IF : 3.62 | IC Value 70.36

Volume-5, Issue-2, Feb - 2016 • ISSN No 2277 - 8160

Research Paper | Engineering

A Study on Influence of Ignition Timing on Performance and Emission of Petrol Engine.

Ragadia Sadiq Y

I/c Head of Mechanical Engineering Department, Government Polytechnic, Dahod Zalod road, Dahod- Gujarat 389151. Affiliated to Gujarat Technological University

ABSTRACT *In the early years engine power and reliability was main focus by the designer for the development of the petrol engine but in today's scenario engine design is mainly focused on performance and emission of the engine. The performance of petrol engine is a function of many factors but ignition timing is one of the important factors for improving performance of the spark ignition engine. Correct ignition timing is required for high performance of the engine and for high efficiency of the engine. The optimum values of ignition timing also reduce the emission form the petrol engine. The main focus of the paper is on influence of ignition timing on performance and emission of petrol engine.*

KEYWORDS : Petrol engine, emission, ignition timing.

INTRODUCTION

In today's engine design, performance and emissions from the engines are main focusing parameters. Engine performance is highly depends on combustion inside the engine and combustion inside the engine depends on ignition strategy. Ignition strategy depends on ignition timing so improper ignition timing leads to incomplete combustion which reduces efficiency of the Internal combustion engine and increased emissions.

Improper ignition for IC engine leads to improper combustion and which reduces engine performance.

Performance of the SI engine depends on ignition and ignition timing.

For petrol engine combustion of the fuel takes place just before end of compression stroke by supplying the spark. So proper spark timing are required which produce maximum peak cylinder pressure and maximum brake torque. So at best timing engine produced more power and reduce engine emission.

Improper spark timing and ignition timing leads to incomplete combustion which reduces efficiency of the Internal combustion engine and increased emissions. So poor ignition timing affects the engine performance reduces its efficiency and increased emissions.

By setting the ignition timing ignition inside the engine cylinder will be optimized with reference to piston position. The distribution of spark depends on ignition timing.

Proper spark timing also lead to increase efficiency of the internal combustion engine. Ignition timing affects fuel economy and particular spark timing gives maximum torque which improves power output of the engine and ignition timing also affect engine emissions. The spark timing has a considerable influence on the combustion characteristics and therefore on the engine performance and combustion products.

LITRATURE SURVEY.

Necati [1]2013 Investigate the effects of ignition timing on engine performance and emissions for spark ignition(SI) engine using ethanol blend. The output performance was evaluated by changing the timing angle and power and efficiency were evaluated.

In the experimentation ignition timing was successively delayed in 2° increments up to 6 ° and then successively advanced by 2 ° up to 6 ° at full load operation. The best performance and emissions were obtained with 4° advancement. Advanced ignition timing resulted in an increase in NOx emissions, while CO and CO2 remained relatively unaffected. Increasing the delay in ignition timing caused poorer combustion and hence more HC emissions and fuel consumption.

The spark timing has a considerable influence on the combustion characteristics and therefore on the engine performance and combustion products. By advancing the spark timing cylinder pressure is increased rapidly which increased the work lost in the compression process, and therefore, decreases the net useful work. In contrast, the too-delayed spark timing results in a lower peak pressure occurring very late in the expansion process. This reduces the work transfer from the expanding gases to the piston. The optimum spark timing produces a satisfactorily high cylinder pressure, with its peak occurring just after the top dead centre.

The investigation concludes that by advancing the ignition timing up to 4 ° increased the torque and power output. By varying the ignition timing did not affects the emissions of CO and CO2 and delayed timings resulted in a substantial loss in NOx emissions and delay in combustion. The investigation also conclude the delay in ignition timing caused poorer combustion and hence increased the HC emissions and fuel consumption.

Jun Lia et al.[2] 2010 Investigate the effect of injection and ignition timings on performance and emissions from a spark-ignition engine fueled with methanol. Optimal injection and ignition timings having significant effect on engine performance and which improve the combustion and reduce the exhaust emissions. At an engine speed of 1600 rpm, full load, and optimal injection and ignition timings, methanol engine can obtain shorter ignition delay, lesser cycle-by-cycle variation, the maximum in-cylinder pressure, the maximum heat release rate, and higher thermal efficiency compared to the case of non-optimized injection and ignition timings. For methanol engine, the optimization of injection timing and ignition timing can lead to an improvement of brake specific fuel consumption of more than 10% compared to non-optimized case in the overall load range and engine speed of 1600 rpm. The best compromise between thermal efficiency and exhaust emissions is reached at optimal injection and ignition timings.

Pertanika R [3] Compare fuel consumption and emissions for SI engine with different ignition timing. By retarding the ignition for lean mixture yielded poor fuel consumption, the poor combustion increased CO emissions and reduces unburnt hydro carbon (UHC). In the test optimum ignition timing with richest mixture was used to achieve maximum best torque. By retarding the ignition timing results in poor combustion increased unburnt hydrocarbon.

S. Maji et al [4], Investigate the emissions and fuel consumption from CNG and gasoline fueled vehicles and also studied the effect of ignition timing on 970 cc, 4 – Stroke S.I engine. Tests were conducted for fuel consumption and mass emissions with a variation of spark timings. The influence of ignition timing on fuel consumption in gasoline mode under Indian Driving Cycle was evaluated. The emissions of HC and CO were found to be maximum in a range of 10° to 16° BTDC and they reduce at retarded timings may be due to lower cycle gas temperature at these timings, while reduction in hydrocarbons at retarded timings is attributed to higher exhaust gas temperatures. Emissions of CO were found to be minimum at 10° BTDC.

Huang[5] Investigate that ignition timing has a large influence on the combustion, emissions and engine performance for a direct injection engine. For improving the engine performance ignition timing played an important role.

Ghazi Karim [6] Investigate influence of spark timing for four stroke spark ignition engine. Proper spark timing is required to optimize the engine performance and increased the efficiency for the spark ignition engine without knock. It was concluded that the onset of knock may be avoided under any set of operating conditions for all the fuels tested by reducing the equivalence ratio for lean mixture operation, lowering the compression ratio and/or retarding the spark timing. The engine was operated unthrottled under atmospheric pressure conditions and at variable compression ratio (from 4:1 to 16:1) and spark timing adjustable to study the effect on performance of the gas fueled S.I engines.

Chan and Zhu[7] By modeling of in-cylinder thermodynamics and by retarding the ignition timing investigate the performance of spark ignition engines. Effects of varying the spark timing on cylinder pressure distribution, in-cylinder gas temperature and trapped mass inside the cylinder were evaluated.

Mustafa et al. [8] Investigate the effects of injection timing on performance, combustion characteristics, and exhaust emissions of an engine fueled with methanol and diesel blends. In the investigation comparison to the values obtained at an injection timing of 20º crank angle before top dead center, at a retarded injection timing of 15 º crank angle before top dead center, the values of peak cylinder pressure, rate of heat release, and combustion efficiency, as well as nitrogen oxides and carbon dioxide emissions, all decreased, while the smoke number and unburned hydrocarbon and carbon monoxide emissions increased under all test conditions. On the other hand, at advanced injection timing 25 º crank angle before top dead center, the smoke number and the UHC and CO emissions diminished, while the peak cylinder pressure, heat release rate, combustion efficiency, and NOx and CO2 emissions increased under all test conditions. In terms of brake-specific fuel consumption, brake-specific energy consumption, and brake thermal efficiency, retarded and advanced injection timings gave negative results in all fuel blends compared to the original injection timing.

Van et al[9] Investigate the effects of ignition timing, fuel composition, and equivalence ratio on the burning rate and cylinder pressure by developing a two-zone thermodynamic model for a natural gas engine. At various operating conditions burning rate analysis was carried out to determine the flame initiation period and the flame propagation period.

David Gardiner et al. [10] Compared the ignition voltage requirements of natural gas and gasoline in a bi-fuel passenger car by comparing the peak ignition voltage requirements of natural gas and gasoline in a typical bi-fuel vehicle application. Chassis dynamometer tests were carried out in which the vehicle was subjected to different types of transient wide open throttle events to create worst case voltage requirements. In addition to measurements of ignition voltage, other factors known to influence voltage requirements such as cylinder pressure, electrode temperature, and fuel/air ratio were recorded during the transient tests in order to obtain a better understanding of the underlying reasons for observed differences in voltage requirements between the two fuels and between the different transient test procedures. The results presented, quantify the increased peak voltage requirements relative to gasoline for reliable ignition of natural gas under various operating conditions. The effects of voltage polarity and spark plug wear are also addressed. Electrode temperature is shown to be the dominant factor influencing how different transient test procedures affect the peak voltage requirement of a given fuel.

The voltage required to fire the spark plug and the voltage available to accomplish this. Natural gas/air mixtures may have a higher breakdown voltage requirement than gasoline/air mixtures under otherwise identical conditions. At part throttle, natural gas fuelling requires higher manifold pressures (because the natural gas displaces air, and the throttle must be opened more to achieve the same power) which would lead to higher compression pressures and tend to increase voltage requirements. On the other hand, the slower burning characteristics of natural gas usually require more advanced timing than gasoline, so the spark takes place earlier during the compression pressure rise.

Natural gas and gasoline produced similar electrode temperatures for all of the transient test procedures, so electrode temperature was not responsible for differences in voltage requirements between the two fuels. Cylinder pressure at the time of the spark event was consistently lower with natural gas than with gasoline, due to the greater spark advance used with natural gas for the engine tested in this study. Under otherwise identical conditions, lower cylinder pressure would be expected to reduce voltage requirements.

For the positive polarity tests that comprised most of the detailed tests evaluating different spark plugs, the additional requirement was approximately 3-4 kV. The use of spark plugs with reduced gap settings had only a modest effect on peak voltage requirements.

The investigation concludes that voltage requirements were lower while using negative polarity and peak voltage requirements with natural gas were found to be consistently higher than with gasoline.

Hassan et al [11] Compare the engine performance of high compression engine at various ignition and injection timing. For proper combustion, emissions and high performance optimum ignition timing is required. For the CI engine by advancing the ignition timing increased the exhaust temperature of gas it also increase the CO emission so optimum timing is required for better performance of the engine.

Gerpan et al [12] Evaluate effects of ignition timing by developing a two zone thermodynamic model. By the study flame propagation period and different engine operating condition was analyzed.

Engine performance of the internal combustion affects by advancing and retarding the ignition timing, the best timing engine produced more power and reduces engine emission. So by advancing and retarding the spark timing engine performance affects i.e. by retarding the timing burning temperature reduces and exhaust gas temperature increases. [13]

Salman et al[14] Investigate that engine performance of spark ignition engine depends on ignition timing by artificial neural network modeling. Optimum spark timing affects the efficiency and reduce emissions for the engine.

Hassan [16] Compare the effect of variation in injection timing on exhaust emission concentrations in a CNG fuelled direct injection engine and observed a decrease in hydro carbon concentration with advancement in injection timing as well as retardation in injection timing resulted in increment of NOx Kakaee et al [17] Evaluate the engine performance under different values of ignition advace for a spark ignition engine. By using a Wiebe modeling result of two-zone in-cylinder combustion is compared with experimental result where ignition timing was varied. At variable timing power, torque, thermal efficiency, pressure, and heat release are obtained and compared. In the results optimal power and torque are achieved at 31°CA before top dead center and performance is decreased if this ignition timing is changed and maximum efficiency is obtained when peak pressure occurs between 5 and 15°CA after top dead center.

CONCLUSION.

- The spark timing has a considerable influence on the combustion characteristics and the engine performance and combustion products. By advancing the spark timing cylinder pressure is increased rapidly which increased the work lost in the compression process, and therefore, decreases the net useful work. The optimum spark timing produces a satisfactorily high cylinder pressure, with its peak occurring just after the top dead centre.
- For the spark ignition engine by advancing the ignition timing up to 4 º increased the torque and power output. By varying the ignition timing did not affects the emissions of CO and CO2 and delayed timings resulted in a substantial loss in NOx emissions and delay in combustion. The delay in ignition timing caused

poorer combustion and hence increased the HC emissions and fuel consumption.

- Optimal injection and ignition timings having significant effect on engine performance and which improve the combustion and reduce the exhaust emissions for spark ignition engine.
- The best compromise between thermal efficiency and exhaust emissions for spark ignition engine is for optimal injection and ignition timings.
- For SI engine optimum ignition timing with richest mixture gives maximum torque. By retarding the ignition timing results in poor combustion increased unburnt hydrocarbon.
- Proper spark timing is required to optimize the engine performance and increased the efficiency for the spark ignition engine without knock for the SI engine.
- For SI engine brake-specific fuel consumption, brake-specific energy consumption, and brake thermal efficiency, retarded and advanced injection timings gave negative results in all fuel blends compared to the original injection timing.
- For the gasoline engine voltage requirements were lower while using negative polarity and peak voltage requirements with natural gas were found to be consistently higher than with gasoline. For proper combustion, emissions and high performance optimum ignition timing is required.
- Engine performance of the internal combustion affects by advancing and retarding the ignition timing, the best timing engine produced more power and reduces engine emission. So for SI engine performance affects by advancing and retarding the spark timing.
- For SI engine optimal power and torque are achieved at 31°CA before top dead center and performance is decreased if this ignition timing is changed and maximum efficiency is obtained when peak pressure occurs between 5 and 15°CA after top dead center.

REFERENCES.

[1] Necati Turkoza, Barıs Erkus, M.Ihsan Karamangilb, Ali Sürmenb,c, Nurullah Arslanog. Experimental investigation of the effect of E85 on engine performance and emissions under various ignition timings. Fuel 115 (2014) 826–832.

[2] Jun Lia, Chang Ming Gonga, Yan Sua, Hui-Li Doub, Xun-Jun Liua. Effect of injection and ignition timings on performance and emissions from a spark-ignition engine fueled with methanol. Fuel 89 (2010) 3919–3925.

[3] Effect of Ignition timing on fuel consumption and emissions of a dual chamber spark ignition engine. Ch.Rangkuti.Pertanika J.Sci & Technol. 8(2)-229-239(2000).

[4] S. Maji, Rakesh Ranjan, P.B. Sharma, "Comparison of emissions and fuel consumption from CNG and gasoline fueled vehicles – Effect of ignition timing ", SAE 2000-01-1432.

[5] Zuohua Huang, J. W. (2006). Combustion Characteristics of a Direct-Injection Engine Fueled with Natural Gas-Hydrogen Blends under Various Injection Timings. Energy & Fuels, 20(4), 1498-1504.

[6] Ghazi Karim, Hailin Li, " Knock in gas fueled SI engines ", International Journal of Hydrogen Energy, Jul 2004.

[7] S. H. Chan and J. Zhu, "Modeling of engine in-cylinder thermodynamics under high values of ignition retard,

" International Journal of Thermal Sciences, vol. 40, no. 1, pp. 94–103,2001.

[8] Mustafa C, Cenk S, Metin G. Exhaust emissions and combustion characteristics of a direct injection (DI) diesel engine fueled with methanol-diesel fuel blends at different injection timings. Energy Fuels 2008;22:3709–23.

[9] S. Soylu and J. Van Gerpen, "Development of empirically based burning rate sub-models for a natural gas engine," Energy Conversion and Management, vol. 45, no. 4, pp. 467– 81, 2004.

[10] David P. Gardiner, Greg R. Pucher, Robert W. Mallory, "Comparisons of the ignition voltage requirements of natural gas and gasoline in a Bi-Fuel passenger car ", SAE Paper No. 1999-01-3567.

[11] M.K Hassan, I.Aris, S..Mahmod, R. Sidek, "'Influence of Injection and Ignition of CNG Fuelled Direct Injection Engine at Constant Speed." Australian Journal of Basic and Applied Sciences, 4(10): 4870-4879, 2010 ISSN 1991-8178

[12] Soylu and Gerpen. Development of empirically based burning rate sub-models for a natural gas engine. Energy conversion Management. 4-4-467-481. 2004.

[13] Jhon .B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Series in Mechanical Engineering.

[14] Golcu, Sekmen, Salman. Artificial neural-network based modeling of variable valve-timing in a spark-ignition engine. Applied Energy 81:187–197. 2005.

Chan Sh et al[15] Investigate in cylinder gas temperature by retarding ignition value and spark timing.thermodynamics under high values of ignition retard. International Journal of Thermal. 40(1):94-103. 2001.

[16] K. M. Hassan . An experimental result of exhaust emission concentration relative to various injection timing of CNG fuelled direct injection engine. European Journal of Scientific Research, 2009. 25(3), 405.

[17] Sensitivity and effect of ignition timing on the performance of a spark ignition engine: an experimental and modeling study by A.H. Kakaee, M.H. Shojaeefard and J. Zareei. Hindawi Publishing corporation Journal of combustion volume 2011. 1155/2011/678719.