JMEL 13 (1) (2024)
Journal of Mechanical Engineering Learning
https://journal.unnes.ac.id/journals/jmel
doi: 10.15294/jmel.v13.i1.7934

Effect of using a high performance-low pollution muffler (hplpm) with catalytic converter on fuel consumption and performance of 110cc

Nugroho Fajar Susanto[1], Ahmad Roziqin[2], Rizqi Fitri Naryanto[3], Ahmad Mujaki[4]
[1,2,3,4]Automotive Engineering Education Study Program, Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Semarang
Building E5, Faculty of Engineering, UNNES Taman Siswa Street, Sekaran, Gunungpati, Semarang 50229, Indonesia
Email: nafajar529@students.unnnes.ac.id

How to cite (APA Style 7th) : Susanto, F.S., Roziqin, A., Naryanto, R.F., & Mujaki, A. (2024). Effect of using a high performance-low pollution muffler (hplpm) with catalytic converter on fuel consumption and performance of 110cc. *Journal of Mechanical Engineering Learning*, *13*(1), 17-23. https://doi.org/10.15294/jmel.v13.i1.7934

ARTICLE INFO

Article History:
Received: June 23, 2024
Revised: February 28, 2025
Accepted: February 28, 2025

Keywords:
Exhaust, Catalytic converter, HPLPM, Power, Torque

Abstract

The increase in the number of motorcycles to fulfill mobility is dominated by the matic type. Over time the vehicle will experience a decrease in performance and appearance, triggering modifications. The purpose of this study was to determine the difference in motorcycle performance with the use of standard exhaust, HPLPM 2 exhaust + catalytic converter and HPLPM mod exhaust + catalytic converter. This research was conducted with a quantitative research method with an experimental approach, performance testing test data at engine speeds of 3000-9000 rpm. Engine temperature 80° with pertamax fuel. This research was conducted at the Department of Mechanical Engineering, Semarang State University in May 2024. In this study, HPLPM mod exhaust + catalytic converter produces 12.23 Nm of torque at 4500 rpm, the highest power produced by HPLPM 2 exhaust + catalytic convereter 8.27 Hp at 5500 rpm. Exhaust HPLPM mod + catalytic converter is able to maintain power at high rpm 7.70 Hp at 8250 rpm.

1. INTRODUCTION

The need for transportation facilities is currently met with various types of motorized vehicles. The increasing number of vehicles triggers innovation in creating vehicle variations and models that have high appeal. Based on the Central Bureau of Statistics, (2021) the development of the number of motorcycle vehicles in 2021 amounted to 120,042,298 which increased by 4.37% from the previous year.

Sidik and Ansawarman (2022) the increase in the number of motorbikes is dominated by the type of automatic motorbike, especially automatic motorbikes with 110 cc. Matic motorcycles were chosen because these vehicles are cheap and have many advantages. In addition to convenience and comfort, matic motorcycles have an attractive appearance. However, over time the vehicle will experience a decline in both performance and appearance.

Some motorcycle users choose an instant and cheap way to improve the performance and appearance of the vehicle by replacing the exhaust in the hope of improving the

appearance and performance without changing the engine settings. In addition to these reasons, exhaust replacement has become an assumption among the public that it can improve performance even though it makes fuel more wasteful. Effect Of Using A High Performance-Low Pollution Muffler (Hplpm) With Catalytic Converter On Fuel Consumtion And Performance Of 110cc

Exhaust is a vital part of a vehicle as an exhaust gas channel. According to (Seprihandiyansyah, et al., 2018) the exhaust is a component in the vehicle that functions as a damper for the combustion explosion in the combustion chamber. Modifications made to the exhaust can affect the performance of the vehicle. In addition, exhaust modifications can affect noise levels and exhaust emissions.

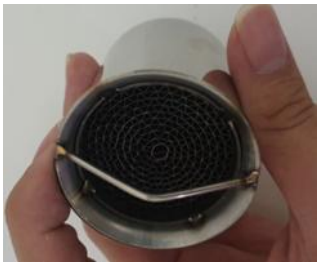

Figure 1. Catalytic Converter

Catalytic converters are located in the exhaust as an important additional component to reduce exhaust emissions in the form of pollutants. The use of a catalytic converter can also affect engine performance because the exhaust air flow rate can be inhibited (Mujaki, et al., 2020: 3834). The use of catalysts can create back pressure so that it can affect engine performance. According to (Trisna and Warju, 2019: 133) back pressure can affect performance where the greater the back pressure, the less fuel will be used because when the exhaust gas is released there will be residual gas that is retained so that new gas is not wasted.

Freeflow exhaust design has a more concise and short turbulence so that it can reduce exhaust gas back pressure (Prasetyo, et al., 2020: 43). According to (Roziqin, et al., 2022: 13) states that vehicle performance is influenced by the use of freeflow exhaust, where freeflow exhaust has lower back pressure. The low back pressure causes combustion to not be maximized. The flushing process can be disrupted due to back pressure that is too high, affecting vehicle performance (Sarwuna, et al., 2017: 144). The reduction in retained residual gas causes new gas to be wasted when the valve overlaps. The loss of new gas will reduce the mixture of air and fuel in the combustion chamber, so that combustion is not optimal.

High performance-low pollution muffler (HPLPM) is an exhaust that uses a conical silencer. The catalytic converter-assisted HPLPM developed in this research is named HPLPM mod. The purpose of developing this HPLPM exhaust is to produce an innovative new exhaust model in order to meet the needs of the modification market and overcome performance, emission, and noise level problems. The product development carried out also considers the HPLPM 1 and HPLPM 2 exhaust designs

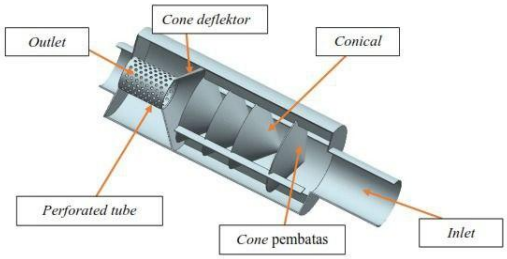

Figure 1. HPMPM 1

Figure 3. HPLPM 2

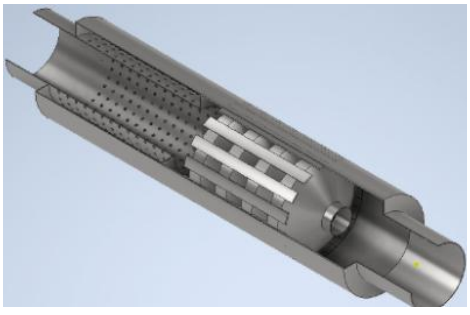

Figure 2. HPLPM mod

Based on the problems that have been described, it is necessary to test by replacing the standard exhaust built into the vehicle with the HPLPM mod exhaust to find out how much influence on performance. In addition, the HPLPM mod exhaust **also** boosts the locally made racing exhaust industry which is still untested practically and theoretically. The innovation product of this exhaust needs to be proven. HPLPM mod exhaust can affect the performance of the vehicle.

2. METHOD

This research uses a quantitative approach with experimental research methods. The research design in this study uses a true experimental design. The experimental research method is used to identify the effect of certain variables on other variables in strictly controlled and controlled conditions (Sugiyono, 2022). This study has several variables that are treated and regulated under controlled conditions. The data analysis method used is descriptive data analysis.

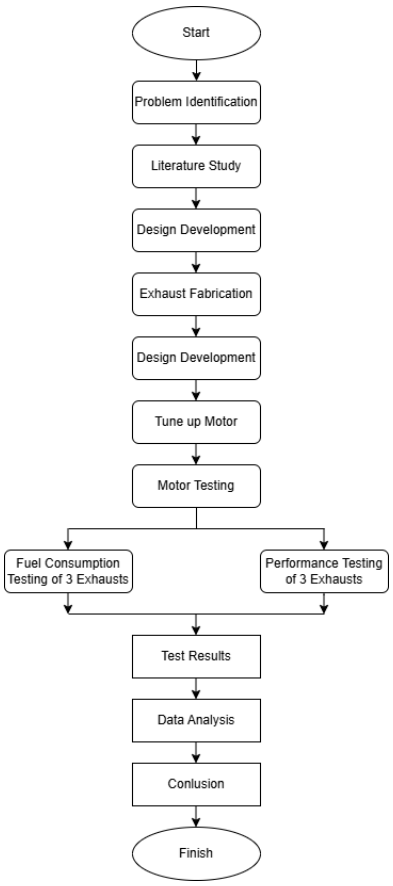

Figure 5. Research Flow Chart

This research was conducted from December 2023 to January 2024, the place of implementation. The preparation stage, the manufacture of HPLPM was carried out at the CV Exhaust Industry. Karya Sinar Terang, Purbalingga Regency, Central Java, the performance testing stage was carried out at the AR SPEED Ungaran racing workshop, Semarang, Central Java. performance testing was carried out at 3000-9000 rpm engine speed.

In this study, data and data sources in the form of tools include DYNO-REKTOR dynamometer, Honda Beat 110 cc motorcycle in 2023, fuel quantity, stopwatch, Honda scanner, thermogun, and tool box set. Research materials include Ron 92 gasoline, Honda Beat standard exhaust, HPLPM 2 exhaust, HPLPM mod catalytic converter exhaust, and headers.

3. RESULTS AND DISCUSSION

Data analysis that has been carried out on the test results data presented in the form of a numerical table which is then converted into a graph shows the difference in torque produced by motorcycles between the use of Honda Beat 110 cc standard exhaust, HPLPM 2 exhaust + catalytic converter and HPLPM mod exhaust + catalytic converter.

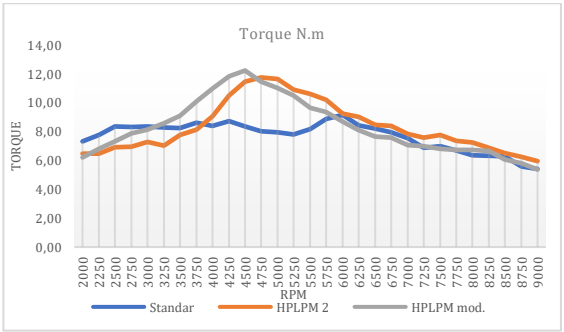

Figure 6. Garph of 3 Exhaust Torque Results

Table 1. Dyno Results Table Torque

Engine Speed	Torque (N.m)		
	Exhaust Type		
	Standar	HPLPM 2	HPLPM mod
3000	8.37	7.29	8.13
3250	8.28	7.03	8.58
3500	8.24	7.75	9,11
3750	8.61	8.13	10,11
4000	8.39	9.05	10,98
4250	8.74	10.51	11,82
4500	8.34	11.46	12,23

4750	8.04	11.75	11,47
5000	7.93	11.63	11,03
5250	7.79	10.90	10,51
5500	8.18	10.61	9,63
5750	8.89	10.21	9,36
6000	9.15	9.25	8,68
6250	8.44	9.01	8,11
6500	8.22	8.48	7.67
6750	7.93	8.40	7.58
7000	7.53	7.83	7.04
7250	6.86	7.59	6.99
7500	6.98	7.77	6.79
7750	6.70	7.37	6.74
8000	6.36	7.23	6.74
8250	6.31	6.89	6.66
8500	6.27	6.49	6.06
8750	5.58	6.24	5.82
9000	5.41	5.95	5.37

By treating the exhaust gas by modifying the muffler and installing it on the Honda Beat New 110 cc year 2023, it results in an increase in torque.The maximum torque on the new 110 cc Honda Beat motorcycle in 2023 refers to the results of torque testing using a standard exhaust. The standard exhaust produces a torque of 9.15 Nm at 6000 rpm engine speed. Then the next test is replaced using HPLPM 2 exhaust + catalytic converter and HPLPM mod exhaust + catalytic converter which affects the increase in torque in each exhaust which gets a different value.

Increased torque occurs in the use of exhaust HPLPM 2 + catalytic converter, which produces a torque of 11.75 Nm at 4750 rpm. The torque produced by this exhaust is lower than the use of HPLPM mod + catalytic converter exhaust. This occurs due to differences in the design of the conical silencer used which can be seen in Figures 1.2 and 1.3. This design difference causes differences in test results even though each test is carried out the same treatment.

The difference in torque results also occurs in the use of HPLPM mod + catalytic converter exhaust at 4500 rpm engine speed with a torque value of 12.23 Nm. The increase in torque occurs due to the characteristics of the HPLPM mod + catalytic converter exhaust such as racing or freeflow exhaust where the air flow is not disturbed because it utilizes the conical silencer principle and creates back pressure so that it helps maintain unburned fuel so that combustion becomes optimal.

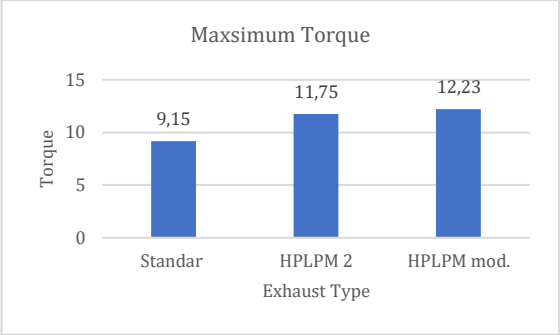

Figure 7. Maximum Torque

The peak torque produced by the 3 exhausts when testing with engine speed variations from 3000 to 9000 rpm HPLPM 2 exhaust + catalytic converter produces the highest torque, with a difference of 260% when compared to the standard exhaust. HPLPM mod + catalytic converter exhaust is 308% superior to the standard exhaust. The standard exhaust produces the lowest maximum torque.

The increase in torque that occurs in vehicles is caused by several factors including the suitability of the back pressure on the exhaust gas which helps hold new gas from being wasted. Back pressure that is too high or too low will affect the flushing process so that it can affect vehicle performance (Sarwuna, et al., 2017: 144). The increase in torque also occurs due to the increase in engine speed which then decreases. According to Rohim et al., 2023: 170 torque in the form of power used by the engine to move and acceleration will increase with increasing engine speed until it reaches a peak and then decreases.

Table 2. Dyno Torque Results Power (HP)

Engine Speed	Power (HP)		
	Exhaust Type		
	Standar	HPLPM 2	HPLPM mod.
3000	3.53	3.07	3.03
3250	3.80	3.23	3.43
3500	4.07	3.83	3.93
3750	4.53	4.30	4.57
4000	4.73	5.13	5.37
4250	5.20	6.33	6.30
4500	5.17	7.30	6.80
4750	5.40	7.87	7.17
5000	5.63	8,20	7.23

5250	5.80	8.13	7.33
5500	6.33	8.27	7.40
5750	7.23	8.27	7.43
6000	7.67	7.83	7.40
6250	7.43	7.97	7.20
6500	7.50	7.80	7.10
6750	7.60	8.07	7.13
7000	7.43	7.77	7.17
7250	7.07	7.80	7.43
7500	7.40	8.23	7.33
7750	7.37	8.10	7.53
8000	7.20	8.20	7.67
8250	7.40	8.03	7.70
8500	7.57	7.83	7.43
8750	6.90	7.73	7.13
9000	6.90	7.60	7.10

Based on data collection that has been done and presented in the form of table 3. and figure 11., shows an increase in performance in the form of power (Hp) caused by replacing the standard exhaust using HPLPM 2 exhaust + catalytic converter and HPLPM mod exhaust + catalytic converter.

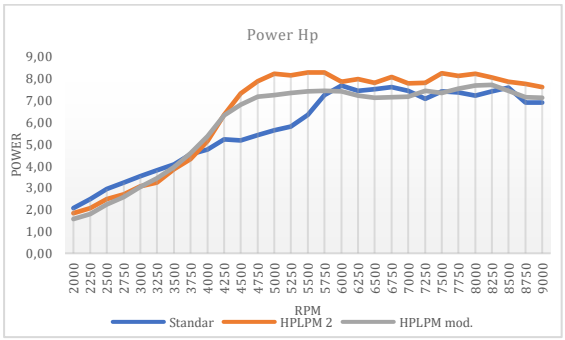

Figure 8. Graph of Power Results 3 Exhaust

The maximum power produced by the engine refers to the use of a standard exhaust. The standard exhaust produces a maximum power of 7.67 Hp at 6000 rpm engine speed. Tests conducted on the 3 exhausts to determine the amount of power starting from 3000-9000 rpm engine speed. The difference in power results is accompanied by an increase in rpm pda exhaust HPLPM mod + catalytic converter but in contrast to the standard exhaust and exhaust HPLPM 2 + catalytic converter which produces lower power

along with the increase in engine speed.

The highest increase occurred when testing using HPLPM 2 exhaust + catalytic converter at 5500 rpm with a power value of 8.27 Hp. The increase that occurs in the HPLPM exhaust is because it uses the principle of freeflow exhaust but still pays attention to the needs of the engine and is environmentally friendly. This is in accordance with research conducted by Wibowo et al., 2020: 39 that using a freeflow type exhaust can affect performance. In addition, it is also supported by research conducted by Sarwuna et al., 2017: 114 that the suitability of back pressure determines engine performance so that engine performance will increase.

The use of HPLPM mod + catalytic converter exhaust has increased. Where the exhaust HPLPM mod + catalytic converter produces a power of 7.70 Hp at 8250 rpm engine speed. The increase occurred due to the back pressure on the exhaust in accordance with the needs of the engine so that it can produce increased power along with the increase in engine speed. this is in accordance with the principle of power where the higher the engine speed generated, the greater the power generated. The greater the torsional moment of the engine will affect the power produced as well. Power as a performance measurement parameter that refers to rpm where the higher the rpm, the higher the power produced (Prasetiyo and Rifdarmon, 2020: 33).

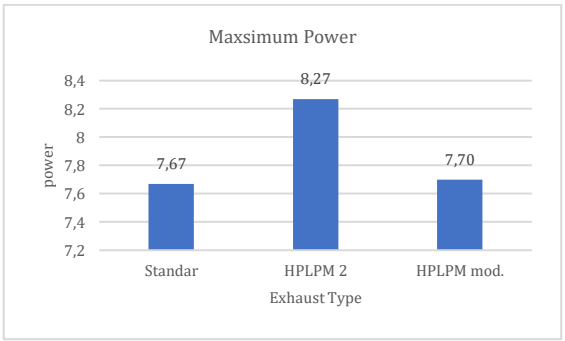

Figure 9. Maximum Power

Based on the description of the data or discussion of the resulting power data, there is an effect of using the HPLPM mod exhaust + catalytic converter on the new Honda beat year 2023 with testing starting from 3000-9000 rpm engine speed. The highest increase occurred in the use of HPLPM 2 exhaust + catalytic converter

which is 60% compared to the use of standard exhaust and the increase also occurred in the use of HPLPM mod exhaust + catalytic converter by 3% compared to the standard exhaust. The use of HPLPM 2 exhaust + catalytic converter is 57% superior compared to HPLPM mod exhaust + catalytic converter.

Back pressure that does not match the needs of the engine can affect vehicle performance (Sarwuna, et al., 2017: 144) as in this test which can be seen in table 3 data. The maximum power generated by the standard exhaust and HPLPM 2 + catalytic converter exhaust is at a low rpm even though the power generated is high. The high power generated is at low engine speed which indicates a rapid combustion process so that the mixture of air and fuel does not burn out (Karim, 2013:). The remaining combustion that is not burned out is also wasted out due to low back pressure so that it cannot maintain power until high engine speed. The waste of new gas is due to the ability of the exhaust to maintain less back pressure, thus affecting engine performance.

4. CONCLUSION

Based on the above conclusions, the suggestions that can be made are as follows:

1. Further research makes exhausts with suitability regarding design so as to produce exhausts with the effect of reducing fuel consumption.
2. Future research needs to make more specific measurements by measuring the back pressure that occurs in the exhaust gas flow.
3. In future research, it is necessary to modify the header development so that the results obtained are more accurate.
4. It is necessary to test fuel consumption using the specific fuel consumption (SFC) method.

5. DECLARATION/STATEMENT

5.1 Acknowledgment

The authors would like to acknowledge all friends who helped in this research.

5.2 Author Contributions

Nugroho Fajar Susanto: Writing - Original Draft, Formal Analysis, Conceptualization; Ahmad Roziqin: Validation, Investigation, Supervision; Rizqi Fitri Naryanto: Review & Editing; Ahmad Mujaki: Review & Editing, Supervision.

5.3 Conflict of Interest

The Authors declare that there is no conflict of interest.

6. REFERENCES

Sarwuna, S., W. Ruslan, and I. Setiawan. 2017. Simulation Study of the Effect of Exhaust Gas Back Pressure on the Performance of a 135cc Four-Stroke Motorcycle Engine. *Teknobiz: Scientific Journal of Mechanical Engineering Master Study Program*, *7*(3), 143-149.

Sugiyono. 2022. *Quantitative, Qualitative, and RandD Research Methods*. Bandung: Alfabeta.

Karim, A. 2013. Performance Test of 4-Stroke Engine Fueled by Bioethanol from Jackfruit Straw Bark Valley as Premium Blend. *JTM UNESA, 1*(2): 146-150

Mujaki, A., Arifin, Z., Nurtanto, M., & Warju, W. (2020). Catalytic Converter Models Tested Based on Plate Hole Variations on Mass Flow Rate and Heat Absorption: ANSYS Fluent Analysis. *International Journal of Advanced cience and Technology*, *29*(6), 3825-3833.

Naryanto, R. F., Bahtiar, F. Z., Delimayanti, M. K., & Setiyawan, A. (2023). The Effects of Alternative Fuel Mixture of HDPE Plastic and Gasoline on Four-Stroke Engine Exhaust Gas Emissions. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 103*(2), 197-204.

Roziqin, A., Maulana, S., Kriswanto, Septiyanto, A., Khoirurroziqin, M. I., & Nasirudin, A. (2023). Exhaust Gas Pressure and Flow Velocity Analysis of the Conical Silencer High Performance Low Noise Exhaust

Muffler. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 109*(2), 39–48. https://doi.org/10.37934/arfmts.109.2.3948 https://doi.org/10.32699/ppkm.v7i3.1282.

Roziqin, A., Nasirudin, A., Kriswanto, K., Khoirurroziqin, I., Setiawan, A., Hangga, A., and Wiratama, B. (2022). Analysis of Sound Power in Freeflow and Conical Silencer Exhaust Types with Comsol Multiphisic 5.6 Software. *Journal of Mechanical Engineering Education, 22*(2).

Wibowo, B. P., Mufarida, N. A., and Kosjoko, K. (2020). Effect of Using Racing Exhaust Variations on Engine Performance of 115 cc Injection Motorcycle in 2013. *Journal of Smart Technology, 2*(1), 35-41.

Rohim, S., Lathifudin, A., Hidayat, S., Sasmito, C. P., and Saputra, T. J. (2023). The Effect of Using Standard Exhaust with Racing on Torque and Power of Yamaha Aerox 155 CC Motorcycle in 2018. *Journal of Engineering Research, 2*(3), 166-174.

Trisna, R. A. (2019). Effectiveness of Resonant, Three Pass Tube and Off-Set Tube Mufflers on Fuel Consumption Reduction in a Multi Cylinder Gasoline Engine. *Journal of Mechanical Engineering Education, 9*(1), 128-133.

Joshi, M. C., Shaver, G. M., Vos, K., McCarthy Jr, J., and Farrell, L. (2022). Internal exhaust gas recirculation via reinduction and negative valve overlap for fuel-efficient aftertreatment thermal management at curb idle in a diesel engine. *International Journal of Engine Research, 23*(3), 369-379.

Julianto, E., & Sunaryo, S. (2020). Analysis of the Effect of Engine Speed on Fuel Efficiency of 2Dg-Ftv Diesel Engine. *UNSIQ Journal of Research and Community Service, 7*(3), 225-231. https://doi.org/10.32699/ppkm.v7i3.128 2

Seprihadaniansyah, G. M., Kuswoyo, A., and Adriana, M. (2018). Exhaust Modification Using Catalytic Converter and Acacia Charcoal to Reduce Vehicle Exhaust Emissions. Elements: *Journal of Mechanical Engineering, 5*(1), 11-19.