Global Scientific JOURNALS

GSJ: Volume 8, Issue 2, February 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

THE EFFECT OF COCONUT SHELL ASH AS AN ADSORBENT IN BIOGAS PURIFICATION PROCESS ON PERFORMANCE OF COMBUSTION ENGINE 100 CC

Rudy Sutanto[1], Sujita[2]

[1,2] *Faculty of Engineering, Departmen of Mechaical Engineering Mataram University, Mataram, Indonesia.*
E-mail : [1]r.sutanto@unram.ac.id, [2]sujita@unram.ac.id

KeyWords
biogas, purification, coconut shell ash, adsorbent, speed, torque, effective power

ABSTRACT

Biogas is an alternative energy that can be a substitute solution for energy fuel that is cheap and environmentally friendly. The composition of biogas is CH_4, CO_2, N_2, H_2, O_2, and H_2S. CH_4 gas is the main element in biogas which has a high heating value. In addition to CH_4 gas which is very much needed, there are also CO_2 contents which actually disturb or damage. If this element is present in biogas, it will disrupt the combustion process itself. Therefore, efforts are needed to reduce CO_2 levels which are expected to increase the quality of biogas. The study was conducted to reduce levels of CO_2 in biogas by using coconut shell ash adsorbent. The method used in this study is pure research that is by taking into account the variation in the flow rate of biogas (2, 4, 6, 8 and 10 lt / min) that passes through the adsorbent. Furthermore, purified biogas was obtained as many as 5 variations of biogas (AB2, AB4, AB6, AB8 and AB10). The research was continued by testing purified biogas in the performance of combustion engines with variations in engine speed 1500, 2500, 3500 and 4500 rpm. Purified biogas with various variations shows a significant effect on engine torque. While all variations of engine speed show an increase in torque. Biogas obtained from the purification process shows that the greater the rate of biogas purification, the greater the torque produced. So if the torque of an engine increases in magnitude, it will indirectly be followed by the effective power that occurs will increase as well.

INTRODUCTION

One of the developments in the area of small islands is in the construction of electricity facilities, because electrical energy is very supportive of economic development in the region, one of which is in supporting the development of factories and coldwater. As a result of the scarcity of petroleum energy sources and the higher world crude oil prices, this makes PLN the main difficulty in connecting electricity networks in the region. Another alternative that needs to be considered is the discussion of environmentally friendly alternative energy for electricity generator fuel, and as a very important consideration is the use of natural resources in the small island region as an alternative energy source to be developed.

One alternative energy that is currently being developed is energy derived from organic materials, this is because organic compounds are classified as renewable energy. The existence of organic materials is easy to obtain and guaranteed continuity, besides the most important is that these organic materials are environmentally friendly. This is the main factor in the existence of organic materials considered as future energy in order to realize green technology. Biogas is a product of green technology that is now being developed. This is because the gas produced from biological processes (anaerobic digester) is able to produce gases such as CH_4, CO_2, H_2S, H_2O and other gases. In this case, of course what is used is methane gas (CH_4), because CH_4 has a heating value / heat that can be used as fuel. Microbiological degradation of organic materials in anaerobic environments can only be carried out by microorganisms that are able to utilize molecules other than oxygen as hydrogen acceptors. Anaerobic decomposition produces biogas consisting of methane (50-70%), carbon dioxide (25-45%) and small amounts of hydrogen, nitrogen, hydrogen sulfide.

The purity of CH_4 produced from biogas is a very important consideration, because it affects the heating value / heat produced. So that the resulting CH_4 needs to be purified of other impurities. Impurity that influences the heating value / heat is CO2, the presence of CO_2 in CH_4 gas is highly undesirable, because the higher the CO_2 content in CH_4, the lower the calorific value of CH_4 and very disturbing in the combustion process. This causes the CH_4 purity to be low.

CO2 gas in biogas needs to be eliminated because it can reduce the heating value of biogas combustion. In addition, the carbon dioxide (CO2) gas content in biogas is quite large at around 30-45% so that the heating value of biogas combustion will be reduced considerably. The heating value of pure methane gas combustion at a pressure of 1 atm and a temperature of 15.5oC is 9100 Kcal / m3 (12,740 Kcal / kg). While the heating value of biogas combustion is around 4,800 - 6,900 Kcal / m3 (6,720 - 9660 Kcal / kg) [1].

Purified biogas by using Ca (OH) 2 solution, biogas purification was carried out by using absorbent concentration variation, namely Ca (OH) 2 solution 0.1, 1.5, and 2.5 M. Gas chromatography test results showed gas after filtered is 100% of the area, whereas before refining methane gas is 82.46% of the area [2].

The process of purification and packaging of biogas pressures and their applications in the process of generating electricity and replacing fossil fuels. The results show that biogas purification is close to 100% CH4 with the efficiency of electricity and combustion results in car engines reaching 97%. Bajracharya (2009) has done biogas purification and increased pressure in its storage system, showing the level of heating efficiency increased to 97%. This shows the success of biogas purification by using CaO, Ca (OH) 2 and NH4OH as CO2 absorbent and H2S gas absorber [3].

The research was conducted to reduce CO_2 levels in biogas by using coconut shell ash adsorbent. Biogas flow rate is varied with 5 variations (2, 4, 6, 8 and 10 lt /min) when passing through the adsorber, then analyzed the levels of CO_2 absorbed and CH_4 (methane) produced using the gascromatography test equipment. The main component contained in coconut shell ash contain silica. Silica in coconut shell ash has the ability to absorb water vapor contained in biogas. The
increase in CO_2 gas levels and CH_4 gas levels is more due to the reduced levels of water vapor in biogas so that the percentage of CO_2 and CH_4 volumes changes by the percentage of the volume of water vapor that can be absorbed by coconut shell ash. In the process of biogas purification with a flow rate of 10 lt / min which is passed into the coconut shell ash, the data obtained for methane gas content is 40,954% while CO_2 gas is 34,894%, this shows that an increase in methane gas levels by an average of 2, 62%, while carbon dioxide gas levels also increased by an average of 3,82% [4].

RESEARCH METHODS

The research method that will be used to achieve the research objectives is to perform engine performance testing to determine the effect of CO_2 in biogas on the performance of the combustion engine, viewed from engine speed (1500, 2500, 3500 and 4500 rpm) and smoothness of engine speed, this stage is carried out at energy conversion laboratory.

The material needed in this study is biomass from cow manure. Furthermore, mix cow dung waste and water with a ratio of 1: 1, stirring until dissolved. The mixture is put in a storage tank (digester). Then all the channels and holes are closed so that no air enters the system. The mixture of impurities with water is allowed to stand for ± 2-3 weeks to form biogas. The study continued with testing the biogas fuel in the performance of the combustion engine, seen from engine speed (1500, 2500, 3500 and 4500 rpm), braking force and fuel consumption. The variable recorded is the amount of braking force and fuel consumption for two minutes. Tests carried out on the engine by injecting biogas through the intake manifold using a conversion kit, while the carburetor here only serves to regulate the air supply into the combustion chamber.

Variables chosen include: fixed variable: biogas composition consisting of a mixture of gases CH_4, CO_2, H_2S, H_2O and others, Operating temperature (Top): At room temperature (30^oC). While the variables change: engine speed: 1500, 2500, 3500 and 4500 rpm

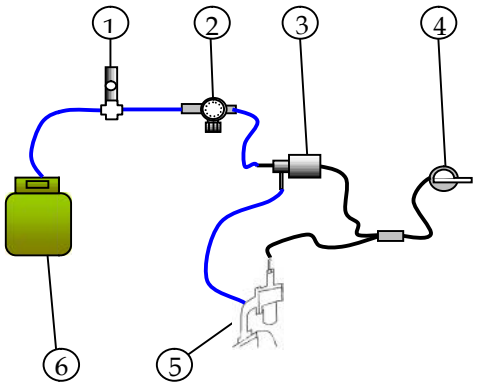

Figure 1. Conversion kit equipment. 1. flow meter, 2. valve regulator, 3. throttle valve, 4. gas regulating on the engine (gas pedal), 5. intake manifold, 6. purified biogas in the tube

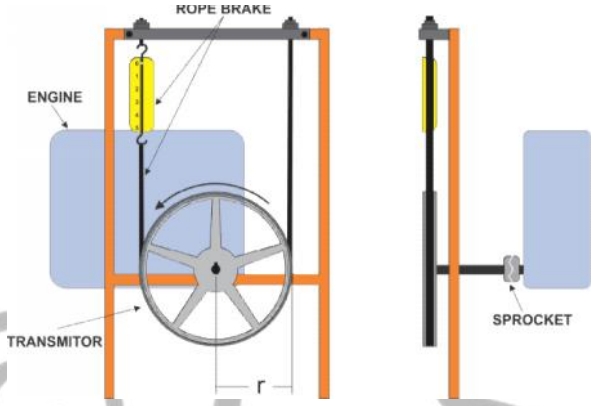

Figure 2. Installation of combustion engine testing

The specifications of the equipment used in this study are shown in table 1.

Name	Specifications
Combustion engine	100 cc
Spring balance	0 - 30 kg
Pulley radius	15 cm
Flowmeter	0 - 30 lt/min
Biogas purifier	Coconut shell ash

Table 1. Equipment and materials

RESULTS AND DISCUSSION

Measurement of engine torque can be done by means of the engine shaft given a brake which is connected by loading. Loading is carried out until the engine shaft almost stops spinning. The maximum load that is read is the braking force that is the same magnitude as the rotating force of the engine shaft. Torque is a measure of the engine's ability to do work, so torque is an energy. Torque magnitude is a derivative quantity commonly used to calculate the energy produced from objects that rotate on its axis.

The value of the torque released by the test combustion engine can be determined by multiplying the braking force, the length of the torque gauge and the torque correction factor from the data obtained previously.

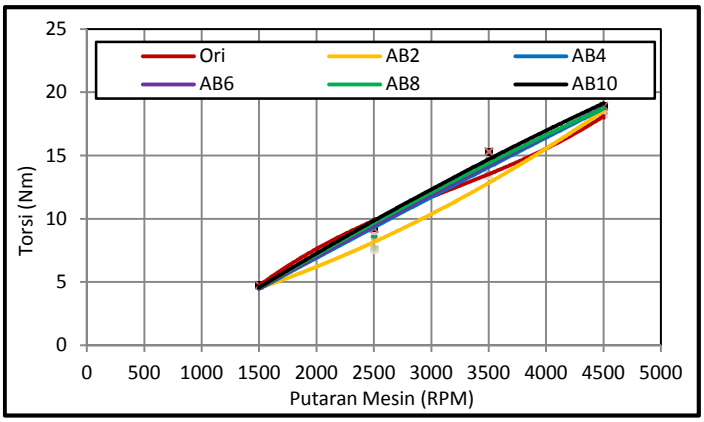

Figure 3. The relationship between engine speed and torque

Based on the research data, the relationship between the variation of the biogas purification rate and torque (Figure 3) shows that of the five purified biogas shows the effect on the torque of the combustion engine in all variations of engine speed. All variations of engine speed show an increase in torque for the use of all variations of biogas fuel with an average increase of 3%. The greater the rate of biogas purification, the greater the torque of the combustion motor produced. This can occur because purified biogas already has good quality compared to before purified.

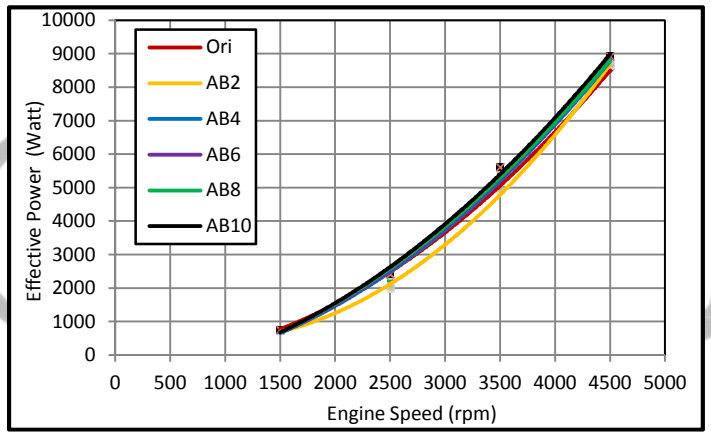

Figure 4. Relationship between engine speed and effective power

The relationship between variations in the rate of biogas purification with effective power as shown in Figure 4 shows that the five purified biogas does not show a significant effect on the effective power generated by the engine at all engine speeds. This research shows an increase in effective power is higher along with the greater rate of biogas purification with an average increase of 3%. This is more because the methane gas content in biogas increases along with the increasing rate of biogas purification which means that purified biogas already has good quality compared to before purification.

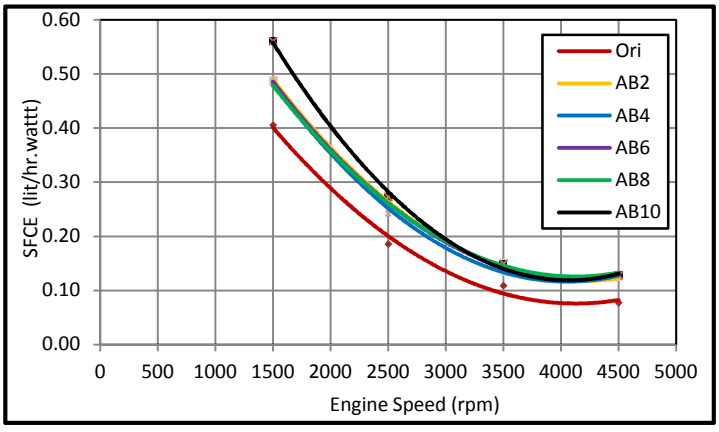

Figure 5. Relationship between engine speed and specific fuel consumption effective

Figure 5 shows that the five purified biogas shows a significant effect on the SFCE generated by the engine on various engine

speeds. The smaller SFCE of a fuel shows that the fuel is of better quality. This implies that the consumption of biogas used per hour to produce every kWatt of axle power or effective power for the same rotation on an engine is less. As for the fuel consumption will increase along with the increase in engine speed (figure 6), this shows that the higher the engine rotation of a combustion engine, the greater fuel consumption will be followed, although fuel consumption rises but also followed by an increase in shaft power or effective power .

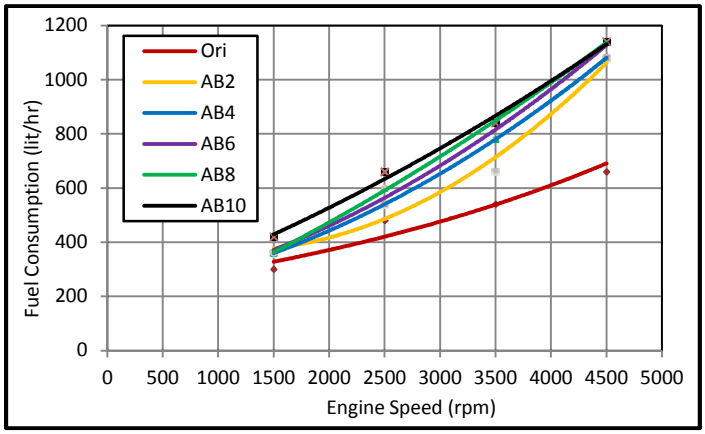

Figure 6. The relationship between engine speed and fuel consumption

CONCLUSION

The five purified biogas variations show a significant effect on the torque produced by the engine in all rotation variations. All variations of engine speed show an increase in torque for the use of all variations of biogas fuel, which is an average of 3%. Biogas obtained from the refining process shows that the greater the biogas purification rate, the greater the torque produced when the fuel is used to drive the engine at all engine speeds. While effective power has a close relationship with torque, if torque is multiplied by engine speed, then the shaft power or effective power will be obtained. So if the torque of an engine increases in magnitude, it will indirectly be followed by the effective power that occurs will increase as well.

References

[1] Harasimowicz, M., P. Orluk , G. Zakrzewska-Trznadel and A.G. Chmielewski, Application of Polyimide Membranes for Biogas Purification and Enrichment, Journal of Hazardous Materials, 2007, vol. 144, pp. 698 – 702.

[2] Naqiibatin Nadliriyah dan Triwikantoro, 2014, "Pemurnian Produk Biogas Dengan Metode Absorbsi Menggunakan Larutan $Ca(OH)_2$", Jurnal Sains dan Seni POMITS vol 3 no 2, 2014, pp.107-111.

[3] Ofori dan Kwofie (2009), Water Scrubbing: A Betterr option for purification and Biogas storage, Journal World Applied Science (Special issue for Environment), 122-125

[4] Sutanto R and Nurchayati, "Effect of Flow Rate Biogas in Purification Carbon Dioxide Process with Coconut Shell Ash Adsorbent," *The International Journal of Engineering and Science (IJES)*, vol. 8, Issue. 9, Series. I, pp. 46-49, 2019, doi: 10.9790/1813-0809014649.