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The Effect of Ignition Timing on Methanol Blended Spark Ignition Engine

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ABSTRACT
The objective of the present work is to evaluate whether variable ignition timing can be effect on exhaust emission and engine performance of a spark ignition engine. The study describes some results of research in the area of spark ignition engine and is assessed by studying its performance and emission characteristics relative to that of conventional ignition engine using gasoline and methanol blended gasoline as fuels at different ignition timings. Experiments were conducted at different ignition timings. The results have shown that performance of methanol blended gasoline engine performed comparatively well over pure gasoline engine fewer than 25^0 to 29^0 BTDC ignition timings. The results have shown considerable performance improvement in brake thermal efficiency, volumetric efficiency, decrease in exhaust gas temperature, as well as reduction in HC, and CO emission.
Keywords – Ignition Timing, Methanol, Spark Ignition

I. INTRODUCTION

Since the invention of Nikolaus Otto's first four stroke engine, the development of the spark ignition engine has achieved a high level of success. In a spark ignition engine, Ignition timing 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 most important in the performance of an engine. The ignition timing affects many variables including engine life, fuel economy, and engine power. Modern engines that are controlled by an engine control unit use a computer to control the timing throughout the engine's RPM range. Older engines that use mechanical spark distributors rely on inertia (by using rotating weights and springs) and manifold vacuum in order to set the ignition timing throughout the engine's RPM range. In recent years, however, ignition timing has brought increased attention to the development of advanced SI engines for maximizing performance. By advancing the ignition timing, an increase of the mean pressure in the combustion chamber was observed, resulting in an increase of the torque and the power [2]. The performance of spark ignition engines is a function of many factors. One of the most important ones is ignition timing. Chan and Zhu worked on modeling of in-cylinder thermodynamics under high values of ignition retard, in particular the effect of spark retard on cylinder pressure distribution [3, 4], [1]. Also it is one of the most important parameters for optimizing efficiency and emissions, permitting combustion engines to conform to future emission targets and standards.

The automobile has changed when the roads became paved and the fuel consumption in the gasoline engine forms a major portion of total petroleum consumption in the automobile industry. This work interweaves the study of experiments on the four-cylinder carburetor-type gasoline engine to cue the performance and emission characteristics by advancing the ignition timing from 25° to 30° BTDC using gasoline and methanol blended gasoline as fuels. The effects of varying the engine working parameters such as ignition timing, brake power, brake thermal efficiency are observed and the variation of different engine emission parameters with the exhaust gas analyser is also observed.

II. METHODOLOGY

Experiment has been carried out with test fuels of pure gasoline and methanol blended gasoline (20% methanol blended with 80% gasoline by volume) on conventional spark ignition engine. The engine performance parameters are compared with conventional engine with pure gasoline operation. The four- stroke, single-cylinder, water-cooled, petrol engine of brake power 2.2 kW at 3000 rpm is used in the experimentation. The engine is coupled to an eddy current dynamometer for measuring its brake power. The compression ratio of the engine is varied from 3 to 9 with the change of the clearance volume by adjustment of cylinder head, threaded to the cylinder of the engine. The engine speeds are varied from 2200 to 3000 rpm. For achieving this goal, at a speed of 3000 rpm, the ignition timing has been changed in the range of 25° to 30° BTDC. For the performance parameters of brake thermal efficiency, exhaust gas temperature and volumetric efficiency are evaluated at different spark timing with different fuels. Pollutants of carbon monoxide (CO) and unburnt hydro carbons (UBHC) are recorded at the peak load operation of the engine for different test fuels with different ignition timings. The exhaust gas temperature of the engine is measured with thermocouples made of iron-constantan. Pollution levels of carbon mono oxide and unburnt hydrocarbon are measured with Netel Chromatograph CO/HC analyzer

III. ENGINE SPECIFICATIONS

Engine: Four-stroke, vertical, single-cylinder, variable speed, variable compression ratio water-cooled petrol engine .

1. Bore : 70 mm
2. Stroke : 66.7 mm
3. Rated output : 2.2 kW
4. Speed : 2200- 3000 rpm
5. Spark ignition timing :25^o to 30^0 bTDC
6. Spark Plug : Make: MICO BOSCH
7. Spark plug gap : 0.6 mm
8. Type of ignition : Battery

IV. RESULTS AND DISCUSSION

The variation of brake thermal efficiency, volumetric efficiency, exhaust gas temperature, UBHC and CO with different ignition timings for conventional pure gasoline and methanol blended gasoline operating at compression ratio of 9:1 and speed 3000 rpm is evaluated.

Brake thermal efficiency & volumetric efficiency

Thermal efficiency of an engine is defined as the ratio of the output to that of the chemical energy input in the form of fuel supply. It may be based on brake or indicated power.Fig.1 shows the comparison of Thermal Efficiency for methanol blended and gasoline at different Ignition Timing 26^0, 27^0 & 28^0 BTDC. The maximum brake thermal efficiency was obtained at 28^0 BTDC using methanol blended gasoline as a fuel, the thermal efficiency is good compared to that of gasoline

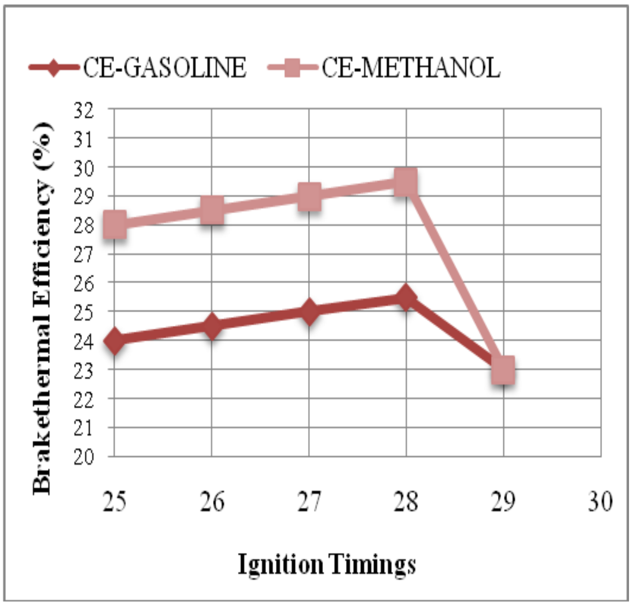

Fig.1 Ignition timing Vs. Brake Thermal Efficiency

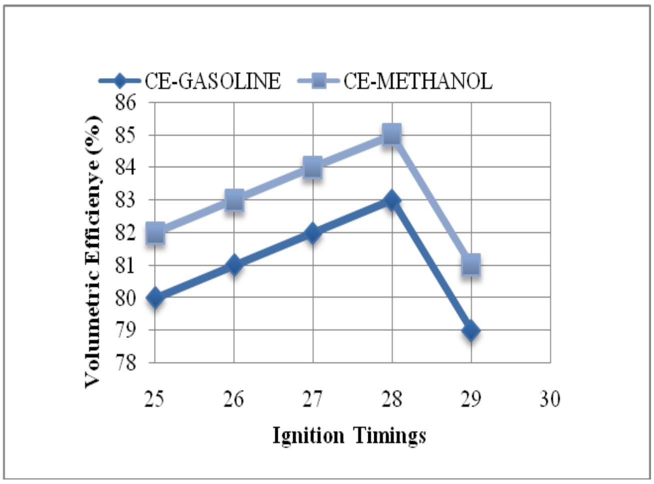

Fig.2 Ignition timing Vs. Volumetric Efficiency

Exhaust gas Temperature

It is been observed that advancing the Ignition timing decreases the exhaust temperature. Advancing the Ignition timing increases the partial oxidation during compression stroke, whereas when the Ignition timing is retarded then there is decrease in pressure and temperature peaks during combustion process as there is less time between Ignition timing and Top dead center to complete chemical reaction, so large amount of fuel gets burn after TDC in expansion stroke which is known as post reaction, post reaction mainly occurs between Carbon monoxide and hydrocarbons in the exhaust system. Therefore retarding the ignition timing is always associated with incomplete combustion and an increase in the exhaust temperature.

Graph in Fig.3 shows the effect of Ignition timing on exhaust gas temperature for Gasoline and Methanol blend it shows advancing the Ignition Timing reduces the exhaust gas temperature, the exhaust gas temperature using methanol blended gasoline as a fuel is having more value compared to gasoline.

It is observed that the exhaust temperature decreases with increasing spark timing between 25^0 to 28^0 BTDC.

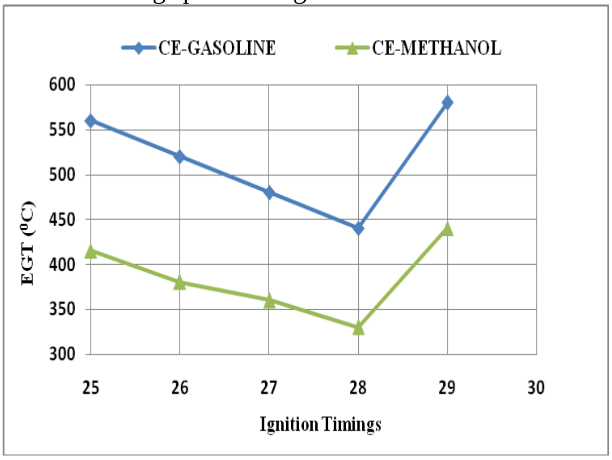

Fig.3 Ignition timing Vs. Exhaust gas temperature

Effect of Ignition timing on Emissions
Hydrocarbon (HC) Emission

Hydrocarbon emissions change if a divergence from MBT (maximum break torque) timing is encountered. As long as MBT timing is maintained, hydrocarbon emissions remain roughly constant. However, if spark timing deviates from MBT, combustion may not be as complete, causing more HC emission. Temperatures will also change, which is changing the amount of oxidation in the cylinder and in the exhaust, results in affecting the amount of HC that gets move out of the exhaust.

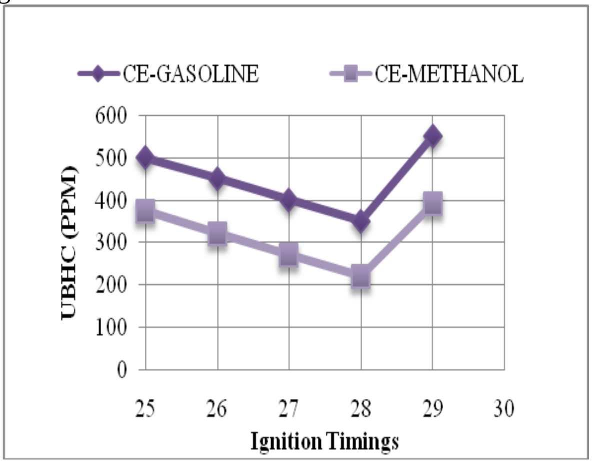

Fig.4 Ignition timing Vs. UBHC

It is observed that there is decrease in hydrocarbon emissions for all ignition timing with increase in load, graph shows that as the Ignition timing is advanced there is increase in hydrocarbon emission, observation showed that hydro carbon emission at 29^0 BTDC is more compared to that at 25^0 to 28^0BTDC. Using Gasoline as a fuel hydrocarbon emission is having more value compared to that of methanol blended fuel.

CO Emission

Ignition timing effects the Carbon monoxide emission, as shown in Fig.5, it is observed that CO emission is higher while using Gasoline as a fuel compared to methanol blended gasoline , it can also be stated that CO emission is not having much variation comparing results at 26^0 to 28^0 BTDC. At 28^0 BTDC the percentage of CO emission is having the least value for all load condition and for both the fuels Gasoline and B20, further when the Ignition timing is advanced there is increase in CO emission percentage, maximum CO emission percentage is observed at 25^0 and 29^0 BTDC using Gasoline and methanol blended gasoline as a fuels.

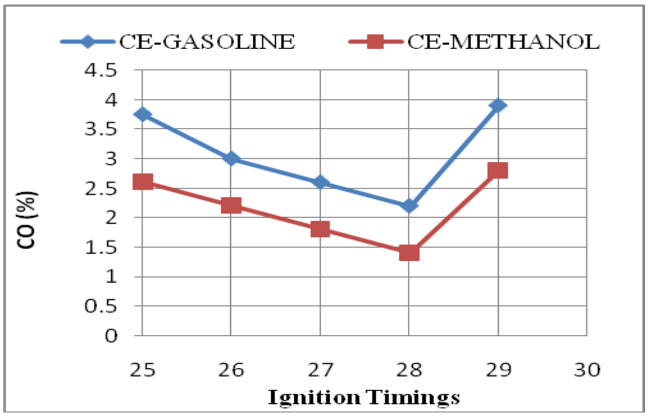

Fig.5 Ignition timing Vs. CO

V. CONCLUSION

From experimentation it is observed that ignition timing can also be used as an alternative way for predicting the performance of internal combustion engines besides specific fuel consumption, brake mean effective pressure, specific power output, specific weight, exhaust smoke and other emissions.

- It is concluded, for both fuel versions of engine brake thermal efficiency and volumetric efficiency increased with ignition timing advance from 25^0 to 28^0 BTDC
- Exhaust gas temperature is reduced in methanol blended gasoline around 400 ^{0}C compared to pure gasoline engine of 500 ^{0}C
- Carbon monoxide and hydrocarbon specific emissions both decreased as the ignition timing was increased because of the higher temperatures

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