CERTIFICATION

This is to certify that this project "Investigation of quality of road sides engine oil in Nigeria and comparison with LUBCON motor engine oil" is the original work of Ayoku A.I. (95/4448EH), carried out wholly by him under supervision of Engr. Duncan Aloko and submitted to the Department of Chemical Engineering Technology, Minna. The project has been read and approved by

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Engr. Duncan Aloko **Date**

Supervisor

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Dr.J.O Odigure **Date**

Head of Department

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External Examiner **Date**

DEDICATION

This project is dedicated to Almighty Allah, the beneficent and the merciful. And to my parents; Alh. Adebayo Ayoku & Mrs. Hassanatu A. Ayoku.

LIST OF TABLES

A PROJECT REPORT

ON

INVESTIGATION OF QUALITY OF ROAD SIDES ENGINE OIL IN NIGERIA AND COMPARISON WITH LUBCON MOTOR ENGINE OIL.

BY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING. SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.

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the formation of weak acid that will later react with the metal parts of an engine and cause the wearing and tearing of the engine parts.

1.1.0 AIMS AND OBJECTIVES

The aims and objectives of this project is to carry out a research work on randomly sampled road side lubricating oil on sale in 5 states of Nigeria, Viz; Abuja, Lagos, Kwara, Niger, and Kaduna states. The results will then be compared with standard products of Lube Blending Company of Nigeria (LUBCON) that conform with standard requirements as published by the Society of Automotive Engineers (SAE) and American Petroleum Institute (API).

1.2.0 SCOPE OF WORK

This project work covers the characterization of road – side lubricants in some of Nigeria states by analysis of their physical and chemical properties.

Comparison of the obtained results with the standard product from Lube Blending Company of Nigeria (LUBCON).

And lastly, to intimate the public about the quality of lubricating oil sold at road – sides.

CHAPTER TWO

LITERATURE REVIEW

2.0 HISTORICAL BACKGROUND

The knowledge of lubrication as a catalyst to industrial revolution dates from the early history in Egypt, Greece, Rome, and Persia where grease made of a combination of animal fats and calcium were used to lubricate chariot wheels.

In the early nineteen century, vegetable oil from olives, rape seeds, castor seeds and animal oil from tallow, land and whales were mixed with potassium sodium, and calcium soaps to make grease use for lubrication of steam cylinders, cutting metals and later an aircraft engines during the world-war 1 (1914 – 1916). (5)

The breakthrough in petroleum distillation and refining technology mid-19th century replaced fatty oils with mineral oils for lubrication where some of the viscous by products were investigated as better substitute for vegetable and animal oils used for lubrication of engine parts.

Further researches into the inherent properties of the base stocks obtained from petroleum refining revealed the inadequacies and limitations in modern engine lubrication, hence, the introduction of chemical additive in the early 20th century to improve their performance.

Additives are chemical compound added to the refined base stocks to impact some specific properties to the lubricating oils either by enhancing the inherent properties or adding new but useful ones into the finished products. (8)

The knowledge of lubrication has helped to reduce considerably the problem posed by loss of energy due to friction developed in all surfaces in relative motion.

Turbine oils are intended to lubricating and cooling the bearing of steam and water turbines and for fitting the control system of steam turbo generators.

Compressor oils are intended for lubricating the cylinder valves, and other mating parts of air compressor and blowers.

Transmission oils are intended for lubricating the transmission of motor vehicles for geared and hyped – transmissions steaming gears and for various rough mechanisms.

Instrument oils are used for lubricating testing instruments, watch, and clock mechanisms.

Motor oils are intended for lubricating the motor engine against friction and wear. This type of lubricating oil is the focus of this project. (1)

2.1.0 SOURCES AND COMPOSITION

2.1.1 MINERAL BASED OILS.

Modern mineral base oils are prepared from naturally occurring crude petroleum oil by initial process of vacuum distillation. The latter is usually followed by additional purification processes such as solvent extraction, dewaxing, ferrofining clay – treatment, acid refining and neutralizing depending on ultimate analysis sought. The chemical composition of the mineral oils produced depends both on the original crude and on the refining processes.

The crude oils are usually define as naphithenic or paraffinic depending on the preponderance of the hydro carbon type present, which are themselves normally a complex mixture of aromatic, naphthenes and paraffins. The proportion of the different species are responsible for the different characteristics of the base oils with the simpler refining techniques, the composition of the finished base oils reflects that of the parent crude. After severe refining variations due to crude are less apparent. (4)

2.2.0 CONDITIONS LIMITING OIL LIFE

Contamination and degradation are the principal causes of impaired lubricating effectiveness. There are few tests required to determine if oil is suitable for engine service. Basic test schedules for characterization of lubricant are Viscosity, Flash Point, Total Base Number (T.B.N), Specific Gravity, Present of Water (Crackle Test), Color, and Present of Particles. (7)

2.2.1 CONTAMINATION OF LUBRICANT

Lubricant stored in an open containers or the use of dirty dispensing equipment may introduce debris when the oil is added. There is high possibility of introduction of contamination like water, atmospheric dirt in an oil been sell on our road – side as motor engine oil. And, these materials are abrasive and promote engine wear that may become catastrophic. (7)

Dilution of lubricant is common practice of road – side engine oil seller by trying to introduce fuel to their oil in order to maximize profit. If the dilution is excessive, their will be serious reduction in an oil's viscosity and destroys its lubricating ability.

However, water contamination can cause a sooty sludge, even through the oil's capacity for dispersing the soot has not been exceeded. (7)

2.3.0 FUNCTIONS OF LUBRICANT

2.3.1 PERMITION OF EASY STARTING

The case of starting an engine depends not only on the condition of the battery and ignition, but also on the flow properties of the lubricant. If the lubricant is too viscous or heavy at starting temperatures, it will impose enough drag on the moving parts that the engine cannot be cranked fast enough to start promptly and keep running.

Cold temperatures always thicken all oils (lubricants), therefore an oil for cold weather use must be thin enough to permit adequate cranking speeds at the lowest anticipated temperature.

In addition oil must be thick enough when the engine reaches normal operating temperatures to provide adequate protection. (3)

2.3.2 LUBRICATE AND PREVENT WEAR

Once an engine is started, the oil must concentrate promptly and lubricate all moving surfaces to prevent the metal-to-metal contact that would result in wearing, scoring or seizure of engine parts. Oils films on bearing and cylinder walls are sensible to movement and pressure and oil supply. These films must be continually replenished by adequate flow and proper oil distribution. This is called full film lubrication. (3)

2.3.3 REDUCING FRICTION

Under full-film lubrication conditions, a thick film of oil prevents metal-to-metal contact between moving engine parts. Relative movement of these lubricated parts requires enough force to overcome the fluid friction of the lubricant.

The viscosity of the oil should be high enough to maintain an unbroken film but must not be higher than necessary in other to permit easy starting. (3)

2.3.4 PROTECTION AGAINST RUST AND CORROSION

Under ideal conditions, fuel burns to form carbon dioxide and water. Gasoline and diesel engine most of the time does not burn all the fuel completely. The partially burned fuel resulted to the formation of soot and carbon. These carbon and soot escape through the rings and into the crankcase and combine with water to form sludges and deposit on critical engine parts (crankcase crankshaft, camshaft e.t.c.).

In addition to water and the by-product from incomplete combustion of fuel, other corrosive combustion gases also get pass the rings and are condensed or dissolved into the crankcase oil. The water present attacks the metal parts to form rust.

The life of engine parts depends on the ability of the motor oil to neutralize the effect of these corrosive substances. (3)

2.3.5 KEEPING ENGINE PARTS CLEAN

Lubricants are generally formulated not only to keep engine parts clean, but also to prevent sludge deposits from interfering with proper engine operation.

Straight mineral oils have only very limited ability to accomplish this task. This is always achievable with the use of chemical additives (detergent and dispersant) that are blended into modern lubricant. These additives keep vital engine parts clean and oil contaminants suspended in such fine form that they could be removed by regular oil changes. (3)

2.3.6 COOLING ENGINE PARTS

Engine cooling is not only accomplished through the action of the water anti-freeze mixture used in the cooling system but also lubricants acts as an effective coolant

The cylinder heads, crankshaft, camshaft, connecting rod, bearing, piston cylinder walls, and many other components in the lower part of the engine are directly dependent on the lubricants for necessary cooling. (3)

2.4.0 ADDITIVES TECHNOLOGY

A lot of unfortified base oil with additive are 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.

The chemical additives are chemical compound 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. (3)

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 chemical and physical properties of mineral oils.

The basic functions of additives can be summarized as; protection of metal surfaces (rings, bearing, gear, e.t.c.) extending the range of lubricant applicability and extending lubricant life.

2.5.0 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: (8)

2.5.1 DETERGENT AND DISPERSANTS

Detergents are metallic organic compounds of sodium calcium and magnesium phenolates, phosphonates and sulfonates. They are soluble metallic compounds of high molecular weight organic acid that have the affinity to dissolve the carbonaceous deposit in ring grooves, piston surfaces, and single deposits in internal combustion engines.

The dispersants are very high molecular weight organic compounds of alkylsuccinimides, alkysuccinie esters and man – rich reaction products.

The primary functions of the dispersants are the bonding together of contaminants by polar attraction and prevention from agglomerating and kept in suspension due to solubility of dispersant.

2.5.2 POUR POINT DEPERSANT

There are polymers of alky-aromatic and polymethacrylate that enable oils to flow easily without any agitation they are used to parent the growth of large wax crystals into interlocked structives as the oils cool down. (8)

2.5.3 VISCOSITY INDEX IMPROVERS

These are large chain and high molecular weight polymers such as polymethacrylates, polysolutyfenes, olefin copolymers, ethylene propylene copolymers, and acrylate polymers that prevent the decrease in viscosity of oil at high temperature.

The viscosity temperature characteristics of oils shows that a low viscosity index (VI number) indicates a large decrease in viscosity while a high viscosity index (VI number) sows a small decrease in viscosity with increasing temperature. (8)

2.5.4 OXIDATION INHIBITORS

These are chemical property modifiers called anti-oxidants e.g. zinc dithiophosphates, hundred phenols, aromatic amines, sulfurized phenols and sulphorized esters. They inhibit oxidation process, acid formation and eventual oil deterioration to prevent varnish and lacquer deposits and catalytic effect of metals on the oxidation process at high temperature of air. (8)

2.5.8 EMUSLFIERS

These are polar compounds made from fatty acid oils. It helps to permit ultimate mixing of oil and water by imparting a hydrophilic property to the oil to promote a coalescence of oil and water particles. They also provide excellent metal wetting and rust protection properties. (8)

2.5.9 SPECIAL PURPOSE ADDITIVES

These are other specialized and customized additives with specific formulation and application, such as friction modifiers, anti-quark agents, seal swill agents, anti-character agents, anti-stain agents and stabilizers. (8)

2.6.0 MOTOR OIL CLASSIFICATION

In selecting proper motor oil the motorist must consider both the oil viscosity and the lubricant service requirements for his vehicle.

Two bodies namely; Society of Automotive Engineers (SAE) and American Petroleum Institute (API) have classified motor oil accordingly based on viscosity and quality (service requirement) respectively. (2)

2.6.1 SAE CRANKCASE OIL VISCOSITY CLASSIFICATION SYSTEM

The society of Automotive Engineers (SAE) developed a classification system based on viscosity. This system established distinct motor oil viscosity classification of grade. These include among others SAE 5W, SAE 10W, SAE 15W, SAE 30, SAE40, and SAE50.

The "W" following SAE viscosity grade stands for water and indicates that oil is suitable for use in cold temperature region. Those SAE classifications such as SAE30, SAE40, and SAE50 that do not include the "W" define oil grades for use at higher temperatures. The numbers 10, 20, 30, 40, 50, show progressively the increase in viscosities.

The development viscosity index improvers made possible the manufacturing of multi-grade oils, These oils include SAE 5W / 20, SAE 20W / 50, and SAE 20W / 40 e.t.c.

These multi – grade oils can perform both at extreme cold regions and hot regions and meet specifications when measured at appropriate both cold and hot temperatures. (2)

2.6.2 MOTOR OIL COMPOSITION

The motor oil is composed of mainly the base oils and the chemical additives blended together in pre-determined proportions and under specified conditions.

The type(s) of base stocks and choice of additives depends on the class of lubricating oil varies from a few hundredths of a percent to 30 percent, while the base oils account for the rest.

2.6.3 BASE OIL

These are high viscosity index distillate of crude oil existing in five grades; 100 Neutral, 150 Neutral, 250 Neutral, 500 Neutral, and the bright stock (BS).

CHAPTER ONE

1.0 INTRODUCTION

A lubricant can be defined as an oil product that separates the metal parts of an engine to reduce friction and keep it clean. Lubricant on the other hand deals with the application of lubricating oil to machine or engine.

The lubrication system of engine is intended to avoid the increased wear, overheating and seizure of rubbing surfaces, to reduce the expenditure of indicated power on overcoming mechanical losses in the engine, and to remove wear products.

There are four major types of lubricants namely; liquid lubricant, plastic lubricant, gaseous lubricant, and solid lubricant, example of which include oils greases air and graphite respectively.

Liquid and plastic lubricants are most and commonly used in industries while gaseous and solid lubricants are recommended only in some special application. (8)

No matter how smooth two moving parts might look even under a microscope, they are still rough and ridge in places, so when these parts rubbed over one another, friction occurs and the consequence is material wear and tear, increasing heat leading to seizure of parts. In view of these problems, lubricating oils are designed to impact varieties of properties and to protect engine in many ways. Thus, lubricating oil is a highly specialized product carefully developed to perform many essential functions among which are the following: permit easy starting of engine, reduced friction, protecting machine against rust and corrosion, lubricating of the engine parts, keeping of engine parts clean, and cooling of engine parts. (3)

Most of engine oils in Nigeria are road – side lubricants. This road – side lubricants are prone to contamination and degradation in quality. Contaminants such as: water, atmospheric dirt, and some debris either introduced during the period of lubricating the engine by the uses of their selling pan or during the course of transportation of these engine oils.

These lubricants are normally stored in an open containers by their sellers and the uses of dirty dispensing equipment make the oil to be exposed to more dangers and more hazardous to the engine been used on. Due to introduction of this foreign body into the lubricants, this can lead to the formation of an abrasive material that promote engine wear which may become catastrophic if care is not taking.

Generally, road – side lubricants are usually Based Stock of which their viscosity at 100^0C is around 30-32cst that is too viscous or heavy at starting temperature. It will impose enough drag on the moving parts of the engine that makes it not to crank fast enough to start promptly and keep running.

Another feature of road – side lubricants in Nigeria are their dilution with fuel by their marketers to maximize profit. Excessive dilution of lubricants will seriously reduce their viscosity and destroy its lubricating ability.

Another characteristic of road – side lubricants is the presence of water, which is very dangerous to the engine because it enhance the formation of abrasives that accelerate wearing process of engine part, and the formation of sludge in the engine.

Last but not the least, road side lubricants are of low base content due to the absent of chemicals. Chemical additives are added to the lubricants to improve their performances and most especially their base content value. The effect of low base content in a lubricant can lead to

AKNOWLEDGEMENT

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It will not be good on my part if I forget the assistance and words of encouragement being given by my uncles and aunties, most especially to Alh. Yusuf Lawal of J.A.M.B office, Abuja, Engr. Tonile Aduagba of Lower Niger Basin, Ilorin, Alh. Muyideen Shomope, C.B.N, Abuja, Mr. Saaid Danfulani, Mr. Funsho Danfulani, Mrs. Nusirat Tunji Gambari, Mr. Deji Bolaji and Mr. Ibrahim Gambari to mention but few. You all touch my life in many ways that I can't repay you back, because you assisted me when your assistance was needed most. I pray Almighty Allah to reward you all abundantly by being the sustainer and provider for you and your entire family (Amen).

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I wish them all brightening and successful future. You all have a special way you make me fill happy, Am proud of you all.

ABSTRACT

The wide application of lubricating oil in our society today can never be over emphasized, but the performance of these lubricants depends on their level of quality. The quality of lubricating oil sold at road – sides in Nigeria was therefore investigated. Sample of the oil were collected from three different locations in five states viz; Kwara, Niger, Abuja, Lagos, and Kaduna states.

Experiments were carried out to test six parameters namely; Viscosity, Neutralization Number, Flash Point, Specific gravity at 15°C, Crackle test, Color test and appearance.

All parameters measured except Viscosity Index (VI) and Specific gravity fall below the API and SAE requirements.

For viscosity test, it was observed that oil samples from all the states considered had viscosity too high for the engine to perform its basic functions. And oil sample from Kwara, Niger, and Kaduna states failed the crackle test. The Total Base Number (T.B.N) of all the states considered fall below the standard value for motor engine oil. Also, the Flash Point of all the states considered fall below standard value and there was presence of impurities in all the oil samples except that of Lagos state.

Similarly, engine oil being sold at our road sides are not of good quality and cause a lot of havoc to the engine.

TABLE OF CONTENT

DECLARATION

I AYOKU ADEBAYO IBRAHEEM hereby declare that the project entitled "Investigation of quality of road side engine – oil in Nigeria and comparison with LUBCON motor engine –oil" is my original work and has never to my knowledge been submitted elsewhere.

Ayoku A. I (95 / 4448EH)

The table below shows the physical properties of the base oils. (8)

Table 2.1: Physical Properties of Base Oils

Characteristic	100N	150N	250N	500N	BS
Kinetic Viscosity (cst)	39-4.3	4.9 – 5.5	6.9 – 7.7	108 – 12.0	305 –325
Viscosity Index	95	95	95	95	95
Flash Point(°C)	193	204	210	221	226
Fire Point(°C)	198	210	217	236	234
Pour Point(°C)	-9	- 9	- 9	- 9	- 9
Appearance	clear and Bright	Clear and Bright	Clear and Bright	Clear and Bright	Clear and Bright
Water Content	Nil	Nil	Nil	Nil	Nil

2.7.0 A SIMPLE BATCH MIXING TANK

Oils are often blended in a tank or vessel usually cylindrical in nature with vertical axis. The cylindrical vessel is closed at the top with a small opening of aeration for water vapor escapades. The bottom is usually dome in shape, lagged so as to prevent heat loss. The oil is dehydrated by heating with the aid of steam coil incorporated into the vessel. The steam coil contained special high viscosity oil used for heating oil in the vessel. The oil is well agitated by an electrically driven impeller which function is to create a conventional flow pattern within the

2.10.0 UNIT OPERATIONS INVOLVED IN LUBRICANTS BLENDING

According to J.little, which says all chemical operation must involve at least one or two unit operations. Therefore, the unit operations involved in lubricants blending occurs mainly by turbulent and interface transport, and this include:.

(i) **MASS TRANSFER:** this occurs when the solid particles present in the Base Oil are separated by filtration.

(ii) **HEAT TRANSFER:** this occurs by interface as well as turbulent heat transfer. The interface heat transfer occurred when heat is being transferred from the steam through the steam coil wall to the cold coil in the blending vessel.

The turbulent heat transfer occurred through the mixing process with the aid of the agitation.

3.4.0 PREPARATION OF REAGENTS

3.4.1 TOTAL BASE NUMBER (T.B.N) REAGENTS

3.4.1.1 TITRATION SOLVENT:

Add 1 volume of glacial acetic acid to 2 volumes of chlorobenzene.

3.4.1.2 TITRATION TITRANT:

Perchloric acid (standard acetous solution 0.1N), 35ml of 70 –72 % perchloric acid (Hclo4) solution with 500ml of glacial acetic and 30ml of acetic Anhdride. Dilute to 1 – liter with glacial acetic acid and allowed the solution to stand for 24 hours.

3.4.1.3 T.B.N INDICATOR SOLUTION:

Dissolve 0.5g of para – Naphthal benzene indicator in 50ml of titration solvent.

Note:

- Avoid adding excess acetic anhydride to prevent acetylation of any primary or secondary amines that may be present.
- Acetic acid, acetic anhydride and chlorobenzene are toxic and irritant. Caring out all operations involving their use under the fume cupboard

3.5.0 NEUTRALIZATION NUMBERT DETERMINATION

(TEST FOR TOTAL BASE NUMBER T.B.N)

3.5.1 TEST DESCRIPTION

This test involves titrating a sample of oil dissolved in a mixture of chlorobenzene and glacial acetic acid with a solution of perchloric acid in glacial acetic acid with a potentiometric titrimeter.

3.5.1.1 TEST PROCEDURE

2.0g of oil samples to be tested were weighed into a 250ml beaker and 10ml of titration solvent (mixture of chlorobenzene and glacial acetic acid) was added and shake to allow mixing of the oil with the solvent.

Then titrated with O.I.N perchloric acid in glacial acetic acid (T.B.N Titrant) and for visual determination 2 drops of para – Naphthal benzene indicators was added to the sample before titration. The orange color changes to green, or brown – green at the end – point.

The Total Base Number (T.B.N) was calculated by using the formula below:

T.B.N = [Vs – vs) X 56.1] / WS

Where

vs is the volume of titrant used for oil sample.

Vs is the volume of titrant used for blank.

N is the normality of the titrant and

Ws is the weight of sample taken. (8)

3.9.0 FLASH AND FIRE POINT DETERMINATION

The flash point of a petroleum to which an oil must be heated in a specified instrument for the vapor given off to be sufficient enough to ignite when tested under that specified condition. The test when properly carried out, indicate the lowest temperature to which an oil can safely be heated without risk or fire hazard. (8)

3.9.1 PROCEDURE

The test cup was filled to a specific level with the sample to be tested, and to make sure that there is no sample outside the cup. The cup was then position on the heating plate and the thermometer was inserted vertically into the oil sample and held vertical by the aid of the thermometer holder. Any bubbles on the surface of the sample was destroyed by blending over the surface of the oil the temperature of the sample was increased rapidly at first and then slowly as the flash point is approached. At 200^0C a small test flame was passed across the cup, with a smooth continuous motion of the test flame across the cup, at a point the vapor above the surface of the sample testing was ignited with the aid of the test flame and temperature at this point, was noted and recorded as flash point. The test is continued and at a certain temperature the test flame caused the oil sample to ignite and burned for 5 seconds. The temperature at which this occurs is known as the fire point. (8)

3.10 TEST FOR COLOR / APPEARANCE

3.10.1 LUBRICANT COLOR

The color of a lubricant may vary from very pale to dark color. Although color is not a critical property, yet a variation from the usual may indicate possible change in quality or possible contamination with another product. (8)

3.10.2 TEST PROCEDURE

The cuvette was filled with the oil sample to a dept of 150mm and above. The sample was then observed in the cuvette for the clarity. Another cuvette was filled with distilled water up to 150mm level. The sample and the distilled water cuvette was then placed into the comparator compartments and the comparator was closed to exclude all exterior lights. The color of the sample was determined by comparing with the standard color.

While the appearance test was done by physical observation for the present of particles and other impurities. (8)

CHAPTER FOUR

4.0 EXPERIMENTAL RESULTS AND DECISION OF RESULTS

4.1 EXPERIMENTAL RESULTS

TABLE 4.1: EXPERIMENTAL RESULTS

S/N	STATE	CRACKLE TEST	V 100 (cst)	V40 (cst)	VI	T.B.N (mgKOH/g	F P (°C)	S.G W 15(°C)	COLOUR	APPEARANCE
1	Kwara	Failed	32.20	475	99	1.50	226	0.8770	Brownish Black	Small debris are present
2	Niger	Failed	31.49	489	95	1.49	235	0.8884	Pale Brown	Small stones are present
3	Abuja	Passed	31.50	490	95	1.47	230	0.8904	Pale Brown	Brownish cotton – like materials are present
4	Lagos	Passed	31.63	491	95	1.30	228	0.8904	Pale brown	Absent of any impurities
5	Kaduna	Failed	31.62	491	95	1.40	236	0.881	Brownish Black	Small debris are present

The results show that the viscosity of the lubricants at the temperature nearer to the room temperature (i.e. 40^0C) are too high for the engine to allow easy starting by permitting adequate cranking speeds at the lowest anticipated temperature.

And the viscosity of the lubricants at the temperature nearer to the operating temperature of the engine (i.e. 100^0C) are too high for the engine to perform its basic functions; lubricating the engine parts and to provide adequate protection against wear, keeping engine parts clean and cooling of the engine parts among the others.

From table 4.2, the viscosity range of motor engine oil at 40^0C are from 250cst to 280cst while at 100^0C are from 19cst to 21cst for ultimum performance of the engine oil both at the operating temperature of the engine.

The viscosity Index (VI) calculated from the results obtained on table 4.1 for viscosity of 40^0C and 100^0C for all the states falls between 95 and 99 which is standard range of viscosity Index (VI) for a good quality engine oils.

Thus, this does not indicate that all roadsides engine oils are good, but only to show that they are good base stocks with good viscosity – temperature coefficient. This means that, the road sides engine oils are good lubricants if fortified with additives and blended with other neutral oils to reduce their viscosities they are going to perform credibly.

4.3.3 TOTAL BASE NUMBER (NEUTRALIZATION NUMBER)

From the experimental results tabulated on table 4.1, the total Base Number (T.B.N) of all the oils samples investigated ranges from 1.30 – 1.50mgKOH/g. This is far below the

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Within the limits of experimental errors it can be concluded that;

(i) Oils samples obtained from Abuja and Lagos states passed the crackle test, while those of Kwara, Niger, and Kaduna failed the test.

The implication of presence of water in a lubricant is the promotion of engine wear that may become catastrophic with time.

(ii) The viscosity of the lubricants at 40^0C and 100^0C are too high for the engine to allow easy starting by permitting adequate cranking speeds at the lowest anticipated temperature.

And the Viscosity Index (VI) calculated indicated that for all states their viscosity have good quality lubricants. Thus, this shows that road sides engine oils have good Viscosity temperature coefficient i.e. if the roadside engine oil is fortified with good Additives and blended with other low viscosity neutral oils to reduce their viscosity. They could produce a better service to their users.

(iii) The Total Base Number (T.B.N) obtained for all the states indicated that the road side engine oils have no enough anti-oxidant to neutralize all the acidic constituents formed during combustion of fuel and thereby increase the wearing of the engine parts.

APPENDIX

(i) VISCOSITY

The time require for a certain volume of the sample to flow through the viscometer tube of viscometer constant = 0.5035

V_{40} (kwara) = 0.5035 X 943 sec = 475cst

V_{40} (Niger) = 0.5035 X 971 sec = 489cst

V_{40} (Abuja) = 0.5035 X 973 sec = 490cst

V_{40} (Lagos) = 0.5035 X 975 sec = 491cst

V_{40} (Kaduna) = 0.5035 X 975sec = 491cst

The time required for a certain volume of the sample flow through the viscometer tube of viscometer constant = 0.03336

V_{100} (Kwara) = 0.3336 X 944 = 31.49cst

V_{100} (Niger) = 0.03336 X 944sec = 31.49cst

V_{100} (Abuja) = 0.03336 X 941sec = 31.50cst

V_{100} (Lagos) = 0.03336 X 948sec = 31.63cst

V_{100} (Kaduna) = 0.03336 X 947sec = 31.62cs

(ii) VISCOSITY INDEX

The value of viscosity of 100^0C and 40^0C was used to calculate the Viscosity Index, making use of the V.I formula stated below

$$V.I = \frac{L-U}{D} \times 100 = \frac{L-U}{L-H} \times 100$$

Where L is the value from Viscosity Index table at V_{100} .

U is the value for viscosity at 40^0C

H is the corresponding value on the Viscosity Index table.

V.I (Kwara);

For oil sample from Kwara States $V_{40} = 475cst$

$V_{100} = 32.20cst$

The value of t from table 6.1.0 = 1164 by interpolation and D = 695.

$$\therefore V.I\ (Kwara) = \frac{1164 - 475}{694.8} \times 100 = 99$$

V.I (Niger);

For oil sample from Niger state, $V_{40} = 489cst$, $V100 = 31.49$.

The value of L from table 6.1.0 = 1118 by interpolation and D = 664.1.

$$\therefore V.I\ (Niger) = \frac{1118 - 489}{664.1} \times 100 = 95$$

V.I (Niger) = 95

V.I (Abuja);

For oil sample from F.C.T, $V_{40} = 490cst$, $V_{100} = 31.50$.

The value of L from table 6.1.0 = 1119cst and D = 664.5

$$\therefore V.I\ (Abuja) = \frac{1119 - 490}{664.5} \times 100 = 95$$

V.I (Abuja) = 95

V.I (Lagos): For oil samples from Lagos state; $V_{40} = 491cst$, $V_{100} = 31.63$.

The value of L from table 6.1.0 = 112.7 by interpolation and D = 670.1.

$$\therefore V.I\ (Lagos) = \frac{1127 - 491}{670.1} \times 100 = 95$$

V.I (Lagos) = 95.

$$\% \text{ of light viscous oil required} = \frac{C(100-A)}{100}$$

On the completion of the blending formulation, the base oil is pumped into the vessel via a meter and fitter in order, so as to weigh and filter the oils respectively. The oil in the vessel is heated to a temperature not above 55% with the aid of steam coil that supply hot steam from the boiler. Heating and stirring continue for about an hour before the oil sample is taking to laboratory for crackle test (to confirm if water is still present). If crackle test is passed, the additive (already pre-heated inside heating cabinet) is added. When all additives had been added, the mixture is further agitated for 30 minutes. The heating would be stopped after the addition of the additive in order not to decompose the additives. Then some sample is taken to laboratory to analyze certain properties such as Viscosity, Flash Point, Total Base Number (T.B.N), Specific Gravity e.t.c., to know whether the blend is in conformity with the required standard and if not a corrective blend is carried out. (8)

2.9.0 DEFINITIONS OF LUBRICANTS CHARACTERISTICS

(i) **VISCOSITY:** In the common engineering sense, viscosity is the resistance to flow or "thickness" of a liquid. Viscosity of oils decreases with increase in temperature. Hence the temperature at which a viscosity is measured must always be specified. The kinematic L^2/T, where L is a length and T is a time. The cgs unit is one centimeter squared per second (one strokes), while the SI unit, is one squared meter per second and is equivalent to 10^4st. (8)

(ii) **VISCOSITY INDEX:** is a number on a conventional scale used to characterize the temperature. A high Viscosity Index indicates a relatively small change of viscosity with temperature and vice versa. (8)

(iii) **POUR POINT:** lowest temperature at which a liquid petroleum product will flow when it is cooled under the conditions of the standard test method. (8)

(iv) **NEUTRALIZATION NUMBER:** an indication of the acidity or alkalinity of an oil; the number is the weight in milligrams of the amount of acid or base expresses as potassium hydroxide (KOH) equivalent required to neutralize 1 gram of oil in accordance with an ASTM test method. (8)

(v) **TOTAL BASE NUMBER (TBN):** the quantity of acid expresses in terms of the equivalent number of milligram of potassium hydroxide, that is required to neutralize all basic constituents present in 1g of sample. (8)

(vi) **TOTAL ACID NUMBER (TAN):** the quality of base, expressed in milligrams of potassium hydroxide, that is required to neutralize all acidic constituents present 1g of sample. (8)

(vii) **FLASH POINT:** the lowest temperature under closely specified conditions at which a combustible material will give off sufficient vapor to form a flammable mixture with air in a standardized vessel. Flash Point tests are used to assess the volatilities of petroleum products. (8)

(viii) **FIRE POINT:** this is the lowest temperature at which the ignited sample under flash point test sustained burning for a period of 5 seconds.(8)

4.2 LUBCON MOTOR ENGINE – OIL STANDARD CHARACTERISTICS

TABLE 4.2: MOTOR ENGINE OIL STANDARD

CHARACTERIZATION	STANDARD VALUE
Cradle Test	Passed
Viscosity (a) 1000°C; V 100	19.00 – 21.00 cst
Viscosity (a) 49°C; V_{40}	250 – 280 cst
Viscosity Index, VI	95 – 100
Specific gravity (a) 15°C	0.880 – 0.895
Flash point; FP	245 – 285 °C
Total Base Number; T.B.N	5.0 – 8.0 mgKOH/g
Colour	Greenish colour
Appearance	Absence of any impurities

4.3.0 DISCUSSION OF RESULTS

The discussion of results obtained from the various experimental analyses carried out:

4.3.1 CRACKLE TEST

Results obtained from the experimental analysis shows that oils samples obtained from Abuja and Lagos state passed the crackle test, while those of Kwara, Niger, and Kaduna states failed the test.

This indicated that oil samples from Kwara, Niger, and Kaduna states might get contaminated with water either in the process of transportation from one place to another or from the exposure of the containers into the atmosphere by their sellers. The advance of pressure of water in a lubricant is the promotion of engine wear that may become catastrophic as the time goes. Water contamination can cause a sooty sludge and accelerate the wearing of the engine. Lubricant from any oil blending company will undergo heating to temperature of 55 – 60^{0}C to allow the elimination of water from the oil content before any further operation can be performed on it.

4.3.2 VISCOSITY AND VISCOSITY INDEX

From the experimental results obtained from the analysis on the road – side lubricants. The viscosity at 40^{0}C of all the states characterized range from 475csrt to 491cst and viscosity at 1000C range from 31.49cst to 32.20cst all from table 4.1.

(iv) The flash point of all the states falls between low standard values. These shows that there is no additives in the lubricants to improve their point and all the oil samples are not of good quality and their cooling effect on the engine parts are very low.

(v) There is discrepancy in the color of the lubricants due to the presence of atmospheric dust in the oil or in the container used in selling it.

(vi) There is presence of abrasive materials in some of the oil samples. The implication of the presence of these abrasive materials will increase the wearing of engine part, which may become catastrophic and later affect the life span of the engine.

(vii) The specific gravity of the roadside lubricants are within the ranges of standard values. This is due to high viscosity number of the lubricants.

5.20 RECOMMENDATION

From various results obtained, it was obvious that most of roadsides engine oil being sold on our road are not of good quality and they cause a lot of catastrophic to the engine being used on.

It is therefore recommended that oil fortified with additives to improve on their parameters should be used for our machinery and motor vehicles to reduce their life span.

standard values for finished product from LUBCON Blending Company that range from 5.0 – 8.0mgKHO/g to table 4.2.

T.B.N is an important characteristic of lubricants because it gives the amount of acid in mg of KOH required to neutralize 1.0g of the sample. During fuel combustion, acid are formed and it is this lubricant that will be called upon to neutralize the acid.

Therefore ordinary base stocks with T.B.N values range from 1.30 – 1.50mgKOH/g will not be able to perform this function and thereby, exposed the engine parts and corrosion.

In addition, the neutralization of the acids prevents the formation of sludge and lacquers and thus keeping the engine clean. The T.B.N of the lubricants can be improved by fortified the base stocks with high base contract additives.

4.3.4 FLASH POINT AND FIRE POINT

From the experimental result tabulated on table 4.1, the flash point of oil samples from all the states investigated are lower to the standard values tabulated on table 4.2 for the finished product from the LUBCON Blending Company which range from 245 – 285^{0}C. The results obtained on table4.1 shows that the Flash Point of all the states ranges from 226 – 236^{0}C which fall below the standard values. This might be due to the absence of additives in the lubricants to improve their flash point.

The significance of this is that, the cooling effect of the oils on the engine parts are very low and serve as confirmatory test for the low quality of the road sides engine oil.

4.3.5 COLOR

Normally, the color of the lubricant supposed to be clear color. But the color of the oil sample from Kwara, and Kaduna states are brownish – black due to the presence of atmospheric dust in the oil or in the container used in selling.

The color of oil samples from Niger, Lagos, and Abuja are of pale brown. Although, color is not a critical property used in characterizing oil, but it can be used to verify for the presence of contaminants in the oil sample.

4.3.6 APPEARANCE

From the experimental results obtained on table 4.1 on the appearance of thee oil sample, there was present of small debris or stones in oil sample obtained from Kwara, Niger, and Kaduna states. While that of Abuja contains brownish cotton – like material settled at the bottom of the simple. That of Lagos contains no physical impurities.

The implication of the presence of these abrasive materials in an oil sample will increase the wearing of engine parts that may become catastrophic and later affect the life span of the engine.

4.3.7 SPECIFIC GRAVITY @ 15°C

From the experimental results tabulated on table 4.1, the specific gravity of all the oils samples investigated fall within the ranges of standard values for quality lubricants for motor engine oils tabulated on table 4.2. The values range from 0.8770 – 0.8904 for the engine oil investigated and the standard values range from 0.880 – 0.895.

This is due to the high viscosity values of the lubricants (roadside engine oil) both at room temperature and operating temperature; 40°C and 100°C respectively.

V.I (Kaduna) :

For oil sample from Kaduna state; $V_{40} = 491$cst, $V_{100} = 31.62$.

The value of L from table 6.1.0 = 1127 by interpolation and D = 669.7

$$\therefore \text{Kaduna} = \frac{1127 - 491}{669.7} \times 100 = 95$$

V.I (Kaduna) = 95.

(iii) NEUTRALIZATION (T.B.N)

For oil sample from Kwara state; volume of solvent (chlorobenzene and glacial acetic acid) used = 10.00cm^3

Ws; mass of sample used = 2.05g

N; Normality of the titrant = 0.06932

Molecular weight of KOH = 56.1

Vs, volume of titrant used (perchloric acid) = 0.79cm^3

Vs; volume of titrant used at blank = 0.00 cm^3

$$\text{T.B.N} = \frac{(Vs - VS)\, N \times 56.1}{Ws}$$

$$\therefore \text{T.B.N (Kwara)} = \frac{0.79 \times 0.06932 \times 56.1}{2.05} = 1.50$$

1.50mgKOH/g

For oil sample from Niger state ;

Volume of solvent = 10.00cm^3

Ws; mass of sample used ==2.03g

N; normality of the titrant = 0.06932

Molecular weight of KOH = 56.1 Vs; volume of titrant used = 0.78cm^3

$:.$ TBN (Niger) $= \frac{0.78 \times 0.06932 \times 56.1}{2.03} = 1.49$

1.49mgKOH/g

For oil sample from Abuja (F.C.T);

Volume of solvent = $100cm^3$

Ws; mass of sample used = 2.10g

N, Normality of the titrant = 0.06932

Molecular weight of KOH = 56.1

Vs; volume of titrant used = $0.70cm^3$

$:.$ T.B.N (Abuja) $= \frac{0.70 \times 0.06932 \times 56.1}{2.10} = 1.47$

1.47mgKOH/g

For oil sample from Lagos state;

Volume of solvent = $10.00cm^3$

Ws; mass of sample used = 2.12g

N, Normality of the titrant = 0.06932

Molecular weight of KOH = 56.1

Vs; Volume of the titrant = $0.70cm^3$

T.B.N (Lagos) $= \frac{0.70 \times 0.06932 \times 56.1}{2.12} = 1.30$

1.30mgKOH/g

For oil sample from Kaduna state;

Volume of solvent = $10.00cm^3$

Ws; mass of sample used = 2.12g

N; Normality of the titrant = 0.06932

NOMENCLATURE

A ....Percentage of additives.

API............American Petroleum Institute

B...............Percentage of heavy viscous oils

BS......... ....Bright Stock

C........... ....Percentage of low viscous oils

F.P.............Flash Point

T.B.N.........Total Base Number.

V_{40}............Viscosity at 40^0C

V_{100}...........Viscosity at 100^0C

V.I..............Viscosity Index.

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Molecular weight of KOH = 56.1

Vs; volume of the titrant = $0.76cm^3$

$$T.B.N\ (Kaduna) = \frac{0.76 \times 0.06932 \times 56.1}{2.12} = 1.40$$

1.40mgKOH/g

TABLE 6.1: VISCOSITY INDEX TABLE

Kinetic Viscosity At 100°C, cst	L	D L –H	H
30.0	1023	601.6	421.7
30.5	1055	622.3	432.4
31.0	1086	643.2	443.2
31.5	1119	664.5	454.0
32.0	1151	686.0	464.9
32.5	1184	708.0	475.9
33.0	1217	730.2	487.0
33.5	1251	752.8	498.1
34.0	1286	776.8	509.6
34.5	1321	799.9	521.1
35.0	1356	823.4	532.5