Intake Manifold Performance with Rotational Speed Variation for the Gasoline Engine

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International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 6, Issue 10, pp 9-12, October-2022

https://doi.org/10.47001/IRJIET/2022.610002

Intake Manifold Performance with Rotational Speed Variation for the Gasoline Engine

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***Abstract* - This experimental work carried out to measure the intake manifold performance. The investigation examined three geometry of tangential, helical port left and right model in the four stroke gasoline engine with rotational speed variation. The results showed that the helical port left model has a better the performance than both tangential port and helical port right. It is indicated by increasing in torque, power, and thermal efficiency in the helical port left were higher than in the tangential port and helical port right.**

Keywords: thermal efficiency, helical port, tangential port, swirling flow.

I. INTRODUCTION

The performance of gasoline engines is affected by the results of combustion in the cylinder chamber. Complete combustion will produce high performance and less exhaust emissions. Some important factors that affect the combustion process in the cylinder are the air-fuel ratio, homogeneity of the fuel and air mixture, octane number, combustion time, ratio of compression, and operating conditions. To get a more homogeneous mixture of air and fuel in the engine, it can be done by making a rotating flow from the end of the intake manifold [10]. The main function this device is to circulate air into the cylinders. The geometric design of the intake system directly affects the performance of the vehicle [7]. The working principle of the helical port is the air flow that enters the combustion chamber is made to rotate. It makes the combustion process become more complete. One of the parameters that affect the flow in the cylinder is the intake port design [3].

Rotating flow serves to create an internal recirculation zone where there is the application of spiral motion to a flow, and forms a vortex that occurs on the core axis [5]. To improve air-fuel mixing and help spread the flame during combustion [9]. Cui et.al [3] analyzed numerically the tangential port design in an internal combustion engine to explore the influence of structural parameters on the performance of the intake port. The results of his study found that the flow capacity and intensity of large-scale eddies, can change regularly with variations in the structure parameters. Wahono et.al [8] tested numerically and experimentally on the effect of the tangential port on the intake manifold. It was found that this port can increase the flow coefficient and the larger the valve lift, the greater the air flow velocity.

Bassiony et.al [1] tested experimentally on increasing the turbulence intensity of the combustion mixture quality, using a spiral-helix shape of three helical diameters (1D, 2D, 3D; where D is the manifold inside diameter), and three port outlet angles of 0°, 30°, and 60°. It was found that the 30o helical port angle can carry out fuel consumption, and exhaust emissions. Ceviz [2] studied experimentally engine performance such as torque, power, thermal efficiency and fuel consumption specific to the length of the intake plenum. The results of the study show that variations in the length of the plenum lead to an increase in engine performance, especially fuel consumption at high loads. Shah et.al [6] tested the helical intake on the level of CO exhaust emissions in a 4 stroke 1 cylinder gasoline engine. It can be seen that carbon monoxide (CO) emissions increase with increasing load.

Therefore, the challenge is how optimize the intake system so that the fuel and air mixture that passes through the intake manifold form a swirling. To form a swirling flow in the intake manifold, a helical port mechanism is required. Many studies related to helical port have been carried out both experimentally and numerical. Several parameters have been tested, however still need to be improved and re-examined to improve engine performance. This study examined the intake manifold using the measurement method. Three types of intake manifold were tested in the engine test bed.

II. EXPERIMENTAL SETUP

1.1 Intake manifold model

This study uses three geometries of intake manifold, namely the tangential port, helical port left, and helical port right as shown in Figure 1. The test engine used is petrol engine of a 4 stroke 1 cylinder 110 CC. The performance parameters such as torque, power, emission CO_2 and CO, and thermal efficiency are measured. The measurement was

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Volume 6, Issue 10, pp 9-12, October-2022

https://doi.org/10.47001/IRJIET/2022.610002

conducted at load range 1 kW to 6 kW. The experiments use two types of fuel for Pertamax (RON 92) and Pertamax Turbo (RON 98). The specification of intake manifold is detailed in Table 1.

(a) (b) (c)

Figure 1: Intake manifold test model (a) tangential port; (b) helical port left; (c) helical port right

Table 1: Geometry Intake Manifold

Parameters	Value
Intake diameter	22 mm
Intake valve diameter	25,5 mm
Valve stem diameter	5 mm
Helicalangle	30^o
Bore	50 mm
Stroke	55 mm

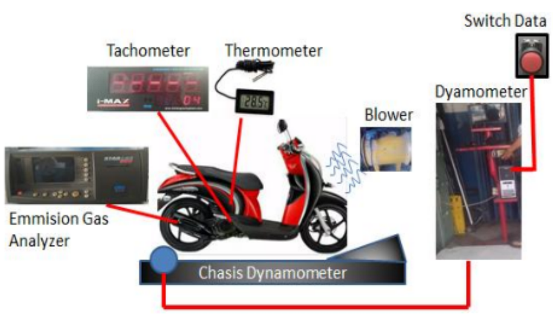

Figure 2: Experimental setup of the test engine

2.1 Test Engine

The experimental device shown in Figure 2 consists of a chassis dynamometer, gas emission analyzer, tachometer, and anemometer. The machine specifications as follows:

Engine type : 4 stroke, SOHC, 2 valves.
Cylinder Volume : 108 CC.
Compression Ratio : 9.2 : 1 (new).
Number of Cylinders : 1.
Max Power : 6.09 kW/8.000 rpm (New).
Max Torque : 8.32 N.m/5500 rpm (New)

III. RESULTS AND DISCUSSIONS

3.1 Torque

The experimental results of torque as a function of engine speedfor both fuels of Pertamax (RON 92) and Pertamax turbo (RON 98) are presented in Figure 3(a) and (b), respectively. In general, the torque trend as a function of rotation is almost the same for the three models of intake manifold for both fuel used. In the beginning, torque increases from 2500 – 3000 RPM. In the speed of 3000 - 4000 RPM, the torque is almost constant. Then with increasing rotation from 4000 RPM the torque decreases for the three intake manifold models tested.

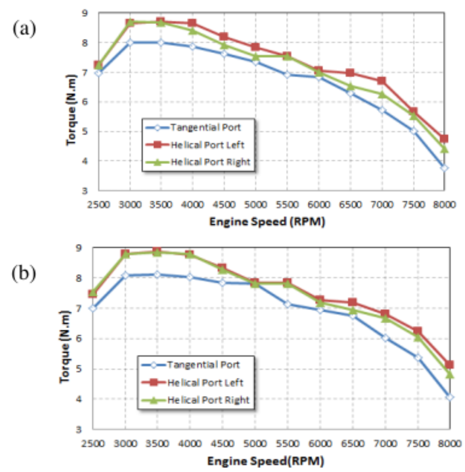

Figure 3: Torque as function of engine speed with two types of fuels (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

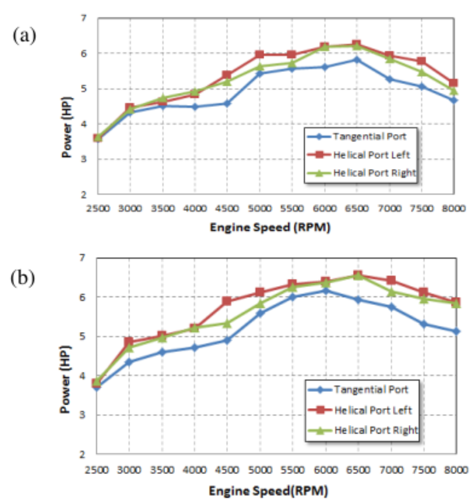

Figure 4: Power as function of engine speed with two types of fuels (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

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3.2 Power

Figure 4(a) and (b) are results of the power as function of engine speed for both fuel of Pertamax (RON 92) and Pertamax turbo (RON 98), respectively. In general, for all test model of tangential port, helical port left and right, the power of engine linearly increases with increase of engine speed. In addition, it shows that the power generated at engine speed of 2500 RPM to 6500 RPM tends to increase in the two kinds of fuel used. When the engine speed is increased again to 8000 RPM rotation, the power produced decreases.

3.3 Emissionof CO_2 and CO

The results of exhaust emissions for both fuels of Pertamax (RON 92) and Pertamax turbo (RON 98) are shown in Figure 5(a) and (b), respectively. Generally, the CO_2 emission for the three intake manifold models both on Pertamax (RON 92) and Pertamax Turbo (RON 98).It can be seen that at 2000 – 8000 RPM the intake manifold of helical port left tends to be lower when compared to the two intake manifolds with tangential port and port right. In addition, it also can be seen that the CO_2 emission at the tangential port is higher than the other two intake manifolds tested.

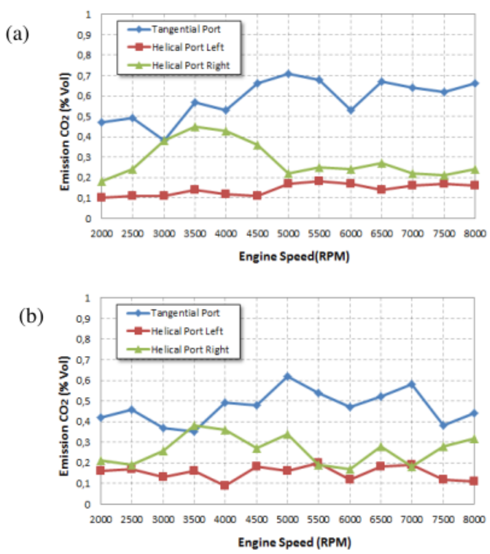


Figure 5: CO_2 emission with two types of fuels (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

Figure 6(a) and (b) show the results of CO emission as function of engine speed for both fuel of Pertamax (RON 92) and Pertamax turbo (RON 98), respectively. Based on the plots, it can be found that the levels of CO produced at engine speed of 2000 to 3000 RPM tend to increase in the three variations of fuel used. When the engine speed is increased again to 8000 RPM, the CO emission tends to be constant. In addition, it is important to note that the CO emission at the tangential port is higher than the other two intake manifolds as shown in the plot in Fig. 6. Meanwhile, the CO emission for the helical manifold port left type produces the lowest emission than two other types of tangential port and helical port right.

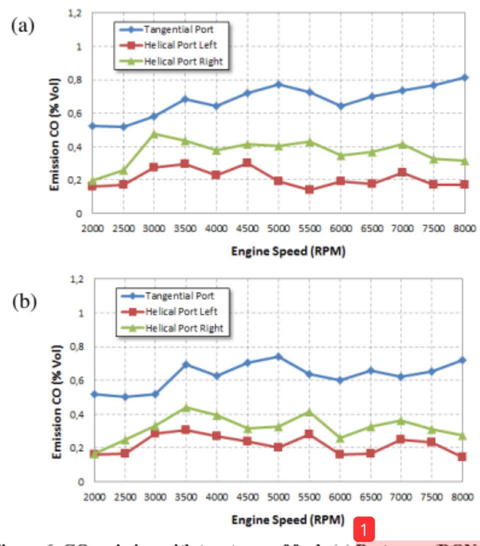
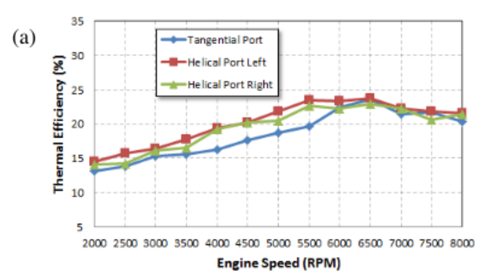


Figure 6: CO emission with two types of fuels (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

3.4 Thermal Efficiency

The results of the thermal efficiency for both fuels used Pertamax (RON 92) and Pertamax turbo (RON 98) are shown in Figure 8(a) and (b), respectively. In general, the trend of thermal efficiency is almost the same for the three models of intake manifold tested. It is found that thermal efficiency increased from 2000 to 6000 RPM. The rotation from 6000 to 8000 RPM, the thermal efficiency is almost constant for the all models tested. Then, it also can be seen that the thermal efficiency of the helical port left is higher than the two intake manifolds other.



ISSN (online): 2581-3048
Volume 6, Issue 10, pp 9-12, October-2022
https://doi.org/10.47001/IRJIET/2022.610002

(b)

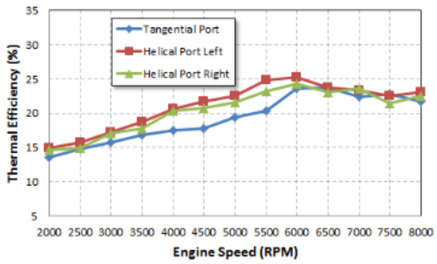


Figure 8: Thermal efficiency as function of engine speed (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

IV. CONCLUSION

Based on the results of the study that has been done, some conclusions can be drawn as follows:

1) The maximum torque value is generated by the intake manifold type helical port left against engine speed conditions using fuel of Pertamax Turbo (RON 98).
2) The optimal power value is generated by the helical port left in the 4 stroke 1 cylinder gasoline engine testing on the engine speed using fuel of Pertamax Turbo (RON 98).
3) The minimum levels of CO_2 and CO emission are produced by the helical left port under various speed testing conditions.
4) The helical port left of intake manifold produces the most optimal thermal efficiency for a 4 stroke 1 cylinder gasoline engine.

ACKNOWLEDGEMENT

I would like to thank for RINUT MOTOR SEMARANG for the facilities and help to conduct the measurement for all experiments data.

REFERENCES

[1] Bassiony MA, Sadiq AM, Gergawy MT, Ahmed SF, Ghani S (2018). Investigating the effect of utilizing new induction manifold designs on the combustion characteristics and emissions of a DI diesel engine. J Energy Res Technol 2018;140(12):122202–17.

[2] Ceviz, M. A., & Akın, M. (2010). Design of a new SI engine intake manifold with variable length plenum. Energy Conversion and Management, 51(11), 2239–2244.

[3] Cui, L., Wang, T., Lu, Z., Jia, M., & Sun, Y. (2015). Full-Parameter Approach for the Intake Port Design of a Four-Valve Direct-Injection Gasoline Engine. Journal of Engineering for Gas Turbines and Power, 137(9), 091502.

[4] Manmadhachary, A., Santosh Kumar, M., & Ravi Kumar, Y. (2017). Design & manufacturing of spiral intake manifold to improve Volument efficiency of injection diesel engine by AM process. Materials Today: Proceedings, 4(2), 1084–1090

[5] Seshadri S. (2015). Design and CFD Analysis of the Intake Manifold For The Honda CBR250RR Engine. University Of Texas At Arlington.

[6] Shah, P., Patel, P. D., Jotava, D. J. (2014). Effect of Intake Manifold Inclination on Performance and Emission Parameters of 4-Stroke Single Cylinder C.I. Engine: A Technical Review. Volume 03, Issue 01.

[7] Souza, G. R., Pellegrini, C., Ferreira, S., Felipe, S. P., Armas, O. (2018). Study of Intake Manifolds of an Internal Combustion Engine: A New Geometry Based on Experimental Results and Numerical Simulations, Elsevier: Thermal Science and Engineering Progress.

[8] Wahono, B., Setiawan, A., & Lim, O. (2021). Effect of the intake port flow direction on the stability and characteristics of the in-cylinder flow field of a small motorcycle engine. Applied Energy, 288, 116659.

[9] Yang, G., Yu, W., Li, X., Su, Y., Yang, R., & Wu, W. (2019). Study on dynamic characteristics of intake system and combustion of controllable intake swirl diesel engine. Energy, 180, 1008–1018.

[10] Zhang, W., Chen, Z., Duan, Q., & Jiang, Q. (2021). Visual test and evolutionary analysis of flow fields in cylinder of helical intake port diesel engine. Energy, 223, 119926.

Citation of this Article:

Khoiri Rozi, Ojo Kurdi, Berkah Fajar TK, Pujianto Aristiawan, "Intake Manifold Performance with Rotational Speed Variation for the Gasoline Engine" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 10, pp 9-12, October 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.610002

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