BIS ENERGY AND ENGINEERING

Volume 1 2024 | DOI: 10.31603/biseeng.60
5th Borobudur International Symposium on Science and Technology (BIS-STE) 2023

UNIMMA PRESS
UNIVERSITAS MUHAMMADIYAH MAGELANG

Performance optimization of pertalite fuel gasoline engine with the addition of turpentine oil and ethanol

T Rokhman[1*], Paridawati[1], R H Rahmanto[1], A Surahto[1], and D A Prasetyo[1]

[1] Mechanical Engineering Department, Universitas Islam 45, Bekasi, Indonesia
*Corresponding author email: rokhman.taufiq@gmail.com

Abstract

Motorized vehicles are the most frequently used mode of transportation in everyday life. Of the many types of vehicles, motorbikes are one of the most popular vehicles among the middle and lower middle class due to their minimalist design, fairly affordable prices and efficiency. With the increasing number of consumers using motorized vehicles, the need for fuel is becoming increasingly high, where there is a phenomenon of wasting energy, especially fuel oil (BBM). Realizing this, a lot of research and development has been carried out to streamline the energy used in petrol motorbikes, one of which is by adding bio-additives turpentine oil and ethanol to pertalite fuel. This research was carried out by testing on a dynamometer engine which was then collected in the form of recorded data to determine the composition of turpentine oil and/or ethanol in the pertalite mixture which produces optimum engine performance. From testing and data analysis, it was concluded that the addition of turpentine oil and ethanol could produce the most optimal torque of 10.97 N.m and power of 9.81 hp, higher than without any mixture or 100% pure pertalite. Likewise, the addition of this composition reduces engine fuel use because the highest savings occur in the mixture composition P: 70%, T: 10%, and E: 20% at 5500, 6000, 6500, 7000, and 7500 RPM with average consumption amounting to 0.3774 L/h compared to without any mixture or 100% pure pertalite which has a higher average consumption of 0.5836 L/h.

Published:
October 20, 2024

Selection and Peer-review under the responsibility of the 5th BIS-STE 2023 Committee

Keywords

Pertalite, Turpentine oil, Ethanol

Introduction

Background

Motorized vehicles are among the modes of transportation that are most often used in everyday life, for example four-wheeled vehicles such as trucks for transporting logistical goods, buses used for activities such as carrying passengers, then twowheeled vehicles include automatic motorbikes. Most popular with mothers for traveling to the market or picking up their children from school and there are many other types of vehicles. Of the many types of vehicles, motorbikes are one of the most popular and popular vehicles among the upper middle class because of their minimalist and efficient design and quite affordable prices. The small engine capacity means that operational costs are not that expensive compared to cars that require extra costs to maintain.

With the increasing number of consumers using motorized vehicles, the need for fuel is also increasing, which results in wastage of energy, especially fuel oil (BBM). Currently, fuel oil reserves continue to decline, especially as prices soar higher every year. In the last three years, it has been recorded that the amount of oil reserves in Indonesia has decreased drastically, from 7.51 billion barrels in 2018 to 3.95 billion barrels in 2021 (Ministry of Energy and Mineral Resources (ESDM), 2021). In fact, recently the leading fuel oil management company in the country, namely PT. Pertamina has officially removed premium fuel types and is making people switch to pertalite fuel.

Realizing this, a lot of research and development has been carried out to streamline the energy used in petrol motorbikes, one of which is by adding additives or using biofuel. Biofuel, which is an alternative energy source, can be used as a substitute for or as a replacement for fossil fuels. The biofuel that has been developed to date is bioethanol. Bioethanol can be used directly or indirectly as fuel, for motor vehicle fuel bioethanol must first be mixed with gasoline in a certain ratio.

Based on the background above, we intend to conduct research by adding turpentine oil and ethanol to pertalite fuel in a 125 CC gasoline engine. This fuel combination is expected to improve engine performance and reduce petroleum consumption.

Research purposes

The aim of this research is:

1. Knowing the composition of turpentine oil and/or ethanol in the pertalite mixture which produces optimum engine performance.
2. Find out the composition of turpentine oil and/or ethanol in the pertalite mixture which reduces engine fuel use because it produces the highest savings.

Combustion motor

Chemical energy from gasoline fuel is converted into heat energy through an oxidation process or combustion process with air in the combustion chamber. The heat energy trapped in it makes the temperature and pressure higher, so that it expands against the engine mechanism. The results of this expansion make the crankshaft rotate which then goes to the transmission system to transmit power so that the output energy can be utilized as needed. A petrol motor consists of several main components, namely the cylinder block, cylinder head, crankshaft, piston, connecting rod, fly wheel, cam shaft. (camshaft), and valve mechanics.

Parameters for gasoline motor performance

The power obtained from an engine or motorbike is the main purpose of producing a combustion motorbike. There are several general performance factors for all motors and prime movers, these operating parameters include: torque (T), power (Bhp), fuel consumption (FC).

Power

Power is defined as the result of work, or in other words power is the work or energy produced by a machine per unit time the machine operates. On petrol motorbikes, Break Horsepower (BHP) is a quantity to indicate the actual horsepower produced by the engine. BHP is usually measured with a special tool to measure the power placed on the engine driveshaft [14]. To calculate the power of a 4 stroke motor, you can look at the following formula:

$$P_b = \frac{2.\pi.n\ T}{60} \quad (1)$$

Where: P_B = Output power (Hp); n = Engine rev (RPM); and T = Torque (N.m).

Torque

Twisting moment or torque is a measure of the ability produced by a motor or machine to produce work. In practice, motor torque is useful when the vehicle is moving (starting) or when accelerating the vehicle, and power is useful for obtaining high speed. The magnitude of the torque (T) will be the same, change or double, the torque arises due to the tangential force at a distance from the axis of rotation. For a machine that operates at a certain speed and transmits power, a force (F) and radius (R) will arise in a constant state [14]. To calculate torque, you can look at the following formula:

$$T = F \times r \quad (2)$$

Where: T = Torque (N.m); F = The balancing force provided (N); and r = Torque arm distance (mm).

Fuel consumption

Fuel Consumption is what reflects the efficiency of an internal combustion engine that burns fuel and produces fuel savings. In motor vehicle applications, fuel consumption (FC) is used to evaluate the efficiency of internal combustion engines or in foreign language usually called Internal Combustion Engines (ICE) [14].

The fuel consumption used in the research is engine consumption, how long it takes to use 20 ml of gasoline mixture. Fuel consumption or (FC) states the amount of fuel consumed by the motorbike.

The lower the fuel consumption (FC) value, the lower the fuel consumption used for combustion. To calculate the fuel consumption (FC) value, you can see the following formula:

$$FC = \frac{V_t \: x \: 3600}{t \: x \: 1000} \qquad (3)$$

Where: FC = *Fuel consumption* (FC); V_t = Volume of fuel used (ml); and t = Consumption time (s).

Fuel

Fuel is a material that can be converted into energy. Usually, fuel contains heat energy that can be generated and manipulated. Especially in fuel oil (BBM), which is fuel in motor vehicles which is a fluid type in the form of gasoline.

Methods

Flow diagram of research

Flow Diagram of Research is given in Figure 1.

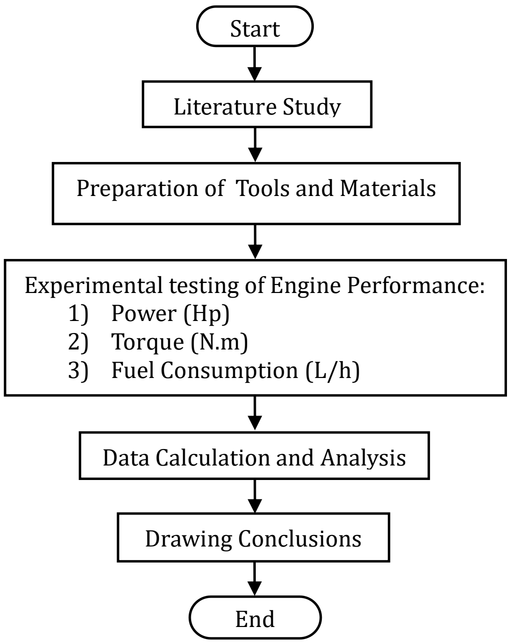

Figure 1. Flow diagram of research

Tools and materials

To carry out tests on research objects, several test equipment and materials are needed as follows:

1. Research tools:
   a. Dynamometer
   b. Measuring Cup
   c. Tachometer
   d. Stopwatch

2. Research materials:

   a. Motorbike Type X 125 CC
   b. Pertalite Gasoline
   c. Turpentine Oil
   d. Ethanol 96 %

Research parameters

1. Independent variables

An independent variable is a variable whose magnitude and value are determined by that variable. The independent variable in this research and testing is the fuel mixture, namely:

   a. Pertalite 100%
   b. Pertalite 70%, Turpentine oil 30%
   c. Pertalite 70%, Ethanol 30%
   d. Pertalite 70%, Ethanol 25%, Turpentine oil 5%
   e. Pertalite 70%, Ethanol 20%, Turpentine oil 10%
   f. Pertalite 70%, Ethanol 15%, Turpentine oil 15%
   g. Pertalite 70%, Ethanol 10%, Turpentine oil 20%
   h. Pertalite 70%, Ethanol 5%, Turpentine oil 25%

2. Dependent variables

The dependent variable is a variable whose value depends on the independent variable, where this variable is obtained after research and testing is carried out. The dependent variable observed in this research is:

   a. Torque
   b. Power
   c. Fuel Consumption

3. Controlled variables

Controlled variables are also called control variables. This variable causes the relationship between the independent variable and the dependent variable to remain constant (appropriate). This variable can have an impact due to the existence of a moderated variable. This controlled variable is the RPM rotation of the Type X 125CC motorbike.

Results and discussion

Maximum torque (N.m)

Figure 2 and Table 1 shows that the highest torque figure is obtained in a fuel mixture with a percentage of P: 70%, T: 10%, and E: 20% of 10.97 N.m at 6000 RPM. Meanwhile, for pure pertalite fuel with a percentage of 100% (without any mixture), the torque figure is 10.27 N.m at 6000 RPM. So, the torque value of fuel with the composition P:

70%, T: 10%, and E: 20% is greater than 100% pure pertalite fuel (without any mixture). So, adding turpentine oil and ethanol to pertalite according to the dosage can have an increasing effect on the torque produced by the motorbike engine.

According to Wiratmaja [14], what needs to be considered in liquid fuel is the size of the flash point. Higher octane fuels have higher flash points too. This can be proven by the flash point of turpentine oil of 33 °C plus ethanol of 13 °C when accumulated, which is greater than the flash point of pertalite fuel of -45 °C. Therefore, the flash point causes the torque shock to become greater.

Table 1. Maximum torque from torque testing on each fuel mixture

Fuel Mixture	Max Torque (N.m)	RPM
P: 100%, T: 0%, E: 0%	10.27	6000
P: 70%, T: 30%, E: 0%	9.90	6500
P: 70%, T: 25%, E: 5%	10.25	6000
P: 70%, T: 20%, E: 10%	10.46	6000
P: 70%, T: 15%, E: 15%	10.48	6000
P: 70%, T: 10%, E: 20%	10.96	6000
P: 70%, T: 5%, E: 25%	9.90	6500
P: 70%, T: 0, E: 30%	9.93	6500

Information: P: Pertalite; T: Turpentine oil; E: Ethanol

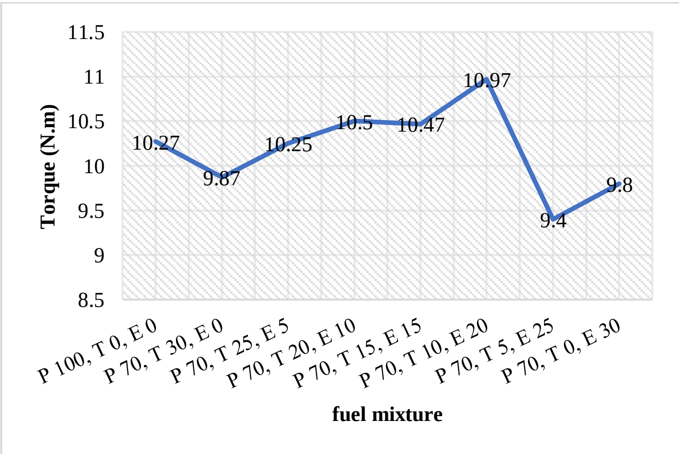

Figure 2. Maximum torque from torque testing on each fuel mixture

Maximum power (Hp)

Figure 3 and Table 2 shows that the highest power figure is obtained from a fuel mixture with a percentage of P: 70%, T: 10%, and E: 20%, amounting to 9.81 HP at 7000 RPM. Then, for pure pertalite fuel with a percentage of 100% (without any mixture), the power figure is 9.80 HP at 7500 RPM. If we refer to the motorbike specifications where the maximum power is 9.17 HP at 7500 RPM, it shows that both mixtures are equally capable of increasing engine power, namely reaching 9.80 HP, but with a mixture of P: 70%, T: 10%, E: 20% which is superior first, although the difference increases by one point, namely: 9.81 HP at 7000 RPM, making the mixture slightly higher. So, the power value of fuel with the composition P: 70%, T: 10%, and E: 20% is higher compared to 100% pure pertalite fuel (without any mixture), the power is smaller. So, the addition of turpentine oil and ethanol to pertalite according to the dosage is quite capable of having an effect in increasing the power produced by the motorbike engine.

So, this shows that the power and torque values are obtained at the same mixture composition, namely P: 70%, T: 10%, E: 20%. This is because the amount of power produced from each type of material is influenced by the increase in torque and increase in engine speed.

Table 2. Maximum power from power testing on each fuel mixture

Fuel Mixture	Max Power (Hp)	RPM
P: 100%, T: 0%, E: 0%	9.80	7500
P: 70%, T: 30, E: 0%	9.59	7500
P: 70%, T: 25, E: 5%	9.50	7000
P: 70%, T: 20, E: 10%	9.69	7000
P: 70%, T: 15%, E: 15%	9.76	7000
P: 70%, T: 10, E: 20%	9.81	7000
P: 70%, T: 5%, E: 25%	9.40	7000
P: 70%, T: 0, E: 30%	9.42	7000

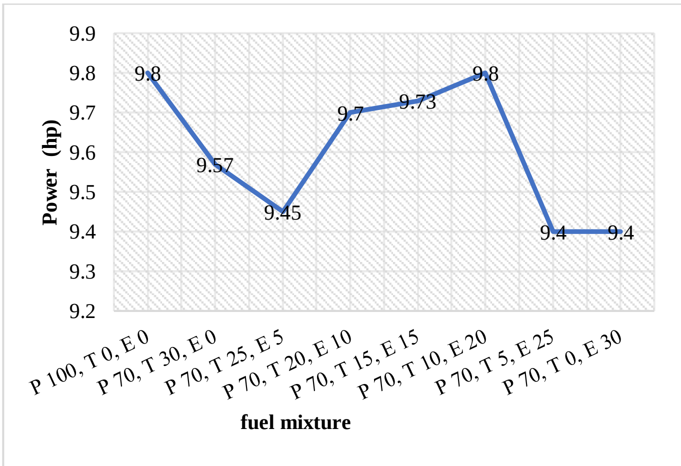

Figure 3. Maximum power from power testing on each fuel mixture

Optimum fuel consumption

Based on Figure 4 and Table 3, it can be seen that the highest fuel consumption for a motorcycle engine is obtained from 100% pure Pertalite (without mixture) with an average consumption of 0.5836 L/h and the lowest fuel consumption for a motorcycle engine is obtained from a mixture of P: 70%, T: 10%, E: 20% with average consumption of 0.3774 L/h. So, the addition of turpentine oil and ethanol to pertalite in adjusted doses can reduce the amount of fuel consumed. With this phenomenon, it can be explained that the same power of 1 HP requires a smaller mass of fuel. This happens because in this mixture the combustion occurs more completely [2].

Table 3. Test results data of fuel consumption

Mixture Composition	Fuel consumption (L/h)				
	RPM				
	5500	6000	6500	7000	7500
P: 100 %, T: 0%, E: 0%	0.533	0.545	0.563	0.628	0.649
P: 70 %, T: 30 %, E: 0%	0.356	0.359	0.383	0.389	0.409
P: 70 %, T: 25 %, E: 5%	0.355	0.360	0.385	0.397	0.411

P: 70 %, T: 20 %, E: 10%	0.361	0.370	0.405	0.415	0.460
P: 70 %, T: 15 %, E: 15%	0.399	0.545	0.585	0.622	0.632
P: 70 %, T: 10 %, E: 20%	0.352	0.358	0.381	0.393	0.403
P: 70 %, T: 5 %, E: 25%	0.358	0.366	0.403	0.414	0.471
P: 70 %, T: 0 %, E: 30%	0.364	0.387	0.403	0.412	0.462

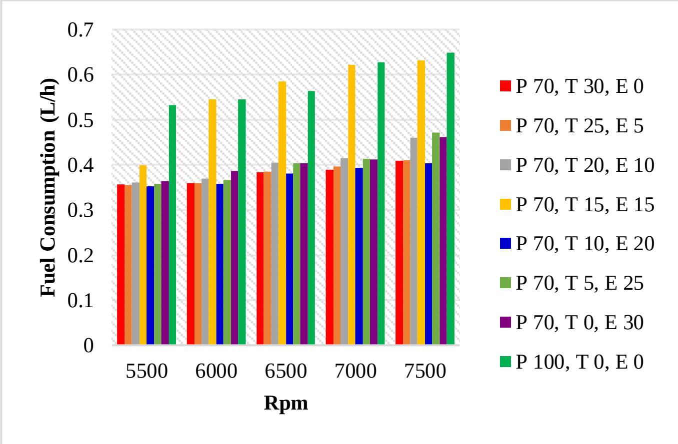

Figure 4. Data graph of fuel consumption test results

Conclusion

After carrying out testing, processing data and analyzing it, this research can be concluded as follows:

1. The addition of turpentine oil and ethanol to pertalite fuel with a mixture composition of P: 70%, T: 10%, and E: 20% produces the most optimal torque of 10.97 N.m and power of 9.81 Hp, compared to without the mixture or pertalite 100% pure which only reaches torque at 10.27 N.m and power at 9.80 Hp.
2. The addition of turpentine oil and ethanol which can reduce engine fuel use because the highest savings occur in the mixture composition P: 70%, T: 10%, and E: 20% at 5500, 6000, 6500, 7000, and 7500 RPM with an average consumption of 0.3774 L/h compared to without any mixture or 100% pure pertalite which has a higher average consumption of 0.5836 L/h.

Recommendation

There are several suggestions in this research, namely:

1. It is hoped that in further research exhaust gas emissions testing can be carried out with adequate equipment preparation.
2. There is a need for research on the bio additive content of turpentine oil so that we know the reactions that result when mixed with several fuels.

References

[1] Handayani, S. U. (2006). Utilization of Bio Ethanol as a Fuel Substitute for Gasoline. Technological Echoes, 5(2), 99-102.

[2] Haqim, L. (2020). Effect of Adding Biogasoline from Pine Sap as a Pertalite Mixture on 110 CC Motorcycle Engine Performance. Sainteknol: Journal of Science and Technology, 18(2), 96-104.
[3] Kadarohman, A. (2009). Exploration of essential oils as bioadditives for diesel fuel. Journal of Mathematics and Natural Sciences Teaching, 14(2), 121-142.
[4] Lai, R. F. (2013). Analysis of fuel consumption for petrol motorbikes installed on Suzuki Smash 110 CC motorbikes used on uphill roads. Unsrat Engineering Axis Journal.
[5] Laksono, A. (2021). The Effect of Varying Additives in Pertamax on Exhaust Gas Emissions from 125cc SOHC Gasoline Motorcycles. Doctoral dissertation, Jember State Polytechnic.
[6] Munasif. (2012). Bioethanol. Indonesian Institute of Sciences.
[7] Muryanto, E. &. (2016). Study of the Effect of a Mixture of Premium Fuel and Ethanol on the Performance of a Four-Stroke Gasoline Motorcycle Engine. Surakarta: Doctoral dissertation, Muhammadiyah University of Surakarta.
[8] Rizal, M. S. (2013). Energy convertion. Cimahi: Ministry of Education and Culture.
[9] Robertus Simanungkalit, T. B. (2013). Performance of Single Cylinder Motorcycle Engines Made from Premium Root and Pertamax Plus with Modified Compression Ratio. E-Dynamic Journal.
[10] Saputra, R. A. (2017). The Effect of Mixing Pertalite Fuel with Turpentine Oil and Astiri Oil on Reducing Exhaust Gas Emissions on Supra X 125 Motorcycles. Undiksha Mechanical Engineering Education Journal, 5(2).
[11] Sunyoto. (2008). Industrial Mechanical Engineering. Jakarta: Department of National Education.
[12] Wikipedia. (2022). Retrieved from wikipedia.org: https://id.wikipedia.org/wiki/Kendaran_bermotor
[13] Winarno, J. (2011). Experimental Study of the Effect of Adding Bioethanol to Pertamax Fuel on the Performance of Gasoline Motorcycles. Engineering journal, 33-39.
[14] Wiratmaja, I. G. (2010). Performance Analysis of Gasoline Motorcycles Due to the Use of Biogasoline. Scientific Journal of Mechanical Engineering, 16-25.