"Performance And Emission Analysis Of Two Stroke Four Spark Plug Single Cylinder SI Engine With Gasoline Fuel"

Hardik A. Patel[1] J. J. Goswami[2]
[1]M. E. Automobile [2]Associate Professor
[1,2]GEC Bhuj

Abstract—Two stroke spark ignition engines have high exhaust emissions and low brake thermal efficiency due to incomplete combustion, which occur during idling and at part load operating conditions. An effort is been made to improve the engine parameters i.e. specific fuel consumption and Thermal Efficiency of the engine and reduction in exhaust emission. This is achieved three basic methods, designing the combustion chamber to achieve an efficient combustion, optimizing operating parameters, i.e. equivalence ratio, spark timing etc. to reduce pollutant emissions and Using after treatment devices in the exhaust system (catalytic converters etc.) Many researchers had found the effect of dual and triple spark plug on engine performance & exhaust emission. This study is aim to find the effect of four spark plug on performance and exhaust emission of two stroke single cylinder spark ignition engine with gasoline fuel. Various performance & exhaust emissions test were carried out on engine with load using four spark plugs. It indicates that brake thermal, indicated thermal, mechanical efficiency increase as compared to using single spark plug. Also it shows significant reduction in HC and CO emission which indicates increase in combustion efficiency.

I. INTRODUCTION

There are three basic methods used to control exhaust emissions:

- Designing the combustion chamber to achieve an efficient combustion.
- Optimizing operating parameters, i.e. equivalence ratio, spark timing etc. to reduce pollutant emissions and,
- Using after treatment devices in the exhaust system (catalytic converters etc.)

This study is focused on using four spark plugs as a design parameter to improve combustion. Quart sparks are one of the important design parameters for SI engines. The primary benefits of using Quart sparks are to achieve a stronger and faster combustion. This enables the engine to operate with leaner fuel-air mixture, i.e., with more EGR (exhaust gas recirculation), for emission control. Although there are some experimental studies about performance analysis of dual spark SI engines. There is a scarcity in the existing literature about theoretical study investigating exhaust emissions of dual spark SI engines. For that reason, this study was concerned with theoretical investigation of the emissions of four spark SI engines. The emissions of CO2, NOX and HC were especially considered in the study. In order to make comparisons, the computations were performed for both single and four spark configurations.

The basic task in the design and development of I.C. Engines is to reduce the cost of production and improve the efficiency and power output. In order to achieve the above task, the engineer has to compare the engine developed by him with other engines in terms of its output and efficiency. Hence he has to test the engine and make measurements of relevant parameters that reflect the performance of the engine. In general the nature and number of tests to be carried out depend on a large number of factors.

To produce efficient and economical engine it is required to take in consideration all parameters affecting the engine design and performance. So engine testing is taken to improve the engine performance and reduce exhaust emission.

A. Graphical Analysis of Engine Performance Parameters

Graphical analysis of variation in various performance parameters with respect to brake power is shown in subsequent graphs.

1) Effect of Four Spark Plugs on Fuel Consumption.

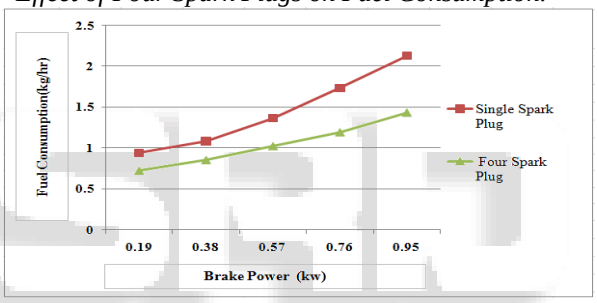

Fig. 1.1: Variations in Fuel Consumption with B.P.

Figure 1.1 shows the variation of FC with Brake power for single plug mode of operation and four spark plugs mode of operation. From above graph it is observed that FC increases with load and was minimum at low load in both modes of operation. This confirms that maximum efficiency is attained. Also it shows wider gap in FC values between single and four plug modes at higher loads.

2) Effect of Four Spark Plugs on BSFC.

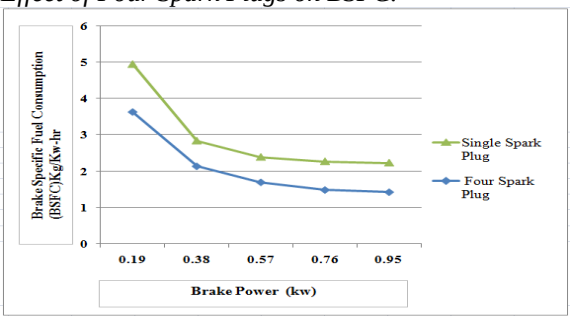

Fig. 1.2: Variations in BSFC with BP.

Figure 1.2 shows the variation of BSFC with Break power for single plug mode of operation and shows the comparison with four plug mode of operation. It shows that BSFC decreased with load and was minimum at full load in both modes of operation, which confirms the maximum efficiency is attained. It is also observed that wider gap in

BSFC values between single and four plug modes at lower loads.

3) Effect of Four Spark Plugs on BSEC.

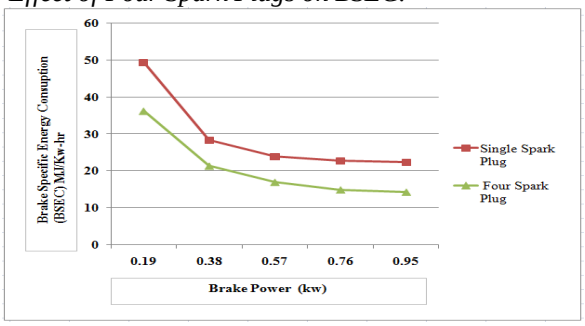

Fig. 1.3: Variations in BSEC with BP

Figure 1.3 shows the variation of Brake specific energy consumption with Brake for single plug mode of operation and shows the comparison with four plug mode of operation. It shows that Brake specific energy consumption decreased with load and was minimum at full load in both modes of operation, which confirms that maximum efficiency is attained at full load condition. It is also observed that wider gap in Brake specific energy consumption values between single and four plug modes at all loads.

4) Effect of Four Spark Plugs on Brake Thermal.

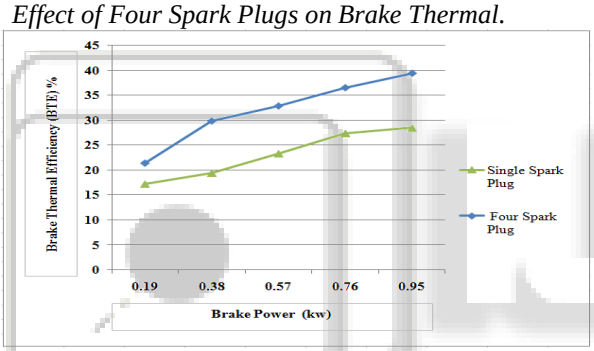

Fig. 1.4: Variations in Brake thermal efficiency with Brake Power

Figure 1.4 shows the variation of Brake thermal efficiency with break power for single plug mode of operation and shows the comparison with four plug mode of operation. It shows that Brake thermal efficiency increases with load and was maximum at full load in both modes of operation, which confirms the maximum efficiency is attained at full load condition. It is also observed that wider gap in Brake thermal efficiency values between single and four plug modes at all loads. This is due to the fact that the combustion of the unburned mixture is equally shared by the four plugs at the optimum ignition timings.

5) Effect On Hydrocarbon (HC) Emission Using Four Spark Plugs As Compared To Single Spark Plug.

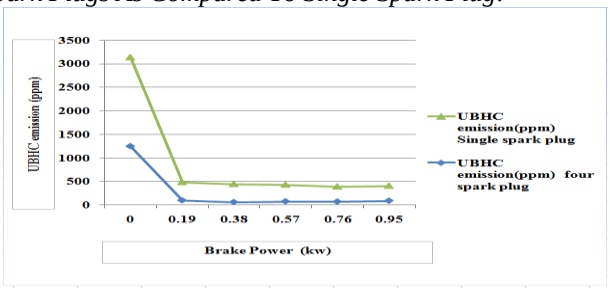

Fig. 1.5: Variations in HC emission versus BP.

Figure 1.5 shows variations in HC emission with brake power. HC emission decreases with load starting from no load for all arrangement of spark plug. HC emissions are highest at no load for all fuels. The reason behind higher HC emissions at no or part load is lower cylinder temperature. Increase in brake power or load results in reduction in HC emissions for all arrangement of spark plug. The reason behind this is increase in cylinder temperature with rise in brake power or load. Unlike NOx emissions, HC emissions are highest at no load and decreases with increase in brake power or load. While using four spark plug configurations gives better results in reduced HC emissions at all load.

6) Effect On Carbon Monoxide (CO) Emission Using Four Spark Plugs As Compared To Single Spark Plug.

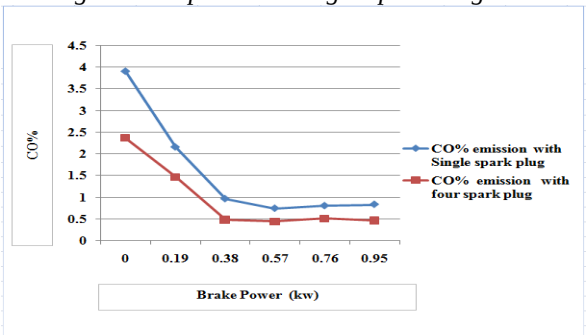

Fig. 1.6: Variations in Carbon monoxide (CO) emission versus Brake Power

Figure 1.6 shows variations in CO emission with brake power. CO emission decreases with load starting from no load to full load condition for all configurations of spark plugs. After reaching minimum value, emission of CO increases again. This rise is continued up to the maximum brake power for all configurations of spark plugs. CO emission decreases with four spark plug configuration. The reason behind high emission of CO at no load may be lower cylinder temperature at no load. As load to brake power increases cylinder temperature also increases. Further increase in brake power results in higher emission of CO. While using four spark plug configurations gives better results in reduced CO emissions at all load. Percentage reduction of CO is shown in above table 4.4.

7) Effect On Nitrogen Oxide (NOX) Emission Using Four Spark Plugs As Compared To Single Spark Plug.

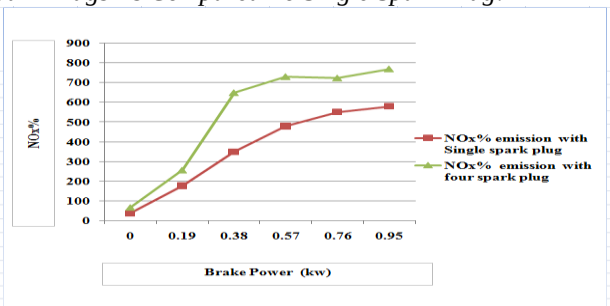

Fig. 1.7: Variations in NOx emission versus BP

Figure 1.7 shows variations in NOx emission with varying brake power. Emission of NOx increases with rise in brake power load increases, percentage of NOx emissions also increase in four spark plug configuration versus single spark plug configuration. Rapid combustion of the fuel increases temperature inside the engine cylinder. At high temperature nitrogen reacts with oxygen to form its oxides. Hence at four spark plugs mode higher NOX emission was observed. At

full load, the increase in F/A decreased NOx emission. While using four spark plug configurations gives raise in emissions of NOX at all load. Percentage increment of NOX is shown in above table 4.4.

II. CONCLUSION

Based on the experimental data obtained on a single cylinder, vertical, air cooled self governed two stroke spark ignition engine with petrol fuel. The engine is run with single spark plug mode and with four spark plugs mode. After performing several experimental run and based on result obtained, following conclusions are made.

The performance parameter of the engines are significantly improved,

- Two stroke engines have a good potential if four spark plugs technology is employed.
- Applying the four spark plug in two stroke gasoline engine combustion process have improved hence efficiency of the engine is improved.
- On applying the four spark plugs in two Stroke Gasoline engine the problem of fuel economy will also be improved due to proper combustion inside the cylinder.
- Carbon Dioxide (CO) emission is reduced significantly when four spark plugs are used when compared single spark plug mode. The CO emission is lower when compared to the Bharat stage IV Norms for selected engine at all operated loads.

Unburned Hydro Cabin (UBHC) emission is reduced significantly when four spark plugs are used when compared single spark plug mode.

- The (UBHC) emission is lower when compared to the Bharat stage IV Norms for selected engine at all operated loads.
- Nitrogen oxides (NOx) emission is increase when four spark plugs are used when compared single spark plug mode. The (NOx) emission is lower when compared to the Bharat stage IV Norms for selected engine at all operated loads.
- The brake thermal efficiency of the engine is more with four spark plugs configuration when compared single spark plug mode at 1500 RPM.
- Brake specific fuel consumption is reduced four spark plugs are used when compared single spark plug mode at all load condition. From the graph we can see that if load increases the brake specific fuel consumption give good results in four spark ignition engine.
- More power can be generated from the same size engine by employing four spark plugs its mean improvement in power without changing other parameter.

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