Tribological Characterization of the Jatropha Oil with hBN as an additive

Yashvir Singh, Nitin Johri, Gaurav Kumar Badhotiya, Pradip Joshi, Jasmeet Kalra

Abstract: This study proposes the wear characteristics of the jatropha oil consisting ofhBNas nanoparticles. During the test, speed was varied at different rpm. The nanoparticles of 0.3% to 1.2% was mixed to the jatropha seed oil. All the experiment was accomplished on pin on disc tribometer. It has been observed that the nanoparticles of 0.6% ratio shows minimum coefficiecnt of friction and wear during all conditions. In terms of sliding speed, maximum wear of the material occurred at lower speeds for all the samples.

Keywords: Coefficient of friction; Nanoparticles; Wear; sliding speed; load.

I. INTRODUCTION

The wear of the machine parts and their life depends on the capacity of their reduction of friction. The friction can be minimized through the lubrication process. The synthetic lubricants are utilized as a lubricant to reduce the friction between the parts during their relative motion. These lubricants are the petroleum products and are in particular usage in the present scenario. Nowadays, more focuss of research is the application of bio based lubricants as petroleum products are toxic in nature and non-biodegradable. The disposal after their usage are the main problems associated with [1-3].

To replace them, alternatives are required in which non-edible vegetable oil are suitable cndidates. They are non-toxic and biodegradable. The contan certain advantages like high viscosity index, more viscosity, low volatility and higher flash point. Despite of several advantages, they are not come into picture due to their limitations like oxidation stability. These limitations can be overcome by chemical modification process like transesterificaion. This type of method is cheaper and found its wider application[4].

Among the non-edible vegetable oils, jatropha oil is one of the option due to its wider application and higher viscosity.

In the previous studies, most of them were conducted while considering its application to engine sin the form of biodiesel. In this study, it was used as a bio based lubricant [4, 5].

The nanoparticles are one of the additives with the help of which lubricity of the lubricants can be improved. The hBN based additive is useful as it reduces the wear of the resourcescondiered during analysis[6].

A very few studies have been performed by involving hBNnanoparticles as an performance booster. To progress the properties of the oils, nanoparticles are the better sources. To the author's best knowledge, earlier this type of work while considering jatropha oil as a bio based lubricant was not conductedThis study explores the tribological characteristics of jatropha oil at dissimilarvelocities.

II. METHODS

2.1. Sample development for the characterization

For the lubricant application, jatropha oil was provided by the local vendor of New Delhi, India. The nanoparticles were supplied by the Chemistry laboratory staff of the University. The proper blending of the hBN nanoparticles to the oil was performed by using Ultrasonicator. The temperature was set at 125^{o}C and the process was performed for 1.5 h duration. The nanopartciels are added to the oil in the ratio 0.3% to 1.2% (wt.%). The following are the designations assigned to the different samples: 1) JO 2) JO+0.3% 3) JO+0.6% 4) JO+0.9% 5) JO+1.2%.

2.2. Properties characterization

Table 1 presented the characteristics of the oils used for the investigation.

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Table 1.Characteristics of the blends used for the examination.

S. No.	Parameters	Viscosity @ 40 ^oC (cSt)	Viscosity @ 100 ^oC (cSt)	Flash point (^oC)	Fire point (^oC)
1.	Jatropha oil (JO)	241.21	18.06	271.6	259
2.	JO+0.3%	244.17	18.67	273.2	263
3.	JO+0.6%	245.39	19.11	274.8	271
4.	JO+0.9%	236.48	19.72	275.6	274
5.	JO+1.2%	238.21	19.91	277.1	279
ASTM Methods		E3116-18	E3116-18	D92-18	D92-18

For performing tribological study, pin-on disc (POD) machine was used as shown in Fig 1. The test was performed using ASTM G99 method. During the test, 8 mm diameter and 32 mm height pin was used. The material of the pin was Al-7%Si [7]. The temperature of 125^{o}C was maintained during the whole process. Table 2 shows the process parameters undertaken for the test.

Figure 1. Image of the machine for the set up.

Table 2. Conditions applied to the apparatus during analysis.

Operating Conditions	Quantity
Applied load	50 N
Operating diameter	90 mm
Velocity (rpm)	100-400
Sliding distance	4000 m

III. RESULTS

3.1. Friction characterization

Figure 2 shows the effect of sliding speed on the coefficient of friction. It can be observed that the friction was reduced with an increase in sliding speed. More friction was occurred at lower speed 100 rpm. This was due to the change of lubrication regime with the speed. Mixed lubrication was there at higher speeds that results in less contact of surfaces that ultimately reduces friction.

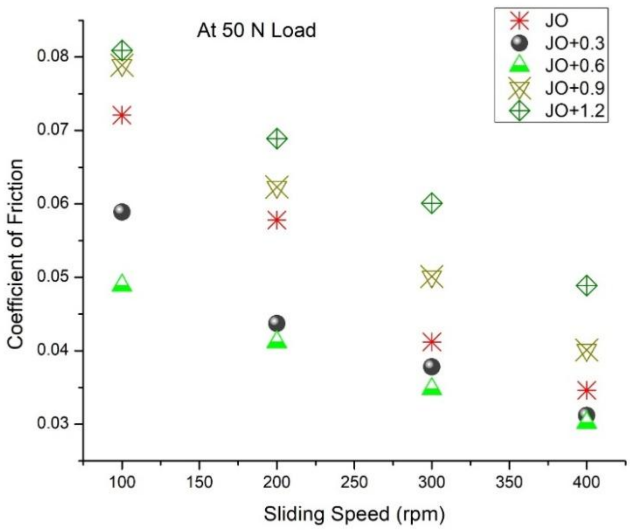

Figure 2. Effect of sliding speed on Coefficient of Friction.

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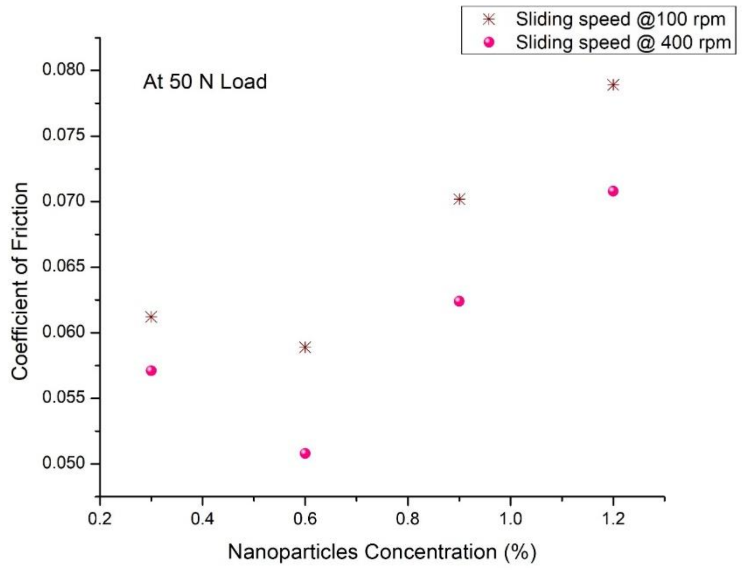

Figure 3. Nanoparticles mixing effect.

Figure 3 shows the outcome of nanoparticles addition on the Coefficiecnt of friction. Load and sliding speed has been considered constant during this analysis. It has been observed that up to 0.6% addition of nanoparticles, reduced COF was observed. The blending of the nanopartclesprovidesadefending film between the exteriors during their interaction[1, 8].

3.2. Rate of wear

Fig. 4 shows material wear at various speeds. The more wear was happenedon lower sliding speed. At lower speed, boundary lubrication regime was there which promotes more contact of surfaces resulting in high wear[9, 10].

Figure 5 shows the individual nanoparticles concentration analysis. It has been observed that mainimum wear of the material was observed up to 0.6% accumulation of the nanoparticles to the jatropha oil.

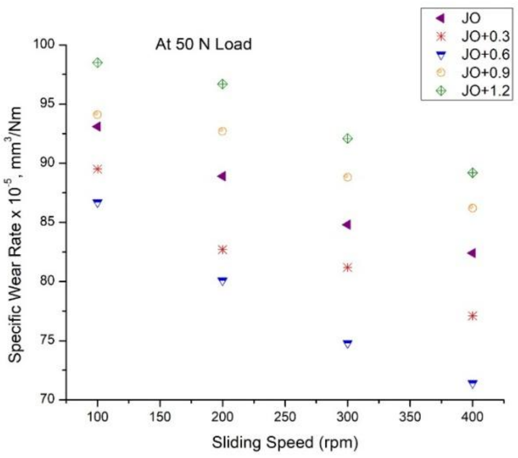

Figure 4. Sliding speed vs SWR.

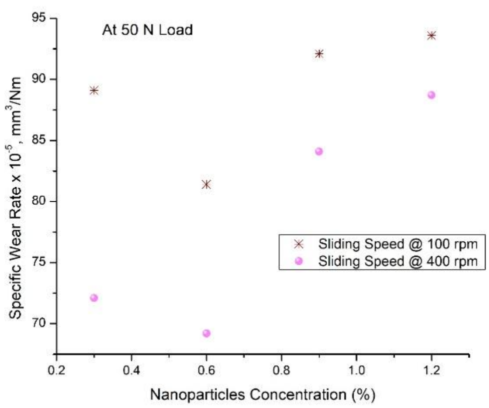

Figure 5. Nanoparticles concentration effect on the wear.

IV. CONCLUSIONS

Based on the analysis, following are the results achieved.

- Reduced COF was achieved when nanoparticles are added up to 0.6%.
- Less specific wear rate was achieved during higher speeds and addition of 0.6% nanoparticles.
- Maximum amount of wear was obtained during slower velocity and when concentration increases above 0.6%

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