

75%
**EXTRACTION OF NEEM SEED OIL FOR LIQUID
FUEL OR BIOFUEL DEVELOPMENT**

BY

OMADIVI ZUBAIR ABDULLAHI

2003/15111EH

**DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**

OCTOBER, 2008.

**EXTRACTION OF NEEM SEED OIL FOR LIQUID
FUEL OR BIOFUEL DEVELOPMENT**

BY

OMADIVI ZUBAIR ABDULLAHI

2003/15111EH

**A RESEARCH PROJECT SUBMITTED TO
DEPARTMENT OF CHEMICAL ENGINEERING
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**

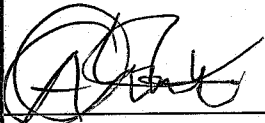
**IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF
BACHELOR OF ENGINEERING (B.ENG) DEGREE
IN CHEMICAL ENGINEERING**

OCTOBER, 2008.

DECLARATION

I, Omadivi Zubair Abdullahi (2003/15111EH) hereby declare that this research project, "Extraction of Neem seed oil for Liquid fuel or Biofuel development" carried out under the supervision of Prof. K.R. Onifade and presented in partial fulfillment of the requirement for the award of Bachelor of Engineering (B. Eng) degree in Chemical Engineering has not been presented for any degree elsewhere, to the best of my knowledge.

All literature cited have been duly acknowledged in the reference.



Omadivi Zubair Abdullahi
(2003/15111EH)

12-11-08

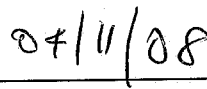
Date

CERTIFICATION

This is to certify that this research project titled "Extraction of Neem seed oil for liquid fuel or Biofuel development" was carried out by Omadivi Zubair Abdullahi (2003/15111EH) and submitted to the department of Chemical Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria, in partial fulfillment of the requirement for the award of Bachelor of Engineering (B. Eng) degree in Chemical Engineering.



Prof. K.R. Onifade.
(Project Supervisor)

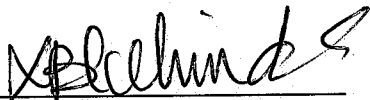


Date

Dr. M. O. Edoga.

(Head of Department)

Date



External Supervisor



Date

DEDICATION

I dedicate this project work to Almighty Allah for His Guidance throughout my period of research and to my parents Late Mall. Zubair Omadivi, Mallama Asmau Omadivi, my brother Idris Omadivi whose sponsorship and words of encouragement cannot be over emphasized, and the rest of my family members, who tried all their possible best to make sure I acquired this education.

Praise be to Allah ta'ala who sustained my life and make dream come into reality.

Alhamdulillah

ACKNOWLEDGEMENT

In the name of Allah the most Beneficent the most compassionate. Praise is to Him for granting me the wisdom and courage to undertake this course and sparing my life up to the time of writing this research work.

I am sincerely grateful to my respected supervisor Professor K.R Onifade for his guidance, corrections, supervision and relentless assistance rendered to me during the course of this research project

It is through that the soul is made lovely to who loves and helps it. My sincere gratitude goes to my parents Late Mal. Zubair Omadiv, Malama Asmawu Omadivi, my noble brother Idris Omadivi whose thoroughness and meticulousness in helping me through my period of stay in this great University is worth about mention . My brother Hassan Omadivi who supported me financially and morally and the rest members of the family. And my well-wishers Mall Abdulazeez, Mall Isah Kumode, Mall Nasir Isah. May Allah continue to bestow his favour on them all in their undertakings (Amin)

Finally my profound gratitude further extends to Mal.Dokko in the Chemical Lab department who aided me during the programme. The entire lecturers of the Chemical Engineering Department for impacting into the enabling knowledge to perform this task. May Allah reward them abundantly.

Also, my friends at home and school are not left out for the nice time we had shared together.

ABSTRACT

The extraction was done using and soxhlet apparatus. The three particle sizes namely 500 μ m, 250 μ m, 150 μ m were used for the extraction. In accordance with the above order, the corresponding percentage extractions were 69.11, 73.58 and 76.10 respectively.

Some fuel properties of the Neem oil blended with kerosene were experimentally determined to establish their suitability for use as heating and lighting fuel. Five blends (20, 30, 50, 70 and 80%) of Neem oil by volume with kerosene were used.

The results show that both the flash point and specific gravity of the blends increased as the Neem oil content increased. The results also show that both the smoke point and calorific value of the blends decreases^d as the content of the Neem oil composition increases^d.

The highest values of flash point, 90.60^bC and specific gravity, 0.884 corresponded to blends with composition 80 percent Neem oil and 20 percent kerosene. This composition also has the smallest smoke point. But its viscosity 1.76^bP at 31°C was a little bit higher than the smallest value of composition 20 of Neem oil to 80 of kerosene, though it has smallest calorific value of 24.76MJ/Kg.

Based on the findings of this study, blend with 80 percent of Neem oil to 20 percent kerosene composition was found to have reasonable and acceptable fuel properties for use as lighting and heating fuel.

TABLE OF CONTENTS

Title page.....	i
Declaration.....	iii
Certification.....	iv
Dedication.....	v
Acknowledgement.....	vi
Abstract.....	viii
List of Tables.....	xi
CHAPTER ONE.....	1-3
1.0 Introduction	
1.1 Rationale for study	
1.2 Aim	
1.3 Objective	
1.4 Scope and Limitation	
1.4.1 Scope	
1.4.2 Limitation	
CHAPTER TWO.....	4-16
2.0 Literature Survey	
2.1 Extraction	
2.2 Choice of Solvent	
2.3.0 Advantages of Solvent Extraction	
2.3.1 Disadvantages of Solvent Extraction	
2.3.2 Factors That Influence Rate of Extraction	
2.4 Neem Plant	
2.4.0 Description	
2.4.1 Propagation	

2.4.2 Uses of Neem
2.4.3 Neem oil (Margosa oil)

2.4.4 Uses of Neem Oil

2.5 Fuels

2.5.1 Liquid Fuels

2.5.2 Fuels properties

2.5.3 Flash point

2.5.4 Sulphur content

2.5.5 Calorific value

2.5.6 Viscosity

2.5.7 Specific Gravity

2.5.8 Smoke point

CAPTER THREE.....17-22

3.0 Experiment

3.1 Preparation of Neem Seed and Experimental Procedure

3.2 Materials

3.2.1 List of Instrument and equipment

3.2.2 List of chemical and Materials

3.3 Methods

3.3.1 Flash point

3.3.2 Relative Density

3.3.3 Viscosity Measurement

3.3.4 Calorific value or heating value

3.3.5 Smoke Point

CHAPTER FOUR.....23-28

4.0 Result and Discussion of Result

4.1 Results
4.2 Discussion of Results
CHAPTER FIVE.....29-30
5.0 Conclusions And Recommendations
5.1 Conclusions
5.2 Recommendations
References.....31
Appendix.....32
Experimental Calculations

LIST OF TABLES

Table 2.1 Fatty acid contents of neem oil (Muhammad 1998).....9
Table 2.2 Further Analysis of Neem oil (NARICT and Muhammad, 1998).....10
Table 4.1 Results.....23
Table 4.2 Values for Flash Point of the Blends.....23
Table 4.3 Values for specific gravity of the blends.....24
Table 4.4 Value for viscosity.....24
Table 4.5 Values for smoke point of blends.....25
Table 4.6 Values for calorific value of the blends.....26

CHAPTER ONE

1.0 INTRODUCTION

Neem or neem tree, a family mahogany botanically named "Azadirachta Indica" or popularly known as "Margosa, cachia, Ike tree, Dongoyaro" has the potential to boost the economic development of this country. Neem is an attractive broad leaved evergreen that can grow up to 30m tall. It is an outstanding example of plants with many commercially exploitable properties. It is said to grow almost anywhere in the low land tropics. It has many uses which cut across medicinal pharmaceuticals and industrial.

The oil (margosa oil) is perhaps the most important. It is composed of triglycerides of oleic stearic acids etc. The oil can be obtained either by cold pressing or solvent extraction (Anonymous, 1992 and Dreyer, 1984).

Extraction of oil has been of a great interest world wide and this has been as a result of constant increase in the world population, and about 29 metric tonnes production of oil and fats per annum can not satisfy all the needs. Therefore, the development of other means of production of oils in an attempt to meet the demand of the society for industrial and domestic purposes is necessary.

Neem oil is generally light to dark brown bitter and has a rather strong odor that is said to combine the odour of peanut and garlic. It comprises mainly triglycerides and large amount of triterpene compounds which are responsible for its bitter taste.

1.1 Rationale for study

Over the years as a result of civilization and rapid expansion of industry, there had been a change over from the use of one major type of fuel to another. In the recent years, petroleum which has taken over has been subjected to various uses which have led to among other factors to rise in price.

However rising petroleum prices with increasing threat to the environment from exhaust emission and global warming have generated intense international interest in developing alternative non petroleum fuel for engine (Ajava, 2003).

In the United States six major electric utility comprises and a number of independent power producers are already using biofuels, while others are experimenting with crop types, fuel mixes and conversion and combustion technologies (Resource, 1996). In order to obtain blends of Neem oil with kerosene that are suitable for use as heating and lighting fuels requires a good knowledge of some basic fuel properties of such Neem oil- kerosene blends

1.2 AIM

Aim of this research work was to explore our local Neem oil as an alternative source of liquid or biofuel

1.3 OBJECTIVE

The objectives of this research work are as follow:

1. To be able to determine basic fuel properties of local Neem oil blended with kerosene.
2. To be able to determine suitable percentage composition of Neem oil to kerosene for lighting and heating.

1.4 SCOPE AND LIMITATION

1.4 SCOPE

The scope of this work covers the following areas/activities:

1. Preparation (Drying, Grinding, sieving, weighing) of neem seeds for extraction process.
2. Extraction of oil from neem seed using soxlet extractor.

3. Preparation of various blend of extracted oil with kerosene.
4. Testing for the blended properties which include: Flash point, caloric value, specific gravity, viscosity and smoke point.

1.6 LIMITATION

The project work was limited to only testing for blended properties to know which one will serve best for heating and lightening properties.

CHAPTER TWO

2.0 LITERATURE SURVEY

2.1 Extraction

Extraction of oil has been of a great interest world wide and this has been as a result of constant increase in the world population. Therefore the development of others means of production of oil in an attempt to meet the demand of the society for industrial and domestic purposes is necessary.

To obtain neem oil, the seeds are first broken open and the kernels separated. The kernels are then pressed in industrial expellers or in hand or bullock operated wooden presses (ghains). The oil yield is some times as high as 50 percent of the weight of the kernel. This cold press is mainly used in lamps soaps and other non edible products.

A large industry in India extracts the oil remaining in the seed cake using hexane. This solvent extracted oil is not as high quality as the cold pressed oil but it also goes into certain soaps and consumer products, purifying neem oil is an elaborate and costly process at present. In one method, the smelly sulphur compounds are distilled of which free oil from both odour and susceptibility to rancidity (because it also removes the free fatty acids) this process has long been used industrially.

Neem oil can be also extracted from ground up oil bearing seed as kernels using ethanol and distilled water as solvents. This also known as leaching that is the solid by means of a solvent.

The extraction process is dependent on several parameters such as particle size, solvent, temperature, extraction time etc. The experiment is designed to demonstrate importance of these parameters and also to demonstrate the recovery of the solvent from the resultant.

The choice of solvent is another factor to be considered and it must exhibit all properties for effective complete and economical extraction of desirable solute.

Therefore, the choice of solvent for extraction is as follows:

2.2 CHOICE OF SOLVENT

In any separation process where the separating agent is material as in leaching rather than energy as in centrifugation, the choice of separating agents is of the most importance. In this case the selection of the solvent should be considered as follow:

1. Preferably, the solvent should be non toxic.
2. The solvent should be readily available.
3. The solvent should have a reasonably low boiling point to allow simple distillation, both for solvent recovery as well as for solvent purification.
4. The boiling point of the solvent should not be too low other wise evaporation loses may be high.
5. The solvent should be cheap so that the cost the initial solvent inventory is reduced as associated cost of solvent replacement.
6. The solvent should be stable chemically toward the component of the system and materials of construction.
7. The solvent should not be contaminant to the extracted solid in later stages of the solid use, if it then drying of other separating stages may be needed.

2.3.0 ADVANTAGES OF SOLVENT EXTRACTION

1. The extraction rates use in this process are usually higher than that from mechanical methods residues normally contain less than 2 percent oil.
2. When dealing with seeds of very minute size, the process results in maximum oil yield.

3. It constitutes the most effective for the recovery of oil from any oil bearing materials. It has advantages over steam distillation since it is not carried out at high temperature.
4. Due to selective and inert of the solvent used, solvent extraction is free from any undesirable impurity which may lower the quality of oil.

2.3.1 DISADVANTAGES OF SOLVENT EXTRACTION

1. Solvent extraction equipment is very difficult to come by, very expensive and costly to maintain.
2. Separation of liquid from solid provides efficient contracting and extracting time.
3. The list of solvents to be used is not much since solvent do not possess the required characteristics for good extraction.

2.3.2 FACTORS THAT INFLUENCE RATE OF EXTRACTION

Some of the factors which may affect the rate of extraction are briefly discussed below:

- a. **Temperature** : this affect the rate of extraction because the solubility of most materials generally increase with increase in temperature. Since the process of extraction depends solely on differential solubility, temperature will definitely increase the rate of extraction.
- b. **Particle sizes**: This also affects the rate of extraction because the smaller the size the greater the interfacial area available between the solid and solvent and this entails higher rate of diffusion which will to increase rate of extraction.
- c. **Solvent**: The solvent used also affect the rate of extraction since all solvents used do not possess the same chemical properties. In whatever situation, solvent used should inert to the oil

X

It must also have a low freezing point and low viscosity to ensure free circulation within the vessel.

The solvent must also be readily and economically available . Have high volatility to ensure easy removal by evaporation.

Any of the above qualities not possessed by the solvent will definitely affect the yield of the oil in the negative direction.

2.4 NEEM PLANT

The Neem tree originated from India, but about 200 years ago where ships began traveling the world, the beautiful Indian Neem tree was carried to all parts of the globe (PHP2000). It is an outstanding of plant with many commercially exploitable properties. Initially, research in the field at Kew Botanical Gardens has disclosed some favorable characteristics of Neem.

2.4.0 Description

It is a broad leaf evergreen that can grow up to 30m tall and 2.5m in girth. Their spreading branches forms rounded crowns as much as 20m across. They remain in leaf except during extreme drought, when the leave may fall off.

Neem can take considerable abuse. It easily withstands Pollarding (repeated lopping at height above about 1.5m) and its topped trunk reroutes vigorously. It also freely copes (repeated lopping at heights above about 1.5m) and it's topped trunk routes vigorous. It also freely copes (repeated lopping at near ground level). Regrowth from both pollarding and copping can be exceptionally fast because it is being serving by a root system large enough to feed a full grown tree.

They have a honey like scent and attract many bees. The fruit is a smooth ellipsoidal drupe, up to almost 2cm long. When ripe, it is yellow and comprises a sweet

X

X pulp enclosing a seed. The seed composed of [^]shell and a kernel (sometimes two or three kernel), each above half of the seeds weight.

A neem tree normally begins bearing fruit at 3-5 years, become fully productive in 10 years and from then on can produce up to 50Kg of fruit annually and it may live for than 200 years (sirdc, 1998). X Not listed in Reference list.

2.4.1 Propagation

It is easily propagated both sexually and vegetatively. It can be planted using seeds, seedlings, roots suckers, or tissues culture. To prepare seeds for planting, dry them carefully if possible in the shade, because temperature of 45 degree cent will reduce germination.

2.4.2 Uses of Neem

X It is one of the most remarkable among the list of more than 1600 species that have been identified with pesticide properties. Traditionally, neem leaves are placed granaries to reduce grain storage losses. A number of neem-based pesticides have also been introduced in the industrial countries. Still, the palatability chemical composition, digestibility, and nutritive value *Azadirachta indica* were examined with Kumaoni and Buffalo bullock and sheep. The value for digestible crude protein and digestive nutrients (dry weight bases) were 8.38 and 53.28Kg/100Kg respectively.

Beyond all the possible pesticides and pharmaceuticals materials. For instance, the solid residue (cake) left after the oil is removed the kernels is employed as a fertilizer and the soil amendment. Its potential as fertilizer is as a result of the fact it contains more nitrogen, phosphorous, potassium, calcium and magnesium than farm yard manure sewage sludge (Anonymous, 1992).

X

The cake is not the only source of fertilizer. In some area in Indians Karnataka state , people grow the tree mainly for its leaves and twigs, which they puddle into flooded ice field before the rice seedling are transported. In addition, wood from the tree is valued for constructions cabinetry and fuel. The bear is trapped for gum and extracted from tennis and dental bear product.

Here in Nigeria, because of the trees good growth and valuable fire wood, it has become the most important plantation species in Northern, Nigeria. It is also grown for fuel around Slarge towns. Charcoal made from this neems wood is excellently quality with calorific value only slightly below that of coal from Nigeria Enugu mines (Muhammad 1998).

2.4.3 Neem oil (Margosa oil)

Of all the product of neem, its oil is perhaps the most commercially important. In composition, it is much like other vegetable oils; composed of primarily of triglycerides of oleic, tearic, lanolin, palm tic and lanoline acids. The actual fatty acid contents are shown in the table below.

1992 listed in Refs

Table 2.1 Fatty acid contents of neem oil (Muhammad 1998)

Fatty acid	Percentage
Oleic	41
Stearic	20
Linolieic	20
Palma tic	18
Linoleic	1

Unlike their vegetable oils, it is bitter and contains sulphur compound whose pungent odour is reminiscent of garlic. The table below shows vividly further analysis.

Table 2.2 Further Analysis of Neem oil (NARICT and Muhammad, 1998)

PARAMETERS	RESULT
Acid value	9.96
Colour	Light brown
Iodine value	77
Free fatty acid	5.0
Odour	Garlic repulsive
Refractive index	1.4664
Saponification	180.22

2.4.4 Uses of Neem Oil

India's supply of neem oil is now used mostly by soap manufacturers. Although, much of it goes to small scale specially soaps, large scale producers also use it, mainly because it is cheap.

Generally, the crude oil is used to produce coarse laundry soap. However, saponifying the crude oil and distilling the resulting fatty acids make more expensive soaps. In addition, the oil also into waxes and lubricants as well as in to fuels for lighting and heating.

Neem oil is nondrying, and it is resists degradation better than most vegetable oils. In rural India, it is commonly used centuries in traditional Indian medicine to aid in the heating of tropical skin disorders such as eczema, psoriasis, rashes, burns and acne.

(Anonymous, 1992)

2.5 FUELS

Fuel is any substance that undergoes combustion with oxygen to produce light, heat or power. Fuels are classified into various types ranging from solid to gaseous fuels.

2.5.1 Liquid Fuels

Petroleum and natural gas are the source of practically all liquid fuels. Crude petroleum varies from a heavy tarry substance with a density greater than water to a colourless straw coloured liquid similar to gasoline. Because this variation in properties, petroleum is normally distilled and separated into fraction, including gasoline, kerosene, diesel oils jet engine fuels, fuel oil and lubricating oil. Heavy residue of lower quality crude oil are frequently decomposed to coke and cracked products. An increasing amount of oil is being used as raw material chemical product. Such as plastics, although most of the product is used as fuel.

Each of the liquid fuel mentioned must meet certain specifications. Gasoline must be volatile enough to vaporized sufficiently to allow a motor to start at low temperature, but not as volatile that it vaporizes in the carburetor and cause vapour lock. Kerosene is used largely as illuminating oil, and it must vaporize and burn clearly. It must also be saved to store and use. This case safely depends on the flash point of the substance. Diesel oils must burn without substantial residue, and those in high-spaced engines must avoid ignition delay. Fuels for jet engine must allow the engine to operate under severe conditions and pressures and start as well as deliver power under those adverse conditions.

2.5.2 Fuels properties

Fuels have different properties which affect their quality. These properties are: flash point, calorific value, power point, cloud point, Fire point, viscosity, specific gravity, smoke point, sulphur content, odour, colour, ash content, corrosion etc.

For petroleum products, there are the predetermined specifications which they have to meet before they are sent out for final consumption. American society for Testing and materials (ASTM) is an organization concerned with setting these specifications before any substance is classified as a fuel, it must be subjected to these tests and specifications.

2.5.3 Flash point

Flash point is defined to be the temperature at which the vapour of a petroleum product heated under defined standard conditions forms an explosive mixture with the surrounding air and ignites when a flame is brought up to it. The flash point depends on the distillation range of the products. The lower this range of petroleum product, its flash point. The average flash point of gasoline range from -30 to -40°C of kerosene, from 30 to 60 , of diesel from 30 to 90°C , and of petroleum oils from 130 to 320°C . The flash point tells us about the presence of a mixture of lower boiling fraction in a commercial or intermediates product (enrich and Rudin, 1992).

The flash point and the vapour pressure of the fuels are used in classification of fuels into flammable and combustible liquids. Flammable liquid means any liquids have a flash point of 40 psia at 100°F (37.78°C). While 140°F (60°C and below 200°F (93.33°C)).

2.5.4 Sulphur content

In addition to the practically infinite mixture of hydrocarbon compounds that form crude oil, sulphur, nitrogen and oxygen are usually present in small but often important

quantities. Sulphur is the third most abundant atomic constituent of crude oils. It is present in the medium and heavy fraction of crude. In the low medium molecular ranges, Sulphur is associated only with carbon and hydrogen, while in the heavier fraction; it is frequently incorporated in the large polycyclic molecules that also contain nitrogen and oxygen. The total sulphur in crude oil varies from below 0.05% (by weight) as in some Pennsylvania oils to about 2 % for average Middle Eastern crude and up to 5% or more Mexican or mississippi oil. Generally, the higher the specific gravity of the crude oil, the greater is its sulphur content. The excess sulphur is removed from crude during refining, because sulphur oxide released into the atmosphere during the combustion oil would constitute a major pollutant.

2.5.5 Calorific value

Since the function of a fuel is to produce heat, the calorific or heating value is one of the fuel properties; and knowledge of this is necessary in obtaining information regarding the combustion efficiency and performance of all types of oil burning equipment.

Calorific value: The total amount heat evolved when unit mass or unit volume of a fuel is burnt completely in excess supply oxygen is known as calorific value of the fuel. For a good fuel, calorific value should be high.

Types of Calorific Value

1. **Higher calorific value:** The amount of heat evolved when unit mass or unit volume of a fuel is burnt completely in excess supply of oxygen and the products of combustion are allowed cool at room temperature is known as higher carolific value. Higher calorific value is also known as Gross calorific value.

2. Lower calorific value: The amount of heat evolved when unit mass or unit volume of a fuel is burnt completely in excess supply of oxygen and the product of combustion are allowed to escape it also known as net Carorific value (NCV). Determination of CV is done by (i.) Bomb calorimeter (ii.) Boy's gas calorimeter.

The calorific value was made by

$$C.V = (a_3 - a_1) \cdot y / z \quad \text{2.1}$$

The calibration constant (Y) is given as

$$Y = 6.32 W_1 / (a_2 - a_1) \quad \text{2.2}$$

The importance of this quantity is that the power available from an engine under content running conditions and with a constant rate of fuel supply is governed. A fuel of low calorific value yields less heat on combustion and, therefore, less power than the same amount of a fuel with higher calorific value. To maintain power output with low calorific value fuel, more of it would have to be used. The calorific value of gasoline is 43.69 MJ/Kg , of kerosene is 43.488 MJ/Kg , of diesel is 44.52 MJ/Kg and of fuel oil is 41.45 MJ/Kg (Erikh, 1992 and Ajava, 2003)

2.5.6 Viscosity

Viscosity is described as the measure of liquid resistance to flow when it is subjected to a shear stress. It is also a measure of the internal friction that arises when there are velocity gradient within the liquid system. Viscosity is usually expressed in centisrokes (cst) or in centipoises (cP) or in poise.

The viscosity of the individual petroleum is dependent on temperature. Hence, the viscosity of 100°F (37.8°C) of gasoline is 0.55 cst , of kerosene is 1.25 cst , of diesel fuel is 3.20 cst , and of fuel oil is between $300-400 \text{ cst}$, (Erkh and Rudin, 1992) it is evaluated by the use of this formular in centipoises.

$$h = 0.073134dt - 5.94458d/t \quad \text{2.3}$$

h = Dynamic viscosity (cp)

d = Specific gravity of the sample

t = Flow time, second

2.5.7 Specific Gravity

Petroleum and their product are generally characterized both by their absolute density, generally called simply density, measured in g/cm^3 or Kg/M^3 and their specific gravity (relative density). The latter is dimensionless quantity equal to the ratio of mass of a petroleum product to that of pure water at 60°F (15.56) taken in the same volume as the product. When reporting the relative density of a solid or liquid, the temperature t_1 and t_2 must be explicitly e.g red $60/60^\circ\text{F}$. Thus, by definition

$$\begin{aligned} \text{Rel. d } t_1 / t_2 &= \frac{\text{mass of given volume of substance at } t_1}{\text{mass of equal volume of water at } t_2} \\ &= \frac{m_2 - m_1}{m_1 - m} \quad \text{2.4} \end{aligned}$$

Where m = mass of bottle, m_1 = mass of bottle and water

m_2 mass of bottle and oil .

The average specific gravity of petroleum range from 0.82 to 0.90 but there are both higher (0.720) and heavier (0.95g) ones. The specific gravity of gasoline usually average s 0.750, of kerosene is 0.800, of diesel fuel is 0.85, of fuel oil is 0.95 and of lubricating and similar oils from 0.880 to 0.930 (Erihh, and Rudin, 1992)

2.5.8 Smoke point

This is another prominent property of the petroleum product. It is defined as the maximum flame height in millimeters at which the fuel product will burn without smoking or soot. Even if full advantage is not taken to utilize maximum non-smoking

X

flame height, the property of high smoke point ensure that in the event of sudden drought causing extension in flame height, there will be fewer tendencies for smoking to occur in such circumstances.

While a low smoke point is undesirable in that it may not give a satisfactory range of smokeless performance, a high smoke point alone is not a guarantee that kerosene has generally satisfactory burning characteristics. In general, the smoke point value specified

X for kerosene ranges from 25mm to 35mm (www.Jatropha.org/cooker)

CHAPTER THREE

3.0 EXPERIMENT

3.1 PREPARATION OF NEEM SEED AND EXPERIMENTAL PROCEDURE

Neem seed collected were decorticated, that is, the hills were removed and then 700g was sun dried. After drying, the weight was noted to be 393g. The weights of the seeds before and after it was dried were denoted as W_1 and W_2 .

The moisture content were calculated as

$$\frac{W_1 - W_2}{W_1} \times 100\% \quad 3.1$$

The screen analysis were done over 3 different particle sizes arrange in decreasing order (i.e. 150 μm , 250 μm , 150 μm) after the seeds had been pulverized into powder form. The extraction was done over all the samples in order to obtain much oil. The experiments were repeated on the different particle size ranges five times

250ml of the solvent (pure hexane) were used through out the extraction.

3.2 MATERIALS

3.2.1 List of Instrument and equipment

1. Tray dryer
2. Soxhlet extractor
3. Heating mantle
4. Screen/sieve plates
5. Round bottom flask
6. Beaker
7. Measuring Cylinder
8. Weighing balance

9. Sample bottle
10. Mortal and pestle
11. Bomb Calorimeter
12. Pensky –martins Closed flash tester
13. Specific gravity bottle
14. Brook field viscometer
15. Smoke point tester

3.2.2 List of chemical and Materials

1. Neem fruits
2. Hexane
3. Neem oil
4. thimble
5. cotton wool
6. Kerosene
7. Water

3.3 METHODS

Five blends of kerosene fuel with Neem oil were used. They were obtained by mixing Neem oil and kerosene by volume in the following proportions.

1. 50 percent Neem oil and 50 percent kerosene
2. 30 percent Neem oil and 70 percent kerosene
3. 20 percent Neem oil and 80 percent kerosene
4. 70 percent Neem oil and 30 percent kerosene

5. 80 percent Neem oil and 20 percent kerosene

The laboratory tests were carried out to determine the following properties. Flash point, Calorific value, relative density, viscosity, and smoke point

3.3.1 Flash point

This is the minimum temperature at which the vapour of a petroleum product heated under definite standard conditions from an explosive mixture with the surrounding air and ignites when a flame is brought up to it. Flash point of the samples were measured or determined by pensky martens of the cup and its accessories were thoroughly cleaned and dried. This was done to remove any solvent that has been used in the apparatus. The cup was fed by the filling mark. The cup with sample was placed in the apparatus where it was contacted with hot water.

The lid was placed on the cup and set with the thermometer inserted in the apparatus. It was ensured that locking device was properly engaged. Then the heat supply was at such a rate that the temperature indicated by the thermometer increased (5°C to 6°C)/min. After some time, the test flash was applied by operating the mechanism on the cover which controls the shutter and the test flame burner so that the flame was lowered into the vapour space of the cup. It was left there in its lowered position for one second and quickly raised to its high position.

Hence the flash point was recorded as the temperature read on the thermometer at the time the test flame quenched off in the interior of the cup.

X

3.3.2 Relative Density

This otherwise known as the specific gravity refers to the ratio of the density of a fuel to the density of water at the same temperature with its other properties could be judged.

A relative bottle of 50ml capacity was washed and dried. The weight of the empty bottle was noted and the mass was recorded as Mg. Distilled water was introduced into the bottle and weighed to give Mg₁. The bottle was empty, dried filled with the blends and weighed and the mass was recorded as Mg. Hence the specific gravity was

X evaluated by ~~Equation~~ Equation 2.4

$$\frac{Mg_1 - Mg}{Mg_1 - Mg} \quad \text{2.4}$$

3.3.3 Viscosity Measurement

The resistance to flow exhibited by fuel blends are expressed in various units of viscosity, it is a major factor of consequence in establishing their suitability for the mass transfer and metering requirements.

It was determined by Brook field viscometer. The blend or fuel blends were charged in to the tube at a room temperature (31°C). The tube and its contents were put in the water of the viscometer. The viscometer was operated by closing the circuit when a certain limit in the capillary tube was reached and the time was noted. Similarly, the reading was noted when simple flow passed a certain level in the capillary tube. Hence

X the viscosity in centipoises was calculated by using ~~Equation~~ Equation 2.3

$$h = 0.073134dt - 5.94458d/t \quad \text{2.3}$$

3.3.4 Calorific value or heating value

The calorific values or heating value of the blends were determined with help of a Gallen Kemp ballistic bomb calorimeter.

Galvanometer deflection without sample was noted and recorded. The maximum deflection of galvanometer on the control box was recorded after burning the sample. The effective heat capacity of the system was also determined using same produce but with pure and dry benzoic acid as the test fuels. The calorific value was calculated by equation

$$C.V = \frac{(a_3 - a_1) Y}{Z} \quad 2.1$$

Where C.V = Calorific value of sample Mg/Kg

A₁ = Galvanometer deflection without sample

A₃ = galvanometer deflection with sample

Y = Calibration constant

Z = mass of the Fuel (g)

The calibration constant (Y) is given as

$$Y = \frac{6.32W_1}{a_2 - a_1} \quad 2.2$$

Where a₁ is as defined in equation above

W₁ = mass of benzoic acid (g)

a₂ = galvanometer deflection with benzoic acid.

3.3.5 Smoke Point

This is the maximum flame height in millimeter at which fuel will burn without smoking or without soot.

This experiment was performed using smoke point tester. The tester contains a small reservoir where the sample was placed. The wick was passed through the hole in the cover of the apparatus to the sample. The wick and sample were allowed there for at least 2minutes for proper soaking. The flame was set to the wick and it was allowed to burn. The amount of smoke produced was read from the calibrated tube for each sample in the tester.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION OF RESULT

4.1 RESULTS

The result obtained from this research work are organized and presented as shown in the flag tables

Table 4.1 Result of extraction

Particle size (μm)	Amount of solvent added (ml)	Weight before extraction (g)	Weight after extraction (g)	Amount of oil extracted (g)	Percentage of oil extracted (%)
500	250	61.80	19.09	42.27	69.11
250	250	61.80	16.30	45.50	73.58
150	250	61.80	14.78	47.02	76.10

Table 4.2 Values for flash point of the blends

S\N	Composition of samples%		Flash point		
	Neem oil	Kerosene	Flash point ($^{\circ}\text{C}$)		Average
1	0	100			60.0
2	20	80	43.26	59.54	56.40
3	30	70	60.00	64.20	62.10
4	50	50	74.50	72.50	73.50
5	70	30	89.20	80.60	84.90
6	80	20	90.60	90.60	90.60
7	100	0			110

Table 4.3 Values for specific gravity of the blends.

Composition sample %			Specific gravity		Average
S/N	Neem oil	Kerosene	Specific gravity		
1	0	100			0.80
2	20	80	0.840	0.802	0.821
3	30	70	0.8279	0.870	0.831
4	50	50	0.820	0.88	0.852
5	70	30	0.7400	0.872	0.873
6	80	20	0.900	0.868	0.884
7	100	0	—	—	0.904

Table 4.4 Values for viscosity

Composition of samples %			Viscosity (cP) at 31°C
S/N	Neem oil	Kerosene	
1	0	100	1.25cp
2	20	80	0.16
3	30	70	0.58
4	50	50	0.99
5	70	30	1.386
6	80	20	1.76
7	100	0	2.5cp

Table 4.5 Values for smoke point of blends

SN	Composition of samples		Smoke point (mm)
	Neem oil	Kerosene	
1	0	100	35.0
2	20	80	29.60
3	30	70	29.40
4	50	50	29.00
5	70	30	28.60
6	80	20	28.40
7	100	0	29.0

Table 4.6 Values for calorific value of the blends

S/N	Composition of sample%		Calorific value MJ/Kg
	Neem oil	kerosene	
1	0	100	43.48
2	20	80	38.80
3	30	70	36.60
4	50	50	31.78
5	70	30	27.10
6	80	20	24.76
7	100	0	41.45

DISCUSSION

4.2 DISCUSSION OF RESULTS

The amount of oil extracted is shown in Table 4.1 above. It was observed that the amount of oil extracted with three different sieve confirm that, the rate of a chemical reaction increases with increase in surface area. This is due to the fact that the particle size decreases the solute available for the solvent attach is increasing and hence more oil extracted.

As shown in Table 4.1 the mixture of Neem oil and kerosene was observed to be a homogenous mixture irrespective of the volumes that are blended. Based on this observation, it can be said that the two samples (i.e. Neem oil and kerosene) have some related properties which makes them to serve similar purpose. The structural difference between Neem oil and kerosene gave rise to their difference in properties as stated in the previous chapter of this work.

X

Combustible liquid is one of with flash point of about 93.33°C (Erikh and Rudin 1992). The standard flash point of Neem oil and kerosene are 110°C and 60°C respectively (European Communities IPSC, CEC 2001, WWW. IPCS INCHEM. CON)

X It can be shown from Table 4.2 that, as the percentage composition of Neem oil in the blends increase, the flash point also increases. This is due to the fact that the Neem oil has higher flash point than kerosene.

Among the composition of the blends, it can be seen that the composition of 80 percent Neem oil to 20 percent kerosene gave the highest flash point. These findings compared well with those earlier reported by Erikh and Rudin (1992)

X The standard average specific gravity of Neem oil and kerosene are 0.904 and 0.80 respectively. Specifically according to Erik and Rudin, (1992), the specific gravity of kerosene is 0.75 to 0.800. It can be seen from Table 4.3 that, all values of the blends fall within the given range. These findings compared well with those earlier reports, it can also be recorded from same table that as the composition of Neem oil increases in the blends the specific gravity also increase. This is due to the fact that the specific gravity of Neem oil is higher than that of kerosene. It can be used for heating and lighting.

It is normally the characteristics of the plant oil to have high viscosity but in order to serve as a good substitute for kerosene and diesel, the viscosity of Neem oil must be reduced to avoid clogging of cubes and Nozzle (www.Jatrpha.org/cooker)

X The standard viscosity for Neem oil and kerosene are 2.5cP at 31°C and 1.25cP respectively. The measured viscosities increased as the percentages of neem oil in the blends increased. These increments in the viscosities of the blends were mainly due to increase in the composition of neem oil. The viscosity of the composition 80% of neem

✓

oil to 20% of kerosene of the blends is close to that of kerosene. Therefore that composition may be considered best for lighting and heating.

A fuel of low calorific value yield less heat on combustion and therefore gives less power than the same amount of a fuel with high calorific value (Manual 2004).the standard value of calorific for kerosene and Neem oil are given to be 43.48Mj/Kg and 41.45Mj/Kg respectively.

X It can be observed from Table 4.5 that, all values are below the standard. But the composition of 20 percent Neem oil to 80 percent kerosene has highest value of calorific value among other properties. It is closer to the standard values than other hence that composition might serve best for heating and lighting purpose.

According to a report (with www.Jatropha.org.) a lower smoke point is undesirable in that it may not give a satisfactory range of smokeless performance. A high smoke point alone is a guarantee that kerosene has generally satisfactory burning characteristics. The standard smoke point for Neem oil and kerosene are 29mm and 35mm respectively.

X From the Table 4.6 the values of smoke point are very close to one another and all fall within the range given. These findings compared well with values from my report.

It can be said that the blends have good burning characteristics.

X

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following conclusion could be drawn from the results obtained

- i The amount of oil extracted with three different sieve conform that, the rate of a chemical reaction increase with increase in surface area.
- ii A significant difference can be seen in miscibility of Neem oil and Kerosene.
- iii The flash points of the blends were all above 45°C. The flash point of 80 percent of Neem oil to 20 percent Kerosene can be regarded as the best for heating and lighting fuel. And it gives safe storage temperature for the blend.
- iv Specific gravity of the blends were found to be closer to the standard value of kerosene than value of Neem oil.

Since the specific gravity is the characterization of absolute density of fuel, then fuel with less density should be considered good. (From the table of result, the composition of 20% of Neem oil to 80% of kerosene can be regarded to be better.

v From the results, the composition of 80% of Neem oil to 20% kerosene might be considered better.

vi Smoke point of the blends were all found to be the standard values. Therefore all compositions have good burning characteristics, but 20percent of Neem and 80 percent of kerosene has best burning characteristics

X vii Calorific values of the blends were all found to be lower than any of the specific liquid fuel. But composition of 20 percent to 80 percent was found to have higher calorific value than other composition. Then it could be considered best for lightining and heating.

In general, blends containing 80 percent of Neem oil and 20 percent of kerosene composition could be used as lightening and heating fuel. And Neem oil and kerosene can be used as blending agent.

5.2 Recommendations

- i Further work should also be carried out using the sample size but different solvent
- ii Further work should be carried out using different size range to find the most economic size to be used. Other factors such as temperature, solvent, time etc could then be varied and worked on and the obtained data can be used in the design of pilot plant.

More research should be carried out on the impact of using such blends on evaporative emission by carrying out measurement with different grades of base gasoline different blending proportions of Neem oil.

- iii A well – Coordinated Neem development program should be set up in the country so as to fully utilize the benefit that can be derived from it.

REFERENCES

1. Ajav, EA March 2003, 'A study of some fuel properties of local ethanol Blend with Diesel fuel Agricultural engineering international vol. iv, Pg 1-3 Available: e-mail: eaajav @ skannet. com
2. Dreyer, m. and Echo staff, (1984), Neem use as Insecticide, institute for phytopathologic and Angewadte Zoologic Justus Lieby universital, Germany (online), Available: [http://www. green- seed .com/neem](http://www.green-seed.com/neem)
3. Erikh, V. N. and Rudin M. G. (1992 Pg 48-59) "The chemistry and Technology of petroleum and gas, Mir publisher Moscow.
4. Mechanical Engineering laboratory manual" ABU ZARIA, 2004
- X 5. Muhammad M. R., ¹⁹⁹⁸ (1992) " Refining of Neem oil for industrial application" A Research project, chemical Engineering department, ABU Zaria(Unpublished).
6. Ferry, R. H., and Chilton, C.H,1978" Chemical handbook 5th Edition, Mc Graw -Hill New York,
7. RAO, B.K.B, 1984. "modern petroleum Refining processes, 2nd Education, Department of chemical Engineering, Indian Institute of Technology, Karag pur,
8. Anon.1998, "Encyclopedia Britannica" vol. 5,Pg 142-49. USA.
9. "Neem" A tree for solving global problems. A report of Board and science and technology for international Development Research council, National Academy press,1992. Washington D.C
10. Anon "oil" (on line), Available: [www. Housed straws co.UK](http://www.Housedstraws.co.UK).
11. European Communities @ ipcs, CEC 2001, [www. IPCSINCHEM con.1](http://www.IPCSINCHEM.con.1)

APPENDIX

EXPERIMENTAL CALCULATIONS

Moisture content

Weight of Neem seed collected before drying = 700g

Weight of Neem seed after dried = 393g

% moisture content $700-393/700 \times 100 = 43.86\%$

250ml of solvent (Hexane) was used.

For 500mm particle size, the weight of the sample taken was 61.80g.

The weight of sample before extraction = 61.80

The weight of sample after extraction = 19.09

The amount of oil extracted = $(61.8-19.09) = 42.71$ g

Percentage of oil extracted % = $42.71/61.80 \times 100 = 69.11\%$

For particle size 250 μ m

The weight of sample before extraction = 61.80g

The weight of sample after extraction = 16.3g

The amount of oil extracted = $(61.80-16.3) = 45.50$ g

Percentage of oil extracted = $45.50/61.80 \times 100 = 73.58\%$

For particle size 150

The weight of sample before extraction = 61.80

The weight of sample after extraction = 14.78

The amount of oil extracted = $(61.8-14.78) = 47.02$

Percentage of oil extracted = $47.02/61.80 \times 100 = 76.1\%$

Calorific value calculations

It was calculated by this formula

$$C.v = \frac{(a_3 - a_1) Y}{Z}$$

Where Cv= calorific value.

a_1 = Galvanometer deflection without sample

a_3 = Galvanometer deflection with sample s

Y = Calibration constant

Z= mass of the fuel sample (g).

But calibration constant (Y) is given as:

$$Y = \frac{6.32w}{a_2 - a_1}$$

a_1 as defined in equation

w_1 = mass of benzoic acid (g)

a_2 = Galvanometer deflection with benzoic acid.

Then, calibration constant

$$w_1 = 10g$$

$$a_3 = 2.98g.$$

$$Y = \frac{6.32 \times 10}{2.98 - 0.5} = 25.5$$

Z= 50g of every samples were taken

$a_1 = 0.5$, a_3 was read from the meter each sample.

For 50/50

$$a_1 = 0.5$$

$$a_2 = 62.81$$

$$Z = 50g$$

$$Y = 25.5$$

$$Cv = \frac{(62 - 0.5) \times 25.5}{50}$$

$$= 31.78 \text{ MJ/Kg.}$$

For 30/70

$$a_1 = 0.5$$

$$Z = 50g$$

$$a_3 = 72.26$$

$$Y = 25.5$$

$$Cv = \frac{(72.26 - 0.5) \times 25.5}{50}$$

$$= 36.60 \text{ MJ/Kg}$$

1. For 20/80

$$a_3 = 78.58$$

$$Y = 25.5$$

$$Cv = \frac{(78.58 - 0.5) \times 25.5}{50}$$

$$= 38.80 \text{ MJ/Kg}$$

2. For 80/20

3. $Y = 22.5$

$$a_1 = 0.5$$

$$Z = 50g$$

$$a_3 = 49.05$$

$$Cv = \frac{(49.05 - 0.5) \times 25.5}{50}$$

$$= 24.76 \text{ Mg/Kg}$$

5. For 70/30

$$a_3 = 53.64$$

$$Cv = \frac{(27.10 - 0.5) \times 25.5}{50}$$

$$= 27.10 \text{ MJ/Kg.}$$

Viscosity Calculations

For 20/80

$$h = 0.073134dt - 5.94458d/t$$

$$= 0.073134 \times 0.821 \times 11 - 5.94458 \times 8.821/11$$

$$= 0.16$$

For 30/70

$$\begin{aligned}h &= 0.073134dt - 5.94458d/t \\ &= 0.073134 \times 0.831 \times 15 - 5.94458 \times 8.831/15 \\ &= 0.583\end{aligned}$$

For 50/50

$$\begin{aligned}h &= 0.073134dt - 5.94458d/t \\ &= 0.073134 \times 0.852 \times 20 - 5.94458 \times 8.852/20 \\ &= 0.994\end{aligned}$$

For 70/30

$$\begin{aligned}h &= 0.073134dt - 5.94458d/t \\ &= 0.073134 \times 0.873 \times 25 - 5.94458 \times 8.873/25 \\ &= 1.386\end{aligned}$$

For 80/20

$$\begin{aligned}h &= 0.073134dt - 5.94458d/t \\ &= 0.073134 \times 0.884 \times 30 - 5.94458 \times 8.884/30 \\ &= 1.765\end{aligned}$$

Specific gravity = 0.904

Viscosity = 2.5cp

Smoke point = 29mm

Calorific value = 41.45MJ/Kg

For the kerosene

Flash point = 60

Specific gravity = 0.8

Viscosity = 1.2cp

Smoke point = 35mm

Calorific value = 43.48MJ/Kg