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Study of Effect of Different Biodiesel blends (60%Diesel + 40% Biodiesel) on Tribological Property of I.C. Engine components

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Abstract

The large increase in the number of automobiles has resulted in great demand for petroleum products in recent years. With crude oil reserves estimated to last only for few decades, there has been an active search for alternate fuels. The depletion of crude oil would have a major impact on the transportation sector. The internal combustion (I.C.) engine is a heat engine that converts chemical energy into mechanical energy. In the present study, the mechanical property viz., the wear of the Piston, piston ring, and cylinder liner are investigated. The test duration 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 using the surface measurement test. The measuring points are considered at the top dead center (T.D.C.), bottom dead center (BDC), and mid of T.D.C. and BDC (MID). The Ra values comparison is made to investigate the surface roughness of the I.C. Engine components considered for the study. The test duration is 2 hours, 4 hours, and 6 hours running of I.C. Engine. Blend of 60% Diesel + 40% Hippe oil has better lubrication properties than Diesel and other blends of biodiesel considered.

Keywords - *Diesel, Hippe oil, Surface roughness.*

I.INTRODUCTION

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 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. The crankshaft rotates, which makes the two links rotate. The Piston is encapsulated within a combustion chamber. The bore is the diameter of the chamber. The valves on top represent induction and exhaust valve necessary for the intake of an air-fuel mixture and exhaust of chamber residuals. The internal combustion (I.C.) engine is a heat engine that converts chemical energy into mechanical energy, usually made available on a rotating output shaft. The fuel's chemical energy is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine, and the high-pressure gas then expands against the engine's mechanical mechanisms. The engine's mechanical linkages convert this expansion to a rotating crankshaft, the engine's output. In turn, the crankshaft is connected to a transmission and power train to transmit the rotating mechanical energy to the desired final use. Much research has been carried out using vegetable oil both in its neat form and modified form. Studies have shown that the usage of vegetable oils in neat form is possible but not preferable. The high viscosity of vegetable oils and the low volatility affect 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 vegetable oils' viscosity.

II. LITERATURE REREVIEW

The review of research work on alternative fuels and combinations on Piston's wear, Piston Rings and Liners has been carried out. After going through the review, the present research work's objectives have been implemented by setting up an 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 engineering applications. Lower hydrocarbon (H.C.), smoke, and particulates emission have been reported in diesel engines operating on biogas diesel dual fuel mode.

C D Rakopoulos, E G Giakoumis, and DC Rakopoulos [2] have discussed the study of the short- term cylinder wall temperature oscillations during the transient operation of a turbocharged 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 exciting aspects of transient engine heat transfer regarding the influence that the engine wall material properties have on cyclic temperature swings' values.

Er. Milind S Patil, Dr. R. S. Jahagirdar, and Er. Eknath R Deore [3] has worked on the Performance Test of I.C. Engine Using Blends of Ethanol and Kerosene with Diesel. They used a 3.75 kW diesel engine, AV1 Single Cylinder water-cooled, Kirloskar Make to test Diesel's blends with kerosene and Ethanol. This paper presents a study report on the I.C. engine's performance using kerosene and Ethanol blends with Diesel with various blending ratios. Parameters like engine speed, fuel consumption, and torque were measured at different loads for pure Diesel and various combinations of dual fuel. Break Power, BSFC, B.T.E., 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 fossil fuel and biogas in a static combustion cell and gasoline in a spray-guided internal combustion engine.

An Nd: YAG laser with six 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 good ignition source in 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] studied basic tribological parameters that influence an internal combustion engine's performance. A mathematical model is developed using the average Reynolds equation. The 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& L.I.U. 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 the Reynolds equation in hydrodynamic lubrication regions. In contrast, in asperities contact regions, the contact pressure can be obtained through the so-called reduced Reynold's equation.

Arkaghosh [7] has worked on combustion chamber essentials, their design, influence in the combustion process, timing, etc. They emphasize research on newer designs requirement for combustion chambers.

Balvinder Budania [8] developed a new I.C. engine concept, 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."

III. METHODOLOGY

In the present study, the mechanical property viz., the wear of the Piston, piston ring, and cylinder liner are investigated. The test duration 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 using the surface measurement test. The measuring points considered at the top dead center (T.D.C.), bottom dead center (BDC), and mid of T.D.C. and BDC (MID).

IV. RESULTS AND DISCUSSION

The results have been tabulated for the R_a values considering the conditions of 100% Diesel (B0), blend of 60% Diesel + 40% Honge oil (H40), blend of 60%Diesel + 40% Hippe oil (M40), and blend of 60% Diesel + 40% Rice Bran oil (R40) and the positions of the measurements for different components of the I.C. Engine. The comparison of the R_a values is made to investigate the surface roughness of the I.C. Engine new components considered for the study. The test duration is 2 hours, 4 hours, and 6 hours running of I.C. Engine. The data about the R_a values for Cylinder liner positions are tabulated in Table 1. The average of circumferential measurement points is taken to plot the variation of R_a values and is shown in Figure 1.

Table 1 R_a Value for Cylinder liner with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

Cylinder Liner positions	R_a values in microns											
	2 Hrs (B0)	2 Hrs (H40)	2 Hrs (M40)	2 Hrs (R40)	4 Hrs (B0)	4 Hrs (H40)	4 Hrs (M40)	4 Hrs (R40)	6 Hrs (B0)	6 Hrs (H40)	6 Hrs (M40)	6 Hrs (R40)
Liner TDC	0.415	0.417	0.360	0.51	0.469	0.404	0.350	0.523	0.37	0.654	0.301	0.513
Liner MID	0.204	0.287	0.189	0.299	0.244	0.275	0.180	0.289	0.27	0.438	0.175	0.381
Liner BDC	0.694	0.586	0.561	0.595	0.785	0.570	0.554	0.590	0.573	0.724	0.502	0.599

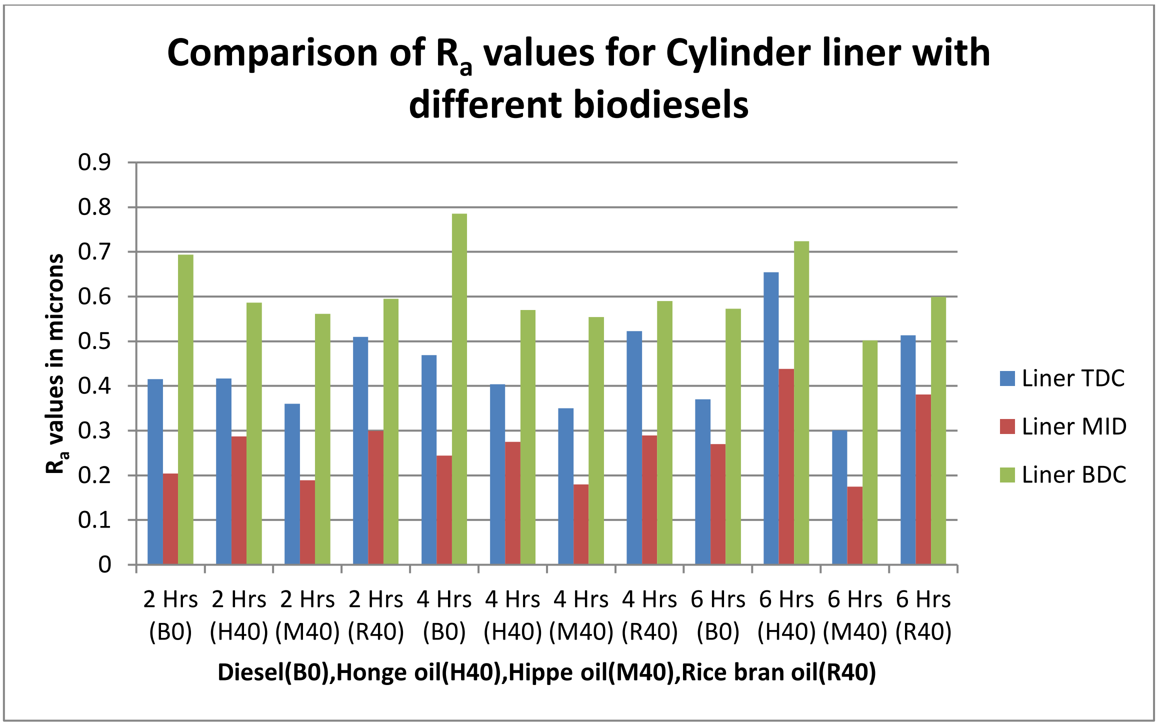

Figure 1 Comparison of R_a Value for a liner with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

The above figure shows that the Ra value of 0.175 microns is minimal at the cylinder liner MID position with 6 Hrs running with Hippe oil (M40). For M40 biodiesel, there is much improvement in the cylinder liner's tribological property compared to the other blends of biodiesel.

The data about 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 Figure 2.

Table 2 R_a Value for piston with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

Piston positions	R_a values in microns											
	2 Hrs (B0)	2 Hrs (H40)	2 Hrs (M40)	2 Hrs (R40)	4 Hrs (B0)	4 Hrs (H40)	4 Hrs (M40)	4 Hrs (R40)	6 Hrs (B0)	6 Hrs (H40)	6 Hrs (M40)	6 Hrs (R40)
Piston TDC	0.566	0.56	0.487	0.598	0.478	0.540	0.260	0.391	0.37	0.310	0.250	0.312
Piston Land	0.366	0.356	0.240	0.350	0.243	0.298	0.198	0.240	0.27	0.201	0.180	0.260
Piston Skirt	0.652	0.55	0.328	0.607	0.236	0.251	0.201	0.230	0.573	0.512	0.189	0.315

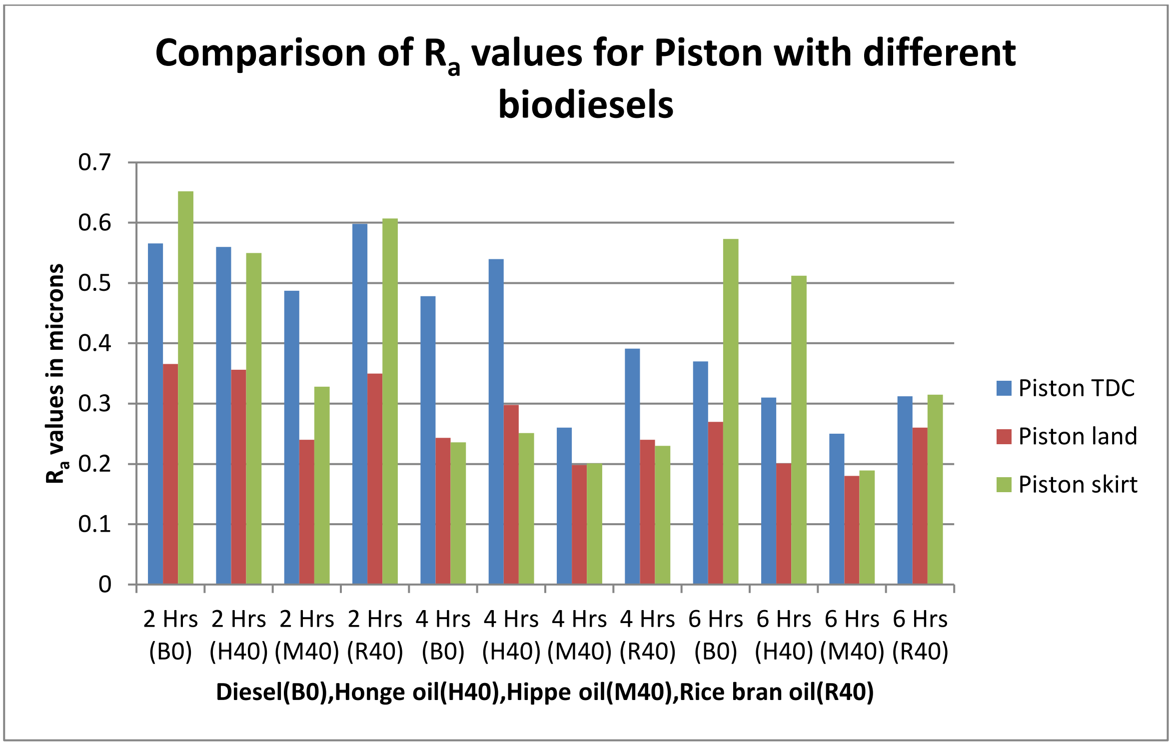

Figure 2 Comparison of R_a values for piston positions with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

From Figure 2, it can be concluded that the R_a value of 0.180 microns is minimum at Piston Land position with 6Hrs run with Hippe oil (M40). Using M40 biodiesel piston also showed an improved tribological property than the other blends of biodiesel considered.

The data about 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 Figure 3.

Table 3 R_a Value for piston ring with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

Piston Rings	R_a values in microns											
	2 Hrs (B0)	2 Hrs (H40)	2 Hrs (M40)	2 Hrs (R40)	4 Hrs (B0)	4 Hrs (H40)	4 Hrs (M40)	4 Hrs (R40)	6 Hrs (B0)	6 Hrs (H40)	6 Hrs (M40)	6 Hrs (R40)
Ring 1	0.73	0.18	0.08	0.27	0.72	0.28	0.31	0.20	0.086	0.32	0.042	0.20
Ring 2	0.65	0.17	0.06	0.19	0.37	0.23	0.10	0.26	0.134	0.23	0.01	0.25

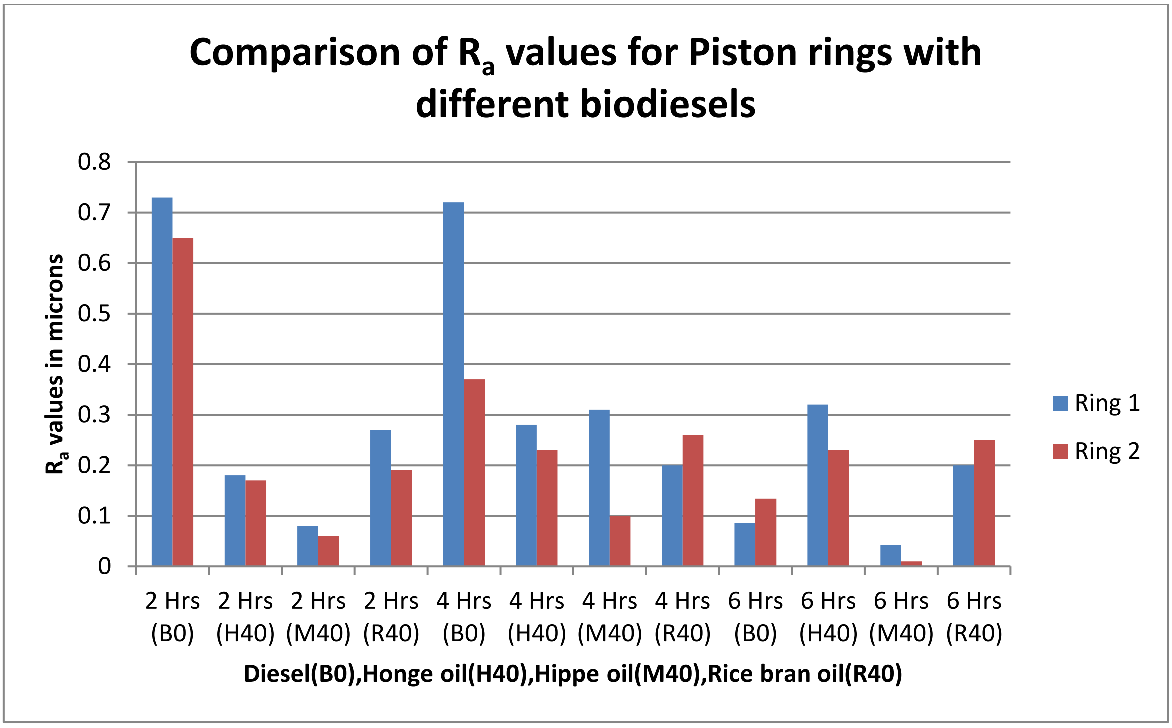

Figure 3 Comparison of R_a values for piston rings with Diesel (B0) and different Biodiesels (60% Diesel + 40% Biodiesel)

From Figure 3, it can be concluded that $R_{a's}$ value of 0.01 microns is minimum for Piston ring2 position for 6Hrs run with Hippe oil (M40). For piston ring also M40 biodiesel showed the better tribological property.

V. CONCLUSION

The wear test reveals the effect of different Biodiesel blends (60% Diesel + 40% Biodiesel) on Tribological Property of I.C. Engine components viz., Piston, piston rings, and cylinder liner. From the above results, it is evident that a blend of 60% Diesel + 40% Hippe oil has better lubrication properties than Diesel and other blends of biodiesel considered.

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