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Surface Wear Study of the IC Engine Components for the Blend of Rice Bran Biodiesel

Dr. Venkata Sundar Rao K. (Post Doctoral Fellow), Professor & Head Dr. Shreeprakash B.
Dept. of Mechanical Engineering
Srinivas University College of Engineering & Technology
Mangalur, India.

Abstract- **Driven by oil price and consumption, engine emissions and climate change, along with the lack of sustainable fossil fuels, transportation sector has generated an interest in alternative, renewable sources of fuel for internal combustion engines. 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. But the existing design of the combustion engines must sustain the same operating parameters, material strength of the different components and emission of the engine as that of the fossil fuel run engine. 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 20% Rice bran oil + 80% Diesel).The use of diesel as a fuel has better tribological properties of the IC Engine components as compared to the blend of 80% diesel+ 20% Rice bran oil.**

Keywords- **Alternative fuels, Rice bran oil, Diesel, Surface roughness.**

I. INTRODUCTION

An **Internal Combustion Engine** (**ICE**) is a heat engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine.

There are several researches undergoing to study the performance of the engines using well-known alternative fuels such as hydrogen, acetylene, natural gas, ethanol and biofuels in internal combustion engines. Alternative fuels such as hydrogen, acetylene, natural gas, ethanol and biofuels are also used in internal combustion engines. The liquid fuels have over the past 100 years evolved as the fuels of choice for transport because of their high energy density and the ease of transport, storage and handling. Conventional fuels are complex mixtures that typically contain more than hundred chemical components whose composition has changed and evolved over time and in connection to engine development. The development has been done in correlation with and in order to meet the engine development demand on power, efficiency and drivability.

The mechanical properties of the materials used for the IC Engine components are considered to be the main objective of the studies to understand the effect of blending the alternative fuels with fossil fuels. However, the fuel in an internal combustion engine undergoes other processes and passes many systems before it is burned, and these also have to be considered. All the systems will influence the fuel and the fuel's different properties will influence the systems. The major part of all energy consumed worldwide comes from fossil sources (petroleum, coal and natural gas). However, these sources are limited, and will be exhausted by the near future. Thus, looking for alternative sources of new and renewable energy, such as hydro, biomass, wind, solar, geothermal, hydrogen and nuclear is of vital importance. Alternative new and renewable fuels have the potential to solve many of the current social problems.

II. LITERATU REREVIEW

The review of research work on alternative fuels and combinations on the wear of the Piston, Piston Rings and Liners has been carried out. After going through the review, the objectives of the present research work have been implemented by setting up experimental test rig. Some of the contributions have been discussed in the following paragraphs.

N.H.S.Ray, M.K.Mohanty and R.C.Mohanty [1] 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 [2] 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 [3] 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 ratio. Parameters like speed of engine, fuel consumption and torque were measured at different loads for pure diesel and various combinations of dual fuel. Break Power, BSFC, BTE and heat balance were calculated. The paper represents the test results for blends ranging from 5% to20%.

M. Lackner, F. Winter [4] have discussed the Laser Ignition in Internal Combustion Engines. Laser ignition tests were performed with the fuels hydrogen and biogas in a static combustion cell and with gasoline in a spray-guided internal combustion engine.

A Nd:YAG laser with 6 ns pulse duration, 1064 nm wavelength and 1-50 mJ pulse energy was used to ignite the fuel/air mixtures at initial pressures of 1-3 MPa. Compared to a conventional spark plug, a laser ignition system should be a favorable ignition source in terms of lean burn characteristics and system flexibility. There are several problems remain unsolved, e.g. cost issues and the stability of the optical window.

Sutaria B.M, Bhatt D.V and Mistry K.N [5] worked on study of basic tribological parameters that influences performance of an internal combustion engine. A mathematical model is developed using average Reynolds equation. Study is performed on 150cc, 2 Stroke Internal Combustion Engine. The Oil Film Thickness (OFT), piston friction forces (PFF), and Ring friction variations are simulated under different variables i.e engine speed, lubricants and different ring geometry. The simulated results of piston friction force, ring friction force and oil film thickness are compared with published literature.

Wang Wenzhong, HU Yuanzhong, WANG Hui& LIU Yuchuan [6] 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 regions while in asperities contact regions, the contact pressure can be obtained through the so-called reduced Reynold's equation.

Arkaghosh [7] 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 [8] developed a new concept of I.C. engine, with homogeneous combustion in a porous medium. They have proposed a new combustion concept that fulfils all requirements to perform homogeneous combustion in I.C. engines using the Porous Medium Combustion Engine, called "PM - engine".

III. METHODOLOGY

In the present work, 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 details of the study is given in the Table 1.

Table 1. Details of fuels used for the investigation.

Case No	% of Diesel	% of Rice bran Oil
1	100	0
2	80	20

The duration of test is considered for 2 hours, 4 hours and 6 hours run of the engine. The corresponding readings of surface roughness (R_a) values of the piston, piston ring and cylinder liner have been recorded by using the surface measurement test equipment shown in the Fig. 2. The measuring points considered at top dead center (TDC), bottom dead center (BDC) and mid of TDC and BDC (MID).

IV. RESULTS AND DISCUSSIONS

The results of the test have been tabulated for the R_a values considering the conditions of 100% diesel and blend of 80% Diesel + 20% Rice bran oil and the positions of the measurements for different components of the IC Engine are as follows;

- Cylinder Liner –Five Circumferential Points At TDC, MID, BDC Positions
- Piston–Two Positions On The TDC, Two Positions On The Land And Two Positions On The Skirt
- Piston Ring -Five Circumferential Points For Two Compression Rings.

The comparison of the R_a values is done to investigate the wear 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 R_a values for cylinder liner are tabulated in Table II.

The average of five circumferential measurement points is taken to plot the variation of Ra values. The data pertaining to the Ra values for Cylinder liner are tabulated in Table 2.

Table 2. R_a values for Cylinder liner positions (B0 and R20).

Cylinder Liner Positions	R_a values in microns					
	2Hrs (B0)	2 Hrs (R20)	4Hrs (B0)	4Hrs (R20)	6Hrs(B0)	6Hrs (R20)
Liner TDC	0.415	0.421	0.469	0.381	0.37	0.305
Liner MID	0.204	0.218	0.244	0.256	0.27	0.224
Liner BDC	0.694	0.585	0.785	0.575	0.573	0.521

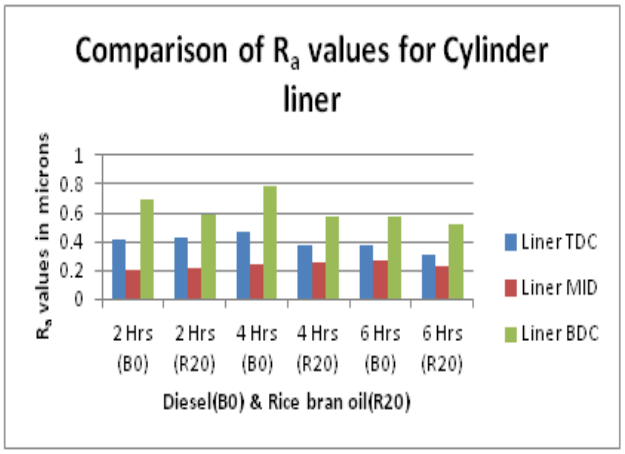

Figure 1. Comparison of R_a values for liner positions (B0 and R20).

From the Figure 1, 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 rings are tabulated in Table 3. The average of five circumferential measurement points is taken to plot the variation of R_a values and is shown in the Figure 2.

Table 3. R_a values for piston positions (B0 and R20).

Piston Positions	R_a values in microns					
	2 Hrs (B0)	2 Hrs (R20)	4 Hrs (B0)	4 Hrs (R20)	6 Hrs (B0)	6 Hrs (R20)
Piston TDC	0.566	0.881	0.478	0.845	0.37	0.586
Piston Land	0.366	0.268	0.243	0.421	0.27	0.532
Piston Skirt	0.652	0.487	0.236	0.384	0.573	0.373

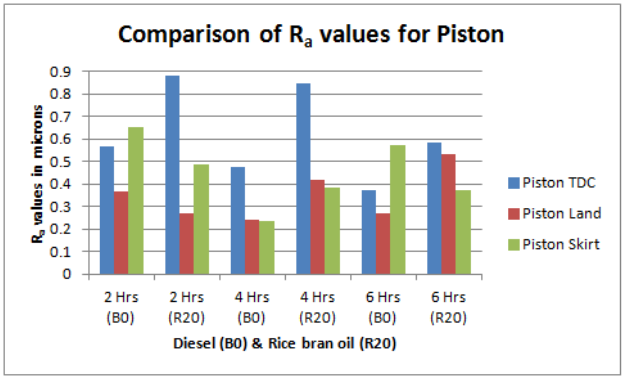

Figure 2. Comparison of R_a values for piston positions (B0 and R20).

From the Figure 2, it is observed that R_a value of 0.236 microns is minimum at Piston skirt position for 4 hours running of IC engine with Diesel (B0). The data pertaining to the R_a values for piston rings are tabulated in Table 4. The average of five circumferential measurement points is taken to plot the variation of R_a values and is shown in the Figure 3.

Table 4. R_a values for piston rings (B0 and R20).

Piston Rings	R_a values in microns					
	2 Hrs (B0)	2 Hrs (R20)	4 Hrs (B0)	4 Hrs (R20)	6 Hrs (B0)	6 Hrs (R20)
Ring 1	0.73	0.1	0.72	0.122	0.086	0.08
Ring 2	0.65	0.178	0.37	0.068	0.134	0.084

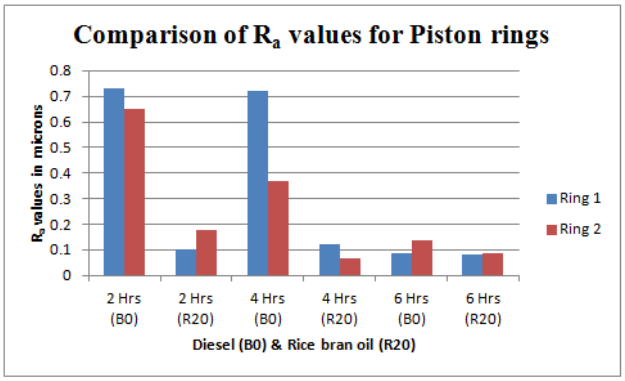

Figure 3. Comparison of R_a values for piston rings (B0 and R20).

From the Figure 3, it is observed that R_a value of 0.068microns is minimum for Piston Ring 2 and for 4 hours running of IC engine with blend of 80% Diesel + 20% Rice bran oil (R20).

V. CONCLUSIONS

The wear test reveals the effect of the combustion of diesel and blend of 80% Diesel+ 20% Rice bran oil on the wear of the materials of the IC Engine components viz., piston, piston rings and cylinder liner. In the present study, the surface roughness of the IC Engine components has been recorded for diesel and blend of 80% Diesel+ 20% Rice bran oil. The use of diesel as a fuel has better tribological properties of the IC Engine components as compared to the blend of 80% Diesel+ 20% Rice bran oil.

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