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Research Article

ANALYSIS OF CHARACTERISTIC OF COMBUSTION FLAME FROM BIOGAS FUEL MIXED WITH BUTANE

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A B S T R A C T

The rapid use of fossil energy makes the supply of fossil fuels decreasing every year. One of alternative energies which can be developed in the rural area of Indonesia is biogas. In this study, the biogas will be mixed with fuel which has a higher heating value, namely butane. The method used is comparing the characteristics of pure biogas fire, biogas mixed with 10% -50% butane and pure butane using bunsen burner with premixed combustion. The characteristics of flame observed during the research is the color, cone and temperature of flame using bunsen burner with premixed combustion. Based on the result of the study about the color, cone and temperature of flame, there is an increase in every addition of butane. The increase is caused by the energy released by the higher fuel in each butane addition. Based on those things, it can be concluded that the addition of butane to biogas can improve the quality of biogas.

INTRODUCTION

The increasing use of fossil energy each year makes the supply of fossil fuels each year less and less. The energy crisis has a significant impact on the Indonesian economy, especially in remote areas [1]. One alternative energy that can be developed in rural areas of Indonesia, especially villages is energy derived from agricultural and livestock waste. One of the livestock waste that can be utilized as an alternative energy is cow dung waste [2].

Biogas from cow dung is an environmentally friendly fuel because it comes from fermentation process of organic waste containing methane gas (50% -70%), CO_2 (30% -40%), N_2 (1% -2%), H_2O (0 , 3%), H_2 (5-10%) and H_2S (0-3%). Other contents of biogas such as CO_2 and N_2 are methane gas impurities that have a bad effect in combustion. The adverse effects of CO_2 and N_2gases are to decrease the burning calorific value resulting in low burning energy and lower combustion reaction rate thus requiring longer combustion [3]. Several research efforts have been made to make biogas a high-quality fuel through the mixing of higher energy fuels. Researches that have been conducted in recent years on biogas quality improvement are done by mixing between biogas and various types of hydrocarbons [4]. Butane is one of two saturated hydrocarbons with a chemical formula C_4H_{10} which has a colorless and flammable property which has a heavier density than air [5].

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Biogas has very low combustion characteristics, mixing biogas with butane is expected to improve fire characteristics to be better. [6].

RESEARCH METHODOLOGY

This research uses experimental method, that is the method used to test the effect of butane mixing on fire quality. Mixing biogas with butane using bunsen burner. In this study, it will compare the characteristics of pure biogas fire with the biogas of butane mixture with butane content of 10%, 20%, 30%, 40%, 50% and pure butane. This test aims to see the color of fire, cone height and temperature of fire..

The tools used among others

- Bunsen burner
- Gas pipe ¼
- Balloon
- Matches
- Knives
- Gas valve
- Camera
- Computer
- Compressor

Materials used are:

- Biogas
- Butane

Stages of Gas Mixing

The biogas and butane mixing step is carried out as in Figure 1

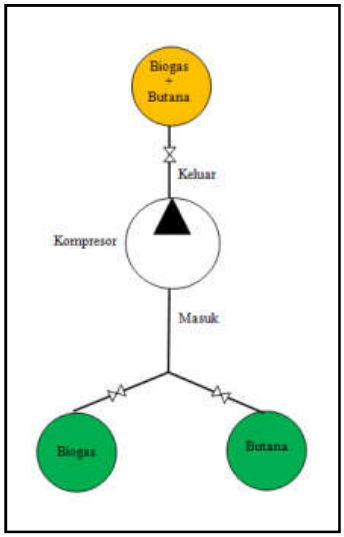


Figure 1 Gas mixing

The control variable from the research is as follows

1. BG100 (100% biogas)
2. BG90Bu10 (90% biogas - butane 10%)
3. BG80Bu20 (80% biogas - 20% butane)
4. BG70Bu30 (biogas 70% - butane 30%)
5. BG60Bu40 (biogas 60% - butane 40%)
6. BG50Bu50 (50% biogas - 50% butane)
7. BU100 (100% butane)

After obtaining the composition of the gas in accordance with the specified continued in the combustion stage using bunsen burner to observe fire characteristics, such as figure 2,

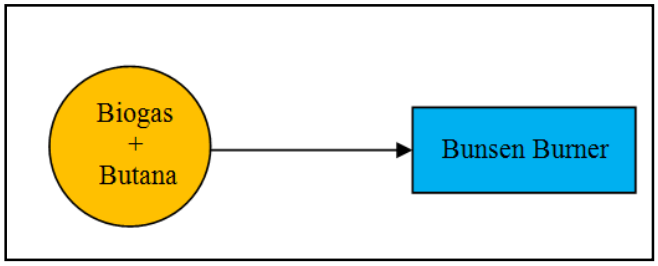


Figure 2 Bunsen burner burning process

Fire cone height measurements are performed on the inner fire cone (h) and the outer fire cone (H) such as figure 3. Stages of measuring the height of the fire cone in biogas are done by using a bunsen burner.

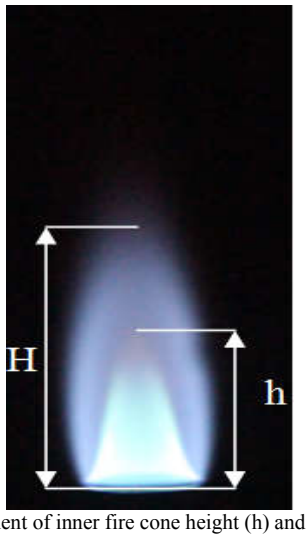


Figure 3 Measurement of inner fire cone height (h) and outer fire cone (H)

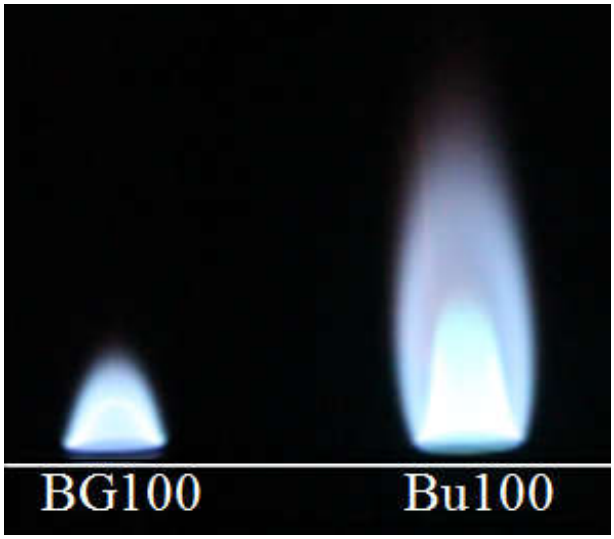
Temperature measurement is performed at one of the highest temperature points at the reaction zone, such as figure 4.

Figure 4 Measurement of flame temperature value

RESULTS AND DISCUSSION

Data Testing Results

The flame of pure biogas and pure butane produces a fire cone as shown in figure 5, data on fire color, fire cone height and fire temperature, of combustion is used to compare combustion results with mixtures of biogas with butane



A). B).

Figure 5, a). Flame of pure biogas and b).Flame of pure pure butane

Flame color, fire cone height and temperature from pure biogas combustion and pure butane can be seen in Table 1

Table 1 Flame characteristics of pure Biogas and Pure butane

	Biogas	**Butane**
Flame color	Red : 45,07%, Blue : 54,93%	Red : 43,66%, Blue : 56,34%
Fire cone height	h : 0,47 cm, H : 0,99 cm	h : 1,71 cm, H : 3,60 cm
The Value of Flame Temperature	864,2 °C	1172,3°C

The height change of the inner and outer fire cones from the burning of biogas from cow manure mixed with 10% -50% butane can be seen as in Figure 6.

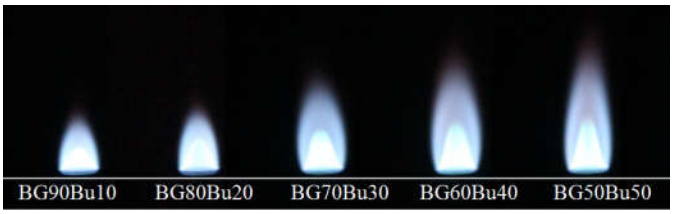


Figure 6 Changes in inner and outer fire cone height from combustion of biogas mixture with butane 10% -50%

Test Fire Color

From this fire color image (figure 6) then look for RGB value. This RGB value is used to obtain the percentage of fire color. The way it does is scan the color percentage of RGB value using image-j software, the result as in Figure 7

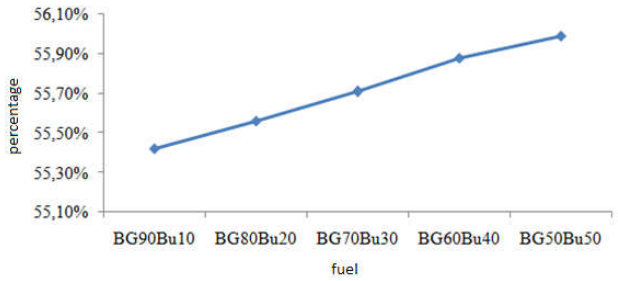


Figure 7 Percentage of the RGB values of fuel

In the test the percentage value of pure blue biogas RGB from cow dung has a percentage of 54.93%. This value when compared to the blue RGB value of the biogas mixture with butane on the graph shows an increase. This happens in every addition of the percentage of butane, although its value is still below the pure butane that is equal to 56,34%.

The blue color is generated because the fuel is perfectly mixed using the premixed combustion method, where fuel and air mixes itself on the bunsen burner. This is in accordance with the expressed Putri [7] where the blue color in the combustion process indicates that the fuel has been mixed perfectly with the air. In another study expressed by Renilaili [8] high heating values can be seen directly from the blue color.

High Value of Fire Cone

The high value of the fire cone in this study l was the change in the height of the inner fire cone (h) and the height of the outer fire cone (H) as shown in figure 8.

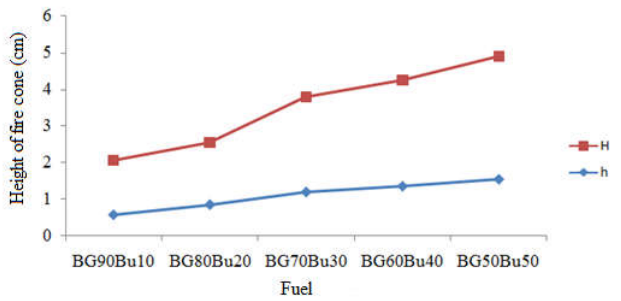


Figure 8 Height of deep fire cone (h) and outer fire cone (H).

On the high test of the inner and outer cone of pure biogas (without mixed butane) has a conical height (h) of 0,70 cm and an outer fire cone (H) of 0,99 cm. This value when compared to the height of the inner fire cone and the outer flame of biogas mixed with butane indicates an increase in each addition of the butane percentage. High values of the inner and outer fire cones of the biogas and butane mixture are still below the height of the inner and outer cone of pure butane ie the inner cone height (h) of 1,71 cm and the outer cone (H) of 3,60 cm

This increased inner and outer cone height proves that the addition of butane gas to biogas can increase the calorific value of the fuel. The increase in fire height is closely related to the energy produced by the fuel [9].

The Value of Flame Temperature

From the results of biogas research with 10% -50% butane mixture is taken fire temperature data to know the trend of increasing temperature in each fuel, as in figure 9.

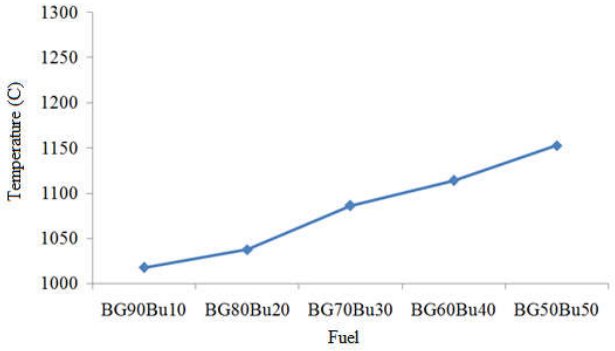


Figure 9 Graph flame temperature of fuel

In testing the temperature of pure biogas fire has a temperature of 864.2 ° C. This value when compared to the biogas mixed with butane gas on the graph shows an increase in temperature in each butane percentage increase, but this value is still below the fire temperature of the butane burni that is 1172.3 ° C, as shown in Figure 9. The increase in temperature occurs because biogas is mixed with a gas that has a higher calorific value so it can make the biogas temperature becomes increased. This is in accordance with the opinion of Lee and Hwang [10] who said to convert biogas that has a low quality then it needs mixing with a fuel that has a higher quality. Previous studies such as Zhen *et al* [4] that mix biogas with hydrogen with rising temperature trends as well when biogas is mixed with butane.To convert biogas that has a low quality then it needs mixing with a fuel that has a higher quality [10]. Temperature increase occurs because biogas is mixed with a gas that has a higher calorific value that can make the biogas temperature increased. Previous research mixing biogas with hydrogen [3] has the same trend in increasing temperature.

Comparison between biogas and butane mixture and biogas with hydrogen mixture, as shown in Figure 10.

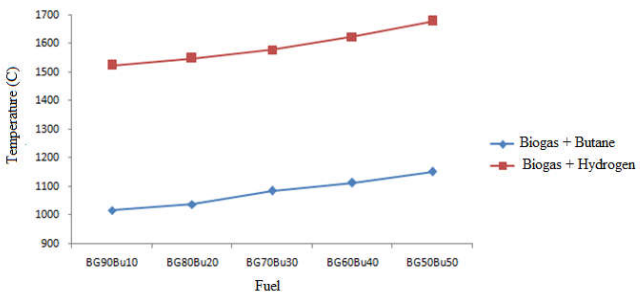


Figure 10. Comparison of flame temperature from biogas combustion mixed with butane to pure hydrogen

From Figure 10 it is seen that there is an equation that the value of the biogas flame temperature will increase in temperature when added with fuel having a higher calorific value. The heating value of butane gas and hydrogen gas is higher than the calorific value of biogas from cow dung. While the calorific value of herbogen gas is higher than the calorific value of butane gas. Figure 9 shows a mixture of butane and biogas graphs whose temperature values are lower than the temperature values of the biogas and hydrogen gas mixtures.

CONCLUSION

From the analysis of fire combustion characteristics of biogas with butane mixture using premixed method which include fire color, height of fire cone inside and outside and temperature of fire summed up things as follows:

1. From the combustion of pure biogas, biogas with 10% -50% butane mixture and pure butane there is an increase in the percentage of blue RGB value in each addition of butane to biogas
2. The test results of the high cone inside and outside of pure biogas, biogas with 10% -50% butane mixture and pure butane that is the height increase inner and outer cone in each addition of butane in biogas dikarnakan energy owned butane higher than in biogas
3. From the measurement of pure biogas temperature, biogas with 10% -50% butane mixture and pure butane ie there is an increase in temperature due to the calorific value found in butane higher than in biogas.

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