MECOMARE, 10 (1) (2021) pp. 31-40

Published by: TRIGIN Publisher

International Journal of Mechanical Computational and Manufacturing Research

Journal homepage: www.trigin.pelnus.ac.id

Experimental Test of Single Cylinder Otto Engine Performance on Dynotest Chassis Using Premium Fuel Types, Pertalite and Pertamax

Agung Mulia Pulungan

Faculty of Engineering, University of North Sumatra, Indonesia

ARTICLEINFO

Article history:

Received March 13, 2021
Revised April 01, 2021
Accepted May 28, 2021

Keywords:

Brake Thermal Efficiency
Emissions
Power
Spesific Fuel Consumption
Torque

ABSTRACT

Public vehicles such as motorcycles today could use some types of fuel selection from PT. Pertamina for premium gasoline engines among other things, pertalite and pertamax. Each type of fuel has an octane number of different. Engine performance is heavily influenced by several factors, including the type of fuel used and the pistons (large and small combustion chamber volume). The purpose of this study was to determine the effect of different octane number of gasoline on the performance of torque, power, and then analyze the specific fuel consumption, brake thermal efficiency and exhaust emissions at otto engine. The results of the experimental test engine performance otto one cylinder indicates a maximum torque of 40 Nm at engine speed 1410 rpm when using gasoline pertamax, followed torque of 38 Nm at engine speed 1221 rpm when using gasoline pertalite and torque of 29 Nm at rpm 1877 when using premium gasoline. While the maximum power when using gasoline pertamax of 13,870 kW at 4409 rpm, followed pertalite 12,602 kW at 4041 rpm rotation, and premium gasoline amounted to 12,229 kW at 4688 rpm rotation. For specific fuel consumption is minimal (economical) when using gasoline pertamax amounted to 0.171 kg/kW.h at 4409 rpm, followed by gasoline pertalite of 0.229 kg/kW.h at 4041 rpm, then premium gasoline amounted to 0.273 kg/kW. h on 4688 rpm. Brake thermal efficiency (BTE) is achieved when the maximum engine using gasoline pertamax amounted to 48.124% at engine speed 4409 rpm, followed by the gasoline engine BTE pertalite 36.659% at 4041 rpm and the engine BTE premium gasoline amounted to 31.673% at 4688 rpm.

Corresponding Author:

Agung Mulia Pulungan
Faculty of Engineering
University of North Sumatra
Jln. Dr.T. Mansur No.9, Medan City, North Sumatra, 20222, Indonesia
Email: agung@gmail.com

1. INTRODUCTION

Motor fuel is a machine or power aircraft which is a heat engine by using heat energy to perform mechanical work by converting chemical energy from fuel into thermal energy so as to produce mechanical energy (Martinus, 2017). How to get the thermal energy from the results of the fuel combustion process in the engine itself (Simanungkalit & Sitorus, 2013). Car and motorcycle engines require a type of fuel that matches the design of the engine itself in order to work properly and produce optimal performance (Sururi & Waluyo, 2015). The type of gasoline is usually represented by an octane number/value (RON), for example Premium 88 octane, Pertalite 90 octane(Amrullah et al., 2021), Pertamax octane 92 and so on. The higher the octane number, the price per liter is generally higher (expensive) (Dance, 2019). But not necessarily that if you fill high octane gasoline in a car or motorcycle engine, then it will produce higher power as well (Muku & Sukadana, 2009).

Different machine specifications. In a good brochure will display information on the compression ratio (Compression Ratio / CR) (Fuaz, 2010). This CR is the result of the calculation of the pressure ratio related to the volume of the combustion chamber to the distance of the piston stroke from the bottom dead center to the top dead point when the engine is running (Majedi & Puspitasari, 2017).

Low octane fuel is more flammable. The higher the CR value on the engine, it means that it requires high octane fuel (Son & Sakti, 2018) A high compression engine makes fuel burn quickly (due to high pressure), which will be a problem is, when the fuel burns early (because the octane is low while the CR is high) before the spark plug sparks (Viandi, 2017). When the piston rises to the top to compress, the gasoline ignites before the spark plug, as a result the piston seems to be hit hard by the combustion chamber explosion, this event is called detonation / knocking. In fact, we see a lot, especially at gas stations, where vehicles with high compression engines have long queues at gas stations in the premium section, not in the pertalite or pertamax sections. This shows that users of these high-compression vehicles prefer to buy and use premium rather than pertalite or pertamax (Hani, 2017). The economic factor is more urgent than the future damage to the vehicle engine or indeed the lack of information regarding the selection of this fuel (Simarmata et al., 2021). Therefore, the authors are interested in conducting research on the comparison between premium fuel, pertalite and pertamax on engine performance using a test medium in the form of a Honda Megapro motorcycle. The parameters used to assess the performance of the engine include: torque, power, specific fuel consumption (specific fuel consumption), brake thermal efficiency and engine exhaust emissions (Nofendri, 2016).

The purposes of writing this thesis are as follows: (1) To compare the performance of the Honda Megapro engine using premium fuel, pertalite and pertamax (Pulungan, 2016)(2) To determine the exhaust gas emissions of the otto engine when using premium fuel, pertalite and pertamax fuel (Habibi, 2016). The benefits of this thesis are as follows: (1) Can find out the comparison of the performance of the Honda Megapro engine using premium fuel, pertalite and pertamax (Sutrisno et al., 2021). (2) As a reference for users of machines that have a compression ratio (rc) of 9.0: 1 or owners of Honda Megapro vehicles to use fossil fuels that are right on target.

2. RESEARCH METHOD

To observe and predict the vibrations that occur in the transmission, it is done by building numerical rules that will simulate the natural frequency and vibration modes that occur (Napitupulu et al., 2021). In this study, the two rules will be reviewed to obtain comfortable vibration characteristics when driving. For this reason, the first step that needs to be done is to identify the design parameters of the vibration object to be studied (Naibaho, 2018).

2.1 Method of Collecting Data

The data used in the later tests include: (1) Primary data, is data obtained directly from measurements and readings on the instrumentation unit and measuring instruments in each test (Supriyatmojo et al., 2018). (2) Secondary data, is data about the characteristics of the fuel used in the test (Country et al., 2009).

2.2 Otto Engine Performance Testing Flowchart

Otto Engine Performance Testing was carried out using a Honda Megapro single cylinder otto engine manufactured by PT. Astra Honda Motor (Winarto, 2014). In the research test, the performance of the otto engine was carried out with variations in fuel and speed (Ariawan et al., 2016). The flow chart of the otto engine performance testing carried out in the study can be seen in Figure 3.19

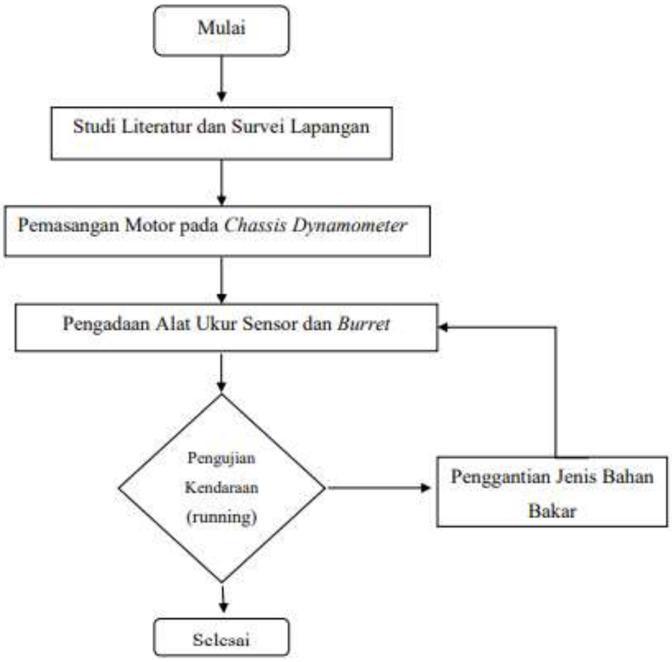

Figure 1. Motorcycle Engine Performance Testing Flowchart

3. RESULTS AND DISCUSSIONS

3.1. Performance Test

The data obtained from the engine performance testing includes rotation, power, torque and fuel consumption time per 10 ml which is carried out directly using variations of premium fuel, pertalite and pertamax.

3.2. Torque and Power

The following is the test result data on the otto engine with variations of premium fuel, pertalite and pertamax.

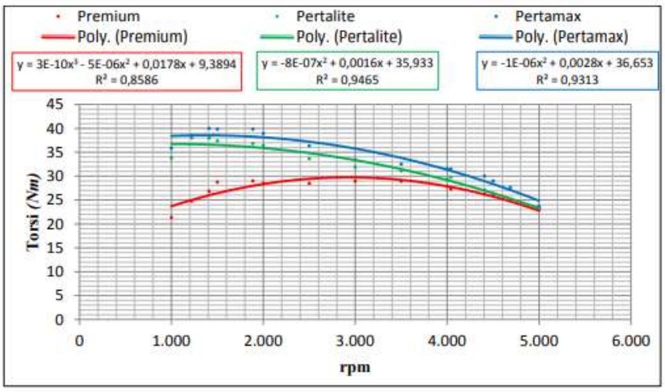

Figure 2. Graph of Comparison of Fuel Against Torque and Speed

From the data above, it can be seen the amount of torque for each test, for premium fuel the lowest torque occurs at 1000 rpm, which is 21.362 Nm, while the highest torque occurs at 1877 rpm, which is 29 Nm. For pertalite fuel, the lowest torque occurs at 5000 rpm, which is 23,337 Nm, while the highest torque occurs at 1221 rpm, which is 38 Nm. And Pertamax fuel has the lowest torque at 5000 rpm, which is 23.711 Nm, while the highest torque occurs at 1410 rpm, which is 40 Nm.

The size of the torque is influenced by the engine speed and load. The heavier the engine load is, the greater the torque required to achieve higher speeds. There are several ways to increase the torque value of an engine, namely by increasing the piston stroke or by increasing the volume of the combustion chamber, but this will greatly affect the fuel efficiency and construction of the engine. From the above test through the use of the right type of fuel can also increase torque.

3.3. Specific Fuel Consumption (SFC)

The following is the data on the calculation of specific fuel consumption (sfc) on the otto engine with variations of premium fuel, pertalite and pertamax.

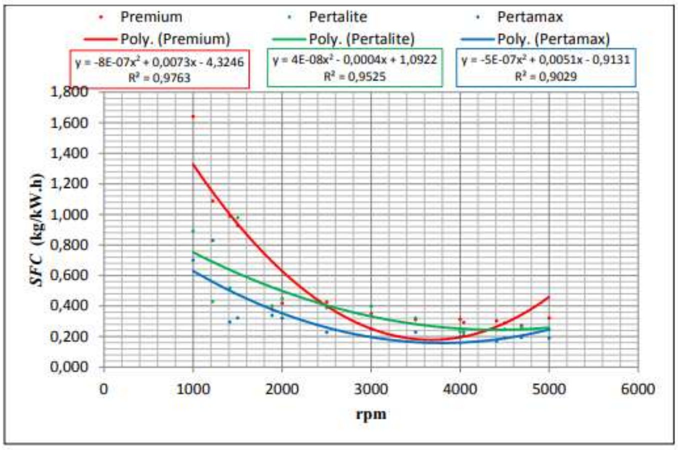

Figure 3. Graph Of The Relationship Of Specific Fuel Consumption To Rotation

From the results of the calculations and the graph above, it can be seen the amount of Specific Fuel Consumption (SFC) for each calculation, for premium fuel, the lowest SFC occurs at 4688 rpm, which is 0.273 kg/kWh, while the highest SFC occurs at 1000 rpm, which is 1.641 kg. /kWh. For pertalite fuel, the lowest SFC occurs at 4041 rpm, which is 0.229 kg/kWh, while the highest SFC occurs at 1500 rpm, which is 0.978 kg/kWh. And for Pertamax fuel, the lowest SFC occurs at 4409 rpm, which is 0.171 kg/kWh, while the highest SFC occurs at 1221 rpm, which is 0.829 kg/kWh. Specific fuel consumption is affected by engine speed when it will reach maximum torque on the engine-engine then the specific fuel consumption will be stable again. When the engine speed is higher and the engine power also reaches its maximum peak, the specific fuel consumption decreases.

3.4. Brake Thermal Efficiency (BTE)

Brake thermal efficiency is the ratio of the actual output power to the average heat rate generated from fuel combustion. The following is the result of calculating the thermal efficiency of brake (ηth)b on an otto engine with variations of premium fuel, pertalite and pertamax with a combustion efficiency value (ηc) = 0.95 which will be used in the formula.

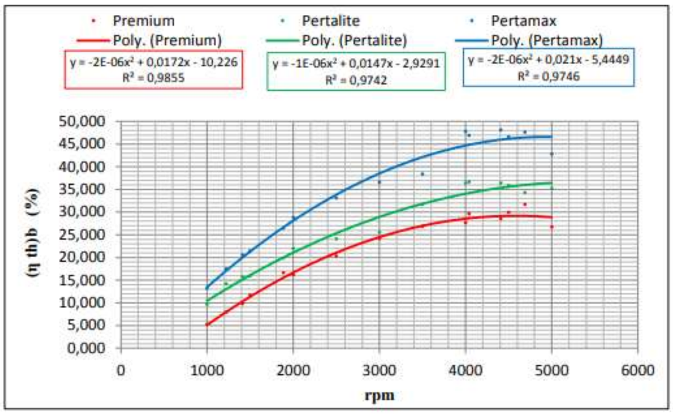

Figure 4. Graph of Comparison of Fuel Against Brake Thermal Efficiency And Rotation

From the calculation results and the graph above, it can be seen the magnitude of the thermal efficiency of the brake for each fuel. For premium fuel, the lowest thermal brake efficiency occurs at 1000 rpm, which is 5.271%, while the highest brake thermal efficiency occurs at 4688 rpm, which is 31.673%. For pertalite fuel, the lowest thermal brake efficiency occurs at 1000 rpm, which is 9.651%, while the highest brake thermal efficiency occurs at 4041 rpm, which is 36.659%. And on Pertamax fuel, the lowest thermal brake efficiency occurs at 1000 rpm, which is 13.167%, while the highest brake thermal efficiency occurs at 4409 rpm, which is 48.124%.

3.5. Vehicle Exhaust Emission Test

On the otto engine exhaust emissions when using premium fuel types, pertalite and pertamax, the results of the Autologic gas analyzer readings can be seen from the levels of carbon monoxide (CO), hydrocarbons (HC), carbon dioxide (CO2), and oxygen (O2) in the table below this :

Table 1. Test Results Of Engine Exhaust Emissions Using Premium Fuel

Putaran Mesin (rpm)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)
1000	1,01	1776	2,8	16,31
1221	1,03	1287	2,9	16,07
1410	1,06	1251	2,9	15,97
1500	1,10	1186	2,9	15,75
1877	1,18	950	3,1	15,27
2000	1,19	922	3,2	15,20
2500	1,27	917	3,4	15,15
3000	1,31	892	3,5	15,14
3500	1,37	833	3,5	15,03
4000	1,45	802	3,6	14,95
4041	1,45	807	3,6	14,99
4409	1,45	798	3,7	14,94
4500	1,44	793	3,8	14,91
4688	1,43	790	3,8	14,88
5000	1,43	789	3,9	14,78

Table 2. The Results Of Testing The Engine Exhaust Emissions Using Pertalite Fuel

Putaran Mesin (rpm)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)
1000	0,92	1250	3,2	15,55
1221	0,97	963	3,2	15,39
1410	1,04	962	3,2	15,38
1500	1,06	948	3,3	15,37
1877	1,16	944	3,4	15,34
2000	1,17	866	3,5	15,15
2500	1,20	860	3,8	15,10
3000	1,23	829	4,1	15,08
3500	1,30	771	4,3	14,94
4000	1,34	727	4,3	14,75
4041	1,35	677	4,3	14,49
4409	1,38	727	4,4	14,75
4500	1,39	646	4,5	14,32
4688	1,40	629	4,5	14,32
5000	1,42	629	4,5	14,32

Table 3. The Results Of Testing The Engine Exhaust Emissions Using Pertamax Fuel

Putaran Mesin (rpm)	CO (%)	HC (ppm)	CO_2 (%)	O_2 (%)
1000	0,84	1160	3,3	16,16
1221	0,86	943	3,4	15,42
1410	0,93	894	3,5	14,91
1500	0,98	840	3,6	14,85
1877	1,10	787	3,7	14,85
2000	1,13	746	3,8	14,79
2500	1,14	621	3,9	14,56
3000	1,15	608	4,6	14,14
3500	1,25	590	4,6	14,07
4000	1,28	526	4,7	13,97
4041	1,29	505	4,7	13,76
4409	1,37	486	4,7	13,60
4500	1,38	466	4,7	13,54
4688	1,40	416	4,8	13,51
5000	1,40	406	4,8	13,46

3.5.1. Comparative Analysis of Oxygen (O2) Levels in Exhaust Gas

The following is a comparison table for each type of fuel that produces O2 exhaust gas against variations in engine speed:

Table 4. Comparison Of O2 Levels After Using Pertalite Fuel

Putaran Mesin (rpm)	O_2 (%) Premium	O_2 (%) Pertalite	Selisih kandungan O_2 (%)
1000	16,31	15,55	0,76
1221	16,07	15,39	0,68
1410	15,97	15,38	0,59
1500	15,75	15,37	0,38
1877	15,27	15,34	-0,07
2000	15,20	15,15	0,05
2500	15,15	15,10	0,05
3000	15,14	15,08	0,06
3500	15,03	14,94	0,09
4000	14,95	14,75	0,2
4041	14,99	14,49	0,24
4409	14,94	14,75	0,19
4500	14,91	14,32	0,59
4688	14,88	14,32	0,56
5000	14,78	14,32	0,46
		Rata-rata	0,332

From the data above, it can be concluded: (1) The largest decrease in O2 levels occurred at 1000 rpm, which was 0.76%. (2) Comparison of exhaust emissions after using pertalite fuel, O2 decreased on average = 0.332 %. (3) The higher the rpm, the lower the O2 exhaust emissions.

Table 5. Comparison Of O2 Levels After Using Pertamax Fuel

Putaran Mesin (rpm)	O_2 (%) Premium	O_2 (%) Pertamax	Selisih kandungan O_2 (%)
1000	16,31	16,16	0,15
1221	16,07	15,42	0,65
1410	15,97	14,91	1,06
1500	15,75	14,85	0,90
1877	15,27	14,85	0,42
2000	15,20	14,79	0,41
2500	15,15	14,56	0,59
3000	15,14	14,14	1,00
3500	15,03	14,07	0,96
4000	14,95	13,97	0,98
4041	14,99	13,76	1,23
4409	14,94	13,60	1,34
4500	14,91	13,54	1,37
4688	14,88	13,51	1,37
5000	14,78	13,46	1,32
		Rata-rata	0,917

From the data above, it can be concluded: (1) The largest decrease in O2 levels occurred at 4500-4688 rpm, which was 1.37%. (2) Comparison of exhaust emissions after using Pertamax fuel, O2 decreased on average = 0.917 %. (3) The higher the rpm, the lower the O2 exhaust emissions.

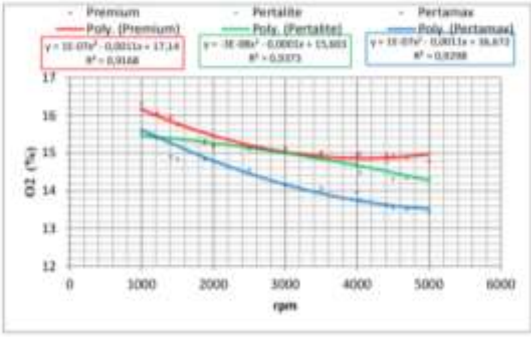

Figure 5. Graph Of The Comparison Of The Type Of Fuel To Oxygen (O2) And Engine Speed

From the graph above, it shows that the type of premium fuel produces more O2 exhaust gas along with the increase in engine speed. Breastfeeding pertalite and pertamax fuel types. When the engine speed is higher, the graph shows the level of exhaust gas O2 is decreasing.

4. CONCLUSION

For single-cylinder otto engines (Honda Megapro) or those with a compression ratio of 9.0: 1, it can produce different torque, power, sfc, BTE and exhaust emissions for premium fuel types, pertalite and pertamax. From the results of this study, several conclusions can be drawn: (1) On a single cylinder motorcycle engine, the highest torque when using premium fuel types is 29 Nm at 1877 rpm engine speed. When using pertalite fuel, the highest torque value is 38 Nm at 1221 rpm engine speed. While the highest torque produced when using Pertamax fuel is 40 Nm at 1410 rpm engine speed. This means that at engine speed of 1221 rpm – 1877 rpm, the torque produced when using Pertamax fuel is higher than that produced when using premium and pertalite fuel types. (2) The highest engine power produced when using premium fuel types is 12,229 kW at 4688 rpm engine speed. For the use of pertalite fuel, the highest engine power is 12,602 kW at 4041 rpm engine speed. And the highest power produced when using Pertamax fuel is 13,870 kW at 4409 rpm engine speed. This means that at 4041 rpm – 4688 rpm engine speed, the engine power produced when using Pertamax fuel is higher than the power produced when using premium and pertalite fuel types. (3) For premium fuel types, the lowest sfc at 4688 rpm is 0.273 kg/kWh and the highest sfc at 1000 rpm is 1.641 kg/kWh. For pertalite fuel type, the lowest sfc at 4041 rpm is 0.229 kg/kWh and the highest sfc at 1500 rpm is 0.978 kg/kWh. While for Pertamax fuel type, the lowest sfc at engine speed of 4409 rpm is 0.171 kg/kWh and the highest sfc at engine speed of 1221 rpm is 0.829 kg/kWh lower (efficient) than the type of premium fuel and pertalite. (4) The thermal brake efficiency (BTE) of the engine when using premium fuel is the lowest at 1000 rpm is 5.271% and the highest BTE is at 4688 rpm is 31.673%. For pertalite fuel type, the lowest engine BTE at 1000 rpm engine speed is 9.651% and the highest engine BTE at 4041 rpm engine speed is 36,659%. Meanwhile, when using Pertamax fuel, the lowest engine BTE at 1000 rpm was 13.167% and the highest BTE at 4409 rpm was 48.124%. This means that at an engine speed of 1000 rpm and an engine speed of 4041 rpm – 4688 rpm, it can be concluded that the thermal efficiency of the engine brake (BTE) when using Pertamax fuel is higher than the premium and pertalite fuel types. (5) Comparison of exhaust emissions after using Pertamax fuel, CO decreased on average = 0.11%. (6) Comparison of exhaust emissions after using Pertamax fuel, HC decreased on average = 319.933 ppm (7) Comparison of exhaust emissions after using Pertamax fuel, CO2 increased on average = 0.813 %. (8) Comparison of exhaust emissions after using Pertamax fuel, O2 decreased on average = 0.917 % CO decreased on average = 0.11%. (6) Comparison of exhaust emissions after using Pertamax fuel, HC decreased on average = 319.933 ppm (7) Comparison of exhaust emissions after using Pertamax fuel, CO2 increased on average = 0.813 %. (8) Comparison of exhaust emissions after using Pertamax fuel, O2 decreased on average = 0.917 % CO decreased on average = 0.11%. (6) Comparison of exhaust emissions after using Pertamax fuel, HC decreased on average = 319.933 ppm (7) Comparison of exhaust emissions after using Pertamax fuel, CO_2 increased on average = 0.813 %. (8) Comparison of exhaust emissions after using Pertamax fuel, O_2 decreased on average = 0.917 %

Suggestions in this study are: (1) Before testing students are expected to make sure the motorcycle is in good condition, sensors or measuring instruments are installed properly, and the latest tools in order to get better and accurate results (2) At the time of testing should always check the engine compression ratio. (3) It is recommended to motorists (cars) to be more vigilant when heating the engine in an enclosed space (closed garages and building parking lots) because the carbon monoxide (CO) gas produced can be inhaled so that it can endanger health. (4) Turn off motorized vehicle engines when there is a long traffic jam on the highway, in order to avoid producing more CO pollutants in the air.

ACKNOWLEDGEMENTS

We would like to thank all those who have contributed to this research, so that the research can be carried out properly.

REFERENCES

Amrullah, A., Syahrir, M., & Pasdah, A. (2021). ANALYSIS OF FUEL MIXING PERTAMAX, PERTALITE WITH 99.6% Ethanol ON ENGINE PERFORMANCE. J-Move: Journal of Mechanical Engineering, 2(3), 57–67.

Ariawan, IWB, Kusuma, W., & Adnyana, IWB (2016). The Effect of Pertalite Fuel Use on Power Performance, Torque And Fuel Consumption In Automatic Transmission Motorcycles. J. METTEK, 2(1), 51–58.

Fuazen, F. (2010). Analysis of the Economic Level of Fuel Use in Motor Vehicles (Experimental Study of the Use of Premium Plus as a Substitute for Pertamax). Technical Voice: Scientific Journal, 1(1).

Habibi, MW (2016). Analysis of Pertalite and Pertamax Types of Gasoline Fuel Usage on Large Torque Engines (Honda Beat FI 110 cc). Thesis UN PGRI Kediri.

Hani, U. (2017). IMPLEMENTATION OF RETAIL GASOLINE BUYING ACCORDING TO IBNU TAIMIYAH'S PERSPECTIVE (Case study in Sei Rotan Village, Percut Sei Tuan District, Deli Serdang Regency). Faculty of Sharia and Law UIN SU.

Majedi, F., & Puspitasari, I. (2017). Optimization of power and torque on a 4 stroke motor with modifications to the crankshaft and porting of the cylinder head. JTT (Journal of Integrated Technology), 5(1), 82–89.

MARTINUS, M. (2017). ONE CYLINDER ENGINE PERFORMANCE TEST WITH PERTAMAX PLUS AND PREMIUM FUEL. MUHAMMADIYAH UNIVERSITY, PONTIANAK.

Muku, I., & Sukadana, IGK (2009). Effect of Compression Ratio on Performance of Four Stroke Engine Using Balinese Arak as Fuel. Scientific Journal of Mechanical Engineering Cakra M, April, 3, 26–32.

Naibaho, CM (2018). Analysis of Noise and Vibration Levels on Motorboat Catamaran Drivers and Passengers. Brawijaya University.

Napitupulu, DFP, Sabri, M., & Surbakti, PAP (2021). ANALYSIS OF VIBRATION CHARACTERISTICS ON THE CASE OF THE SLUDGE SEPERATOR TRANSMISSION PARTS WITH FEA. DYNAMIC, 9(1), 14.

Negara, S., Suyasa, IB, & Suarna, IW (2009). The Effect of Fuel Octane Value And Engine Speed In Motor Vehicles On Exhaust Emission Characteristics. Ecotrophic Journal, 4(2), 106–111.

Nofendri, Y. (2016). Effect of Additive Additives Oxygenate Into Diesel Fuel on Engine Performance. Journal of Mechanical Engineering Studies, 1(2), 94–103.

Pulungan, AM (2016). Experimental Test of Single Cylinder Otto Engine Performance on Dynotest Chassis by Using Premium Fuel Types, Pertalite and Pertamax.

Putra, DK, & Sakti, G. (2018). Comparative Analysis of Fuel Mixture RON 90 with RON 92 on Engine Compression Ratio 11, 3: 1 Piston Displacement 150 cm3. Proceedings of SNITP (National Seminar on Aviation Technology Innovation), 2(1).

Simanungkalit, R., & Sitorus, TB (2013). Performance of Single Cylinder Motorcycle Engine with Premium Fuel and Pertamax Plus with Modified Compression Ratio. Journal of E-Dynamic, 6(1).

Simarmata, MMT, Sudarmanto, E., Kato, I., Nainggolan, LE, Purba, E., Sutrisno, E., Chaerul, M., Faried, AI, Marzuki, I., & Siregar, T. (2021) . Natural Resource Economics. Our Writing Foundation.

Supriyatmojo, BDSK, Putra, WT, & Winangun, K. (2018). Effect of using three injector cleaner methods on exhaust emissions and fuel consumption on Honda Vario 125 injection. Komputek, 2(2), 23–34.

Sururi, E., & Waluyo, B. (2015). Experimental Review: Comparison of Premium and Pertamax Fuel Usage on Engine Performance on Suzuki Thunder Motorcycle Type EN-125.

Sutrisno, MZD, Rijanto, A., & Isnaining, D. (2021). Comparative Analysis of Pertalite and Pertamax Fuel Types on 4-Step Motor Performance. Majapahit Islamic University.

Tarigan, K. (2019). Analysis of the Effect of Stroke on the Performance of a Four Stroke Engine with a Capacity of 150 CC Fuel Pertamax 92, Pertamax Turbo 98 and Bensol on Data and Fuel Consumption. Scientific Journal of Core IT: Community Research Information Technology, 7(2).

Viandi, ESS (2017). The effect of the use of premium ethanol mixed fuel on the performance of a motorcycle engine with a capacity of 100 cc with a compression ratio of 9.

Winarto, E. (2014). The Effect of Modification of Intake Manifold Curvature on Engine Performance on Four Stroke Motors. Journal of Mechanical Engineering, 2(02).