Surface wear study of Rice Bran (R40) Biodiesel on Tribological Property of IC Engine Components

Dr. Venkata Sundar Rao K#1, Dr. Shreeprakash B#2

#1 Post Doctoral Fellow, Dept. of Mechanical Engineering, Srinivas University College of Engineering & Technology, Mangaluru-574146, India

#2 Professor & Head, Dept. of Mechanical Engineering, Srinivas University College of Engineering & Technology, Mangaluru-574146, India

Abstract

Bio fuels are chemical fuels as the fossil fuels and generate heat to perform mechanical work, hence, are the most desirable alternative to the fossil fuels. The surface roughness (Ra) values for piston, piston ring and cylinder liner of the engine is measured for both diesel (fossil fuel) and alternative fuel (blended 40% Rice bran oil + 60% Diesel). The use of diesel as a fuel has better tribological properties of the IC Engine components as compared to the blend of 60% Diesel + 40% Rice bran oil.

Keywords — Rice bran oil, Diesel, Surface roughness.

I. INTRODUCTION

The name internal combustion refers also to gas turbines except that the name is usually applied to reciprocating internal combustion (I.C.) engines like the ones found in everyday automobiles. There are basically two types of I.C. ignition engines, those which need a spark plug, and those that rely on compression of a fluid. Spark ignition engines take a mixture of fuel and air, compress it, and ignite it using a spark plug. The name ‘reciprocating’ is given because of the motion that the crank mechanism goes through. The piston-cylinder engine is basically a crank-slider mechanism, where the slider is the piston in this case. The piston is moved up and down by the rotary motion of the two arms or links. A lot of research work has been carried out using vegetable oil both in its neat form and modified form. The usage of vegetable oils in neat form is possible but not preferable. The high viscosity of vegetable oils and the low volatility affects the atomization and spray pattern of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. Methods such as blending with diesel, emulsification, pyrolysis and transesterification are used to reduce the viscosity of vegetable oils. Among these, the transesterification is the most commonly used commercial process to produce clean and environmentally friendly fuel.

II. LITERATURE REVIEW

Wang Wenzhong, HU Yuanzhong, WANG Hui & LIU Yuchuan [1] has found that Piston and piston ring lubrication is a factor that strongly affects the performance of the reciprocating internal combustion engine. Their work is based on a unified numerical approach assuming that the pressure distribution obeys Reynolds equation in hydrodynamic lubrication areas, while in asperities contact regions, the contact pressure can be obtained through the so-called reduced Reynolds equation.

Arka Ghosh [2] has worked on the essentials of combustion chamber, their design, influence in combustion process, timing, etc. They emphasize research on newer designs requirement for combustion chambers.

Balvinder Budania and Virender Bishnoi [3] developed “A New Concept of I.C. Engine with Homogeneous Combustion in a Porous Medium”. They have proposed a new combustion concept that fulfills all requirements to perform homogeneous combustion in I.C. engines using the Porous Medium Combustion Engine, called “PM - Engine”.

S. Jaichandar and K. Annamalai [4], have discussed the effect of use of biodiesel fuel on engine power, fuel consumption and thermal efficiency, data are collected and analyzed with that of conventional diesel fuel.

Maro JELIĆ and Neven NINIĆ [5] have discussed the “Analysis of Internal Combustion Engine
They used the numerical simulations in modeling the ICE engine processes together with the analysis by the second law of thermodynamics and got a very potent tool for better insight and optimization of spark- and compression-ignition engines achieving lower fuel consumption and lower emissions.

N.H.S.Ray, M.K.Mohanty and R.C.Mohanty [6] have worked on “Biogas as Alternate Fuel in Diesel Engines”. They reviewed the current status and perspectives of biogas production, including the purification & storage methods and its engine applications. Lower hydrocarbon (HC), smoke and particulates emission has been reported in diesel engines operating on biogas diesel dual fuel mode.

C D Rakopoulos, E G Giakoumis, and D C Rakopoulos [7] have discussed the Study of the short-term cylinder wall temperature oscillations during transient operation of a turbo-charged diesel engine with various insulation schemes. The work investigates the phenomenon of short-term temperature (cyclic) oscillations in the combustion chamber walls of a turbocharged diesel engine during transient operation after a ramp increase in load. The investigation reveals many interesting aspects of transient engine heat transfer, regarding the influence that the engine wall material properties have on the values of cyclic temperature swings.

Er. Milind S Patil, Dr. R. S. Jahagirdar, and Er. Eknath R Deore [8] have worked on Performance Test of IC Engine Using Blends of Ethanol and Kerosene with Diesel. They used 3.75 kW diesel engine, AV1 Single Cylinder water cooled, Kirloskar make, to test blends of diesel with kerosene and Ethanol. This paper presents a study report on the performance of IC engine using blends of kerosene and ethanol with diesel with various blending. Parameters like speed of engine, fuel consumption and torque were measured at different loads for pure diesel and various combination of dual fuel. Break Power, BSFC, BTE and heat balance were calculated.

III. METHODOLOGY
In the present study, the mechanical property viz., the wear of the piston, piston ring and cylinder liner is investigated. The experiments have been conducted using diesel and then the fuel is blended with Rice bran oil. The duration of test is considered for 2 hours, 4 hours and 6 hours run of the engine. The corresponding readings of surface roughness (Ra) values of the piston, piston ring and cylinder liner have been recorded by using the surface measurement test equipment.

IV. RESULTS AND DISCUSSION
The results of the test using Rice Bran (R40) Bio diesel have been tabulated for the Ra values considering the conditions of 100% Diesel (B0) and blend of 60% Diesel + 40% Rice Bran oil (R40) and the positions of the measurements for different components of the IC Engine are as follows;

a. Cylinder liner – five circumferential points at TDC, MID, BDC positions.
b. Piston – two positions on the TDC, two positions on the land and two positions on the skirt.
c. Piston ring - five circumferential points for two compression rings.

The comparison of the Ra values is done to investigate the surface roughness of the IC Engine components considered for the study. The duration of the test considered is 2 hours, 4 hours and 6 hours running of IC Engine.

The data pertaining to the Ra values for Cylinder liner positions are tabulated in Table 1. The average of five circumferential measurement points is taken to plot the variation of Ra values and is shown in the Figure 1.

<table>
<thead>
<tr>
<th>Cylinder Liner Positions</th>
<th>2 Hrs (B0)</th>
<th>2 Hrs (R40)</th>
<th>4 Hrs (B0)</th>
<th>4 Hrs (R40)</th>
<th>6 Hrs (B0)</th>
<th>6 Hrs (R40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liner TDC</td>
<td>0.415</td>
<td>0.51</td>
<td>0.469</td>
<td>0.523</td>
<td>0.37</td>
<td>0.513</td>
</tr>
<tr>
<td>Liner MID</td>
<td>0.204</td>
<td>0.299</td>
<td>0.244</td>
<td>0.289</td>
<td>0.27</td>
<td>0.381</td>
</tr>
<tr>
<td>Liner BDC</td>
<td>0.694</td>
<td>0.595</td>
<td>0.785</td>
<td>0.590</td>
<td>0.573</td>
<td>0.599</td>
</tr>
</tbody>
</table>
Figure 1 Comparison of $R_a$ values for Cylinder liner positions (B0 and R40)

From the above figure, it can be concluded that $R_a$ value of 0.204 microns is minimum at Cylinder liner MID–2Hrs run with Diesel (B0).

The data pertaining to the $R_a$ values for piston are tabulated in Table 2. The average of two measurement points is taken to plot the variation of $R_a$ values and is shown in the Figure 2.

Table 2 $R_a$ values for piston positions (B0 and R40)

<table>
<thead>
<tr>
<th>Piston Positions</th>
<th>2 Hrs (B0)</th>
<th>2 Hrs (R40)</th>
<th>4 Hrs (B0)</th>
<th>4 Hrs (R40)</th>
<th>6 Hrs (B0)</th>
<th>6 Hrs (R40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston TDC</td>
<td>0.566</td>
<td>0.598</td>
<td>0.478</td>
<td>0.391</td>
<td>0.37</td>
<td>0.312</td>
</tr>
<tr>
<td>Piston Land</td>
<td>0.366</td>
<td>0.350</td>
<td>0.243</td>
<td>0.240</td>
<td>0.27</td>
<td>0.260</td>
</tr>
<tr>
<td>Piston Skirt</td>
<td>0.652</td>
<td>0.607</td>
<td>0.236</td>
<td>0.230</td>
<td>0.573</td>
<td>0.315</td>
</tr>
</tbody>
</table>
From the above figure, it can be concluded that $R_a$ value of 0.230 microns is minimum at Piston skirt—4Hrs run with blend of 60% Diesel + 40% Rice Bran oil (R40).

The data pertaining to the $R_a$ values for piston rings are tabulated in Table 3. The average of two measurement points is taken to plot the variation of $R_a$ values and is shown in the Figure 3.

Table 3 $R_a$ values for piston rings (B0 and R40)

<table>
<thead>
<tr>
<th>Piston Rings</th>
<th>$R_a$ values in microns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 Hrs (B0)</td>
</tr>
<tr>
<td>Ring 1</td>
<td>0.73</td>
</tr>
<tr>
<td>Ring 2</td>
<td>0.65</td>
</tr>
</tbody>
</table>
From the above figure, it can be concluded that $R_a$ value of 0.086 microns is minimum for piston ring1–6Hrs run with Diesel (B0).

V. CONCLUSIONS

The wear test reveal the effect of the combustion of diesel and blend of 60% Diesel+ 40% Rice bran oil on the wear of the materials of the IC Engine components viz., piston, piston rings and cylinder liner. The use of diesel as a fuel has better tribological properties of the IC Engine components as compared to the blend of 60% Diesel+40% Rice bran oil.

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