DESIGN AND CUNSTRUUCTION OF PALM KERNEL OIL EXTRACTOR

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NOVEMBER, 2022

CERTIFICATION

This is to certify that this project work "Design and construction of palm kernel oil extractor'' was carried out by the following persons:

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Under the supervision of Mrs. Joy Dennis of the Department of Mechanical Engineering Technology.

………………………	…………………………………
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Project Supervisor	Head of Department
Date………………	Date………………

DEDICATION

This project work is dedicated to God Almighty, the source and the giver of knowledge. We also dedicate this project work to our parents and all staffs and HND2 students of mechanical engineering department, Auchi Polytechnic, Auchi.

ACKNOWLEDGEMENT

We would like to acknowledge the immeasurable assistance given to us by our supervisor Mrs. Joy Dennis whose vast knowledge saw us through the completion of this project work.

Our thanks also goes to all the lecturers in the department of Mechanical Engineering Technology, to list among others are BNG. Aliemekhe,. ENGR. Akhigbe, A.E.

Finally, we are very grateful to our parents for their love and support, both morally, spiritually and financially, we would not have made it without them.

ABSTRACT

The process of palm kernel oil extraction existed since early human civilization. In ancient times, palm kernel oil extraction process merely involves the cleaning of palm kernel and grinded with the use of grinders or stone mills. When Modernization came, with the advancement of Science and Technology. Palm kernel screw press and palm kernel oil extracting machine were introduced which offered a much efficient solution and means of extracting palm kernel oil. This machine is fabricated and evaluated for small and medium scale palm fruit processors, in order to mechanize the extraction process and increase production output. The major components of the machine are; standing frame, thread shaft, speed reduction gear motor, driving and discharge outlet. The highest oil extraction ratio [OER] of 17.90 {and oil extraction efficiency [OEE}of 79.56 were obtained at the sterilization time of 60mm, digestion time of 10mm and screw speed of 10rpm.

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CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND TO THE STUDY

Oil palm is originated in West Africa, the main belt run through Ghana, Liberia, Sierra Leone, Togo and Congo. Processing oil palm fruits for edible oil has been practiced in Africa for thousands of years and the oil produced, highly Coloured and flavoured, is an essential ingredient in most of the traditional West African. Large percentage of palm oil produced ends in food products while the small percentage remaining is used for industrial production (Aghalino 2000,FAO,2005). Palm kernel is the edible seed of the oil palm fruit, it is gotten after the palm fruit has been milled to extract palm oil, the endocarp which is the nut is collected, dried, and stored. The nut is then cracked and the shell blown out leaving the palm kernel itself.(Poku&Kwasi,2002)

Traditional method of producing palm kernel oil is by putting the palm kernel in boiling water, the heat allows the oil to melt out, hence mixing with water. The water is allowed to cooled, thereby condensing the palm kernel oil on the top of the water. The oil is then drained off and the remaining water is heated out of the oil so as to evaporate. This method was described by different researchers and it is time consuming. Another method of producing palm kernel oil is by heating the crucible to a very high temperature, causing the oil to melt out. This method is said to be not too good as it result to the burning of the oil (Owolarafe and Faborode ,2002).

Palm kernel oil processing involves various procedures, therefore the ability to make machinery that can handle the plenty unit operation include is indicative of a generalized ability to produce processing machines for other crops, palm industry machine developed can be used for the same functions for other crops application with little modification (Gbadamosi, 2006). The traditional method is used in rural areas of many developing countries. The oil-bearing material is ground and then heated in boiling water. The liberated oil floats to the surface and is collected. The solvent extraction method is a chemical extraction method, and is very expensive and complex for small-scale extraction. In the mechanical method such as the screw press, a rotating screw forces the oil-bearing material down the length of the cylindrical pressing cage. Increasing pressure squeezes oil out through perforations in the sides of the cage. The cake emerges from the end of the press (Gbadamosi, 2006). The working part of the machine used in processing palm kernel oil is shaft, hopper, oil collector, bearing, and cage bar.

1.2. STATEMENT OF THE PROBLEM

Despite the encouraging nature of palm kernel oil production, not many people are involved in its production. The probable reason could be that the local extractor machine used in extracting the oil is not economically efficient when compared with the industrial machines. It is lower in output and industrial machine has dryer, this is the reason the expansion palm kernel is delayed.

The hike in cost of production due to high cost of input like electricity and inadequate working capital made it impossible for most of the investor in palm kernel oil to produce optimally.

1.3. AIM AND OBJECTIVE

1.3.1. Aim of the study

The aim of the project is to design and construct a palm kernel extractor.

1.3.2. Objectives of the Study

i. Material selection of palm kernel extractor machine

ii. Mathematical design of palm kernel extractor machine

iii. Graphical modeling of palm kernel extractor machine

iv. Construction of palm kernel extractor machine

v. Performance evaluation on the machine

1.4. SIGNIFICANCE OF THE STUDY

In this design and fabrication, the method used is the mechanical extraction method, because it is suitable for production of small and large quantities of palm kernel oil. Its time rate is faster and much manual labour is not required; therefore, it is efficient, effective and cheaper than traditional method which requires more manual labour.

1.5. SCOPE OF THE STUDY

The palm kernel oil extractor comprise mainly of coupling, gearbox, pressing stations and motor. The palm kernel oil extractor is designed with the main shaft directly driven by a coupling affixed to the gearbox. The automated palm kernel oil extractor are designed to protect the gearbox from breaking or the main shaft or bearing from malfunctioning. Thus, our palm kernel oil extractor will improve the pressing efficiency of the palm kernel, so as to extract the oil and to reduce the oil in the final cake.

1.6 DEFINITIONS OF TERMS

1. Hopper:

Steel sheet is used for hopper due to its strength to withhold or withstand vibration.

Fig 1.1 Hopper

2. Shaft:

Shaft is a cylindrical machine element that transmits steel is selected for shaft due to its tensile strength, it is easily machined.

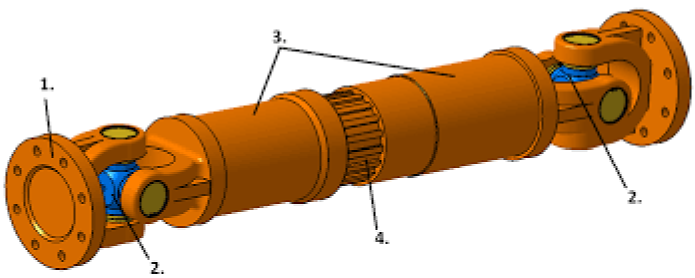

Fig 1.2 Shaft

2. **Coupling:**

Coupling is another machine element that connects or joins two components together. There are different kinds or type of coupling sleeve, flexible, rigid flange. The rigid coupling is used.

Fig 1.3 Coupling

4. Oil collector:

Black steel is chosen due to its strength also because the oil entry cannot corrode the materials.

5. Support:

Angular steel bar was selected due to the tensile strength, its ability to withstand deformation when it is overloaded.

6. Pressure barrel:

Thick wall allow cylinder was chosen for the construction of pressure barrel because of its tensile strength and ability to withstand internal pressure.

7. Cake collector:

Steel sheet is selected due to the high tensile strength it has.

CHAPTER TWO

LITRATURE REVIEW

2.1. SOURCE OF PALM KERNEL OIL

Palm kernel is a product obtained from palm fruit. The red fruit is harvested when the mesocarp has ripened i.e. it has become redlined and also become softened to thumb press. Steaming accelerate the softening of the mesocarp or boiling of ripe fruit to facilitate the extraction of the oil from the mesocarp and this process is called “par boiling”.

Palm kernel is a vital commodity in Nigeria economy with reference to it role as a sourc0e of farm income and food requirement, in addition to providing direct and indirect employment for about four(4) million people, palm kernel oil contributes around 70% of the country national consumption requirement of vegetable oils. (Poku, 2002:Nzeka, 2014)

2.2. TRADITIONAL OR LOCAL METHOD OF PALM KERNEL OIL EXTRACTION

Palm kernel extraction is specialized operation undertaken by a completely different set of processors. They are usually better organized as a group and are not as dispersed as palm oil processors. The kernel processors have to go around the palm oil processors during the peak season, when prices are lowest, to purchase the nut for drying. The nut processing and oil extraction is undertaken in the day season(Adebayo, 2004)

A large percentage of the palm kernel oil produced in Nigeria is obtained using the traditional method. And this method of processing palm kernel oil is not only unhygienic but is equally laborious tedious intensive and time consuming.(Owolarafe, 2004)

Before getting the palm kernel from the nut for processing, the palm fruit is first harvested and processed to get the palm oil out of it. Climbing is one of the method which is commonly used for harvesting palm fruit from the palm tree, most especially on tall palm trees. This method is slow and dangerous that most farmers now grow hybrids that are shorts which can easily be harvested while standing from the ground.

The harvested palm fruit bunches are mostly carried by women or men, by stacking them in basket and carried on their head or using wheel barrow/ vehicle to convey it to the place where the processing is done. (Owolarafe and Faborode, 2002)

After getting the palm oil, the nut with the fibrous mass are then spread on an open space where it is allowed to dry so that the nut can be separated easily from the fibrous mass, and allowed to dry properly, the nut are now cracked to manually by placing the nut on a stone and striking it with another stone. After drying the kernel to the required texture, the palm kernel is then steamed or boiled to bring out the oil. The oil then rises above the water and allowed to cool so that the oil at the top can be decanted and it is being re-heated on the fire to remove the traces of water in it.

The final product is stored in drums, bottles thin or other containers. Because of the high temperature, the oil coming out of the kernel getting in contact with crucible, the palm oil is then oxidized and result to a black product. (FAO 2005)

2.3. MECHANISED METHOD OF PALM KERNEL OIL EXTRACTION

Machine manufacturing is a recent development in the West African sub region and until recently it has not been possible to develop the sophisticated machine required to improve on traditional method.

One of the problems faced by several small scale producers is processing the palm kernel oil using the traditional methods. It is estimated that about 250,000 tons of palm kernel oil is lost yearly due to the inefficient traditional processing method being used by majority or small scale palm kernel oil producers which account for over 70%of the producers and the oil. the demand for palm kernel oil and the need for it large scale production in many countries are not satisfied worldwide. The local method of extracting oil from palm kernel is not adequate. (Akinoso and Bankole, 2006)

In an attempt to solve this problem, the mechanized method of palm kernel oil processing was developed in a palm kernel oil company at Ondo State (Akure),Nigeria. In this method different procedures are involved in the processing of palm kernel oil, these procedures involved the feeding of the palm kernel on the conveyor which then carries it to the expeller at a rated or control speed, the oil is then collected through pipe from the expeller to a tank where clarification takes place, i.e. removal of dirt, water and other impurities from the oil. The cake which is the residue is not wasted; it is being collected in another conveyor and carried to a section where it is bag for feed. (Olukunle, 2012)

Mechanizing the palm kernel oil extraction process would reduce waste and improve efficiency and output and encourage rural development by generating wealth and promoting self-employment (Olayiwola, 1998)(Jimoh and Olukunle, 2012,). In the mechanized method such as the screw press a rotating screw forces the oil bearing material down the length of the cylindrical pressing cage. Increasing pressure squeezes oil out through perforations in the sides of the cage. The cake emerges from the end of the press (Gbadomosi, 2006).

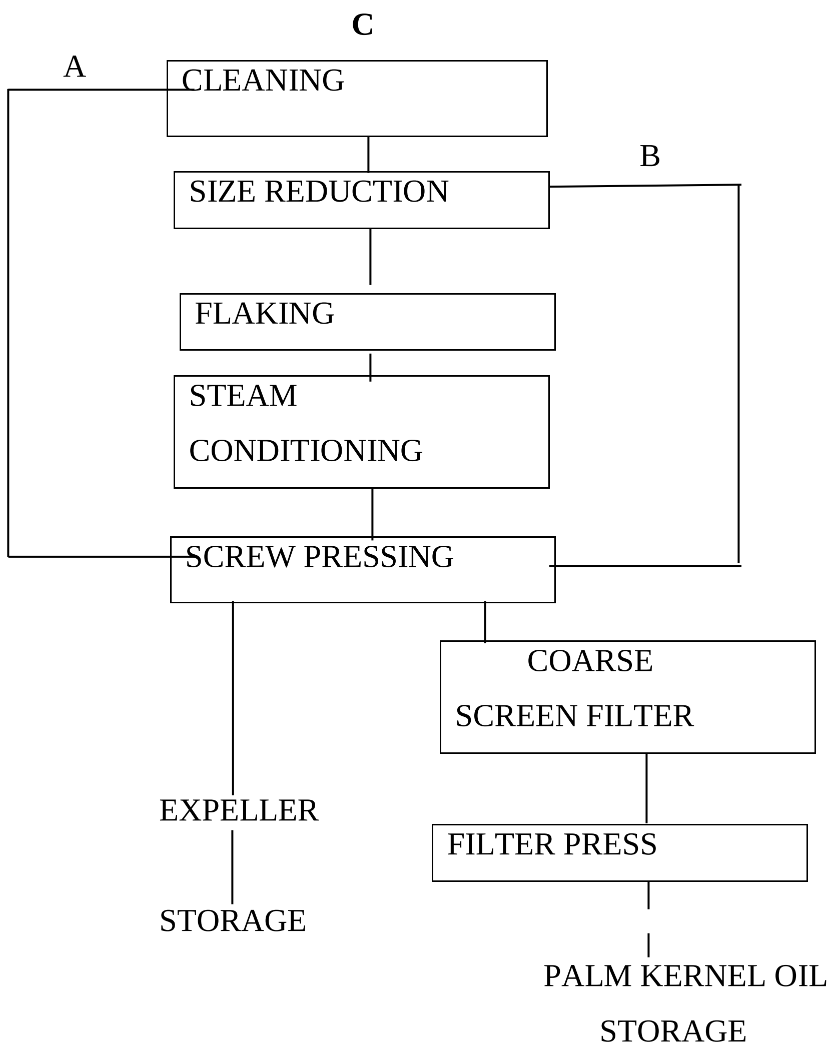

Fig. 2.1 Flow chart of mechanical oil extractor processes

In Fig 2.1, Direct screw pressing without kernel pre-treatment is indicated in Line A, Partial kernel pre-treatment followed by screw pressing is indicated in Line , and Line C is for complete pre-treatment followed by screw-pressing.

CHAPTER THREE
METHODOLOGY

3.1 RESEARCH DESIGN

This section involves all the design considerations which entail the design calculations, ergonomics, and safety precautions during use and the production stages that involved in the project.

3.2 MATERIAL SELECTION

Material selection is the process of choosing suitable materials for construction by considering their mechanical and physical properties. Some factors that must be considered before material selection from which to construct the palm kernel crushing machining include:

i. Service Requirement

ii. Fabrication Requirement

iii. Economic Requirement

iv. Availability of material

3.2.1 SERVICE REQUIREMENT

The service requirement of a material ensures that the material is of suitable strength, toughness, rigidity, elasticity, hardness etc…

3.2.2 FABRICATION REQUIREMENT

The fabrication requirement is to make sure that the materials are suitable for working which are machining, brazing or soldering, joining by welding.

3.2.3 ECONOMIC REQUIREMENT

This takes into consideration the total cost of components which are made up of raw material cost, welding/joining, cost of machine and finishing.

3.2.4 AVAILABILITY OF MATERIAL

This influences the date of delivery of the component and the cost of material.

3.3. DESIGN CONSIDERATIONS

While designing the machine some design considerations were made which include the choice of material to be used, the power transmission, the production cost should be affordable, it should be portable, easy to maintain and operate. This is important and is concerned with the sizing, dimensioning of all the component parts of both fabricated and purchased of the palm kernel oil extractor which goes into the making of product.

3.4 DESIGN ANALYSIS OF THE WORM SHAFT

There is need to consider the rapture or crushing strengths of the palm kernel under a compression load, when analysising the design of the worm shaft. In the screw shaft, the crushed palm kernels are subjected to compressive load against a rigid stationary body.

The America Society of Agricultural Engineering (ASAE) describe compression test using a spherical hand tool. This test gives the crushing strengths of the palm kernel under a compressive load.

From the experiment carried out by the (ASAE), the value of the crushing strength of a palm was given as $1.042 N/mm^2$.

The design for the shaft is such that it can exert this value of crushing strengths on the palm kernel. The formula for calculating the area of contact between a spherical kernel and worm shaft is given by

$$A = \frac{HdD}{2(H+d)} \text{ in } mm^2 \qquad (3.1)$$

The compressive strength on the kernel at crushing point is

$$\delta = \frac{E}{A} = \frac{\text{Force}}{\text{Contact}} \text{ in } N/mm^2 \qquad (3.2)$$

substituting eqa 3.4.2 into 3.4.1, we have

$$\delta = \frac{F/HdD}{2(H+d)}$$

$$\frac{2(H+d)F}{HdD} \quad \text{in N/mm}^2 \qquad (3.3)$$

The force (F) which is the load on the shaft screw, is given by

$$F = \frac{(HdD)\delta}{2(H+d)} \qquad (3.4)$$

Where

A = Area of contact between the surface of the tool(screw shaft) and palm Kernel (mm).

H = average diameter of the kernel at the point of compression (mm).

d = radius of crushing point (mm)

F = crushing load at crushing point (N)

δ = stress t crushing point (from stated experiment the value is 1.402, thus, force or load builds up at torsion moment at the shaft.

3.4.1 TORSIONAL LOAD ON WORM SHARF

The generation of the total torsion load exerted on the shaft result from the load and force built up along the line. The torsion load can be determine as given in equation 3.4.4 where F is the force that would produce a crushing stress of 1.042N/mm^2 on the palm kernel.

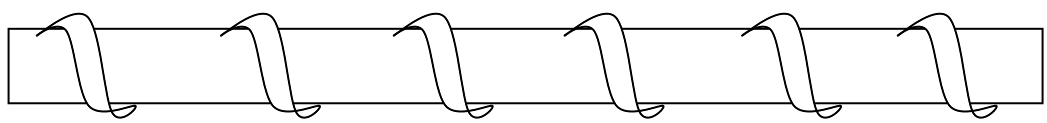

Fig 3.1 Diagram of worm shaft

Torsion load = f x l (3.5)

Where

L = Length of the worm shaft

The total torsion load on the shaft is derieved by multipling the toque developed by the numbers of screw thread on the shaft.

That is

T_{shaft} = n x f x L (3.6)

Where n = number of screw threads.

3.4.2 CALCULATION OF CRUSHING FORCES EXERTED ON THE KERNEL BY THE WORM SHAFT

The length and cross sectional diameter of the shaft used in construction of the worm shaft is selected accordingly to the size of the shaft.

Diameter of shaft cross sectional D = 75mm by measurement

Radius of shaft cross section d = 37.5mm

Length of shaft (L) = 914.4mm

Let the deformed or broken palm kernel before crushing to paste be D = 1mm

Then, area of contact between screw surface and body of palm kernel is computed thus.

$$A = \frac{HdD}{2(H+d)} \quad (3.7)$$

Substituting the above values into equation (3.1)we have

$$A = \frac{5 \text{ x } 37.5 \text{ x } 1}{2(5+37.5)}$$

$$= \frac{187.5}{85}$$

$$= 2.21\text{mm}^2$$

To exert a pressure equal to the crushing strength on the kernel, the tangential force required is given by

F = δ_s x A

Where δ_s(crushing strength of the palm kernel)

= 1.042mm,

A =2.21mm^2

F 1.042 x 2.21

=2.30N

The toque developed on the shaft is given as:

T_{shaft} = f x L x n (3.8)

Where L = length of shaft = 914.4mm

N = number of crew thread = 6

T_{shaft} = 2.30 x 914.4 x 6

= 12618.72mm

To meter (m)

$$= \frac{12628.72}{1000}$$

= 12.619Nm

But for sudden surge, T_{shaft} = 6660 Nm (ASAE)

According to Gupta and kurmi (2000) the electric motor capacity is obtained by

P = Tω (3.9)

But $\omega = \frac{2\pi(RPM)}{60}$ (3.10)

Substituting eq. 3.4.8 into eq. 3.4.7

$$P = \frac{T2\pi(RPM)}{60 \text{ x } 746}$$

Since 1hp = 746watt, then

$$Hp = \frac{T2\pi(RPM)}{60 \text{ x } 746}$$

Assume RPM of shaft = 284

Therefore,

$$Hp = \frac{12.619 \text{ x } 2 \text{ x } 3.142 \text{ x } 284}{60 \text{ x } 746}$$

$$= \frac{22520.574}{44760}$$

Hp = 0.5 = 373 watt.

3.4.3 WORM SHAFT DESIGN

3.4.3.1 DESIGN ANALYSIS FOR SOLID SHAFT

The shaft in this design is subjected to both bending moment and torsion. Hence, the shaft was being design ob the basics of rigidity and strength in order for the shaft to be able to accommodate or resist both moment simultaneously.

Maximum shear stress theory which is usully used for ductile material. Such as mild steel is applied and this is given as

Shear stress (δ) = $^1/_2(\delta^2 w + 4\ \delta_s^2)^{½}$

(3.10)

Where δ_w = allowable working stress

$$= \frac{32Ms}{\delta d3} \quad (3.11)$$

δ_s = allowable shear stress

$$= \frac{16Mt}{\delta d3} \qquad (3.12)$$

Substituting eq. 3.2.10 and 3.2.11 into eq. 3.2.9

$$\delta_{s(max)} = {}^{1/2}\left[\left[\frac{32Ms}{\delta d3}\right]2 + \left[\frac{16Mt}{\delta d3}\right]2\right]^{1/2}$$

$$= \frac{16}{\delta d3}(M_s + M_t)^2 \qquad (3.13)$$

For solid shaft, using the ASME code equation, the shaft diameter is

$$d^3 = \frac{16}{\delta s\pi(max)}\left[(k_b m_s)^2 + (k_t m_t)^2\right] \qquad (3.14)$$

The torsional moment or torque acting on the shaft due to tension in the belt can be calculated from the expression.

$$M_t = (\pi\text{-}T_2)R \quad \text{in [N/m]} \qquad (3.15)$$

Where

Mt = torsional moment

Mb = bending moment

D = diameter of shaft

$\delta_{s(max)}$ = maximum shear stress

kb = combined shock and fatigue factor to torsional moment

R = radius of shaft

3.4.3.2 DETERMINATION OF SUPPORT REACTION DUE TO LOAD CARRIED BY SHAFT

To determine the diameter of the shaft from the formula in equation (3.16), the equivalent bending moment must be known. These can be determined using the bending moment diagram of the shaft as shown. In fig 3.2 with both load and bearing indicated.

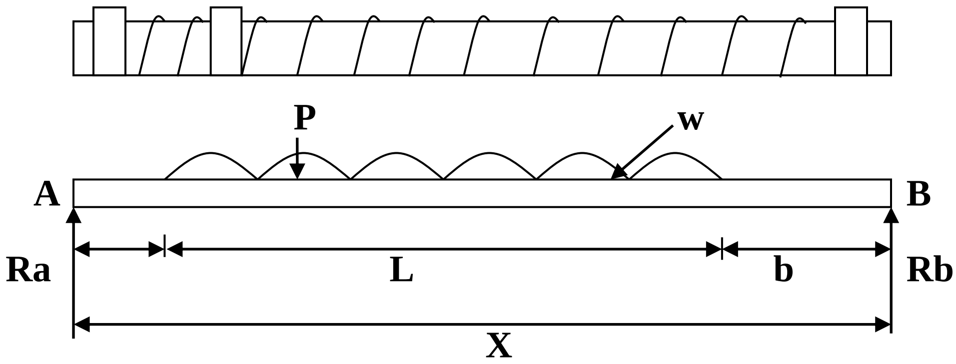

Fig. 3.2 Diagram of the worm shaft

From the formula

Upper force = downward force

$R_A + R_B = p + WL/2$ (3.16)

Taking moment at B

$R_{Ax} - P_S = WL/2\ (L/2 + b) = 0$

$$R_A = P_S + \frac{WL/2\ (L/2 + b)}{x} \quad (3.17)$$

Substituting 3.2.18 into eq. 3.2.17, we have

$P_S + WL/2\ (L/2 + b) – P + WL/2 = -Ra$

Or

$$R_B = p + WL/2 - \left[\frac{WL/2\ (L/2 + b)}{x}\right] \quad (3.18)$$

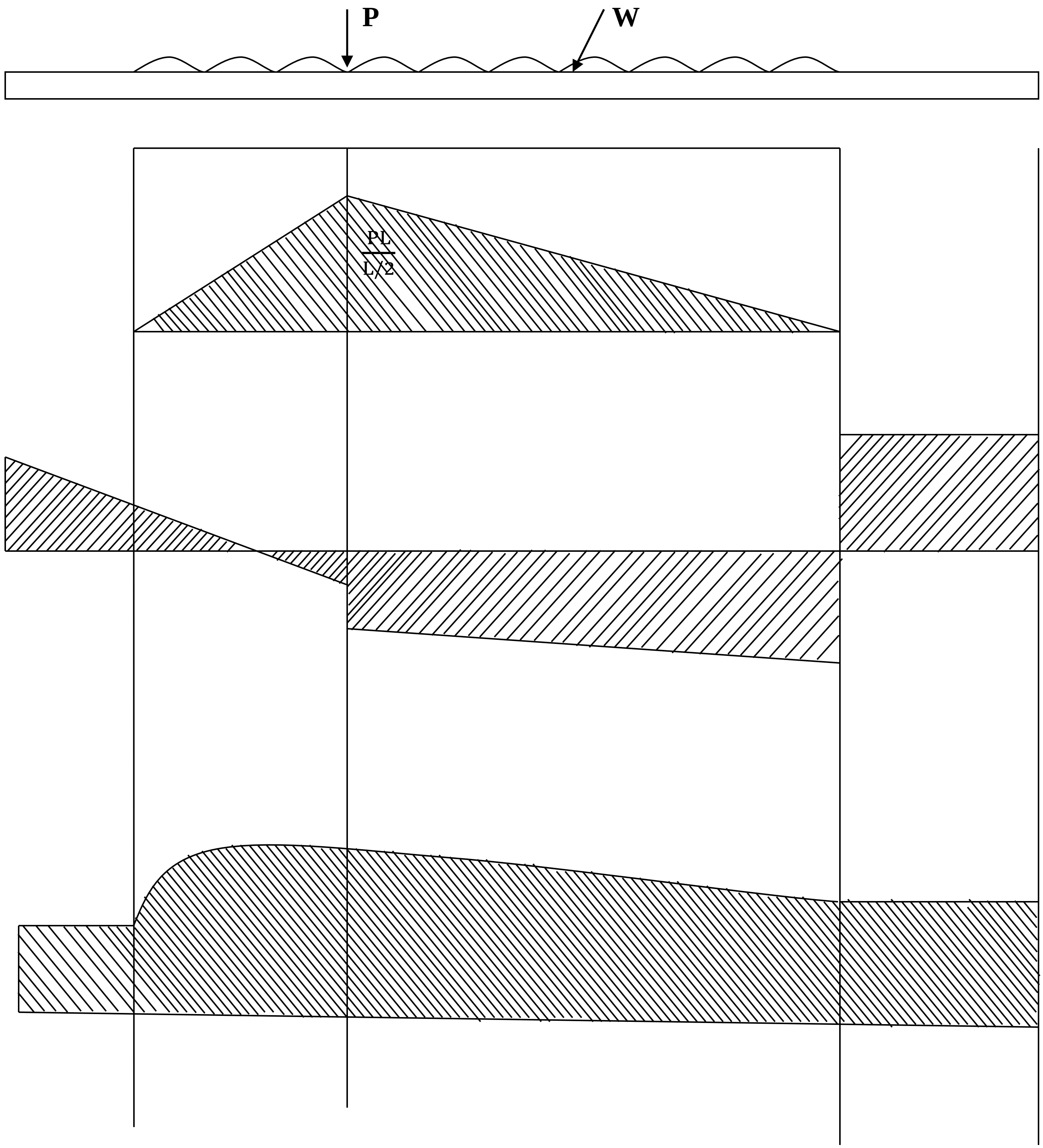

Fig 3.3 Bending Moment Diagram

3.4.4 BEARING SELECTION

Bearings are mechanical assemblies that consist of rolling element and usually inner and outer races which are used for rotating and linear shaft applications.

Bearings are manufactured according to standard to take axial loads, radial loads or the combination of two.

For this design, a single roller bearing was chosen for the following reasoning.

i. Roller bearing are able to take higher radial loads.
ii. Roller bearings are used to reduced fiction for effortless application.
iii. Reduces maintenance and servicing costs.
iv. Less noise when in operation at moderate speed.

Fig3.4 Single Roller Bearing

Where

B = bearing width (mm)

D = bearing over diameter (mm)

d = bore diameter

3.4.5 CONSTRUCTION OF HOPPER

The hopper as for side of equal dimensions which together. The diagram of the hopper is shown in fig 3.4 with one side of its faces. Its is made of mild steel plate.

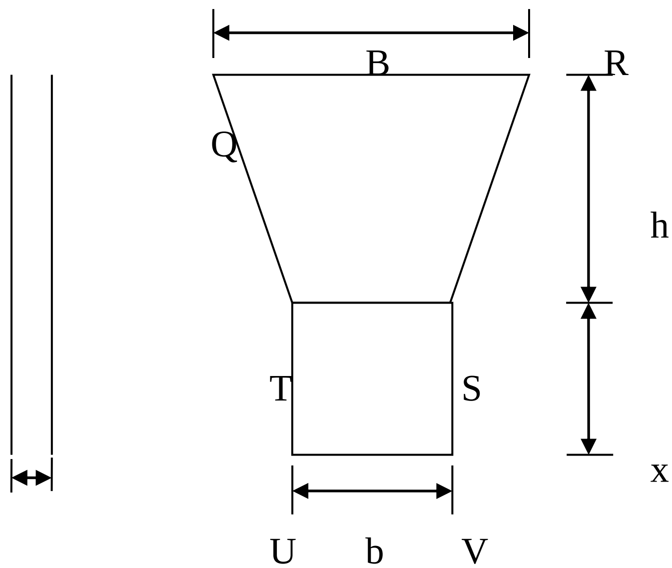

Fig 3.5 Hopper

Where

B = length of the hopper

b = base length of the hopper

h + x = height of the hopper

t = thickness of the materials used for the hopper

Therefore,

Volume of material used for the hopper = 4(area of trapezium TQRS x thickness) + (area of square TSUV) x thickness

$V = 4(1/2(B + b)\ hx) + 4(b \times X) \times t)$

Let B = 406.4mm

b = 101.6mm

t = 1.5mm

h = 304.8mm

x = 101.6mm

Therefore

$V = 4(1/2(406.4 + 101.6)304.8 \times 1.5 + (101.6 \times 101.6)\ 15)$

$= 4(11612.8 + 15483.84)$

$= 526450.56mm^3$

$V = 5.26 \times 10^{-4}\ m^3$

But

Mass = density x volume

Density of the material [steel]

$= 78331kg/m^3$

Therefore,

Mass of hopper $= 7833 \times 5.26x10^{-4}$

$= 4.12kg$

Weight of hopper $W_h = M \times g$

Where

g = force of gravity 9.81m/s^2

Therefore,

W_h = 4.12 x 9.81 = 40.4172g

= 40.42g

3.4.6 DESIGN OF KEY FOR THE SHAFT

Keys are need to prevent relative motion between a shaft and the connecting member through which torque is being transmitted.

Through gears, universal coupling etc are assembled with an interference fit yet it is desirable to use key designed to transmit the developed torque.

The material for key is steel with allowable shear stress of torsion compression. The key chosen for this design is a square key.

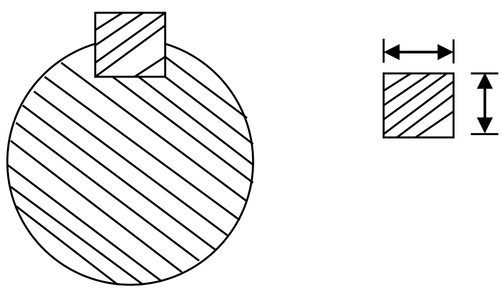

Fig. 3.6 Square key

The width of this square key is usually one quarter (1/4) of the shaft diameter hence,

$$b = \frac{Ds}{4} \qquad (3.19)$$

where

Ds = diameter of shaft at the section concerned = 75mm

B = 75/4 = 18.75mm

Area of the key way is

A = L x B

Where

L = length of key = 80mm

A = 80 x 18.75

= $1500mm^2$

3.4.7 ELECTRICAL ENERGY CONSUMED BY THE MACHINE PER DAY (8 HRS)

The product of the rated horse power of motor efficiency and the time taken was used to determine the electrical energy usage by the equipment. The motor efficiency of 75 percent was assumed to compute the electrical inputs.

Thus,

$$E_c = \eta pt \qquad (3.20)$$

Where

E_c = electrical energy consumed (Kwh)

P = rated horsepower of motor (w)

t = hours of operation (h)

ŋ = motor efficiency

where

p = 2hp = $\frac{2 \text{ x } 746}{1000}$

= 1.49kw

t 8hours operation/day

ŋ = 75% = 0.75

Therefore,

E_c = 8 x 0.75 x 1.49

= 8.9kw/h/day

3.4.8 HUMAN ENERGY CONSUMED

Human energy expended was quantified by multiplying the number of persons engaged in an operation by the man hour requirement and 0.075kw being the average power normal human labour can supply per hour (odigbo 1992).

Thus,

E_h = human energy consumed (kw/h)

N = number of person engaged in operation

M_h = man hour requirement = 0.075, the physical power output of normal human

labour in tropical climate (kw)

where

N = 1 person

M_h = 8hours

Therefore,

E_h = 0.075 x1 x 8

= 0.6kw/h

3.4.9 POWER TRANSMISSION

Power transmission is very essential, the power gotten from or generated by the electric motor is transmitted to the machine through a self reduction gear by the help of the coupling.

The gear is connected to the machine shaft by the use of the coupling. The gear reduced or minimize the speed of the electric motor to the requirement of the shaft. The reduction ratio of the gear is 59/1 which means that the input shaft of the turn 59 times for the output shaft to make one complete revolution.

3.4.10 EFFICIENCY OF THE PALM KERNEL CRUSHING MACHINE

Considering this design mechanical efficiency should be very important.

Mechanical Efficiency=work output/work input x100%

Where

Work input= Power put into use or power produced by electric motor

Work output= Total work achieved or developed by the crushing

machine.

This includes work done against friction and force needed to overcome twisting moment(torque) of the shaft.

Other efficiency that can be considered is work efficiency, which can be explained as the ratio of oil extracted from a given quantity of palm kernel to estimate the quantity of oil from the same quantity.

Work efficiency depends on some factor which includes consideration and specification of the machine condition under which the machine is to be used. The design must be able to achieve maximum efficiency due to 100% efficiency may not be achievable. Some draw backs in actual production, material used, lack of standard tools hindering the 97% efficiency which was expected.

3.4.11 ERGONOMICS

Ergonomics from engineering design the science that deals with dimension e.g shape, height, of human and machine conditions. It how human relate or interact with machine. Therefore three(3) things are carefully looked into which are

a) Operational environment of the palm kernel oil extractor
b) Condition of the extractor
c) Efficiency

3.4.11.1 CONDITION OF THE PALM KERNEL CRUSHING MACHINE

To achieve good efficiency, good operational conditions for the machine should be provided in which some are listed below.

1. Bearing and shaft must be in alignment.
2. Good and appropriate motor capacity should be used or installed.
3. Design should be properly housed and supported with frame to withstand vibration when in operation.
4. Thick wall cylinder must be reinforced to prevent sudden surge or vibration when in operation.

3.4.11.2 OPERATIONAL ENVIRONMENT FOR PALM KERNEL CRUSHING MACHINE

The palm kernel crushing machine must be sheltered to prevent draught and sunlight, these two element are responsible for commissioning of metallic parts.

3.4.12 SAFETY PRECAUTION DURING USE

General safety in engineering that should be observed while using the machine are;

1. All rotating parts must be properly guarded.
2. The motor must be started first so that the system will attain maximum speed before feeding in the palm kernel.

3. Palm kernel should be selected carefully to prevent stone or other solid particles in it, as these will result in cracks on warm shaft and screw press.
4. The kernel should be gradually fed until the hopper is 3/4 full.
5. Tools that may obstruct the smooth operation of machine should be put aside.
6. The floor should be kept clean of oil to prevent slippage.

3.4.13 MAINTENANCE OF THE MACHINE

The various maintenance carried out on the machine are regular cleaning of the shaft and oiling of speed reduction gear and other mating parts.

3.5 FABRICATION/MANUFACTURING PROCESS

Various manufacturing process that was undergone during assembling and construction of the component parts of the machine include:

1. Marking out
2. Cutting
3. Machining
4. Drilling
5. Fabricating
6. Assembling
7. Finishing

3.5.1 MARKING OUT

After the selection of the appropriate material for each component, the required sharp and size were marked out according to the design specifications.

Marking out tools used for the operation are tri-square, steel rule, venier caliper, pair of divider, scriber and center punch. Measurement was carried out using steel rule and scriber for metal components.

Marking out 0lines were centre-punch at desirable point for easy identification during cutting.

3.5.2 CUTTING FOR MATERIAL TO DESIRED SHARPS

All the marked section of the components was cut to size to the required shapes and sizes using the tools listed below.

i. **Hand drilling machine**: For drilling holes.
ii. **Oxy-acetylene equipment**: For cutting metal plates.
iii. **Grinding machine**: For removing sharp edges and smoothening rough surfaces of metal component.
iv. **Sand paper**: For smoothing rough surface of metal component after cutting.

Hack saw/Power saw: For cutting metal plates, rods, shafts pipes

IV. OXY-ACETYLENE EQUIPMENT: This is use for cutting metal plate.

v. **HAND DRILLING MACHINE**: This machine is use for drilling holes.

3.5.3 MACHINING

In other to obtain the required diameter, the shaft was machined on the lathe machine. The various part that were subjected to the fatigue loads or rotary motion were produced by end milling using a milling machine.

3.5.4 DRILLING

The drilling machine was used to drill all required and specified holes/slot for assembling or mounting various component. The holes for electric motor, casing bolt etc are also inclusive.

3.5.5 FABRICATION

Depending on the material concerned and the use of different method, various materials were fabricated into sub-assembled component. Where permanent joining was desired, parts were welded together with gauge 10 electrode while temporary joint which is the use os bolt and nut were introduced to ease disassembling of parts for maintenance purpose.

3.5.6 ASSEMBLING

This has to do with the coupling and putting together various parts and components to form a single unit.

3.5.7 FINISHING

In order to prevent rusting and corrosion, finishing works were introduced to the machine by applying paint to it and costing.

CH0APTER FOUR
RESULT AND DISCUSSION

4.0 PERFOMANCE EVALUATION

The machine adopted for performance test has 1.49kw (i.e 2hp) power of electric motor and was put to test by using dried palm kernel having been exposed to sunlight for about 48 hours.

The following procedure were taking during the test:

1. The electric motor was switched on.
2. The machine was left to run for about 2 minutes after the electric motor was switched on and it ran smoothly.
3. The dried palm kernel was put into the crush chamber through the hopper.
4. 10kg of palm kernel were gradually put into the machine. It was observed that the electric motor was able crush the palm kernel to a paste form.
5. It was observed that the palm kernel was coming out from the oil outlet (chute) at this stage and also the cake (residue) was coming out from the cake outlet.
6. The machine remained on and continued to work until all the palm kernel were completely milled.
7. The oil was collected and was weighted 8kg.
8. The machine was then switched off.

4.1 DISCUSSION OF RESULT

4.1.1 OBSERVATION

At the end of the test, it was observed that there was a reduction in the speed of the electric motor and crushing machine when 5kg of palm kernel was fed into the machine. This was due to the friction force caused by the palm kernel fed into it.

4.1.2 CONCLUSION

It was concluded from the test that and observation being carried out that since the machine was able to extract the palm kernel using a 2HP electric motor, then the machine can operate efficiently.

4.2 DATA ANALYSIS

From the table 4.2 below, the energy used per unit operation for a typical small PKO mills for 1000kg of palm nut is shown. It was observed that in this category of mills, thermal energy is mostly used, then the electrical energy and mechanical energy. In this category of plant, there is a measure of mechanization in production of palm kernel oil.

Unit	Duration (h)	Energy		Manual	Total	Percent of Total
		Electrical	Thermal			
Operation						
Drying	3.00			11.25	11.25	3.24
Cracking	2.50		109.54	9.45	118.96	34.31
Roastry	1.00		49.09	2.70	48.79	14.09
Crushing	2.00	28.80		2.70	31.50	9.08
Oil	5.00	129.74		5.4	135.14	38.97
Expression				0.81	0.81	
Shifting	1.00			0.32	0.32	0.23
Bottling	0.40	158.25	155.6	32.6	346.8	0.10
Total	14.90	45.7	44.9	9.4		

4.3 BILL FOR ENGINEERING MATERIAL AND EVALUATION(BEME)

Table 3: Cost associated with the palm kernel oil extraction machine.

Item No	Material Description	Quantity	Unit Cost	Total
1	50mm Angle bar	4	9000	36000
2	Φ12mm twist rod	3	1,800	5,400
3	Φ75mm shaft(4ft long)	1	30,000	30,000
4	Φ120mm pipe	1	5,000	5000
5	G'10 Electrode	1	3,000	3,000
6	Pillow block bearing	2	1,600	3,800
7	Cutting disc	1	1000	1,000
8	1.5mm mild steel sheet	1	18,500	18,500
9	2inch Angle bar	1	3,000	3,000
10	2 by 2 flat bar	1	5,100	5,100
11	6mm plate[2ft by 2ft]	1	3,500	3,500
12	Electric motor [2Hp]	1	30,000	30,000
13	Grinding disc	1	500	500
14	24mm bolt and nut	4	500	2,000
15	Washers	26	25	650
16	22m Bolt and nut	18	60	1,080
17	Universal coupling	1	6,000	6,000
18	Paints	1	1,500	1,500
19	Workmanship		12,000	12,000
20	Transportation		1,500	1,500
21	Miscellaneous		1,500	1,500
	TOTAL			**196,880**

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Palm kernel machine was designed and fabricated, the result was encouraging. The cost of production of this extractor was lesser compared to imported extractor. It is expected that this design will increase public confidence in the ability of indigenous eagerness to design and fabricate workable machines that can complete with imported ones. With this design, obviously the standard of living of the country will be improved.

5.2 RECOMMENDATION

To reduce the stress of searching for equipment and tools, there should be access to sufficient tools. The use of electric motor can be replaced by a hydraulic motor because of the advantage hydraulic motor has over electric motor and some of these advantage are:

i. Instance reversing
ii. Less maintenance
iii. Self lubricating
iv. Sudden stoppage

Oncoming project students should be encouraged to research into this alternative

REFERENCE

Adetola, O.A., Olajideb,J.O. And Olalusi,A.P.(2014). Development Of A Screw Press For Palm Oil Extraction. International Journal Of Scientific And Engineering Research, Vol.5, Issue 7, PP.1416-1422

Aghahno (2000) "British Colonial Policies And The Oil Palm Industry In The Niger Delta Region OfBayelsa, Nigeria 1900-1960" (PDF). African Study Monographs 21(1):19-33. Archived from the original (PDF) on 2013-01-16 retrieved 2012-09-09

Akinoso R, Igbeka J. Olajanju T. And Bankole L. 2006. Modeling Of Oil Expresson From Palm Kernel (ElaeisGuineosisJaca). Agricultural Engineering International: the CIGR Ejournal Manuscript fp 05 016-vol 8

Fashina A.B., Durodola O.S., And Hammed L.A. (2017). Development and Performance Evaluation Of An Oil Palm Digester. Bioprocess Engineering Journal 1(2)49-53

Fao,(2005) Small-Scale Palm Oil Processing In Africa. Food And agricultural Organization (FAO) Agricultural Series 148:pp.1-5 http:/www.foa.org/document/show_edr.asp?urlfile=/docrep/005/y4355e/y4355e03.htm(accessed2005)

Gbadamosi, L. (2006) Some Engineering Properties Of Palm Kernel Seeds (PKS). Journal Agricultural Engineering And Technology, 14,58-66

OwolarafeO.K., Faborode M.O., AndAjibola O.O. (2002). Comparative Evaluation Of The Digester-Screw Press And Hand-Operated Hydraulic Press From Oil Palm Fruit Processing,JournalOf Food Engineering.U.K , Vol. 52, PP.249-55