Conversion Of Plastic Waste Into Alternative Fuel (Synthetic Fuel) By Gasification Method

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Abstract: *This study discusses about the synthetic fuel made from plastic waste using gasification method. The instrument used is a simple one phase distillatory. Sample has been tested and analyzed at PT. Pertamina RU V Balikpapan laboratory and Department of Transportation Banjar District. The result showed that this fuel is more alike to diesel fuel type according to its Final Boil Point and density. The smoke result showed that synthetic fuel has 19.73% and diesel fuel has 29.67%. The gas analyses also showed the carbon monoxide of synthetic fuel is 0% and the carbon monoxide of diesel fuel is 0.01%. So both smoke and gas analyses test of synthetic fuel are less than diesel fuel. Since the distillation process had been done for four to five hours, and the ratio of plastic bucket waste (PP) and plastic bottle waste (PET) is 3:1 (PP:PET) so the pressure vessel capacity is 800 grams. 4000 grams of plastic waste is required to produce 1000 mL of synthetic fuel. The cycle time was approximately 20 hours. The sample testing using ASTM D.1298 method showed that the fuel condition is good and the density 15^oC of temperature of 0.8031 g/mL . The result using ASTM method D.85 showed the Initial Boil Point (IBP) is 60 °C, and the Final Boil Point (FBP) is 345^oC.*

Keywords: distillation, synthetic fuel, diesel, smoke and gas analyses, boil points

1. Introducing

Global warming issue had been discussed on June 1992 at Rio de Janeiro, Brazil. This issue was mainly discussed on High Level Convention about Environment and Development. Indonesia was one of those countries whose there became an active member on some of this meeting (Murdiyarso et.al 2003).

Global environment has suffered from air pollution that impacted the global climate change. Since industrial revolution, the industry was built using an energy which made from coal, oil and greenhouse gases, such as carbon dioxide, methane and nitrous oxide. Recently, the topic that has been discussed is plastic waste. Its role has a huge impact (in negative way) to air pollution.

Plastic is the polymerization of crude oil (Alvin, 2012). The most familiar resin from its polymerization is poly(ethylene) terephtalate (PET) and polypropylene (PP) (Surdia et.al 2005). To produce plastic, it is required about 12 million barrel of crude oil and 14 million trees per year (Gusnanto 2008). Plastic can not be decomposed and during this time plastic were pulling out the greenhouse gases (due to the sun light). Actually, greenhouse gases are useful for the Earth to cover it from ultraviolet radiance. Some of the radiance can not be coming back to the outside of Earth surface. This radiation caused the greenhouse gases. The most common gas is dioxin which will be dangerous not only for the environment, but also for the human being (Alvin 2003).

The impact of energy crisis is always huge. Both of the economics and politics value will be impacted (Chadidjah et.al 2011). Most of the environment will be destroyed because people keep searching another energy sources on Earth.

Beside the negative side of plastic waste, it is also has the positive side as an alternative

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energy which more beneficial for environment and human being. The plastic waste can be used as an alternative energy sources by gasification method. This study will explain about the characteristics of synthetic fuel and compare it to diesel fuel.

2. Experimental Method and Facility Needed

Quantitative research was used. Three liter of synthetic fuel was collected to be a sample for both type of fuel (distilling) and gas emission (smoke) test. Both of synthetic and diesel fuel were tested to be known for their boil points, density and gas emission. The ASTM section D was used to be a method for distilling test. The smoke and gas emission were being tested using a gas analyzer. A pilot testing of the gas emission using a diesel car was performed to test suitability of the fuel on street.

The raw materials were plastic waste from the black bucket waste and bottle waste. Poly (ethylene) terephtalate and poly propylene were two specific types for this plastic waste. Those materials were being mixed in 3:1 of ratio.
The flow chart of methodology is depicted in Figure 1.

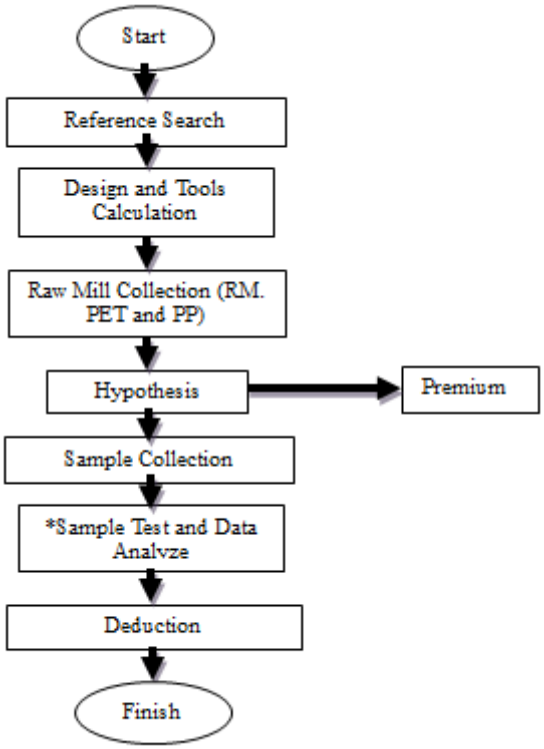

Figure 1 Flow Chart of Methodology

*The test was conducted in Laboratory of PT. Pertamina RU V Balikpapan, East Kalimantan

3. Result

The result showed that the hypothesis was unlike the tested result. It is showed that the synthetic fuel is more alike to diesel fuel. This conclusion is obtained from the final boil point (FBP) and the density of this fuel that are close to diesel fuel. Tables 1 and 2 showed the result data of synthetic fuel and diesel fuel distilling using the ASTM method.

Table 1. Data of Synthetic Fuel Distilling

No.	Analysis	Methods	Results
1.	Density at 15 °C	ASTM D. 1298	0.8031
2.	Distillation:	ASTM D. 86	

	- IBP		60
	- 5% vol. Rec. At		104
	- 10% vol. Rec. At		119
	- 20% vol. Rec. At		133
	- 30% vol. Rec. At		150
	- 40% vol. Rec. At		164
	- 50% vol. Rec. At		187
	- 60% vol. Rec. At		218
	- 70% vol. Rec. At		237
	- 80% vol. Rec. At		278
	- 90% vol. Rec. At		334
	- FBP		345

Table 2 Data of Diesel Fuel Distilling

Analysis	**Methods**	**Results**
Density at 15 °C kg/m³	D. 1298-99	845.9
Color	D. 1500-98	1
Cetane Number	D. 613	
Cetane Index	D 4737	50
Visco. Kin, at 40 °C mm²/s	D 445-01	3.8
Pour Point °C	D 97-96a	12
Sulphur Content % m/m	D 2622	0.07
Copper Strip Corr. (3hrs 50 °C)	D. 130	Class 1
Conradson Carbon Res. % m/m	D 189	<0.1
Sediment % m/m	D 473-95	<0.01
Ash Content % m/m	D 482-00a	<0.01
Strong Acid Numb. mgKOH/gr	D 664	Nil
Total Acid Numb. mgKOH/gr	D 664	0.2
Water Content ppm	D 1744	110
Flash Point PMcc °C	D 93-00	58
Appearance	Visual	C & B
Distillation	D 86-01	
IBP		156
- 10% vol. Rec. At		212
- 20% vol. Rec. At		240
- 30% vol. Rec. At		255
- 40% vol. Rec. At		266
- 50% vol. Rec. At		277
- 60% vol. Rec. At		287
Density at 15 °C kg/m³	D 1298-99	
- Upper		840.9
- Middle		847.9
- Lower		848.7
- 80% vol. Rec. At		312
- 90% vol. Rec. At		345
- 70% vol. Rec. At		300

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From the tables above, it can be seen the differences of both synthetic fuel and diesel fuel in the form of chart. Figure 1 showed the comparison of boil point between those two types of fuel.

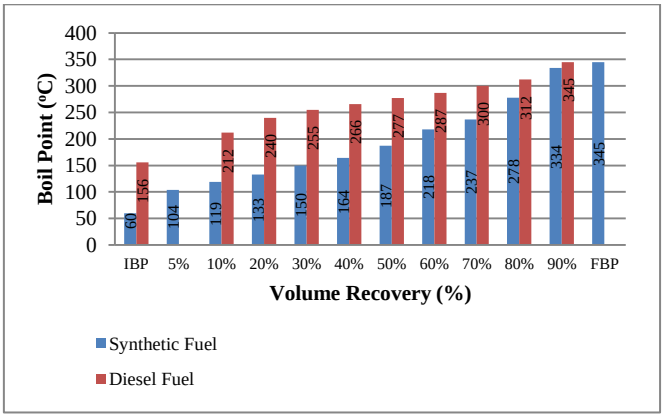

Figure 2. Boil Point Comparison Chart

Figure 2 shows the comparison of density between synthetic and diesel fuel.

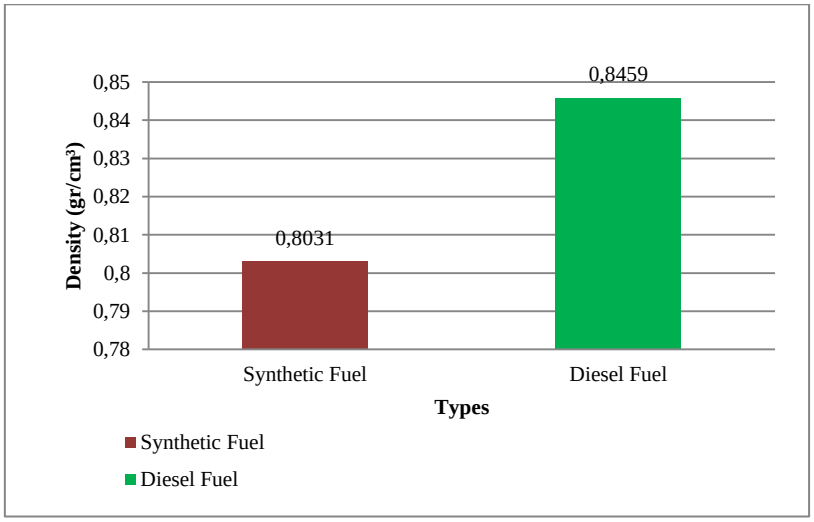

Figure 3. Density Comparison Chart

The gas emission has been tested, too. It was tested at Department of Transportation, Banjar District. Tables 3 and 4 are showed the result smoke of synthetic fuel and diesel fuel. On Tables 5 and 6 are showed the gas analyses of synthetic fuel and diesel fuel.

Table 3. Smoke Result of Synthetic Fuel

TESTS	RESULTS
Test 1	**25.2%**
Test 2	**21%**
Test 3	**12.7%**
Result	**19.73%**

Table 4. Smoke Result of Diesel Fuel

TESTS	RESULTS
Test 1	**34.9%**
Test 2	**32.6%**

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Test 3	**21.5%**
Result	**29.67%**

Table 5. Gas Analyses of Synthetic Fuel

Parameters	Results	Parameters	Results
CO	**0%**	**O_2**	**25%**
CO_2	**1.7%**	**[redacted]**	**2**
HC	**28 ppm**	**AFR**	**0**

Table 6. Gas Analyses of Diesel Fuel

Parameters	Results	Parameters	Results
CO	**0.01%**	**O_2**	**25%**
CO_2	**1.7%**	**[redacted]**	**2**
HC	**11 ppm**	**AFR**	**0**

From tables 3 and 4, it shows that smoke result of synthetic fuel is less than diesel fuel based on the average of the tests.
The carbon monoxide of synthetic fuel is also less than diesel fuel (Tables 5 and 6). Carbon monoxide is the most poisonous gas on air, because it was came from an imperfect combusted of vehicle gases.

4. Conclusion

The conclusion of this study is that plastic waste beside its negative impact for the environmental, it is has a beneficial impact as synthetic fuel. Synthetic fuel is more alike to diesel fuel according to its FBP and density. This synthetic fuel is friendlier than diesel fuel and it is viable to be use in diesel vehicles.

5. Acknowledgment

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6. Nomenclatures

PT : *Persero Terbatas*
Pertamina : *Perusahaan Minyak dan Gas Bumi Negara* (National Company of Petroleum and Gas)
RU : Rifinery Unit
PET : Poly(ethylene) Terephtalat
PP : Poly Propilene
ASTM D : American Society for Testing and Material section D
IBP : Initial Boil Point
FBP : Final Boil Point
CO : Carbon-Monoxide
CO_2 : Carbon-Dioxide
HC : Hydro-Carbon
O_2 : Oxygen
AFR : Air per Fuel Ratio

Subscripts
Vol. Rec. : Volume Recovery
Visco. Kin : Kinematics Viscous
Corr. : Corrosion
Numb. : Number

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