PERFORMANCE EVALUATION OF LHR ENGINE USING PALM STEARN METHYL ESTER OIL WITH A SELECTED CONFIGURATION OF PISTON GEOMETRY

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Abstract

Now a days for any country energy resourses in particular petroleum products have become important for its development. The products derived from crude oil continued to be the major and critical source of energy for transportation sector all over the world. For economic development of any country both industries and transportation sectors are very important for a growth of country like India. It is strongly depends on transportation and power generation. It is learnt that the fossil fuel are depleting at faster rate than expected. Hence the increasing demand of fossil fuel leads to exhaust of petroleum products in near future. In this connection the rising price of petroleum products and environmental concern lead to intensive studies on the use of alternative fuels. Any alternative fuel which find suitable as substitute to diesel is comparatively inferior to diesel in performance, emission and combustion characteristics. Hence there is a need to improve and optimize the fuel properties.

In the present work an attempt is made to improve the performance of CI diesel engine using Vegetable oil ester. Hence in this work palm stern methyl ester is used with a modified piston geometry and LHR using concepts. The experiments are carried out on a 4-stroke single cylinder CI diesel engine of 5.2 KW. The experiments are conducted repeatedly with diesel fuel and palm stern methyl ester. Since these oils have slightly longer ignition delay, The low heat rejection engine concept is used in this work. In order to convert the base engine has LHR engine the piston crown is coated with partially stabilized zirconium PSZ of 0.5 mm thickness. From the results it is observed that the modified piston geometry with LHR engine concept has considerably given superior all round performance.

Keywords: *LHR Engine, Stearn Methyl Ester Oil, Piston Geometry, Piston Geometry*

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1. INTRODUCTION

A serious objection to the use of vegetable oils as fuels in C.I engine is their high cost. At present, the market prices of vegetable oils are higher than that of diesel. However, it is anticipated that in due course the cost will be reduced as a result of developments in agricultural methods and oil extraction techniques. Even now it is possible in certain localities to purchase a number of non-edible oils at fairly low prices. Due to the wide variations in climate, soil conditions and competing uses of land, different nations have to consider different vegetable oils as potential fuels.

A number of vegetable oils have been tested all over the world to evaluate their performance in diesel engines. The main problems associated with the use of vegetable oils were high viscosity and poor volatility. In this connection different methods can be adopted to overcome these problems in using vegetable oils effectively. Some of them are preheating, transesterification with alcohols, blending with diesel/alcohol, use of semi adiabatic engine components, combustion chamber design, dual fuelling with gaseous and liquid fuels and use of additives.

The previous researchers were used different types of vegetable oils. Among them many are edible oils. Use of edible vegetable oils will in turn create shortage of food for consumption. Hence in this work an attempt is made to test the suitability of non-edible vegetable oil like palm stearn oil for diesel engines. The experiments are conducted after converting the vegetable oil into biodiesels through esterification. The physical and chemical properties this estrified vegetable oil is determined before testing the Performance, emission and combustion characteristics. To enhance some of these characteristics of base engine the modified configuration of piston is designed by considering experience of previous researchers and is used in LHR test engine[1-6].

Most suitable esterified vegitable oil is selected with a modified piston geometry. The choosen esterified vegitable oil and the piston are tested in LHR test engine. In this the configuration of modified piston is coated with partially stabilized zirconium (PSZ) and the insulation thickness employed in 0.5mm.The coating material, methodology and parameters selected are proven to be one of the best suitable sets of laboratory test engines. However their viscosity values are higher but can easily be overcome by heating them. Since these oils have slightly longer ignition delay, they are most suitable to use in low heat rejection engine. The PSME oil is tried in the LHR test engine[7-12].

2. RESULTS PERTAINING TO LHR ENGINE USING PALM STEARN METHYL ESTER OIL

The base engine is converted as LHR engine by providing insulator to the piston head. In this the modified piston choosen using PSME as fuel. The results obtained are processed to examine and evaluate the required parameters.

2.1. Brake Thermal Efficiency

Fig.1 shows the comparison of Brake Thermal Efficiency with engine output for methyl ester of Palm Stearn oil in Low Heat Rejection engine and Conventional engine. The Brake Thermal Efficiency of Palm Stearn Methyl Ester in low heat rejection engine is higher than that of diesel and Palm Stearn Methyl Ester in conventional base engine. This is because of cylinder temperature produced in low heat rejection engine, which in turn increases the combustion. The maximum efficiency of Palm Stearn Methyl Ester in the low heat rejection engine is about 34.12 against 30.82 of diesel fuel, where it is increased about11%.

2.2. Indicated Thermal Efficiency

The variation of Indicated Thermal Efficiency with Break Power for the modified piston geometry is shown in Fig. 2. It is observed that the indicated thermal efficiency obtained is maximum for Palm Stearn Methyl Ester in low heat rejection engine compared to standard base engine of using Palm Stearn Methyl Ester and diesel as fuel. The maximum efficiency obtained with Palm Stearn Methyl Ester in low heat rejection engine is about 37.01 where as with diesel fuel in conventional engine is about 33.73. This is due to improvement in the rate of combustion and heat release rate using the concept of adiabatic process by converting the base engine as low heat rejection engine.

2.3. Mechanical Efficiency

The graph is drawn between mechanical efficiency and engine output for diesel, PSME and PSMEL respectively as shown in Fig.3. It is observed that in both engines the mechanical efficiency is low at part load operations and then gradually increases as the engine output increases. The mechanical efficiency obtained for PSME in LHR engine is slightly higher than diesel in standard base engine at closer to rated load. This is due to proper flame propagation speed with respect to time.

2.4. Specific Fuel Consumption

The variation of specific fuel consumption with brake power is shown in Fig.4 for the modified piston geometry of both low heat rejection engine and base engine. It is learnt that the specific fuel consumption is comparatively low with Palm Stearn Methyl Ester of low heat rejection engine compared to both diesel and Palm Stearn Methyl Ester of base engine. Specific consumption of LHR engine is 0.254 lower than that of normal diesel engine at closer to rated load operation, this is due to reduced heat losses in the engine obtained with insulation provided for LHR engine.

2.5. Volumetric Efficiency

Fig.5 shows the comparison of volumetric efficiency with engine output for the modified piston geometry. It is learnt that volumetric efficiency is minimum with Palm Stearn Methyl Ester compared to other two cases. The general trend is that the volumetric efficiency drops with increase in power output. Hence in this case a large drop in volumetric efficiency is observed for this configuration of piston geometry at closer to rated load operation. Because of insulation combustion chamber temperature increases, there will be mere heat loss to incoming air, resulting a drop in volumetric efficiency.

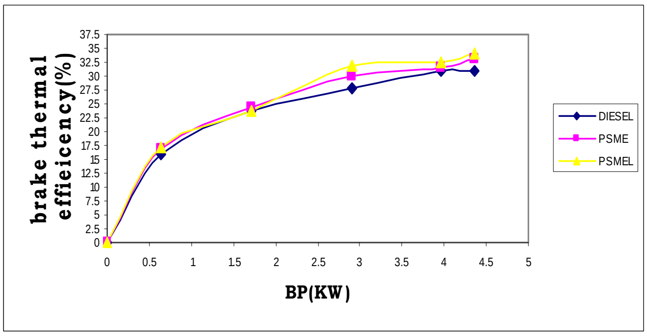

Fig.1. Break power vs brake thermal efficiency

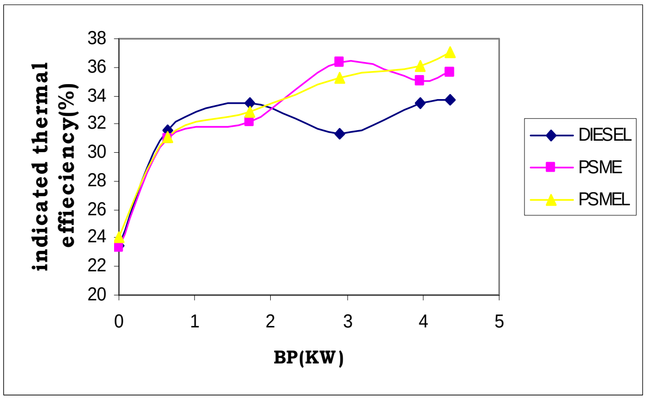

Fig.2 Break power vs indicated thermal efficiency

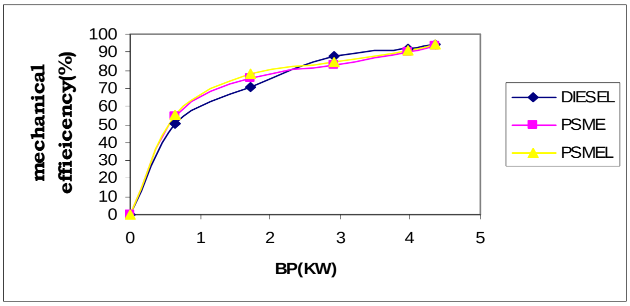

Fig.3 Break power vs mechanical efficiency

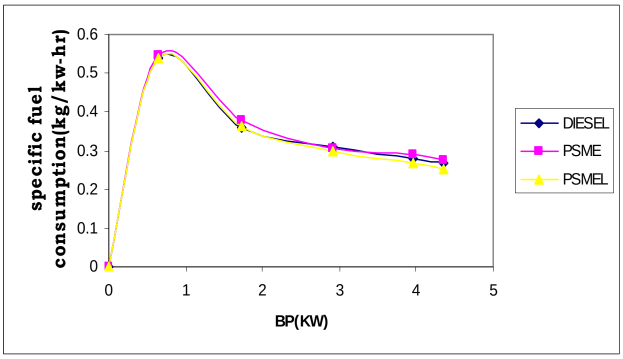

Fig.4 Break power vs specific fuel consumption

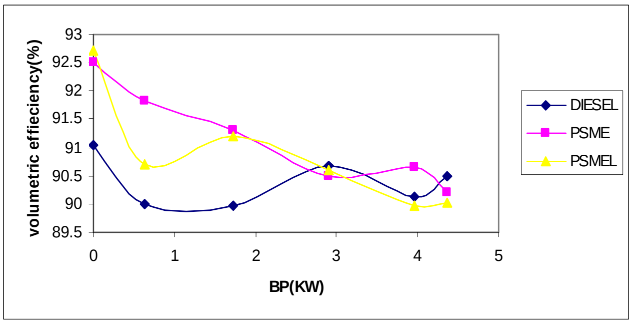

Fig.5 Break power vs volumetric efficiency

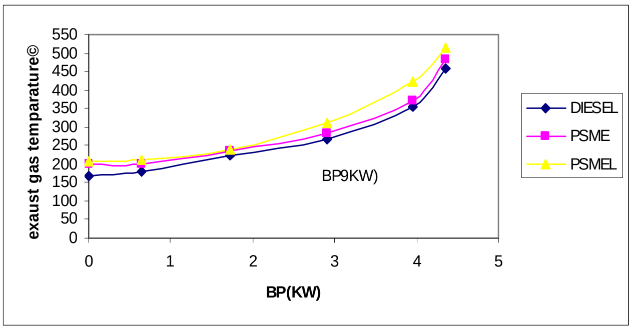

Fig.6 Break power vs exhaust gas temperature

3. CONCLUSIONS

In view of the plight of the energy crisis, in this work an attempt is made using alternative fuel in particular estrified vegetable oils as substitute fuels to diesel fuel. It is learnt that any kind of vegetable oil is inferior to diesel fuel in all aspects like performance, emission and combustion parameters. Hence in this work a modified piston geometry and LHR engine concepts have been used to enhance afore said parameters. The esterified vegetable oils used as substitute fuel to diesel are mutton tallow methyl ester (MTME), palm stearn methyl ester (PSME), safflower methyl ester (SME).

The important physical and chemical properties of the above oil is computed and tested with modified piston. In this connection the performance, emission and combustion characteristics are evaluated and also its suitability as alternate fuel to diesel is examined. After conducting a detailed experimentation a successful low heat rejection engine is developed which can run with PSME oil. In this work the following significant conclusions are drawn.

- For LHR engine the mechanical efficiency obtained is maximum and is almost equal to diesel. This is because of reduced heat losses in the engine obtained with insulation provided for LHR engine.
- The volumetric efficiency is further reduced for PSME in LHR engine and is about 89%. The general trend is that the volumetric efficiency drops with increase in power output. Because of insulation combustion chamber, the temperature increases due to heat loss to incoming air results a drop in volumetric efficiency.
- The EGT computed for PSME is moderate and is about 481.5^{0}C in a base engine. Whereas with LHR engine the EGT obtained is about 514.8^{0}C. The increase in the EGT with LHR engine is higher than the base engine and is about 6.07%. This is due to better and complete combustion process with in the stipulated time.
- From the investigations it is learnt that the SFC obtained is minimum for PSME fuel and is about 0.277 kg/kW-hr. The SFC for diesel is about 0.269 and is lower than PSME, which is about 3%. This is due to piston relative velocity between the air moment and injected fuel vapour.
- The SFC is further reduced in LHR engine compared to base engine and is about 5.5%. This is due to reduced heat losses in the engine obtained with insulation provided for LHR engine.
- The indicated thermal efficiency obtained with PSME in LHR engine is about 37%. Where as with diesel fuel in conventional engine is about 33.73%. This is due to enhancement of combustion rate and heat release rate using the concepts of adiabatic process in converting the normal engine as LHR engine.

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