Squared = .994 (Adjusted R Squared = .990)

Estimates

Dependent Variable: Hasil_TSS

group	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
1:00	8,867	.057	8727	9006
2:00	8433	.057	8294	8573

3:00	7133	.057	6,994	7273
4:00	6,600	.057	6,461	6739

Pairwise Comparisons

Dependent Variable: Hasil_TSS

(I) group	(J) group	Mean Difference (IJ)	Std. Error	Sig. A	95% Confidence Interval for Difference a	
					Lower Bound	Upper Bound
1:00	2:00	.433 *	.081	.002	.236	.630
	3:00	1,733 *	.081	.000	1,536	1,930
	4:00	2,267 *	.081	.000	2,070	2,464
2:00	1:00	- .433 *	.081	.002	- .630	- .236
	3:00	1,300 *	.081	.000	1,103	1,497
	4:00	1,833 *	.081	.000	1,636	2,030
3:00	1:00	-1733 *	.081	.000	-1930	-1536
	2:00	-1300 *	.081	.000	-1497	-1103
	4:00	.533 *	.081	.001	.336	.730
4:00	1:00	-2267 *	.081	.000	-2464	-2070
	2:00	-1833 *	.081	.000	-2030	-1636
	3:00	- .533 *	.081	.001	- .730	- .336

Effect of Deposition Time Against pH

Tests of Between-Subjects Effects

Dependent Variable: pH

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1,649 a	5	.330	48 639	.000
Intercept	685 087	1	685 087	101037.061	.000
group	1,499	3	.500	73 686	.000
treatment	.150	2	.075	11,070	.010
Error	.041	6	.007		
Total	686 777	12			
Corrected Total	1,690	11			

a. R Squared = .976 (Adjusted R Squared = .956)

Estimates

Dependent Variable: pH

group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1:00	8057	.048	7940	8173
2:00	7,700	.048	7584	7,816
3:00	7333	.048	7217	7,450
4:00	7133	.048	7017	7,250

Pairwise Comparisons

Dependent Variable: pH

(I) group	(J) group	Mean Difference (IJ)	Std. Error	Sig. A	95% Confidence Interval for Difference a	
					Lower Bound	Upper Bound
1:00	2:00	.357 *	.067	.002	.192	.521
	3:00	.723 *	.067	.000	.559	.888
	4:00	.923 *	.067	.000	.759	1,088
2:00	1:00	- .357 *	.067	.002	- .521	- .192
	3:00	.367 *	.067	.002	.202	.531
	4:00	.567 *	.067	.000	.402	.731
3:00	1:00	- .723 *	.067	.000	- .888	- .559
	2:00	- .367 *	.067	.002	- .531	- .202
	4:00	.200 *	.067	.025	.035	.365
4:00	1:00	- .923 *	.067	.000	-1088	- .759
	2:00	- .567 *	.067	.000	- .731	- .402
	3:00	- .200 *	.067	.025	- .365	- .035

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References

[1] J. Skousen, A.Rose, Etc., 1998, â € œ ***A Handbook of Technologies for Avoidance and Remediation of Acid Mine Drainage*** â €, the National Mine Land Reclamation Center Located at West Virginia University in Morgantown, West Virginia.

[2]. Fripp, Jon, etc., 2000, **Acid Mine Drainage Treatment,** Journal EMRRP ERDC-TN-SR-14, Baltimore, **USA.**

[3]. Widdowson, JP, in Munawar Ali, 2007, **"Utilization of Biological Resources Local For Passive Control of Acid Mine Water",** Journal of Soil and Environmental Science, Vol.7, No.1.

[4]. Ibrahim Eddy, 2009, **Environmental Degradation Due to Mining,** Proceedings of the National Seminar on Environment Handling After Mine, Palembang Oct. 2009, UNSRI Research Institute, ISBN 978-602-95695-0-6.

[5] Tresnadi, Hidir, 2008, **"Characteristics of Acid Mine Water in Mine Environmental PIT 1 Banko west, Tanjung Enim in South Sumatra,** Journal of Environmental Engineering, Vol.9 No.3, Jakarta.

[6] J. Skousen, A.Rose, Etc., 1998, â € œ ***A Handbook of Technologies for***

Avoidance and Remediation of Acid Mine Drainage â €, the National Mine Land Reclamation Center Located at West Virginia University in Morgantown, West Virginia.

[7] Government Regulation No. 82 of 2001, **Water Quality and Water Pollution Control.**

[8] Ibrahim Eddy, Endang WDH and Destry Fendianza, 2010, ***Evaluate the Effectiveness of Calcification Between The Inlet and Outlet Channel in the Handling of Acid Mine at Settling Ponds Sludge,*** Journal IATPI.

[9] Gomez, Kwancahai A., Gomez, 2010, ***Statistical Procedure for Agriculture Research***, 2 Edition, National Library, p. 194-221.

[10] Technical Guidelines for Management of Coal Mine Wastewater, 2008, the Ministry of Environment.