CHARACTERISATION AND IMPROVEMENT OF NIGERIAN LUBRICATING OILS

BY

SUMAILA ADINOYI
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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG) DEGREE IN THE DEPARTMENT OF CHEMICAL ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE, NIGERIA

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CERTIFICATION

I certify that this project titled "Characterisation and improvement of Nigerian Lubricating oil" was carried out by Sumaila Adinoyi under the supervision of Dr. Edoga and Mrs. Elizabeth Eterigho.

I found the work adequate both in scope and quality for the partial fulfilment of the requirement for the award of bachelor of engineering degree in chemical engineering.

....	....
DR.M.O. EDOGA PROJECT SUPERVISOR	DATE
....	....
DR. J.O. ODIGURE HEAD OF DEPARTMENT	DATE
....	....
EXTERNAL EXAMINER	DATE

DEDICATION

This project is dedicated to the almighty God and my late parents; Chief Obaro Ismaila, and madam Ismaila Mariyetu Attah. May their gentle souls continue to rest in perfect peace. Amen.

ACKNOWLEDGEMENT.

To God be the glory and adoration for bringing my dream into reality. I exalt your name and praise your majesty for your faithfulness and grace.

This well accomplished task is a result of collective efforts. I came to this lofty height in my career due to the influences of many people.

First and foremost is my father who laid the foundation even before his death. I could remember the last words you said to me before your demise, that your at most desire is to see me through my academic pursuit. I thank God almighty that I have achieved your aspiration. Oh my dad, you have created a vacuum that can never be filled.

This project came to being as a result of the following people influences; Dr. M.O. Edoga and Mrs. Eterigho Elizabeth (who supervised the project) as well as Mr. T.O. William (quality controller LUBCON Limited, Ilorin kwara State).

I gratefully acknowledge Mariyam Ismaila, Mummy Aishetu Salami, Maminat Shaidu, Hanjarat Aliyu, Arametu Shaibu for their love, encouragement, moral and financial support,I am proud of you.

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ABSTRACT.

This research work centred on characterization and improvement of Nigerian Lubricating oils. The Nigerian products selected for the work were Mobil (SAE 40) and shell motor oil (40).

The kinematic viscosities at 40°c and 100°c, the viscosity index, the specific gravity, the total Base number (TBN), the flash point and the pour point were all determined according to ASTM specifications.

The viscosity index was enhanced by adding 4.5% of alkylated styrene (Lubrizol®) so as to conform with the optimum value specified by the international standard.

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CHAPTER FIVE

CHAPTER ONE.

1.0 INTRODUCTION.

Lubricating oils are petroleum products used to minimize friction and wear by prevention of contact between parts in relative motion. Lubricating oils also serve to cool working parts, reduce corrosion and deposition of solids on close fitting parts. These properties in conjunction with others help to minimize the maintenance cost and increase the economic and life span of equipment and machinery.

The general suitable range of hydrocarbons that constitute petroleum fractions varies from molecular weight of 150 to 1000. The viscosity also ranges from light machine oil to heavy gear oil. Fraction obtained during the refining process includes saturated (normal ISO and cycle paraffin), mono aromatic with saturated rings and saturated side chain. Other are substituted Poly-aromatics, hetero compounds containing sulphur, Nitrogen and oxygen and asphalt materials made up of mono aromatics and poly condensed aromatics and hetero compounds. Of these free saturated provide the desired viscosity and temperature range required for finished oils called neutrals. After the removal of the neutrals, the residual fractions are treated with activated clay to remove asphaltic and heteromaterials to yield the bright stock. Further treatment involves extraction of the oils with solvents such as liquid sulfur dioxide (SO_2), furfural and phenol. The process removes the polyaromatic and hetero compounds hereby improving the stability and viscosity temperature characteristics of the oil. High melting paraffin are removed by dewaxing.

Basically, Base oils from which motor oils are manufactured do not have the sufficient properties to meet the lubrication requirement of modern highly rated engines. Chemical substances known as additives are therefore added to the base oils to enhance the properties in various directions such as increasing the viscosity index (VI).

1.1 AIMS AND OBJECTIVES.

The aims and objectives of this research are to study the characteristics of Nigerian lubricating oils as well as compare them with the international standard specifications. Moreso, the aim of research is to improve the Nigerian lubricating oils properties so as to compare favourably with the international standard.

1.2 SCOPE AND LIMITATION.

In attempt to carryout the investigation, two Nigerian lubricating oils of viscosity grade SAE 40 from Mobil and shell were selected. The physicochemical properties of the samples, such as flash point, total Base Number (TBN), Kinematics viscosity, viscosity index (VI), specific gravity and API gravity were determined.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 GENERAL CONSIDERATION.

The principle of supporting a sliding load on a friction reducing film is known as lubrication. The substance of which the film is composed is a lubricant and to apply it is to lubricate. The concept of lubrication is not new, farmers lubricate the axles of their ox cart with animal fat centuries ago. History has it that many centuries ago, grease made of a combination of animal fat and calcium were used to lubricate chariot wheels in Greese, Rome and Egypt. Also, in early 19th century, vegetable oils from olives, race seed, castor seeds and animal fat from tallow and whale were mixed with potassium, calcium and sodium soaps to make grease used for the lubrication of steam cylinder and cutting metals.

But modern machinery has become many times more complicated since the days of the ox cart, and demands placed upon the lubricant have become proportionally more exacting. Though the basic principle still prevail, the prevention of metal to metal contact by means of an intervening layer of fluid has become a complex study situation, petroleum lubricants stand high in metal wetting ability, and they possess the body or viscosity characteristic that a substantial film requires. Though the subject is beyond the scope of this discussion, these oils have many additional properties that are essential to modern lubrication, such as good water resistance, inherent rust prevention-characteristics, natural adhensiveness, relative thermal stability, low volatility, ability to transfer frictional heat away from the lubricated parts and low cost.

What is more nearly all of these properties is that they can be modified during manufacture to produce a suitable lubricant for each of a wide variety of applications. Oils have been

developed hand-in-hand with the modern machinery that they lubricate; indeed the efficiency if not the existence, of many of today's industries and transportation facilities are dependent upon petroleum fuels.

The basic petroleum lubricant is lubricating oil, which is often referred to simply as "oil". This complex mixture of hydrocarbon molecules represents one of the important classifications of product verified from the refining of crude petroleum oils, and are readily available in a great variety of types and grades.

Lubricants are from the higher boiling fraction and the undistilled residue of fractional distillation of crude oil. These portions are chosen because they posses the required viscosity and they are not volatile in nature.

Motor oils are made from fractions covering the following range of carbon atom content Gruse (1967).

GRADES	RANGE OF CARBON	AVERAGE VALUE FOR WHOLE OIL
SAE 10	C_{25} TO C_{35}	C_{28}
SAE 30	C_{30} TO C_{50}	C_{38}
SAE 50	C_{40} TO C_{100}	C_{41}

The chemical composition of the hydrocarbon contained in the lubricating oil is complex. Great bulk of hydrocarbon and hydrocarbon type compounds containing the other elements normally found in petroleum usually sulfur, nitrogen, and oxygen are derivatives of a few main and rather simple types. These are the paraffin, the napthenes, and the aromatics in the case of unchanged crude oils.

2.1 PHYSIOCHEMICAL PROPERTIES OF LUBRICATING OIL

1. POUR POINT Pour point is defined as the lowest temperature at which the oil is observed to flow, when cooled. Pour point is very important in selecting lubricants.

2. FLASH POINT- The flash point is the temperature at which a lubricant momentarily flashes in the presence of test flame. Flash point aids in evaluating fire resistant properties and like the pour point, flash point may in some instance become the major factor in selecting the proper lubricant, especially in lubricating Machinery handling highly flammable material.

3. COLOUR:- The color of lubricating oil varies from very pale to dark and may be expressed on some chosen scale. The color of lubricating oil is essential so that variation outside the established range automatically indicates change in quality or possible contamination with another product.

4. DENSITY AND SPECIFIC GRAVITY –Density is defined as mass per unit volume. In petroleum industry the system international (SI) units for density is Kg/l. specific gravity on the other hand is the ratio of the mass of a given volume of liquid at 15°c to the mass of an equal volume of pure water at the same temperature. The most important use of specific gravity in the petroleum industry is for the purpose of bulk oil measurement, that is calculating weights from measured volume.

5. NEUTRALIZATION NUMBER- The neutralization number is a measure of the acid or alkaline content of new oils and an indicator of the oxidation degradation of used oils. The total acid number (TAN) and the total bass number (TBN) is the measures of this amount of acid or basic substances under the conditions of the test.

6. VISCOSITY- Viscosity is the most important since it determines the amount of friction that will be encountered between sliding surfaces. Viscosity which is measured with viscometer can be defined as the resistance to flow of a liquid. Ideally, lube oil should have sufficient viscosity to maintain a sufficient thick film but not so viscous as to cause drag.

7. FREEZING POINT- The freezing point of lubricating oil is the temperature at which solid crystal separates from lubricating oil.

8. CARBON RESIDUE- This is to determine the degree of refining and carbon forming tendency of lubricating oil. Carbon residue is the amount of deposit (in percentage by weight) after evaporation and pyrolysis of the product under prescribed conditions.

9. ASH AND SULFATED ASH- This is the residue in percentage by weight remaining after burning the product. The knowledge of the ash content may provide information as to whether or not the product is suitable for use in a given application.

10. WATER SEPARATION- Lubricants used in certain type of equipment often become mixed with water in service. Oil intended for these type of service should separate quickly and clearly from water and particularly avoid the formation of emulsion.

2.2 FUNCTIONS OF LUBRICANTS

Although a lubricating oil primarily controls friction and wear, it can and ordinarily perform numerous functions which vary with the application.

1. Reduced Friction- Under lubrication conditions, a thick film of engine oil prevents metal to metal contact between moving engine parts. The amount and character of the lubricant available to sliding surfaces have a profound effect upon the friction that is encountered.

2. Prevent Wear- Wear occurs on lubricated surfaces by abrasion, corrosion and solid to solid contact. Proper lubricants will help combat each type. They reduce abrasive and solid to solid contact between sliding surfaces there by lessening the damage by abrasive contaminants and surface aspirates. Corrosion wear is generally caused by the products of oxidation of petroleum lubricant. Use of oxidation inhibitors reduces deterioration of petroleum lubricants.

3. Temperature Control-- Lubricants assist in controlling temperature by reducing friction and carrying off the heat that is generated. Effectiveness depends upon the amount of lubricant supplied, the ambient temperature and the provision for external cooling. Generally, it is assume that engine cooling is accomplished only through the action of the water antifreeze mixture used in the cooling system. This mixture, infact does only about 60 percent of the cooling job. It cools the upper parts of the engine only such as cylinder heads, cylinder walls etc but crank shaft and its bearing, the pistons and many other components in the lower part of the engine are directly dependent on the motor oil for necessary cooling.
4. Protection Against rust and corrosion-- The role of a lubricant in controlling corrosion of the surfaces themselves is two folds, when machinery is not in use, the lubricant acts as preservative. When machinery is in use, the lubricant control corrosion by coating lubricated part with a protective film that may contain additives to neutralize corrosive materials. The ability of a lubricating oil to control corrosion is directly proportional to the thickness of the lubricant film remaining on the metal surface and the chemical composition of the lubricants. Additives that react with the

sliding surfaces enhance the corrosion control of the lubricant.

5. Seal combustion pressure:- The surfaces of the piston rings, ring grooves and cylinder wall, are not completely smooth. If examined under a microscope, these surfaces would show minute hills and valleys. For this reasons the ring by themselves can never completely prevent high combustion and conversion pressures from escaping into the low

pressure area of the crankcase, with the consequent reaction on engine power and efficiency. Lubricating oils fill these hills and valleys on the ring surfaces and cylinder walls and help to seal in the compression and combustion pressures.

Also lubricating grease frequently performs the special function of forming a seal to rotten lubricants or exclude contamination .

6. Keeping engine parts clean:- Lubricants help to keep engine parts clean and prevent sludge and vanish deposits from interfering with proper engine operation. Straight mineral oils have only very limited ability to keep these contaminants from clumping and forming masses of sludge within the engine. This is the job of the detergent/dispersing additives that are blended into modern motor oils. These additives keep vital engine parts clean and oil contaminants suspended in such fine form that they can be removed by regular oil changes.
7. Aid fuel economy:- Oils are available which have been formulated by the oil chemist to give improved fuel economy in gassoline fueled engines. The fuel economy benefits are delivered in various means including use of friction modifier additives.

In practice, many other properties must be taken into account to make sure that oil continues to lubricate properly over a long period or to make sure that nothing else goes wrong with the system and so on.

The following are some of those properties:

8. Thermal stability:- If an oil becomes hot in use, then it is important that the heat does not make it to break down so that it ceases to lubricate properly;
9. Chemical stability:- This is the ability to resist chemical attack such as attack by oxygen from the air, or by water or by the other substances.

10. Compatibility:- This refers to any interaction between the oil and other material present. For example, an oil may cause the rubber of a seal to swell or shrink, or to soften or harden.
11. Toxicity:- this means in every respect a substance that can affect health. The oil should not be toxic.
12. Flammability:- It is obviously important that the oil should not be flammable under the conditions under which it is used, especially some industries such as aviation and coal mining.
13. Heat capacity:- this affect the amount of heat the oil can carry away from the bearing in an oil circulation system.
14. Corrosiveness:- Corrosion is a particular type of incompatibility in which the oil or something in the oil, attacks a metal component in the system. An Oil which is completely non corrosive when new may become corrosive after a period.

2.3 TYPES AND FUNCTIONS OF ADDITIVES.

A straight mineral oil regardless of how well- refined does not provide satisfactory lubrication for engines. From research work, chemical substances known as additives

have been discovered to boost the properties of oil in various directions such as increase the viscosity index (VI). These chemical additives have different functions and are of different types. They includes:

1. POUR POINT DEPRESSANTS- These are chemical mostly polyalkyl metacrylates that are added to oils to prevent it from congealing at low temperatures. They are called pour point depressant because they lower

the temperature at which oils will pour or flow. They are commonly found in most motor oil designed for cold weather use.

2. DETERGENT/DISPERSANT ADDITIVES—This class of additives prevent combustion by-products from forming harmful sludge or vanish deposit by keeping them suspended in a very fine form. The purpose of this additive is not so much cleaning up already existing engine deposits as to prevent their formation. Example of detergent additives are sulphonates, phonates salicynates and phosphates of calcium, magnesium and barium. Dispersants often used includes ashes (non metallic) substances such as polyisobutanyl succinimides metallic and polyisobuteryl succinic esters.
3. FOAM INHIBITORS-Foam is simply lots of bubbles whipped into oils during service, since foam is not a good conductor of heat, it impairs engine cooling and therefore accelerates oil oxidation. Foam inhibitors when added to oil increases the surface tension of oil and cause bubbles to collapse as they are formed. Poly silicones are widely used as antifoam agent.
4. VISCOSITY INDEX IMPROVER—The viscosity of an oil is a function of temperature, thinner when hot and thicker when cold. Viscosity index number is the measure of viscosity change with temperature and the higher the number, the smaller the change with temperature. Motor oils which are used under a wide range of engine operating temperature benefit from having high viscosity index number. Polymers or polymeric compounds which are viscous chemical is used to decrease the rate at

which oil change viscosity with temperature and they are called viscosity index improper. They give rise to "multigrade" or "all season" oil.

5. RUST AND CORROSIVE INHIBITORS—The combustion process produces water and corrosive acid which lead to rust and corrosion of engine parts These acid are neutralized by the use of alkaline material such as vinegar, baking soda, and thereby preventing rusting and corrosion.
6. ANTI OXIDANTS—Excessive engine heat oil oxidation can cause permanent thickening of the oil. Bearing metals are often attacked by oxidation product in oil. To Counteract this tendency, antioxidant additives act either as a free radical inhibitor or as a peroxide decomposer. Zinc dithiophosphates hindered-phenols or aromatics amines are commonly antioxidants.
7. FRICTION MODIFIER—Fuel consumption can be reduced by adding friction modifying additives which have a long waxy soluble hydrocarbon. The friction of moving engine part or oil flow in the engine will be reduced.
8. ANTI WEAR IMPROVER—These are organic phosphate esters such as alkaline detergents, zinc dithiophate etc, that help to reduce friction and wear in moving part of engines.

2.4 ENGINE OIL CLASSIFICATION.

The engine manufacturers and the petroleum industries, classified engines oils using two systems based on their viscosity grades and their performances. This is to enable the motorist and the likes in selecting proper engine oil to meet the required lubricant service.

2.1.1 SAE Crankcase oil viscosity classification system.

The society of automotive engineers (SAE) developed a classification system based on viscosity measurement. According to LUBCON (1993), the system establishes seven distinct motor oil viscosity grades which are 5 W, 10 W, 20 W, 20, 30, 40 and 50. The ranges of viscosity for each grade are given below:

VISCOSITY GRADE	VISCOSITY RANGE COST AT 100^{o}C		VISCOSITY RANGE IN CP AT 18^{o}C
5W	MINIMUM	MAXIMUM	1,250
10W	3.8	-	1,250
20W	4.1	-	10,000
20	5.6	-	-
30	.5.6	9.3	-
40	9.3	12.5	-
50	12.5	16.3	-
	16.3	21.9	-

Table 2.1: shows the viscosity range of oil grades. (LUBCON laboratory manual).

The "W" following the SAE viscosity grade stand for winter and indicates that an oil is suitable for use in colder temperature. Those SAE classification without "W" designation defined oil grades for use at higher temperature.

Today, well defined high viscosity index oil, however an SAE 20 will usually meet the viscosity requirement of SAE 20w and vice versa. This is the simplest form of multigrade oils such as SAE 10w-20, and SAE 10w-40 are widely used because under all but extremely hot or cold conditions, they are light enough for easy cranking at low temperature and heavy enough to perform satisfactorily at high temperatures.

2.1.2 API ENGINE SERVICE CLASSIFICATION SYSTEM.

The SAE crankcase oil viscosity grade classification do not consider the type and quality or performance of the oil.

According to LUBCON (1993), in 1970, The American Society for Testing and materials (ASTM) and the Society of automotive Engineers (SAE in collaboration with the American Petroleum Institute (API), established an API engine service classification system. This system enables engine oils to be defined and selected on the basis of their performance characteristics and the type of service for which they are intended.

The system uses letter designation for each service category thereby providing a convenient means for indicating the services characteristics of various engine design and lubrication requirement. The classification system is divided into two series.

2.5.2.1"S" series - This classification defines the performance level associated with oils sold at service station, car dealers and grades.

API ENGINE SERVICE CATEGORY	MAJOR ADDED PERFORMANCE FEATURES
SA	None
SB	Mineral antiwar and antiscuff
SD	Mould deposit wear, corrosion, rust and deposit control
SE	Added oxidant and deposit control
SG	More strongest wear, oxidation and deposit control, long drain capability and prevent sludge formation.

Table 2.2 shows "S" series classification (LUBCON laboratory manual).

2.5.2 "C" Series – This classification is mainly related to commercial off road and farm vehicles.

Commercial and fleck engine service category	Major added performance features.
CA	For height duty diesel engine service operating on high quality fuel
CB	Moderate duty diesel engine operation on lower quality fuels. Provides more protection against wear and deposits.
CC	Moderate duty diesel and gasoline engine sludge and highly supercharged diesel performance.
CD	Severe duty diesel engine. Highly effective control of wear and deposit

Table 2.3 shows "C" series classification (LUBCON 1993)

2.2 TEMPERATURE – VISCOSITY RELATIONSHIP

The viscosity of a particular fluid is not constant, however, varies with temperature. As an oil is heated, its viscosity drops and it becomes thinner. Conversely, an oil becomes thicker if its temperature is reduced and it will not flow as rapidly. Therefore a numerical figure for viscosity is meaningless unless accompanied by the temperature to which it applies.

To a certain extent, a lubricating oil has the ability to accommodate itself to variation in operating conditions. If speed is increased, the greater frictional heat reduces the operating viscosity of the oil, making it better suited to the new condition.

Similarly an oil of excessive inherent viscosity induces higher operating temperature and corresponding drops in operating viscosity. The equilibrium temperature and viscosity had been applied. So the need for proper viscosity selection is by no means eliminated.

Oils vary however in the extent to which their viscosities change with temperature. An oil that thins – out less at higher temperature is said to have a higher viscosity index (VI).

This is true for example of motor oils which may operate over a 100°F temperature range. With an automobile engine, there is an obvious advantage in an oil that does not become sluggishly thick at low starting temperature or dangerously thin at high temperature. So good lubrication practices include consideration of the viscosity index of the oil as well a its inherent viscosity.

The rate at which oil changes with temperature varies with the type of oil and it nature. Figure 2.1 shows the variation of viscosity and temperature for unmodified mineral oil and mineral oil with viscosity index improve. Obviously, in selecting the best oil viscosity for any application, it is the viscosity at the normal operating temperature which is most important.

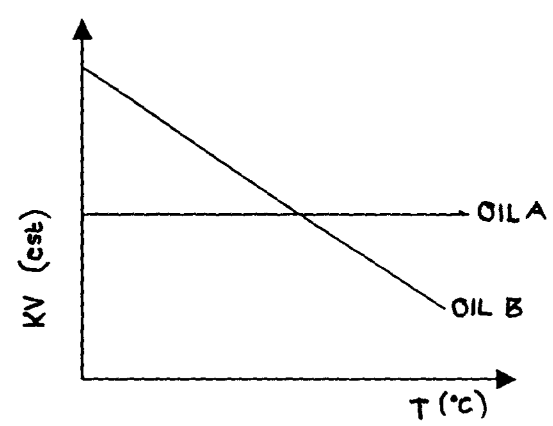

Fig 2.1 Temperature- viscosity relationship of oil A and B where oil "A" is mineral oil

With viscosity index improver and oil "B" is unmodified mineral oil .

The viscosity index (VI) supplies a method for assigning number to the extent to which the viscosity of a particular oil is dependent on temperature. It involves adopting two natural petroleum oils as standard of viscosity change with temperature according to Gruse (1967).

1. Oil "H" showing comparatively little change was assigned the number 100. This was a penny slavancia type oil.
2. Oil "L" Showing comparatively little change was assigned O value, it was a Gulf coastal oil.

The two standards were of the same viscosity at 210°F, so the interporation of values for oils of intermediate characters is made by using the viscosity at 100 °F in all cases.

$$VI = \frac{\text{viscosity of L} - \text{viscosity of sample}}{\text{Viscosity of L} - \text{viscosity of H}} \times 100$$

This index has been quite valuable and is usually and is widely used. High viscosity index which signifies a relatively flat viscosity – temperature curve has become one mark of quality.

Some few oils have index number above 100, one way of producing these is to add substance to the oil such as ordinary polymers which will raise viscosity values at high temperature relatively more than they will at low temperatures.

Among the mineral oils, the highest natural viscosity index is obtained with paraffin oil and the lowest with naphthenic oils. Oils having a natural VI above 80 are called High viscosity Index (HVI), those with a natural viscosity index below 30 are called low viscosity index (LVI), while the intermediate oils are medium viscosity index according to Lansdown (1982).

CHAPTER THREE.

3.0 EXPERIMENTAL METHOD.

The standard procedures or method for testing and measurement of the physiochemical properties of lubricating oils have been specified down by some bodies such as American Society for Test and materials (ASTM), American petroleum institute (API) etc. This research which was carried out at Lube Bend company Nigerian (LUBCON) limited was limited to the following physicochemical properties due to lack of reagents and apparatus:

1. Specific gravity
2. API gravity
3. Total Base Number (TBN)
4. Kinematics viscosity
5. Viscosity Index (VI)
6. Flash point.

3.1 DETERMINATION OF SPECIFIC GRAVITY

3.1.1 APPARATUS.

- Hydrometer
- Thermometer
- Hydrometer cylinder
- Stop watch.

3.1.2 PROCEDURE.

The sample was transferred into a clean and dried hydrometer cylinder without splashing air bubbles formation. The cylinder containing the sample was placed in a vertical position and the hydrometer was lowered gently into the sample with the thermometer. The hydrometer was left in the oil for 15 minutes, and then the temperature

(T) and the reading of the hydrometer was noted and recorded. This procedure was repeated for the other sample.

3.1.3 CALCULATION.

The specific gravity (SG) was calculated with the formula

$$(T-15) \times 0.00062 \times X \quad ---- \ 3.1$$

where

T = Temperature of the sample (T)

X -= Hydrometer measured value (obtained value)

0.00062 = constant.

API gravity was calculated with the formula

$$API = \frac{141.5}{SG \text{ at } 15/15^{\circ}c} - 131{,}5 \quad ---- \ 3.2$$

Where SG = specific gravity calculated from 3.1.3.1 above.

3.2 FLASH POINT DETERMINATION

3.2.1 APPARATUS.

- Test cup – made of brass or other non rusting metal of equivalent conductivity.

- Heating plate – with a centre hole surrounded by an area of plane depression and a sheet of hard asbestos covering the metal except depression.
- Test flame applicator – For applying the flame with an operating device mounted to permit automatic duplication of the sweep of the test flame.
- Shield – with an open front.
- Thermometer – with a range of – 6-400°c

3.2.2 **PROCEDURE.**

The test cup was carefully cleaned and dried. The sample was filled into the cup to the marked level and all the air bubbles on the surface were destroyed. The test cup was then placed on the heating plate and heat was applied to the sample. When vapour started forming slowly from the sample, the test flame was lit and passed across the centre of the cup at right angle to the diameter of the cup in one direction only.

The flash point was recorded as the temperature at which the instantaneous flashes occur on application of the flame.

This procedure was repeated for the second sample

3.3 DETERMINATION OF TOTAL BASE NUMBER (TBN)

3.3.1 APPARATUS

- Burette
- Titration stand
- Beaker

- St ırrer

3.3.2 REAGENTS

- TBN Indicator
- KOH
- Titrant solvent – one volume of glacial acetic acid was added to two volumes of chlorobenzene
- Acetic acid
- Chlorobenzenes

3.3.3 CALCULATION.

$$TBN = \frac{EXMXC}{W} \text{-----3.3}$$

Where E = Titre value cend point)

M = Milecular weight of KOH = 56.1

C = Titrant constant = 0.0771

W = Weight of the sample in gramme.

3.4 DETERMINATION OF KINEMATIC VISCOSITY V100 & V40

3.1.1 APPARATUS.

- Connon Fenske Routine Viscometer
- Viscometer holders
- Thermometer
- Paraffin oil (Transparent medium)
- Stop watch.

3.4.2. PROCEDURE.

The bath was maintained at the test temperature of 40 °c and 100 °c accordingly.

The sample was introduced into the capillary of the viscometer tube using suction or pressure. The viscometer tube was then inserted into the bath and allowed enough time to attain the test temperature. Sdction or pressure was used to adjust the head level about 5mm ahead of the first timing mark. With the sample following freely, the time in seconds required for the meniscus to pass from the upper timing mark to the lower timing mark was measured and recorded. This procedure was repeated for the other sample.

3.4.3 CALCULATION.

The kinematics viscosity was calculated using the formula below:

Kv = kinematics viscosity

T = time in seconds

Vc = Viscosity tube constant.

3.5 DETERMINATION OF VISCOSITY INDEX (VI)

3.5.1 PROCEDURE.

If the kinematics viscosity of the lube oil at 100 °c fall between 2.0 and 70.0 centistokes, the values of kinematics viscosity obtained in 3.4 above at 100oc and 40°c with the viscosity index interporation equation is used to determine the viscosity index.

3.5.2 CALCULATION.

$$Vi = \frac{L - U}{L - H} \times 100 \quad \text{----3.5}$$

Where

U = kinematic viscosity at 40°c of the oil whose viscosity index is to be calculated.

L = kinematic viscosity at 40°c of an oil of zero viscosity index having the same viscosity at 100°c as the oil whose viscosity index is to be calculated.

H = kinematics viscosity at 100°c of an oil at 100 viscosity index having the same viscosity at 100°c as the oil sample.

3.6 VISCOSITY INDEX IMPROVEMENT

3.6.1. - APPARATUS

- Flat bottom flask
- Weighing machine
- Electromagnetic mixer/blender
- Stop watch
- Thermometer
- Constant temperature bath
- Viscometer tube

3.6.2 PROCEDURE

Various proportions of lubricating oil and viscosity index improver, respectively, were weighed and put into the flat bottom flask. This was placed on an electromagnetic mixer and mixed using an electromagnetic mixer commenced mixing at a temperature of 60°c until a well blended product was obtained. The kinematic viscosities of the blended oil were determined at 40°c and 100°c. These were used to determine the viscosity index of the improved oil. This procedure was repeated until a viscosity index of 110.

The specific gravity and the Total Base Number were determined as in 3.1 and 3.3 respectively.

CHAPTER FOUR

4.0 RESULTS.

4.1 TABLE OF ANALYTICAL RESULTS

SAMPLE	CONSTANT	TEMPERATURE ToC	HYDROMETER READING	SPECIFIC GRAVITY	API GRAVITY
Mobil Oil	0.00062	25	0.8680	0.8742	30.36
Shell motor Oil	0.00062	26	0.8601	0.8670	31.71

TABLE 4.1 CALCULATED SPECIFIC GRAVITY AND API GRAVITY.

SAMPLE	TABLE CONSTANT	AT 100°C		AT 40°C		
		TIME (SEC)	V100 (cst)	TIME (SEC)	V 40 CST	VISCOSITY INDEX
Mobil Oil	0.03336	432	14.40	4197	140.00	101
Shell Motor oil	0.03351	406	13.60	3790	127.00	102

TABLE 4.2 kinematics viscosity of samples measured at 100°c (V_{100}) and 40 °C (V40)

respectively in centistocks (cst) and the calculated values of viscosity index.

PROPERTIES	MOBIL OIL	SHELL MOTOR OIL
Kinematics viscosity at 40°C (cst)	140.00	127.00
Kinematics viscosity at 100°c (cst)	14.40	13.60
Viscosity index (VI)	101	102
Viscosity (kg.ms) at 100°C	0.01259	0.01179
Specific gravity at 15 °C	0.8742	0.8670
Density (kg/m3)	874.20	867.00
API Gravity	30.36	31.71
Total Base Number (mg/KOH)	8.44	6.93
Flash point (oc)	263	276

TABLE 4.3 Measured and calculated values for the physicochemical properties of Nigerian lubricating oils.

4.2 RESULTS ON THE VISCOSITY INDEX (VI) IMPROVEMENT OF SHELL MOTOR OIL

Percentage of VI improver (%)	Percentage of VI base stock (%)	Kinematic viscosity at 40c(cst)	Kinematic viscosity at 100oc (cst)	Viscosity Index	Specific Gravity	API Gravity	Total Base Number
O	100	127	13.60	102	0.867	31.71	6.93
2.5	97.5	148	15.66	106.82	-	-	-
3.5	96.5	156	16.94	108.76	-	-	-
4.5	95.5	164	17.30	110.69	0.876	30.03	6.76

CHAPTER FIVE

5.1 DISCUSSION OF RESULT

The physicochemical properties determined from the analysis and calculations are as shown in Table 4.3 above. These values compared with the international standards show little or no deviation, indicating that they conformed with the standard.

KINEMATIC VISCOSITY – From the analysis, the Kinematic viscosities at 40°C and 100°C of the two Nigerian lubricating oils selected conformed with the international standard (see table 5.1 below).

VISCOSITY INDEX – This is a dimensionless value used to denote viscosity change with temperature at two extreme range 40°c and 100°c as a measure of it sensitivity. Viscosity index is a function of base stock and the additives used.

From the analysis, the viscosity index of the two products analyzed fall within the range. But they are far below the maximal value as shown by table 5.1 below:-

PROPERTIES	MOBIL OIL	SHELL MOTOR OIL	STANDARD VALUES
Kinematic viscosity at 40°c(cst)	140	127	135-155
Kinematic Viscosity at 100°c (cst)	14.40	13.60	13.50-16.80
Viscosity Index	101	102	95-110
Specific gravity	0.8742	0.8670	0.873-0.898
API Gravity	30.36	31.71	-
Total Base Number (TBN)	8.44	6.93	5.00min
FLASH POINT (°c)	263	276	204

TABLE 5.1 shows the analyzed physiochemical properties and the standard specifications.

c. SPECIFIC GRAVITY – The specific gravity of the analyzed Nigerian products meet up with the international standard as shown in Table 5.1 above.

d. API GRAVITY – The two samples tested conformed with the international standard.(see Table 5.1)

e. FLASH POINT- This property is very sensitive because of the risk involved in it deficiency. The flash points of the two Nigerian products analyzed are highly favorable as they are far above the minimal value.

f. TOTAL BASE NUMBER (TBN) – TBN is the measure of alkaline content under fasted conditions. The TBN of the two Nigerian products analyzed were better than the standard specification (see Table 5.1) .

5.2 IMPROVEMENT ON VISCOSITY INDEX

NECESITY FOR IMPROVEMENT- The viscosity index of shell motor oil and Mobil oil of grade SAE 40 analyzed were found to be 102 and 101 respectively. From the literature, the standard specification varies from 95 to 110 for SAE 40, making the viscosity index of the analyzed Nigerian lubricating oils to be lagging far below the maximum value. Since it is the almost desire of any manufacturer to triumph over the rivals in the market, it is highly imperative for Nigerian lubricating oils to be among the highest quality product.

This research therefore found it very necessary to upgrade the viscosity index of Nigerian lubricating oils to at least 110 for SAE 40.

IMPROVEMENT – It is a well known fact that viscosity index is a function of base stock and additives. A good base stock connotes an elevated viscosity index, and this depend on the choice of an individual manufacturer or blender as the quality of base stock has relationship with profit maximization.

Additive, which is emergent determining factor for viscosity index elevation is taken into cognizance in this research work. There are various additives being used as viscosity index improver such as poly-isobutylenes, polymethacrylate's, and calcium alkyl salicylate atc. Some of these viscosity index improver are being blended into Nigerian oil and still, there is need for improvement.

For this research work, a better viscosity index improver, which is alkylated styrene, under the trade name (Lubrizol ®)is discovered which when 4.5% of it is added in addition to the former viscosity index improvers will up grade the viscosity index of for about 8% of Nigerian lubricating oil. From analysis, this new viscosity index improver was found to have positive response on the other physicochemical properties such as specific gravity, Total Base Number etc of the product.

5.3 CONCLUSION.

This research characterised Nigerian lubricating oils such as Mobil oil and shell motor oil of viscosity grade SAE 40.

From the results obtained, it can be noticed that though most of the physicochemical properties analyzed conform with the international standard, there is need to up grade the viscosity index of Nigerian lubricating oil to 110 which is the highest value specified by the standard.

A new and better viscosity index improver such as Lubrizol® is discovered from this research, to enhance the viscosity index to 110, especially when 4.5% of it was added in added original lubricant.

5.4 RECOMMENDATIONS

I wish to recommend that further research be embarked upon to select other improvers that combine virtually all the functions and characteristics needed of lubricating oils.

Also, more research work should be carried out to determine how long lubricating oils can stay in the engine parts efficiently and this should be labeled on the products.

The base oil from Nigerian refineries should be developed to meet the expected standard instead of importing base oil from overseas and leaving our own to waste away.

I recommend also that research on the use of local substance as viscosity index improver be carried out. This will help in reducing the cost of production and also make us be self reliance.

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APPENDIX A

API – American petroleum institute

ASTM – American society for Testing and Materials

CST – Centistock

HVI – High viscosity index

KV – Kinematic viscosity

LUBCON – Lube bend company Nigeria

LVI – Low viscosity index

M – Molecular night

SAE – Society of Automotive Engineers

SG – Specific gravity

SI – System international

ꜰ – Temperature

ɅN – Total Acid Number

TBN – Total Base Number

VC – Viscometer tube constant

VI – Viscosity index

W - Winter