THE EFFECT OF MIXING PLASTIC PYROLYSIS OIL WITH PERTAMAX AND VARIATION OF IGNITION TIMING ON PERFORMANCE AND EMISSIONS

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Article Information

Manuscript Received 2023-08-24
Manuscript Revised 2024-04-18
Manuscript Accepted 2024-04-18
Manuscript Online 2024-04-18

ABSTRACT

One source of energy that has not been utilized optimally is waste. One of the abundant waste materials is plastic waste. Processing plastic waste in the form of plastic pyrolysis oil affects the performance and emissions of motor vehicles when mixed with Pertamax fuel, as well as variations in ignition timing. The purpose of this research is to determine the influence of changes in ignition timing on engine power, as well as to investigate the impact of using Pertamax mixed with pyrolysis fuel results on engine power. The fuel mixture is prepared based on volume ratios (0%, 10%, 20%, 30%, 100%) of pyrolysis to gasoline, with engine speeds ranging from 6500 to 9000 rpm. The experiment results, when the ignition timing was set at 6º, 8º, and 10º, there was a slight decrease in power and less stable results in some engine speed.

Keywords: *Fuel, Ignition Timing, Power, Pyrolisis.*

1. INTRODUCTION

The increasing demand for motor performance has led to the need for various approaches to reduce the consumption of fossil fuels due to the utilization of non-renewable energy sources [1]. Among the energy sources that have not been fully utilized is waste. One of the abundant waste materials is plastic waste [2], [3]

Pyrolysis is a process of thermal decomposition of polymer materials or plastics through heating in the absence of oxygen, where the raw materials undergo a chemical breakdown into a gaseous phase [4]–[6]. During this process, the hydrocarbon chemical structure will be transformed into a new hydrocarbon structure. Subsequently, the gas is cooled, causing condensation and forming a liquid. This liquid is the one that will become the oil-based fuel.[7], [8]

Ignition Timing functions to regulate the combustion process of the fuel-air mixture inside the cylinder at a predetermined time, which is at the end of the compression stroke. Spark ignition engines, or gasoline engines, are internal combustion engines where the combustion of the fuel-air mixture is initiated by a spark from the spark plug.[9], [10] Power is one of the parameters used to determine the performance of an engine. The definition of engine power is the amount of work the engine does in a certain period of time. The unit used is horsepower (hp) To calculate the power of a 4-stroke engine, the following formula can be used [11]:

$$P = \frac{2\pi.n.T}{60.000}$$

Based on Achmada Riski Aditya Mustofa, from Politeknik Negeri Malang conducted research on the Yamaha Mio Soul by adjusting the settings on a programmable ECU. Subsequently, testing was conducted by advancing and retarding the ignition timing with variations of timing (+2º, +4º, -2º, -4º). This research yielded the appropriate mapping of ignition timing when advanced by 2 degrees [12]–[14].

The study was conducted on (SI) engines using fuel derived from pyrolysis of LDPE plastic waste, which was compared to pertalite fuel. The results of the study indicated that the power generated from the pyrolysis-derived fuel was relatively lower by 14% compared to pertalite. Additionally, plastic fuel resulted in lower fuel consumption compared to pertalite[15], [16]

Necati Turkoz also conducted experiments to determine the optimal ignition timing in the engine by adjusting the variables forward (+2º, +4º, +6º) and backward (-2º, -4º, -6º). The results of the experiments indicated that the best performance and emissions were obtained when the ignition timing was advanced by 4 degrees[17], [18] A higher level of CO_2 in the combustion process indicates complete combustion within the combustion chamber. This occurs because oxygen molecules (-OH) in the fuel react with CO, producing CO_2. The mixture of gasoline and bioethanol can reduce CO emissions to a greater extent. The addition of cycloheptanol oxygenation additive can further decrease CO emissions. This is due to the more effective combustion and higher oxygen content resulting from bioethanol and cycloheptanol oxygenation. The addition of additives in fuel variations increases the O_2 content in emission gases due to the elevated oxygen content in the fuel [19], [20]

Vehicle exhaust emissions are the residual byproducts of fuel combustion inside the vehicle's engine, emitted through the engine's exhaust system. Meanwhile, the combustion process is a chemical reaction between the oxygen in the air and the hydrocarbon compounds in the fuel to produce energy [21].

2. RESEARCH SIGNIFICANCE

The difference in the research conducted by the authors from previous studies lies in the utilization of pyrolysis fuel, employing polypropylene plastic type with a mixture ratio used up to 100%, or pure pyrolysis, along with the addition of the ignition timing variable advanced by up to 10 degrees before TDC on a 110cc gasoline engine. The aim of this research is to ascertain the impact of utilizing pyrolysis fuel combined with variations in ignition timing on power parameters and exhaust gas emissions.

3. RESEARCH METHODS

The research method is a structured approach that guides the implementation of the study, enabling the collection of necessary data. Research is an activity conducted to comprehend and scientifically address problems in a systematic and logical manner, resulting in the acquisition of more objective data.

The concept of this research aims to investigate the power output of a vehicle fueled by a blend of pyrolysis fuel, with varying ignition timing from the CDI Programmable IMAX2 Super Pro, applied to a 4-stroke, 1-cylinder engine. The testing is carried out using the Dyno Test method to analyze the Power and Emissions of the study.

The pyrolysis used in this testing employs polypropylene plastic. The fuel mixture is prepared based on volume ratios (0%, 10%, 20%, 30%, 100%) of pyrolysis to gasoline.

All performance tests are conducted using the IQUTECHE DynoMax DW-25 engine testing equipment with a maximum power of 250hp and a maximum engine speed of 300 km/h. The engine used in the experiment is a single-cylinder, 4-stroke, 100cc capacity engine with a carburetor. HC, CO, NOx, and CO_2 values are measured using the SUKYOUNG SY-GA401 device. The pyrolysis fuel testing is conducted under wide-open throttle conditions, with engine speeds ranging from 6500 to 9000 rpm at this throttle position to determine performance parameters.

A new Capacitor Discharge Ignition (CDI) system is designed to detect and control different levels of ignition advance in the engine's performance and emissions. Seven sets of different ignition advance values are used in performance testing. One set includes advance values of 2, 4, 6, 8, and 10 for each test point. These are denoted as +2, +4, +6, +8, and +10 maps. Altered ignition times marked with (+) signs imply advancing the time with respect to the original values. However, advancing the ignition by 8^o and 10^o leads to improper combustion conditions for some test points.

4. RESULTS AND DISCUSSION

After conducting the testing, data from the test results were obtained, which were then processed into graphs and described.

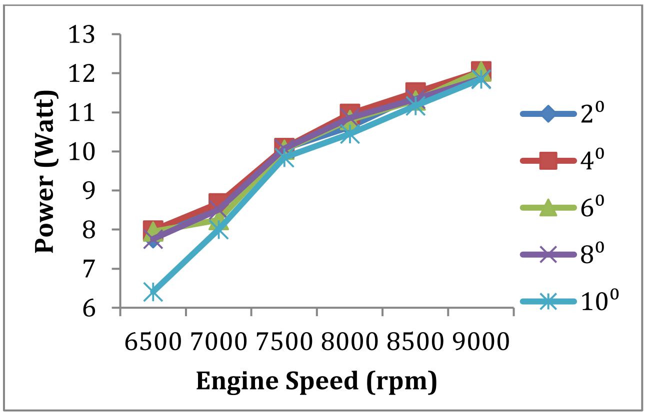

Figure 1. Power use *pyrolysis* 0%

Figs 1 represents the engine power generated using 100% Pertamax fuel or without a mixture of pyrolysis fuel. In this graph, it is observed that the power from Pertamax fuel exhibits a consistent increase in output, but there is a decrease in power at ignition timings of 6°, 8°, and 10°. Many factors can influence the power decrease at ignition timings of 6°, 8°, and 10°. These factors are linked to combustion efficiency. If the ignition timing is too early, the fuel might start burning before the piston reaches Top Dead Center (TDC), leading to energy loss due to the presence of unoccupied space where air and fuel haven't mixed completely.

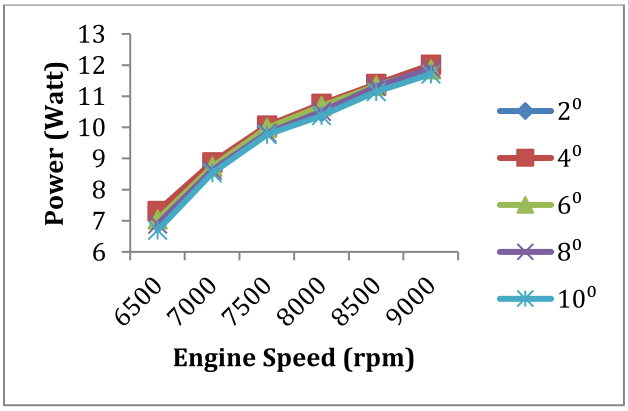

Figure 2. Power use *Pyrolysis* 10%

Figure 2,3,4, and 5 shows As engine speed increases, the power output also rises consistently across all displayed incline angles. It shows the relationship between engine power produced using 90% Pertamax fuel or without a 10% pyrolysis fuel mixture. In this graph it can be seen that the power from Pertamax fuel shows a consistent increase in output, but there is a decrease in power at 6°, 8° and 10° ignition times. If the ignition timing is too early, the fuel may start to burn before the piston reaches Top Dead Center (TDC), causing a loss of energy due to the empty space where the air and fuel are not completely mixed.

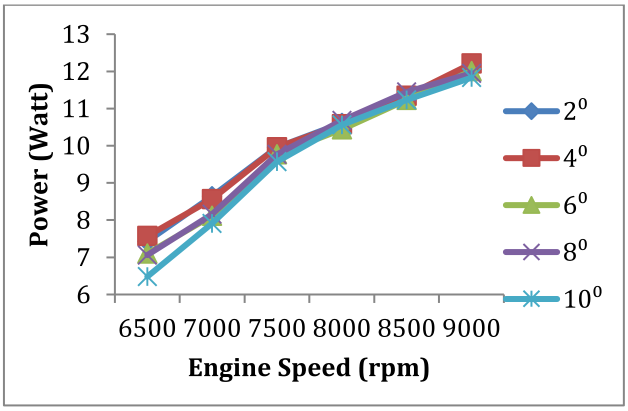

Figure 3. Power use *Pyrolysis* 20%

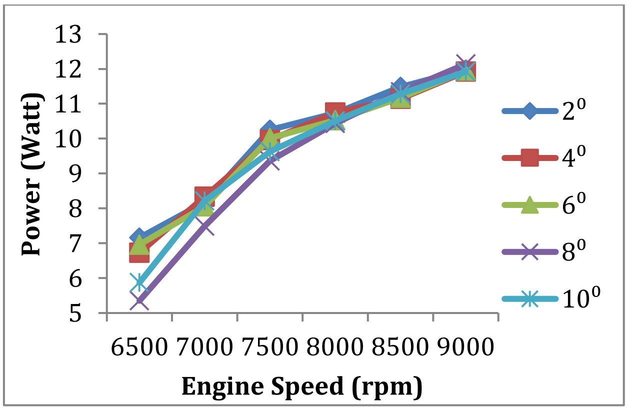

Figure 4. Power use Pyrolisis 30%

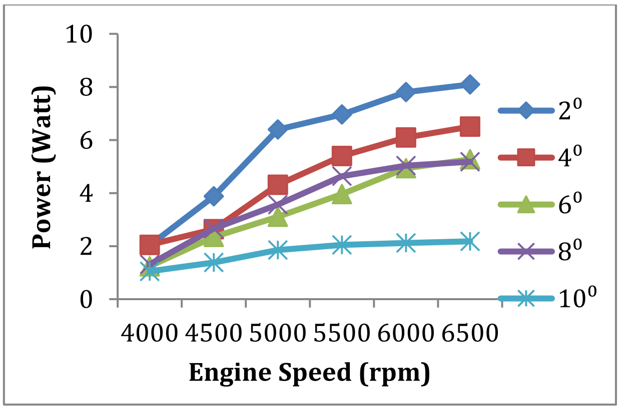

Figure 5. Power use Pyrolisis 100%

5. CONCLUSIONS

After conducting the testing, the use of fuel in this study also significantly affects the power and tested exhaust gas emissions. The power generated from this pyrolysis fuel experiences a drastic or significant decrease when using 100% pyrolysis fuel, thus causing difficulties and obstacles in the testing process.

6. ACKNOWLEDGEMENTS

Thanks from the author to individuals or groups who have contributed or supported the research or writing of the article.

7. AUTHOR CONTRIBUTIONS

- Conceptualization: Ratna Monasari, Naufal Hana Rizqullah,
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- Investigation:, Candra Aditya
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