An Experimental Investigation on Tribological Behaviour of Jatropha Biolubricant with Pyrolysed Cardanol Biolubricant at Varying Loads

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Abstract: Nowadays Demand for bio lubricants is increasing due to pollution and depletion of crude oil based fuels in this globe. This paper portrays and compares the tribological behavior of jatropha bio oil with cardanol oil by wear testing machine. SAE20W40 base lubricant is blended with 5%, 10% and 15% ratios of Jatropha and cardanol based bio lubricants. While testing with 2.6m/s sliding velocity friction and wear rate of jatropha and cardanol bio lubricant is accomplished while testing under 50N, 100N and 150N loads. Low wear rate was discerned while mixing 5% and 10% jatropha bio oil with SAE20W40 lubricant, when this limit increases then the wear rate gradually increases. While conducting the experiment with cardanol oil, addition of 5% and 15% blend with SAE20W40 lubricant has given least rate of wear. 10% blend of Cardanol oil shows increase in wear rate with SAE20W40 lubricant. The mechanical efficiency was raised during the usage of CB5 and CB15 at the sliding velocity of 2.5 m/s. So, CB5 and CB15 can act as best alternative lubricant.

1. Introduction

Friction between surfaces which are in mutual contact during motion can be reduced by introducing lubricant. It will reduce friction in components of an IC engine such as liners and rings in cylinder. Due to depletion of non renewable sources and increase of population, need for bio-degradable Lubricants and unhazardous is increasing day by day. So, natural and reproducible lubricating oils are introduced for meeting these requirements. Oils which are having high flash point and viscosity index have the capability to be a better substitute for the biolubricant. Also oils which are selected as a lubricant must have high thermal stability, Hydraulic stability and resistance to corrosion. Less pollution will be emitted while using vegetable oils instead of mineral oils. While using vegetable oil as a lubricant, it shows some limitations such as hydraulic stability and cold flow characteristics. Oil structure has to be changed to meet the need, so there is a necessity to blend vegetable oils with base lubricant. Here, we have used cardanol bio lubricant and jatropha bio lubricant with SAE20W40 base lubricant for testing at varying loads and velocities using tribometer. From the test results, wear rate and frictional characteristics of cardanol bio lubricant and jatropha bio lubricant has been compared to analyze the tribological characteristics. Seeds of Jatropha curcas are the source of Jatropha oil extraction; it is an important oil crop for biodiesel production. Among the components of Cashewnut
shell liquid oil, cardanol plays a vital role. During the pyrolysis process acid has been converted to alcohol.

2. Experimental Setup
Frictional force and wear rate of the materials which are in contact while in motion will be predicted using pin on disc tribometer. The setup consists of Rotating disc, Weight loaded pin assembly, motor and a recorder. The figure which is given below represents the set up of Pin on disc tribometer.

![Figure 1. Pin on disc Tribometer](image)

The rotating part (disk) which is used in the setup is driven a motor. LVDT sensor is the main component to collect and send rate of wear and friction force to recorder. The pin assembly is kept in contact with the rotating disc using dead weight and the load during the experiment will be given by counter weight. While rotating, due to wear on the pin the lever makes contact with the LVDT sensor. The collected values of wear and frictional force from the LVDT sensor are transferred to the recorder.

| Device      | Pin on Disk |
|-------------|-------------|
| rpm         | 200 to 2000 |
| Load range  | 1N to 2000N |
| Frictional force | 0 to 250N |
| Wear        | ± 1.8mm |
| Sliding Speed | Min 0.49m/s to Max 9.5m/s |

Wear test is carried out in the pin on disc setup at 50N, 100N and 150N load using Jatropha oil mixed with SAE20W40 lubricant in the proportions of 05% JB, 10% JB and 15% JB. The same experiment was conducted using cardanol bio lubricant in the proportions of 5% CB, 10% CB and 15% CB with the same loads which is mentioned above. Base lubricant and the mentioned percentage of bio lubricants stirred by magnetic stirrer. Initially, using sand paper the disc is rubbed to clean the disc surface. The experiment is conducted by varying the loads and sliding velocity and the readings were noted. The charts conspired to observe readings of rate of wear, coefficient of friction at variable loads.
The Figure 2 shows sample of cardanol biolubricant mixed with SAE20W40 lubricant in specified ratios.

3. Results and Discussion
3.1 Discussion on rate of wear for different proportions of biolubricant
Figure 3 shows loading effect on rate of wear for different proportions of bio lubricants at different loads. From the observation of readings of wear rate for variant loads, wear rate is increasing with different ratios of bio lubricants. However, while compared to JB 15, Lubricants JB5 and JB10 shows least wear rate. Figure 4 shows effect of wear for Cardanol bio lubricants. Least rate of wear is noted with CB5 lubricant while compared to CB10 and CB15.
3.2 Discussion on friction coefficient for different proportions of biolubricant

Figure 5 and figure 6 shows loading effect on friction coefficient for different proportions of biolubricants at different loads. From the observations of coefficient of friction, JB 5 and JB10 show least value as compared to JB15. While testing with cardanol bio lubricant, test result shows least value of coefficient of friction is observed with CB5 whereas CB10 and CB15 have shown maximum value of coefficient of friction.

![Figure 5. Load vs Friction Coefficient for CB](image1)

![Figure 6. Load vs Friction Coefficient for JB](image2)

4. Conclusion

From the observations and discussions, it is summarized that

1. Least rate of wear is noted for the blend CB5 at 50N and 150N loads because of high viscosity of the blend.
2. JB 5 shows minimum rate of wear at 50N, 100N and 150N loads.
3. Minimum metal contact between the pin and disc was observed due to high viscosity of blend CB5.

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