CERTIFICATION

This is to certify that this project titled Production of lubricant from palm oil and groundnut oil was fully carried out by Umeadi Lilian O. under the supervision of Dr. F. Aberuagba and submitted to the Department of Chemical Engineering of the Federal University of Technology, Minna in partial fulfillment of the requirement for the award of Bachelor of Engineering (B.Eng.) Degree in Chemical Engineering.

.... 26/10/2006

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DECLARATION

I hereby declare that this project work was carried out by me under the supervision of Dr. F. Aberuagba in the Department of Chemical Engineering, Federal University of Technology, Minna during 2005/2006 Academic Session.

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UMEADI LILIAN O.

....

DATE

DEDICATION

This project is dedicated to GOD Almighty, my parents, Chief & Mrs. Emmanuel Umeadi and to my siblings; Emmanuel, Stella, Linda, Anthony and Ruth

ACKNOWLEDGEMENT

My profound gratitude goes to my supervisor Dr. F. Aberuagba for the excellent and accommodating manner in which he supplied and aided me with all the necessary information that led to the eventual completion of this work. I am grateful to my parents, Chief & Mrs. Emmanuel Umeadi for their moral and financial support and to my siblings for always being there for me.Also, my sincere appreciation goes to my friends; Hajara, Abbas, Rachael, Ademola, Yemisi and Akeem who made my stay in school memorable and remarkable.

ABSTRACT

Due to growing environmental concerns, vegetable oil is finding its way into lubricants for industrial and transportation applications. These oils indeed offer significant environmental benefits with respect to resource renewability, biodegradability as well as providing satisfactory performance in a wide range of application.The aim of this research project is to produce lubricant (two stroke engine oil) from palm oil and groundnut oil .The groundnut oil and palm oil was each blended with additives and properties such as flash point, kinematic viscosity, viscosity index and density were determined. From the analysis, the flash point, viscosity index and density of the blended palm oil was obtained as 236^0C,189, and 0.9209g/cm^3 respectively while that of blended groundnut oil was obtained as 294^0C, 210 and 0.9173g/cm^3 respectively. These results clearly show the blended groundnut oil gave a better result than that of blended palm oil and both samples fall within SAE 30 (two stroke engine oil) specification.

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CHAPTER ONE

1.0 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 quest to improve the standard of living continues to invent and produce new machines. In machinery, friction wears metal and converts energy which should do work into sometimes destructive heat. These frictions, wear, excessive heat caused by the interaction between the surfaces of the moving part of the machine has to be controlled by lubrication.

Lubrication is the use of a substance to decrease friction and wear between two surfaces that move in relation with one another, prevent oxidation and corrosion while acting as a coolant facilitating heat dissipation from the engine. Such substances called lubricants 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. (http.//lejpt.academicdirect.org)

Continued growing environmental concerns are providing the impetus for increased demand and usage of vegetable oil in lubricants for many applications. These oils indeed offer significant environment benefits with respect to resource renewability, biodegradabi y, as well as providing satisfactory performance in a wide range of applications. Historically speaking, vegetable oils have been used in applications where leakage of equipment is inevitable, or where a system is designed to function by loss lubrication. They are;

- Two stroke engine oil.
- Chain saw oils.
- Hydraulic oils.
- Greases.
- Farming, mining and forestry equipment.
- Open gear lubricants.

Lubricants can be classified into two categories as engine and non-engine. The two categories are:

Engine lubricants	Non-engine lubricant
Diesel engine oils	Transmission fluid
Two-stroke engine oils	Hydraulic fluid
Gasoline engine oils	Grease
Aviation engine oils	Power steering fluids
Natural gas engine oils	Gear oils

1.1 TYPES OF LUBRICANTS

a. Solid lubricants.

b. Semi-solid lubricants.

c. Liquid lubricants.

d. Gaseous lubricants.

(a) SOLID LUBRICANT

It includes graphite, molybdenum disulphide, teflon and talc. These are used not only to carry heavy weights and resist high temperature, but also to form a smooth surface on wrought bearings.

(b) SEMI-SOLID LUBRICANTS (GREASE)

They consist of either animal fats such as tallow and lard or petroleum based oils thickened with substances containing calcium, or lithium stearate. Lithium stearate known as all purpose grease is valued because they are resistant to high and low temperatures and to water. They make up more than 1/3 of the various kinds of automobile greases.

(c) LIQUID LUBRICANTS

They are oils and are the most widely used because they can be drawn between moving parts by hydraulic action. This movement not only keeps the parts separated but removes heat. Most liquid lubricants are obtained from petroleum but animal, vegetable and synthetic oils are

1.4 JUSTIFICATION

Vegetable oil base lubricants are environmentally friendly, that is, they cause less contamination and harm to the environment. This is largely due to the fact that vegetable oil are readily biodegradable (petroleum products can persist for years) and also reduce spill effects due to less toxicity. Consequent, a good advantage of vegetable oil lubricants is that they will be found greatly to reduce cost on environment and safety.

Also, vegetable oils are made with renewable resources (plants) and this will remove the fear of unavailability of petroleum resources in countries that have the wherewithal (land) to produce the vegetable oil. Consequently, there will be a boost in the economy by creating more jobs from increase in crop production of the oil to the establishment of industries for the processing of the final produce.

corrosion and oxidation, contamination and so on. Lubricants are classified by origin such as mineral, vegetable or animal and by the state in which they exist such as gas, liquid, semi-solid and solid. (Boughton and Horvath, 2003)

2.3 FUNCTIONS OF LUBRICANTS

The automobile industry is the major user of lubricants. Engine designs have been continually improved to reduce weight, increase fuel economy, increase power output, and at the same time meet environmental emission guidelines. Research is on going to formulate lubricants to meet the demands of the redesigned engines. In general, a lubricant must perform the following functions for the efficient operation of the engine:

(1) Permit Easy Starting: Engine oil must be thin enough when first starting the engine to allow for sufficient cranking speed. The oil must then be able to flow immediately to lubricate vital engine components. Most of the engine wear occurs at start-up before the oil can reach all the engine parts. As the engine is heated, the oil must not become too thin and be unable to provide adequate engine lubrication. The viscosity of the oil is the measure of this resistance to flow.

The effect of temperature on viscosity varies widely with different types of oils. The standard used to measure the amount of viscosity change with temperature is the viscosity index (V.I).

(2) Cool Engine Parts: The cooling system performs about 60% of the cooling job of the engine. It cools the upper part of the engine including the cylinder heads, cylinder walls and valves. The crankshaft, the main and connecting rod bearings and other components in the lower engine are cooled as the oil flows around the parts. What is critical is the continuous circulation of large quantities of oil. If the oil passages are allowed to become clogged, the flow is restricted, and the parts are not cooled properly.

(3) Minimize Combustion Chamber Deposits: Some oil must reach the area of the top of the piston ring in order to lubricate the rings and the cylinder walls. It is important that the oil prevent excessive combustion deposits. Combustion deposits acts as a heat barrier and as a result pistons, spark plugs and valves are not properly cooled.

The motor oil must accomplish two things in preventing excessive combustion deposits:

a) The oil must keep the rings free so as to reduce the amount of oil reaching the combustion chamber and

b) The portion of the oil reaching the combustion chamber must burn as clean as possible.

(4) Lubricate and Prevent Wear: As the engine oil is being circulated by the oil pump to the engine parts, the oil must now prevent the metal-to-metal contact that will result in wear to the moving part. Full-film lubrication occurs when the moving surfaces are continuously separated by a film of oil. The viscosity of the oil must remain high enough to prevent metal-to-metal contact. Wear will only occur if the surface is scratched by particles thicker than the oil film.

Boundary lubrication occurs when it is impossible to maintain a continuous oil film between the moving parts and intermittent metal-to-metal contact occurs because of high spots on sliding surfaces, during engine starting and in new or rebuilt engines. This lubrication is accomplished by the additive package in the oil.

(5) Reduce Friction: Under full-film lubrications, the film of oil prevents metal-to-metal contact. The viscosity of the oil should be high enough to maintain the film. A delicate balance must be maintained. If the viscosity is higher than required, the engine must overcome the excess fluid friction.

(6) Protect against Rust and Corrosion: Under perfect conditions, fuel burns to form carbondioxide and water. Some of this water passes by the piston rings and becomes trapped in the crankcase. This is more of a problem in cold weather before the engine is warm. In addition to water, other corrosive combustion gases also get past the rings and are dissolved in the crankcase oil. Add to this, the acids formed by the normal oxidation of oil and the potential for rust and corrosive engine deposits become significant.

Corrosion inhibitors are part of the additive package to protect non-ferrous metals by coating them and forming a barrier between the part and the acids. Also, rust inhibitors are added to the oil to protect iron/steel surfaces from oxygen attack by forming a protective screen.

(7) Seal Combustion Pressures: The surfaces of the piston rings, cylinder walls are not completely smooth. For this reason, the ring can never prevent high combustion and compression pressures from escaping into the low pressure area of the crankcase. This would result in a reduction of engine power and efficiency. Motor oil fills in the hills and valleys and greatly improves the seal. In a new or rebuilt engine, oil consumption will be relatively high until these surfaces have been smoothed out enough to allow the oil to form a good seal (http://www.mts.net/~dbrad1/index).

2.4 GENERAL COMPOSITION

Lubricants are generally composed of a majority of base oil and a minority of additives to impart desirable characteristics.

2.5 ADDITIVE TECHONOLGY

A lot of unfortified base oil with additives is being sold as motor oils in our country. Base oils have to an extent some of the properties required for lubrication. However, these by themselves are not sufficient to meet the lubrication requirement of modern highly rated engines. Additives must therefore be added to base oil to produce quality lubricants.

Additives are chemical compounds added to the refined base oil stocks to impact some specific properties to the lubricating oil either by enhancing the inherent properties or adding new but useful ones into the finished products. (Luhanim, 1990). The most important aspects in the use of additives is the fact that in the majority of cases, only very small amount (<1-25%) are required to profoundly modify or improve the physical and chemical properties of mineral oils.

The basic function of additives can be summarized as; protection of metal surfaces (rings, bearings, gear and so on), extending the range of lubricant applicability and extending lubricant life.

2.5.1 TYPES OF ADDITIVES

There are different types of additives used in blending the various classes and grades of lubricating oils to enable such finished products meet the performance requirement of the engines. The properties specification and characteristics of additives enable them to perform one of more specific functions in achieving the desired level of improvement in the finished engine oil. The different types of additives commonly in use are as follows.

(a) **Dispersants**: are chemicals blended into the oil that suspend materials that can cause varnish and lacquer resulting from oil oxidation to form. The measure of an oils ability to neutralize these acidic by products of combustion is called the total base number (TBN).

(b) **Detergents**: keeps the engine parts clean by significantly reducing the formation of deposits. The use of these detergents does not clean an engine but rather serve to delay the formation of deposits and reduce the rate at which they accumulate. They do this by neutralizing the acidic by products of combustion.

(c) **Anti-wear Additives**: are mainly used in order to reduce the effects of engine operating conditions when a full hydrodynamic oil film cannot be maintained. These anti-wear additives primarily act as friction reducers that prevent metal-to-metal contact.

(d) **Anti-foamants**: reduces foam in crankcase and blending. Motor oil that foams excessively cannot perform the job of properly lubricating an engine under severe operating conditions or even in average operating conditions. When air bubbles form in the foam, the antifoam additives will attach themselves to the air bubbles in the foam and cause the foam to weaken which in turn causes other foam bubbles attached to each other collapse. The anti-foam additives essentially break down the foam when the oil film surrounding the air bubbles is ruptured.

(e) **Pour-point Depressants**: are required in order to obtain low pour point, that is, give oil better low temperature fluidity. This they do by lowering the point at which wax crystals form and also restrict the growth of wax crystals.

(f) **Viscosity Index Improvers**: are present to make oil stay thick at lower temperatures so as to allow for easy cold weather starting but at the same time, it must not be too fluid (thin) at higher operating temperatures in order to prevent excessive wear and oil consumption. Viscosity index improvers (VI's) are blended in motor oil in order to impart specific performance characteristics to the oil under these operating extremes.

(g) **Oxidation Inhibitors**: oxidation is the result of oxygen mixing with oil at engine operating temperatures. It is not so much the amount of oxygen absorbed by the oil that is important, but the amount of oxidation products formed. Oxidation causes an increase in oil viscosity as well as the formation of acids, lacquers and varnish on internal parts.

In order to decrease the effects of oxidation, oxidation inhibitors are used which disrupt the chemical reaction that is responsible for the formation of oxidation as well as chemicals that actually decompose the oxidation products already formed.

(h) **Rust and Corrosion Inhibitors**: are special compounds blended into motor oil that in addition to the motor oil itself, attach themselves to internal components and prevent the formation of rust by forming a barrier that prevents water from contacting the metal surfaces.

Corrosion inhibitors serve the function of preventing corrosion of internal engine bearings made from a mine of copper, lead, aluminum and tin (E.P.T 2003).

2.6 CHARACTERISTICS OF LUBRICANT

Some of the physical and chemical properties of lubricants and their significance include.

(a) **FLASH AND FIRE POINT**

The flash point is the lowest temperature that a flame will cause the vapours of a lubricant to ignite. The fire point is the lowest temperature that particular oil will sustain burning for five seconds. The test sample is heated and a flame is brought near its surface.

Flash points are the most commonly used flammability tests and are typically used for safety of shipping, handling and storage of lubricants. Generally, in specific high temperature engine operation, oil with a low flash point would indicate higher volatility and thus may result in higher rates of oil consumption. Flash and fire points can be drastically reduced when fuel contamination is present in a motor oil.

(b) **KINEMATIC VISCOSITY**

Kinematic viscosity is a measurement of the time taken for a known volume of oil to flow under gravity through calibrated glass capillary viscometer. Kinematic viscosity is measured at 40^0C (104^0F) and 100^0C (2120F) in order to have standard reporting temperatures. It is essentially the ratio of the viscosity to the density of oil being tested.

Kinematic viscosity is typically measured in centistokes (cSt) centistokes can be thought of as the result of dividing the dynamic viscosity of oil by its density, both measured at the same temperature.

(c) **VISCOSITY INDEX**

The viscosity index is used to determine how much a particular motor oils viscosity changes with temperature. It is a method of applying a number to this rate of change based on a comparison with two arbitrary selected oils [published in tables by the American Society for Testing and Materials (ASTM) at a given temperature typically 40^0C and 100^0C] that have significant variation in viscosity index. A higher viscosity index indicates that viscosity changes less with temperature than a lower viscosity index.

(d) **POUR POINT**

The pour point of oil is the lowest temperature that the oil will flow. The viscosity of oil also affects the pour point. Oil with a high viscosity, even though it may be wax and paraffin free, is still limited in its pour point due to higher viscosity.

Pour point is a very important parameter especially for people that live in cold climates. The oil must be able to flow into the oil pump and be pumped to various parts of the engine at the lowest anticipated temperatures.

(e) TOTAL BASE NUMBER (TBN)

Total base number is a measurement of reserve alkalinity of oil for neutralizing acids. The resulting quantity is determined as mg KOH/ (gram of lubricant). The detergent / dispersant additive package is critical in determining how effective the motor oil is in neutralizing these acids. TBN depletes with time in service. Higher TBN oils are more effective at neutralizing acids for longer period of time.

(f) TOTAL ACID NUMBER (TAN)

The total acid number (TAN) of oil is the weight in milligrams of potassium hydroxide required to neutralize one gram of oil and is a measure of all the materials in oil that will react with the potassium hydroxide under specified test conditions. The usual major component of such materials are organic acids, soaps of heavy metals, intermediate and advanced oxidation products organic nitrate, nitro compounds and other compounds that may be present as additives.

(g) DENSITY AND SPECIFIC GRAVITY

Density is defined as mass per unit volume. Specific gravity on the other hand is the ratio of the mass of a given volume of liquid at 15^0C to the mass of an equal volume of pure water at the same temperature (Dolan, 1971).

2.7.0 VEGETABLE OILS

These are primarily triglyceride esters derived from plants and animals. For lubricant base oil use, the vegetable derived materials are preferred. Common ones include high oleic canola oil, palm oil, sunflower, seed oil, groundnut oil and rapeseed oil from vegetable and as base fluids in lubricants are perceived to be the following; non-toxicity, biodegradability, resource renewable, affordable application cost, good lubricity and high viscosity index (David, 2000).

2.7.1 DESIRED VEGETABLE OIL CHARACTERISTICS

The lubricant industry could be poised to take advantage of oilseed biotechnology to produce high performance base fluids that are compatible with the current stable of additives used in lubrication industry. The drivers that will influence the vegetable base oil composition and market penetration are.

a. Regulatory

b. Public perception of need

c. Original equipment manufactures (OEM) acceptance and continued support.

d. Cost / benefits

The use of additives in formulated lubricant systems will undoubtedly be needed. This is even true for mineral oils based products that have successfully been used for decades. Requirements for high performance compatible vegetable oils are;

(1) High biodegradability; low toxicity.

(2) Excellent oxidative stability.

(3) Good lower temperature properties.

(4) Lower cost than synthetic esters.

(5) Performance comparable to mineral and synthetic esters.

Accepting the fact and notion that additives can compensate for the many inadequacies of vegetable oils, it is therefore to utilize a vegetable oil that can provide the rudimentary basic properties. Maximum oxidative stability while maintaining fluidity. The ideal vegetable oil regardless of source e.g. palm, sunflower e.t.c. would not need to have an oleic content over 90%. Since additives to finished lubricant products is always essential, the focus should be at having the lowest cost vegetable oil having the "ideal" fatty acid composition.

Some guidelines for properties of vegetable oil designed for lubrication ba... oils are.

Viscosity, cSt at 400C	30—35
Viscosity index, VI	greater than 200
Iodine value	94-126
Saponification number	186—198
Specific gravity	0.91—0.92
Pour point 0C	-20
Flash point	259

Some vegetable oils inherently contain naturally occurring anti-oxidants can also assist in oxidative stability properties. Although most oils go through a deodorization process, natural occurring anti-oxidants do carry through into the finished product.

To summarize the value and utility of vegetable oils as base fluids for l... rication, the advantages and disadvantages are listed below.

Advantages (+)

- Very high viscosity indexes
- Good thermal stability
- Low volatility
- High flash points
- Good miscibility with other lubricant base fluids and solvents.
- Good additive compatibility

(+/-) * Polar nature of the ester linkage in vegetable oils imparts good lubricity, but also competes with the surface active additives.

Disadvantages (-)

- Poor oxidative stability
- Questionable hydrolytic stability
- Poor low temperature characteristics
- Poor response to pour point depressants

For the purpose of this research, the vegetable oil to be considered for the production of lubricants is groundnut oil and palm oil.

2.8 PALM OIL

Palm is a form of edible vegetable oil obtained from the fruit of the oil palm tree. It is the second – most widely produced edible oil after soya bean oil. Oil palm is found growing wild in the humid lowlands of West Africa from Cape Verde to Angola. It is grown commercially in plantation in West Africa, Zaire, South-east Asia and Central America and is generally regarded as the highest yielder of all the oil producing plants (http://www.wikipedia.org/palm_oil)

There are two species of oil palm, the better known one is the one originating from Guinea, Africa and was first illustrated by Nicholas Jacquin in 1763, hence its name, Elaeis guineensis Jacq. The fruit is reddish about the size of a larger plum and grows in large bunches. A bunch of fruits can weigh between 10-40kg each. Each fruit contains a single seed (the palm kernel) surrounded by a soft oily pulp. Oil is extracted from both the pulp of the fruit (palm oil, edible oil) and the kernel (palm kernel oil, used mainly for soap manufacture).

Palm oil itself is reddish and contains a high amount of carotenoids. It is used chiefly in making soaps, candles and lubricating grease and in processing tin-plate and coating iron-plates. The palm fruit is the source of both palm oil and palm kernel oil. Palm oil extracted from the palm fruit flesh is composed of fatty-acids esterified with glycerol just like any ordinary fat. It is high in saturated fatty acids. The oil palm gives its name to the 16 carbon saturated fatty acids, palmitic acid found in palm oil, monosaturated oleic acid is also a constituted of palm oil. Palm oil is the largest natural source of tocotrienol, part of the vitamin E family.

The physical and chemical properties of palm oil have been reported to be determined by the nature of the constituent fatty acids making up about 95% of the glyceride molecule. The oil contains saturated and unsaturated fatty acids including palmitic, stearic, lauric and myristic acids as saturated constituents with linoleic and oleic forming the bulk of the unsaturated acids.

The proximate concentration of fatty acids in palm oil is as follows: myristic C14:0 1%, palmitic C16:0 44.3%, stearic C 18:0 46%, oleic C18:1, 38.7% and linoleic C18:2 10.5%.

Palm oil has been reported to be relatively stable to oxidation due to the presence of high concentration of potent anti-oxidants like tocopherols and tocotrienols (Eckey, 1954).

2.9 GROUNDNUT OIL

Groundnut, arachic hypogaea .L. also know as the peanut African nut or earth nut, is a member of the papilionaceae, largest and most important of the three divisions of leguminosae (Williams et al, 1986). The oldest indications of groundnut cultivation are from the pre-columbian native societies, peru, 2000-3000 BC, well to the north-west from which it can reasonably be assured to have been originally domesticated in the distant past by predecessors of the Arawak-speaking people who now live in it.

2.9.1 PHYSICAL AND CHEMICAL PROPERTIES OF GROUNDNUT OIL

PHYSICAL PROPERTIES

Fats are organic compounds which consist of glycerides and fatty acids. However, the groundnut oil contains a high proportion of stearic, palmitic, oleic, linoleic and myristic acids. Fats are insoluble in water and only slightly soluble in lower alchohols. They are readily soluble, in chloroform, benzene, hexane and carbon tetrachloride. With this, it is therefore important to note when fats are to be used for soap making. Furthermore, fats to be used or

PRODUCTION OF LUBRICANT FROM PALM OIL AND GROUNDNUT OIL

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which are permitted for soap making should contain no solvent as this will affect the required properties of the fat plasticity.

CHEMICAL PROPERTIES

The insolubility of fats in water is the basis for the ability of liquid fat to form emulsions with water because fats consists of complex mixtures of different triglycerides, they do not have a sharp melting point but melt gradually over a range of temperatures.

The iodine value has also been used to classify fats and oils. The iodine value is related to their degree of unsaturation and also has much to do with the reaction of fats with oxygen at ordinary temperatures. The result is expressed as iodine value (that is, number of grams of iodine needed to saturate 100g of fats), groundnut oil is known to have iodine of between 82—106. (Lawrence, 2002)

2.9.2 EXTRACTION OF OIL FROM GROUNDNUT OIL

The groundnut seed contains about 47% oil. This shows that the oil content of the seed is much, thus, there is need to develop process for the extraction of this oil for both domestic and industrial uses. There are two methods of extraction.

a) Mechanical screw pressing
b) Solvent extraction

(a) MECHANICAL SCREW PRESSING

This process can be likened to the squeezing of the oil mechanically from the nut. The seeds are put in the screw presses after the necessary pretreatment and the oil is squeezed or pressed out. This process is simple and can be done locally at home using domestic apparatus such as pestle and mortar.

(b) SOLVENT EXTRACTION

This involves the use of a solvent to extract the oil from the seed. It is also referred to as leaching. Any organic solvent can be used but it is advisable to use one with low boiling point such as hexane for easy removal after extraction. The solvent is used to wash the seed down allowing the oil to dissolve in it and pour down as raffinate is then heated to about 900c to remove the solvent. (Macrea et al, 1997)

CHAPTER THREE

3.0 EXPERIMENTALS

3.1 MATERIALS / EQUIPMENT

The table below shows the list of materials (equipments) used in the determination of the physiochemical properties of the blended samples.

TABLE 1.0: SHOWING VARIOUS EQUIPMENT USED IN THE DETERMINATION OF THE PHYSIOCHEMICAL PROPERTIES OF THE BLENDED SAMPLES.

Viscometer
Stop watch
Cleveland open cup flash point tester
Beakers
Electronic weighing balance
Magnetic stirrer
Thermometer
Viscometer constant temperature bath

3.2 METHODOLOGY

3.2.1 COLLECTION OF SAMPLE MATERIALS

The sample materials used in this experiment are groundnut oil, palm oil and additives. The groundnut oil and palm oil were obtained from Mobil central market, Minna, Niger state and Awka central market, Anambra state respectively while additives was obtained from Whiz Oil (W/A) Limited.

3.2.2 SAMPLE PREPARATION

The sample materials used in this experiment are represented as X and Y for groundnut oil and palm oil respectively. Where X and Y is the composition or volume of each material in a particular sample. Two samples represented as A and B was prepared with the following composition and volumes. Into each sample, $3cm^3$ of additive was added ($2cm^3$ of two stroke additive and $1cm^3$ of anti-rust, anti-oxidant additives).

TABLE 2.0: SAMPLE PREPARATION

SAMPLE	MATERIAL COMPOSITION (%)		MATERIAL VOLUME (cm^3)	
	X	Y	X	Y
A	100	0	100	0
B	0	100	0	100

3.3 EXPERIMENTAL PROCEDURE

Qualitative analysis tests are designed to measure physical and chemical properties of oils. These properties include flash and fire point, kinematic viscosity, viscosity index and density.

3.3.1 DETERMINATION OF FLASH AND FIRE POINT

PROCEDURE

- The sample to be tested was poured into the open cup.
- The cup was then placed on the heating element.
- Heat was applied at constant rate.
- Flame from the torch nozzle was directed over the heated sample at regular intervals.

- The flash point was reached when the torch flame ignited the vapour of the sample (that is, the first spark).
- As heat was continuously applied and flame was continuous passed over the heated sample, a further spark was observed that lasted for five (5) seconds which indicated the fire point.

3.3.2 DETERMINATION OF KINEMATIC VISCOSITY PROCEDURE

- The viscometer was charged with the sample fluid through tube.
- The viscometer was inserted into the viscometer bath.
- The viscometer bath was switched on to attain the experimental temperatures of 40^0C and 100^0C.
- The sample was allowed at least 10 minutes to come to the bath temperature at 40^0C and 15 minutes at 100^0C.
- The sample was sucked up the capillary tube above the upper mark.
- Stopwatch was started when the sample to the upper mark and was stopped when the sample reached the lower mark.
- The kinematic viscosity was calculated by multiplying the efflux time in seconds with the viscometer constant.

3.3.3 DETERMINATION OF VISCOSITY INDEX

Using the values of the kinematic viscosity (in cSt) at temperatures of 40^0C and 100^0C, the viscosity index is obtained from a table published by ASTM (American Society for Testing and Materials) either directly or by interpolation.

3.3.3 DETERMINATION OF DENSITY

PROCEDURE

- The beaker was weighed on the weighing apparatus.
- The weight of the beaker was deleted from the screen.

- A known volume of the sample was poured into the beaker and weighed.
- The reading on the screen was taken which indicated the weight of the sample.
- Density was obtained from the relation:

$$\text{Density} = \frac{\text{Weight of sample}}{\text{Volume of sample}}$$

CHAPTER FOUR

4.0 RESULTS

4.1 EXPERIMENTAL RESULTS

The results obtained after various tests were carried out on the samples under consideration are tabulated below.

TABLE 1.0: SHOWING THE KINEMATIC VISCOSITY AND VISCOSITY INDEX OF SAMPLES

SAMPLE	K.V(40^0C) cSt	K.V(100^0C) cSt	VISCOSITY INDEX
A	39.15	8.69	210
B	39.97	8.28	189

TABLE 2.0: SHOWING FLASH POINTS AND VISCOSITY OF SAMPLES

SAMPLE	FLASH POINT (^0C)	V (40^0C) g/cm sec	V (100^0C) g/cm sec
A	294	35.91	7.97
B	236	36.80	7.63

TABLE 3.0: SHOWING THE DENSITY OF SAMPLES

SAMPLE	DENSITY (g/cm^3)
A	0.9173
B	0.9209

4.2 DISCUSSION OF RESULTS

From the experimental analysis carried out, the flash point (which shows the response of the sample to heat under controlled conditions) of sample A and B was observed to be within the acceptable limit, that is, it conforms with the specification of 210°C minimum for flash point. From Table 2.0 the flash point of sample A and B was obtained as 294°C and 236°C respectively showing that though both samples conforms with specification for flash point, sample A (blended groundnut oil) gave a higher flash point than that of sample B (blended palm oil) and both sample falls within SAE 30 (two stroke engine oil) specification.

Also, density of sample B was observed to be greater than that of sample A from table 3.0 with sample A having a density of 0.9173g/cm^3 and sample B with density of 0.9209g/cm^3 .This value indicates that sample A is less dense than sample B.

From table 2.0, the kinematic viscosity of sample A at 40°C is less than that of sample B at the same temperature, that is, 39.15cSt and 39.97cSt for sample A and B respectively while the kinematic viscosity of sample A (at 100°C) was obtained as 8.69cSt and that of sample B was obtained as 8.28cSt, though both conform to specification for kinematic viscosity. Using the results of kinematic viscosity at 40°C and 100°C for both samples, viscosity index was obtained. Sample A and B has a viscosity of 210 and 189 respectively. This value indicates a higher viscosity index for both samples and indicates a low rate of change of viscosity with temperature though the viscosity index of sample A is higher than that of sample.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

At the end of this experimental analysis, the results of both samples (A and B) were observed to conform to specification for two stroke engine oil. Therefore, both oils (groundnut oil and palm oil) can be used as alternatives for petroleum - based mineral oil in the formulation of lubricant. Also, the results obtained clearly shows that the blended groundnut oil has better lubricating properties than that of blended palm oil, and in terms of appearance, the blended palm oil separated into two layers with the heavier part settling at the bottom.

In terms of cost, the use of vegetable oil for lubricant production is more expensive than that of petroleum based mineral oil but because vegetable based lubricants evaporates less quickly and adhere better to metal surfaces and users often use less product per application the cost is justifiable and are good for systems that function by loss lubrication.

5.2 RECOMMENDATION

If palm oil is to be used, it is recommended that it should be bleached. Bleaching helps in removing the gummy materials and destroying the carotene (red color) of palm oil, thereby reducing its staining characteristics. Also, groundnut oil should be further refined to remove its smell and improve its appearance. The refined vegetable oil (groundnut oil and palm oil) can be combined with petroleum based mineral oil in lubricant formulation as this will reduce cost.

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APPENDIX

1. CALCULATION OF KINEMATIC VISCOSITY

Kinematic Viscosity = Efflux time x viscometer constant

Viscometer constant at $40^0C = 0.09844$

Viscometer constant at $100^0C = 0.03530$

TABLE 1.0 : **SHOWING SAMPLES AND THEIR EFFLUX TIME**

SAMPLE	EFFLUX TIME (SECONDS)	
	40^0C	100^0C
A	397.72	246.04
B	406.00	234.44

SAMPLE A

K.V (40^0C) = 397.72 X 0.09844 = 39.15 cSt

K.V (100^0C) = 246.04 X 0.03530 = 8.69 cSt

SAMPLE B

K.V (40^0C) = 406.00 X 0.09844 = 39.97 cSt

K.V (100^0C) = 234.44 X 0.03530 = 8.28 cSt

2. CALCULATION OF DENSITY

Weight of empty beaker = 33.0168g

Volume of sample = $5cm^3$

$$\text{Density} = \frac{\text{Weight of beaker with sample} - \text{Weight of empty beaker}}{\text{Volume of sample}}$$

SAMPLE A

Weight = 37.6034g

Density = $\frac{37.6034 - 33.0168}{5}$

$= \frac{4.5866}{5}$

$= 0.9173 g/cm^3$

SAMPLE B

Weight = 37.6213g

Density = $\frac{37.6213 - 33.0168}{5}$

$= \frac{4.6045}{5}$

$= 0.9209 g/cm^3$

3. CALCULATION OF VISCOSITY

Viscosity of a sample is the product of kinematic viscosity and its density, that is;

V = K.V X D

SAMPLE A

K.V (40^0C) = 39.15

K.V (100^0C) = 8.69

Density = $0.9173 g/cm^3$

Viscosity (40^0C) = 39.15 x 0.9173 = 35.91g/cm sec.

Viscosity (100^0C) = 8.69 x 0.9173 = 7.97g/cm sec.

SAMPLE B

K.V (40^0C) = 39.97

K.V (100^0C) = 8.28

Density = 0.9209g/cm^3

Viscosity (40^{0}C) = 39.97 x 0.9209= 36.80g/cm sec.

Viscosity (100^{0}C) = 8.28 x 0.9209 = 7.63g/cm sec.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

Oils and fats of vegetable and animal origin were extensively used as lubricants till the middle of the 19th century. Vegetable oil formed a major share in the total usage of lubricants. By that time, the rapid industrialization made the requirement of lubricants very high, putting pressure on the price and availability of lubricants from vegetable and animal sources. Successful prospecting and extraction of mineral oils during the second half of the 19th century made available large quantities of cheap replacement for lubricants of vegetable and animal origin. But soon it was found that mineral oil with the same viscosity, as that of the vegetable or animal based oils, was not as effective as a lubricant as the latter. This was attributed to a property of the vegetable or animal oils and fats called oiliness or lubricity.

To impart oiliness to mineral oils based lubricants, a small percentage of vegetable or animal oil was added to it as oiliness additive. Later, many organic, inorganic and polymer additives for mineral oil-based lubricants were developed to meet the operating requirements made on the lubricants used in various applications including high-speed and high performance internal combustion engines. (Karian, 2003)

2.2 LUBRICATION AND LUBRICANTS

Lubrication is the application of scientific principles for reducing the friction between two sliding surfaces by separating them from each other with a substance termed a lubricant. A lubricant is a substance introduced between two moving surfaces to reduce the friction and wear between them. A lubricant provides a protective film, which allows for two sliding surfaces to be separated thus lessening the friction between them. Of all the lubricant, engine oil is the most important.

Typically, lubricants contain 90% base oil (most often petroleum fractions called mineral oils) and less than 10% additives. Vegetable oils or synthetic liquids are sometimes used as base oils. Additives deliver reduced friction and wear, increased viscosity, resistance to