



COMPARISON OF THE FUEL CALORIFIC VALUE FROM PLASTIC PYROLYSIS WITH COMMERCIAL FUEL

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ABSTRAK

Plastic, which is originated from petroleum, is possible to turn it to alternative fuel. Moreover in 2008, the estimated amount of midden in Indonesia reached 38.5 million tons per year with the largest compositions are organic waste (58%), waste plastics (14%), waste paper (9%) and wood waste (4%) (Ministry of Environment, 2008). Meanwhile in Depok City, the amount of waste which goes to Depok City's landfill waste is 350-400 tonnes / day (Head of Technical Unit Landscape Depok City Sanitation Department, 2012). From the data, above, can be confirmed using plastic waste as an alternative fuel can be superior because plastic waste is the raw material which is cheap, easily processed, and can reduce environmental pollution. The processing of plastic waste into fuel conversion is done using a plastic waste machine with a continuous system, the working principle of heating at high temperature. Tests which are conducted in this study is to test the octane rating by bomb calorimeter, test analyzer gas emissions, and test octane gas chromatography. Plastic waste fuel, which is the outcome from plastic waste conversion machine with continuous system, can be used as fuel for vehicles, it is because the plastic oil calorific value 10 519 cal / g equivalent calorific value premium. This research is expected to address the scarcity of fossil fuels, and increasing public awareness of using alternative fuel, especially plastic waste fuel.

Kata kunci: plastic waste fuel, conversion, caloric value

1. PENDAHULUAN

Indonesia is a country with the highest consumption of fossil fuels. Petroleum consumption can be seen year around 1.6 million barrels per day, while in 2006 reached 1.84 million barrels per day, while other countries such as Japan and Germany in the equal only consume less than 1 million barrels per day. The oil consumption was not enjoyed by the whole people of Indonesia because there are people who can not enjoy electricity. Based on these data contribute to the decline in Indonesia's oil reserves and as well as the problem of energy crisis being faced by the world today (Ministry of Energy and Mineral Resources 2008).

Plastic, which is originated from petroleum, is possible to turn it to alternative fuel. Moreover in 2008, the estimated amount of midden in Indonesia reached 38.5 million tons per year with the largest compositions are organic waste (58%), waste plastics (14%), waste paper (9%) and wood waste (4%) (Ministry of Environment, 2008). Meanwhile in Depok City, the amount of waste which goes to Depok City's landfill waste is 350-400 tonnes / day (Head of Technical Unit Landscape Depok City Sanitation Department, 2012). From the data, above, can be confirmed using plastic waste as an alternative fuel can be superior because plastic waste is the raw material which is cheap, easily processed, and can reduce environmental pollution.

The processing of plastic waste into fuel conversion is done using a plastic waste machine with a continuous system, the working principle of heating at high temperature. Research on the processing of plastic waste into fuel has been done and tested before the paper is organized. Tests carried out on samples of 1 kg of plastic waste by Agus Sapriyanto, PKMT PNJ (2012). Based on previous testing performed by Agus Sapriyanto, PKMT PNJ (2012), the sample used is 1 Kg dry various types of plastic waste, was tested on a machine with heating temperature 530°C, machine input power of 3000 watts and a testing time for 2 hours, can produce fuel up to 300 ml with a calorific value of 9758 cal / g, equivalent to a premium.

Utilization of plastic waste as an alternative fuel requires some form of further research in order to produce a fuel that can be used for vehicles and industrial applications which are environmentally friendly and affordable economic value, so it can be used by all people.

2. METODE PENELITIAN

The processing of plastic waste into propulsion engine fuel includes several stages / processes are:

1. Pyrolysis process
Pyrolysis is the technique of burning garbage (plastic waste) without O₂ and performed at a high temperature of between 800°C to 1000°C. This technique ables to produce combustion gases that are useful and safe for the environment. Pyrolysis technology can be regarded as an environmentally friendly method for producing final products CO₂ and H₂O, which is a non-toxic gas. Pyrolysis process produces compounds of liquid hydrocarbons ranging from C₁ to C₄ and long-chain compounds such as paraffins and olefins.
2. Hydrotreating / hydrocracking process
This process uses distillation to separate the elements produced in the process of pyrolysis. This process aims to reduce or eliminate the aromatic compounds and polar compounds.
3. Hydro-isomerization process
This process is used to make a special catalyst that serves isomer molecules have a high viscosity. (Rahyani Ermawati, 2011)

2.1 Fuel Testing Process

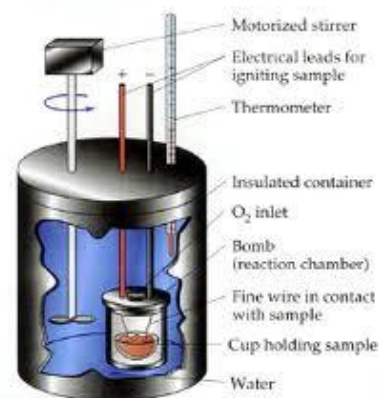
1. Testing Calorific Value
The calorific value is the amount of heat energy which is released the fuel when there is an oxidation from chemical elements that exist in the fuel. The calorific

value of a material can be obtained by using laboratory equipment, the bomb calorimeter.

Calorimeter working principle is as follows: Calorimeter consists of a metal vessel of its kind known, partition wall of the insulator that serves to prevent the propagation of heat into the surrounding environment, a thermometer, and a stirrer. Metal vessel containing water can be determined from the initial temperature thermometer. If a material is heated unknown kind of heat, then put in a calorimeter with fast, specific heat can be calculated.



Gambar 1. Calorimeter Bomb

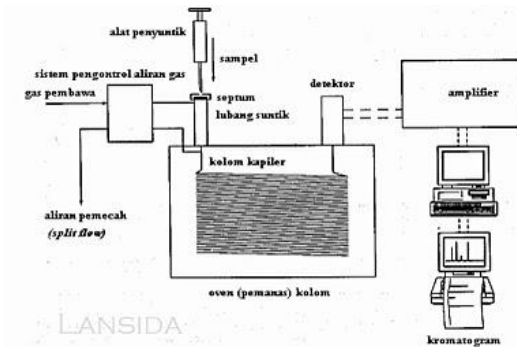


Gambar 2. Bomb Calorimeter sectional

2. Octane Rating Testing
The name of octane is originated from octana (C₈), because of all constituent molecules of gasoline, octane has the best compression properties. Testing can be done using an octane rating of laboratory testing equipment, namely, Gas Chromatography (CG).



Gambar 3. Gas chromatography



Gambar 4. Gas Chromatography sectional

3. Exhaust Emission Testing

This emission test is to measure the exhaust emissions from motor vehicles (gasoline and diesel) by using a special tool that is often called the Gas Analyzer. The advantage from good emission is not only for the environment, but also to the vehicle itself. Vehicle becomes powerful and fuel efficient



Gambar 5. Gas Analyzer

Research held in several places: the analysis of chemical physics diesel, premium, pertamax and plastic fuel (Polymium) performed at the Laboratory Petrolab Services, Rawamangun, East Jakarta. To test the heat, and exhaust emissions test performed on Energy Conversion Laboratory Department of Mechanical Engineering, State Polytechnic of Jakarta. For more details will be explained a few steps below:

1. *Provision of Alternative plastic waste fuel*
 Alternative plastic waste fuel is generated from the conversion of waste plastics testing machine with a continuous system. Testing is done by including 2 kg of plastic waste into the machine, with the optimal

- operating temperature of 500°C, resulting in fuel oil of 700 ml in 3 hours.
2. *Provision of Variable Fuel Test*
 Variable test fuel used, which is diesel, kerosene, premium and pertamax, can be obtained at the pump around.
3. *The design of experiments*
 Experiments using several test tools such as Bomb Calorimeter, Gas Chromatography and Gas analyzer.
4. *Variables observed*
 Analysis of calorific value and octane levels of carbon in exhaust emissions testing can be seen from the comparison, between the alternative fuel from waste plastics with other variables test fuels, such as kerosene, diesel, premium and pertamax.

3. HASIL DAN PEMBAHASAN

Fuel Calorific Value

Calorific value test result table using a calorimeter bomb :

Table 1. calorific value test result (tests were conducted in the lab Energy Conversion Engine

Name	Mass	CV (Cal/g)	Δ T	Fuse Length (cm)	Method
Plastic waste fuel	1 gr	10519	4.114	10	1000
Solar	1 gr	10896	4.274	10	1000
Premium	1 gr	10285	3.993	10	1000
Kerosene	1 gr	11021	4.314	10	1000
Pertamax	1 gr	11729	4.066	10	1000

Sumber: analisa laboratorium

Although any oil that is burned can be called fuel but the name is usually only used for residual fuel and to distillate fuel. Residual fuel is usually obtained by coagulating oil or splitting gas oil and residue kerosene. Fuel used for :

1. Large type diesel motor
2. The oil burner which is ignited by the cooking furnace used for
3. Producing steam
4. Hot work of metal
5. Dilutting the results of industry
6. Burning rocks, emaile and so on

The characteristics that must exist in fuel oil are:

Has a certain viscosity limits

The viscosity of oil is located between the gas oil viscosity is approximately 4 cs = 1.30 E at 50 ° C and about 550/650 cs = 75/850E at 50 ° C. More diluted fuel oil is needed for a smaller fuel aircraft, such as automated tools for central heating in the house.

The amount of heat given

The limit of heat oil burning approximately 10,000 and 10,550 cal/g.

Levels of sulfur

It is very important in diesel fuel than oil because sulfur in diesel fuel can cause damage and corrosion of the cylinder from the exhaust system.

Freezing point

It has a certain maximum freezing. Usually freezing point depends on prior treatment done on the material. For example, fuel oil mostly consists of residue cracking after

heating to 100°C has a boiling point of -21°C, but when left for a long time freezing to 150°C.

Octane Test Results :

Sample from testing of alternative fuel octane rating of plastic waste oil 250 ml tested in Petrolab Services, Rawamangun, East Jakarta. Currently still in the testing process.

The name of octane is originated from octana (C8), because of all constituent molecules of gasoline, octane has the best compression properties. Octana can be compressed to a small volume without experiencing spontaneous combustion, not as happens in heptana, for example, which can burn spontaneously although freshly pressed slightly.

Some of the octane number for fuel:

87 → Gasoline standards in the United States

88 → Premium without lead gasoline

91 → Gasoline standard in Europe, Pertamina

92 → Gasoline standard in Taiwan

91 → Pertamina

95 → Pertamina Plus

Emission Test Result:

This testing is conducted in order to determine whether or not the generator on / lit using alternative plastic waste fuel, and how much carbon content output fumes.

The steps taken are as follows :

1. prepare generator and required tools.
2. turn generators using diesel fuel. At the time generator has lived, generator is left for some time to reach operating temperature, therefore need to consider whether the generator running normally. It should also be observed conditions at the time the machine is idle and accelerated. Please note how long engine life with this fuel and all the symptoms and changes the sound generator to be noted include the color and smell of smoke. Data performance result uses plastic waste fuel then compares with the data obtained from the test results using biodiesel fuel, diesel, premium, and pertamax. The data obtains from each experiment and test analyzed in the following way: data from laboratory analysis shows in table form, and then analyzes through the study of literature by examining existing theories. To analyze the level of opacity can be done by showing the table form then associated with the standard exhaust emissions limits.

4. KESIMPULAN

Plastic waste fuel, which is the outcome from plastic waste conversion machine with continuous system, can be used as fuel for vehicles, it is because the plastic oil calorific value 10 519 cal / g equivalent calorific value premium. This research is expected to address the scarcity of fossil fuels, and increasing public awareness of using alternative fuel, especially plastic waste fuel.

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