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Thermal Characteristic of Flame As Quality Parameter of Biogas of Market Waste

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Abstract

A research on the thermal characteristics of the flame as a parameter to determining the quality of biogas from waste market materials. The study was conducted by observing the color of fire and flame temperature biogas on a Bunsen burner. Biogas purified with solution of KOH 1 M and 4 M. Figure flame obtained by using cameras and temperature of flame was measured using thermocouples at some point in the fire. The results showed that the quality of biogas can be observed from the color and temperature of the flame. The flames from biogas that not purified having color blue, this flames higher than the color red, which indicates the methane gas is still quite dominant as indicated by the CO_2 content of about 44% and methane as well as the other impurities about 56%. Results purfikasi using 1 M KOH cause the CO_2 content decreased 6.4% so the color of flame is more blue this is reflected in declining percentage of red flame color conversely percentage of colors blue flame increased to 68%. Purification using 4 M KOH still cause a decrease in the CO_2 content in biogas, although not too big, so the decline in the percentage of red and blue color flame is not too big. These results were confirmed by the temperature of flame on the third conditions flame of biogas flame, before purification after purification purfikasi with solution KOH 1M and 4M, both on the temperature distribution flame horizontally or vertically. At the flame of biogas before purification, the flame
temperature lower than the flame after purified.

I. INTRODUCTION

Energy problems in Indonesia is very urgent that needs to be solved immediately, along with the increasing number of population resulted in an increase energy consumption and decrease the amount of energy availability. The domination of fossil

energy should be terminated immediately saw the potential of other energies is still very abundantly, especially based on renewable energy. Additionally, the magnitude of the potential of biomass in Indonesia which is supposed to be one very large source of energy that has not been used. Organic wastes can be harnessed into alternative energy, such as rice husks, corn cobs, coconut fiber, etc. Garbage is not manageable and let to piled will lead to increased environmental effects as it will sparked establishment of methane gas global warming, where the methane gas has 23 times destructive force of more powerful than carbon [1].

The research making use of waste as a source biogas has done much [2,3,4]. Biogas is a fuel that has a dominant composition of CH_4 and CO_2. The presence of CO_2 in the fuel lowers the combustion reaction rates [5] so the quality of the fuel decreases. In order to overcome this problem, a lot of research had done to reduce the CO_2 content in the biogas by conducting purification using NaOH, KOH, $CaCO_3$, etc. Results many research has been proved that the purification of biogas able to lower the the CO_2 content in the biogas. Various studies have been conducted to determine quality of the biogas fuel purification process results. In the study, the determination of the quality of biogas which is indicated by a decrease in CO_2 was analyzed by the rate of propagation of the fire, where CO_2 reduction causes the rate of propagation of fire is increasing.

Research of usage of fire temperature and colour as fuel parameter have been done. Najib and of Darsopuspito (2012) conducting research of downdraft gasifikasi with colour parameter and fire temperature of syngas, where level of content of flammable gas shown with colour of blue fire [6,7,8, and 9]. Hadi and Dasopuspito (2013) conducted a study of gasification with AFR variation to determine the quality of the syngas fire form flame temperature and composition as well as the flammable gas calorific value using a bomb calorimeter in which on the syngas with a high calorific value generated a high flame temperature and flame color blue [10]. Harihastuti, et al (2016) conducted a study to know the quality of biogas using a gas appliance Chromatography [11].

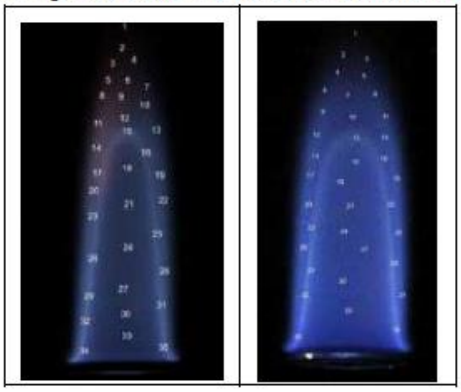
From a number of studies to determine the characteristics of fire syngas, is still widely used equipment that is relatively expensive, namely is calorimeter bomb to determine the value of heat and gas chromatography to determine the composition of gas. Required research to know the quality of a gas fuel with equipment and way of which is easy to be conducted and cost is not expensive.

II. RESEARCH METHODS

Biogas as research material obtained from digestor output with the main material of organic market garbage (vegetables) which given starter in the form of cow dung and addition of rice straw to increase C / N ratio. Biogas reactor is made of plastic drum

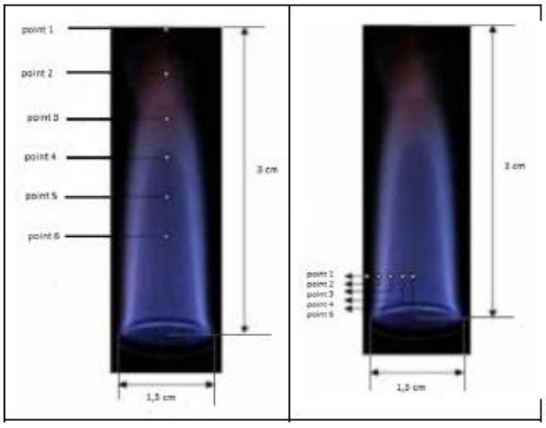
with circle diameter 58 cm and height 93 cm. The resulting biogas is accommodated in several storage tanks which each have the same volume. Biogas from storage tank was then purified by using 1 M and 4 M. potassium hydroxide (KOH) solution. The composition of carbondioside (CO_2) from biogas before and after purification was measured and tested by its flame with parameters of color observation and fire temperature.

The research equipment is form of one unit of biogas purifier and gas analyzer. Colour fire analysis using application software on fire images taken with Fujifilm camera with 1280 x 720 so that resolution, resulting in fire color distribution that can be compared between red and blue fire color. The fire temperature is measured by K type thermocouples at some point in the fire in either horizontal or vertical positions.



(a) (b)

Figure 1. The distribution of fire color on the biogas flame
(a) before purification (b) after purification



(a) (b)

Figure 2. Distribution of flame temperature measurement points
(a) the vertical position (b) the horizontal position

III. DISCUSSION

Have been conducted by research of characteristic of termal flame of biogas of market waste materials. Testing of composition of karbondioksida of biogas before and after purifikasi with KOH solution 1 M and 4 M shown at Tables 1

Table 1. Composition of market waste biogas

Composition	Before purification	After purifikation	
		1 Mol	4 Mol
Carbon dioxide, CO_2	44,2 %	6,4 %	6,56 %

From result of composition test with gas of analiser at Tables 1 seen that purifikasi with solution of KOH can decrease content of CO_2 in biogas till reach 6%. Solution of KOH 1 M and 4 M did not show result of which is significant , that indicating purifikasi at both solutions have reached saturated condition. The decrease of CO_2 content in biogas is strengthened by fire color and temperature of fire flame test results.

Result of examination of fire colour shown at Figure 4. At these the picture seen, that the percentage of blue flame color before purification seen around 65% and red fire colour only around 45%. After conducted by purification with KOH 1 M seen fire colour composition of change, where blue colour mount until around 72% and red fire colour get down to around 35%. This indicates that KOH 1 M purification is able to decrease KOH content effectively. In KOH 4 M purification, the change of fire color composition is almost identical to purification with KOH 1 M, where the blue fire color reaches about 75% and red fire color is about 33%.

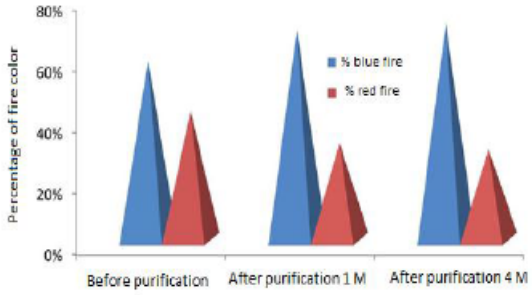


Figure 3. The distribution of the fire color of biogas

Result of examination of fire temperature shown at Figure 4 and 5. At Figure 4 shows the fire temperature distribution at the horizontal fire measurement. At those picture

seen that before purificationi, fire temperature seen lowest, where highest value of fire temperature only reaches around 275 °C. As for fire temperature at biogas after conducted purification with KOH 1 M seen higher horizontal fire temperature distribution, with highest temperature reach 345 °C. At purifikasi with KOH 4 horizontal M fire temperature distribution seen slightly increased, where highest termperatur reach around 350 °C.

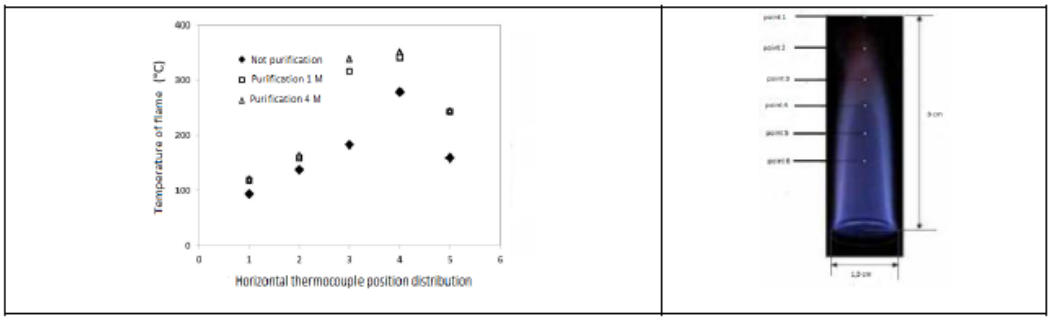


Figure 4. Distribution of horizontal biogas flame temperature

The result of the vertical fire temperature test is shown in Figure 5. In the figure it appears to have the same trend as the horizontal temperature test, where the fire temperature before purification has a relatively lower temperature with the highest temperature reaching about 475 ° C. As for after purification the highest fire temperature reached more than 600 °C both in purification with KOH 1M and 4M.

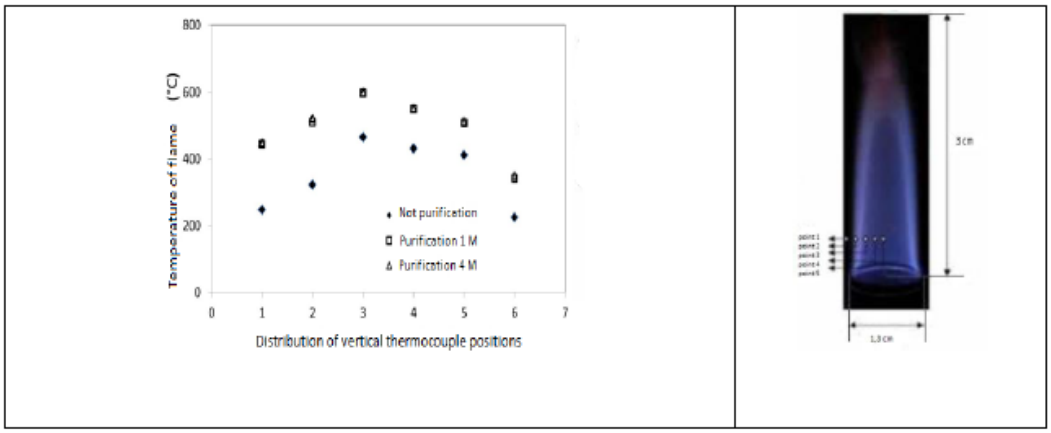


Figure 5. Distribution of vertical biogas flame temperature

From result of this research seen that quality of good biogas (content of CO_2 low) can observed from its flame colour. This matter is proved by biogas with content of

CO_2 low, percentage of blue fire colour mount and percentage of downhill red fire colour. Besides, this result is also strenghtened that a] flame with content of CO_2 low, temperature mount. This matter as according to research of Ilminnafik (2010) expressing that existence of CO_2 will reduce the rate of combustion reaction.

IV. CONCLUSION AND SUGGESTION

Have been conducted research of characteristic of ternal flame at biogas of market waste materials with purification use KOH 1M and 4M. Results of research are:

1. Purifikasi use KOH 1 M and 4 M can degrade content of CO_2 until 6 %.
2. Degradation of content of CO_2 cause change of fire colour composition, where at flame with high CO_2, percentage of blue fire colour is higher the than red colour. Decrease in CO_2 causes the percentage of blue color decreases, which causes the percentage of red color increases.
3. These results are reinforced by fire temperature measurements, where in the fire dominance color blue, fire temperature is higher. More and more Increased fire percentage of fire blue color, fire temperature is increasing.

This research still needs to be continued by using other software so it can perform a fire color analysis that can be used as a standard fuel quality determination parameter.

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