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Measurement of Methane (CH4) Emission from Spontaneous-Combustion Coal at an Open Pit Coal Mining Activity

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Abstract – Spontaneous-combustion coal is a natural phenomenon that often appears at an open pit coal mining activity. This phenomenon leads to the methane (CH_4) emission. It has been known that the CH_4 emissions contribute up to about 10% to the global warming, in which the emission from open pit coal mining activities contribute up to 34%. This study is designed to measure the CH_4 emission in a front mining at Air Laya Field, PT. Bukit Asam (Persero), Tbk, South Sumatra, Indonesia. There were 43 samples used in this study, which were observed randomly from a spot of spontaneous-combustion coal at a front mining. The resuts show that the mean CH_4 emission in the study area is about 1.14 ppm, while the cummulative CH_4 emission is about 49.05 ppm. The mean CH_4 emission observed in this study is smaller compared to that observed at an open pit coal mining in Australia, which is about 2.80 ppm.

1. INTRODUCTION

The phenomenon of spontaneous-combustion coal in open pit coal mining activities has long been studied by various experts. At the end of the 19th century (1871-1880) the studies on spontaneous-combustion coal were conducted intensively due to frequent occurences of mine fire in the UK. In the years between 1983 and 1992 the cases of spontaneous-combustion coal in open pit coal mines increased by 13%. In Indonesia, the cases of spontaneous-combustion coal in the open pit coal mining activities often occur in the front and the stockpile of a coal mine, particularly for low-grade coal (<5,900 kcal/kg). The spontaneous-combustion coal will lead to the emissions of greenhouse gases, mainly CO_2 and CH_4 gas emissions that cause environmental pollution, which contributes to the causes of global warming. In addition to having an effect on global warming, the spontaneous-combustion coal will also reduce the quality and quantity of coal production. The objective of this study was to design a measurement of CH_4 emissions and at the same time to perform the measurements at the mining front in Air Laya Mine of PT. Bukit Asam (Persero), Tbk, South Sumatra, Indonesia.

The studies on the spontaneous-combustion coal and mine gases in the open pit coal mining activities have been conducted by many researchers who studied the following aspects of the subject: physical properties, chemical properties, mechanical properties, geology, modeling, and the simulation of the causes of the spontaneous-combustion coal [1-10].

The studies on the mine gases generated by the spontaneous-combustion coal were only focused on the physical properties and chemical properties of the gases. Whereas the method of measurement, especially the taking, the measuring, and the processing and the analyzing of the samples were not fully explained. Therefore, it is very difficult to apply, because the operational cost was very expensive and the mobilization of equipment in the field is very difficult.

The measurement of the CH_4 gas was more intensively performed by means of chromatography, especially for the ambient conditions. Therefore, in this study a cheaper and simpler measurement equipment for CH_4 gas which meet the standards of calibration and validation was developed.

2. MATERIALS AND METHODS

The study on the emission of the CH_4 gas was conducted in Air Laya Mine (*TAL*) of PT. Bukit Asam (Persero), Tbk, South Sumatra, Indonesia with a total area of mining of 7.621 ha. The main variables of this study are the average and the cumulative magnitude of the emissions of CH_4 in ppm unit. The main equipment of the study of the CH_4 emission are multi gas detector and gas trap (chamber). The multi gas detector and the chamber are a set

equipment for catching the emission of the CH_4 that serves as a tool for measuring and the chamber serves as a trap of the CH_4 emissions. The CH_4 gas is a light gas, therefore when it comes out into the atmosphere, it will be very fast and difficult to detect, so that a tool is needed to trap the gas (Figure 1).

Figure 1 Measuring the Emission of CH_4 at the Front of Mine

Figure 1 shows a set of gauges for measuring the CH_4 emissions which is placed on the surface of the ground or the surface of the spontaneous-combustion coal. The CH_4 gas contained in the cracks in the underground or at the spontaneous-combustion coal will be trapped in the chamber and out through the small hole above the chamber, and the magnitude of the CH_4 emissions will be read by the multi gas detector. The length of time of observation of the CH_4 emission is for an hour in accordance with the Standard Operation Procedure (SOP) used for the measurement of CH_4 emissions.

The first observations of CH_4 gas emissions in Air Laya Mine include: the front of mines, the coal stockpiles, the non-mine areas, the dumping areas and the post-mining land by using cluster sampling. The cluster sampling was used in order to classify the wide area of Air Laya Mine into six groups. The observations of each cluster were done by using random sampling and as many as 73 samples were obtained. Out of all the observational data, only 43 samples that could be used to determine the magnitude of the CH_4 emissions, which were located on the spots of the spontaneous-combustion coal which were scattered in the mining front. The location of Air Laya Mine is a geologically complex region where there are many different types of coal ranging from low rank coal to high rank coal. Therefore, this location is very interesting to be observed, especially which regards to CH_4 emissions.

The normality of the data of the CH_4 emission from the 43 samples was tested by using the statistical method for a further analysis. The analysis by means of statistical methods will generate an average and a cumulative magnitude of the CH_4 emissions. The average magnitude of the CH_4 gas emissions is used to determine an average magnitude of the CH_4 emissions which is emitted out into the atmosphere, while the cumulative magnitude of the emissions of the CH_4 is used to determine the magnitude of the total gas emissions that come out from the front of mines due to open pit coal mining operations. The average and the cumulative figures of the CH_4 emissions obtained are then compared with other measurements as a basis of consideration of measurement results.

3. RESULTS AND DISCUSSION

The average and the cumulative emissions of CH_4 are indispensable for the characterization of coal in order to see the phenomenon of the gas emissions in the front of Air Laya Mine due to the open pit coal mining activities of PT. Bukit Asam (Persero), Tbk. An overview of the CH_4 emissions can be used to disclose the magnitude of the gas coming out into the atmosphere. The activities of measuring the CH_4 gas emissions from open coal mining operations in Indonesia have not been carried out intensively and the measurement methods have not been uniformly agreed upon. Therefore, the measurement of the CH_4 emissions being conducted is a new stage in the method of measurement being developed.

The validation of the data of the CH_4 gas emission uses the measurement results of other methods. The measurement results show a figure of 2.80 ppm for an average CH_4 gas emissions and 200 ppm for a cumulative CH_4 gas emissions [8]. The normality of the data of observations obtained from 43 samples is tested and it is found to be normally distributed and can be used for further analysis. The results of analysis show that the value of the CH_4 emissions by an average of 1.14 ppm is still lower than the average value of the CH_4 emissions of other previous researches [8] See Table 1.

Table 1 The Results of Measurement of the CH4 Emission

Method of Meausurement	Concentration of CH_4 Emission (ppm)
Saghafi (2009)	2,80
Yusuf et al (2015)	1,14

Table 1 shows that the emissions of the CH_4 gas which is conducted with the new measurement method is smaller than the above a methods of measurement. The difference in value is very reasonable because the measurement which is done in [8] in which the CH_4 emission which goes out of the surface is more dominant due to the presence of fractures that occur as a result of the activities of some existing coal mining companies in Australia, whereas the new measurement method shows a smaller value simply due to spontaneous-combustion coal. More intensive studies need to be done so that the data obtained will better represent the activities of open pit coal mining operations, especially in South Sumatra. Although the results of the analysis can still be debated, these measurements will open up a discourse that the studies on the emission of the CH_4 generated by spontaneous-combustion coal in open pit coal mining operations will be more intensively implemented in Indonesia.

The emission of the CH_4 gas generated by spontaneous-combustion coal occurs more intensively during the rainy season. This condition occurs because the material attached to the coal will be eroded by rain water that causes the pores of the coal to be open. The open pores of the coal cause oxygen to attach to the pores and exothermic reaction will occur that causes combustion to occur more intensively and the CH_4 emissions will go out into the air more intensively.

The descriptive statistical testing of the cumulative CH_4 gas emission was not performed considering that the objective of the study was just to see an overview of the magnitude of the emissions of CH_4 gas polluting the air. The magnitude of CH_4 gas which was exposed in the air on the front quarry amounted to only 49.05 ppm and the value was much smaller than the average cumulative emissions of the coal mines in Australia of 200 ppm [8].

The threatening problem is not the size of the cumulative emissions of CH_4 into the air, but the amount of the gas will accumulate in the air and the length of its staying time in the air is approximately 10 years. Thus, the more intensive the spontaneous-combustion coal occurs in the front of mines, the greater the amount of the CH_4 gas emissions that come out into the air, and the more intensive the process of the global warming will occur.

The mitigation of the CH_4 gas emission in the front of the open pit coal mines needs to be done considering the fact that the spontaneous-combustion coal would lead to declining of coal quality, decreasing of coal production, and the most important thing is its influence on the global warming.

4. CONCLUSIONS

The average concentration of the CH_4 gas emissions in the front of the coal mines of Air Laya Mine (TAL) in open coal mining operations is 1.14 ppm and that of the cumulative is 49.05 ppm. The values of the average and the cumulative magnitude of CH_4 gas emission are is still lower than those of the measurements [8].

A further study should be carried out, especially the one that develops the relationship between the temperature and the time of the occurrence of the spontaneous-combustion coal for different types of coal, ranging from low-calorie coal to high-calorie coal. By considering the variables of temperature and time, the characteristics of each type of coal will be acquired.

5. ACKNOWLEDGEMENT

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6. REFERENCES

1. Arisoy, A., Beamish, B. B., and Cetegen, E, et al., 2006, *J. Eng. Env. Sci, 30,* 193-201.
2. Carras, J. N., Day, S A., Saghafi, A., Roberts, O. C., 2015, Spontaneous Combustion in Open Pit Coal Mines-Recent Australian Research, Research Online, Coal Operator's Conference, University of Wollongong.
3. De-ming, W., Xu-yao, Q., Xiao-xing, Z., and Jun-jie, G., 2009, *Procedia Eart and Planetary Science*.1, 20-26.
4. Ejlali A., Aminossadati, S. M., and Ejlali, A., 2009, Numerical Analysis of Flud Flow and Heat Transfer through a Reactive Coal Stokpile. Seventh International Conference on CFD in the Minerals and Process Industries, CSIRO, Melbourne, Australia, 9-11 December 2009.

5. Guranova P., Zubicek, V., and Fiuraskova, D., 2010, *GeoScience Engineering*, Volume LVI, No. 4, 50-56.
6. Kaymakci and Didari, V., 2002, *J. Eng. Env.* Sci: 59-64.
7. Quintero J. A., Candela, S. A., Rios, C. A., Montes, C., and Uribe, C., 2009, *International Journal of Coal Geology*, 80: 196-210.
8. Saghafi A., 2009, Tier 3 Method for Estimating Fugitive Emission from Coal Mines, Research Online, University of Wollongong.
9. Sen R., Srivastava, S. K., and Singh, M. M., 2009, *Indian Journal of Chemical Technology*, Vol. 16, 103-135.
10. Zubicek V., 2008, *Geo Science Engineering,* Volume LIV, No. 4, 1-9.

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