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The Effect of Types of Biogas and Methanol Purification and Loading as Fuel for Four-Stroke Generators on Exhaust Emissions

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A B S T R A C T

Biogas is a type of new renewable energy that is formed through the fermentation process of organic waste materials, such as livestock manure, organic waste, and other materials by methanogenic bacteria in anaerobic (without oxygen) conditions. Methanol is a very light, volatile, colorless, tasteless, flammable, toxic liquid with a very faint odour. In addition, methanol can be used as a solvent and also as an alternative fuel. This study aimed to determine the effect of the type of biogas and methanol purification and loading as fuel for a 4-stroke generator on exhaust emissions. An experimental study to test the efficacy of biogas and methanol fuels with or without loading with RON-90 gasoline (Pertalite→). The percentage of carbon monoxide (CO) and hydrocarbon (HC) emissions is used as a reference in assessing the efficacy of fuels in reducing emissions. The results of exhaust emission test studies using biogas purified from H_2S, H_2O, CO_2, and methanol produce exhaust emission values of HC and CO with a lower value compared to the maximum value of the threshold according to the standards of the Minister of Environment Number 05 of 2006 so that biogas purified from H_2S, H_2O, CO_2, and methanol is more environmentally friendly than RON-90 gasoline on the market.

1. Introduction

The energy crisis is the result of the reduced availability of the world's primary energy sources, which is marked by soaring oil prices on the world market, which has triggered economic and social crises in various countries, including Indonesia. Fuel oil, which is dwindling in number, has shown a declining trend over the past 10 years, from 346 million barrels (949 thousand bph) in 2009 to around 283 million barrels (778 thousand bph) in 2018. The decline in production was due to wells, the main production of petroleum, which is generally old, while the production of new wells is still relatively limited. As a consequence, it is a must to look for other sources. One alternative is the utilization of renewable energy, which is used to replace the use of fuel oil or natural gas (fossil fuels). After the oil energy crisis in the 1970s, several countries initiated programs to develop renewable energy technologies to reduce dependence on imported fuel oil.[1-7]

Biogas is a type of renewable energy that is formed through the fermentation process of organic waste materials, such as livestock manure, organic waste, and other materials by methanogenic bacteria under conditions anaerobic (without oxygen). In general, biogas technology can overcome the problem of

overflowing livestock manure that cannot be managed. Methanol is a chemical that belongs to the group of alcohol compounds with a compound formula that includes one carbon atom and four hydrogen atoms, and one oxygen or is described by its chemical formula as methyl alcohol (CH_3OH). Methanol is a very light, volatile, colorless, tasteless, flammable, toxic liquid with a very faint odour. Used as a solvent and also as an alternative fuel.[8-12]

A generator set (Genset) is a device that functions to produce electric power. At this time, there are many types of generators and their development. There are generators that are driven by 4-stroke engines, 2-stroke engines, and diesel engines. In terms of the fuel used, generators are no longer limited to gasoline and diesel as fuel, but some are already using biogas and LPG as alternative fuels to replace gasoline and diesel. As an example, a diesel engine can be converted to life by using gas fuel efficiently. These engines, called dual fuel engines or gas diesel engines, usually have gaseous fuel mixed with air in the engine cylinders, either by direct mixing in the intake manifold with air or by direct injection into the cylinders.[13-16] This study aimed to determine the effect of the type of purification of biogas + methanol and loading as fuel for a 4-stroke generator on exhaust emissions.

2. Methods

This study is experimental research. The independent variable in this study is the type of fuel used, namely a. biogas purified from H_2S, H_2O, and methanol (type 1 fuel), b. biogas purified from H_2S, H_2O, CO_2, and methanol (fuel type 2), c. pertalite; as well as loading, namely a. loading 300watt and b. without loading. Meanwhile, the dependent variable in this study is the CO (carbon monoxide) and HC (hydrocarbon) emission test results. Initially, the biogas that comes out of the digester enters the desulfurized to remove H_2S. Then biogas goes into CO_2 remover to remove CO_2 levels, and then the biogas flows into the volume meter to measure how much gas will enter the biogas bag. Before the biogas bag is used to accommodate biogas, the bag is filled with calcium chloride ($CaCl_2$) to absorb water vapor contained in the biogas. The biogas that is in the bag enters the flexible fuels mixer. After the biogas is mixed with air in the flexible fuels mixer and the addition of methanol to the carburetor is then injected into the combustion chamber, resulting in a combustion process in the combustion chamber. As a result of combustion, the pressure and temperature will rise, resulting in a business step in the generator. The combustion gases exit through the exhaust of the generator.

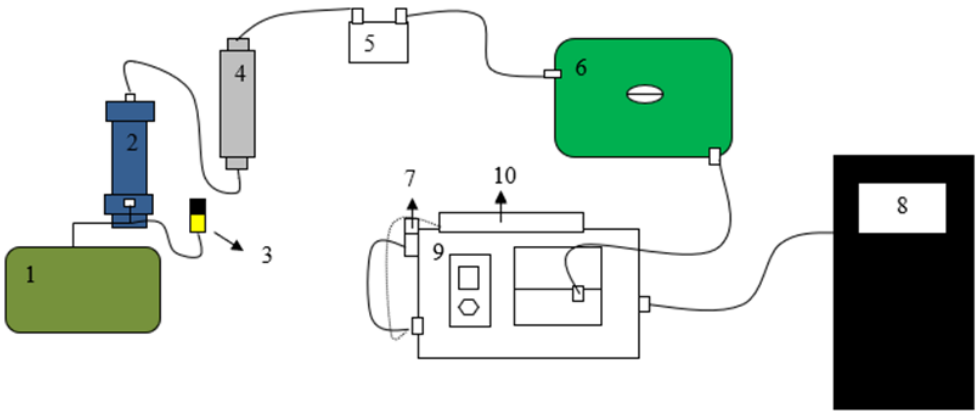

Figure 1. Series of research installations. Description: 1. Digester; 2. Desulfurizer; 3. Multi-gas detector; 4. CO_2 removers; 5. Volume meters; 6. Biogas bags; 7. Methanol place; 8. Emission test equipment; 9. Gasoline generator; 10. Gas tank.

Flow the biogas through the volume meter into the bag, and record the amount of biogas flowing into the bag and the defects in the time data for Biogas fuel consumption and the addition of methanol to turn on the generator. For gasoline, measure the initial how many liters of gasoline using a measuring cup, then turn on the generator. The generator can run for a few minutes using the gasoline and record the time. The exhaust emission test is carried out by first turning on the generator with the specified fuel, then connecting the exhaust of the generator to the emission test kit and recording the emission results. Data analysis was carried out in a univariate manner where a table was presented of the average distribution of each measured variable. Then a comparison was made between each test variable.

3. Results and Discussion

In general, type 2 fuel produces the lowest CO emission value compared to type 1 fuel and pertalite fuel. The reduction in CO emission values for type 2 fuel is due to the fact that before being distributed to the generator engine, biogas is purified for its CO value using a CO tool remover so that before combustion is carried out in the generator engine, the CO value content in type 2 fuel has been reduced so that the combustion process produces the lowest CO emission value. There is a difference in the value of CO emissions on the generator engine where type 1 and type 2 fuel, when the generator is loaded, produces the lowest CO emissions compared to without loading, while pertalite fuel produces the highest CO value when the generator is not loaded. This is due to the fact that when the generator is loaded, the rotation of the generator decreases so that fuel consumption decreases, causing the amount of fuel burned during the combustion process to take place less so that the gases resulting from the combustion reaction decrease, such as CO.

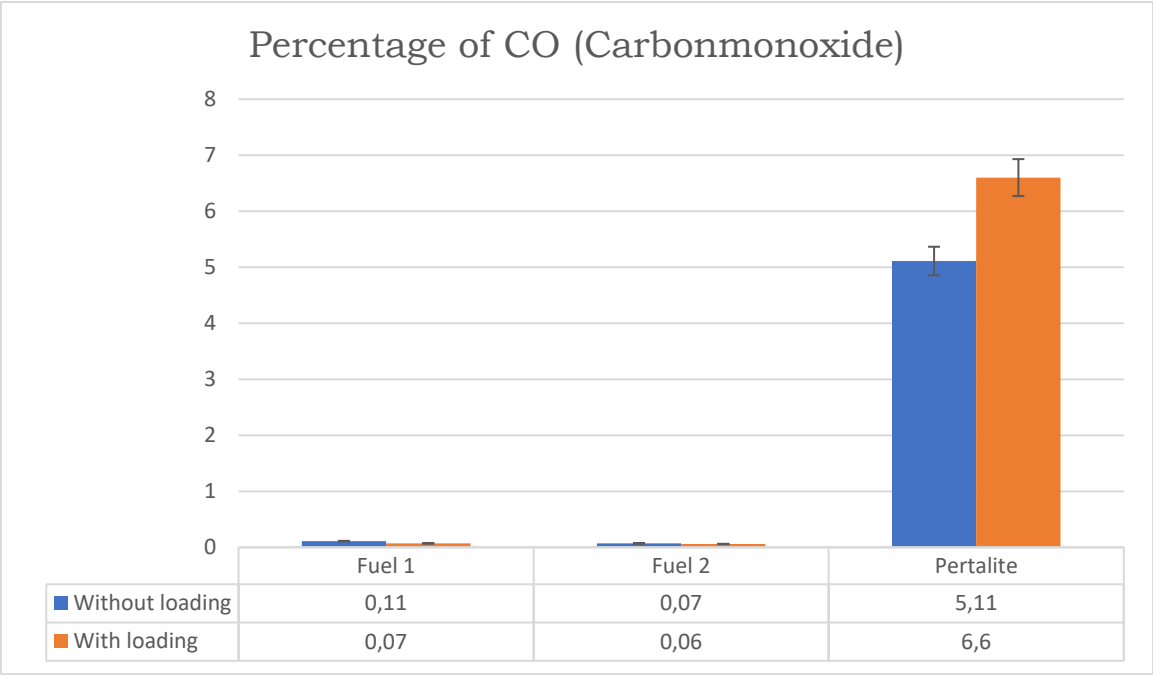

Figure 2. Comparison of CO emissions (%) of each fuel.

The lowest HC emissions occur in type 2 fuel. Type 2 fuel has gone through a CO value purification process before the combustion process is carried out in the engine. The C content in type 2 fuel has decreased due to the refining process, causing a chemical combustion reaction to produce low HC

emission values. Type 1 and type 2 fuels produce the lowest HC emissions when the generator is loaded, and this is caused by the decreased engine speed so that the engine cycle becomes slow. Thus the amount of fuel burned during the combustion process decreases, so HC emissions from the reaction combustion are reduced.

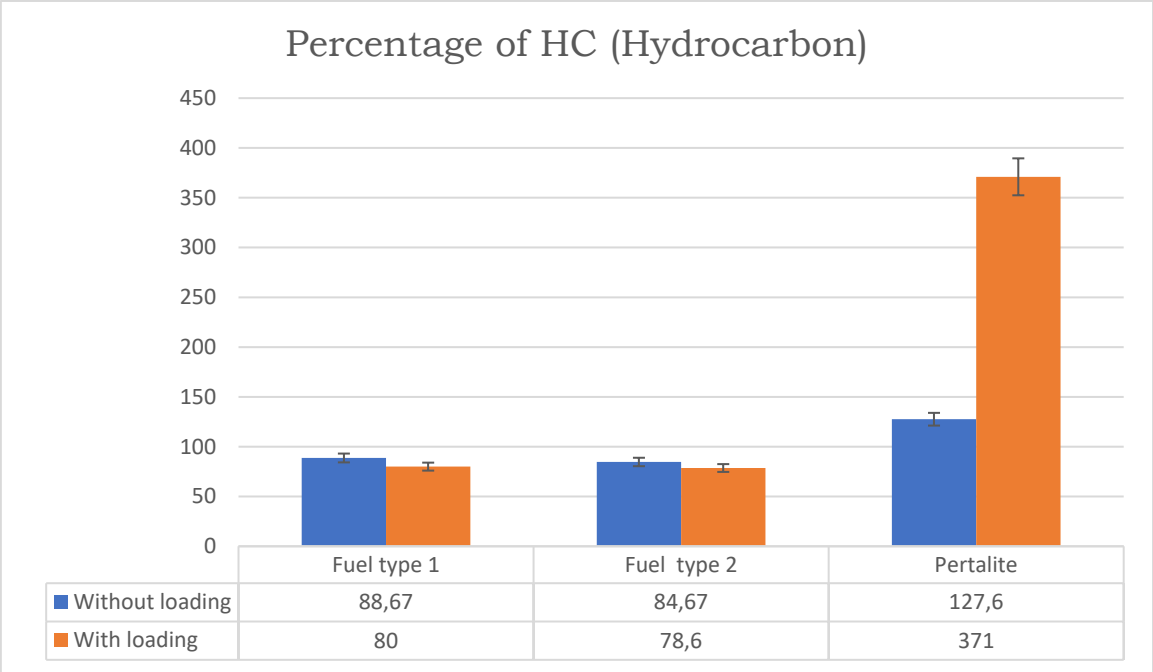

Figure 3. Comparison of HC emissions (%) of each fuel.

CO purification on type 2 fuel results in a reduction in CO exhaust emissions of 36.36% compared to type 1 fuel at no load and 16.41% at 300 watt loading conditions. HC exhaust emissions on fuel purified from CO content (type 2 fuel) result in a 4.5% reduction in emissions compared to type 1 fuel at no-load conditions, whereas at 300 watts of loading, there is a 1.75% reduction in emissions. The results of exhaust emissions, namely the CO and HC values from the combustion process of type 1 and type 2 fuels, are smaller than the maximum threshold values for HC and CO values that have been standardized by Regulation of the Minister of Environment Number 05 of 2006, where CO emission values on motors 4 the maximum permitted step is 5.5% and the HC emission value is 2,400 ppm at the idle condition. The results of the research on exhaust emission tests using type 2 fuel resulted in emission values of HC and CO with lower values compared to the maximum value of the threshold according to the standard of the Minister of Environment Regulation Number 05 of 2006, so that type 2 fuel is more environmentally friendly than pertalite fuel in the market.[17-20]

4. Conclusion

Biogas purified from H_2S, H_2O, CO_2, and methanol as a fuel for a 4-stroke generator effectively reduces exhaust emissions compared to pertalite.

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