Surface Wear Study of Cylinder Liner for Different Blends of Biodiesel in IC Engine

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Abstract. The Diesel engine is an Internal Combustion engine (IC engine), on combustion of fossil fuel, high pressure and high temperature gases makes the piston to move. This reciprocating motion is converted into rotary motion for applications in industry, power generation, automotives and marine applications. The chemical energy of fuel is converted into mechanical work in the process of conversion of energy. Internal combustion engines play a major role in industry, transportation and power generation. The experiments have been conducted using diesel and then the fuel is blended with different biodiesel. The corresponding readings of surface roughness (Ra) values of cylinder liner have been recorded by using the surface measurement test equipment. The blend of Hippe oil has better lubrication properties exhibited as compared to diesel and other biodiesel blends considered.

Keywords: Hippe Oil, Diesel Engine, Chemical Energy, Surface Roughness.

1. Introduction

In Internal Combustion engine, on combustion of fossil fuel, high pressure and high temperature gases makes the piston to move. This reciprocating motion is converted into rotary motion for applications in industry, power generation, automotives and marine applications. The chemical energy of the fuel is first converted to thermal energy and this energy raises the temperature and pressure of the gases and high-pressure gas then expands. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, to mechanical energy to the desired final use. Tribology is branch of engineering of studying interacting surfaces in relative motion of two mating surfaces. The friction, wear and lubrication are the fields of interest in the study of tribology. The diesel fuels boil within the temperature range of 150ºC to 390ºC. The quality of the final product depends on the characteristics of the crude oil processed and the characteristics blended in the product. The large increase in demand of automobiles in recent years has resulted in great demand for petroleum products and there has been an active search for alternate fuels. The depletion of crude oil may cause major impact on the transportation sector.
2. Literature survey

Sutaria B.M et.al [1] studied the performance of IC engine for tribological parameters using Reayholds equation. The piston force, piston ring force and lubrication oil film thickness are compared with the published articles.

Er. Milind S Patil et.al [2] have studied on the blends of diesel with kerosene and ethanol. They considered the speed of engine, fuel consumption and torque for the blends ranging from 5% to 20%.

S. Jaichandar et.al [3] have studied the effect of biodiesel on working of IC engine for engine power, fuel consumption and thermal efficiency. They also studied on NO\textsubscript{x} and particulate emissions.

Dr. B.K.Venkanna et.al [4] studied on combustion characteristics of diesel engine with emphasis on pressure of injector opening. The neat hone oil as an alternative fuel was used for the study. The best injector opening pressure was found to be 240 bars.

Dr. B.K.Venkanna et.al [5] have studied the use of non-edible oil, hone oil. The effect of temperature on the viscosity, density, flash point of hone oil and its blends were investigated and found that 80% diesel and 20% hone oil was close to neat diesel.

Balvinder Budania et.al [6] have developed a new concept in which the homogeneous combustion in diesel engines. Porous medium combustion engine called “PM- Engine” was developed to study the homogeneous combustion.

Horng-Wen Wu et.al [7] have studied the combustion characteristics of diesel engine and mean effective pressure was varied from 0.9% to 2.8%. An EGR (Exhaust Gas Recirculation) system was designed and focused on NO\textsubscript{x} emission.

N.H.S.Ray et.al., [8] have done literature review on status and perspectives of biogas production for engine applications. They also found that by using biofuels the HC, smoke and particulate emission has been reduced.

Zhiwei Guo et.al [9] worked on marine diesel engine to investigate tribological property of cylinder liner and piston ring. The different wear surface texture features for rubbing surfaces were reported. They found that concave texture was superior to concave groove structures.

3. Methodology

In present work, Kirloskar engine is used for conducting experiments. The experiments have been conducted using diesel and then the fuel is blended with different biodiesel. The corresponding readings of surface roughness (R\textsubscript{a}) values of cylinder liner have been recorded by using the surface measurement test equipment. The diesel and biodiesel blends considered for the present study are mentioned as follows:

1. B0 – 100% Diesel
2. H20 – 80% Diesel + 20% Hoge oil
3. H30 – 70% Diesel + 30% Hoge oil
4. H40 – 60% Diesel + 40% Hoge oil
5. M20 – 80% Diesel + 20% Hippeoil
6. M30 – 70% Diesel + 30% Hippe oil
7. M40 – 60% Diesel + 40% Hippe oil
8. R20 – 80% Diesel + 20% Rice Bran oil
9. R30 – 70% Diesel + 30% Rice Bran oil
10. R40 – 60% Diesel + 40% Rice Bran oil

4. Results and Discussion

The tribological analysis was carried out using the different biodiesel blends considered for the experiments, to investigate the variation of $R_a$ value (in microns) for the IC engine components. The present investigation is focused to find out the minimum $R_a$ value of cylinder liner which indicates the minimum wear of the material.

The surface roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 2 hrs run are listed in Table 1.

**Table 1. Surface Roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 2 hrs run**

| Cylinder liner positions | 2 Hrs (B0) | 2 Hrs (H20) | 2 Hrs (M20) | 2 Hrs (R20) | 2 Hrs (H30) | 2 Hrs (M30) | 2 Hrs (R30) | 2 Hrs (H40) | 2 Hrs (M40) | 2 Hrs (R40) |
|--------------------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Liner TDC                | 0.415      | 0.412       | 0.401       | 0.421       | 0.456       | 0.375       | 0.414       | 0.417       | 0.36        | 0.51        |
| Liner MID                | 0.204      | 0.208       | 0.198       | 0.218       | 0.372       | 0.192       | 0.382       | 0.287       | 0.189       | 0.299       |
| Liner BDC                | 0.694      | 0.537       | 0.492       | 0.585       | 0.583       | 0.571       | 0.594       | 0.586       | 0.561       | 0.595       |

**Figure 1.** Comparison of $R_a$ values for cylinder liner with Diesel (B0) and Biodiesel blends for 2 hrs run

From figure 1, for 2 hrs run, surface roughness ($R_a$) value is low at liner MID position because contact is less as compared to other two portions. The Hippe oil has better lubrication properties exhibited as compared to diesel and other blends of biodiesels considered.

The Surface roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 4 hrs run are listed in Table 2.
Table 2. Surface roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 4 hrs run

| Cylinder liner positions | 4 Hrs (B0) | 4 Hrs (H20) | 4 Hrs (M20) | 4 Hrs (R20) | 4 Hrs (H30) | 4 Hrs (M30) | 4 Hrs (R30) | 4 Hrs (H40) | 4 Hrs (M40) | 4 Hrs (R40) |
|--------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Liner TDC                | 0.469      | 0.409      | 0.398      | 0.381      | 0.457      | 0.377      | 0.461      | 0.404      | 0.35       | 0.523      |
| Liner MID                | 0.244      | 0.248      | 0.224      | 0.256      | 0.377      | 0.215      | 0.384      | 0.275      | 0.18       | 0.289      |
| Liner BDC                | 0.785      | 0.64       | 0.62       | 0.575      | 0.598      | 0.574      | 0.601      | 0.57       | 0.554      | 0.59       |

Figure 2. Comparison of $R_a$ values for cylinder liner with Diesel (B0) and different Biodiesel blends for 4 hrs run

From figure 2, for 4 hrs run, surface roughness ($Ra$) value is low at liner MID position because contact is less as compared to other two portions. The Hippe oil has better lubrication properties exhibited as compared to diesel and other blends of biodiesels considered.

The surface roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 6 hrs run are listed in Table 3.

Table 3. Surface roughness ($R_a$) values for cylinder liner positions for diesel and biodiesel blends for 6 hrs run

| Cylinder liner positions | 6 Hrs (B0) | 6 Hrs (H20) | 6 Hrs (M20) | 6 Hrs (R20) | 6 Hrs (H30) | 6 Hrs (M30) | 6 Hrs (R30) | 6 Hrs (H40) | 6 Hrs (M40) | 6 Hrs (R40) |
|--------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Liner TDC                | 0.37       | 0.337      | 0.339      | 0.305      | 0.459      | 0.311      | 0.473      | 0.654      | 0.301      | 0.513      |
| Liner MID                | 0.27       | 0.266      | 0.212      | 0.224      | 0.218      | 0.205      | 0.41       | 0.438      | 0.175      | 0.381      |
| Liner BDC                | 0.573      | 0.598      | 0.557      | 0.521      | 0.622      | 0.513      | 0.632      | 0.724      | 0.502      | 0.599      |
Figure 3. Comparison of $R_a$ values for cylinder liner with Diesel (B0) and different Biodiesel blends for 6 hrs run

From figure 3, for 6 hrs run, the surface roughness ($R_a$) value is low at liner MID position because contact is less as compared to other two portions. The Hippe oil has better lubrication properties exhibited as compared to diesel and other blends of biodiesels considered.

5. Conclusions

The surface roughness test is conducted to investigate the suitable materials for cylinder liner of an IC engine for diesel and blends of biodiesel. In the present work, the wear of cylinder liner is investigated. The wear tests reveal the effect of different Biodiesel blends on Tribological property of cylinder liner of IC Engine. From the above discussions, it is clearly evident that blend of Hippe oil has better lubrication properties exhibited, as compared to diesel and other blends of biodiesels considered.

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