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# Performance Test of A mixture of Polypropylene Plastic Fuel from Pyrolysis with Gasoline to Torque and engine Power

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**Abstract.** Utilization of Polypropylene plastic waste (Polypropylene) by using pyrolysis process for being fuel of plastic waste using reactor with 10 kg plastic waste Polypropylene capacities produce 6 liter diesel fuel, 0.5 liter kerosene, 1.5 liter gasoline. That use as a fuel mixture of gasoline with the concentration 10%, 15% and 20% of the mixture to be tested the torque and engine power in motor vehicle using dynotest before testing conducted calorific values are test with bomb calorimeter for 11,111 calori/gram of Polypropylene plastic waste calorific value (Polypropylene) in 90% mixture of gasoline + 10% plastic waste fuel produces the highest calorific value 11,482 calori/gram. With the torque and power testing which is use dynotest in motor vehicle known for the first testing torque and maximal power are in the mixture of 20% plastic waste fuel (Polypropylene) + 80% gasoline occurs in 3000 rpm 4.373 HP and torque occurs in 3000 rpm 10.43 N.m. In the second testing torque and maximal power are in the mixture of 20% occurs in rpm 3500 rpm 4.391 HP and torque 10.28 N.m in rpm 3000. In the first testing there is an increase of torque and power when compare to the result of gasoline.

## 1. Introduction

The increasing use of fossil fuels which is increasingly increasing makes the government have to think hard to overcome this. Energy renewal continues to be explored by scientists to be able to create a safe and environmentally friendly renewable energy. Seeing this, it is necessary to be given the latest breakthroughs regarding renewable energy, one of which is utilizing plastic waste as fuel. The large number of uncontrolled users of plastic waste will cause environmental pollution such as soil pollution, garbage burning pollution that can affect the surrounding air. Some types of garbage that we often encounter are plastic bottles, for example plastic cups, plastic bottle caps, children's toys, etc. which is one type of PP waste (Polypropylene). Each weight unit can produce 70% oil, 16% gas 6% carbon solid and 8% water. And for this type of PP (Polypropylene) plastic it has a melting point of 70 °C – 80 °C [4][5][6]

Heat values in plastics and others include: Polyethylene 46.3 (MJ / Kg), Polypropylene 46.4 (MJ / Kg), Polyvinylchloride 18.0 (MJ / Kg), Polystyrene 41.34 (MJ / Kg), whereas in petrol at 44.0 (MJ / Kg) and diesel 43.0 (MJ / Kg). Proving that plastic waste has a high enough heat content this can be developed to become an alternative source of energy that uses renewable resources, [2][6][8]

Today many scientists are researching and developing plastic waste to be converted into fuel oil. Some of the technologies used to convert plastic waste include the Thermal Cracking method. That heating the polymer / plastic material without oxygen, this process is usually carried out at temperatures of 350 °C – 900 °C, this process includes the pyrolysis process. Thermal Catalytic cracking process to four fraction. That Four fraction are Polymer, degrade polymer, liquid, and gases [2][9][10][11]



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## 2. Formulation of Engine Performance

Engine performance parameters performance characteristics of a piston fuel motor are expressed in several parameters including fuel consumption, specific fuel consumption, ratio of fuel, air, and output power. [12][13]

The following formulas are presented from several parameters used in determining the performance of piston fuel motor:

### 2.1. Torque

Torque is the rotary force produced by the engine shaft. The amount of torque can be measured using the dyno test tool. In this research that will be analyzed is the torque that has been transferred to the motorcycle wheel using the dyno test tool, to measure the performance of the engine output produced. [13 – 17]

### 2.2 Engine Power

What is meant by power in the motor is the amount of motor work produced by the drive shaft. [13 – 16]

Motor power can be calculated by the equation:

$$P = \frac{2 \cdot \pi \cdot n \cdot T}{60000} \text{ (KW)}$$

Information:

n = Engine Rotation (rpm) .

T = Torque (Nm).

## 3. Pyrolysis Reactor

Pyrolysis reactor is a simple tool that functions as a producer of liquid plastic waste fuel, by heating the type of PP plastic waste with a temperature of 50 °C – 200 °C so that it will evaporate through pipes, the steam produced from the reactor is then cooled to become liquid through the condenser. The reactor capacity used is 10 kg. [2 - 8] [18-21]



Fig 1. Pyrolysis Reactor

3.1. Pyrolysis Process Flow Diagram

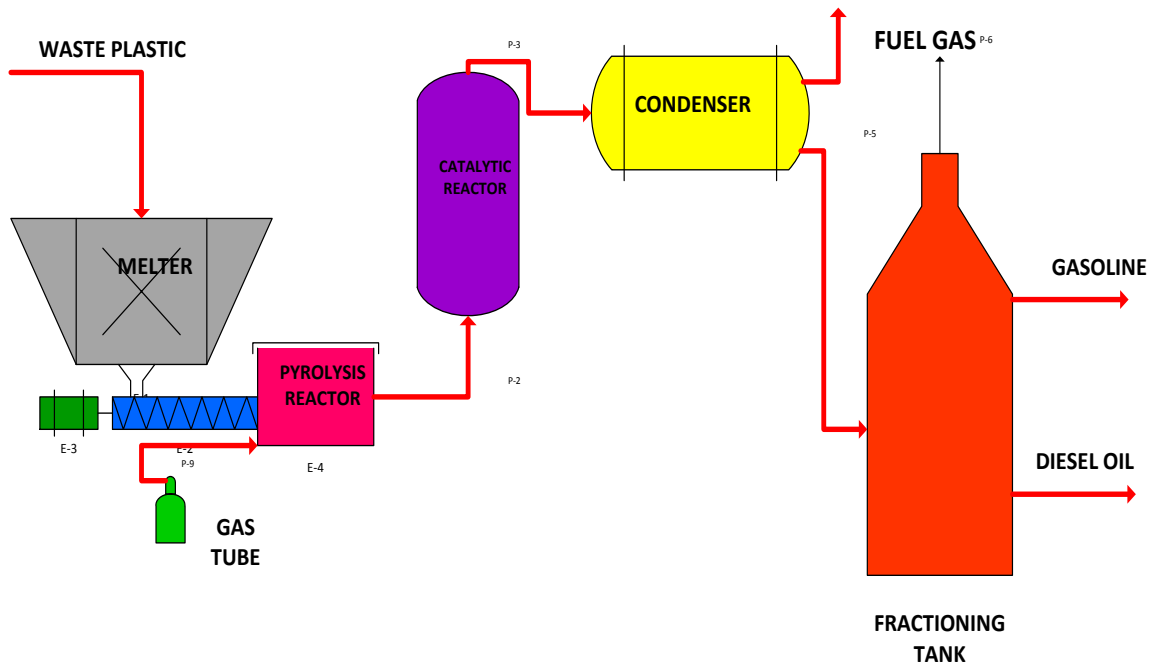


Fig 2. Pyrolysis Process Flow Diagram

3.2. Research Flowchart Diagram

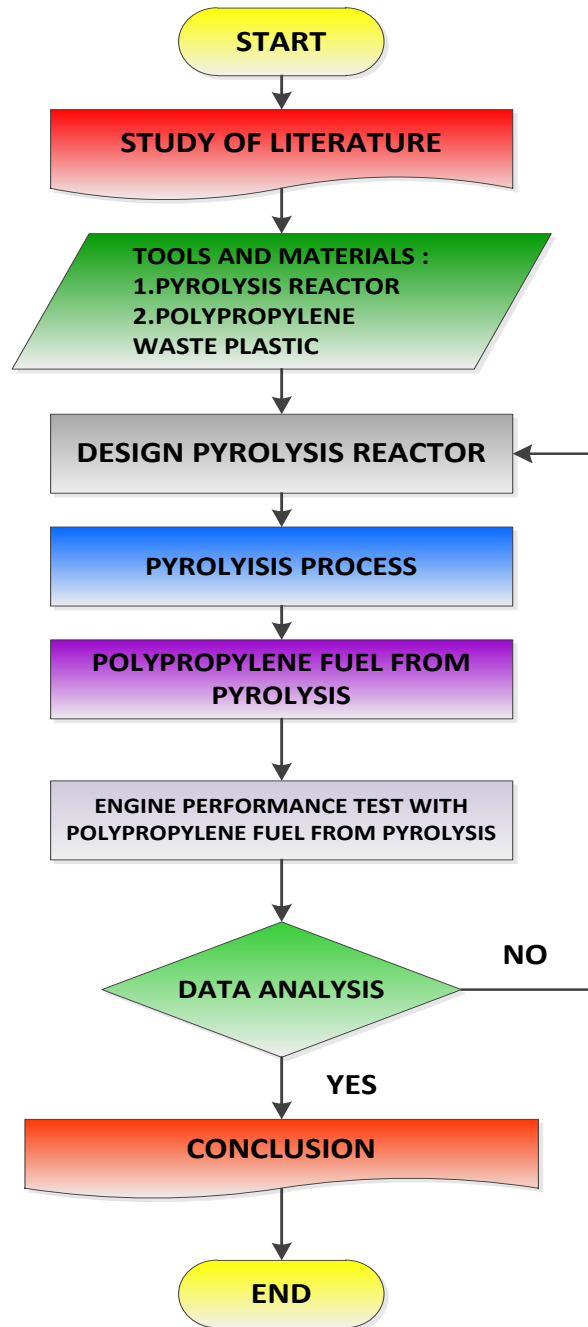


Fig 3. Research Flowchart Diagram

#### 4. Polypropylene

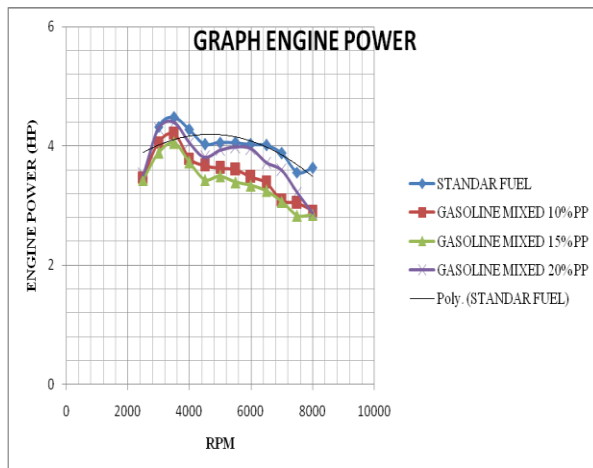
Polypropylene (PP) is a thermo-plastic polymer made by the chemical industry and is used in a variety of applications, including packaging, textiles (for example ropes, thermal underwear, and carpets), stationery, various types of containers and plastic parts, equipment laboratories, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from monomer propylene, the surface is uneven and has unusual resistance to most chemical solvents, alkaline and acidic. Polypropylene is usually recycled, and the recycling symbol is number "5". The processing of melting polypropylene can be achieved through extrusion and printing. A common extrusion method includes the production of fiber spun bond (spun bond) and blowing (blowing) melting to form long rolls to later be converted into various useful products such as face masks, filters, diapers and wipes. Surfaces can be applied to various parts of PP to improve adhesion (paint) of paint and printing ink.[2 – 8]

#### 5. Result

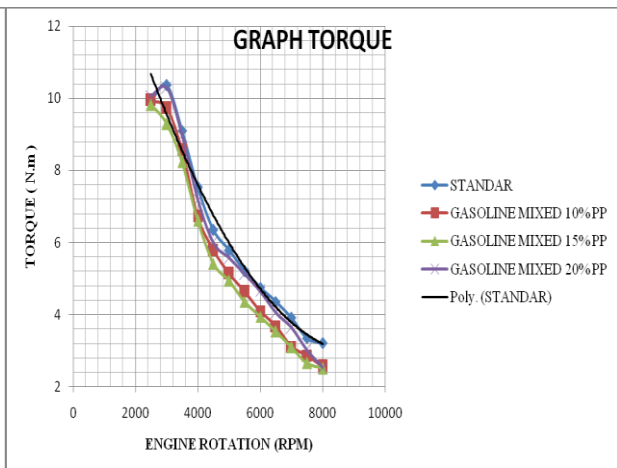
##### 5.1. Table

**Table 1. comparison of motor power using standard fuel and PP (Polypropylene) Liquid Plastic Fuel (BBPP) Mixture of 10%, 15% and 20%.**

RPM	ENGINE POWER (HP)			
	Standard Fuel	Gasoline mixed 10% Polypropylene	Gasoline mixed 15% Polypropylene	Gasoline mixed 20% Polypropylene
2500	3.433	3.142	3.473	3.436
3000	3.893	3.955	4.303	<b>4.373</b>
3500	<b>4.055</b>	<b>4.075</b>	<b>4.327</b>	4.345
4000	3.728	3.653	4.017	4.022
4500	3.431	3.506	3.786	3.899
5000	3.492	3.596	3.824	3.900
5500	3.391	3.510	3.807	3.872
6000	3.340	3.361	3.787	3.833
6500	3.250	3.170	3.603	3.693
7000	3.068	2.808	3.408	3.435
7500	2.833	2.850	3.144	3.264
8000	2.849	2.664	3.187	3.356



**Fig 4.** Graphic Engine Power (HP) with Gasoline mixture Polypropylene



**Fig 5.** Graphic TORQUE (N.m) with Gasoline mixture Polypropylene

5.2. Table

**Table 2.** Torque comparison uses standard fuel and PP (Polypropylene) Liquid Plastic Fuel (BBPP) Mixture of 10%, 15% and 20%.

RPM	TORQUE (Nm)			
	Standard Fuel	Gasoline mixed 10% Polypropylene	Gasoline mixed 15% Polypropylene	Gasoline mixed 20% Polypropylene
2500	9.95	<b>9.94</b>	<b>9.82</b>	10.07
3000	<b>10.36</b>	9.73	9.29	<b>10.28</b>
3500	9.10	8.56	8.23	8.97
4000	7.53	6.72	6.61	7.19
4500	6.35	5.78	5.41	5.99
5000	5.78	5.14	4.94	5.57
5500	5.21	4.64	4.36	5.13
6000	4.75	4.10	3.94	4.66
6500	4.36	3.68	3.53	4.05
7000	3.91	3.11	3,1	3.63
7500	3.35	2.87	2.66	3.03
8000	3.21	2.57	2.51	2.54

## 6. Conclusion

Based on the results of research observations, testing the mixture of PP (Polypropylene) type liquid plastic fuel and data analysis that has been carried out in the previous chapter, it can be concluded that the following are:

1. The higher the liquid plastic fuel mixture type PP (Polypropylene) with gasoline will increase the torque value.
2. The higher the liquid plastic fuel mixture type PP (Polypropylene) with gasoline will increase the engine power value
3. In this study the addition of 20% BBPP produced the highest power value of 4,373 HP at 3000 rpm.
4. In this study the addition of 20% BBPP produces the highest torque value of 10. 43 N.m at 3000 rpm.
5. At the test carried out the maximum torque and power occur at 2500 - 3500 rpm.

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