Evaluation of the Lubricating Properties of Palm Kernel Oil

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Abstract

The search for renewable energy resources continues to attract attention in recent times as fossil fuels such as petroleum, coal and natural gas, which are been used to meet the energy needs of man are associated with negative environmental impacts such as global warming. Biodiesel offered reduced exhaust emissions, improved biodegradability, reduced toxicity and higher carotene rating which can improve performance and clean up emissions. Standard methods were used to determine the physical and chemical properties of the oil, which includes the Density, Viscosity, flash/fire point, carbon residue, volatility and Specific Gravity were determined by chemical experimental analysis. The flash/fire points of the Heavy duty oil (SAE 40) and Light duty oil (SAE 30) is 260/300(°C) and 243/290(°C) respectively while the pour points of the samples are 22°C for palm kernel oil while 9°C and 21°C for SAE 40and SAE 30 respectively.

Keywords:

Biodiesel, flash point, fire point, density, viscosity, heavy duty, light duty

Introduction

Modern biofuels have been reported as a promising long term renewable energy source which has potential to address both environmental impacts and security concerns posed by current dependence on fossil fuels [4, 1, 5]. Fossil fuels such as petroleum, coal and natural gas, which have been used to meet the energy needs of man, are associated with negative environmental impacts such as global warming [10, 15]. Besides, supply of these non-renewable energy sources is threatening to run out in a foreseeable future [14, 10]. It has been widely reported that not less than ten major oil fields from the 20 largest world oil producers are already experiencing decline in oil reserves.

In comparison to petroleum-based fuels, biodiesel offered reduced exhaust emissions, improved biodegradability, reduced toxicity and higher carotene rating which can improve performance and clean up emissions. Typical biodiesel produces about 65% less net carbon monoxide, 78% less carbon dioxide, 90% less sulphur dioxide and 50% less unburned hydrocarbon emission [8, 13, 6, 7].

The search for renewable energy resources continues to attract attention in recent times. It has been reported that in diesel engines, vegetable oils can be used directly as fuel, or as blend with petroleum diesel [5, 9]. However, due to high viscosity of these oils, poor fuel atomization occurs in CI engines resulting in improper fuel-air mixture and inefficient combustion [3, 15]. The problem also manifests in injector coking, engine deposits and thickening of lubricants during extended operation of the engine [13, 1].

Oil palm is indigenous to the Nigerian coastal area. It was discovered by European explorers in the early 1400's and was distributed throughout tropical Africa by humans who practiced shifting agriculture about 5000 years ago. The palm plant originated from the jungle forest of East Africa and about 5000 years ago, palm oil was used by the pharaohs for cooking and lighting. The cultivation of oil palm is restricted to the eastern sub zones where its growth is favoured environmentally and climatically. Besides, it is a major cash crop in this region. The first oil palm plantation was established at Sumatra in 1911 and at Malaysia in 1917. About this time it was simultaneously established in West Africa and tropical America.

Over the years, a little attention was paid to the industrial use of palm kernel oil. Nevertheless, recent studies have indicated that apart from their domestic uses that they can be used as engine lubricants, as replacement for biodiesel if their properties are enhanced.

Although high in saturated fats, it is a different oil to extract from the nut or kernel of palms which has a yellowish white colour and a pleasantly mild flavor similar to coconut oil in fatty oil acid composition and properties.

Palm kernel oil (PKO) is gotten from the kernel of the palm fruit and it is located inside the hard shell while the outer fleshy mesocarp gives palm oil. The fatty acids mostly found in palm kernel oil are presented in Table 1 below.

Table 1. Fatty acid profile of PKO

Type of fatty acid	Percentage
Lauric (C12:0)	48.2
Myristic (C14:0)	16.2
Palmitic (C16:0)	8.4
Capric (C10:0)	3.4
Caprylic (C8:0)	3.3
Stearic (C18:0)	2.5
Oleic (C18:1)	15.3
Linoleic (C18:2)	2.3
Others (unknown)	0.4

Source: [2]

Palm kernel oil (PKO) is more unsaturated and hence can be hydrogenated to a wider range of products which could be used either alone or in blends with other oil for biscuit dough, filling creams, cake icing, ice cream, imitation whipping cream, substitute chocolate and other coatings, sharp melting and melting margarines etc. Lauric oil (CNO, PKO) is very important in soap making and a good soap must contain at least 15% lauric acids for quick lathering while soap made for use in sea water is based on virtually100% lauric oils. Mostly palm kernel oil are now used for the manufacture of short chain fatty acids, fatty alcohols, methyl esters, fatty amines, for use in detergents, cosmetics and many other cosmetic products but less consideration is given it for other purpose [11].

Lubrication is the process or technique employed in reducing wear or tear of one or both surfaces in close proximity and moving relative to each other by interposing a substance called lubricant between the surfaces to carry or help carry the load between the opposing surfaces [12]. It could be a solid e.g. graphite, liquid, solid-liquid dispersion or liquid–liquid dispersion e.g. grease. It also helps to reduce the friction generated between surfaces in contact, frictional forces tend to develop within the surfaces and this phenomenon can be of adverse effect if not controlled. However, all of these effects can be minimized if surfaces are kept constantly lubricated. Basically, the engine oil is the liquid used for the lubrication of various internal combustion engines. They are mostly derived from petroleum products which consist of Hydrocarbons, in the combination of Hydrogen and Carbon elements. Wears and Tears are reduced by applying lubrication oil because it creates a separating film between surfaces of adjacent moving parts to minimize direct contact between them and hence decrease friction, wear, production of excessive heat and thus protecting the engine.

The main objectives of this study are to evaluate the lubricating properties of palm kernel oil and to compare these characteristics to those of the normal engine oil.

Materials and Methods

The materials and equipment used in carrying out this research work include palm kernel oil samples, water, open viscometer cup, stopwatch, beakers(Graduated), retort stand, weighing equipment, camp magnetic stirrer regulator hot plate, cleave land open cup Apparatus, thermometer, gas burner, viscometer bath, holding cylinder, heater, flask (flat bottom) and torch nozzle.

Standard methods were used to determine the physical and chemical properties of the oil, which includes the Density, Viscosity, flash/fire point, carbon residue, volatility and Specific Gravity were determined by chemical experimental analysis. Bleaching of the samples and test for the above-mentioned properties were also carried out. Conventional sample lubricant was collected and similar tests were conducted to compare results obtained.

Results

The results obtained were based on the physical and chemical analysis carried out on the samples. The open cup method was adopted for the flash/fire points test due to its simplicity. Viscosity was determined with the aid of the viscometer. From the results obtained, it is seen that the flash points of palm kernel oil 242°C while the fire points are 251°C. This property of lubricant shows their response to heat and flame under controlled conditions. Conversely the flash/fire points of the Heavy duty oil (SAE 40) and Light duty oil

(SAE 30) is 260/300(°C) and 243/290(°C) respectively. Tables 2 presents the properties of the various samples considered for both the physical and chemical properties.

Table 2. Properties of samples and their values

Sample Properties	Flash point(°C)	Fire point(°C)	Pour point(°C)	Specific density(mg/ml)	Viscosity at 40°(cst)	Viscosity at 100°C (cst)
Palm Kernel oil	242	251	22	0.886	115.55	8.10
Heavy duty oil (SAE 40)	260	300	9	0.868	159.20	15.87
Light duty oil (SAE 30)	243	290	21	0.895	104.00	12.00

It is quite clear from the results obtained that palm kernel oil have very good flash/fire points as they can be compared with those of the conventional lubricants like SAE 40 and SAE 30. The pour points of the samples are 22°C for palm kernel oil while 9°C and 21°C for SAE 40and SAE 30 respectively meaning that the flash point for PKO is close to that of the light duty oil of SAE 30 though the firing point of PKO is far lower when compared with those of the SAE 30 and 40. The implication of this is that PKO could be used both in humid and temperate regions. Since the pour point is the minimum temperature of a liquid, particularly a lubricant after which on decreasing the temperature, the samples cease to flow. Consequently, it will be correct to say that the samples under consideration have pour points that satisfy their use as engine lubricating oils.

The densities of the samples were also determined to ascertain the compatibility of PKO with either the heavy or light duty engines which is the ability of the samples to mix with other liquids. The results showed palm kernel oil (PKO), Heavy duty (SAE 40) and Light duty (SAE 30) have densities of 0.886, 0.868, and 0.895(mg/ml) respectively. The results indicate that palm kernel oil has good values of specific gravity and will help in case of contamination with water which will settle below the oil and can be drain off.

Consequently, the viscosity of the samples was also determined, when the operating temperatures of the engine was 40°C and 100°C respectively. It is seen from the results in Table 2 that PKO at 40°C and 100^{0}C have viscosities of 115.55 and 8.10(centistokes) respectively. This indicates a decrease of 93% which when compared with the conventional lubricants showed a decrease of about 90% and 88% for the heavy duty (SAE 40) and light duty (SAE 30) respectively. This percentage decrease in viscosity shows that as the temperature is increased from 40°C to 100°C the viscosity of the light duty reduces by 88%, while that of the heavy duty reduces by 90%. Since viscosity is the most important parameter in terms of lubricating oil, their individual strength is reflected in the percentage decrease in viscosity on increasing their temperatures from 40°C to 100°C.

Although the percentage decrease is high in PKO it can be enhanced by adding certain additives such as Thiadiazole dimmer (DMS2) and Polyglycol (DMS2-GL) by synthesizing them as ashless grease additives or bleaching the samples to help improve on their lubricating qualities.

Conclusions

Based on the results obtained from the various tests carried out on the lubricating properties of palm kernel oil, the following conclusions can were drawn;

- It was observed that the flash/fire points of the palm oil and palm kernel oil and the bleached sample meet the required SAE specifications. The values obtained were 242°C for palm kernel oil. This value is in line with those obtained from both Heavy duty oil (SAE 40) and Light duty oil (SAE 30) with flash/fire points of 260°C/300°C and 243°C/290°C respectively.
- The pour point of 22°C for PKO when compared with that of Light duty (SAE 30) which had a pour point of 21°C is more preferred. While that of heavy duty oil (SAE 40) is 9°C. The reason for the low pour point value obtained from heavy duty is owned to the fact that it has a higher viscosity compared to the other samples. In essence, the higher the viscosity of a sample the lower its pour point and vice versa. This statement is evident from the results obtained from the tests conducted on the samples.
- The specific density of 0.882mg/ml, 0.886mg/ml and 0.899 for palm oil, palm kernel oil and the bleached palm oil respectively conforms to those of Heavy duty (SAE 40) and Light duty (SAE 30) with values of 0.868mg/ml and 0.895mg/ml respectively. It is obvious that palm kernel oil (PKO) has good value of density. Hence it will help in case of contamination with water which will settle below the oil and will subsequently be

drained off.

- It was also observed that the viscosity of the samples decreased with increase in temperature. This was best with the Light duty which decreased from 104cst to 12cst while PKO had a viscosity of 115.55mg/ml at 40°C and 8.1mg/ml at 100°C and the heavy duty (SAE 40) had a viscosity of 159.20mg/ml at 40°C and 15.87mg/ml at 100°C. On increasing the operating temperatures from 40°C to 100°C, the samples analyzed showed various percentage decrease in their viscosities. PKO showed a decrease of 93% on increasing their operating temperatures.
- It was also observed that the shear strength of the various samples varies depending on their various carotene contents. On increasing the temperature from 40°C to 100°C the sampled, each showed various percentage decrease in their shear strength which is indicated in their viscosities.

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