

Effect of Side Gapping Spark Plug on Engine Performance and Emission



Ahmad Shahril Daut, Mohd Zaki Bahrom, Rifqi Irzuan Abdul Jalal, Eida Nadirah Roslin

Abstract: Gasoline ignition system in automobiles is still one of the world's main fuel consumption today. The spark plug is one of the key features of a gasoline engine during the combustion process. The incompatibility between the width of the plug and the combustion engine fuel used causes a backfire and a knock. The spark plug gap had therefore been investigated in order to improve the engine's performance by controlling the combustion process. The main objective of this study is to analyze the effect of side gapping spark plug engine performance and emission. The selected type of spark plug being used for this study is cooper spark plug. This study has examined the parameters of side gapping spark plug gap (0.7 mm, 0.8 mm, 1.0 mm and 1.2 mm) and of revolution per minutes RPM (1000 rpm, 1500 rpm, 2000 rpm, 2000 rpm, 2500 rpm, 3000rpm, 3500 rpm, 4000 rpm, 4500 rpm and 5000 rpm) also the emission effect in term of carbon monoxide (CO), hydrocarbon (HC) and oxygen (O₂). In this test, performance and power are showed an increment of side gapping spark plug. Other than that, this study is also showed positive results where the reduction in the percentage of opacity is demonstrated. Since the result has obtained for engine performance and emission showed positive outcome, this study can be used in future and highly recommended for continue with different type of spark plug.

Index Terms: Spark plug, Engine performance, Spark ignition, emission, Fuel consumption

I. INTRODUCTION

Nowadays, the spark plug for every petrol car is one of the most significant parts, because it is used to move the car from another location. A spark plug helps to convey power from an ignition scheme to the combustion chamber of a spark inflame to burn the compressed air / fuel combination via an electric spark while maintaining the fuel pressure within the motor [1].

The spark plug has a big purpose in engine components which are to start the vehicle, to help the engine performance growth, to evacuate heat from combustion chamber and many more. According to the study conducted by [2], the primary parameters under investigation as the impact of the spark plug design on spark ignition engine efficiency are many elements including number of components, electrode, gap projection, gap, size and orientation. Due to the design of the center and floor electrodes, it is become the main factor demonstrating the efficiency of the spark plug. There are have several types of spark plug available today are known as "copper", "platinum", "double platinum", "iridium" and "silver". Each types of spark plug have their own characteristics which are making them able to withstand the heat and have a lifespan according to each type. According to [3], with different spark plug gaps it can helps to produce different result at various powers. Mostly, the engine performance and emission parameters are affected by spark plug gap, excess air ratio and compression ratio.

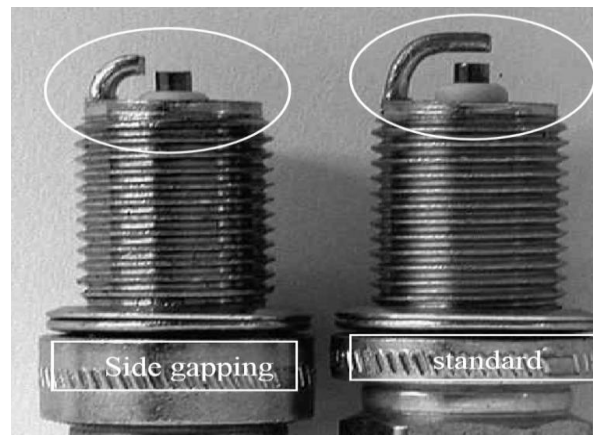


Fig. 1 Standard vs side gapping spark plug [4]

The main objectives in this study are:

- To study the differences of side gapping of spark plug based on the gapping of each spark plug.
- To observe the emission of vehicle when using this kind of gapping of spark plug.
- To observe the engine performance before and after using side gapping spark plug.

II. METHODOLOGY

A five (5) sets of spark plug type copper are used in this study. The gap of spark plug is measured by using feeler gauge and the measurements are recorded before testing. The engine performance is tested at engine dynamometer by using engine CamPro CPS1.6 liters.

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For collecting emission data, gas analyzer BOSCH 720 is used.

A. Side gapping installation

Side gapping installation is the process after done getting the result of standard spark plug. The standard spark plug is being used inside the engine dynamometer, so it is needed to replace at the first place before install the side gapping spark plug inside the engine dynamometer. There is no engine modification is required to perform the installation. The installation process for side gapping spark plug is just as same procedure as replacing the spark plug inside the engine. Therefore, the most important things are to make sure all the components such as ignition coil and connector locking tab are tightening very well after install the side gapping spark plug. (Fig. 2)



Fig. 2 Spark Plug Compartment.

B. Engine dynamometer

The engine dynamometer (Fig. 3) is reads numerous amounts of parameter reading such as revolutions per minute (rpm), engine power, torque, water temperature, oil pressure and temperature, exhaust temperature, and air/fuel ratio.



Fig. 3 Engine Dynamometer

As for the first phase of the experiment, the spark plug was installed into the engine dynamometer to analyze for the engine performance and emission by using standard spark plug and side gapping spark plug.

Before installing side gapping spark plug, the data from actual speed of engine is collected by using standard spark plug. The data collected from the engine dynamometer will be tested three times and the best one of data will be selected to do the comparison with each of different side gapping. From the beginning, it will be set up for fully loaded which mean the throttle body is fully open 100% for ease the comparison and to see the effect on the engine performance.

After the collection of the data, side gapping spark plug was set up to the engine dynamometer then the same process of collecting the data of SI engine with the help of side gapping spark plug earlier is applied. Best result will be analyzed and compared.

The experiment is set up at eight different sets of engine RPM ranging from 1000 RPM to 5000 RPM with the incremental of 500 RPM. All this sets of engine speed are in constant state.

III. RESULTS AND DISCUSSION

The findings of the experiment were obtained and taken into line graphs one by one, with the completion of this experiment, to accomplish a natural aspired motor condition during the first run. D. Engine speed vs power between standard and side gapping spark plug.

A. Engine speed vs power between standard and side gapping spark plug

The Fig. 4 shows the 0.8mm side gapping spark plug can reach is 66.7 kW at 5000rpm. The 1.0mm side gapping showed an improvement where it can maintain the highest power starting from 1000rpm until 4000rpm. The result for 1.1mm side gapping were not reach the expectation since the power was produced by 1.0mm side gapping spark plug impressive but when the size was increased to 0.1 mm, it only showed a slightly improvement.

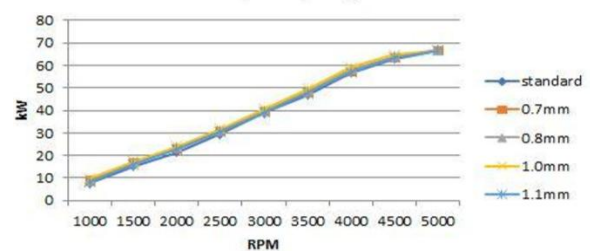


Fig. 4 Comparison for overall data of engine speed vs power between standard spark plug and side gapping spark plug

B. Engine speed vs torque between standard and side gapping spark plug.

As have been discussed before, every side gapping spark plug showed an improvement even the different of side gapping only 0.1mm but the result impressive. Based on the figure 4.11, at the 1000rpm, the differences of each torque were produced showed different outcome. Since the 1.0mm side gapping spark plug produced the highest power, it also produced the highest torque. The differences gapping for torque were produce from the lowest to the highest is 0.5Nm. As can be seen from the graph, each of side gapping spark plug also showed the torque was increase since have improvement on the engine power.

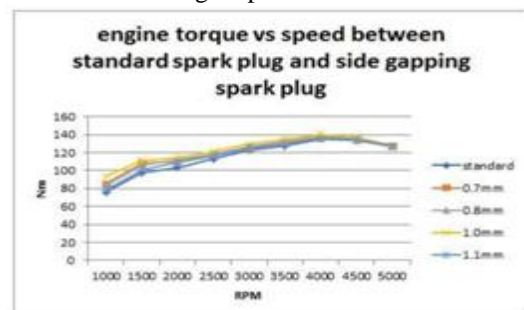


Fig. 5 Comparison for overall data of engine speed vs torque between standard spark plug and side gapping spark plug

C. Fuel consumption

Based on the Fig. 6, overall data was showed the highest fuel consumption was produced by standard spark plug and the less consumed is 1.0mm side gapping spark plug. The result for others side gapping spark plug showed a better fuel consumption when compared to the standard spark plug. 409.7 g/KWH of fuel required to produce a power of 1 kilowatt for duration of 1 hour was obtained from standard spark plug means it is consumed more fuel compared to the all of side gapping spark plug. For overall data, side gapping spark plug has consumed less fuel consumption.

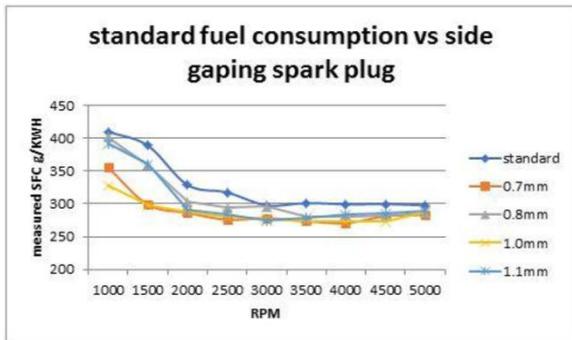


Fig. 6 Comparison for overall data for standard fuel consumption vs side gapping spark plug

D. Emission

On this part, it will cover 3 types of data related to the emission which are carbon monoxide, hydrocarbon and oxygen. The data has been obtained was discussed based on the graph between standard spark plug and side gapping spark plug.

Based on the Fig. 7, the gas of carbon monoxide showed the number is rapidly increase at 3000rpm until 5000rpm for standard spark plug, 0.7mm and 0.8mm side gapping. The carbon monoxide increased after the rpm was increased. The result for large width side gapping spark plug like 1.0mm and 1.1mm a bit different as can be seen from the graph where at the 2500rpm it showed the carbon monoxide was decreasing and after it reached 3000rpm, it was increased until 5000rpm. But at the end of result, the large width side gapping was produced less carbon monoxide compared to the rest spark plug.

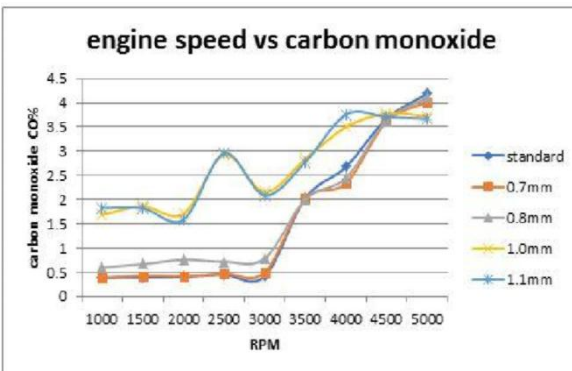


Fig. 7 Engine speed vs carbon monoxide

Fig. 8 is showed the result of engine speed versus hydrocarbon. As can be seen from the graph, standard spark plug produced the highest hydrocarbon at 1000rpm when it reached 173 ppm vol. but the result for side gapping showed

is was decreased the amount of hydrocarbon as much as 20% to 30%. The effect of side gapping really showed the impact on this result. The lowest produced hydrocarbon was 0.7mm side gapping when it reached at the 3000rpm.

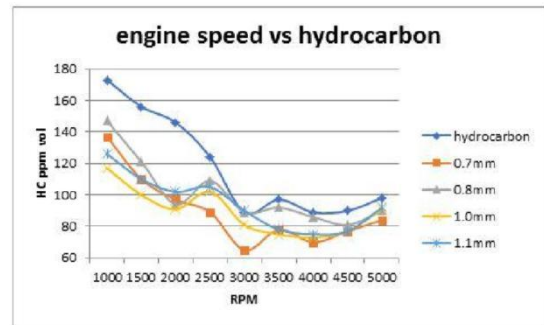


Fig. 8 Engine speed vs hydrocarbon

Based on the data from Fig. 9, it showed the result of 0.7mm side gapping spark plug produced more oxygen compared to the standard spark plug. The result for others side gapping spark plug like 0.8mm, 1.0mm and 1.1mm was produced less oxygen compared to the standard spark plug. All the data for standard and side gapping spark plug showed it was drastically decreased when the RPM become higher and the amount of the oxygen was produced almost equally. Overall, the effect of side gapping spark plug over engine performance and emission showed a positive feedback which it can be conclude as a successful research. All of the side gapping spark plug has a different result and that really helping in doing this research.

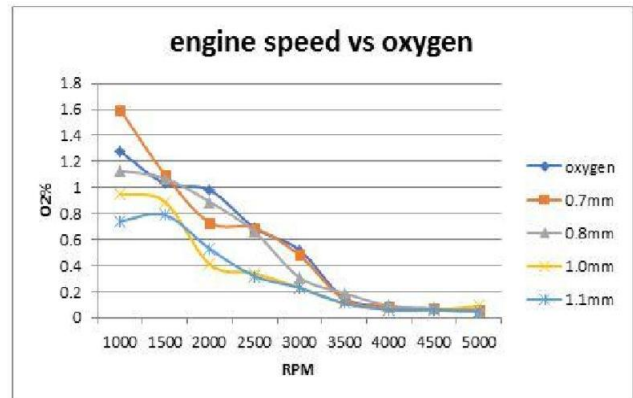


Fig. 9 Engine speed vs oxygen

IV. CONCLUSION

By the end of the research, we can conclude all of the data collected at the end of the research. We can say it was done successfully, although it had lots of ups and downs. In this research project, the objectives had to be reached:

- To study the differences of side gapping of spark plug based on the gapping of each spark plug.
- To observe the engine performance before and after using side gapping spark plug.
- To observe the emission of vehicle when using this kind of gapping of spark plug.

The outcome and the data can be seen as reasons for claiming that these objectives were achieved. The comparison of torque, fuel and power generated between standard spark plug and side gapping spark plug had provided a good answer and, at the same time, both the first and the second goals of this research experiment had been verified. From the data collection the side gapping spark plug had a stronger impact on engine performance, with a 1.0 mm side gapping spark plug being the obvious one that showed the better result.

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