Performance & Emission Characteristics of a Linseed Oil Fueled Ceramic Coated Head LHR Engine

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Abstract: The rapid growth in automotive industry is placing a limit on usage of fossil fuels and demanding for the search of alternative fuels to fossil fuels. Linseed oil is considered as one of the alternative fuels to diesel. Experiment are conducted to evaluate the performance of LinseedOil (L) on ceramic coated cylinder head Low Heat Rejection (LHR) engine for various injection pressures. The comparison with diesel fuel has shown increase in Brake Specific Energy Consumption (BSEC), Exhaust Gas Temperature (EGT), Smoke Levels (SL) and decrease in Brake Thermal Efficiency (BTE), Volumetric Efficiency (VE), Air Fuel ratio (A/F)
Keywords: Linseed oil, low heat rejection, Brake Specific Energy Consumption, Volumetric Efficiency

I. INTRODUCTION

The rapid growth in automotive industry, fast depletion and steep hike in price of fossil fuels is placing a limit on usage of fossil fuels and demanding for the search of alternative fuels [1-4].Researchers conducted experiments on the use of vegetable oils as fuel on conventional engines(CE) and cited that the performance was poor, quoting the problems of high viscosity, low volatility and their polyunsaturated character. Efforts [6-12] for high viscosity problems by preheating and blending have been made and stated that there is a marginal improvement in performance. However, the problems of vegetable oil call for LHR diesel engine. The LHR engine minimizes heat loss to the coolant by providing thermal insulation in the path of the heat flow to the coolant. LHR engines are classified in to Low grade, Medium grade and High grade. Low grade engines employ ceramic coated insulation, Medium grade uses air gap piston and liner and High grade combination of the two. Hot Combustion chamber of LHR engine offers reasonable advantages for the efficient and effective combustion of non-edible vegetable oils on 100% replacement basis. Investigations on Low grade LHR diesel engines using Jathropha and Linseed oil with varied injection pressure and timing are reported in the literature [13-14]. Investigations on medium grade LHR engine were presented using Jatropa, Pongamia and Linseed oil [15-17].

In the present investigation on performance and emission characteristics of diesel engine with ceramic coated cylinder head Low grade LHR engine with Linseed oil with varied injector opening pressure are presented and shown compatible performance

II. EXPERIMENTAL SETUP

Fig. 1 gives the experimental setup employing the 5 hp conventional Kirloskar AV1 engine which has been used in the experimentation. A ceramic coated cylinder head is employed in experimentation. Partially stabilized zirconium (PSZ) of thickness 500 microns was coated by means of plasma coating technique. The rated output of the engine was 3.68 kW at a rated speed of 1500 rpm. The compression ratio was 16:1 and manufacturer's recommended injection timing and injection pressures were 31 $^{\circ}$bTDC and 190 bar respectively. The fuel injector had three-holes of size 0.25mm.The engine is coupled to an electrical dynamometer for power measurement. The brake power and exhaust gas temperature are measured with suitable instrumentation conventionally. The consumption of Linseed oil is evaluated by the burette arrangement. The various attachments of experimental set up are as follows.

1. Engine 2. Electrical dynamometer 3. Load Box 4. Orifice meter 5. U-Tube water manometer 6. Air box 7. Fuel Tank 8. Three way valve 9. Heater 10. Burette 11. Exhaust gas temperature indicator 12. AVL Smoke meter 13. NetelChromotographNOx Analyzer 14. Outlet jacket water temperature indicator 15. Outlet water flow meter 16 Piezo electric pressure transducer 17. Consol, 18 TDC encoder 19 Pentium personal Computer and 20. Printer

The experiments are conducted for variable loads like 0%, 20%, 40%, 60%, 80%, 90%, 100% of full load i.e. 13.7 Amp at rated speed of 1500 RPM with 3 different injection pressures 190 bar, 240 bar, 270 bar. Trials were carried out with pure diesel and Linseed oil at all loads and injection pressures. The engine was sufficiently warmed up and stabilized before taking all the readings. All the observations recorded were replicated thrice to get a reasonable value. The performance parameters such as Brake Thermal Efficiency (BTE), Brake Specific Energy Consumption (BSEC), Exhaust Gas Temperature (EGT) and Volumetric Efficiency (VE) andSmoke Levels (SL) are evaluated. These performance and emission parameters of oils are compared to those of pure diesel.

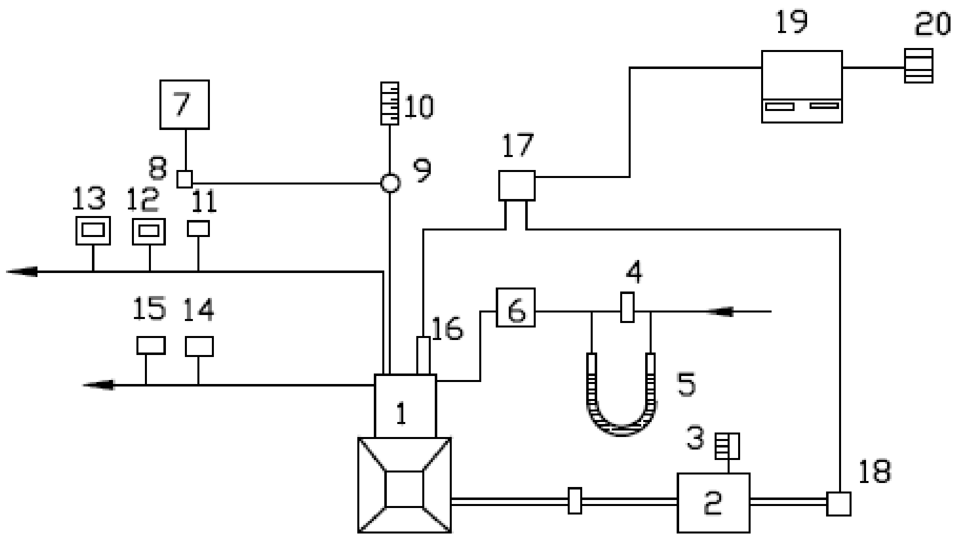

Fig.1 Experimental Setup

III. RESULTS AND DISCUSSION

The variation of BTE with BMEP is shown in Fig. 2. BTE for both versions of fuel is increased up to 80% of full load. It drops for further increase in load because of reduction of air fuel ratio. The BTE increased with increase in injection pressure in both oils of LHR engine. The improvement in BTE at high injection pressure was due to improved fuel spray characteristics. The linseed oil showed reduced performance at all loads when compared to pure diesel oil owing to the lower calorific value and high viscosity of linseed oil compared with diesel fuel.

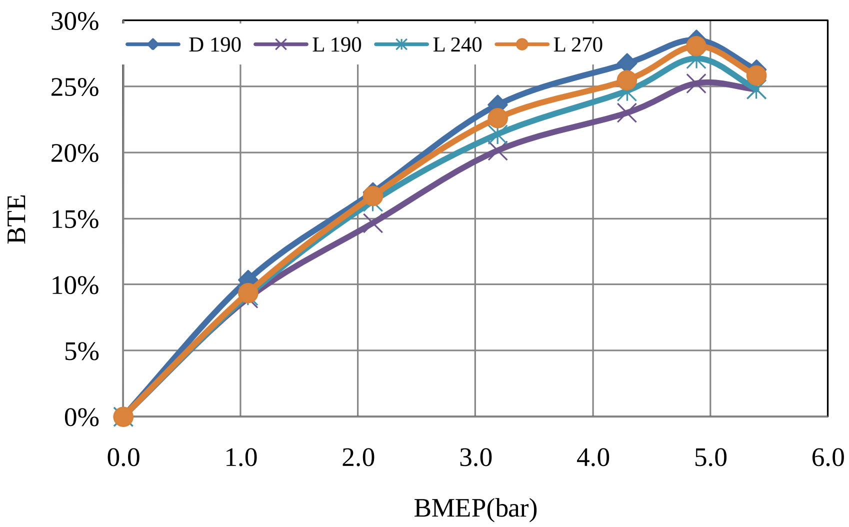

Fig.2. Variation of Brake Thermal Efficiency (BTE) with BMEP

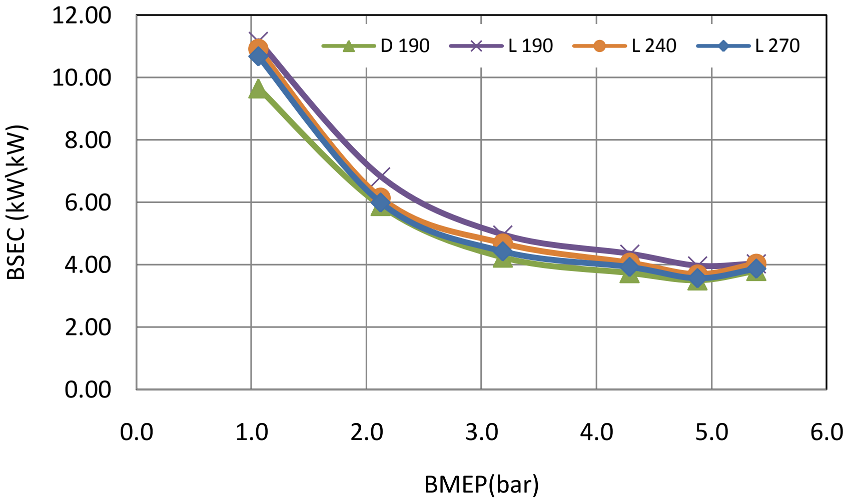

Fig.3 Variation of Brake Specific Energy Consumption (BSEC) with BMEP

From Fig.3 it is evident that BSEC with BMEP is reduced with the increase of injection pressure. This may be due to initiation of combustion and with improved spray characteristics. FromFig.4, it is observed that Volumetric Efficiency (VE) decreases with an increase of BMEP for both the fuels. This was due to increase of gas temperature with the load. Volumetric Efficiency (VE) increased with the increase of injection pressure for linseed oil. This was due to better fuel spray characteristics and evaporation at higher injection pressure leading to marginally increase of Volumetric Efficiency (VE). The Volumetric Efficiency (VE) of linseed oil is lower compared to diesel fuel because of high wall temperatures due unburnt fuel concentrations of linseed oil in operation.

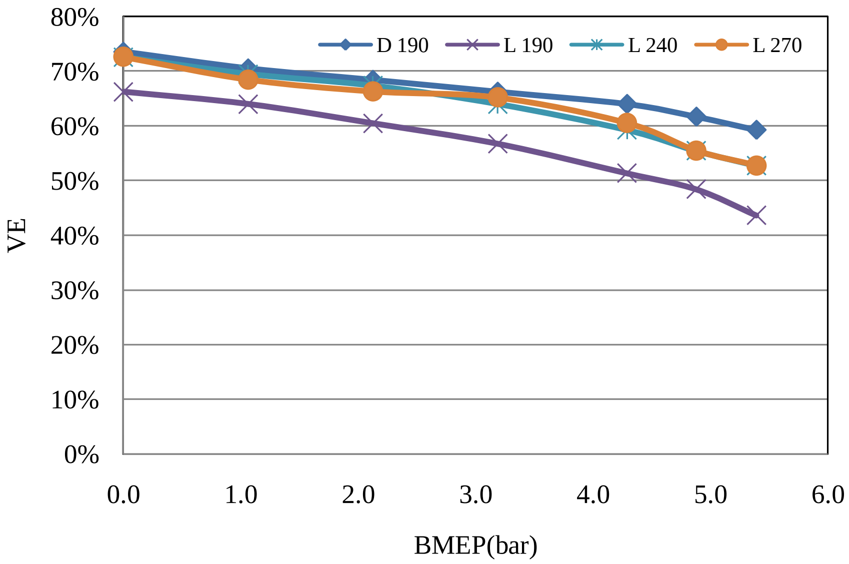

Fig. 4 Variations of Volumetric Efficiency (VE) with BMEP

From the Fig. 5. Higher EGT for linseed oil compared with pure diesel operation. Lower heat release rates and retarded heat release associated with high specific energy consumption caused increase in EGT. This was due to reduction of ignition delay in the hot environment with the provision of the insulation in the LHR engine, which caused the gases expanded in the cylinder giving higher work output and lower heat rejection. The magnitude at peak load decreased with advancing of injection pressure. It is evident that EGT decreased with increase in injection pressure of both oils of LHR engines, which confirmed that performance increased with increase of injection pressure.

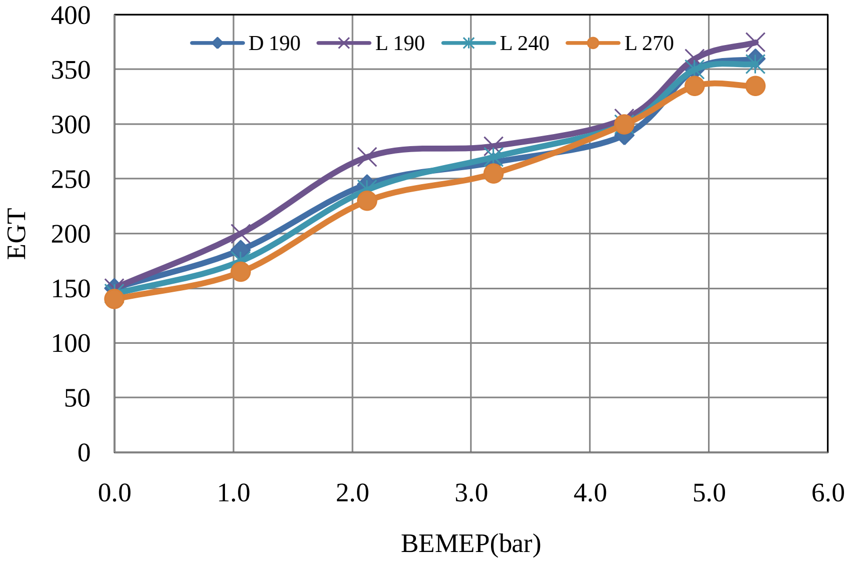

Fig.5 Variation of Exhaust Gas Temperature (EGT) with BMEP

From the Fig.6. It is observed that the Air Fuel ratio (A/F) decreases with increase in BMEP. This is due to increase in combustion chamber temperatures. Thereby, reducing the incoming air. The Air Fuel ratio (A/F) of linseed oil increases with increase of injection pressure. This was due to increase of fuel spray characteristics and decrease of combustion chamber temperature there by the mass of intake air increases.

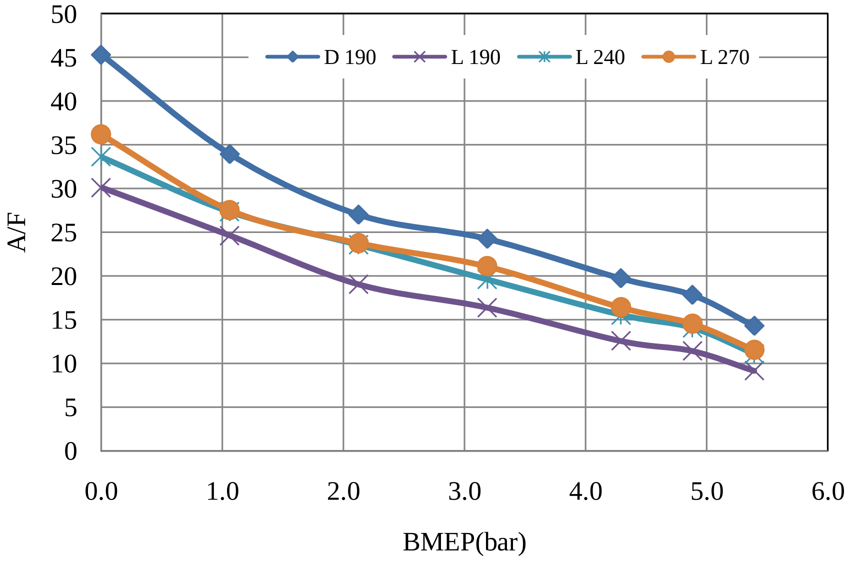

Fig.6. Variations of Air Fuel ratio (A/ F) with BMEP

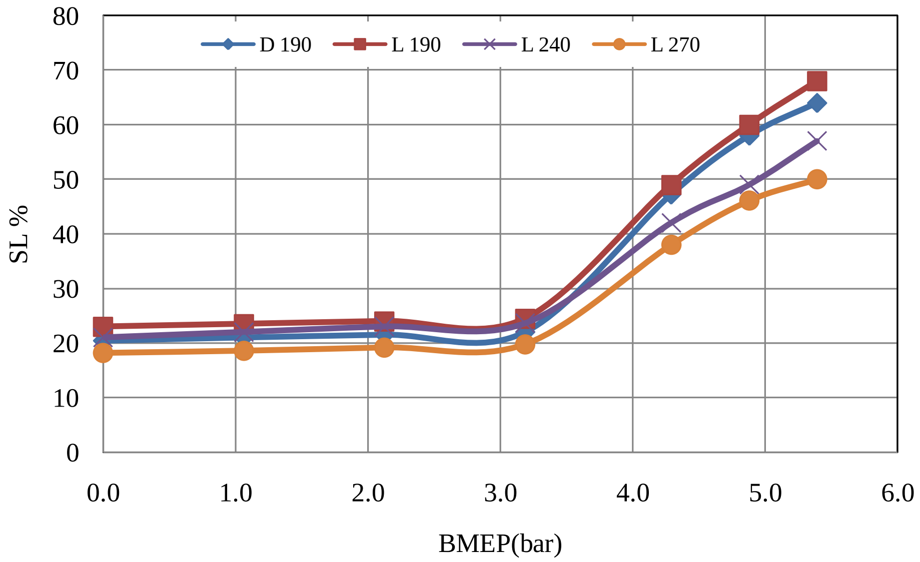

Fig.7. Variations of Smoke Levels (SL) with BMEP

Fig.7. Indicates that the values of smoke intensity increased from no load to full load in both fuels. Constant variations were observed initially and abruptly increased with large variations in later portion. The abrupt rise in smoke level is due to less available of oxygen, causing decrease of air fuel ratio, leading to incomplete combustion, producing more soot density. The increase of Smoke Levels (SL) of linseed oil compared with pure diesel oil was due to the higher magnitude of the C/H ratio of linseed oil when compared with fuel diesel. The increase of Smoke Levels (SL) was also due to decrease of A/F ratio and Volumetric Efficiency (VE) with linseed oil compared with pure diesel operation. The Smoke Levels (SL) decreased with increase of injection pressure. This was due to improvement in fuel spray characteristics at higher injection pressures and increase of air entrainment causing low Smoke Levels (SL). Decreasing the fuel density tends to increase the spray dispersion and spray penetration.

IV. CONCLUSION

Experimental investigations on ceramic coated head LHR engine using linseed oil at 31° bTDC on LHR engine showed the deterioration in performance when compared with pure diesel operation on LHR Engine. The various parameter deviated at peak load with respect pure diesel at 190 bar are as follows.

- BTE decreased by 11.58%, 4.91%, 1.75 % at 190 bar, 240 bar, 270 bar injection pressures
- BSEC increased by 15.26%, 15.26%, 10.66% at 190 bar, 240 bar, 270 bar injection pressures
- VEdecreased by 9.92%, 1.36%, 1.36% at 190 bar, 240 bar, 270 bar injection pressure
- EGT increased by 4.17% at 190 bar and decreased by 1.4%, 6.9% at 240 bar, 270 bar injection pressure
- A/F increased by 33.5%, 25.82%, 20.18% at 190 bar, 240 bar, 270 bar injection pressure
- SL increased by 14.8%at 190 bar and decreased by 10.94%, 21.80% at 240 bar, 270 bar injection pressure

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