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Intake Manifold Performance for the Four-Stroke Gasoline Engine with Load Variation

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***Abstract* - This experimental study was conducted to investigate the intake manifold performance. The work examined three intake manifold models of tangential, helical port left and port right in the four-strake gasoline engine with load variation. The interesting parameters of torque, power, emission, and thermal efficiency were measured in the test engine. The results showed that the helical port left has a better the performance than tangential port and helical port right. It is shown that 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

In the internal combustion engine, complete combustion will produce high performance of engine. The some important factors that influence the combustion process in the engine cylinder are the air-fuel ratio, homogeneity of the fuel and air mixture, octane number, compression ratio, and operating conditions. In order to get a more homogeneous mixture of air and fuel, it can be done by making a swirling in the intake manifold [10]. The main function of this device is to circulate air into the cylinders. In particular, the main design goal was to distribute it evenly to each intake port, increasing the engine's ability to generate torque and power efficiently. The geometric design of the intake system affects the volumetric efficiency of the engine, and directly affects the performance of the vehicle [7]. The intake system construction has a major influence on engine performance at various RPM [4].

The working principle of the helical port is the air flow that enters the combustion chamber is made to rotate, which leads to one point to help the combustion process become more complete. One of the parameters that affect the flow in the cylinder is the intake port design [3]. This mechanism is located in the cylinder head near the valve, where during the flow process from the intake to the combustion chamber there is a more perfect vortex change, so that the fuel and air mixture becomes more homogeneous [8]. 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 and 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 and showed 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°. The results found that the 30^o helical angle can carry out fuel consumption, and exhaust emissions. Ceviz and Akin [2] studied experimentally on engine performance characteristics 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 port on the level of CO exhaust emissions in a 4 stroke 1 cylinder gasoline engine and found that carbon monoxide (CO) emissions increase with increasing load.

Many studies related to intake manifold characteristics have been carried out both experimentally measurements and numerical simulations. Several parameters have been tested, however examined to improve engine performance. This study examine the flow at the intake manifold using the experimental method. This research was conducted by comparing three geometry of the intake manifold models; the tangential port, left and right helical port. All the models were tested with load variation in the engine test rig by using gasoline engine four-strike with one cylinder.

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II. EXPERIMENTAL DEVICE

2.1 Intake manifold model

In this experimental study, the intake manifold model uses three geometries, namely the tangential port, helical port left, and helical port right as shown in Figure 1. The medium used is a 4 stroke 1 cylinder 110 CC petrol engine. Using fuel Pertamax turbo (RON 98) and Pertamax Turbo (RON 98). To look for changes in engine performance and exhaust emissions on torque, power, CO_2, CO, and Thermal Efficiency. At load testing is carried out at 1 kW to 6 kW. The geometry information intake is shown 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
Valve diameter	25,5 mm
Stem diameter	5 mm
Helicalangle	30°
Bore	50 mm
Stroke	55 mm

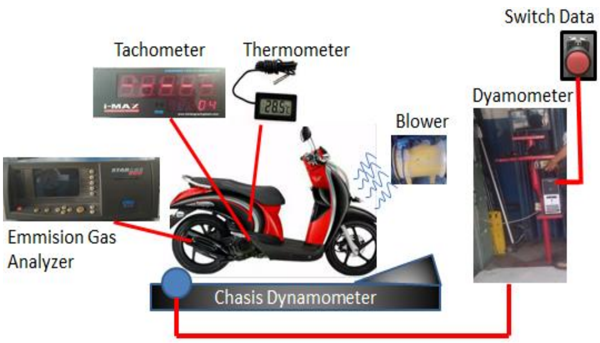

Figure 2: Experimental setup of the test engine

2.1 Engine Equipment

The experimental device shown in Figure 2 consists of a chassis dynamometer, gas emission analyzer, blower, tachometer, and anemometer. With the following machine specifications: Engine specifications in this test are 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 results of torque as a function of engine load are presented in Figures 3(a) and (b), respectively. In general, the torque trend as a function of load is almost the same for the three models of intake manifold tested on both Pertamax - RON 92 and Pertamax Turbo - RON 98 fuel. Torque value increased from 1 kW – 2 kW. As the load increases from 2 kW – 4 kW, the torque value is almost constant. Then with increasing load from 4 kW the torque value decreases for the three intake manifold models tested.

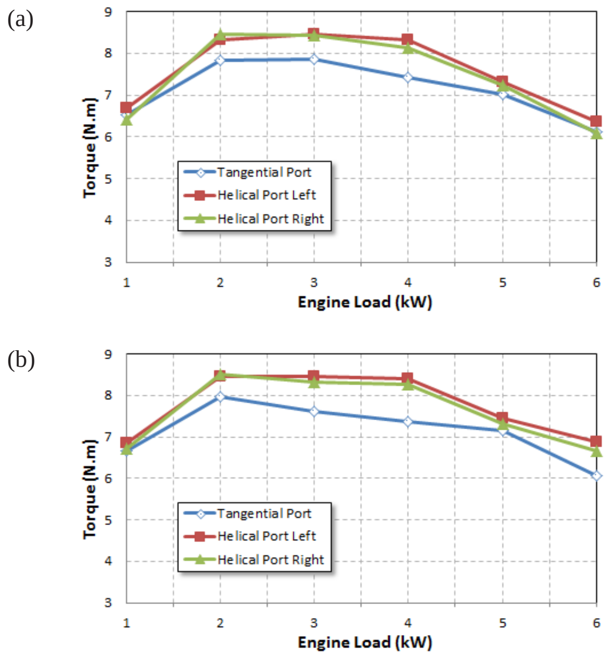

Figure 3: Torque as function of load with fuel (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

3.2 Power

The measurement results of the power test on the engine load (kW) functions of load for tangential port helical port left and helical port right are plotted in Figure 4(a) and (b), it can be found that the power produced at engine load of 1 kW to 6 kW tends to increase significantly in the three variations of fuel use. The research plots show that the power value at the tangential port is lower than the helical port left and helical port right for all rounds. In addition, it is also seen that the helical port left produces the most optimal power at all engine loads.

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(a)

(b)

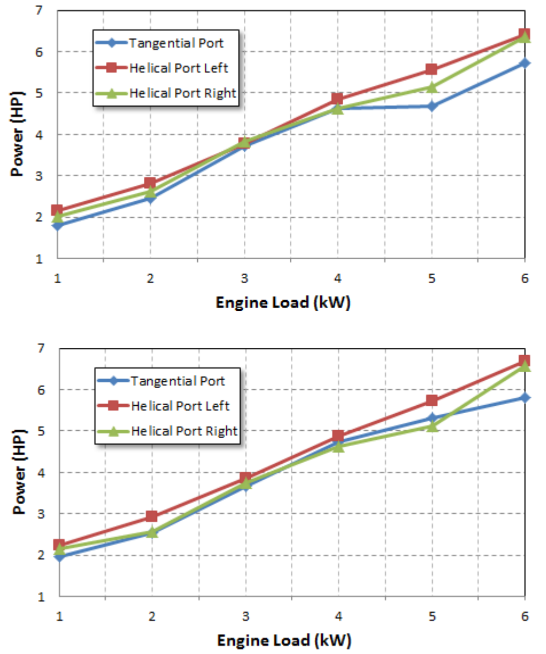

Figure 4: Power as function of load with fuel (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

3.3 Emissionof CO_2 and CO

The results of exhaust emissions as function of loadfor tangential, helical port left and rightare presented in Figure 5(a) and (b), in general it can be seen that the graph in this test has the same trend, at a load of 1 kW to 6 kW there is a significant increase in the use of the three test materials. However, at a load of 5 kW, the intake manifold type helical port left and right tends to decrease. From the two experimental plots, it can be seen that the CO_2 emission levels at the tangential port are higher than the left and right helical ports for all loads. In addition, it is also seen that the CO_2 emission values for the two helical left intake manifolds are lower at all engine loads. In short, it is important to note that the CO_2 emission for all the intake manifold models tested steadily increase with increasing the engine load.

The measurement results of CO emission as a function of engine load for tangential port, helical port left and helical port rightare shown in Figure 6(a) and (b), respectively. From graph presented in Figure 6(a) and 6(b)it can be seen that in general at engine load of 1 kW – 2 kW there is a continuous increase for the use of the three intake manifold test materials, but with increasing engine load from 2 kW to 5 kW the CO content tends to be constant, and at engine load of 5 kW to 6 kW tends to increase for the three use of intake manifold test materials. The lowest CO levels are produced by the intake manifold type helical port left when compared to the tangential port and helical port right for all engine load conditions. In addition, the highest CO content in the engine load test from 1 kW to 6 kW was produced by the intake manifold of the tangential port type. It can be concluded that the CO emission slightly increase with increasing the engine load for all the test models of intake manifold tested as can be seen in the plot.

(a)

(b)

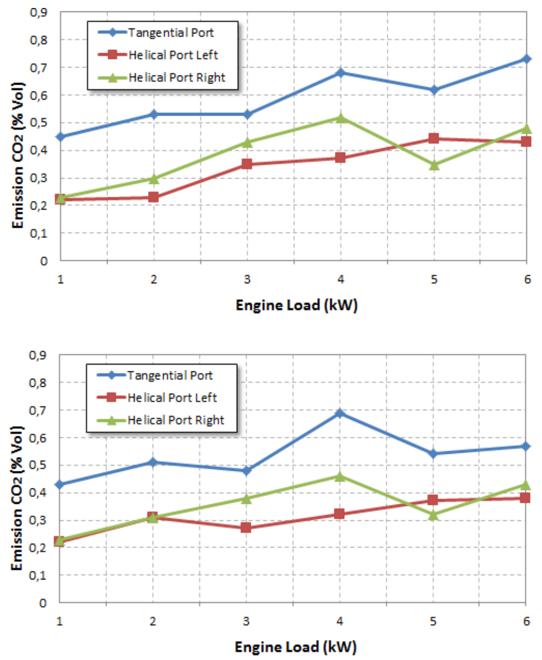

Figure 5: CO_2 emission with fuel (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

(a)

(b)

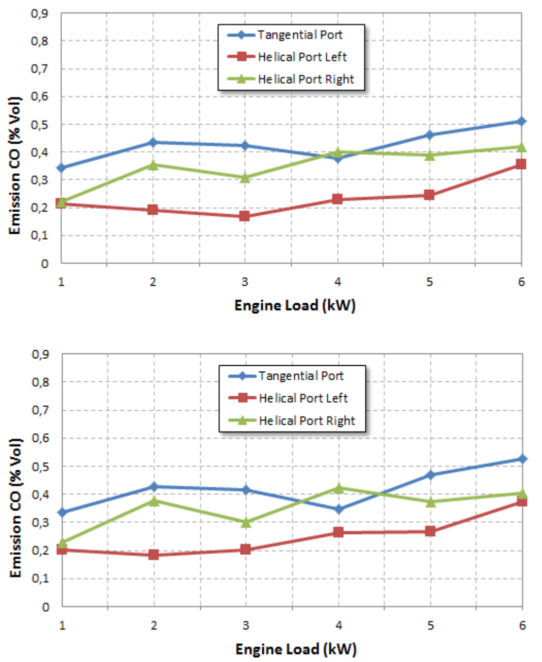

Figure 6: CO emission with fuel (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

3.4 Thermal Efficiency

The results of testing the thermal efficiency as a function of load (kW) are shown in Figure 7 (a) and (b). In general, the thermal trend as a function of load is almost the same for the

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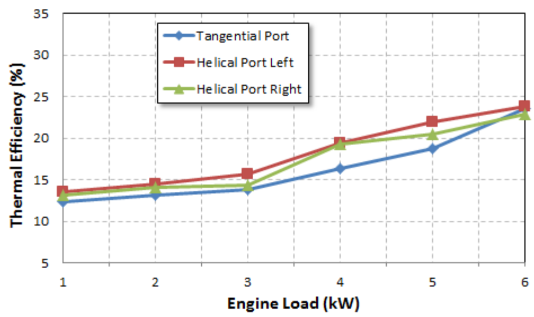
three intake manifold models tested on both Pertamax - RON 92 and Pertamax Turbo - RON 98 fuel. Based on the two plots of Figures 4.16(a) and 4.16(b) it is found that at load the initial thermal value increases continuously from 1 kW to 3 kW. Along with the addition of the engine load from 3 kW – 6 kW, the thermal value has increased steadily for the three intake manifold models tested.

In addition, from the two test plots, it can be seen that the thermal efficiency value at the tangential port is lower than the two intake manifolds with port left and port right for all engine loads. In addition, it is also seen that the thermal values for both intake manifold both port left and port right have almost the same value under all load conditions.

(a)



(b)

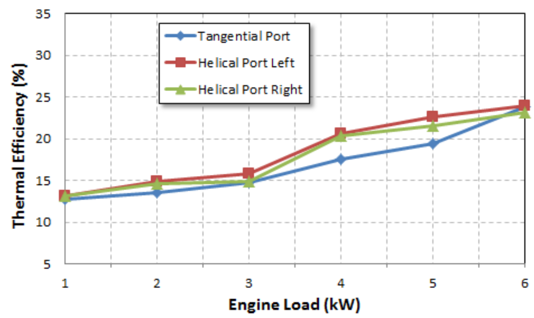


Figure 7: Thermal efficiency as function of load with fuel (a) Pertamax (RON 92); (b) Pertamax turbo (RON 98)

IV. CONCLUSION

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

1. The maximum torque is resulted by the intake manifold type of helical port left against engine load (kW) conditions by using fuel of Pertamax Turbo - RON 98.
2. The optimal power is produced by the helical port left in the 4 stroke 1 cylinder gasoline engine testing on the engine load (kW) with using fuel of Pertamax Turbo - RON 98.
3. Based on the exhaust emission test results, it can be noted that the minimum levels of CO_2 and CO emission are produced by the helical left port under various load testing conditions.
4. Based on the calculation of thermal efficiency, it can be seen that the left helical hole produces the most optimal efficiency value for a 4 stroke 1 cylinder gasoline engine.

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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] Wang, 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

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cylinder of helical intake port diesel engine. *Energy*, 223, 119926.

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