International Conference On Emanations in Modern Technology and Engineering (ICEMTE-2017) ISSN: 2321-8169
Volume: 5 Issue: 3 218 - 222

# "Ignition Timing Investigation On The Performance And Emissions Of Spark Ignition Engine Fuelled With Gasoline"

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**Abstract**: Ignition timing, in a spark ignition engine, is the process of setting the time that an ignition will occur in the combustion chamber (during the compression stroke) relative to piston position and crankshaft angular velocity. Setting the correct ignition timing is crucial in the performance and exhaust emissions of an engine. Experimental investigation carried out to study the effect of spark timing on engine performance and emission study shows that spark timing has significant effect on engine performance and emission. Minimum BSFC found at spark timing 18°Crank AnglebeforeTop Dead Center (CA BTDC). Better thermal efficiency is obtained at 80% load.

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## I. INTRODUCTION

The performance of spark ignition engines is a function of many factors. One of the most important one is ignition timing. Also it is one of the most important parameter for optimizing efficiency and emissions, permitting combustion engines to conform to future emission targets and standards [1].The ignition processes strongly affect the overall performance in spark ignition engines. Thermal efficiency and the level of NOx emission are strongly influenced by ignition timing. Proper ignition timing can offer high engine thermal efficiency, low levels of NOx emission and longer engine operational life. Knowledge of the ignition timing and the residence time are required before simulating any spark ignition engine design, where improper ignition timing can lead to misfire or knock and high level of cycle-to-cycle variation [2]. Ethanol addition increases the brake torque at all ignition timings at the compression ratio of 10:1. Advancing the ignition timing to 241 CA caused knock occurrence with gasoline fuel. The variation of exhaust temperature with ignition timing at the compression ratio of 8:1 was very similar to the variation at the compression ratio of 10:1. Retarding the ignition timing caused the exhaust temperature to increase[3].Effects of ignition timing of a spark ignition engine using different initial timing and engine speeds on engine performance were studied experimentally. The overall results show that ignition timing can be used as an alternative way for predicting the performance of internal combustion engines. In this paper, the best results were obtained at 31°BTDC for 3400RPM. Also engine speed and throttle position were all found to significantly influence performance in this engine. Volumetric efficiency, BMEP have increased with rising ignition timing. Hydrocarbon (HC) emissionincreasedwith advance of ignition timing. $O_2$, $CO_2$, CO has been almost constant and the lowest amount NOx is obtained at10°BTDC. For future work, it is recommended that ignition timing and valve timing be controlled together and change throttle position in different speeds[7].

Engine with single cylinder spark ignition was fuelled with 30% iso-butanol-gasoline blend. Retarding the ignition timing causes the exhaust temperature to increase. Advancing the ignition timing causes the combustion process to occur near top dead center and leads to an increase in the level of NOx. Advancing the ignition timing causes the peak of NOx to be shifted towards the lean fuel-air equivalence ratio. For a lean mixture, advancing the ignition timing has a great effect on the increase of the level of NOx, whereas for a rich mixture advancing the ignition timing has a minimal affect. Retarding the ignition timing causes engine thermal efficiency to decrease[2].For the spark ignition engine by advancing the ignition timingup to

4º increased the torque and power output. By varying theignition timing did not affects the emissions of CO and $CO_2$ anddelayed timings resulted in a substantial loss in NOx emissionsand delay in combustion. The delay in ignition timing caused poorer combustion and hence increased the HC emissions andfuel consumption. For SI engine optimum ignition timing with richest mixture gives maximum torque. By retarding the ignition timing results in poor combustion increased unburnthydrocarbon. Engine performance of the internal combustion engine is affected by advancing and retarding the ignition timing [8].Maris Gailis and VilnisPirs developed that the exhaust gas temperature increased with ignition timing retard and was higher when the gasoline was used, compared to E85 used. Volumetric shared of unburnt hydrocarbon, carbon monoxide and acetaldehyde emissions was significantly affected by variation of ignition timing within the tested range. Ignition timing, adjusted by the test vehicle's manufacturer for gasoline use, was found suitable for E85 from emission analyses point [4].Since the advent of Otto's first four stroke engine, the development of the spark ignition engine has achieved a high level of success. In the early years, increasing engine power and engine working reliability was the principal target for engine designers. In recent years, however, ignition timing has brought increased attention to development of advanced SI engines for maximizing performance [10].

## II.EXPERIMENTAL SET-UP

The block diagramof experimental setup shown in Fig.1shows 5 HPKirloskar Engine (3.7kW) with 80mm bore and 110 mm stroke length An eddy current dynamometer was directly coupled to the engine output shaft to measure engine torque(20 kW Power at 2400 rpm). Fuel consumption was measured in terms of the volume of gasoline by fuel measurement tank. In-cylinder pressure was measured using quartz crystal pressure sensor. The crankshaft position was obtained using an encoder with 1°resolutions to determine the in-cylinder pressure as a function of crank angle.Air box is used with orifice meter having diameter 10 cm toreduce fluctuating flow.The exhaust emissions HC,CO and NOx were measured with AVL exhaust gas analyzer. The detection limits of CO, HC and NOx are 0.01%, 1ppm and 1 ppm, respectively. Control panel consist of fuel measuring tank to measure volume of gasoline volume, load control is provided for varying load and it indicates in 1 gram, temperature indictor indicates temperature in 1°C.

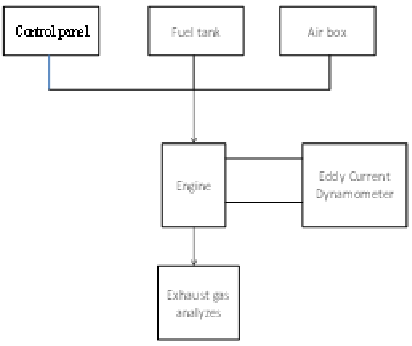


Fig.1 Block Diagram of Experimental set-up

## III.RESULTS AND DISCUSSION

Experiments are carried out to optimize the spark timing at 1500 rpm and at fixed load. Figure shows the effect of spark timing on the specific fuel consumption (BSFC) and brake thermal efficiency (BTE). Minimum BSFC and maximum brake thermal efficiency found at spark timing 18° CA BTDC. It may be because of maximum pressure achieved at this spark timing which is the indication of good combustion corresponding to this point. For other spark timing BSFC is higher which indicates poor combustion to these points than optimize point.

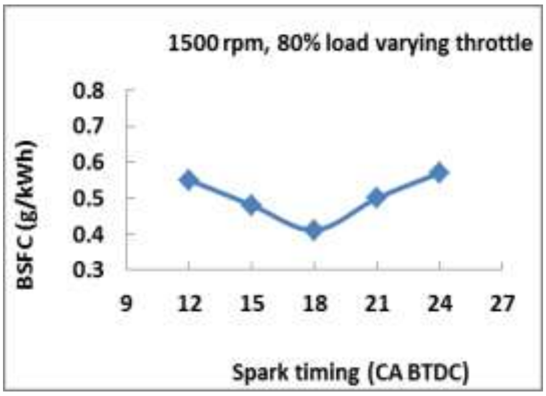


Fig. 1a: Effect of spark timing on BSFC

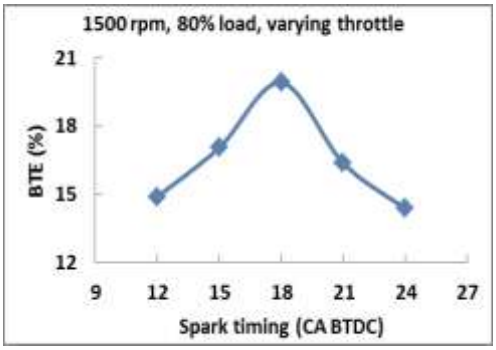


Fig. 1b:Effect of spark timing on Brake Thermal Efficiency

**Effect of spark timing on engine emissions:**

**NOx Emission:**

Figure 2 shows effect of spark timing on emission as follows. NOx emission increases with advanced in spark timing. Emissions of nitrogen oxides (NOx) depends upon temperature and residence time, as temperature increases and residence time increases NOx formation increases.Spark advanced increases peak pressure and residence time hence NOx emission increases with increase in spark advance.

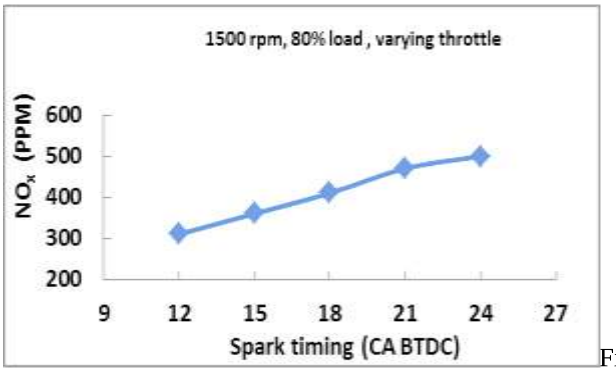


Fig. 2

**Carbon monoxide (CO) Emission:**

Figure 3shows the effect of spark timing on carbon monoxide (CO) emission. It is found that CO emission decreases with increased in spark timing, so better combustion takes place. Higher peak pressure at advanced timing shows better combustion which reduces CO emissions.

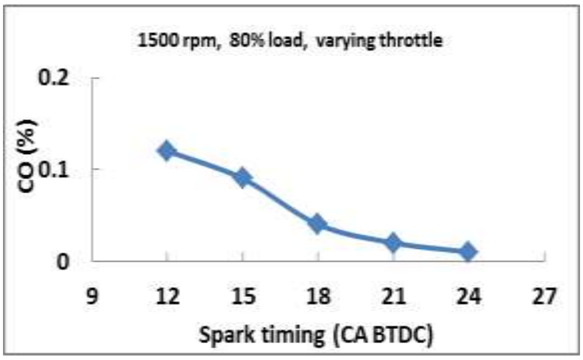


Fig.3

**Hydrocarbon (HC) Emissions:**

Figure 4 shows the effect of spark timing on hydrocarbon (HC) emissions. Hydrocarbon emission decreases with increased spark advance.The better combustion at advanced timing effects inreduction of the hydrocarbon emission.

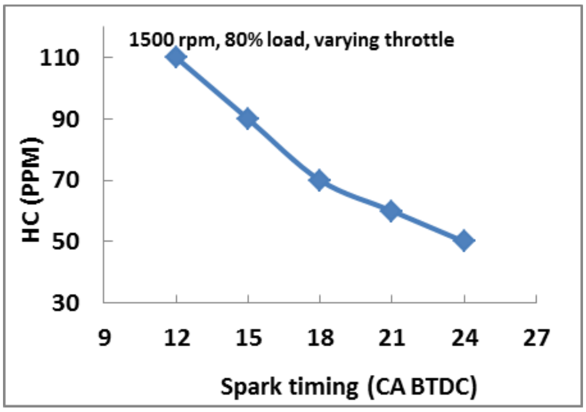


Fig. 4

**Effect of engine load on Engine performance:**

Experimental investigations were carried out to study the effect of load on engine performance and emissions at optimized spark timing 18° CA BTDC, 1500 rpm. The load varied from 20 to 100% and throttle position changed to keep engine speed constant. Figure 5 shows the effect of load on BSFC and BTE.

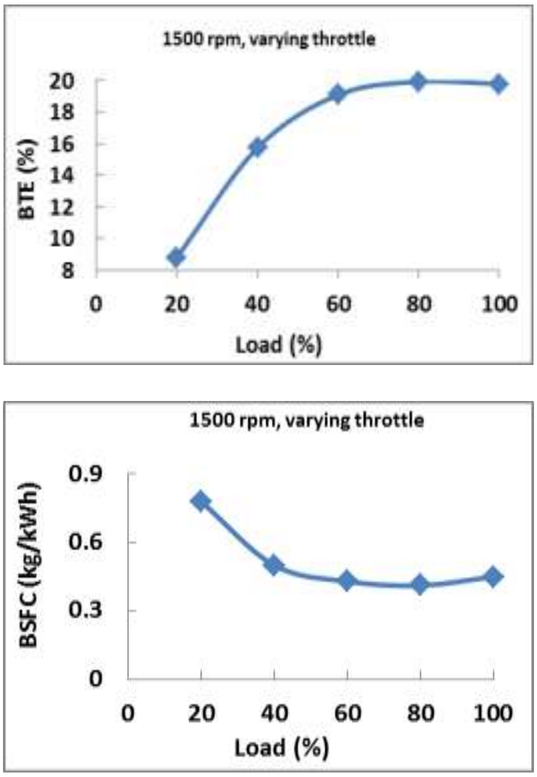


Fig.5. Effect of load on Brake thermal efficiency and BSFC

Figure 5shows effect of load on BSFC, as load increases BSFC reduces and Brake thermal efficiency increases. MinimumBSFC and maximum BTE found at 80% load (0.411 kg/kW-hr) and 19.9% respectively.Higher combustion pressure at higher load indicates better combustion and increased specific fuel consumption.

**Effect of engine load on engine emission:**

**NOx Emission:**

Figure6 shows effect of engine load on NOx emission. NOxemission increases with increase in load. Higher pressure and temperature at higher load increases the NOx.

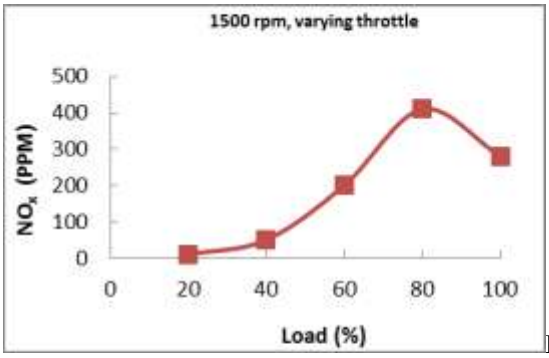


Fig. 6

**Carbon monoxide (CO) Emissions:**

Figure 7 shows the effect of load on CO emissions. CO emissions are higher only at 100% load. It is because of rich mixture is used at higher load.

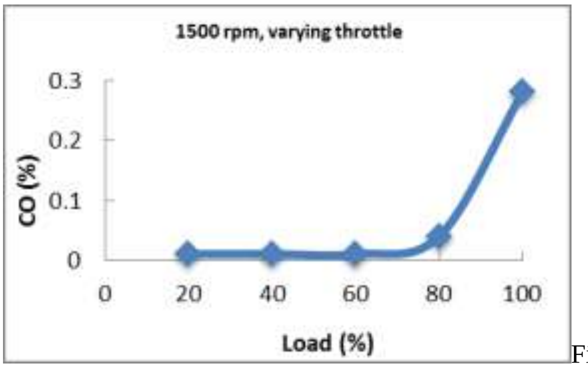


Fig. 7

**Hydrocarbon (HC) Emission:**

Figure 8 shows that more hydrocarbon emissions found at higher load. It may be due to rich mixture utilization at higher load leads towards incomplete combustion which results into higher HC formation.

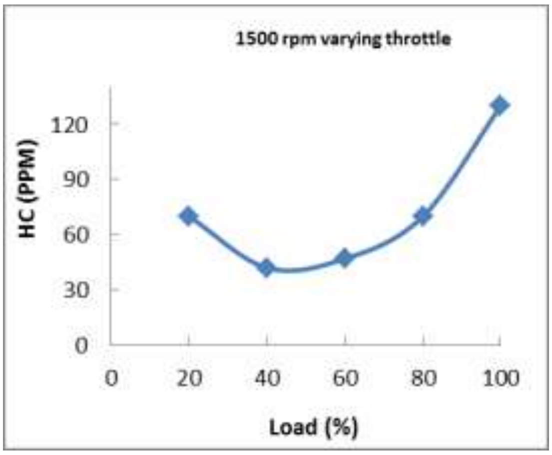


Fig. 8

## IV. CONCLUSION

1) Minimum BSFC found at spark timing 18° CA BTDC.
2) Spark timing has significant effect on engine emission and performance.
3) Better brakethermal efficiency obtained at 80% load.

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