

# Performance and Emission Analysis of Two Stroke Multi Spark Plug Single Cylinder SI Engine with Petrol Fuel

Nikunj B.Patel<sup>1</sup> Akash B.patel<sup>2</sup> Hardik A. Patel<sup>3</sup>

<sup>1,2</sup>SPIT <sup>3</sup>Ganpat University

**Abstract**— This paper describes some results of the research in the area of multiple spark ignition engines. In the single spark plug engine there is a high exhaust emission and low brake thermal efficiency because of incomplete combustion. To overcome this problem a new dual spark plug engine is developed. Dual spark ignition system has proved their potential in improving the performance of the engines and improved emissive characteristics as compared with the single spark plug ignition system. Recently a new type engine has been introduced which uses triple spark plugs at different locations, controlled by an advanced electronic control unit. This advanced electronic control unit uses three different ignition timings with variable spark plug number. Experiments were conducted at different load conditions and different types of engines has proved that dual spark plug ignition engines are surely better than a single spark plug engine, but triple spark ignition engines has proved their potential. It is experimentally investigated that in the single spark plug mode the centrally located spark plug is most effective and gives best performance. In the dual, triple and four spark plug mode if the central location of the spark plug is not possible because of the design of the engine then spark plugs were considered to be located diametrically opposite to each other on cylinder head axis symmetrically. According to Dimensionless distance from the cylinder centre to spark plug location on cylinder head,  $rsd = rs/R$ , five locations ( $rsd = 0, 0.25, 0.50, 0.75, \text{ and } 1.0$ ) were considered. Inevitably  $rsd = 0$  corresponds to the single spark arrangement that the plug is located at the centre. To comparison, single-spark plug configurations were also considered for other selected spark plug locations. Current paper investigates the effect of multi spark plug to the single spark plug on the basis of the performance of engine and emissive characteristics of engine. The result shown that the considerable improvement in the performance of engine output and considerable reduction in BSFC, HC and CO emission in multi spark plug mode.

**Key words:** SI Engine, Flame Propagation

## I. INTRODUCTION

Most of the internal combustion engines are runs on the fossil fuel which is contain the hydrocarbon (HC). Normal combustion products of any IC engine are CO<sub>2</sub>, H<sub>2</sub>O and N<sub>2</sub> in the complete combustion process of engine. These exhaust products are not considered as a pollutant because they do not cause direct hazard on human. But normally in real combustion process some additional products such as unburned hydrocarbon (HCs), carbon monoxide, nitrogen oxide (NO<sub>x</sub>) and particulate matter (PM) also appears. This product creates the most harmful effect on the environment as well as human. Quantity of this harmful product of SI engine is five times more than that of CI engine. CO is the dominating pollutant component with about 80 percent of all pollutant emissions, i.e., CO, NO<sub>x</sub>, unburned HCs and PM. Its high concentration affects the haemoglobin and low

concentration is sufficient to cause suffocation. This poisonous gas is mostly generated in to the engine. When engine is operated in fuel rich equivalence ratio and there is not sufficient oxygen to convert all carbon in to CO<sub>2</sub>, some fuel carbon form into CO. Concentration of nitrogen is about 12 percent. Most of the NO<sub>x</sub> is in the form of nitrogen monoxide (NO) with small amount of nitrogen dioxide (NO<sub>2</sub>). The rest of the exhaust is in form of HCs and PM. Hydrocarbon are 8% of total emission and PM concentration is in ppm (part per million) levels.

Methods to control combustion in IC engine are

- 1) By using after treatment device at exhaust of engine like catalytic converter etc.
- 2) By optimising operating parameter like spark timing equivalence ratio etc. To reduce emission of engine
- 3) 3)By modifying the combustion chamber design for efficient combustion.

As a engine design parameter number of spark plug are taking into account. After detail study of literature paper it is clear that the exhaust emission in the single spark plug engine is higher than that of twin spark plug and emission of twin spark plug is higher than of tetra spark plug engine. This is because in the single spark plug mode the burning of fuel is slower because of larger delay period so some time the smoky emission is there. If we are using twin spark plug instead of single spark plug the burning rate of air fuel mixture is quite higher so the possibility of emission of unburned hydrocarbon is decrease. And in the tetra spark plug mode result is more improved. Flame propagation in single, dual and tetra spark plug mode is shown in figure.

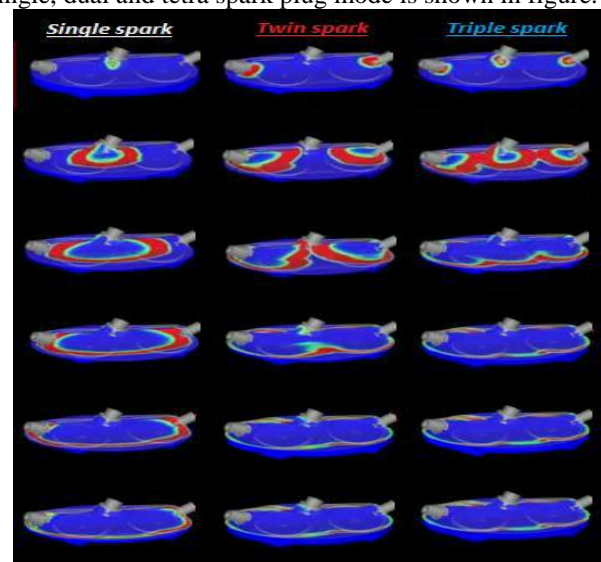


Fig. 1: Flame propagation

Combustion process takes place faster in dual spark plug mode and fastest in tetra spark plug mode as compared to single spark plug mode. Combustion is about 27% faster in tetra spark as compared to dual spark and 50% faster as compared to single spark. Brake thermal efficiency is maximum for tetra spark mode. Variation increases more the

increase in load. Similar trend can also be seen in twin plug mode but variation is lesser than tetra plug mode. BSFC is maximum for single spark engine and lower for the multi spark engine.

*A. Ismail Altın, Atilla Bilgin:*

From the result of study it was found that centrally located single-spark plug arrangement gives the best engine performance and fuel economy, while for the all the other spark-plug locations away from the centre twin-spark arrangement favourable to the single-spark plug configuration. If central location of spark plug is not possible because of the some design constraints, twin-spark plug configurations can be preferred. It was obtained that the twin-spark configurations give better performances and fuel economy than single-spark configurations. The centrally located single-spark configuration gives the best performance and fuel economy in comparison to all other configurations.

*B. Arpit Dubey, Akshay Pareta and Pawan Sharma:*

The result has shown that there is a considerable performance improvement in power output, increase in thermal efficiency and reduced maintenance due to lower emission of BSFC, HC and CO emission in triple spark plug mode of operation as compared to single and dual spark plug mode of operation.

*C. Narasimha Bailkeri, Krishna Prasad, Shrinivasa Rao:*

It is experimentally observed that for any given engine configuration there exists an optimum compression ratio, which gives best performance with respect to efficiency and exhaust emissions, in dual plug mode. Hence it is suggested that care must be taken to select a compression ratio in the design stage, so as to obtain maximum benefits from the dual plug combustion engines.

*D. Manoj Kumar M. Rathwa, Prof. S.A. Shah:*

The following conclusions can be drawn from the study:

Spark plug number and its location have important effect on the SI engine exhaust emissions. The centrally located single-spark and mid located dual-plug configurations gives almost similar and the best combustion with the lowest exhaust emissions in comparison with all other configurations. Therefore, if centrally located single plug, cannot be used due to any geometrical constraints; mid-radius dual-plug configuration can be used to lower emissions. Side-located dual-spark configuration gives similar 3. results with mid-radius single spark configuration. Increase in CO and NO emissions under various 4. Conditions can be diminished by using dual-spark ignition in SI engines

*E. Atilla BILGİN, Ismail ALTIN and Ismet SEZER:*

They conclude that side-located dual-spark configuration gives similar results with mid-radius single spark configuration. Increase in CO and NO emissions under various conditions can be diminished by using dual-spark ignition in SI engines.

*F. S.N. Sridhara, Abdul Nassar and N.L.N. Murthy, S.R. Shankapal:*

In the first phase of the investigation, they found that, the possibility of adopting twin spark plug is explored and validated. In the second phase, the parametric study was carried out to optimize the location of the spark plugs for improved performance in terms of higher specific power and reduced emission and knocking. The other parameters considered viz., ignition advance, compression ratio and swirl ratio were tuned to get the best output. In the last phase, the practical implementation of the investigated spark plug arrangement has been discussed which include the technical and financial aspects.

*G. A.Rehman, Ajay K. Singh:*

Studies done by them has shown that introduction of dual spark ignition has considerably increased the performance of the engine by increasing efficiency & power and reducing its exhaust emissions and dual spark ignition system is better for improving ignition process even in 2-stroke engines. Thus reviews and studies have clearly indicated that use of multiple spark ignitions can increase the rate of combustion by rapidly completing the process. Thus, generating more power, increased the engine efficiency and lower the exhaust emissions.

*H. Imran G. Qureshi, Prof. R. J. Jani:*

This paper describes review on performance and emission characteristics of twin spark ignition engine fuelled by gasoline and natural gas. Here, it will be shown that due to lower volumetric efficiency and lean effect in CNG Fuelled SI engine, the maximum torque generated is diminished compared to gasoline fuelled engines. We showed that the torque reduction can be recovered and performance of single spark CNG engine can be enhanced by modifying twin spark ignition system.

*1) Single and Dual Spark Plug Engine:*

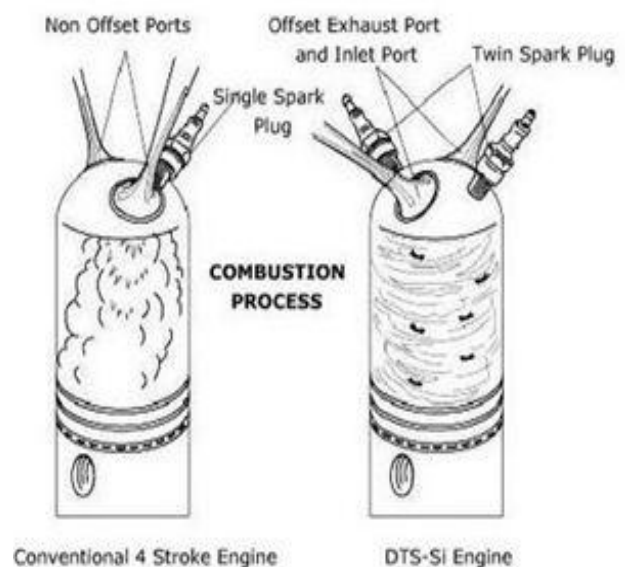


Fig. 2: Single and dual spark plug engine

## 2) Triple Spark Plug Engine:



Fig. 3: Triple spark plug engine

## II. ACKNOWLEDGEMENT

Grateful to Faculties for giving me the strength to finish this dissertation work completely beside gaining valuable experiences and knowledge throughout completing this thesis, this experiences and knowledge may assist me to develop my personal skill in the future. Special thanks are addressed to my supervisor, Mr. Akash B. Patel for his guidance, advices, idea, and his patience to me in accomplishing this project, a special debt of gratitude towards him. Without their continue support and encouragement, I could not have gone further than where I have. In spite of being very busy, He always ready to help me whenever and whatever is being required. He provides me continuous guidance and aware us with actual core part of Development strategy of Model Design and in each and every stage. I also express our sincere thanks to all the staff members of Sardar Patel Institute Of Technology, for their timely advice and expertise.

## REFERENCES

- [1] Ismail Altın , Atilla Bilgin, Parametric study on the performance parameters of a twin-spark SI engine Energy Conversion and Management 50 (2009) 1902–1907 Contents lists available at Science Direct Energy Conversion and Management journal homepage.
- [2] Arpit Dubey, Akshay Pareta and Pawan Sharma, Study of Multiple Spark Ignition Engines with Single Spark Ignition Engines on the Basis of Engine Efficiency and Emission Characteristics Size International Journal of Current Engineering and Technology ISSN 2277 - 4106 Accepted 10 March 2014, Available online 01 April 2014, Special Issue-3,(April 2014)
- [3] Narasimha Bailkeri, Krishna Prasad, Shrinivasa Rao, Performance Study on Twin Plug Spark Ignition Engine at Different Ignition Timings International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064 Volume 2 Issue 8, August 2013.
- [4] Manoj Kumar M. Rathwa, Prof. S.AShah, Effect of dual ignition on the exhaust emission of an SI engine operating on different conditions, International Journal of Advanced Engineering Technology E-ISSN 0976-3945

- [5] Atilla BİLGİN, Ismail ALTIN and Ismet SEZER Technical University 61080 Trabzon, Turkey Investigation of the Effect of Dual Ignition on the Exhaust Emissions of an SI Engine Operating on Different Conditions by Using Quasi-dimensional Thermodynamic Cycle Model, CODEN STJSAO, ZX470/1404 ISSN 0562-1887
- [6] S.N.Sridhara, Abdul Nassar and N.L.N. Murthy, S.R.Shankapal Dept of Automotive Engineering M.S. Ramaiah School of Advanced Studies, Bangalore, India “ Numerical Investigation of Effect of using Twin Spark Plug on Power and Emission Characteristics in an IC Engine”.
- [7] A.Rehman ,Ajay K. Singh, The Effect of Dual Spark Plug on Engine Performance Parameter in Two Stroke Gasoline Engine International Journal of Applied Research and Studies (IJARS) ISSN: 2278-9480 Volume 2, Issue 7 (July- 2013) www.ijars.in
- [8] Imran G. Qureshi, Prof. R. J. Jani Performance and Emission Analysis of Four Stroke Twin Spark Single Cylinder SI Engine Fuelled with Gasoline and CNG - a Technical, International Journal of Applied Research and Studies, Review Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 – 8179
- [9] Narasimha Bailkeri, Krishna Prasad, Shrinivasa Rao, Comparative Study Of Performance Of Dual Plug And Single Plug S.I Engine At Different Compression Ratios, International Journal of Advanced Research In Engineering And Technology (IJARET), ISSN 0976 - 6499 Volume 4, Issue 5, July – August 2013, pp. 188-197