International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 11, Issue 3 [May.-June. 2022] PP: 508-513

Development and Evaluation of Eco-Friendly Lubricant from Local Biomass in Nigeria

[1]Okure Unyime Enobong
Chemical Engineering
Niger Delta University,Wilberforce Island, Bayelsa

[2]Odiki, Esther Ebimoboere
Department:Petroleum and Gas Engineering
Nigeria maritime University,Okerenkoko,Delta State

[3]Tegu Benson Tuebi
Petroleum and Gas Engineering
Nigeria maritime University,Okerenkoko,Delta State

In recent years, as fossil fuels like hydrocarbon, coal, and natural gas have been used to supply the world's energy needs, the quest for renewable energy sources has attracted increased interest. As petroleum - based fuels, coal, and natural gas, have been utilized to supply mankind's energy demands, are connected with detrimental environmental repercussions such as global warming, hence the quest for renewable energy supplies has continued to garner widespread attention in recent years. Biolubricant from biomass offers reduced exhaust emissions, enhanced nontoxic nature, decreased toxicity, and a better carotene rating, which can increase effectiveness and cut emissions. Standard procedures were utilized to determine the physical and chemical parameters of the oil, including its Density, Viscosity, flash/fire point, carbon residue, volatility, and Specific Gravity, which were evaluated by chemical experimental analysis. Biolubricant was produced from local biomass and its physiochemical parameters investigated and compared with srandard lubricants.The following locally obtained biomass,(Palm Kernel oil and Jatropha Curcas Oil) biolubricants properties were investigated: They are specific density(mg/ml) 0.886,0.8730, Kinematic Viscosity @ 40^{0}C, (cSt,)111.6,64.7 Kinematic Viscosity @ 100^{0}C, (cSt,)8.10,14.26 , Pour Point,(^{0}C)22, -8, Fire point(^{0}C) 251, 179 and flash Point(^{o}C) 242,175 respectively. To be suitable for widespread industrial usage, a biolubricant must meet t Specifications and possess exceptional lubricating characteristics. Overall flash/fire points of Heavy duty oil (SAE 40) & Light duty oil (SAE 30) are 260/300(^{0}C) & 243/290(^{0}C), compared to palm kernel oil & Jatropha oil of 242/251(^{0}C)&175/179(^{0}C) respectively. The pour points of the oils are 22^{0}C for palm kernel oil, -8^{0}C for Jatropha oil ,9°C for SAE 40, and 21°C for SAE 30. The biolubricant produced from biomass conforms to Heavy duty oil (SAE 40) and Light duty oil (SAE 30) specifications, as well as ISO viscosity grades 32 and 46 for gear oil and other low-temperature Usage

Keywords:
Biolubricant, Biomass, flash point, fire point, density, viscosity, heavy duty, light dut

---

Date of Submission: 07-06-2022 Date of Acceptance: 22-06-2022

---

1. Introduction

Today bioenergy have been described as a viable long-term renewable source with the potential to mitigate both the environmental problems and security challenges faced by the current fossil fuel usage (4, 1, 5). Hydrocarbons such as crude oil, coal, and oil and gas, which have been exploited to satisfy human energy needs, are linked to detrimental environmental effects such as climate warming (10). Moreover, the supply of these fossils fuels may run out in the near future (14, 10). It has been generally stated that oil reserves in at least ten of the 20 biggest oil fields globally are already decliIning compared to oil and gas fuels, biolubricant has lower emission levels, enhanced biodegradability, decreased toxicity, and a better carotene rating, which can enhance performance and decrease emissions. Typical biolubricant produces around 65 percent less net carbon monoxide, 78 percent less carbon dioxide, 90 percent less sulphur dioxide and 50 percent less unburned hydrocarbon pollution (8,, 6, 7).Recent years have witnessed continued interest in the hunt for alternative energy sources. In diesel engines, Biomass oils can be utilized directly as fuel or blended with petroleum diesel, according to reports (7, 9). Moreover, due to the high viscosity from these oils, poor fuel atomization ensues in CI engines, culminating in an ineffective fuel-air combination and combustion (3, 15). In addition to injector coking, engine deposits, and lubricant thickening, the issue reveals itself in prolonged engine operation (13, 1).

LUBRICANT

Lubricant is a material used to minimize frictional forces in motion. It may also serve as a carrier for foreign particles. Lubricity refers to the quality of minimizing friction (2)

A good lubricant comprises the features listed below.
1. elevated boiling point
2.Lower freezing temperature
3. High index of viscosity
4.Temperature stability
5. Corrosion mitigation
6. Extremely resistant to oxidation.

Protection of internal combustion engines in motorized vehicles and powered equipment is among the main uses of lubricants, in the format of motor oil.
Typical lubricants comprise ninety percent base oil (often petroleum fractions known as mineral oils) and fewer than ten percent additives. As base oils, oftentimes biomass oils or synthetic liquids like hydrogenated polyolefins, esters, silicones, (5)fluorocarbons, and more are employed. Additives provide less wear and friction, higher viscosity, an enhanced viscosity index, good corrosion resistance and oxidation, ageing or contaminants, and so forth.
Low-lubricity fuel like gasoline are augmented with lubricants such as 2-cycle oil. The lubricating qualities of sulfur impurities in fuels must be considered when moving to low-sulfur diesel; biodiesel is a popular diesel fuel additive that gives extra lubricity (2).

Lubricants serve the following purposes:
1. Keep moving elements apart
2. lower friction
3. conduct heat
4. Remove pollutants and waste
5. guard against wear
6. Prevent deterioration

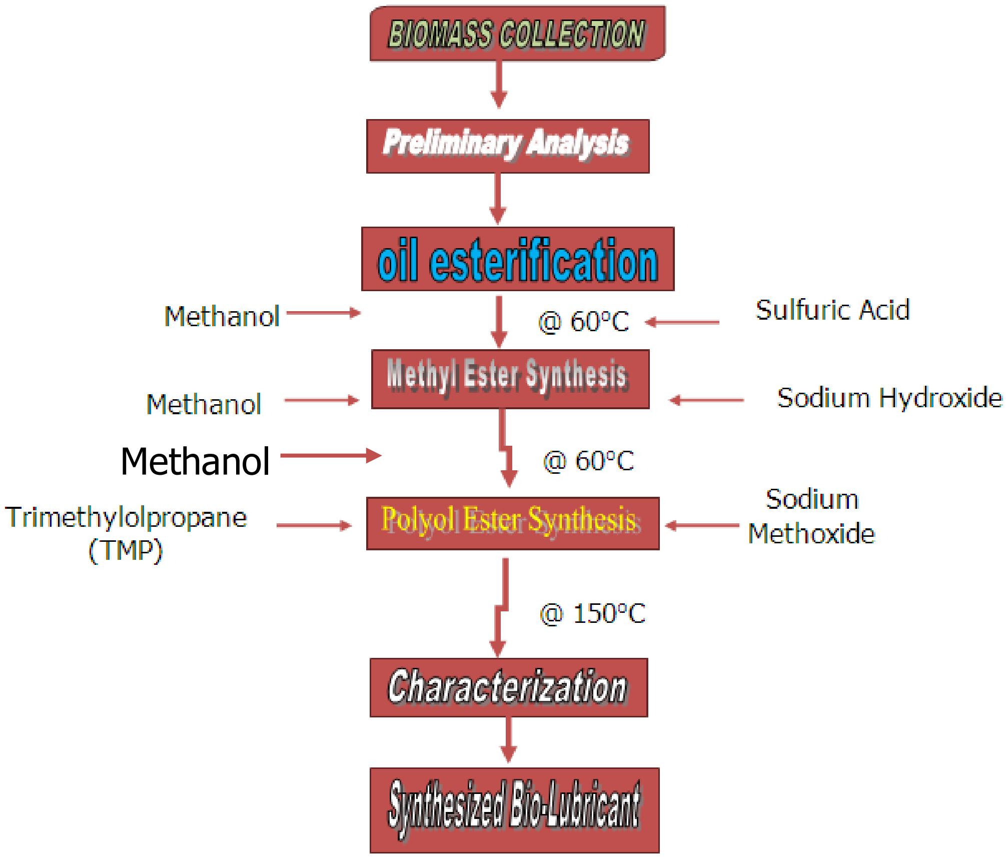
The aim of this research is to investigate the possibilities of using biomass obtained locally to produce Biolubricant. The Biomass sourced locally are palm kernel nut and jatropha seeds as shown in figure 2 below.

2. Material and Method

Raw Materials and Reagents Collection:

Palm kernel and Jatropha curcas seed were obtained from Tombia city market. The chemicals were obtained from department of chemical engineering Niger Delta University. These chemicals are anhydrous methanol, NAOH,KOH, sodium methoxide (30% in methanol tetraoxosulphate (IV) acid, HCL hydrochloric acid, Trimethylolpropane (TMP), isopropyl alcohol, phenolphthalein indicator.

FIGURE 1: EXPERIMENTAL PROCEDURE



Preliminary Analysis:

The present investigation provides the foundation for the oil's evaluation in order to establish if the oil is suitable for use as a lubricant base. The oils of palm kernel and jatropha, seed were analyzed. This analysis consists of density, pour point, flash point,, saponification value,viscosity index, iodine value, and free fatty acid reduction (esterification reaction).

Figure 2: Locally Sourced Biomass Used in the research

A: Jathropha Seeds B: Palm Kernels

Oil Esterification

This is due to the requirement to lower the free fatty acid (FFA) concentration of the oil, as excessive saponification may result. Using sulphuric acid as a catalyst, the esterification of the biomass oil with methanol decreased the bio-oil's high FFA level. 100g of the bio-oil samples were weighed and put to a round-bottom

flask with three necks. In a conical flask, 20 percent w/w methanol and 5 percent w/w sulphuric acid also were measured and combined. The methanol-acid solution and the biomass oil extract were heated to 60 degrees Celsius in a water bath.
A mechanical stirrer was placed via one of the necks, while the stirrer's 700 rpm rotation blocked the other two necks. For uniformity, the temperature of the water was controlled at 60 degrees Celsius. At this point, timing began. (5,6,&7) After 60 minutes, the sample was withdrawn with a picking pipette and titrated against 0.1 N KOH solution to estimate the FFA content of the oil. The titration were repeated at 60-minute intervals until 240 minutes had passed.

3. TRANSESTERIFICATION

Manufacture (synthesis) of biolubricant includes a two-stage transesterification; the first is designed to process an intermediate product, methyl ester of the oils, and the second employs the methyl ester as a reactant to achieve the desired product, polyol ester. The respective procedures are as follows:
The respective procedures are as follows:

METHYL ESTER FORMATION; Utilizing potassium hydroxide as a catalyst, 89.36 grams (100 milliliters) of the oil were transesterified with methanol. The oil-to-methanol ratio was 3:1 by weight, and the amount of catalyst utilized was 0.5% by weight of the oil. The reaction were carried out in two hours at a temperature of 60 0C. (2 hrs).

SYNTHESIS OF POLYOL ESTER (BIOLUBRICANT):

The methyl ester were transesterified with timethylolpropane (TMP) in fifty ml batches utilizing sodium methoxide (in 30% methanol) as the catalyst. The ratio of vegetable oil methyl ester to trimethylolpropane was 3,5:1, the dosage of catalyst utilized was 0.8% w/w of the overall reactants, and the reaction was completed at 150 0C for 3 hours (3 hours) (3,5,9). To enhance the forward reaction by removing all methanol generated, the process was carried under vacuum conditions.

4. RESULTS AND DISCUSSIONS:

Table 4.1 shows the results of the physico-chemical characteristics for both the Extracted Biomass oils and Produced biolubricants.

Table 4.1 Physiochemical properties of the Extracted Biomass ,Biolubricant compared to standard Lubricants

	Palm Kernel Oil		**Jatropha CURCAS Oil**		**Heavy duty oil (SAE 40)**	**Light duty oil (SAE 30)**
Properties	**Extracted Biomass OIL**	**ProducedBio-lubricant**	**Extracted Biomass OIL**	**Produced Bio-lubricant**	**-**	**-**
Kinematic Viscosity @ 40 ^{0}C, cSt	**104.2**	**111.6**	**56.8**	**64.7**	**159.20**	**104.0**
Viscosity @ 100 ^{0}C, cSt	**14.28**	**8.10**	**13.5**	**14.26**	**15.87**	**12.00**
Flash point	**235**	**242**		**175**	**260**	**243**
Fire point	**245**	**251**		**179**	**300**	**290**
Pour point	**20**	**22**	**6**	**-8**	**9**	**21**
Specific density(mg/ml	**0.8723**	**0.8860**	**0.8630**	**0.8730**	**0.868**	**0.895**

Before the investigation to lower the moisture content, the palm kernel and jatropha seed methyl esters was previously dried in hot air oven at little above 100 degrees Celsius overnight. Due to the fact that Trimethlyolpropane (TMP) is hygroscopic, or susceptible to absorb moisture, TMP was introduced to the reaction mixture with great care.It was noticed that the density of the bio-lubricant was below that of the crude oil specimen. Due to the esterification & transesterification processes, it underwent a sequence of transformations.The saponification value findings for the Biomass oils were 198.76mg KOH/g for Palm Kernel and 193.04mg KOH/g for jatropha seed oil. These values are extremely near to those of soybean oil and indicate that the biomass oil will not be suitable for soap production (8).As demonstrated in Table 4.1, the pour points of the produced biolubricants were much higher than those of Biomass crude oils.

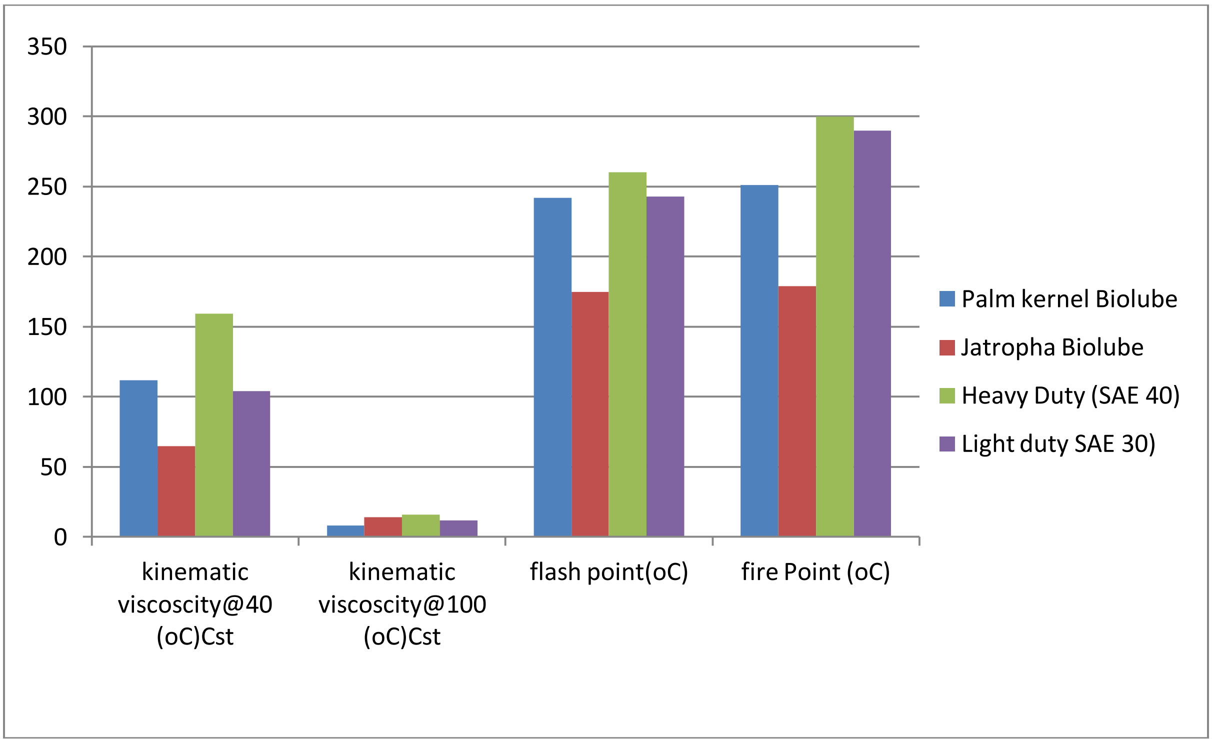


Figure 2: **A plot of Physiochemical properties of the Extracted Biomass Biolubricant (BIOLUBE) compared to standard Lubricants**

This was attributed to the existence of a polyol group in the TMP during polyol synthesis and the lack of beta-hydrogen in the biolubricant that was ultimately formed. Similar to the pour point value of 5 to -7 observed by Bilal et al 2013 (5).

5. Discussions:

According to the data, the flash point of palm kernel oil and jatropha oil were 242 &175°C whereas the fire point is 251 &179 °C respectively. This characteristic of lubricating oil indicates their reaction to controllable heat and flame. In contrast, the flash/fire points for Heavy duty oil (SAE 40) as well as Light duty oil (SAE 30) are 260/300(C) and 243/290(C), respectively. Assessing the flash/fire values of palm kernel oil and jatropha oil to those of standard lubricants such as SAE 40 and SAE 30 makes it abundantly evident that both Biolube oils have excellent flash/fire points. The pour points of the specimens are 22^{o}C for palm kernel oil, 9C for SAE 40, and 21C for SAE 30, indicating also that flash point for Palm kernel oil is comparable with that of the light-duty SAE 30 oil, however the ignition point of Jatropha oil and Palm kernel is significantly lower than those of SAE 30 and 40(14,15,13).

This implies why Palm kernel oil could be utilized in both Temperate and humid environments. Because the pour point is the lowest temperature for which a liquid, especially a lubricant, will flow, decreasing the temperature causes the samples to stop flowing. Therefore, it is accurate to state that the samples under evaluation had pour points that are suitable for use as engine lubricants(16).

The densities of the specimens were also evaluated in order to determine the suitability of Palm kernel and Jatropha Biolubricants either with the heavy or light load engines, i.e. their capacity to mix with some other liquids. According to the data, palm kernel biolube, Jatropha biolube, Heavy duty (SAE 40), & Light duty (SAE 30) possess respective densities of 0.88, 0.873,0.86, and 0.89(mg/ml). The results indicate that palm kernel and jatropha biolubricants does have good specific gravity qualities, which would aid in the event of pollution with water, which will settle well below oil's viscosity;(8,9,12) viscosity in biomass can be increased by adding additives such like Thiadiazole dimmer (DMS2) as well as Polyglycol (DMS2-GL) by synthesizing them as ashless grease additives or bleaching the ex tracted biomass oil to enhance their lubricating properties.

6. Conclusions:

From the examination, the following conclusions can be drawn:
1.The viscosity of palm kernel bio-lubricant is comparable to Heavy duty oil (SAE 40) and Light duty oil (SAE30)
2.The biolubricant developed from palm kernel and Jatropha has a little lower fire point and flash point than the mineral oil utilized.
3.The biolubricant produced from biomass conforms to Heavy duty oil (SAE 40) and Light duty oil (SAE 30) specifications, as well as ISO viscosity grades 32 and 46 for gear oil and other low-temperature Usage.

7. REFERENCES:

[1]. .Alamu, O. J.; Waheed, M. A.and Jekayinfa, S. O.: Biodiesel production from Nigerian palm kernel oil: effect of KOH concentration on yield, Energy forSustainable Development. 11(3): 77-82, 2007.
[2]. Alamu, O. J.; Akintola, T. A.; Enweremadu, C. C. and Adeleke, E. O. Characterization of palm kernel oil biodiesel produced through NaOH- catalysed transerterification process. Scientific Research and Essay Vol. 3 (7) 308-311, 2008.
[3]. Bari S, Yu CW, Lim TH Performance deterioration and durability issues whilerunning a diesel engine with crude palm oil, Proc. I Mech E Part D, J. Automobile Eng. 216: 785- 792, 2002.
[4]. .Batidzirai B, Faaij APC, Smeets E Biomass and bioenergy supply fromMozambique, Energy for Sustainable Development, 10(1): 54-81, 2006.
[5]. Bilal, S., Mohammed-Dabo, I. A., Nuhu, M., Kasim, S. A., Almustapha, I. H. and Yamusa, Y. A. (2013). Production of Biolubricant from Jatropha Curcas Seed Oil:*Academic Journal of Chemical Engineering and Materials Science*, 4(6): 72-79.
[6]. Gupta PK, Kumar R, Panesar BS, Thapar VK Parametric studies on bio-diesel prepared from rice bran oil. Agricultural Engineering International: the CIGR J. Sci. Res. Dev. 9(EE 06-007), 2007
[7]. Knothe G, Steidley KS Kinematic viscosity of biodiesel fuel component andrelated compounds: Influence of compound structure and comparison to petrodiesel fuel components, Fuel, 1059–1065, 2005
[8]. .Krahl J, Munack A, Schröder O, Stein H, Herbst L, Kaufmann A, Bünger J Fuel design as constructional element with the example of biogenic and fossil diesel fuels, Agricultural Engineering International: the CIGR J. Sci. Res. Dev. 7(EE 04 008), 2005
[9]. .Margaroni D Fuel lubricity, Industrial Lubrication and Tribology. 50(3): 108-118, 1998.
[10]. Math MC Performance of a diesel engine with blends of restaurant waste oil methyl ester and diesel fuel, Energy for Sustainable Development, 11(3): 93-95, 2007.
[11]. Munack, A.; Schroder, O.; Krahl, J. and Bunger, J.: Comparison of relevant exhaust gas emissions from biodiesel and fossil diesel fuel Agricultural Engineering International: the CIGR J. Sci. Res. Dev. 3(EE 01- 001), 2001.
[12]. Pantzaris T.P and Mohammed J. A.: Palm Kernel oil article. Palm Oil ResearchInstitute of Malaysia (PORIM), 2000.
[13]. Parsons, G. M. :Biodiesel and Engine Lubrication; Part 2. Chevron Products Company Publishers, San Ramon, Califonia. Pp 1 -16, 2007.
[14]. Ryan TW, Callahan TJ, Dodge LG: Characterization of vegetable oils for use as fuel in diesel engines, Proc. International Conf. on Plaint Oils as Fuels. American Society of Agricultural Engineers 4(82): 70-81, 1982.
[15]. Sambo AS Renewable energy technology in Nigeria: resource availability and potential for application to agriculture. J. Agric. Technol., 3(1): 1-4, 1981.
[16]. Saravanan S, Nagarajan G, Rao GLN, Sampath S Feasibility study of crude rice bran oil as a diesel substitute in a DI-CI engine without modifications, Energy for Sustainable Development, 11(3): 83- 95, 2007.