

Evaluation of Tribological Properties of Jatropha Curcas Oil by Addition of Nanoparticle Additives

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ABSTRACT: This work discusses the tribological properties of bio lubricating oil with nanoparticles additives. The objective of this work is to evaluate the tribological properties of Jatropha curcas Oil with addition of Cu, Graphite, MoS₂ nanoparticle additives. The effect of additives on tribological properties of Jatropha curcas Oil has been investigated on four ball tester. Test balls are made from chrome alloy steel of AISI standard. Instead of traditional materials, new bio lubricant and nanoparticles have been investigated as lubricants or lubricant additives because of their environment friendly, bio degradable properties. Now, there are numerous different types of nonmaterials with potentially interesting friction and wear properties described the literature.

KEYWORDS: Jatropha oil, properties, Nano particles, ASTM D 4172, performance, Cu, Graphite, MoS₂.

I. INTRODUCTION

In this research the tribological properties of Jatropha curcas oil by adding nanoparticle additives like Cu, C-G and MoS₂ nanoparticles are studied. The Cu, C-G are anti wear additives and they will reduce the friction and wear and will help to improve the viscosity and viscosity index (VI), friction and Cu, MoS₂ are EP additives and they will increase load carrying capacity of cost effective Jatropha curcas oil. The anti wear and extreme pressure properties of Jatropha curcas oil will be analysed according to ASTM D 4172 and ASTM D-2783 standards

The anti-wear properties of Jatropha curcas oil are investigated. In this research. Jatropha curcas oil is inedible oil extracted from the seeds of Jatropha curcas tree. The oil's non-edible nature and wide availability makes it a suitable candidate as alternative base oil for lubricants. Vegetable oils are preferred to synthetic fluids because they are renewable, economic and eco-friendly improvement of the anti-wear and anti-friction properties of Jatropha curcas oil by adding Cu, C-G, and MoS₂ for the development of alternative lubricant with good tribological characteristics. The physico-chemical, isometric and other technological properties of Jatropha curcas oil which have a bearing on its use as lubricant base oil is scarcely reported in literature. Investigation of anti-wear properties predominantly.

II. LITRATURE REVIEW

This work studies the effect of base oils on the tribological performance of WP additives. The difference between the absorbability of the WP additives and that of base oils dominates the mutual compatibility and performance of the WP additive. When used,

The WP additive forms a saturation layer on the rubbing surfaces. The concentration of WP additive in the saturation layer exceeds the additive concentration in the lubricants. A comparative account of performance of the tested compounds is presented on the basis of various tribological parameters such as initial seizure load, 2.5 s seizure

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delay load, weld load, mean Hertz load, flash temperature parameter, pressure wear index, and friction coefficient(m) and wear scar diameter (d), etc

S. Bhaumik et.al. has studied the tribological properties of neat castor are inferior to that of mineral oil although close observation of the results shows that both AW and EP properties of neat castor oil are much closer to that of commercial mineral oil. Thus, the present work would help in formulating castor oil based new bio lubricants with better anti wear and extreme pressure properties .

MeenaLaad et. Al. has studied that, the dispersion analysis of TiO₂ nanoparticles in lubricating oil using UV spectrometer shows that TiO₂ nanoparticles possess good stability and solubility in the lubricant and improve the Lubricating properties of the engine oil.

DigheYogesh et. al. has studied. All the tested complexes have been found to possess significant Extreme Pressure (EP) efficiency under the experimental conditions of four ball test. In paper evaluated and investigated of tribological properties of SAE 60 lubricating oils without using extreme pressure additives.

Anand Kalani et .al. studied that, three bio-lubricants Castor oil, Neem oil, Jatropha oil and mineral oil SAE 20W50 is used alternatively to check the output of the Journal bearing operating parameters. The results so generated put castor oil on first priority on the base of low operating temperature with comparison to other three lubricants. The performance of jatropha curcas oil and neem oil are more or less equivalent to mineral oil SAE 20W50. The main intention was substitution of mineral oil for bio-lubricants.

Vijay Kumar S. Jatti et .al examined Stribeck curves are used to reveal the lubrication regimes where the CuO Nano-particles are most effective. It was found that the addition of CuO nanoparticles to the base oil results in up to 50% reduction in coefficient of friction in the mixed lubricant regime.

Vijay Kumar S. Jatti studied that This work presented and discussed the tribological behaviour of a TiO₂ Nan particles suspension (nano lubricant or nanofluid) in mineral based multi-grade engine oil. Friction reduction and anti-wear properties were obtained using a pin-on-disc tribometer. Test were carried under loads of 40 N, 60 N & 90 N, sliding speed of 0.5 m/s, 1.0 m/s and 1.5 m/s, nanoparticle concentration of 0.5 wt%, 1 wt%, 1.5 wt% & 2 wt%. This study resulted that, all nano-lubricant tested exhibited reductions in friction and wear compared to the base oil, the antifriction and anti-wear behaviour mechanism is attributed to the deposition of soft TiO₂ Nanoparticles on the worn surface, which decreases the shearing resistance, thus improving the tribological properties.

H.C. Ong studied that the production, performance and emission of palm oil, Jatropha curcas and Calophyllum biodiesel. Palm oil is one of the most efficient oil bearing crops in terms of oil yield, land utilization, efficiency and productivity.

M.T.S. Syaima et .al Studied that the main advantages of bio-lubricant are its renewability and biodegradability. Utilization of bio-lubricant as a substitute to fossil – based lubricant is an alternative to solve world's crude oil depletion .In this paper bio-lubricant is prepared from Jatropha curcas oil using bioprocess method.

Bilal S . et .al studied that Synthetic esters namely Jatropha biolubricant was synthesized via transesterification method and the major lubricating properties of the synthesized biolubricant were analysed. These properties when compared with standards as specified by the international standards organization (ISO) conform to those of viscosity grade 46 (VG-46). Hence, the synthesized biolubricant can favourably serve as substitute for petroleum based lubricants for light gear applications

A. Imran. et .al studied that Explain that to prepare the bio-lubricant, 0%, 20%, 30%, 40% and 50% by volume of Jatropha oil were blended with lubricant SAE 40. It has been found that 10% of Jatropha oil bio-lubricant gives lowest wear and creates less amounts of heat than others samples.

Summary of Literature Review

It is been conclude that Lubricant used in this investigation is Jatropha Curcas oil , focused on the issues related to environmental pollution, toxicity, and its cost. There has been growing concern for the use of mineral oils as lubricants because of the world wide environmental issues. This has promoted research into developing and using

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Jatropha Curcas oil as alternative base oil for environmentally gentle lubricant. Jatropha Curcas oil in general have excellent properties such as high viscosity index, high lubricity, high flash point, high bio-degradability and low toxicity with regard to their use as base oils for lubricants.

III. METHODOLOGY

1. Material Selection

A. Basic Oil Selection

- Oil –Jatropha Curcas Oil ,
- Application –IC Engines Gear Lubrication

Table 1 Specifications of oil ^F

Sr. No.	Parameter	Value
1	SAE Grade	Jatropha Curcas Oil
2	Viscosity Index	220.7
3	Viscosity@40°C	66.74
4	Viscosity@100°C	14.28
5	Pour Point 0C	5
6	Flash Point 0C	135
7	Density kg/m ³	920

B. LIST OF ADDITIVES TO BE USED WITH THEIR PROPERTIES

a. Copper (Cu):

Purity > 99.9%

Average Nanoparticle Size 20-50nm

Specific Surface Area 13.1m²/g

b. Molybdenum Disulfide (MoS₂) Nano powder

Purity > 99.0%

Average Nanoparticle Size 20-50nm

Specific Surface Area 35m²/g

Nanoparticle Morphology nearly spherical

Crystallographic Structure monoclinic

c. Graphite Powder(C-G)

Purity >98.0%

Average Nanoparticle Size 400nm

Specific Surface Area not mentioned

Nanoparticle Morphology fragment

Crystallographic Structure monoclinic

Density, bulk N/A

Density, true 2.26g/cm³

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➤ **Objectives:**

- To Evaluate wear scar diameter of Jatropa curcas oil and additives. To improve anti wear properties.
- To improve anti-friction property and calculate coefficient of friction of Jatropa curcas oil and additives.
- To evaluate properties like viscosity, Flash point, pour point etc.
- To evaluate the best combination of additive % in base oil.

C. Sample Preparation

Table 2 Sample Preparation ^C

Sr.No.	Base Oil	Additives	% of Additives in Base Oil by Weight (g).
1	JATROPHA Curcas Oil	-	0
2	JATROPHA Curcas Oil	Cu	0.5
3	JATROPHA Curcas Oil	MoS ₂	0.5
4	JATROPHA Curcas Oil	C-G	0.5
5	JATROPHA Curcas Oil	Cu	1
6	JATROPHA Curcas Oil	Cu	1.5
7	JATROPHA Curcas Oil	Cu	2
8	JATROPHA Curcas Oil	MoS ₂	1
9	JATROPHA Curcas Oil	MoS ₂	1.5
10	JATROPHA Curcas Oil	Cu + MoS ₂	0.5 + 1.5

D. EXPERIMENTAL SET-UP



Figure 1: Four Ball Tester

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Summary of Test Method: ASTM D 4172 B

ASTM D 4172 B:

Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four Ball Method): This test method gives procedure for making a primary evaluation of the anti – wear properties of lubricant by mean of the four ball wear testing machine. The balls are made of chrome alloy steel form AISI standard steel E-52100, having diameter of 12.7 mm (0.5 in.) and grade 25 EP (extra polish). This machine uses four balls, three steel balls at the bottom which are clamped together and covered with the lubricant oil. A fourth steel ball, referred to as the top ball, is pressed with a force of 40 kg (392 N) into the cavity formed by the three clamped balls for three-point contact. Then the top ball is rotated at 1200 rpm for 60 min. Lubricants are compared by using the average size of the scar diameters on the three lower clamped balls.

IV. RESULTS AND DISCUSSION

Table 3: comparison of Jatropha Curcas Oil, Jatropha Curcas Oil +0.5 % MoS₂, Jatropha Curcas Oil +1 % MoS₂, Jatropha Curcas Oil +1.5 % MoS₂.

Sr. No.	Sample name	Wear scar dia. (micromete r)	Coefficient of friction
1	Jatropha Curcas Oil	190	0.06180
2	Jatropha Curcas Oil +0.5 % MoS ₂	159	0.03536
3	Jatropha Curcas Oil +1% MoS ₂	166	0.05384
4	Jatropha Curcas Oil +1.5 % MoS ₂	176	0.07721

Table 4: comparison of Jatropha Curcas Oil, Jatropha Curcas Oil +1 % Cu, Jatropha Curcas Oil +1.5 % Cu, Jatropha Curcas Oil +2 % Cu.

Sr. No.	Sample name	Wear scar dia. (micrometer)	Coefficient of friction
1	Jatropha Curcas Oil	190	0.06180
2	Jatropha Curcas Oil +1% Cu	166	0.02536

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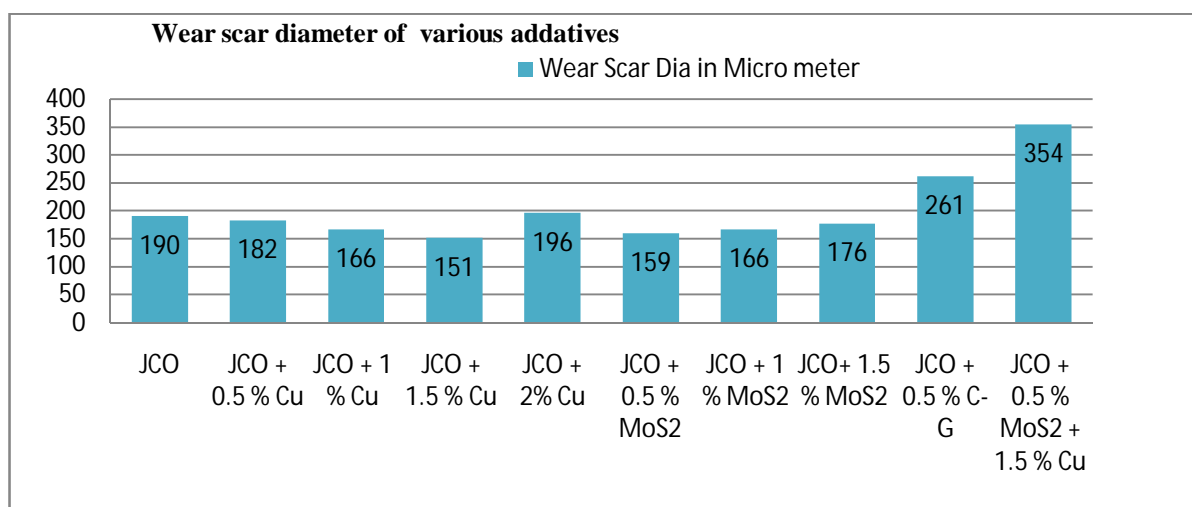
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3	Jatropha Curcas Oil +1.5% Cu	151	0.02503
4	Jatropha Curcas Oil +2% Cu	196	0.02537

Table 5 comparison of Jatropha Curcas Oil , Jatropha Curcas Oil +0.5 % MoS₂ , Jatropha Curcas Oil +1.5% Cu , Jatropha Curcas Oil+ 0.5 % MoS₂ +1.5 % Cu

Sr. No	Sample Name	Wear scar dia. (micrometer)	Coefficient of friction
1	Jatropha Curcas Oil	190	0.06180
2	Jatropha Curcas Oil +0.5 % MoS ₂	159	0.02536
3	Jatropha Curcas Oil +1.5% Cu	151	0.02503
4	Jatropha Curcas Oil+ 0.5 % MoS ₂ +1.5 % Cu	354	0.02741

Comparison of Wear Scar Diameter of Various Additives:



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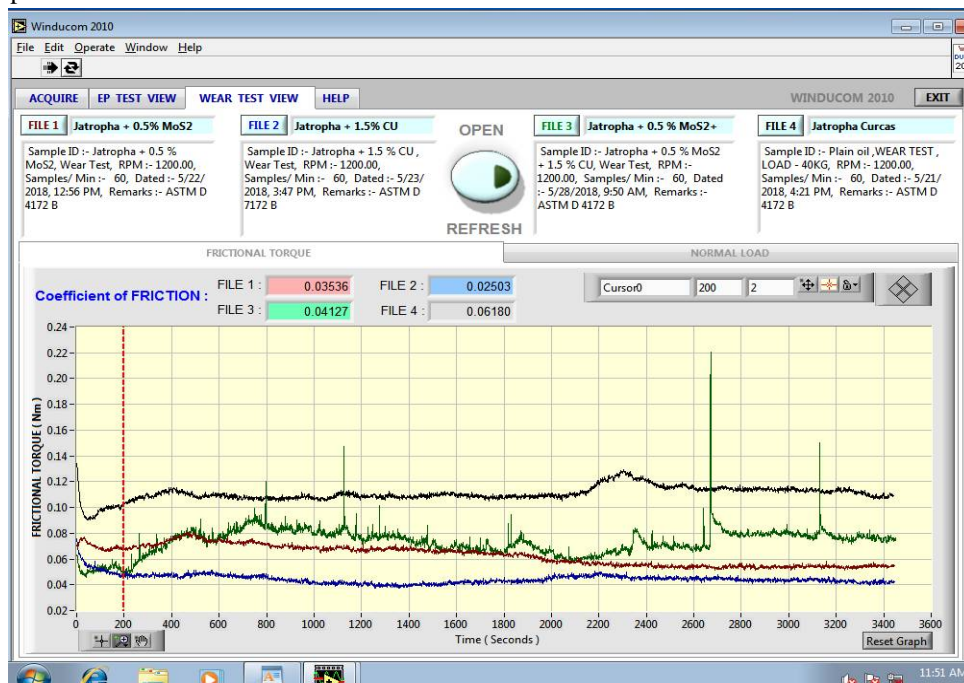
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Comparison of Coefficient of Friction:

- **File 1:** Jatropha curcas oil + 0.5 % MoS₂ by wt.
- **File 2:** Jatropha curcas oil + 1.5 % Cu by wt.
- **File 3:** Jatropha curcas oil + 0.5 % by wt. MoS₂ + 1.5 % Cu by wt.
- **File 4:** Jatropha curcas oil



V. CONCLUSION

- Experimental investigation on DUCOM Four ball tester shows that
- Jatropha Curcas Oil + 0.5 % MoS₂ by Wt. GIVES 0.03536 coefficient of friction & 128 CST, Kinematic Viscosity.
 - Jatropha curcas oil + 0.5 % MoS₂ + 1.5 % Cu by wt. increases coefficient of friction up to 0.04127, 120 cSt, Kinematic Viscosity
 - Jatropha Curcas Oil + 1.5 % Cu By Wt GIVES 0.02503 coefficient of friction & 131 Cst, Kinematic Viscosity which is the best combination of all samples.

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REFERENCES

1. S. Bhaumik et.al., —A Comparative Experimental Analysis Of Tribological Properties Between Commercial Mineral Oil And Neat Castor Oil Using Taguchi Method In Boundary Lubrication Regime Tribology in Industry Vol. 38, No. 1 (2016) 33-44
2. Meena Laad ET. al. —Titanium oxide nanoparticles as additives in engine oil Journal Of King Saud University – Engineering Sciences (2016).
3. Dighe Yogesh et .al., —Investigate the load carrying capacity of SAE 40 lubricating oils without using extreme pressure additives on four ball extreme pressure oil testing machinel, International Advanced Research Journal in Science, Engineering And Technology . Vol 3. , Special Issue 1, March, 2016.
4. Ajinkya S. Pisal. al. —Experimental Investigation of Tribological Properties of Engine Oil with CuO Nanoparticles. International Journal on Theoretical and Applied Research in Mechanical Engineering (IJTARME) ISSN (Print): 2319-3182, Volume -3, Issue-2, 2014
5. Diana Berman et. al. —Graphene: A New Emerging Lubricant I. Materials Today Volume 17 , Feb 2014
6. Anand Kalani, Rita Jani. June 2015 .Comparative Study Of Full Journal Bearing With bio Lubricants – Jatropha Oil, Castor Oil, Neem Oil And Mineral Oil (SAE 20w50) International Journal Of Mechanical Engineering And Technology . Vol. 6, Issue 6 (Version 8), Pp. 127-131.
7. Vijay Kumar S. Jatti Aug 2015 et .al., —Copper Oxide Nano Particles as Friction-Reduction and Anti-Wear Additives in Lubricating Oil. Journal Of Mechanical Science And Technology 29 (2) 793~798
8. Vijay Kumar S. Jatti 2015, Titanium oxide nano-particles as anti-wear and friction-reduction additives in lubricating oil. Journal Of Chemical And Pharmaceutical Research, 7(4):1049-1055 issn : 0975-7384
9. H.C. Ong , October 2014 Comparison Of Palm Oil, Jatropha Curcas And Calophyllum For Biodiesel: A Review International Journal Of Precision Engineering And Manufacturing Vol. 15, No. 10, P.P. 805-809
10. M.T.S.SYAIMA ,I.M.NOOR , MAY 2014 development of bio-lubricant from jatropha curcas oils international journal of research in chemical ,metallurgical and civil engg .vol.1 , issue 1
11. Bilal S. Production of biolubricant from Jatropha curcas seed oil. Vol. 4(6), pp. 72-79, September 2013 DOI 10.5897/JCEMS2013.0164 ISSN 2141-6605 © 2013 Academic Journals
12. A.Imran. And M.A.Kalam, Jan 2013, Study Of Friction And Wear Characteristic Of Jatropha Oil Blended Lube Oil, The Malaysian International Tribology Conference.