International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 5 ǁ May 2023 ǁ PP. 523-527

Analysis of Refined Biogas Fuel Consumption in Internal Combustion Engine 110 CC

Rudy Sutanto[1], I Gede Bawa Susana[2]
[1,2] *Departmen of Mechaical Engineering, Faculty of Engineering, Mataram University, Mataram, Indonesia.*
Corresponding Author: r.sutanto@unram.ac.id

Abstract
One alternative energy that is environmentally friendly as a substitute for fossil fuels is biogas. Biogas is energy in the form of gas which is dominated by methane gas which can be used as fuel for internal combustion engines. This study aims to determine the effect of flow rate in the purification process using coconut shell charcoal adsorbent on the consumption of biogas as fuel in 110 cc combustion engines. The method used in this study is an experimental study, the flow rate in the biogas purification process with variations in flow rates of 2 lt/minute, 4 lt/minute, 6 lt/minute, 8 lt/minute, and 10 lt/minute. The results of biogas purification will be taken for testing on the performance of internal combustion engines with loading variations of 5, 10, 15, 20 and 25 kgf. The results showed that the effective fuel consumption of the engine showed that biogas type AR10 had the best quality because it had the lowest effective fuel consumption value with the highest effective power when compared to biogas types AR0, AR2, AR4, AR6 and AR8. The lower the SFCe value indicates the level of efficiency in using fuel for the power generated the better.

Keywords: *Biogas, internal combustion engines, fuel consumption, effective power*

Date of Submission: 07-05-2023 Date of acceptance: 18-05-2023

I. INTRODUCTION

Biogas is a renewable energy that is currently being developed as a substitute for petroleum energy sources. In general, biogas itself consists of methane (CH_4) 50% - 70%, carbon dioxide (CO_2) 30% - 40%, hydrogen (H_2) 5% - 10% and other gases in small quantities [1]. The content of CO_2 in biogas is still quite large, in the use of biogas as a new renewable energy, it is necessary to carry out the process of purifying biogas from carbon dioxide gas (CO_2) in biogas.

One of the methods to separate methane gas (CH_4) from carbon dioxide gas (CO_2) in the biogas content can be done by adsorption method. Several studies on the use of adsorption methods in biogas purification have been carried out. Purification of biogas by the adsorption method uses activated carbon to reduce CO_2 levels by 10.503% in biogas [2]. Purification of biogas by adsorption method using activated carbon to reduce H_2S levels from hospital liquid waste biogas [3]. Optimal H_2S adsorption process is shown in the use of 14 mesh sized activated carbon.

Biogas used as fuel for motor fuel in this study first went through a purification process using the adsorption method with coconut shell charcoal adsorbent material. In this study, it is expected that the methane (CH_4) gas content in biogas can increase and the CO_2 gas content can be reduced in order to obtain good quality biogas. This study examines the effect of variations in the flow rate of biogas in the biogas purification process.

Testing the performance of an internal combustion engine is important to determine the value of the performance parameters of an internal combustion engine. Effective power is a useful power that drives the load where the amount of effective power depends on the amount of torque generated. Effective power can be found using the following equation:

$$N_e = \frac{2\pi \cdot n \cdot T}{60} \qquad (1)$$

Where :

N_e = effective power (Watts)
n = number of revolutions (rpm)
T = torque (Nm)

Fuel Consumption is a measure of fuel consumption by an internal combustion engine, usually measured in units of volume of fuel used per unit of time.

$$FC = V \times 60 \qquad (2)$$

Where :

FC = fuel consumption (lt/hour)

V = fuel volume (lt/minute)

Effective Specific Fuel Consumption is a value that shows the amount of fuel consumption that can produce one power in a certain time. The greater the SFCe value, the lower the performance of the engine (the more wasteful it is), as well as the SFCe which is a value that shows the amount of fuel consumption that is capable of producing one power in a certain amount of time. The greater the value of SFCe, the lower the performance of the machine.

$$SFCe = \frac{FC}{Ne} \quad \ldots\ldots \quad (3)$$

Where :

SFCe = spesific fuel consumption effective (lt/watt.hour)

FC = fuel consumption (lt/haur)

Ne = effective power (Watts)

In the biogas purification process with a flow rate of 10 lt/minute which was passed into coconut shell ash, the methane gas content was 40.954% while CO_2 gas was 34.894%. This shows that there was an increase in methane gas levels by an average of 2.62%, while for carbon dioxide gas levels there was also an increase of an average of 3.82%. [4].

The results showed that unpurified biogas contained methane gas content of 49.7%. After purification using limestone sediment adsorbent ($Ca(OH)_2$) the highest concentration of methane gas (CH_4) was obtained at a biogas flow rate of 10 lt/minute of 91%. While the concentration of carbon dioxide gas is absorbed perfectly for all variations in biogas flow rate. [5]

II. RESEARCH METHODS

The tools used in this study were: ½ pk compressor, digester, bucket, gas faucet, 110 cc internal combustion engine, digital balance, pipe cover, 2" pipe, plastic, flow meter, biogas pump, gas hose, mesh filter. The materials used in this study were: water, coconut shell charcoal, EM-4, pipe glue, cow dung

This study uses cow dung as the main ingredient in the production of biogas. The ratio of mixing cow dung with water is (1: 1) or 500 liters of water with 500 liters of cow dung. Biogas purification uses five variations of the flow rate of biogas purification, namely 2, 4, 6, 8, and 10 lt/minute and coconut shell charcoal as an adsorbent. The results of biogas purification will be taken for testing on motors with load variations of 5, 10, 15, 20 and 25 kgf.

Prior to the refining process, the biogas in polyethylene plastic is pumped first to flow the biogas into the flow meter by adjusting the flow rate variations according to what was studied, namely 2, 4, 6, 8 and 10 lt/minute and flowed to the coconut shell charcoal adsorbent so that it becomes biogas. which has been purified then immediately accommodated in polyethylene plastic. Each variation of the flow rate has its own plastic container measuring 100 cm x 100 cm before the next testing process is carried out.

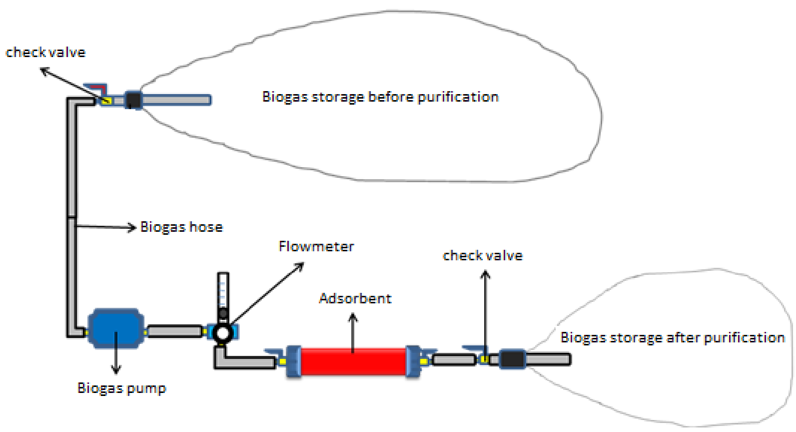

Figure 1: The biogas purification process [6].

The research was continued by testing the biogas before it was purified and after it was purified on a 110 cc combustion engine. Tests were carried out with variations in loading of 5, 10, 15, 20 and 25 kgf. Before testing, the engine is heated using gasoline first to normalize the performance of the motor, then turned on again until the remaining gasoline in the engine runs out. Furthermore, biogas is flowed through the intake manifold to the combustion chamber. After the engine starts normally, then enter 4th gear, then set the tachometer to 4500 rpm rotation, then hold it down and then load it by pulling the brake lever (or stepping on the brake pedal) according to the variation of loading.

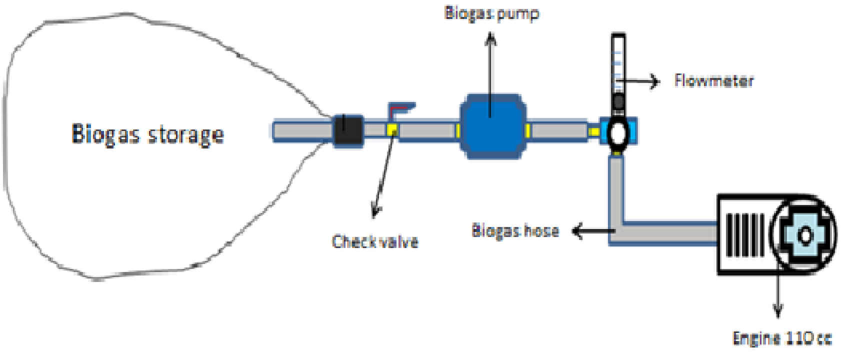

Figure 2. Testing process on combustion engines [6].

III. RESULT AND DISCUSSION

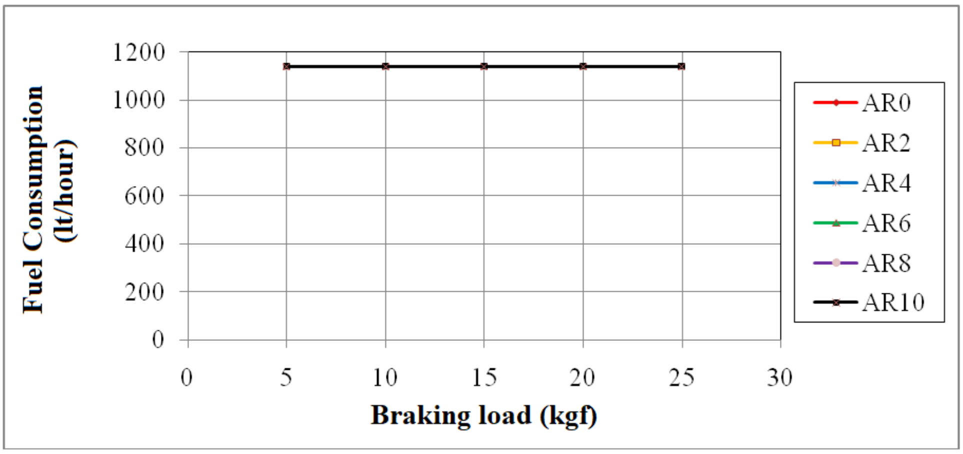

Figure 3: The Relationship Between Fuel Consumption and Braking Load.

Open throttle is controlling engine power by adjusting the amount of fuel or air entering the engine. Fig 3 shows that the fuel used in the open throttle for 4500 rpm is constant, but changes occur in engine speed due to the loading process. Of all types of biogas that are used as fuel, neither the biogas before being purified nor that which has been purified has not changed. This is because fuel consumption is closely related to the calorific value of fuel. Fuel consumption at 4500 rpm engine speed is 1140 lt/hour.

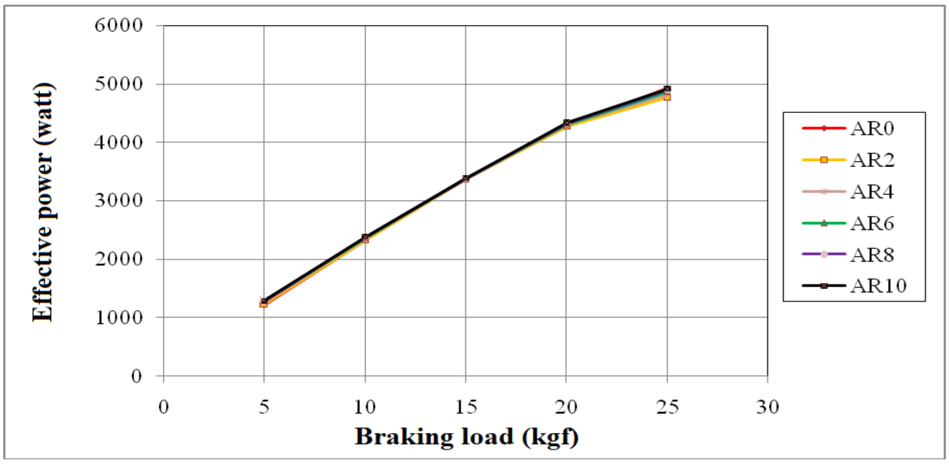

Figure 4: The Relationship Between Effective Power and Braking Load.

Effective power and braking load have a very close relationship, where the magnitude of the loading value will certainly increase the torque value and will affect the value of the effective power, in Fig 4 shows that the increasing the braking load, the effective power will also increase. AR10 type biogas fuel shows the greatest effective power, namely 4938.17 Watts at a maximum load of 25 kgf. This is influenced by the high torque value and AR10 type biogas has the highest methane gas content so that a more complete combustion process occurs. At the same load (25 kgf) for all types of biogas produce power respectively AR0 (4933.29 watt), AR2 (4769.91 watt), AR4 (4808.92 watt), AR6 (4869.89 watt), AR8 (4891.84 watts).

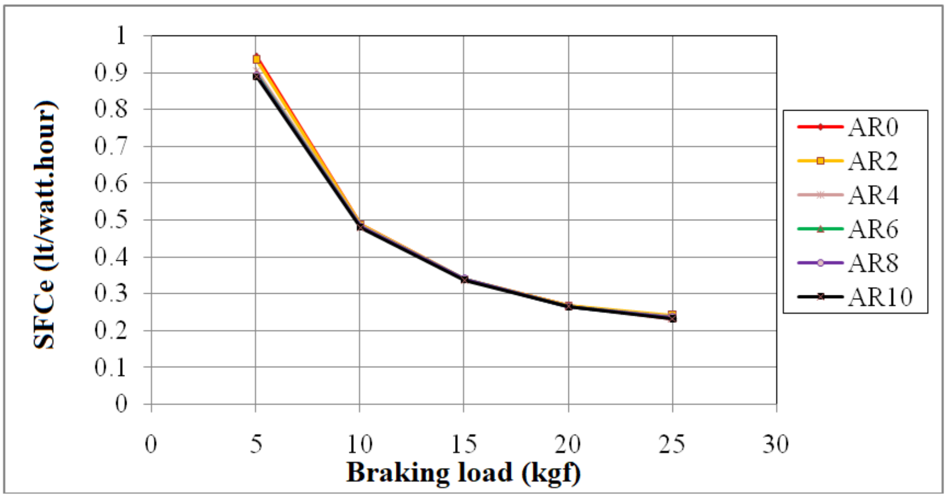

Figure 5: The Relationship Between Sfce and Braking Load.

Specific fuel consumption effective (SFCe) states the amount of fuel used per hour for each power generated by the combustion engine. Based on Fig 5, the lowest specific fuel consumption effective value for each load is AR10 type biogas compared to AR0, AR2, AR4, AR6 and AR8 biogas, meaning that AR10 type biogas fuel is the best quality type of biogas fuel with the highest calorific value. tall. The SFCe AR10 value is (0.230 lt/watt.hour), the lower the SFCe value produced, the better the level of efficiency in using fuel for the power produced.

IV. CONCLUSION

The best application of purified biogas to a 110 cc combustion engine is obtained from the AR10 type of biogas. Biogas AR10 is capable of producing an effective power of 4938.17 watts, a fuel consumption of 19 (lt/minute) and an SFCe of 0.230 lt/hour. Watt. The effective fuel consumption of the engine shows that biogas type AR10 has the best quality because it has the lowest effective fuel consumption value with the highest effective power when compared to biogas types AR0, AR2, AR4, AR6 and AR8. The lower the SFCe value indicates the level of efficiency in using fuel for the power generated the better.

LIST OF NOTATIONS

AR0 : biogas before purification
AR2 : purified biogas with a flow rate of 2 lt/minute
AR4 : purified biogas with a flow rate of 4 lt/minute
AR6 : purified biogas with a flow rate of 6 lt/minute
AR8 : purified biogas with a flow rate of 8 lt/minute
AR10 : purified biogas with a flow rate of 10 lt/minute

REFERENCES

[1]. Hamri., dan Muh. Zaenal A., 2018, "*Analisis Digester Biogas Kotoran Sapi Di Lanna Kecamatan Parangloe Kabupaten Gowa"*, Jurnal Teknologi, Volume 19 No. 1.

[2]. Prayugi, G.E., Sumardi, H.S., dan Rini, Y., 2015, "*Pemurnian Biogas dengan Sistem Pengembunan dan Penyaringan Menggunakan Beberapa Bahan Media".* Jurnal Keteknikan Pertanian Tropis dan Biosistem. Vol. 3, No.1, pp.7-14.

[3]. Alwathan., Mustafa. dan Ramli T., 2013, *"Pengurangan Kadar H_2S dari Biogas Limbah Cair Rumah Sakit dengan Metode Adsorpsi*", *Konversi*, Volume 2, No.1.

[4]. R. Sutanto and Nurchayati, 2019, "Effect of flow rate biogas in purification carbon dioxide process with coconut shell ash adsorbent". IJES. Vol. 8, No. 9, pp. 46-9. DOI:*10.9790/1813-0809014649*

[5]. R. Sutanto, Nurchayati, A. Mulyanto, M. Wirawan, I.B. Alit., 2019, " Adsorbsi gas karbon dioksida dalam biogas dengan menggunakan endapan batu kapur". J. Dinamika Teknik Mesin. Vol. 9, No. 2, pp. 133-9. DOI: https://doi.org/10.29303/dtm.v9i2.290
[6]. Rudy Sutanto and Ida Bagus Alit., 2023, "Analysis of the Internal Combustion Engines Performance Using Biomethane Fuel". International Journal of Engineering Inventions Volume 12, Issue 4, PP: 82-86