EXPERIMENTAL INVESTIGATION OF LOW HEAT REJECTION WITH RETARDED INJECTION TIMING ON DIESEL ENGINE USING KARANJA OIL METHYL ESTER

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Abstract
Rising demand for fuel will now pose a significant risk for global pollution levels in various applications. The biodiesel of Karanja oil methyl ester (KOME), an alternative to diesel fuel, is a potential source of unspent fuel in India. Karanja oil contains fatty acid esters, which are environmentally friendly fuel. This experiment aimed to research low heat rejection using Karanja oil methyl ester with retarded injection timing diesel-fueled. The piston, cylinder walls, and engine valves were coated with a 0.5 mm thickness of partially stabilized zirconium (PSZ) without affecting the engine compression ratio. Experiments in the engine with and without coating were carried out using Karanja oil methyl ester. The results showed that Karanja oil methyl ester's specific fuel consumption at retarded timing (RT) with coated engine decreased by 7.4 percent and the brake thermal efficiency improved by 5.5 percent compared to the conventional engine with diesel fuel. CO and UBHC emissions on the LHR with RT engine are lower, whereas the zirconia coating has increased NOx emissions.

Keywords: Karanja oil methyl ester, Retarded timing, Low Heat Rejection, CO, UBHC, NOx

1. Introduction
Diesel engines are ideal for transport, power harvest and farm industries. There have been many studies into alternative fuels replacing fossil fuels [1]. Biodiesel made from various vegetable oils, such as Honge, Neem, rubber seed, Jatropha and Karanja was used as Diesel engine fuel. The Cetane Number (CN) marginally below the high-speed diesel fuel and energy value. The jet injection parameters have been studied to achieve the maximum power output from a naturally suctioned CI engine [2]. At high load operation, the injection time's progress increases spontaneous combustion with shorter combustion of the NOx emission. The delay of 11.4°bTDC injection time helps to burn in the middle of the chamber properly. The injection timing effect on combustion is studied along with the addition of nanoparticles in the fuel. Compression ignition (CI) engines with the combustion chamber coated using ceramic materials are called low heat rejection (LHR) engines [3]. An LHR engine can improve fuel efficiency by the regular non-utilized use of part of the heat energy. For chosen biodiesel combinations, several researchers used LHR engines. Isolation of the LHR engine decreases thermal transmission and leads to greater BTE and heat in exhaust gases. Due to its assertive isolation behaviour, comparable in thermal expansion to metals [4], partially stabilized zirconium (PSZ) has proven very successful in LHR engines. Higher plasma sprayed thermal coating thickness decreases the coating's longevity and involves modifying the coating structure [5]. Comprehensive research was carried out in the present study on a KOME to evaluate the performance, emission and combustion characteristics of coated with retarded injection timing.

2. Methods and Materials
2.1 Kanranja methyl ester preparation
The biodiesel and various diesel-biodiesel mixtures were tested for the fuel properties. On average, 1 litre Karanja oil produced 700 mL of Karanja methyl ester (biodiesel). The karanja coloured oil changed from deep brown to rody yellow after esterification. As biodiesel's percentage in the diesel/biodiesel combines increases, the mixtures' heat value decreases simultaneously [6]. With an increased percentage of biodiesel in fuel mixtures the burning point, fire point, cloud point and percentage point of diesel-biodiesel fuel mixtures rose. Vegetable oils have the same characteristics as diesel fuel. However, the use of straight vegetable oil leads to fuel injection, and it is hard to start, especially when the engine is cold. Straight vegetable oils can be processed chemically to improve its properties by naming them the methyl ester (ME) or biodiesel. Methyl ester (ME) is also known as fatty acid methyl ester (FAME). Remove unreacted methoxide present in raw methyl ester and purified by air-bubbling water washing process.

Table 1. Compared to ASTM biodiesel standards, the physical-chemical properties of test fuels.
2.2 Low heat rejection engine
In diesel engines, expanding ignition temperature improves performance and decreases emissions. It calls for combustion chamber components of materials that are more thermally obstructed. The coating of the ceramic components is one way to increase their higher thermal efficiency [8]. Higher ignition temperatures increase burning and thereby enhance the execution of electrical power emissions. The coatings also form a heated boundary for transportation of heat through the combustion chamber components. A little bit of all out energy is converted from burning into precious energy in the powerful combustion engine. Most of the energy is consumed from the cooling framework frame to guarantee engine components from overheating, corrosion, exhaust and other misfortunes. A reduction in the misfortunes already alluded to is the best way to expand the useful engine job. For instance, ceramically coated engines have a higher temperature in the combustion chamber than uncoated engines. The use of low quality energises is conceivable. Furthermore, the heat that is removed through the cooling frame decreases and thus, after pressure, the gas is higher in the combustion chamber [9]. Figure 1 (a). In this investigation, a partly stabilised zirconia of 0.5mm thick was coated in the test engine's cylinder head, valve, and piston.

Table:2 Properties of zirconia

<table>
<thead>
<tr>
<th>Property</th>
<th>Partially stabilized</th>
<th>Fully Stabilized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poisson ratio</td>
<td>0.24</td>
<td>0.24 - 0.33</td>
</tr>
<tr>
<td>Density (g.cm(^{-3}))</td>
<td>5.8 - 0.74</td>
<td>5.55 - 6.2</td>
</tr>
<tr>
<td>Specific Heat (J/kgK)</td>
<td>399</td>
<td>501</td>
</tr>
<tr>
<td>Hardness – Knoop (GPa)</td>
<td>10.2 – 11.5</td>
<td>11 - 16</td>
</tr>
<tr>
<td>Modulus of Rupture (MPa)</td>
<td>701</td>
<td>248</td>
</tr>
<tr>
<td>Thermal Conductivity (W/mK)</td>
<td>1.9 - 2.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Young’s Modulus (GPa)</td>
<td>206</td>
<td>101 - 201</td>
</tr>
</tbody>
</table>
3. Experimental setup

Figure 1 (b) the unit consists of a single, four-stroke, steady-speed cylindrical unit that is water-cooled, direct ignition, 16:5:1, produces 4.4 kW 1,500 rpm and a variable resistance generator. At 200 bar and the static injection, speed was 23°C BTDC, the engine's high pressure was assessed. The fuel level in the fuel tank, refresher water, oil level in the oil sump engine is checked before turning over. The engine was triggered and lifted. The engine speed was held at the measured speed. The force produced by the engine was determined by estimating the current and voltage. The thermocouple determined the cooling temperature. The cylinder pressure was calculated by the use of a piezo-electric weight sensor. The QROTECH gas analyzer measured the exhaust flow of, for example, CO, NOx and HC.

4. Results and Discussion

4.1 Brake Thermal Efficiency

The difference in the brake thermal efficiency of standard and LHR engines was shown in Figure 2. The figure illustrates that the full load's KOME brake thermal efficiency is 26.52, 25.03 and 29.20 percent for regular engines and retarded injection with ceramic coating. The Commission found that the partially stable Zirconia, brake thermal efficiency was more significant than the ceramic coating as a barrier to thermal transfer from the engine to the engine's atmosphere. The decrease in heat loss increasingly increases engine power and heat efficiency [10].

Fig. 1. a). Cylinder head and piston bowl; b). Experimental setup with exhaust gas recirculation
4.2 Brake Specific Energy Consumption
A good deal of useful energy is externally exhausted until the cooling and exhaust in the internal combustion engine are used. The disparity in the use of specific fuel energy for regular and LHR engines is presented in illustration 3. The KOME low-heat rejection fuel discharge was 5.63% and 3.21% lower in the retarded timer than regular Karanja Oil methyl ester (KOME), which was retarded in the injection period.

4.3 Exhaust gas temperature (EGT)
Figure 4 shows the EGT for standard engines and retarded timing with ceramic KOME coating are 135°C, 124°C and 164°C at no-load condition. It has 389°C, 364°C and 438°C at full loading operations. It can be noticed that the EGT in KOME fuelled low heat rejection at optimum load conditions the retarded timing engine was 18.64 percent increased and 13.27 percent higher than the standard retarded and injection time. Increasing the coated engine's exhaust gas temperature as a contrast with those without coating can be clarified by reducing the heat loss in the cooling system and passing this heat to the exhaust gas via a thermal barrier coating [11].
Conclusion

Experiments have been performed with a single, water-cooled direct injection and four-stroke diesel engine with and without clean diesel coating and Karanja oil methyl ester biodiesel. The following conclusions are taken based on the experimental findings. Karanja's specific fuel consumption is enhanced in comparison to diesel fuel, and the brake thermal efficiency is reduced. But the specific fuel consumption in the LHR engine is low, and the brake thermal efficiency is high compared with an uncoated engine. With the application of the ceramic coating in the engine, KOME showed a reduction in CO, HC and smoke emissions, with a penalty for increasing NOx emissions. Compared with diesel during the pre-combustion process, lower heating release rates of diesel-biodiesel (KOME) are observed.

Future studies are essential to examine impacts on different compression ratios and distinguish diesel and biodiesel combustion activity with differing EGR rates.

Reference


