Study of Fly Ash and Organic Material Utilization as AMD Control Layer of Dry Cover Method in Coal Mining: Indonesia Coal Mine Site Study Case

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1. Introduction

The common practice of AMD prevention in the mining site is a dry cover method; by placing potentially acid forming (PAF) rocks under non-acid producing (NAF) rocks hence minimize the water and oxygen infiltration. Currently, various studies have been investigating novel dry cover type as a measure in against AMD, which mainly focus in the ore metal mining. This includes the investigation of fly ash (FA)/biosludge mixture for dry cover layer in Sweden copper mine (Hallberg, R. O. et al., 2005). In Indonesia, the novel cover method is still rare to be constructed. Nearly most of the coal mines use the conventional dry cover method which likely face difficulties when there is limitation of NAF rock and low capacity in buffering pH. Moreover, the iron-oxidizing bacteria presence as AMD reaction catalyzer can also harm this system. Therefore, this study aims to overcome those problems with the utilization of the novel cover type using the by-products that easily can be found in the coal mine, FA and organic material (OM). This combination acts as a layer to consume the oxygen and AMD reaction inhibitor. This research is important to be conducted since the past research was only conducted in the metal mining, which have a different AMD formation due to the difference in mineralogy and geochemical properties of rock and site condition (Akcil & Koldas, 2006). In order to investigate the possibility of using these materials, a column leaching test in the laboratory scale was conducted. The leachate water behavior and the changes in the rock material within the column were observed. Furthermore, iron-oxidizing bacteria were also inoculated to the column in order to observe the effect of cover layer to the cell's activity.

2. Materials and Methods

PAF and NAF rock materials were sampled from Asam-asam coal mine, Indonesia. OM was collected from empty fruit bunches of palm oil plant while FA from Asam-asam coal steam power plant. For investigation of FA and OM utilization as cover layer, simulation of leaching test (d=100 mm and h=300;100 mm) was conducted. Dry and wet phase was applied, with the daily cycle heating by lamp at $\pm 35^{o}$C for 12 hours and 12 hours natural drying. After spraying with deionized water, leachate water was collected and analyzed for pH, electrical conductivity (EC), oxidation reduction potential (ORP) and further measurement for major cations-anions, metals and dissolved organic carbon (DOC). After 56 days, rock material changes were investigated. This consists of column direct observation, particle size distribution, XRD and XRF analysis, SEM-EDX and geochemical characterization. Furthermore, the same materials were used for investigation of iron-oxidizing bacteria inoculation to the PAF layer with the smaller column and 18 days (d=50 mm and h=150 mm). The similar leaching method was carried out to the column and leachate water was analyzed for pH, EC, Eh and dissolved metals.

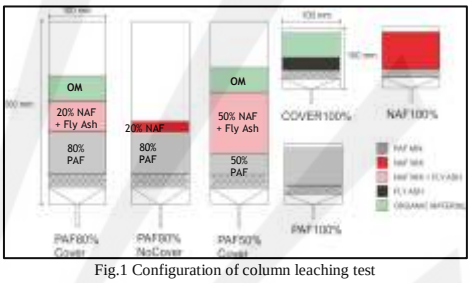

Fig.1 Configuration of column leaching test

3. Result and Discussions

Simulation of leaching test: From simulation result, columns with FA and OM cover showed near-neutral to alkaline pH (see Fig 2) with the decreasing EC compared to without cover. Decreasing of AMD generation was suspected, which also supported by lower sulfate anion in the leachate water of column with cover. The DOC of the leachate water with the cover was significantly higher, therefore implies that oxygen was consumed during the degradation process of organic material thus impede sulfide mineral oxidation.

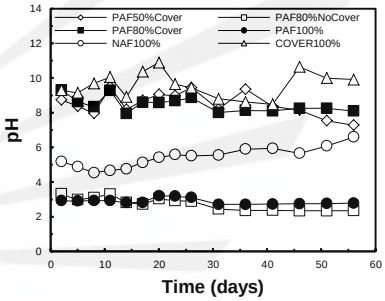

Fig.2 Column leaching test result

Disintegration of rock which resulted in the finer rock size after the leaching test was observed both in the PAF100% and NAF100% column. However, the PAF layer in the column with FA and OM shows different result with increasing particle size. The surface reaction of sulfide mineral and rock permeability were expected to decrease. SEM-EDX result also showed the occurrence of Ca and increasing Fe element on the PAF layer material of the column with the cover, which covered the surface. Interestingly, capacity of acid producing in the PAF layer with FA and OM was also decreased significantly compared to column without cover.

Iron-oxidizing bacteria inoculation: Based on the isolation-growth experiment result, iron-oxidizing bacteria from the Asam-asam site could thrive. From the inoculated columns, the bacteria were observed to be active in the column without cover meanwhile the bacteria growth activity was decreased gradually as the time passes in the column. After 12 days, the pH measurement was indifference with the non-inoculated column with cover. In contrary, the gap pH between inoculated and non-inoculated in the column without cover was kept stable until the end of the experiment. This result was also supported by Eh and EC measurement that informs the capability of cover in decreasing cell growth.

4. Conclusions

Leachate water improvement was shown in the column that used the FA and OM as an additional cover layer. Rock physical of PAF layer after leaching test also showed the changes which suitable for long-term AMD prevention strategies. Moreover, these materials were also effective to decrease the iron-oxidizing bacteria activity growth. As the conclusion, the utilization of FA and OM combination has beneficial impact of the dry cover construction in the coal mine. Appropriate techniques for dry cover construction with the additional layer needs to be studied further.