Investigation on the Use of Palm Olein as Lubrication Oil

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Abstract

The research work is on the possibility of producing lubricating oil from vegetable oil with palm olein as a case study. The sample analysed was obtained from Vandeikya Local Government Area of Benue State. Some of the physical and chemical properties such as viscosity, flash/fire point, pour point and specific gravity were analysed. This sample was bleached to remove the red colour (carotene) and gummy materials. The bleached sample was tested to determine the above mentioned properties. Comparison of the crude palm olein and the bleached sample with the conventional lubricants obtained from Elf Plc, Kaduna and Unipetrol Plc, Kaduna was made. Finally, it was discovered that the crude palm olein and the bleached sample exhibit a good base as a lubricant.

Keywords

Lubrication oils, Palm olein

Introduction

The need for lubrication cannot be over-emphasized as far as its role in engineering is concerned. With the technological advancement, man in his guest to improve his standard of living continues to invent and produce new machines. When two metal parts are in contact, the amount of asperities and interaction within the contact area increases thereby causing; frictions which insist motion wear of the metal parts and generation of excessive heat. These

friction, wear and excessive heat caused by the interaction between the surfaces of the moving parts of the machine has to be controlled by lubrication whose function is to reduce friction and wear, prevent oxidation and corrosion while acting as a coolant facilitating heat dissipation from the engine. A lubricant may be in gaseous, liquid, semi-solid (grease) or solid form. Lubrication is achieved when the surfaces in contact are separated by a continuous lubricant film. The lubricant is expected to have lower shear strength than that of the materials of the contact surfaces and also be able to withstand the loading of the parts in contact. The improved quality of today's synthetic lubricants has enabled the design of machines with higher stresses, load and operating temperature than before. Consequently, automobile engines capable of high rotational speed and higher specific power have been produced [1,2]. Liquid lubricants have the highest application because they headily provide the separation of surfaces when correctly applied. They also perform other functions of a lubricant as discussed earlier. Because of the importance and wide application of lubrication, coupled with the ever increasing world energy crisis, there is need to source out lubricants other than the computational ones obtained from mineral oils [3,4].

This research work considered one alternative of producing a lubricant from vegetable oils with specific emphasis on palm olein obtained from Elaeis Guinaesis generally known as 'oil palm'. The possibility of sourcing an effective lubricant from palm olein is hereby investigated. In determining whether this will be possible or not, an analysis of its properties in its raw and processed form was carried out compared with that of a conventional lubricant. Properties such as the viscosity, flash point, pour point, density, carbon residue, drop point etc were analyzed. Where any of these properties does not favour its use as a lubricant, efforts were made to see if certain additives could be introduced to palm olein to reduce or remove the deficiencies and thereby rendering its suitable as a lubricant. Also efforts were made to ascertain whether it will be commercially viable to produce lubricants from this source.

Materials, Equipment and Methods

The materials and equipment used in carrying out this research work include Palm onlein sample, Calcium hypochlorite, Ice block, Water, SAE 30 oil (Unipetrol Plc Kaduna), SAE 40 Heavy duty (ELF Plc Kaduna). Open cup Viscometer, Stop watch, Beakers

(graduated), Retort Stand, Ohous Weighing Equipment, Gallam Kamp magnetic stirrer regulator hot plate, Cleavland open cup apparatus, Thermometer, Gas burner, Viscometer bath, Holding cylinder, Heater, Flask (flat bottom), Torch nozzle.

Method

The crude palm olein sample was collected in Vandeikya Local Government Area of Benue State. The physical and chemical properties of the palm olein which include density, viscosity, flash/fire point, pour point and specific gravity were determined by chemical experimental analysis in the Chemical Engineering Laboratory of Kaduna Polytechnic.

The palm olein sample was bleached in the same laboratory and the above mentioned properties were tested. Conventional lubricants were collected from Unipetrol and ELF Plc Kaduna and the above mentioned properties were analysed and compared to the crude and bleached samples of palm olein.

Analytical Tests of Crude Palm Olein

Tests are designed to measure such physical and chemical properties of oils like Viscosity, Pour point, Flash/free point, Density, Acidity/Alkalinity (pH), Specific gravity, Carbon residue, and volatility.

Apart from the purpose of quality control, tests are carried out for the following reasons:

- To find out the origin and properties of a given oil;
- To know whether the oil will meet the set specifications which include the mentioned qualities; these specifications are laid down by bodies like the British Ministry of Defence (BMD) and for lubricating oils SAE (Society of Automobile Engineers) for automotive oils specifications;
- To get technical information and determine the availability of contaminants; these tests give technicians much valuable information to enable them assess given oil by considering the earlier mentioned factors.

Experiments

Flash/Fire Point

- Objective: To determine the temperature at which the vapour of the sample will ignite;

- Procedure:
  1. The Sample of palm olein was poured into the open cup;
  2. The cup was placed on the heating element;
  3. Heat was applied at constant rate;
  4. Flame from the torch nozzle was directed over the heated sample at regular intervals;
  5. The flash point was reached when the torch flame ignited the vapour of the sample (i.e. the first spark);
  6. As heat was continuously applied and flame was continuously passed over the heated sample, a further spark was observed that lasted for 5 seconds which dictated the fire point;

Pour Point

- Objective: To determine the minimum temperature at which the oil can flow;
- Procedure:
  1. Palm olein sample was poured into a holding cylinder;
  2. The oil sample was heated above its pour point in the holding cylinder;
  3. The heated sample was cooled gradually by adding ice block into the cooling bath;
  4. The holding cylinder was tilted at regular intervals to check the movement of the oil;
  5. A temperature was reached when the oil did not show any movement after 5 seconds of tilting the holding cylinder;
  6. 5°C was added to the temperature at which the oil solidified to indicate the pour point;

Density

- Objective: To determine the compatibility of the samples;
- Procedure:
  1. The beaker was weighed on the ohous weighing apparatus;
  2. The weight of the breaker was deleted from the screen;
  3. A known volume of the oil sample was poured into the beaker and weighed;
  4. The reading on the screen was taken which indicated the density of the sample;
  5. Specific gravity was obtained from the relation: Density of Substance/ Density of water;

Viscosity

- Objective: To know the flow ability of the samples;
- Procedure:

1. A sample of palm olein was poured into the viscometer cup;
2. The cup was inserted into the viscometer bath which contained water;
3. The viscometer bath was switched on to attain the experimental temperature of 40°C and 100°C;
4. The sample was slowly ran into the viscometer and allowed for 15 minutes to attain bath temperature;
5. The sample was sucked up the capillary tube above the upper mark;
6. The stop watch was started when the sample dropped to the upper mark and it was stopped when the sample reached the lower mark;
7. The time in seconds was multiplied with the viscometer constant to obtain viscosity.

Bleaching of Palm Olein

- Objective: To remove the gummy materials and improve the colour;
- Procedure:
  1. 30g of calcium hypochlorite (a bleaching agent) and 500ml of palm olein were mixed in a beaker;
  2. The mixture was placed on magnetic stirrer regulator hot plate equipment (Gallen Kamp);
  3. The magnetic stirrer was dropped into the mixture;
  4. The set up was heated gradually and the speed of the stirrer was also regulated;
  5. The bleaching stage was attained when the traces of soap stock were foamed over the bleached oil;
  6. The stock soap traces were packed and the bleached palm olein decanted into a beaker where it was filtered.

Test Analysis for Bleached sample

The steps in 4.1.1 to 4.1.4 were repeated for the bleached sample under the same conditions.

Test Analysis for Conventional Lubricants

The tests carried were repeated for two samples of conventional lubricants from ELF Plc and Unipetrol Plc Kaduna.

Results and Discussions

The measurements are given in table 1.

Table 1. Measured Properties and their values

Property	Crude Palm Olein	Bleached Sample	ELF Plc Kaduna (SAE 40)	Unipetrol Kaduna (SAE 30)
Flash Point [°C]	255	305	260	243
Fire Point [°C]	260	311	300	290
Pour Point [°C]	20	24	9	21
Specific Density	0.8651	0.889	0.899	0.895
Viscosity at 40°C [cSt]	81.2	126.4	158.7	104
Viscosity at 100°C [cSt]	5.6	9.1	15.8	12

The experiments as seen in the previous chapter were carried out on the crude palm olein, bleached palm olein and the conventional lubricants produced from mineral oil.

The objective of this investigation was to find out if the properties possessed by the crude and bleached samples of palm olein conform to those of the conventional lubricants. Consequently, a comparison of viscosities at 40°C and 100°C, pour point, flash/fire point and specific gravity of these samples was made.

While the crude palm olein has low viscosities at the proposed temperatures of the engine (i.e. 40°C and 100°C), the bleached sample shows a highly improved viscosity at these temperatures comparing to values obtained with those of the conventional lubricants (see table 4.1). Operating temperatures of 40°C and 100°C were assumed for the engine. Using crude palm olein as lubricant will cause serious damages to the moving parts of the engine and subsequently cause engine breakdown.

The flash/fire point shows responses of the sample to heat and flame under controlled conditions. Using Unipetrol SAE 30 and Elf heavy duty SAE 40 as reference lubricants as they agree with the SAE specifications, one will see from the result obtained that the crude and bleached samples of palm olein have good flash/fire points.

The pour point compared favourably with that of Unipetrol SAE 30.

The bleached and crude palm olein have good values of specific gravity and will help in case of contamination with water which will settle below the oil and will be subsequently drained off.

Conclusions and Recommendations

Conclusions

The following conclusions were drawn from the investigations and results obtained:

- It was observed that viscosities of all the samples decreased with increase in temperature. This was worst with crude palm olein which gave 5.6 cSt at 100°C and best with Elf Plc heavy duty SAE40 with 15.8 cSt (Centistokes) as can be seen in table 1;
- The bleached palm olein which gave better properties than crude palm olein which signifies that carotene (red colour agent) of the palm olein has effect on the properties of the palm olein or the bleaching agent used improved the properties. However, the pour point of the bleached sample was higher than that of the crude plam olein which shows that oxidation increased with the bleached sample. This could be attributed to the formation of free fatty acid (FFA);
- For the flash/fire points, the crude and bleached palm olein met the required SAE specification with flash/fire points of 225°C/260°C and 305°C/311°C respectively;
- Bleaching of crude palm olein helps in removing the gummy elements and destroying the carotene (red colour) of palm olein thereby reducing its staining characteristics.

Recommendations

It is hereby recommended that this research work should be repeated and more detailed analysis should be carried out with emphasis on the following:

- The palm olein to be analysed should be extracted by the next researcher. This should be done immediately the free fruit bunch (FFB) is obtained from the parent plant to avoid formation of free fatty acids (FFA);
- Different bleaching agents other than the calcium hypochloride should be used. Bleaching agents like activated carbon (charcoal) and acid activated clay should be used as they are readily available and cheaper;
- The close-cup apparatus should be used to determine flash fire point in order to obtain better results;
- Other properties such as foaming characteristics should be determined;

- Additives should be introduced in the bleached palm olein such as viscosity index improvers, pour point depressant, dispersants (sludge-control agents), corrosion and anti-rust additives to improve its lubricating efficiency;
- The API (American Petroleum Institute) rating should be determined which grades the quality of the lubricating oil;
- Finally, this end product can be used for lubrication of moving parts such as rollers and gears.

References

[1] Bishop D. D., Carter L. P., and Chapman S. P., *Crops Science and Food Production*, McGraw-Hill, 1982.

[2] Eckey E. W., *Vegetables fats and oils*, Rein Hold, 1954.

[3] Joy D. C., Wibherlay E.J., *A Tropical Agricultural Handbook*, Chassell, 1979.

[4] Peters M. C., Francis W., Fuels and fuel technology, McGraw-Hill, p. 251-266, 1981.