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Performance and Emission Characteristics on Glow Plug Hot Surface Ignition C.I. Engine Using Methanol as Fuel with Additive

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***Abstract*— The concept of using alcohol fuels as alternative to diesel fuel in diesel engine is recent one. The scarcity of transportation petroleum fuels due to the fast depletion of the petroleum deposits and frequent rise in their costs in the international market have spurred many efforts to find alternatives. Alcohols were quickly recognized as prime candidates to displace or replace high octane petroleum fuels. Innovative thinking led to find varies techniques by which alcohol can be used as fuel in diesel engine. Amongst the fuel alternative proposed, the most favourest ones are methanol and ethanol. The specific tendency of alcohols to ignite easily from a hot surface makes it suitable to ignite in a diesel engine by different methods. The advantage of this property of alcohols enables to design and construct a new type of engine called surface ignition engine. Methanol and ethanol are very susceptible to surface ignition, this method is very suitable for these fuels. The hot surfaces which, can be used in surface ignition engine are electrically heated glow plug with hot surface. Hence present research work carries the experimental investigation on glow plug hot surface ignition engine, by adding different additives with methanol and ethanol as fuels, with an objective to find the best one performance, emission and compression parameters.**

***Index Terms*— *GHCSI,* Ethanol*, Low Heat Rejection,* PSZ Additive (Iso amyl nitrate).**

I. INTRODUCTION

Transportation fuels, which can be derived from non-crude oil resources, include Methanol, Ethanol, Natural gas, Liquefied petroleum gases (LPG), and Hydrocarbons (from coal and shale). Each of these fuels has advantages and disadvantages associated with cost, availability, environmental impact, engine and vehicle modifications required safety, and customer acceptance. Ethanol has been widely used as gasohol, a mixture of 90% gasoline and 10% Methanol, as transportation fuels for pickup trucks, especially in the Southwest US. LPG has been used as an alternative fuel for a longer continuous period of time than either Methanol or Natural gas. Although no effort has been made in the US by vehicle manufacturers to develop an optimized LPG engine, Chrysler [1] Canda has developed an engine for use in an LPG – fueled van. The US Department of Energy (DOE) is presently supporting research in this area.

II. EXPERIMENTAL WORK

The single cylinder, four strokes 5.2kW Kirloskar, water-cooled DI diesel engine with a bore of 87.5 mm and stroke of 110 mm and a compression ratio of 17:1 is used for the experiment. The engine load is applied with eddy current dynamometer. For the reduction of heat to the cooling water .the plain engine is modified by fitting with a PSZ coated cylinder head and liner. Then the existing aluminum piston is replaced by a copper piston crown with an air gap. These air gap surfaces are coated with PSZ. These tests are conducted with Methanol as fuel in GHSI engines as usual.

The experiments are carried out on the plain engine with the copper piston crown material with or without additive on GHSI engine and in LHR engine using Methanol as fuel to determine the performance, emissions and the combustion parameters which are presented below

Fig1.1 Experimental setup of GHSI LHR Engine Test rig

III. .RESULTS AND DISCUSSION

A. Methanol Operation in GHSI LHR Engine

The experiments are carried out on the plain engine with the copper piston crown material with or without additive (Iso amyl nitrate) on GHSI engine and in LHR engine using Methanol as fuel to determine the performance, emissions and the combustion parameters which are presented below.

B. Brake Thermal Efficiency

The variation of brake thermal efficiency with brake power output is illustrated in figure 1.2.

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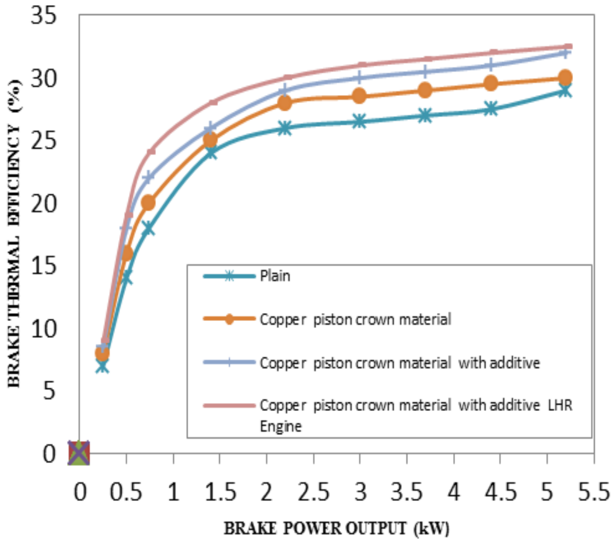
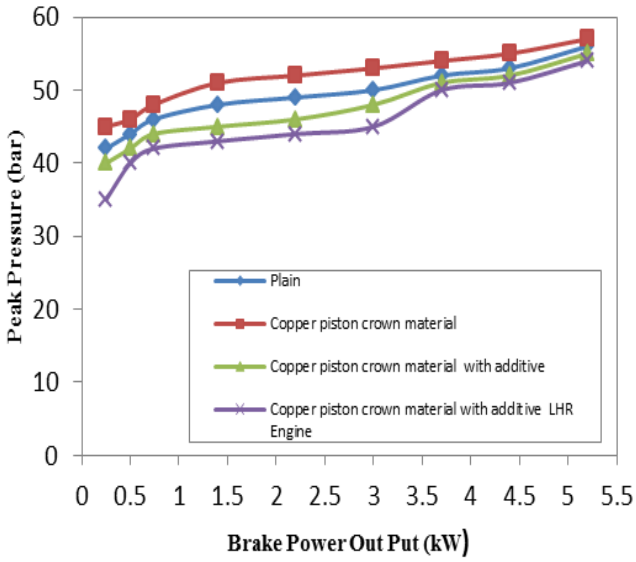


The brake thermal efficiency of copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine shows maximum efficiency over a wide range of operation. The brake thermal efficiencies of copper piston crown material GHSI engine with and without additive are found to be closely following the plain GHSI engine. The plain GHSI engine indicates minimum performance as compared to other above configurations. The percentage improvement for the copper piston crown material GHSI engine with additive in LHR engine over the plain engine is 6% at rated load. This is due to the positive ignition of the injected Methanol spray under all conditions by the ceramic glow plug. The improvement with glow plug with copper piston crown material additive is multiplied by the ability of the LHR engine to prepare the injected Methanol spray into a readily combustible mixture within very short time. The hotter combustion chamber of the copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine is instrumental in preparing the Methanol spray.

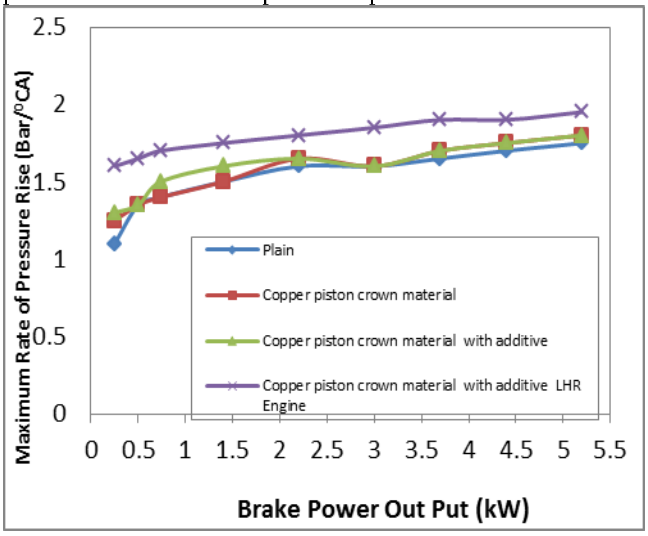
C. Peak Pressure and Maximum Rate of Pressure Rise

Figure 1.3 shows the variation of peak pressure with brake power output.



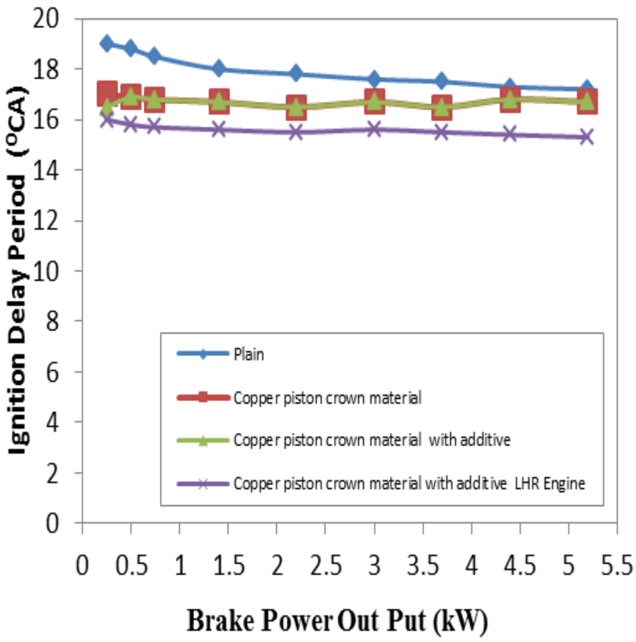
The peak pressure for plain GHSI engine is lower compared to the copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine. The copper piston crown material GHSI engine with additive in LHR engine at rated load shows higher peak pressure and is about 62 bar.

Figure 1.4 illustrates the variation of the maximum rate of pressure rise with brake power output.



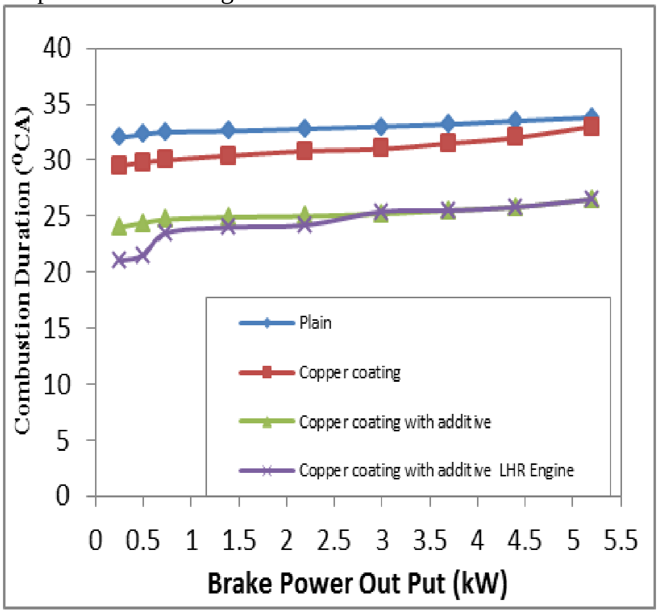
It is found that the maximum rate of pressure rise is higher for copper piston crown material GHSI with additive in LHR engine when compared with plan GHSI engine. It is the highest for copper piston crown material CHSI engine with additive (Iso amyl nitrate) in LHR engine and is about 46% at rated load.

Figure 1.5 illustrates the variation of ignition delay with brake power output.



The ignition delay is observed to be highest for the plain GHSI engine. The reduction in ignition delay for copper piston crown material GHSI with additive(Iso amyl nitrate) in LHR engine over plain GHSI engine is about 2.2^{0}CA. This is due to hotter combustion chamber of the LHR engine. Therefore the operation of LHR engine is smother as compared to the plain engine.

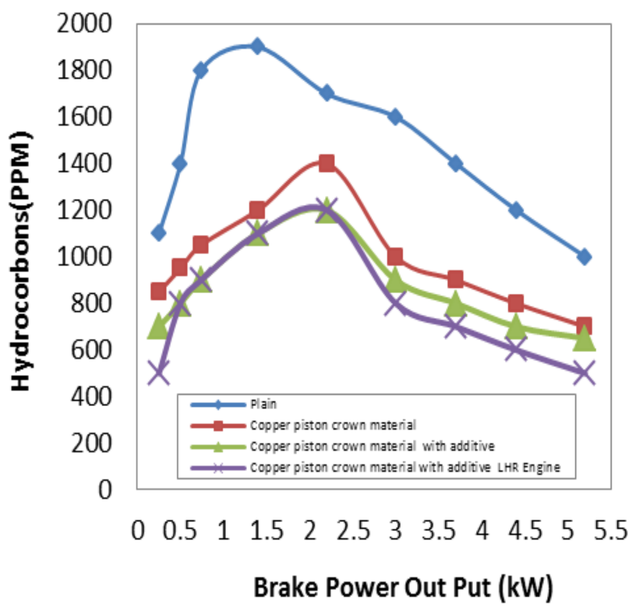
The variation of combustion duration with brake power output is shown in figure 1.6.



There is only a marginal variation in combustion duration between the various modes of operation. The copper piston crown material GHSI engine with additive (Iso amyl nitrate) in LHR engine shows the shortest combustion duration as compared to the plain GHSI engine. The combustion duration of copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine is shorter by 4.2^{0}CA at rated load when compared to plain GHSI engine.

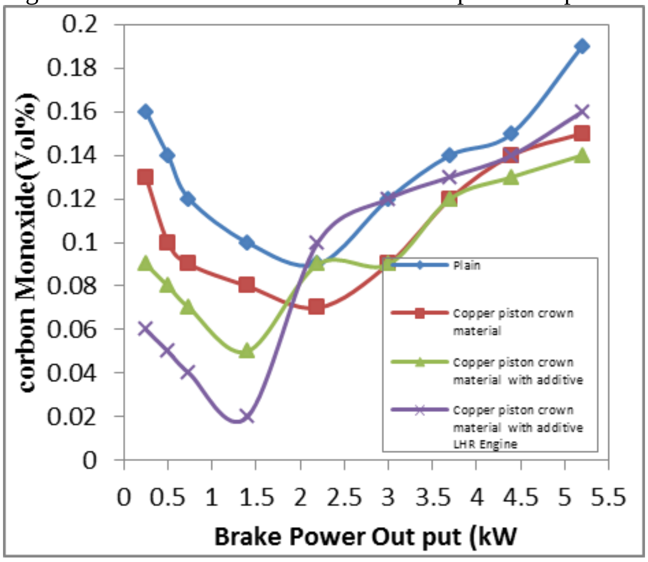
D. Exhaust Emission

The HC emission levels for plain GHSI engine and copper piston crown material with additive in GHSI and in LHR engines are shown in figure 1.7.



It is observed that the copper piston crown material GHSI with additive in LHR engine shows a maximum reduction in HC emission level when compared to plain GHSI engine. The reduction in HC emission level over the corresponding plain GHSI engine is about 380 ppm at the rated load.

Figure 1.8 shows the variation of CO with power output.



The copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine indicates the lower level of CO emissions when compared to the plain GHSI engine and about 7% by volume at rated load. The reeducation is more pronounced at rated loads than at part loads.

IV. CONCLUSIONS

The following conclusions are drawn with Methanol operated GHSI with additive (Iso amyl nitrate) in LHR engine.

1. It is found that due to better combustion the maximum percentage improvement for the copper piston crown material GHSI with additive in LHR engine over the plain engine is 6%.
2. Reduced ignition delays, lower combustion duration, higher peak pressure and higher rates of pressure rise are noted for the copper piston crown material GHSI engine with additive in LHR engine.
3. This must be due to the better vaporization of injected fuel in a shorter time. For copper piston crown material GHSI with additive in LHR engine, the ignition delay is lower by 2.2^{0}CA.
4. The increase in peak pressure level is 62 bar, the maximum rate of pressure rise increase by 46% at rated load and the combustion duration is shorter by 4.2^{0}CA. Hence copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine is smoother.
5. It is found that, the emission levels are lower with copper piston crown material GHSI with additive (Iso amyl nitrate) in LHR engine.
6. The LHR engine indicates lower level CO emissions and is about 7%. The maximum reduction in HC level over the corresponding plain GHSI engine is about 380 ppm.

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