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Research Paper

Study of the Effect of Proximate, Ultimate, and Calorific Value Analysis on Methane Gas Emission (CH_4) on Combustion of Coal for Sustainable Environment

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Abstract
Coal is a hydrocarbon fuel consisting of a mixture of substances containing carbon, hydrogen, oxygen, and containing less sulfur and nitrogen. Utilization of coal as fuel, especially in large scale causes methane gas emissions that can increase the impact of global warming, causing a decrease in environmental quality. Methane gas emissions in coal combustion are influenced by coal proximate and ultimate analysis. Proximate analysis includes moisture content, volatile matter, and fixed carbon, while ultimate analysis is carbon, hydrogen and oxygen. This study aims to determine the analysis of the effect of proximate, ultimate, and caloric value of methane emissions in coal combustion. This research is experimental, using quantitative method with descriptive and associative approach. The effect of proximate analysis, the lower the calorific value, the higher content moisture, the time and duration of coal combustion will be longer. Coal 5674 cal/g, burning time 65 min, combustion time 39 min, moisture content 14.85%, coal 5747 cal/g, burning time 60 minutes, duration of burning 31 min, moisture content 14.71%, coal 5617 cal/g, burning time 49 min, combustion length 28 minutes, moisture content 12.17%, while coal 6992 cal/g combustion time 38 min, combustion time only 4 min, and moisture content 3.53%. Volatile matter in coal will affect the incubation period, the higher the volatile matter of the incubation period the faster. Coal 5617 cal/g incubation period 21 min, volatile matter 39.20%, coal 5674 cal/g incubation period 26 min, volatile matter 38.39%, coal 5747 cal/g, incubation period 29 min, volatile matter 39,30 %. For coal 6992 cal/g incubation period 34 min, volatile matter 18.13%. The effect of ultimate analysis, the higher the carbon content, the higher the fixed carbon content, and the lower the hydrogen, the higher the calorific value of the coal and the less methane gas emissions. While the higher the oxygen content, the more burned the coal will be, the faster the incubation time and the longer burning time, so that the emissions of methane gas out into the atmosphere will be more and more raised.

Keywords
Coal, Proximate, Ultimate, Methane Emission

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1. INTRODUCTION

Coal is a hydrocarbon fuel composed of mixtures or mixtures of various substances containing carbon, hydrogen, and oxygen bonded in chemical bonds and containing less sulfur and nitrogen (Iqbaludin, 2012). Coal is chemically composed of three main components, physically bound water is called moisture, coal compound or coal matter is an organic compound consisting of carbon, hydrogen, oxygen, sulfur, and nitrogen, and mineral or mineral matter, inorganic, such as carbonate, pyrite. The use of coal as a source of fuel, especially in large scale will cause the impact of global warming, which causes the decline of environmental quality due to coal combustion, especially low calorie coal will cause gas emissions, one of methane gas emission (CH_4). As stated in Maulana (2016), the low rank coal combustion process will result in higher methane (CH_4) emissions compared to high calorie coal. Coal Methane gas is one of the greenhouse gases that ranks second after CO_2 (Lauder et al., 2012). The emissions of methane gas (CH_4) globally averaged 1.75-1.80 ppm with a global temperature rise rate of about 1-2 °C (Rizki, 2016). While the emission of methane gas (CH_4) at the open coal mining site at Tanjung Enim of 1.14 ppm is still below the global average. Methane gas emissions (CH_4) that occur in the coal combustion process is strongly influenced by the results of proximate analysis and ultimate from coal. The result of coal proximate analysis influencing the formation of methane gas emission (CH_4) in coal combustion process in this research are: (1) total water content (total moisture) consisting of free moisture and inherent moisture, (2) volatile matter, and (3) fixed carbon. The results of coal ultimate analyzes that influence the formation of methane gas emission (CH_4) in coal combustion process are coal forming constituents consisting of carbon, hydrogen, and oxygen. The scope of the problem in this research are: the influence of proximate analysis, ultimate, coal calorific value, methane gas emission (CH_4). While the objectives of the study are: (1) to analyze how the effect of proximate, ultimate, and coal calorific value to methane emissions for the environment is sustainable; (2) calculate how much methane gas emissions will occur in coal combustion, especially low calorie coal

2. EXPERIMENTAL SECTION

2.1 Coal Quality

Coal obtained from the mine will contain impurities (Sukandarrumidi, 2005). Impurities in coal are divided into 2, namely (1) inherent impurities, an innate impurity contained in coal. Formed at the time of coal formation process, when coal is still gelly. Inherent impurities include: gypsum ($CaSO_4 \cdot {}_2H_2O$), anhydride ($CaSO_4$), pyrite ($FeSO_4$), silica (SiO_2). This inherent impurities can not be eliminated can only be reduced by using clean coal technology; (2) external impurities, impurities derived from outside, arise during the mining process, among others, land derived from the overburden. External impurities can not be avoided, especially in open pit mining. There are many ways to find out the quality of coal, among others through coal quality analysis, ie direct analysis and final analysis (Syardilla, 2014).

2.1.1 Proximate Analysis

Proximate analysis is an analysis performed on coal which aims to find out: (a) moisture content, consisting of free moisture, ie free water content found in coal, inherent moisture, ie the bound water content formed together with the process coal formation, and total moisture, ie free moisture and inherent moisture combined; (b) ash content, is an organic substance left behind after coal is burned under standard conditions until a fixed weight is obtained. Ash content can be generated from innate impurities or derived from mining activities. Ash content according to (Pulung and Simon, 2008), has a chemical composition such as SiO_2, Fe_2O_3, Al_2O_3, MgO, and CaO; (c) volatile matter, are many substances that are lost if the coal is heated at a prescribed temperature and time, depending on the moisture content. Volatile matter is mostly flammable gas, such as hydrogen, carbon monoxide, and methane. Volatile matter affects the perfection of burning and the intensity of the flame. The content of volatile matter is closely related to the rank of coal, the higher the volatile matter content, the lower the coal quality; (d) fixed carbon, represents the amount of carbon present in the waste material after the moisture, ash, and volatile matter are removed.

2.1.2 Ultimate Analysis

The ultimate analysis is an analysis performed on coal to know the coal-forming elements, including the levels, carbon, hydrogen, oxygen, nitrogen, and sulfur present in coal.

2.2 Burning on Coal

Burning coal is a very quick reaction between coal and oxygen that produce the product. The oxygen here is air comprising 21% oxygen and 79% nitrogen (Daud, 2009). The optimal combustion process will occur if the required air requirements for the coal combustion process are met proportionately. Based on fire triangle theory, the supporting elements of the combustion process are oxygen, heat source, and fuel. Oxygen is the air required for combustion, the heat source is the source of the fire used for the combustion process, and the fuel is coal.The chemical reaction to the coal combustion process as written in Maulana (2016), is as follows:

$$C + O_2 \longrightarrow CO_2$$
$$C + \tfrac{1}{2}\,O_2 \longrightarrow CO$$
$$CO + ½O_2 \longrightarrow CO_2$$

2.3 Coal Gas Methane (CH_4) Coal

The coal combustion process can lead to greenhouse gases to the atmosphere that causes global warming. The methane (CH_4) gas as described in [9] is one of the greenhouse gases that has the potential to have a greater impact on global warming than carbon dioxide (CO_2) gases, because methane gas can cause greater heating effects, methane (CH_4) that already exist in the atmosphere can not be absorbed by plant chlorophyll so that methane gas will be more stable in the atmosphere than carbon dioxide (CO_2) gas that can be absorbed plants through photosynthesis.

This coal methane gas can come from natural sources as well as the source of human activities. Human activities as a source of methane gas as according to [9], among others, mining activities and use of fuel, farms, and landfills. The use of coal as an alternative fuel source for petroleum replenishes the impact of methane emissions, especially if the use of such coal is used as fuel in industries such as steam power plants, cement plants, fertilizer factories, and other small industries. Methane gas sources derived from human activities will have a greater impact than natural resources. According to [9] the amount of methane gas emissions derived from human activities is estimated to have reached 320 million tons/year, while the methane gas emissions from natural sources amounted to 208 million tons/year. Methane gas generated from the coal combustion process can cause the effects of global warming because the gas can cause an increase in the temperature of the earth. This is due to the presence of methane gas emissions in the Earth's atmosphere of long-wave radiation that penetrates to the Earth's atmosphere when reflected back in the form of infrared rays which normally returns to space, but with the emission of gas covering the Earth's atmosphere the infrared rays will be absorbed and reflected back to earth, causing the earth's temperature will increase, so that will affect the quality of the environment.

The increase in global temperature of the earth as described in (Waluyo, 2007), can cause sea levels to rise due to the melting of glaciers and icebergs in the polar regions, which in turn will lead to higher sea levels. This sea level rise will have a direct impact on the coastline and can lead to flooding on small islands or urban areas flat on the beach. This temperature rise can also cause extreme weather that will cause storms, droughts, hurricanes, and other weather phenomena that will have a direct impact on the social and economic life of humans. A rapid rise in global temperatures will also have an impact on ecosystems, where ecosystems must adapt to environmental conditions that can cause many species of plants and dead animals. In addition, humans will also experience various difficulties because it can impact on agriculture, water supplies, and forests.

Coal as sedimentary rock is composed of elements of carbon, hydrogen, oxygen, nitrogen, and sulfur. The carbon content contained in coal causes coal to become combustible. For coal, especially low calorie has a large amount of cleats so that oxygen will be able to easily enter into coal, causing the oxidation reaction in the coal. This oxidation reaction can cause heat to coal so that emission of methane gas (CH_4) occurs when coal is burned. If in the coal combustion process occurs a reaction that causes heat transfer or heat from the system to the environment, causing the temperature or temperature of the environment will increase. Heat or heat transfer will cause exothermic and endoteremic reactions. These exothermic and endothermic reactions will cause changes in the enthalpy of the reaction. Exothermic reactions occur when the system releases heat so that the change in its ental strength will be negative, whereas the endothermic reaction if the system absorbs heat and the positive changes are positive. The reaction of methane gas (CH_4) generation formation in the coal combustion process according to Rizki (2016), is as follows:

$$C_{(s)} + 2\,H_{2(g)} \longrightarrow CH_{4(g)} \qquad \Delta H = -47.9\ \text{kJ}$$

Another possibility the formation of methane gas (CH_4) (methanization reaction) with the reaction as follows:

$$CO_{(g)} + 3\,H_{2(g)} \longleftrightarrow CH_{4(g)} + H_2O_{(g)} \qquad \Delta H = -210.7\ \text{kJ}$$

$$CO_{2(g)} + 4\,H_{2(g)} \longleftrightarrow CH_{4(g)} + 2\,H_2O_{(g)} \qquad \Delta H = -165{,}0\ \text{kJ}$$

$$CH_{4(g)} + H_2O_{(g)} \longleftrightarrow CO_{(g)} + 3\,H_2O_{(g)} \qquad \Delta H = +206{,}2\ \text{kJ}$$

The reaction of methane gas formation as in reaction (6) is a one-way reaction, whereas the reaction of methane formation such as the reactions 7, 8, and 9 is a reversible reaction or reaction in two direction or reaction which occurs back, where the reaction that occurs from the substance of the reactant forming a product is called the forward reaction and the reaction that occurs from the product to form a reactant is called a back-reaction. Based on the reaction enthalpy 6, 7 and 8 are exothermic reactions, ie heat-releasing reactions because they have negative enthalpy values, whereas reaction Tontowi (2012) is an endothermic reaction, a reaction that absorbs heat because its enthalphy value is positive.

2.4 Method

This research is an experimental research with quantitative method, where. this research method of analysis is more focused on numerical data (numbers) are processed by using statistical methods (Sugiyono, 2012). This research will analyze how the effect of methane gas emission (CH_4) to proximate analysis, ultimat, and calorific value of coal.

This research activity for coal combustion process is done in Laboratory of Materials Processing Department of Mining Engineering Faculty of Engineering Sriwijaya University, while testing of proximate and ultimat analysis done in Laboratory of Mineral Technology and Coal (Tekmira) Bandung. The location of coal sampling conducted at PT. Bukit Asam (Persero), Tbk. Kertapati Palembang Pier Unit, which is a dock that serves deliver coal for various needs both at country and abroad. The calorific value used as the sample in this research is the calorific value of 5617 cal/g, 5674 cal/g, 5747 cal/g, and 6992 cal/g. Stages of activities undertaken in this study include:

2.4.1 Preparation Stages

This preparation stage starts from collecting materials and references related to research, then determining research variables and preparing equipment for coal combustion process.

2.4.2 Coal Sampling and Data Collection

The coal sample used in this research is from PT. Bukit Asam (Persero) Tbk, Kertapati Palembang Pier Unit, with a calorific value of 5617 cal/g, 5674 cal/g, 5747 cal/g, and 6992 cal/g. Sampling aims to obtain primary data and secondary data that will be used to complete this research.

2.4.3 Primary data

Data obtained directly from the coal combustion process and the results of proximate and ultimate analyzes. Primary data include: data of coal combustion gas emissions, data of proximate analysis, ultimat, and calorific value of coal

2.4.4 Secondary Data

Complementary data in completing the study. Secondary data are: map of coal sampling location, and coal transportation process from Tanjung Enim Mining Unit as mining location to Kertapati Palembang Dock Unit.

2.4.5 Burning and Coal Testing

Coal combustion activities by measuring gas emissions, including gas CH_4, CO, H_2S, O_2. Measurement of this gas emission by using Multigas Detector tool. Testing of coal samples include proximate test, ultimat, and calorific value of coal ie calories 5617 cal/g, 5674 cal/g, 5747 cal/g, and 6992 cal/g.

2.4.6 Processing and Data Analysis

Data processing in this research using statistical test with Microsoft Excel 2010 and SPSS version 22. As for data analysis, analyze the influence of proximate analysis, ultimat and calorific value of coal to methane gas emission (CH_4) on coal burning process for environment sustainable.

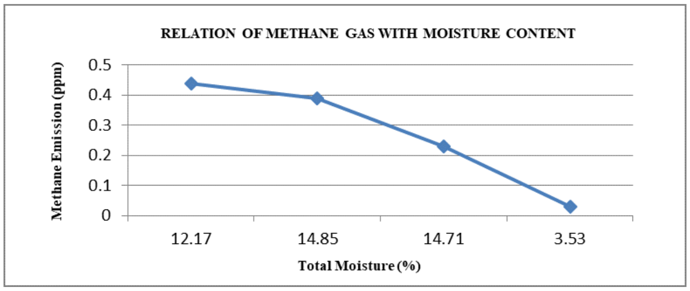

Figure 1. Graph of Emission Relation of Methane Gas with Moisture Content

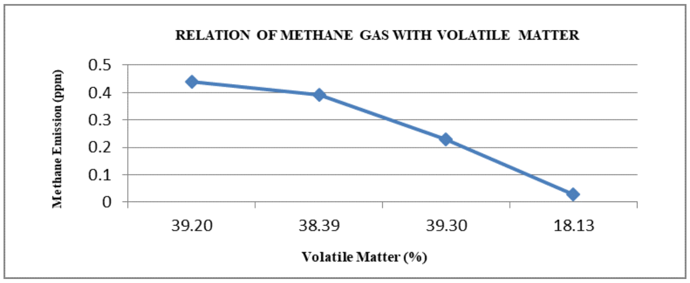

Figure 2. Graph of Emission Relation of Methane Gas with Volatile Matter

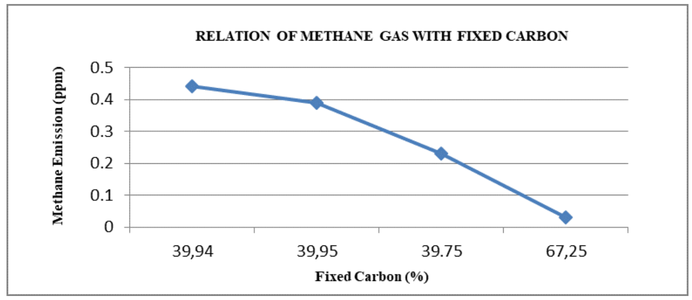

Figure 3. Graph of Emission Relation of Methane Gas with Fixed Carbon

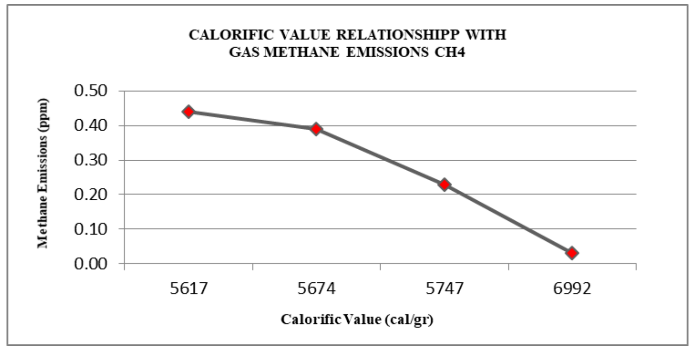

Figure 4. Graph of Calorific Value Relationship with Average Methane Gas Emissions

3. RESULTS AND DISCUSSION

3.1 Coal Quality

Coal is a heterogeneous compound containing elements of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), and sulfur (S). Coal used in this research comes from PT. Bukit Asam (Persero) Tbk. Kertapati Palembang Pier Unit. Coal in Kertapati Palembang Pier Unit is sent from PT. Bukit Asam (Persero) Tbk Tanjung Enim Mining Unit, where this coal comes from two mining sites in Tanjung Enim, Bangko Barat mining site, is sub bituminous coal with calorific value of 5617 cal/g, 5674 cal/g, 5747 cal/g and the location of Air Laya mining, is an anthracite coal with a calorific value of 6992 cal/g.

The quality of the coal can be seen from the analysis of proximate and ultimate analysis of coal. The result of proximate analysis, ultimat, and calorific value of each coal sample used in this study can be seen in Table1.

3.2 Effect of Proximate Analysis on Methane Gas Emission (CH_4)

Proximate analysis which will be used as variable in this research is moisture content which is inherent moisture, volatile matter, carbon fixed (fixed carbon). The three results of this analysis are used as research variables because it will affect the formation of methane gas emissions in coal combustion. Moisture content, especially inherent moisture as described in Sukandarrumidi (2005), is a chemically bonded water content in coal, formed along with the coal formation process, and affects the combustion process in coal. The three results of this analysis are used as research variables because it will affect the formation of methane gas emissions in coal combustion. Moisture content, especially inherent moisture as described in Sukandarrumidi (2005), is a chemically bonded water content in coal, formed along with the coal formation process, and affects the combustion process in coal. Moisture content according to Maulana (2016), it is also very closely related to the formation of methane gas emissions (CH_4), the lower the calorific value of coal then the burning time will be longer. Volatile matter (VM) according to (Wulandari, 2014); (Sukandarrumidi, 2005), very closely related to rank or rank of coal, the higher the volatile matter content, the lower the rank or rank of coal. Volatile matter affects the perfection of burning and the intensity of the flame. Burning perfection is determined by fixed carbon value. The higher the fixed carbon, the value of coal fuel ratio will also be higher.

Coal combustion process in Sukandarrumidi (2005), the high volatile matter content will accelerate the burning of fixed carbon, otherwise if the volatile matter is low it will complicate the process of burning fixed carbon. This is also related to the coal incubation period. The incubation process in coal combustion is a process that starts from the beginning of combustion (when the burner is turned on) until the gas exits from the combustion process. The higher the volatile matter, the carbon remains (fixed carbon) will be more easily burned, so the incubation period faster.

The results of proximate analysis, methane gas emission

Table 1. Results of Proximate and Ultimate Coal Analysis (Tekmira, Bandung)

Analysis Parameters	Sample Marks				Unit	Basis	Standart
	5617	5674	5747	6992			
PROKSIMATE ANALYSIS							
Moisture in Air Dry	12.17	14.85	14.71	3.53	%	adb	ASTM D. 3173
Ash Content	8.69	6.81	6.24	11.09	%	adb	ASTM D. 3174
Volatile Matter	39.2	38.39	39.3	18.13	%	adb	ASTM D. 3175
Fixed Carbon	39.94	39.95	39.75	67.25	%	adb	ASTM D. 3172
Gross Calorific Value	5.617	5.674	5.747	6.992	%	adb	ASTM D. 5865
ULTIMATE ANALYSIS							
Total Sufur	0.48	0.5	0.6	0.67	%	adb	ASTM D. 4239
Carbon	56.72	57.27	57.75	72.24	%	adb	ASTM D. 5373
Hydrogen	6.3	6.31	6.39	4.54	%	adb	ASTM D. 5373
Nitrogen	0.96	0.92	0.95	0.95	%	adb	ASTM D. 5373
Oksigen	26.85	28.19	2.07	10.51	%	adb	ASTM D. 3176

Table 2. Proximate Analysis Results, Methane Gas Emissions (CH_4), and Coal Burning (Source: Tekmira Results and Research, 2017)

Parameters	Calorific Value (cal/g)				Unit
Analysis Ultimate Analysis	5617	5674	5747	6992	
Carbon (C)	56,72	57,27	57,75	72,24	%
Hydrogen (H)	6,30	6,31	6,39	4,54	%
Oksigen (O)	26,85	28,19	28,07	10,51	%
Methane Emission (CH4)	0,44	0,39	0,23	0,03	ppm
Duration Burning	28	39	31	4	minute
Incubation period	21	26	29	34	minute

(CH_4), and coal combustion process for each calorific value of coal can be seen in Table 2. While the relationship between proximate analysis and methane gas emission can be seen in Figure 1, Figure 2, and Figure 3 .

Based on the results data in Table 1 and graphs in Figure 1, Figure 2, and Figure 3, generally see lower coal methane gas emissions, moisture content and volatile matter will be lower, and fixed carbon will be higher. The combustion time and length of coal combustion in Table 2 can be seen, the higher the moisture content (inherent moisture), the longer burning time and burning time, 5674 cal/g coal has 65 minutes combustion time and duration burning 38 minutes with moisture content of 14.85%, coal 5747 cal/g combustion time 60 minutes and duration of burning 31 minutes with moisture content 14.71%, for coal 6992 cal/g combustion time 38 minutes and duration burning only 4 minutes with moisture content 3.53%, while for coal combustion time and burning duration 5617 cal/g smaller than coal 5674 cal/g and coal 5747 cal/g which is 49 minutes and 28 minutes combustion time, this is because coal 5617 cal/g has moisture content which is smaller than coal 5674 cal/g and coal 5747 cal/g is equal to 12,17

This result has the same pattern as the result of research Maulana (2016), where it is said that moisture content especially inherent moisture is closely related to methane gas emission formation and combustion time. For coal incubation period will be affected by the volatile matter matter in coal , (Sukandarrumidi, 2005; Wulandari, 2014). Table 2 can be seen coal 6992 cal/g its incubation period is 34 minutes, because the smallest volatile matter is 18,13%, for coal 5747 cal/g has 29 minute incubation period and volatite matter content is 39,30%, coal 5674 cal/g incubation period 26 minutes with volatile matter content of 38.39%, while for coal 5617 cal/g incubation period 21 minutes and volatile matter content 39.20%.

3.3 The Effect of Ultimate Analysis on Methane Gas Emission (CH_4)

The methane gas emission (CH_4) occurring as a result of the combustion process is in addition influenced by the proximate analysis, also influenced by the ultimate analysis. The ultimate analysis which will be used as research variable is carbon (C), hydrogen (H), and oxygen (O). For sulfur (S) and nitrogen (N) coal Indonesia generally tend to be small. Based on the study [13], for Indonesia sulfur coal ranged from 0.34% -0.70%, and nitrogen ranged from 0.53% -1.20%. Coal used in this study

Table 3. Results of Ultimate Analysis, Methane Gas Emissions, and Burning Time (Source: Result of Tekmira and Research, 2017)

Parameters Analysis	Calorific Value (cal/g)				Unit
	5617	5674	5747	6992	
Proksimat Analysis					
Moisture Content (IM)	12.17	14.85	14.71	3.53	%
Volatile Matter (VM)	39.2	38.39	39.3	18.13	%
Fixed Carbon (FC)	39.94	39.95	39.75	67.25	%
Emisi Gas Metana (CH4)	0.44	0.39	0.23	0.03	ppm
Waktu Pembakaran (t)	49	65	60	38	minute
Masa inkubasi	21	26	29	34	minute
Lama Pembakaran	28	39	31	4	minute

Table 4. Relationship of Calorific Value and Methane Gas Emissions in Coal

Calorific Value (cal/g)	**Combustion gas emissions (ppm)**			
	CH4	**CO**	**H2S**	**O2**
5617	0.44	1185.57	5.57	19.57
5674	0.39	885.22	5.36	19.81
5747	0.23	17.48	0	20.43
6992	0.03	81.89	0	20.51

has sulfur content of 0.48% -0.67%, and nitrogen content of 0.92% -0.96%. The results of ultimate analysis data, methane gas emissions, and firing time of each calorific value used in this study can be seen in Table 3 below. Based on Table 3, the higher the carbon content in coal, the less methane gas emissions will be, this is because the higher the carbon content in coal means the higher carbon (fixed carbon) in coal and the lower the hydrogen content will mean the coal will have value the higher the calorie, and with the higher the calorific value, methane gas emissions will also be smaller. While for the oxygen content, the higher the oxygen content in coal then the coal will be more easily burned, so the incubation time will be faster and the combustion process (length of burning) will be longer, so the emissions of methane gas that will go out into the atmosphere also more and more.

3.4 The Effect of Caloric Value on Methane Gas Emissions (CH_4)

The combustion process in coal can cause gas emissions such as CO, CH_4, and H_2S. This emission of gas will essentially cause a decrease in environmental quality, especially if the combustion process is done on a large scale or industrial scale. Coal used in this study when viewed from the calorific value is in bituminous and sub bituminous rank. CH_4 methane gas emissions that occur in coal combustion process is influenced by the calorific value of coal used, where the higher the calorific value of coal, the resulting methane gas emissions will be smaller. The relationship of caloric value to methane gas emission (CH_4) as shown in Table 4 and Figure 4.

Based on Table 4 and Figure 4, it can be seen that the calorific value of coal will greatly affect the average amount of gas emissions to be generated, and the calorific value of coal is influenced by the carbon content in the coal. Coal with a calorific value of 5617 cal/g yields the highest average emission of CH_4 methane is 0.44 ppm with the lowest carbon content of 56.72%, coal calorie 5674 cal/g averaged CH_4 gas emissions produced by 0.39 ppm and carbon content of 57.27%, decreased by 11.36%. For coal 5747 cal/g the average methane emissions of 0.23 ppm decreased methane gas emissions 41.03%, with carbon content of 57.75%. While the average emissions of methane gas generated in coal combustion with calorific value of 6992 cal/g has a very large decrease, that is 86.95%, where the emissions produced only by 0.03 ppm and the highest carbon content of 72.24 %.

Coal calorific value 6692 cal/g comes from Air Laya Mine (TAL), where it is affected by the geological structure and topography of the area, ie the intrusion of igneous rocks in the form of anthracite rocks, causing the calorific value of coal to increase and higher than Bangko Barat coal.

4. CONCLUSIONS

Proximate analysis, ultimate, and caloric value will affect methane gas emissions (CH_4). The lower emissions of methane moisture content and volatile matter gas are also lower whereas fixed carbon will be higher. With the higher carbon content, and the lower the hydrogen content the higher the calorie value of coal will be and the smaller the methane gas emissions will be. As for the oxygen content, the higher the oxygen content, the more flammable the coal will be, the faster the incubation period, the longer burning time and the more methane gas emissions.

The average methane emissions for each calorific value of coal are calorific value of 5617 cal/g of average emissions of 0.44 ppm, 5674 cal/g of average emissions of 0.39 ppm, 5747 cal/g emissions 0.23 ppm, while the calorific value of 6992 cal/g, emissions averaged 0.03 ppm. Methane gas emissions in addition to being influenced by calorific values, also influenced by proximate and ultimate analyzes, the geological structure of the deposition area, the coal hydrocarbon bonds and the environment and the transport process. While the research variables that most influence methane emissions are fixed carbon which is one of the parameters of coal proximate analysis.

REFERENCES

Daud, P. (2009). Air Combustion Requirement Analysis for Burning Different Types of Coal. *Journal of SMARTek, Vol. 7 No. 4, pp. 279-280*

Iqbaludin, S. E. (2012). *Gas Content Coal Bed Methane Analysis with Desorption Test Method on CBM Well "X"*. Mining Engineering, UPN Veteran, Yogyakarta

Lauder, A., I. Enting, J. Carter, N. Clisby, A. Cowie, B. Hendry, and M. Raupach (2012). Offsetting Methane Emissions - An Alternative to Emission Equivalence Metrics. *International Journal of Greenhouse Gas Control, pp. 419-420*

Maulana, Y. (2016). Methane Gas Emission Characteristics (CH4) on Coal Burning of Calorie Values. *Environmental Science Program*

Pulung, K.-K. and S. Simon (2008). Characteristic of Burning Coal Bukit Asam as Ceramic Material. *Journal of Basic Sciences Volume 9 Number 2, pp. 127-128*

Rizki, F. (2016). *Methane Gas Emission Assessment (CH4) at Swabakar Coal at Stockpile West Bangko PT. Bukit Asam (Persero)*. Department of Mining Engineering, University of Sriwijaya

Sugiyono (2012). *Qualitative Quantitative Research Methods and R & D*. Alfabeta Publisher. Bandung, pp. 7-8, 35-36

Sukandarrumidi (2005). *Coal and Peat*. Gadjah Mada University Press (UGM)

Syardilla, P. (2014). *Ultimate Coal Analysis*. Medan Institute of Technology

Tontowi (2012). *Methane Gas Emissions from Dam and Dams*

Waluyo, C. E. (2007). *Global Warming Effect on Earth Environment, Research on Ozone and Pollution Assessment*. LAPAN, pp. 28-30

Wulandari, A. (2014). *Coal Quality Analysis*