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Utilization of Jatropha oil as a lubricant

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Abstract

Due to the environmental concern and limited resources of petroleum oil and with the growing concern regarding global warming issues, the research for clean alternative biolubricants sources became a must. Among the most demanded sustainable clean energy sources is the Jatropha oil. The leached Jatropha oil used in this research work has explored the possibility of utilizing Jatropha oil as a lubricant and was analyzed for density, viscosity at (40 C°, 100 C°) viscosity index, and the flashpoint which are necessary tests for base oil. Explore the commercial additives for the improvement of the Jatropha oil as a lubricant and comparison of the improved Jatropha oil lubricant against other commercial lubricant oils. The results show that all these properties are satisfactory and give good agreement. In this study, the Jatropha oil was found to be compatible with the required additives which are specified by API BASE OIL CATEGORIES. The experimental tests for these properties were performed as prescribed ASTM procedures, and the results were tabulated and discussed.

Key words-*biolubricants; Base oil; Jatropha; solvent extraction; API Base Oil; ASTM; Flash Point; Pour Point; Kinematic Viscosity; Viscosity Index; Total base number; Density; Iodine Value*

I. Introduction

Lubricants are in use ever since man had learnt to build equipment for various applications. Lubricants manufactured until the 19th century were completely based on vegetable and animal fats. Only after the petroleum was discovered and the establishment of the refineries resulted in producing of high-quality base oils they gradually replaced these classical lubricants, due to the superior performance and stability of the mineral base oils at an affordable cost[1]. Over the past six decades, research investigations on mineral oil-based lubricants have improved the lubricating oil in terms of various properties like viscosity, dispersant, detergent qualities, to diversify their applications [2]. But it also increased the concerns related to the bioaccumulation, toxicity and disposal of mineral oil based lubricants. Therefore today the developing biodegradable functional lubricant has become top priority in lubricant industry, and the presence of long-chain fatty acids in vegetable oil, has increased the research interest in the use of vegetable oil as an alternative source to the mineral oil based commercial lubricants [3]. Jatropha is widely spread in the Caribbean and in Central America historically it is known that it is the origin of Jatropha, Jatropha genus has more than 100 species, shrubs, and trees. Which are found in tropical and subtropical areas including North America, Africa and Asia through its trade as a valuable hedge plant [4].

During the last decades, more interest was thrown into Jatropha plantation through cross-fertilization to be adapted to different climates on different continents [5]. As a result, we have different plant species of Jatropha with different characteristics. The studies focused mainly on micro-propagation of seedlings exhibiting the necessary characteristics for mass plantings in a varies region Jatropha life cycle and harvest mature Jatropha has a height of five meters it bears separate male and female flowers Jatropha plant gets mature and begins to provide seeds at one year to five years age. The convenient height suitable for collecting seeds by hand is less than one meter tall. Seeds get mature during December to January [6] season it continues producing seeds for more than twenty years depending on the soil, fertilization and irrigation [7]. Each seed contains high oil content in the range of 30-40% [8]. The objectives of the present study were to investigate the Utilization of Jatropha oil as a lubricant.

II. Experimental Work

To evaluate the Jatropha oil testing the physical property of lubricating oil is essential. The measure of oil's flow characteristics though the significance of viscosity test results has been considered from the standpoint of new oils, these tests also have an essential place in the evaluation of base oils, as well as used formulated oils. In the present work, the kinematic viscosity of fresh Jatropha and modified Jatropha oil samples were determined according to the ASTM Standard D445-04 [9] and ASTM standard D446-04 [10] using U-tube viscometers at a constant temperature Flash point of the fresh oil samples was determined according to the ASTM Standard D92-05a [11].

A. Oil Extraction.

Solvent extraction using n-hexane as extraction solvent. In this method five operating parameters effect on leaching and extracted yield temperature, type of solvent, solvent to solid ratio, Processing time and particle size. The optimum conditions were found at 8h leaching time, temperature of around 68c, coarse particle size (0.5-0.75) mm, and solvent to solid ratio 6:1and hexane as solvent [12].

B. Characterization of crude and modified oils

These analysis were done for both crude and modified oil using the BRITISH [13], version 11 method and AMERICAN STANDERD TESTING METHODS (ASTM) [14].

III. Results and Discussion

A. Results

The result is shown in table III.

TABLE I
PHYSICAL PROPERTIES OF JATROPHA OIL

properties	Jatropha oil	unit	Method of test
Density	0.907	KG/L	D4052
Viscosity @100 c°	7.950	CST	D445
Viscosity @40 c°	36.44	CST	D445
Viscosity index	199	-	D2270
Flash point	273	c°	D92
Pour point	-6	c°	D97

TABLE II
CHEMICAL PROPERTIES OF JATROPHA OIL

Property	Jatropha oil	Method of test
FFA	2.23	-
Iodine value	103.62	EN 14111
Saponification value	193.55	OAC CD3-25
Peroxide value	1.93	EN 14105
Phosphorous	0.019	D7751
Calcium	0.046	D7751
Zinc	0.020	D7751
TBN	4.9	D2896 B
Sulfur	0.011	D4294

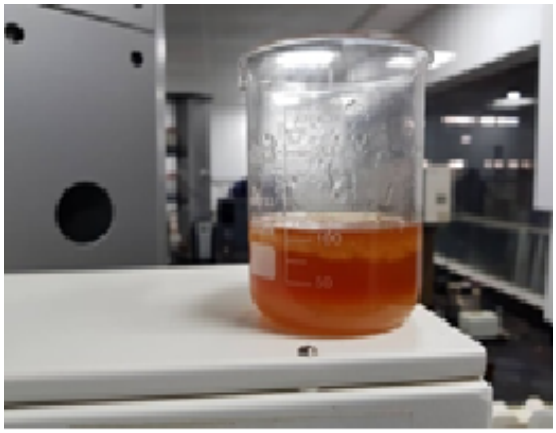


Fig. 1. nonhomogenous mixture

B. Discussion

The Jatropha oil which was used in this research work was analyzed for density, viscosity at 40 c°, viscosity at 100 c°, viscosity index, flash point, pour point and TBN which are necessary tests for base oil. Their respective values are 0.95, 175 CSt, 21.5, 146, 273cc°, -6c°, 4.9, all the values have complied with the standard specified by ASTM (D4052, D445, D2270, D92, D97, D2896B). Based on these properties the Jatropha oil is equivalent to group three of API base oil categories and due to solid metal content in some additives, the Jatropha oil and additives are immiscible. The polarity of these additives is not compatible with the Jatropha oil and due to the polarity added of emulsifier was needed to get a homogenous

TABLE III
CHEMICAL PROPERTIES OF JATROPHA OIL

Properties	Ja oil	unit	Test method
density	0.95	g/ml	ASTM D 4052
Flashpoint	273	C	ASTM D 92
Pour point	-6	C	ASTM D 97
Kinematic viscosity @40c	175	mm2/s	ASTM D 445
Kinematic viscosity @100c	21.5	mm2/s	ASTM D 445
Viscosity index	146	-	ASTM D 2270

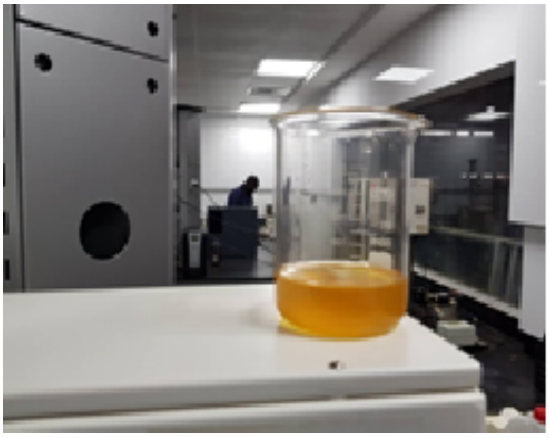


Fig. 2. Homogenous mixture

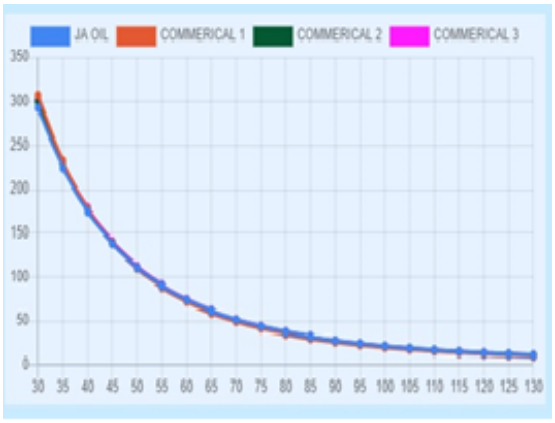


Fig. 3. Test for Viscosity ageist Temperature

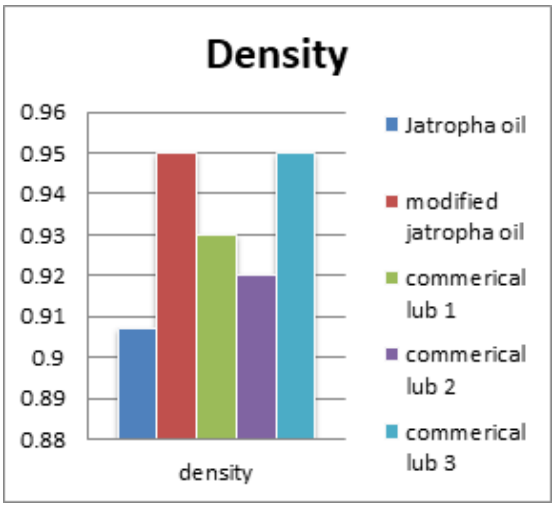


Fig. 4. Density comparison

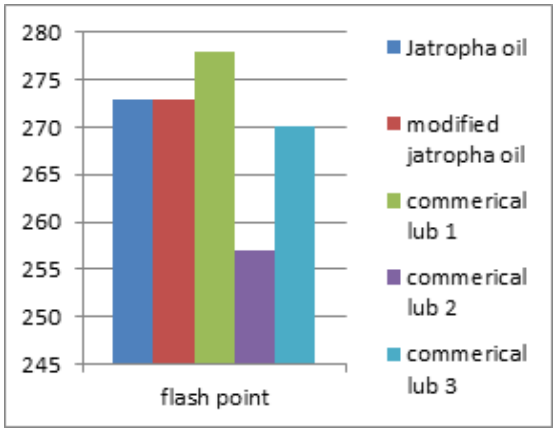


Fig. 5. Flash point comparison

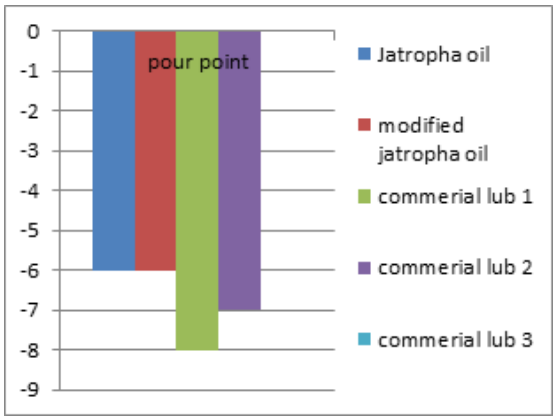


Fig. 6. Pour point comparison

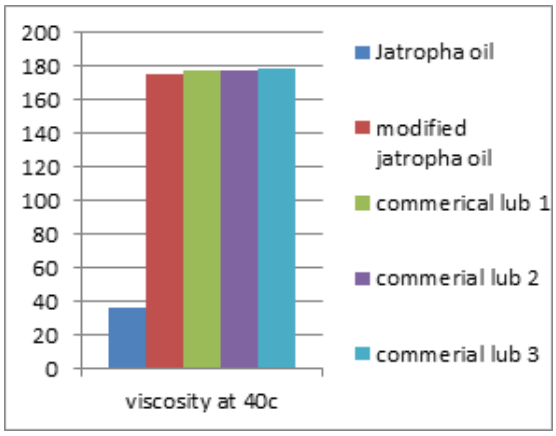


Fig. 7. Viscosity at 40 c° comparison

mixture. Jatropha oil was modified by some additives which are used for 20w-50 the number 20w-50 follow the Society of Automotive Engineers (SAE) format for multigrid engine oil, with the W meaning winter. Adding this high performance SL gasoline engine oil additive package lubricant including TBN, Phosphorus, Calcium, Sulfur, Sulfated ash, viscosity improver and ante foam by volume. The modified oil is of good quality and suitable for use and compared for density, viscosity, flash point and pour point with commercial oils by

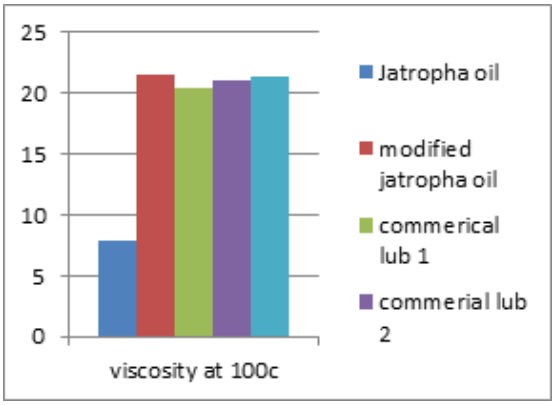


Fig. 8. Viscosity at 100 c° comparison

Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig. 7, and Fig. 8. The product compared with other commercial lubricant oil and the product could be recommended for lubricant base oil utilization for rotary, 2 strokes and 4 strokes engine lubricants. Jatropha oil is much desired for its application as a lubricant because it is a renewable resource. The modified jatropha oil has a good density compering with other commerical lubricant oil. The modified jatropha oil shows good result compering with other commercial lubricants of flash point. The modified jatropha oil shows great result in pour point test compering with other commercial lubricant oil. The viscosity of modified jatropha oil at 40 c° shows spectacular result compering with other commercial lubricant oil. The modified jatropha oil shows astoundingresults compering with other commercial lubricant oil.

IV. Conclusion

Depending on the different classification methods of base oil (API and SAE) and the ideas of lubricant company data the main properties of base oil necessary to be measured are:

- Viscosity at 40c°.
- Viscosity at 100c°.
- Viscosity index.
- Flashpoint.
- Pour point.
- Density

And due to these properties, Jatropha oil is a suitable candidate for base oil to formulate a lubricant for various types of engines depending on the oil additives that are to be used. Vegetable oil is much desired for its application as a lubricant in the metal forming process and internal combustion engines because it is a renewable resource and has high biodegradability compared to mineral oil.

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