ESTIMATION OF ACID GENERATION IN COAL MINE WASTE

○ Lana SARIA Student Member Institute of Environmental Systems, Kyushu University
Takyuki SHIMAOKA Member Institute of Environmental Systems, Kyushu University
Kentaro MIYAWAKI Member Institute of Environmental Systems, Kyushu University

1. Introduction

Acid Mine Drainage (AMD) is the result of the natural oxidation of sulphide minerals, when exposed to the combined action of water and oxygen. It is considered as the worst environmental problem associated with mining activities (Peppas, et. al., 1999). Oxidation of sulphide minerals takes place through a complex series of reaction involving direct, indirect and microbial assisted mechanisms; some oxidation reactions result in acid generation, while other result in dissolution and mobilization of heavy metals. Pyrite (FeS_2) in the main mineral responsible for acid generation.

In this research, 2 types of tests; static test and column test were conducted to estimate acid generation and acid neutralization reaction rates, and to predict metal solubility and release rates.

2. Site Description and Material

The study site is located in PT. Berau Coal Mining, East Kalimantan, Indonesia. The mine waste (waste rock) originated from 3 pit mine dumps which has different dumping time. T1 is fresh overburden, R8 is less than 1 year dumped, and Q3 is more than 1 year dumped.

3. Past Results

Leaching test were conducted to determine the leaching of organic and inorganic components from coal mine waste. These tests are part of a kinetic test. Kinetic tests are use to confirm the findings static test. Leaching test indicates that in an overburden disposal, which is dumped a long time ago will raise of pyrite oxidation. Heavy metal concentration of leaching test has higher value than Japan`s Standard (JLT No. 46). From pH dependency test was found that the condition pH 2 would be supported by high heavy metal mobilization. This indicates that a treatment for heavy metal can be developed to save the environment for AMD (Saria, L. et al., 2003).

4. Methods

4.1 Static Test

Static tests evaluate the balance between acid generation and acid neutralizing processes. The two main approaches to static testing are the acid-base account and the hydrogen peroxide oxidation procedure. Current best practice for static tests comprises: net acid producing potential (NAPP) test and net acid generation. (NAG) test,. NAPP is determined by subtracting the estimated acid neutralizing capacity (ANC) and maximum potential acidity (MPA). MPA is calculated by determining the sulfur (S) content of the sample (Miller, 1997). Principles of tests, after neutralization is completed, by reaction with hydrogen peroxide, the remaining H_2SO_4, if any, is titrated with sodium hydroxide. The amount of NaOH needed is equivalent to the NAG of the material (expressed in kg H_2SO_4/ton material).

4.2 Column Test

This test is the small scale and specific test conditions have the capability of simulating site waste disposal. Once a day everyday, 100 ml of water was added to a column with a diameter 2.5 cm, length 30 cm and a content 100 grams sample. Sample was crushed to –4 mm and each sample had a different height in each column (figure 1 and table 1):

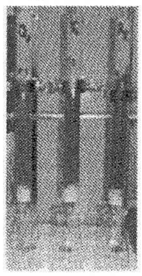

Table 1. Set-up sample for column test

Sample	Height	Density
T1	15 cm	1.36
R8	19 cm	1.07
Q3	17 cm	1.2

The analyses which can be conducted on the leachate water.

Figure 1. Leach column set-up for column test

5. Result and Discussion

5.1 Static Test

Table 2 shows that samples have NAGpH values less than 4, positive NAPP values greater than 10 kg H_2SO_4/ton, and sulphide S content greater than 3 %. From the results, all samples classified as a potentially acid forming-high capacity (Miller, 1997). This mean that all samples have indicated to high generate acid.

Table 2. Static test values

Parameter	Unit	Value		
		T1	R8	Q3
ANC	Kg H_2SO_4/ton	0	-0.55	-0.95
S	%	3.62	3.78	3.36
MPA	Kg H_2SO_4/ton	111	116	111
NAPP	Kg H_2SO_4/ton	111	116.	112
NAGpH		2	1.89	2.14
NAG	Kg H_2SO_4/ton	78.4	103	49

5.2. Column Test

pH profile from column test shown in Figure 2. There was an increase in 12 days and relative decrease after 12 days. After 21 days there was an increase. Sample T1 had higher pH than the other samples. Related with static test, sample T1 has NAPP lowest than the others. Increased of pH after 21 days couldn't yet indicate neutralization happened., because range pH still < 4.

Figure 3 shows oxygen reduction (ORP) of leachate. relative increased in 21 days and decreased after 21 days (Figure 3). ORP for R8 and Q3 was higher than T1 sample. High ORP leads to an increasing oxidation of pyrite by oxygen to consumption and by catalytic bacterial activity. After 21 days, pyrite oxidation decreased related with the increased of pH. It means oxygen consumption also decreased.

Figure 4 shows electrical conductivity (EC) was related with ion SO_4^{2-}. From the result, it can be seen that in 21 days EC had a lower value. It's correlated by the decrease of the SO_4^{2-} value (Figure 5). The result shows showed that the EC of sample R8 was greater than the others. This result correlated with static test which R8 has greatest NAPP, MPA, S content, and NAG.
Figure 5 shows SO_4^{2-} concentration of leachate. All samples concentration became lower with time. Sample T1 was lower than the others at day 3. It is possible that T1 have not produce high sulfate by pyrite oxidation yet

Table 3 shows the heavy metal concentration of leachate from these columns. Concentrations of some heavy metals were higher at first day than environmental standard in Japan. In this test, L/S = 1. At the real site, L/S is smaller and it is probable that the heavy metal concentration become higher than the data of this test. The results indicated that mine waste have risk of environmental pollutants release.

Table 3. Heavy metal concentration (mg/l) in 10 days:

Pit-day	Cr	Cd	Pb	Ni	Fe
T1-1	0.155	0.06	0.1	3.48	300
T1-5	0.01	0.02	0.01	0.15	6.96
T1-10	0	0	0	0	0.65
R8-1	0.18	0.39	0.1	3.65	332
R8-5	0.02	0.06	0.01	0.08	37
R8-10	0	0	0	0.02	4.31
Q3-1	0.36	0.1	0.16	2.43	605
Q3-5	0.04	0.02	0.01	0.12	36
Q-10	0	0	0	0.12	3.15

6. Conclusions

Based on the results of the analysis, the following statements are concluded:

- Static test shows that samples on this research classified as a potentially acid forming-high capacity.
- Leaching test indicates that in an overburden disposal, which is dumped a long time ago will raise of pyrite oxidation.
- Column test results indicated that water washed the samples as well as column test principal.

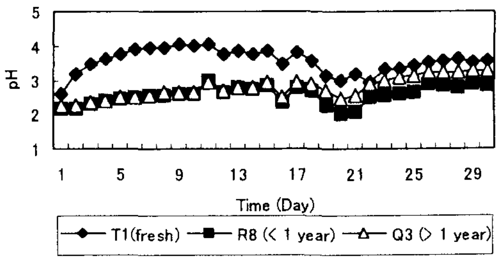

Figure 2. pH profiles of column test

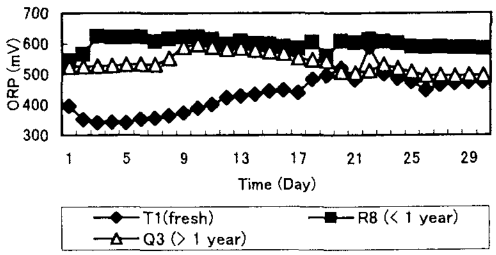

Figure 3. ORP of column test

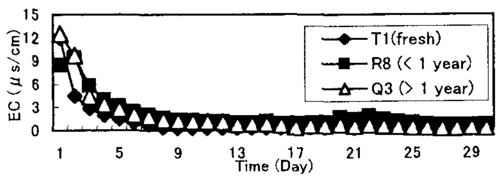

Figure 4. EC of column test

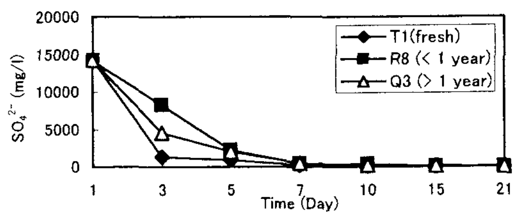

Figure 4. SO_4^{2-} concentration of column test

References

Miller, S.D. (1997), Advances In Acid Drainage: Prediction And Implications For Risk Management, 3rd International 21st Annual Minerals Council of Australia.

Peppas, A.K. et al. (2000) Use Organic Covers For Acid Mine Drainage Control, Mineral Eng., Athens, Greece.

Saria, L., Shimaoka, T., Miyawaki, K., (2003). "Elution Characteristics of Pyrite Oxidation In Coal Mine Waste." Proceedings of International Workshop on Earth Science and Technology, Fukuoka, Japan, 17-22.

Wildeman, T., et al., (1993), Wetland Design for mining Operations, Bitech Publishers Ltd., Canada..