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Modification of Fuel Input on Oil Fuel Electric Generator to Gas Fuel Engine

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Abstract. National energy demands continue to increase in 2050 in line with economic growth, population growth, energy prices, and government policies. During 2016-2050, the final energy demand growth rate could reach 5.3% per year. For this reason, alternative energy is needed to meet these needs. One of them is by modifying the generator engine that uses fuel oil (gasoline) with gas (LPG and Biogas) by using a 1250 watt generator set with the aim of knowing how effective the performance of the generator engine is after fuel changes are made. The modification of the engine generator is located in the way the fuel enters the combustion chamber, where the modification lies in the rubber boundary between the carburetor and the manifold installed in the main jet. The test time takes 20 minutes. The test uses no-load with 0.1 kg fuel consumption, 160 watts load with 0.1 kg fuel consumption, 350 watts load with 0.2 kg fuel consumption, and 700 watts load consumption with 0.2 kg fuel. For the use of biogas without load, the fuel consumption is 0.03 m³, with a load of 160 watts, the fuel consumption is 0.03 m³, while for larger loads, the engine is unable. From the results of testing on the modified generator set, the highest fuel consumption was obtained with 0.01 kg/minute LPG, and the consumption of fuel with biogas was 0.03 m³/min. From this test, it was concluded that in the material of fuel consumption (LPG), the power generated was 8.571 kW/hour at the cost of Rp. 12.573 and biogas 0.01125 kWh/hour at a cost of Rp. 16.

1. Introduction

Indonesia is the country with the largest energy consumption in the Southeast Asian region and ranks fifth in the Asia Pacific in primary energy consumption, after China, India, Japan, and South Korea. The high GDP growth, reaching an average of 6.04% per year over the 2017-2050 period, is expected to further encourage the increase in Indonesia's energy needs in the future. This energy problem has led to Indonesia's role in the world energy market and in efforts to reduce global greenhouse gas emissions significantly [1].

Indonesia's final energy consumption (without firewood) in 2016 is still dominated by fuel by 47%. When viewed by sector, the transportation sector has the largest share, which is 42%, higher than the industrial sector with a share of 36%. Energy consumption in the transportation sector is almost entirely fulfilled by petroleum fuel. On the other hand, Indonesia has been a net importer of fuel since



2004. Imports fulfilled One-third of Indonesia's fuel consumption in 2016. If the energy demand which is dominated by fuel continues to increase without changing the pattern of energy use, especially in the transportation sector, then the sustainability and security of Indonesia's energy will be disrupted. In addition, commitments to reduce Indonesia's greenhouse gas emissions listed in the First Nationally Determined Contribution, which is 29% or 314 million tons of CO₂e (unconditional) and 41% or 398 million tons of CO₂e (conditional) in 2030 can also be challenging to achieve [2,3].

National energy needs until 2050 continue to increase following economic growth, population, energy prices and government policies. With an average GDP growth rate of 6.04% per year and population growth of 0.71% per year during 2016-2050 resulting in a final energy growth rate of 5.3% per year [4,5].

To face challenges in the energy sector, it is necessary to utilize the potential of new and renewable energy that is reliable and well tested in terms of quality and quantity. One of the alternative energy sources comes from renewable resources and has the potential to be developed in Indonesia, the use of Biogas as an alternative fuel in the Generator set (Genset) [6].

Genset or stands for generator set is a device that functions to produce electrical power. Referred to as a generator set with the understanding is a set of equipment combined from two different devices, namely engine and generator or alternator. The engine as a rotating device while the generator or alternator as a power generation device. The engine can be a diesel engine or diesel engine, while the generator or alternator is a copper coil or coil consisting of a stator (static coil) and rotor (rotating coil) [7]. The engine can be a diesel engine or diesel engine or gasoline engine, while a generator or alternator is a copper coil or coil consisting of a stator (static coil) and rotor (rotating coil) [8,9].

2. Materials and Methodology

2.1. Methodology

This research was conducted with several stages of testing, modification of tools, measurement tools, and data collection, including modification of fuel oil generators (premium) to gas fuels (LPG & Biogas) and genset testing using LPG & Biogas Gas.

The material to be used in this study is one of the new and renewable energy sources whose potential in Indonesia is quite large, namely biogas and uses fossil materials, namely Gas (LPG) with fuel characteristic specifications used under Indonesian national standards. In this study, which is used as fuel is Biogas and LPG Gas as engine fuel generator set (Genset) which is the object of research and material testing of engine performance.

The engine generator set (Genset) specifications are as follows: [10]

Brand	: MAESTRO
Model	: MT2500C
Engine type	: 4 Strokes
Fuel	: Biogas, Gas LPG dan Premium
Power Generator	: 1250 Watts
Voltage	: 220 V
Frequency	: 50 Hz
Ac Output	: 1.25 – 1.35 kW
System	: Automatic
Ignition	: Pulling system
Engine weight	: 40 kg



Fig 1. Modified Generator Set

2.2. Experimental setup

2.2.1 Research preparation

Modifications made to the engine generator set located in the fuel chamber where the primary fuel of this generator uses Oil (Premium) to Gas (LPG & Biogas) changes made are located on the limiting rubber between the carburetor and manifold so that the gas fuel directly enters the combustion chamber without passing through carburetor first and to the tool is also added to the stock faucet that serves to use fuel oil or gas (Gas & Biogas) and regulate the opening of the fuel flow for the generator set.

a. Modification of the combustion chamber on the generator

Modified tool in the combustion chamber, which is located on the rubber manifold or the boundary between the carburetor and the manifold.



Fig 2. Modifications to the Combustion Chamber

b. Add a stop valve to the generator set

The addition of the tap functions to regulate which fuel will be used when testing whether to use biogas and LPG or gasoline gas because this engine is designed to use 3 fuels.



Fig 3. Addition of faucet stock on the generator set

2.2.2 Data collection procedure

In this test data retrieval, several preparations will be carried out before testing in this study which includes making modifications to the engine generator set (Genset) where this generator is fueled from Oil (Premium) to Gas fuel (LPG & Biogas).

- a. Setting up the generator set
- b. Check the generator engine.
- c. Prepare electronic devices that will be used to put pressure on the generator engine
- d. Check the measuring instrument to be used
- e. Prepare the fuel to be used and directly attached to the engine.

Data collection procedure: Several steps will be carried out during testing.

- a. For a long time, the test is carried out for 20 minutes for every 1 time testing with no-load parameters and given a load and carried out 3 times testing for each parameter.
- b. Adjustments are made to the stop valve so that the fuel and wind that enters the combustion chamber are balanced, and the control is done manually.
- c. Remove the side cover of the engine so that engine speed can be measured with a tachometer.
- d. Install LPG hoses and gas regulators for fuel to be used in the generator set.
- e. Perform tests with several parameters, no-load, low load 160 watts, medium load 350 watts, high load 750 watts.

3. Results and Discussion

3.1. Testing of Generator Set (Genset) with Gas (LPG)

Researchers conduct tests in accordance with the data to be taken and then prepare to measure devices and other equipment starting from a load of gas cylinders scales. Then, it is complete and immediately does the testing in order to obtain the data taken.

Table 1. Generator Performance Data (Genset) using Gas fuel (LPG)

Time Minutes	Load Watts	Engine speed (Rpm)	Voltage (V)	Current (A)	Frequency (HZ)	Genset engine testing Fuel consumption (kg)		
						Before	After	Difference
0-20	0	3783	220	0	63.2	7.6	7.5	0.1
0-20	160	2921	230	0.72	48.3	7.5	7.4	0.1
0-20	350	1947	187	0.97	32.4	7.4	7.2	0.2
0-20	700	1699	190	1.21	28.3	7.2	7.0	0.2

From Table 1 it can be seen that this is the average value of the test where each test parameter is carried out with 3 times the test, so the above data is the value of the average at each time of the test and for the time and load it is determined where for each time the test is carried out 20 minutes, for loads ranging from no load, low load, medium load and high load.

From the results of testing the generator set engine or generator set, it is found that the higher the load is given to the generator, the rpm and voltage values will be lower, and the consumption of fuel will be even higher, and where we can see a decrease in engine rotation speed is very large at the time No-load and no-load testing.

From the test, it can be assessed genset testing using Gas fuel (LPG), the speed from no-load to 700 Watts load, the reduction of engine speed is very drastic, where the engine speed at no load is 3783 Rpm; 160 Watts load, 2921 Rpm; load 350 Watts, 1957 Rpm and load 700 Watts, 1699 Rpm.

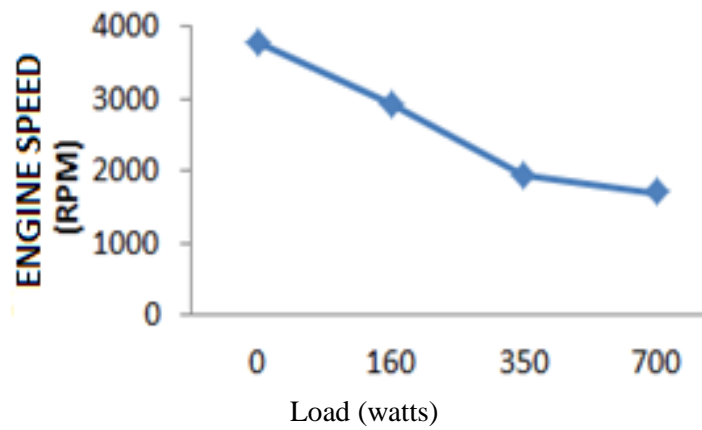


Fig 4. Genset engine generated rotation

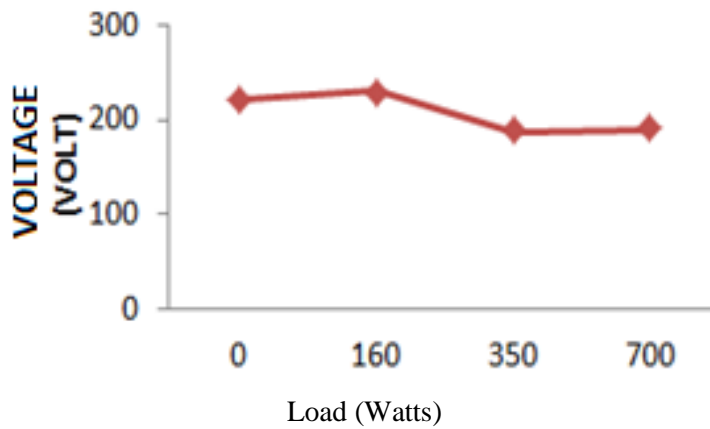


Fig 5. The voltage generated by the generator engine

From the above test, it can be assessed Genset testing using Gas fuel (LPG) where the voltage generated at no load 220 volts, 160 watts 230 volts, load 350 watts 187 volts and load with 700 watts 190 volts.

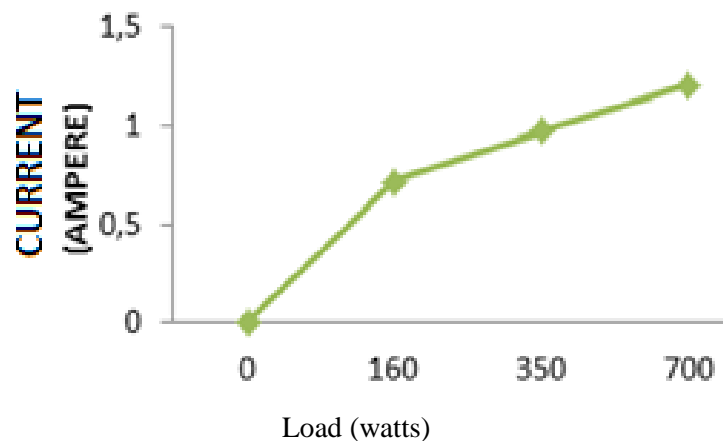


Fig 6. Current generated by the generator engine

From the above test, it can be assessed Genset testing using Gas fuel (LPG) where the gauge cannot read the amperes that are memorized by the genset engine with no load for amperes because the

amperes will appear when the Genset is given a load, 160 watts of amperes produced 0.72 A, a load 350 watts amperes load generated 0.97 and 700 watts load then the amperage produced 1.21 A.

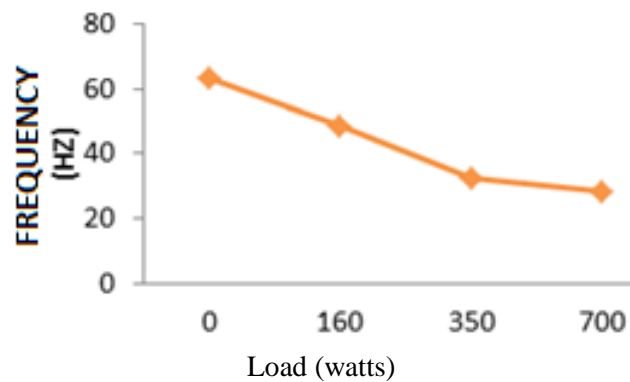


Fig 7. The frequency generated by the generator engine

From the above test it can be assessed Genset testing using Gas fuel (LPG) where the frequency is calculated manually using the formula then obtained with no load for its frequency 63.2 Hz, with 160 watts load frequency 48.3 Hz, load 350 watts frequency 32.4 Hz, loads 700 watts with a frequency of 28.3 Hz.

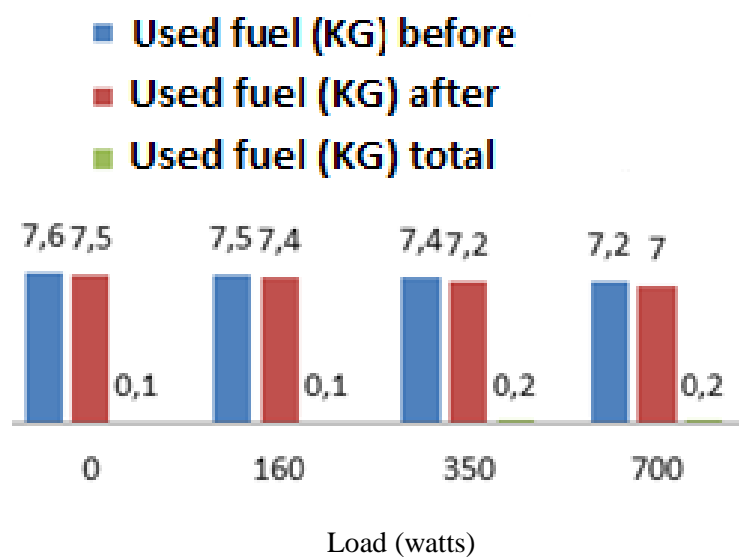


Fig 8. LPG Gas Fuel Consumption

From the above test it can be assessed Genset testing using Gas fuel (LPG) where its fuel consumption is obtained without the burden of fuel consumption 0.1 kg, with a load of 160 watts fuel consumption 0.1 kg, load 350 watts fuel consumption 0.2 kg, and load of 700 watts fuel consumption 0.2 kg.

3.2. Generator Set (Genset) with Gas (Biogas)

From Table 2, it can be seen the average value of the test where each test parameter is done with 3 times the test, so the data above is the value of the average at each time of testing and the load and time it is set where for each time the test is performed 20 minutes, for loads ranging from no load, low load, medium load and high load, so that it is obtained from the results of testing the generator set or generator set it is found that the higher the load given to the generator feeds rpm and voltage will be lower and the consumption of fuel will be more massive, even in the data can be seen there are some data variables

that do not have numbers because when testing the generator engine experience lost because the biogas used is insufficient to move the generator set.

Table 2. Generator Performance (Genset) using Gas (Biogas) fuel

Time Minutes	Load Watts	Engine speed (Rpm)	Voltage (V)	Current (A)	Frequency (HZ)	Genset engine testing
						Biogas fuel consumption (m ³) Total
0-20	0	1413	82.1	0	23.6	0.03
0-20	160	1091	85.9	0.51	18	0.03
0-20	350	0	0	0	0	0
0-20	700	0	0	0	0	0

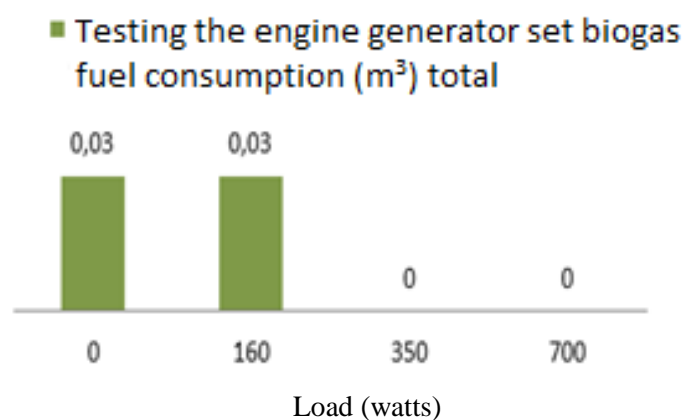


Fig 9. Gas Fuel Consumption (Biogas)

From this test using gas fuel (Biogas) where the fuel consumption obtained without the burden of fuel consumption is 0.03 m³ and with a load of 160 watts fuel consumption is 0.03 m³, the load 350 watts fuel consumption is 0 m³ load, and a 700 watts load of fuel consumption is 0 m³. For fuel consumption, it has zero value because the generator set engine (generator set) is no longer able to accept such a large bar because there are several factors, namely low pressure and lack of fuel gas (biogas) itself.

4. Conclusions

From testing using the Maestro MT2500C brand engine with an engine capacity of 1250 watts using Gas (LPG) and biogas fuel, the test results for the highest fuel consumption at 0.057 kg/min biogas with power generated 1.063 kg.kwh/hour, while with using 0.01 LPG gas fuel/minute with a power generated 8.571 kg.kwh/hour. Judging from the performance of the engine-generator set that using LPG fuel is much more effective if seen from a stable engine speed compared to biogas fuel.

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