DESIGN AND CONSTRUCTION OF RED SEED GROUNDNUT PEELING MACHINE

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CERTIFICATION

This is to certify that this project work Design and construction of red seed groundnut peeling machine" is jointly designed and produced by IDIAGHE ANOINTED UWAILA ENG/2142070044, OKEVWIE OGAGA ENG/2142040054, IKE NELSON ENG/2142040045, AFEKAHZOE DESTINY IDONEE ENG/2142070006, IWALEFUN EMOLA ENG/2142070053, under the supervision of ENGR. SUNDAY OSOSOMI and submitted to the Mechanical Engineering Department of Auchi polytechnic, Auchi, Edo state; in partial fulfillment of the requirement for the award of Higher Diploma (HND) in mechanical engineering Technology.

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DEDICATION

We dedicate this book to God Almighty, the creator of heaven and earth. He is the one that had given us the opportunity and strengths to carry out this project work.

ACKNOWLEDGEMENT

I want to specially appreciate God

The giver of life and all good things , My parents Mr. and Mrs. IDIAGHE for their support towards this project n their love and encouragement without them I will be nothing

My special appreciation goes to my friends, coursemates, my project supervisor ENGR A.S OSOSOMI ,my HOD and lastly to my lecturers.

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ABSTRACT

Groundnut seed is one of the most common oil nut grown as an annual crop on about 19 million hectares of land in sub- tropical and warm temperature region of the world. This research work was conducted to design, construct and carry the performance evaluation of a red seed groundnut peeling machine and separating the skin from the white groundnut. Fundamental design analysis and calculations were carried out in order to determine and select materials of appropriate strength and size of the machine component parts. The major machine parts include; hopper, the brushes (The skinning unit), the skinning shaft, auger and electric motor(1HP),at a speed of 140rpm.. the efficiency of the machine is 75% The material used for the shaft is mild steel , the materials used in the design and construction of the machine are sourced locally so as to ensure that it is cheap, affordable and easily maintained by the peasant farmers.

CHAPTER ONE

1.0 Introduction

Groundnut seed (Arachis hypogea), also known as peanut, is one of the most common oil nut grown as an annual crop on about 19 million hectares of land in tropical, sub-tropical and warm temperature regions of the world. It is grown principally for its edible oil and protein rich seeds. The oil content of the seeds is between 45% and 55% depending on the variety (Abubakar et al, 2015). As human food the nuts are eaten raw, lightly roasted or boiled, sometimes salted or made into paste, which is known as peanut butter. It is also widely used in making candy bars, cookies and peanut brittle as well as cosmetics, plastics, dyes and paints production ,(FAO, 2002) In developing countries, most of the groundnuts are used for extraction of oil for domestic and industrial uses . It provides high-quality cooking oil and is an important source of protein for both human and animal diet and also provides much needed foreign exchange by exporting the nuts and cake. For example, groundnuts are important component of Nigerian diet and about 5% of the estimated 58.9 g of crude protein available per head per day, is contributed by groundnut (Lawan et al. 2015) . Groundnut oil extraction involves shelling the groundnut pods, roasting the shelled groundnut seeds, de- skinning and winnowing the roasted groundnut seeds, milling the cleaned groundnut seeds and kneading the paste produced(Asiodu,1989).

Traditional methods of Peeling groundnut are done using hand with fingers or using mortar and pestle. Whichever method is used, it is associated with drudgery, pains at the joints and blistering of fingers. The quality of nuts is mainly determined by the percentage of whole undamaged nuts.

This factor among others has made the designing of a groundnut peeling machine an important process that must be developed to enhance value addition and also remove human efforts and associated difficulties with the traditional method of peeling which result to losses, labour intensity, time consuming and low output capacity .

1.1 Background to the Study

Groundnut is the sixth most important oilseed crop in the world. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fiber, minerals and vitamins. It grows best on soils that are well drained, loosely textured and well supplied with calcium, potassium and phosphorous. Over 100 countries worldwide grow groundnut. Developing countries constitute 97% of the global area and 94% of the global production of this crop. The production of groundnut is concentrated in Asia and Africa (56% and 40% of the global area and 68% and 25% of the global production, (Acharya, 1990). Over 60% of global groundnut production is crushed for extraction of oil for edible and industrial uses while 40% is consumed in food uses and other.

In Nigeria groundnut is mainly decorticate by hands (traditional method). This method is not hygienic as dirt from hands and mouth could pose health risk

from the nuts. (FAO,2001) peeling is a fundamental step in groundnut processing as it allows the nuts to be used as well as other post harvesting technologies to take place such as oil extraction (Pradhana et al., 2010).

Peeling can be carried out in the farm or at home that is to enable the farmer sell his product because groundnuts in the shell are fifty per cent heavier than kernels alone and therefore costlier to transport. Peeling can generally be done by hand or machine. Hand peeling is the process in which the roasted or fried nuts is pressed between the thumb and first finger so that the red skin is removed and the nuts is released. In mechanization now we use large and smaller machinery for groundnut peeling.These machines are used in industries where large production is required.

There are different methods of peeling groundnut and different machines have been designed and constructed and used to peel wide variety of crops under different conditions (Nyeaanga et al., 2003).

1.2 Statement of the Problem

It has been observed that de-skinning and winnowing of groundnut is being carried out by manual manipulation which is a tedious exercise, time consuming and labour intensive. The traditional skinning operation provides for manipulation

of the nuts between opposing tenacious yielding surfaces with which the nuts are preliminarily aligned. This exerts a retarding effect upon the skins while the nuts and the tenacious surfaces are being subjected to relative movement. The skin is being ruptured and loosened. The loosened skins are withdrawn by free falling of the kernels across the air flow or by blowing air through the nuts with mouth. On the other hand, the industrial machine used for groundnut oil extraction are expensive and sophisticated to be operated and maintained by local processors. The constraint to skinning as a unit operation in the processing line of peanuts demands for design and fabrication of a machine capable of removing the outer coat of roasted peanut effectively, rapidly and gently without abrasion of the kernels, with minimum breakage and splitting, hence the reason for embarking on this project.

1.3 Aim and objectives of the Study

Aim

The main aim of this project is to design and construct a red seed groundnut peeling machine.

Objectives

The objective of the project are ;

(1) To use a 3D solid work to design the machine.

(2) To construct, fabricate and assemble the component parts of the machine .

(3)To carry out comparison between hand peeling and machine peeling.

(4) Data will be collected and result analysis.

1.4 Significances of the Study

The successful completion of this project will eliminate or reduce the use of traditional methods which involves the use of hand with fingers to peel the groundnuts, also it will increase efficiency, reduce labour intensity and save time.

1.5 Scope of the Study

This study covers the design and fabrication of red seed groundnut peeling machine capable of skinning roasted groundnut and separating the skin from the white groundnut with minimum damage. Performance evaluation of the assembled parts will be carried out to determine the efficiency of the machine .

1.6 Limitations of the Study

The fact that the groundnut peeling machine will make use of an electric motor as it’s prime mover means that it’s operation could be affected by poor supply of electricity .Hence poor supply of electricity in Nigeria is a major limitation to the overall performance of the machine .Also, the present economic situation in Nigeria poses a huge challenge in terms of cost of materials, transportation cost , manufacturing and maintenance cost .

1.7 Operational Definition of terms

1.Development: is a process that creates growth, progress, positive change or the addition of physical, economic, environmental, social and demographic components.

2.Machine: is an object or mechanical device that receives an input amount of work and transfers the energy to an output amount of work.

3.Power: is the time rate of doing work or delivering energy, expressible as the amount of work done W, or energy transferred, divided by the time interval t or W/t.

4.Energy: The capacity or power to do work, such as the capacity to move an object (of a given mass) by the application of force.

5.Efficiency : the ability to produce something with a minimum amount of effort.

6.Design : is the process of devising a system, component, or process to meet desired needs.

7. Peeling: is the removal of the outer covering or skin from the groundnut.

CHAPTERTWO

2.0 LITERATURE REVIEW

Many researchers have been trying to develop the economical machines which is used to remove the red skin on groundnut. Many researchers have been carried out to develop the economical machine for the same purpose. which will help farmers as well as small entrepreneurs, basically the research in this area Is divided into the manually operated and electric power operated machines. The design and development of a manually and electrical power operated groundnut decorticating machine.

The decorticating machine Which Is powered by 0.161HP, 1500rpm electric motor comprises of the hopper which contains the unpeeled groundnut seeds and is opened directly to the decorticating unit. The body of the work is made with galvanize steel of Thickness 1mm.The dimension of the body inside the frame is 580 mm x 180 mm x 580mm,the frame of the work is made with mild steel square bar of thickness 20 mm and the frame is of size 600mm × 200 mm × 600 mm. The decorticating unit comprises of inner drum of length 550 mm and a diameter of 60 mm with brush like projections and a shaft of 68mm passing through its centers and a fixed cylindrical drum of length 600mm and diameter 120 mm. The inner drum with a rotation speed of 150 rpm is attached with the help of a v-belt and two pulley to the electric motor Which drives it in an anti clockwise direction to peel the groundnut seeds. The peeled groundnut seeds and the chaffs fall directly into the cleaning unit where an installed fan

blow away the chaff and the seeds are collected directly through an opening below the decorticating unit. He then reports that the machine was made from locally source materials and it can be used by both urban and rural area seven where there is no electric power supply and the percentage of roasted groundnut seeds been peeled in manual and electrical operation in three successive runs was found to be 52.3% and 61.7% respectfully.(Oladeji et.al, 2013)

The design and development of electrical power operated groundnut peeling machine after that testing and analysis of the groundnut which include size variation and compressive strength of ground nuts. Basically there are two types of peanuts which are widely used for domestic and industrial applications of food products which are Java and bold types. During this research bold types peanuts was used as they are mostly used in confectionary and food industries also out of consumption 60% to 70% are of bold type as well as its compression strength is greater than other Peanuts. The length of peanuts varies in the range of 14mm to 18.4mm and diameter of peanuts varies in the range of 9mm to10.6mm. During testing an average 5.042kgofredseedgroundnut, groundnut was fed into the hopper of the machine which produces an average mass of 3.989 kg of peeled groundnut , 0.605kg of unpeeled groundnut and 0.448 kg of broken groundnut. An average time of 248 seconds and efficiency of 79.129% o was recorded. The fabricated machine was easy to operate and had a peeling capacity of 75 kg/hrs.

The fabricated machine was useful in food industries and also for domestic work for the need of peeled groundnut. This machine reduces manpower and production time. (Vinay et. al, 2017).

The design and development of a low cost groundnut decorticating machine for home and commercial use in Nigeria was developed by (Ebunilo et. al, 2016)

In his research work detailed designed of decorticating machine was given, During operation 4.36 Kg of roasted groundnut was fed into the machine: this produces an average mass of 3.43 Kg of peeled roasted groundnut seeds, 0.462Kg of unpeeled groundnutseeds,0.399Kg of partially peeled groundnut seed and 0.07 Kg of broken groundnut seed. An average time of 488.8 seconds and an average peeling efficiency of 78.46 % was recorded. It was observed that the higher the mass of groundnut seed the longer the time of peeling ,the machine is cheap because it's part are locally fabricated.

In his research focused on the design and development to manually operated groundnut seeds peeling machine which comprises of a specially designed peeling chamber which greatly reduces the amount of breakages during peeling and a transmission mechanism, which greatly reduces the required effort to drive the system. It has a peeling efficiency of about 85%.The machine is easy to operate and has a capacity of 5.4kg/hr. of groundnut seeds. He concluded that the machine can be used both in medium scale industries and also for domestic needs of peeled groundnut seeds.(

Ikechukwu et.al,2014)

They Developed a screw conveyor groundnut peeling machine with human power operation, and the rotary motion was obtained by the sprockets of a bicycle which rotated by pedaling action. This rotary motion was used to drive the shaft of a screw conveyor, the groundnut get crushed in between the shaft and the casing of the conveyor and the groundnut are delivered into the conveyor with the help of a hopper. He finally concluded that the efficiency of the machine is79.61%.(Pratima et.al, 2016)

The modeling and performance testing of a groundnut extracting machine was done by (Onwuka et. al, 2013.) the machine was designed and fabricated by Onwuka as per for market oriented production. The formal procedure of designing was adopted which involves synthesis, design and specification of components and material selections which includes mild steel sheet, galvanize sheet. Copper tubes, brass taps. The operations Involved including folding, cutting, welding, Brazing, etc. after the testing of this model, the results how good agreement with performance prediction.

They designed a groundnut peeling machine with aim of reducing drudgery associate with manual blanching of groundnuts. Fabrication and performance evaluation were carried out in Department of Agricultural and Environmental Engineering, Federal University of technology Akure, Nigeria. Groundnuts purchased at a local market were used for performance evaluation. Three operating parameters: blanch clearance, blanch speed and

speed rate were considered for the purpose of this research. Three levels each of feed rate, brush speed and blanch clearance were compared Blanch clearances were varied from I0mm to 20mm at an increment of 5mm for three different feed rates of 0.2Kg/hr.0.4Kg/hr and 0.6kg/hr respectively. while blanch speed was varied from 100rpm to 200rpm with an increment of 50rpm. The machine blanching capacity was found to be 30.91 Kg/hr. Changes In blanch Clearance, feed rate and blanch speed affected the launching efficiency, cleaning efficiency, and mechanical damage. Maximum values of blanching efficiency of 89.46% and cleaning efficiency and maximum mechanical damage of 53.02% were obtained at blanch clearance of 10mm and blanch speed of 200rpm. Minimum values of blanching efficiency of 44.56%, cleaning efficiency of 41.70% and mechanical damage of 9.90% were also obtained. Results show that the feed rate has effect on the evaluation parameters with blanch speed having a positive relationship with evaluation parameters.(Akintade et.al, 2015)

The development and performance evaluation of pedal operated decorticator. The major component of the decorticator is the shaft, sieve, decortications chambers, hopper, and supporting frame of a pedal operated device.(Anantachar et.al, 1997)

In Nigeria a student of federal university of technology in Adamawa state fabricates the manually operated fabricated in 1992.(Mathew, 1992)

2.1 Current literature review

The designed and developed a groundnut separator machine which runs with a robotic arm. The main purpose of the robotic arm is to pluck the ground nutfromtheplantandputintotherotorwhichhasblades.Withthisthehumaneffortis reduced and also efficiency is increased as it is fully automatic. (Ashok et.al,,2019).This report is focused designed and fabricated the electric Operated groundnut peeling machine. It is a automatic process where the groundnuts are peeled. There will be no much work and the cost of production is less. It has less maintenance cost.(Kulbhushan et.al,2016)

This research is focused designed and fabricated a groundnut Peeling machine. It is very cheap and five experiments were per formed with peanuts. Since this machine is made for small businessman or for farmers, therefore the work carried out by this machine is less. The decocting process of groundnut by this machine is more economical and faster than manual processor any other process. This machine saves tremendous time, energy manpower and save financial input of the project, reducing the cost and time considerably which is the backbone of the present world economy. (Ashish et.al, 2014).

This report focused on the design and fabrication of a portable dry groundnut husk peeling machine electrically powered by a 1H. P electric motor in order to reduce the rigors encountered by the traditional (manual) method of peeling while optimizing the production of good quality groundnut seeds. The machine was designed, fabricated and tested. The materials for the fabrication

were locally sourced which make sit cheap, easily affordable and maintainable. They also reported that the performance result of the machine peeling efficiency and capacity are 92.14% and 36.12kg/hr respectively. In addition the performance test of the groundnut husk peeling that resulted in a peeling capacity around 35kg/hr., with a percentage of split husks at35% and when compared with the manual method that only produces 4.2kg/hr/person, they finally concluded that the portable groundnut husk peeling machine using a rotary peeler could save energy, time (increasing work efficiency) and enhances productivity. The machine meet the need of small scale and medium scale farmers.(Agbonkhese et.al, 2018).

Design and fabrication of a groundnut peeling machine, the performance of the machine was evaluated in terms of through peeling efficiency, material efficiently and mechanical change. (Handa et.al,2014).

In his reports made two improvements on the machine, to reduce the fatigue and difficulty in using the manually conventional type by employing the use of electric motor or diesel engine as the power source. (Sanusi, 2012).

In their research paper reported that based on the peeling action they can be divided into two categories. Hand operated and pedal operated, hand operated groundnut decorticator 50-75Kg per hour capacity was evaluated, whereas a pedal operated groundnut decorticator was found to have capacity of 75Kg/hr.(Kulbhushan et.al,2017)

2.2 Method of processing groundnuts

The following are the methods of processing groundnuts.

1. Oil fried method

In this method of processing groundnut, table salt is sprinkled on the groundnut to improve the taste, which is stirred by a wooden spatula in order to mix the salt thoroughly. After stirring , the groundnut is covered with a lid for few minutes. At the end of this period the water is then drained out and the groundnut are poured into a tray where hands will be used to peel off the redskin from the groundnut.

These coat less nuts will then be fried in a well refined boiling groundnutoil for few minutes and transferred from the boiling oil into a sieve where the oil will be drained out from the nuts completely, the drained nuts will be transferred into a tray padded with a soft napkin cloth to mop off any oil left on the nuts , then the nuts are allowed to cool then transferred into bottle and covered with a tight cork for storage.

2. Sand fried method

This method of processing groundnut involves adding cold water and sprinkling of salt on the groundnut seed and rubbed In until the groundnut seed absorbs the salt. these salted nuts will be air dried for some hours and fried in fine river sand with an iron pot for few minutes with constant stirring. The fried nuts will be removed from the sand, sieved and allowed to cool, then transferred into a bottle with a tight cork .

2. Oven treated method

This method is similar to that of sand fried method. The only difference is that while sand fried method uses heated sand to fry the groundnut seeds with local firewood, gas cooker or kerosene stove, oven treated involves placing the groundnut seeds in the oven and the temperature regulated to 80 degree Celsius for few minutes. At the end of the regulated time the groundnut seed are removed and allowed to cool then transferred to a bottle with a tight cork.

3. Smoked with seeds inside shell

This method of processing does not involve shelling the seeds. The unshelled pod will be boiled and salt will be added to the boiling groundnut. After boiling, the pods are sieved out with a sieve and the water is allowed to drain off . The pods are placed on a local altar and the fire is used to smoke the pods to dryness usually 24 hours then the properly dried pods will be broken and their skin will be peeled off and stored in a bottle with a tight cork

2.3 Method of storage of groundnut

The groundnut seed is stored in an air tight container for up to one month on the shelf, in the refrigerator they can be stored up to six months.

In the freezer they are good for up to one year

2.4 The summary of the review

The above literature review shows that the roasted groundnut peeling machine is very applicable for small farmers and local business productions. In some cases the operation of this machine were manually and electrically

operated which can be used in various domestic application, food industries, oil industries and many more .It will save the time, energy as well as human efforts ,also cost of machine fabrication is less, which will help for more production of peeled groundnuts.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 Materials.

The materials used for the construction of the component parts of the machine where carefully considered and selected and the design of the various parts was based on such factors as the properties of the materials, availability, weight, size, shape, material cost, cost of fabrication and overhead changes, strength, e.t.c.

3.2 Machine Components.

The various components of the machine are:

3.2.1 Hopper

The hopper is where the roasted groundnuts are fed into the machine. The hopper is made of mild steel and has the shape of a truncated cone (frustum of a cone)

3.2.2 Skinning unit

This unit consists of both the inner and outer drum. The drums are cylindrical in shape and are carefully tapered to enhance easy removal of the skins. The outer drum serves as an enclosure for the inner drum while the cylindrical segment of the inner drum contains the auger which conveys the roasted groundnuts to the frustum segment. Galvanized steel was used for the construction of the skinning unit and the conveyor so as to prevent food contamination.

3.2.3 Brushes

The brushes are attached to the frustum segment of the machine, and are used for the skinning of the roasted groundnuts. The brushes are made of fabric.

3.2.4 Cleaning unit

This unit consist of the blower and its enclosure. The blower winnows the groundnut skins off the free falling groundnut kernels, while the enclosure controls the direction of air movement.

3.2.5 Drive Mechanism

This consists of the pulleys, belts and the electric motor. The pulleys are made of cast iron and they are the wheels around which the belt passes for power transmission from the electric motor to the machine pulley. A flat belt (rubber type) was chosen for power transmission because of the large centre distance between pulleys.

3.2.6 Main frame

This is the rigid frame work on which another component parts of the machine are fitted. It bears the loads of the various components of the machine. The main frame is made of mild steel angular bar (40mm by 40mm).

3.2.7 Shaft

The shaft is cylindrical in shape and solid in nature. It transmits bending and twisting moments. It is made of carbon steel.

3.3 Design Method

In order to select the right materials for the construction of the various machine members, fundamental design calculations and analysis were done. This was carried out to ensure that the machine elements are sufficiently strong, rigid and wear resistant with minimum weight and least dimensions.

Hopper Design

The hopper was designed to accommodate 9.6kg of roasted groundnut and from available literature the bulk density of roasted groundnut is 590kg/m^5.

Volume of Hopper

The volume of the hopper was computed using the equation:

$$V_h = \frac{m_g}{e_g} \qquad (3.1)$$

Considering safety, and adding 20% of the calculate volume of roasted groundnut to be fed into the machine at a time (eqn.3.1.), the volume of the hopper was optimized as :

$$V_h = \frac{m_g}{e_g} + \frac{20}{100}\frac{m_g}{e_g} = \frac{m_g}{e_g}(1 + 0.2) \qquad (3.2)$$

Where

V_h is the volume of hopper (m), mg is mass of roasted groundnut (kg), e_g is the bulk density of roasted groundnut (kg/m^5).

The height of the Hopper

The height of the hopper was obtained as follows:

$$V_h = \frac{1}{3}(A_1 + A_2\sqrt{A_1}\, A_2 \qquad (3.3)$$

$$V_P = \frac{3Vh}{A_1 + A_2 + \sqrt{A_1 + A_2}} \qquad (3.4)$$

Where h_p is the height of the hopper (m), A_1 and A_α are the area of the upper and lower base respectively (m^2)

Mass of the Hopper the equation:

$$M_P = \ell_h V_h \qquad (3.5)$$ (Gana et. al, 2017)

Where M_P is the height of the hopper is the bulk density of the material of the hopper. Taking the bulk density of mild steel as 7830 kg/m^3 was obtained from equation (5) as :

$$M_h = 7830\ V_P \qquad (3.6)$$

Machine Capacity

The capacity of the machine was obtained as :

$C_M = M_h \frac{\chi n_1}{n_2}$ (3.7)

Where C_M is the capacity of the machine per day/ per 8 hours operational time (hr/day), n_1 is the number of minutes in 8 hour per day (minutes), $n_2$is the number of minutes to complete one operation including loading and discharging (minutes) (Gana et al, 2017).

Mass of brush

The total mass of brush is given by:

$m_b = \rho \frac{\pi {d_b}^2 l}{4}$ (3.8)

WhereM_b is the mass of brush (kg)

Determination of power requirement of the machines is dependent on the centripetal force acting on the skinning shaft and anger and the total mass of skinning mechanism. The total mass including mass of shaft, anger, brush, pulley, roasted groundnut and blower.

Px60

And it is given by:

$M = (M_S + M_a + M_b + M_p + M_g + M_L)$ (3.9)

Where M is the total mass (kg), M_S, M_a, M_b, M_p, M_g, and $M_L$are the mass of shaft, anger, brush, pulley, groundnut.

The centripetal force acting on the skinning mechanism is obtained as

$F_{cp} = Mw^2rd$ (3.10)

Where F_{cp} is the centripetal force (N) w is the angular velocity (rad/s), rd is the radius of the skinning anger

$$\omega = \sqrt{\left(\frac{2F}{M_g d}\right)} \quad (3.11)$$

The circumference velocity of the skinning shaft is given by

$$V = \frac{2\pi N}{60} \quad (3.12)$$

$$N = \frac{60\omega}{2\pi}$$

Where V = circumferential velocity (m/s), do is the diameter of the driving pulley (m)

The driving torque is given by:

$$T = \frac{I_T \omega^2}{2\pi} + Fr \quad (3.13)$$

Where T is the driving torque (NM).

The power required to drive the machine is given by:

$$P = T\omega_s \quad (3.14)$$

Where P is the power (watt)

Determination of the length of belt.

A flat belt was chosen for the machine because of the large centre distance between the motor pulley and the machine pulley. The length of belt required to transmit the given power from the motor pulley to the machine pulley is given by;

$$L_b = \Lambda(r_1 + r_2) + 2\chi + \frac{(r_1 + r_2)2}{\chi} \quad (3.15)$$

Where L_b is the length of belt , r_1 and r_2 are the radius of motor pulley and machine pulley respectively, and χ is the centre distance between pulleys (m)

3.4 Shaft Design.

The material of the shaft is carbon steel (C-35 steel). It is excellent heat treatment properties with ultimate tensile strength of 800MPa and elastic limit stress of 550MPa and (Sharma and Aggarval, 2008). The shaft bears the load of the inner drum and its associated components, and that of the pulley. The power is delivered to the shaft by some tangential force and the resultant torgue (or twisting moment set up within the shaft permits the power to be transferred to the machine pulley. The shaft is subjected the combined action of bending and twisting moment (Khunmi and Gupta, 2011).

Fig 3.1 Shows the load distribution on the shaft and the support reactions provided by the bearings due to vertical loading.

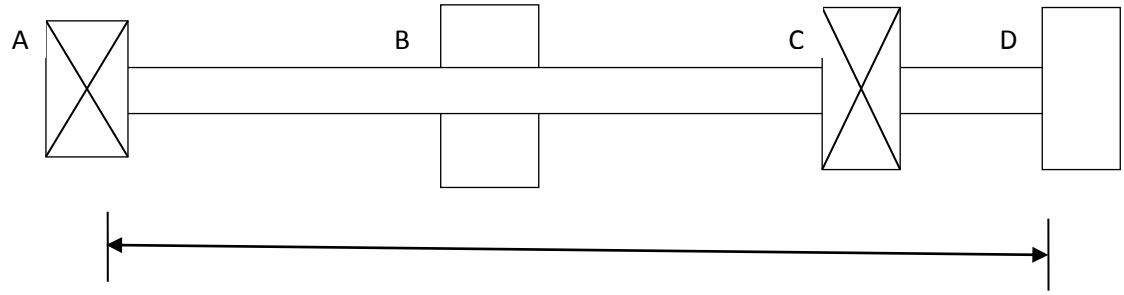


Fig 3.1 Load distribution on the shaft

From fig 3.1, A and C are the left and right hand bearings respectively, B is the inner drum and D is the pulley. The weight of the inner drum is uniformly distributed over the portion AC of the shaft.

Considering the shaft as a beam, the various loads acting on the beam are as shown in fig 3.2.

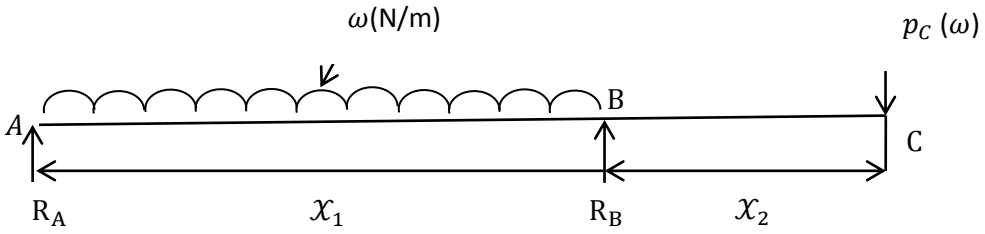


Fig 3.2

From fig 3.2, ω is the uniformly distributed load (N/M) P_C is the pulley weight (N), R_A and R_B are the reactions at A and B respectively.

Converting distributed to point load and rearranging fig 3.2, we have fig 3.3

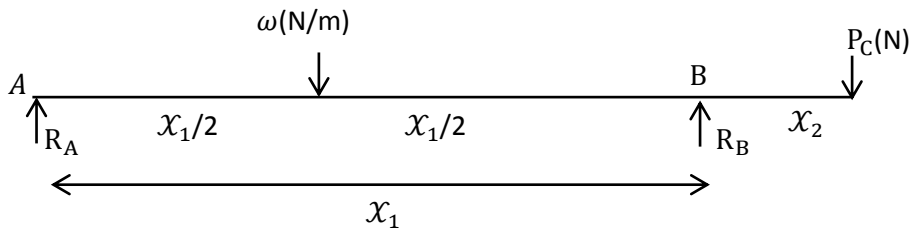


Fig 3.3 converted load diagram.

Using static equilibrium equations, the support reactions are obtained as follows:

$\sum f = 0$

$RA + RB - \omega x_1 - P_1 = O$

$R_1 + R_1 = \omega x_1 - P_1$

$R_A = \omega x_1 - R_C - R_B$ (3.16)

$\sum M = 0$

Taking moment about point A,

$\frac{\omega x_1 - R_C}{2} P_C (\chi_1 + \chi_2) - R_C \chi_1 = 0$ (3.17)

Solving equations (16) and (17) give R_A and R_B

The maximum bending moment occurs at the point where shear force is zero, and it is given by

$M = R_a L_o + \frac{fl^2}{2L}$ (3.18)

Fig. 3.4 shows the load diagram, shear force diagram and the bending moment diagram.

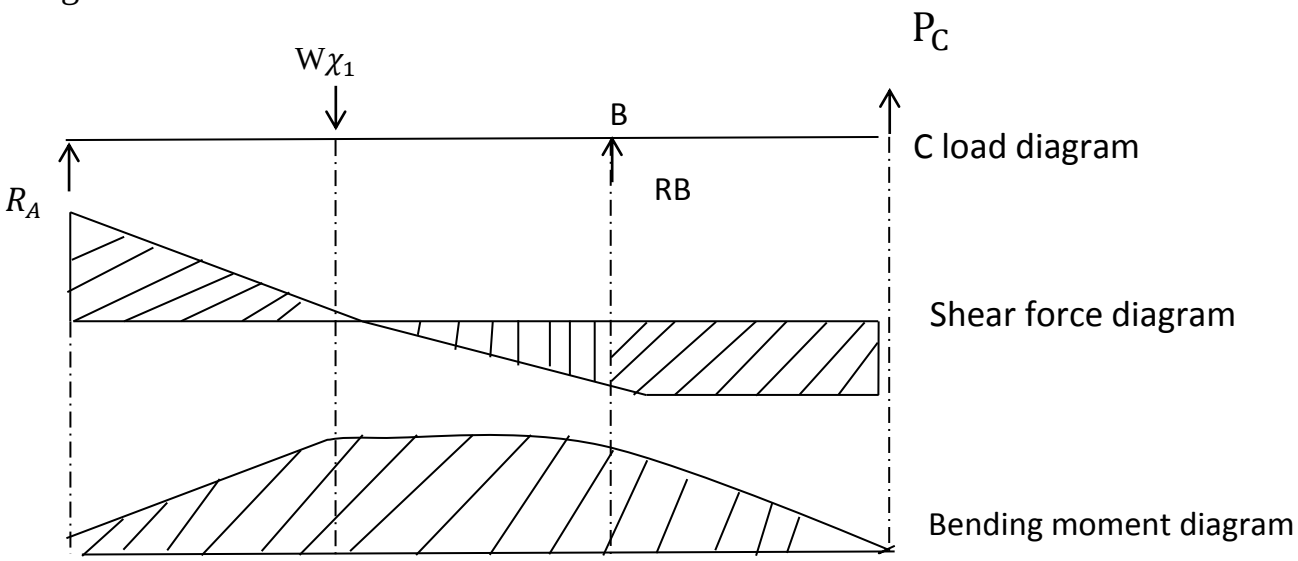


Fig 3.4 Shear force and bending moment diagrams.

The twisting moment acting on the shaft is given by

$$M = \frac{60P}{2\Lambda N} \qquad (3.19)$$

Where P is the power transmitted (watt), N is the rotational speed (rev/min) (khurmi and Gupta, 2011).

The diameter of the shaft was obtained using eqn

$$D = \sqrt[2]{\frac{1}{L}\left(\frac{4V}{\pi} + d^2 l\right)} \qquad (3.20)$$

Where d = shaft size (m), Te is the equivalent twisting moment (Nm) m_t is the twisting moment (Nm), M_b is the bending moment (NM), K_b and K_t are the shock and fatigue load factors applied to bending and torsion respectively. For gradually applied load, $K_b = 1.5$ and K_t = 1.0 (Sharma and Aggarval, 2008).

The shaft was purchased according to physical specifications and so the design stress for shaft without allowance for keyways is obtained as:

γ = 0.3 times elastic limit stress in tension or

$\gamma = 0.18$ times ultimate tensile strength (which ever is smaller (Sharma and Aggarval, 2008).

3.5 DESIGN ANALYSIS AND CALCULATIONS

3.5.1 Geometry of Peeling Chamber

The design analysis was carried out to determine the parameters necessary for the selection of appropriate grade and size of materials for the fabrication of the various machine components. From specification, the total of groundnut to be peeled at an instant is 5 kg.

From the mechanical properties of groundnut, density of groundnut is $752.34 kg/m^3$

Recall that

$$\rho = \frac{M_g}{V} \qquad (3.1)$$

where,

M_g = mass of groundnut

V = volume

ρ = density

Therefore the volume to occupied by the specified mass of groundnut is given by

$$V = \frac{M_g}{\rho} = \frac{5}{752.4} = 0.00664 m^3$$

3.5.2 Force required to Peel Groundnut

In order determine the force required to peel the groundnut, we have to determine the force required rupture the groundnut kernel. Any force less than this critical value is sufficient to peel the groundnut.

According to the research done by (Iraj *et. al*, 2011), on the mechanical behavior of groundnut kernel under compressive load, it was deduced that the minimum force required to rupture groundnut kernel is 60N.

3.5.3 Design of the Peeling Chamber

Due to the available material, the peeling brush available has the following below:

Figure 3.1: The Peeling Brush

From the geometry above of peeling brush, to obtain the minimum dimension to take all the groundnut been fried we recall that the volume of the 5 kg of groundnut is $0.00664 m^3$.

Total volume that can be occupied by groundnut kernel is:

$V = volume\ of\ peeling\ chamber - volume\ of\ peeling\ brush$

For the length of the peeling chamber, to accommodate for the total length of the peeling brush and also provide clearance for free rotation of the brush, a length of 600 mm was selected. To obtain the minimum diameter we recall that:

$$V = \frac{\pi}{4}(D^2L - d^2l) \qquad (3.2)$$

$$therefore \quad D = \sqrt[2]{\frac{1}{L}\left(\frac{4V}{\pi} + d^2l\right)}$$

$$D = \sqrt[2]{\frac{1}{0.6}\left(\frac{4 \times 0.00664}{\pi} + 0.11^2 \times 0.55\right)}$$

$$D = 0.158\, m = 158\, mm$$

To accommodate for the spaces occupied by the shaft and the brushes, a diameter of 170 mm was used as shown below

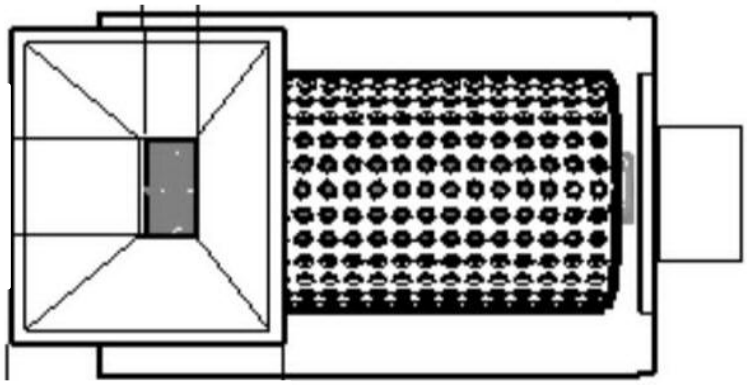


Fig. 3.2: The Peeling Chamber

3.5.4 Speed Required to Peel Groundnut

Recall that the force required to peel groundnut should be less than the minimum rupture force which is 60 N. To achieve this we recall that centrifugal force due to rotation of the brush is given by:

$$F = \frac{M_g \omega^2 d}{2} \quad (3.3)$$

Where,

M_g = mass of groundnut

ω^2= the speed of peeling shaft

d = the diameter of the peeling brush

Therefore,

$$\omega = \sqrt{\left(\frac{2F}{M_g d}\right)} = \sqrt{\left(\frac{2 \times 60}{5 \times 0.11}\right)}$$

$$\omega = 14.77\ rad/s$$

Speed is

$$N = \frac{60\omega}{2\pi}$$

$$= \frac{60 \times 14.77}{2\pi} = 140\ rpm$$

3.5.6 Design of the Peeling Brush Shaft

Design against bending

$$Bending\ stress\ \sigma_b = \frac{Mc}{I}$$

$$and\ shear\ stress\ \ \tau = \frac{Tr}{J}$$

$where, c = \frac{x}{2}\ and\ r = \frac{d}{2}$

(3.4)

$$I = \frac{\pi d^4}{64} \quad and \quad I = \frac{\pi d^4}{32}$$

$$Mass\ of\ wooden\ cylindrical\ brush\ base\ (m_b) = \rho \frac{\pi {d_b}^2 l}{4}$$

$$= 650 \times \frac{\pi \times 0.11^2 \times 0.55}{4}$$

$$= 3.4\ kg$$

Reaction force of groundnut on shaft is not to exceed 60N and is assumed to be uniformly distributed across the brushes.

Therefore total force on shaft is

$$F = 60 + 3.4 \times 9.812 = 93.36\ N$$

From the geometry of the shelling brush mechanism,

Reaction forces

$$R_a + R_b = F = 93.36\ N$$

$$R_a \times 0.665 = F \times 0.31$$

$$R_a = \frac{93.36 \times 0.31}{0.665} = 43.52\ N$$

$$R_b = 93.36 - 43.52 = 49.8\ N$$

M, which is the maximum bending moment on the shaft is:

$$M = R_a L_o + \frac{fl^2}{2L} = (43.52) \times 0.325 + \frac{93.36 \times 0.55^2}{2 \times 0.8} = 31.79\ N.m$$

Where $L_0 =$ the length between the first bearing and the centre of the shaft.

Torque on shaft due to load alone is

$$\tau = Fr = 93.36 \times \frac{0.11}{2} = 5.138\, N.m$$

The von Mises stress on a shaft is given by the formula

$$\sigma_{max} = \sqrt{k_f^2\sigma^2 + 3k_{fs}^2\tau^2} \qquad (3.5)$$

Also from the distortion energy-Gerber equation,

$$\left(\frac{S_a}{S_e}\right)^2 + \left(\frac{S_m}{S_y}\right)^2 = 1 \qquad (3.6)$$

Combining equations (3.4), (3.5) and (3.6)

The diameter of the shaft to withstand bending is

$$d = \left\{\frac{32n}{\pi}\left[\left(\frac{K_F M}{S_e}\right)^2 + \frac{3}{4}\left(\frac{T}{S_y}\right)^2\right]^{\frac{1}{2}}\right\}^{\frac{1}{3}}$$

For stainless steel, $S_e = 505MPa \;\; and \; S_y = 215MPa$

And since the shaft is a uniform solid shaft $K_F = 1$. Assuming a factor of safety of 5.0

$$d = \left\{\frac{32 \times 5}{\pi}\left[\left(\frac{31792}{505}\right)^2 + \frac{3}{4}\left(\frac{5135}{215}\right)^2\right]^{\frac{1}{2}}\right\}^{\frac{1}{3}} = 15\, mm$$

Also the twisting due to the torque is given by

$$\theta = \frac{TL}{JG} = \frac{16TL}{\pi d^4 G}$$

$$= \frac{16 \times 5135 \times 800}{\pi \times 15^4 \times 86000} = 0.0048°$$

The diameter of shaft used during construction process to further minimize the twisting effect was a 25 mm shaft which is far above the minimum, therefore it is safe and account for shock loads and unexpected misuse.

3.5.7 Power Required for Peeling

Recall that power is

$$P = T\omega_s \tag{3.7}$$

Where the overall torque of the system is given by

$$T = \frac{I_T \omega^2}{2\pi} + Fr$$

But

$$I_T = \frac{m_s r_s^2}{2} + \frac{m_b r_b^2}{2}$$

$$m_s = \frac{\rho \pi d_s^2 L}{4}$$

$$= \frac{7700 \times \pi \times 0.025^2 \times 0.8}{4} = 3.02\ kg$$

$$I_T = \frac{3.02 \times 0.0125^2}{2} + \frac{3.4 \times 0.055^2}{2} = 0.00538\ kgm^2$$

Therefore the total maximum torque is

$$T = \frac{I_T \omega^2}{2\pi} + Fr$$

$$= \frac{0.00538 \times 14.77^2}{2\pi} + 93.36 \times 0.055 = 5.32\ N.m$$

Using the standard speed obtained from AC electric motor of 1450 rpm, the power of the electric motor that can provide the required torque is given by the formula

$$P = T\omega_s$$

$$= 5.32 \times 2 \times \pi \times \frac{1450}{60} = 0.8\ kW$$

Therefore a 1hp Variable speed drive electric motor was selected so as to be able to vary the speed to the required maximum peeling which is 140 rpm.

3.6 MANUFACTURING PROCESS

These are the processes involved in the production of different components of the peeler. Marking out processes was carried out using measuring tape, rule, scriber, steel rule, punch and engineering tri-square. The tape rule was used to measure the required dimensions, while the scriber inscribed paints, lined and areas. The engineering tri-square was used to check for square ness of the angle bar and metal plates that are cut out before welded together.

The oxy-acetylene gas cutting flame was used in cutting thick metal plates to the required dimensions. The hack saw was used to cut the angle bar; also the cutting disc was used in cutting sheet metal plates. Parts of the main frame were joined together by first tacking using arc welding after which, the frame (top and bottom hood) was checked for squareness and alignment before welding through.

The shaft was first center drilled on the lathe and machined to the required dimension. Electrodes having standard wire gauge size of 10 were used.

The design and construction of roasted seed groundnut peeling machine is made up of various parts and dimensioned according to the capacity at which it would work.

During fabrication, from the blue print design of machine, various dimensions were taken in regards to materials needed up to precision.

3.6.1 Production Process, Tools and Machines

The fabrication of the machine was carried out in a step-by-step manner from one part to the other. This makes the process easier. The order of fabrication was as follows.

Table 3.1: The production process, tools and machine

S/N	ITEM	PRODUCTION PROCESS	TOOLS AND MACHINES
1.	Shaft	Facing ,turning, and milling	Lathe machine and milling machine
2.	Hopper	Shearing, welding, grinding	Shearing machine, arc welding machine and grinding machine
3.	Hopper support	Cutting, welding, grinding and drilling	Hacksaw, electric welding machine, grinding machine and drilling machine.
4.	Bearing housing	Drilling and boring	Drilling machine and lathe machine.
5	Frame	Cutting, welding, Grinding	Shearing machine, arc welding machine and grinding machine
6	Peeling Cylinder	Cutting, Rolling, Welding, Grinding	Shearing machine, Rolling machine, Arc welding machine and grinding machine

Other tool use in the production process is:

1. **Centre Punch:** It is used for marking the point to be drilled or the point for placement of a divider.
2. **Divider:** It is use for marking out circles or circular distances to be hand cutting disc.
3. **Scriber and marking chalk:** It is use for making the markings on metal visible. It is immune to water and dirt.
4. **Vernier Caliper steel rules and tape:** It is used for dimensions for marking out on the work piece. Tape was use for longer dimension and the Vernier caliper for dimension the diameter of the shaft.
5. **Drill bit:** They are used for drilling holes.
6. **Hammer:** It is used for beating metal into shape.

3.6.2 Machining Operation

- **Marking and Cutting:** This operation encompasses the use of scribers in marking and hand cutting disc in cutting out the marked parts.
- **Drilling:** a hand drilling machine normally called hand drill was used to make bolt holes and shaft holes. The hand drill is also use for making the bolted holes.
- **Joining:** Full welding was used to join the frames and some other parts bolt and nuts are used, the bolts are usually welded permanently in place for nut to be used in order to ensure the ease of maintenance and for the nuts not to loose due to vibration.
- **Balancing and Alignment:** The drum has to be well balanced to minimize vibration of the brush. Alignment is important between the

brush shaft and cylinder to ensure a good rotation of the brush when the machine is started. If good balancing is not achieved, it will cause misalignment and wear of parts.

- **Turning Facing and Boring:** The shaft on the lathe.
- **Grinding:** The welded parts are smooth (dressed) and then excess sheets are trimmed off.

3.7 SAFETY PRECAUTION DURING USAGE

Safety simply means to be free from danger. Right from birth people are expose hazard. Some safety precautions needed fall under the following;

- Health – cleanliness
- Overcrowding
- Lightening
- Ventilation
- Safety – Fencing
- Training
- Tiredness

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 PERFORMANCE EVALUATION

The performance of the groundnut peeling machine depends to a large extent on the design and conditions under which the system is operating.

The design of the roasted seed groundnut peeling machine was done to achieve maximum output and of improved efficiency. The groundnut peeling machine can peel groundnut and other food substances like dry maize depending on the quality in use.

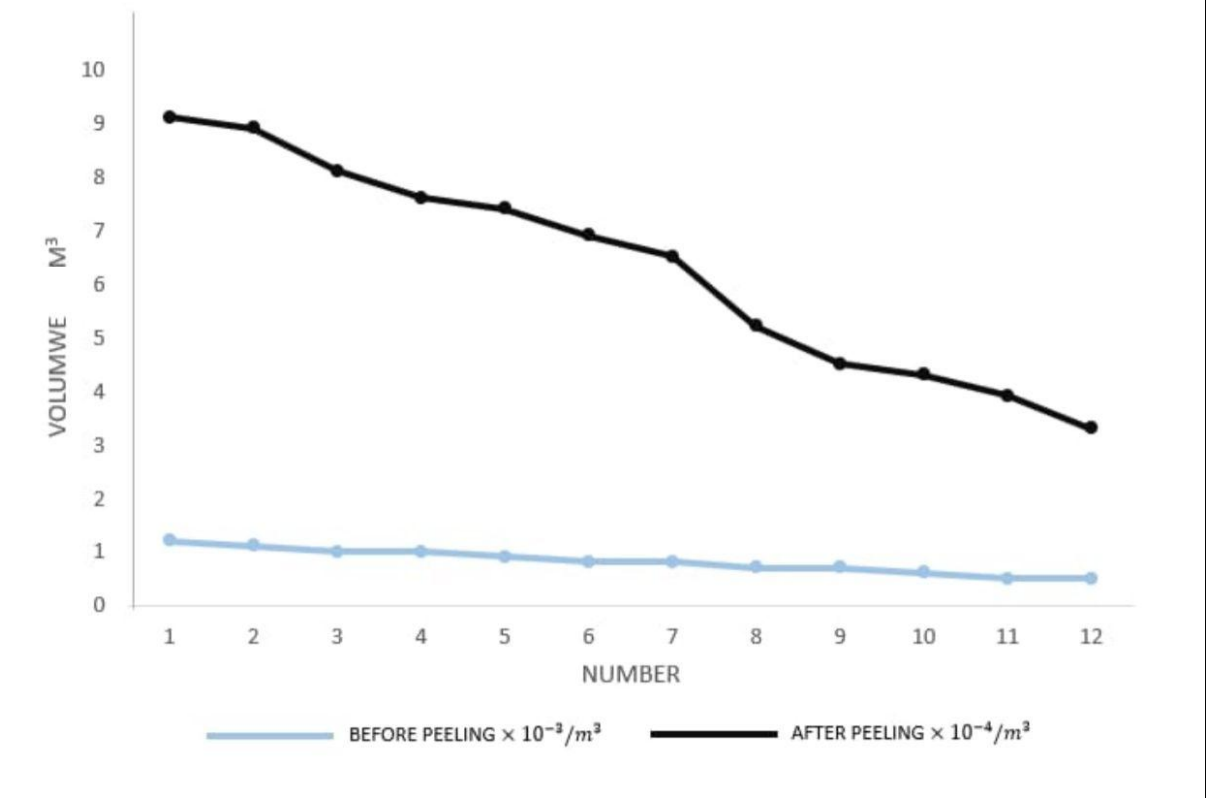
4.2 TESTS AND RESULTS

The groundnut peeling machine was test run using voltage supplied by PHCN with different masses of groundnut.

Table 4.1; Performance Evaluation of the Machine Before and After Peeling

s/n	**Volume of groundnut $(M)^3$**		
	Before peeling X 10^{-4}	**After peeling X 10^{-3}**	**Time (Secs)**
1.	1.20	9.10	79
2	1.10	8.90	76
3	1.07	7.60	72
4	1.03	7.40	69
5	0.97	6.90	65
6	0.93	6.50	62
7	0.86	5.20	59
8	0.84	4.50	57
9	0.75	4.30	53
10	0.72	3.90	50
11	0.65	3.30	47
12	0.50	2.60	45

Fig4.1



SCALE: On volume axis 1m^3 represents 1 unit
On number axis 1 represents 1 unit

$$\text{Slope} = \frac{\text{change in volume}}{\text{change in number}}$$

$$= \frac{V_2 - V_1}{N_2 - N_1}$$

$V_2 = 9.1m^3$

$V_1 = 8.9m^3$

$N_2 = 12$

$N_1 = 8$

$\therefore$ Slope = $\frac{9.1-8.9}{12-8}$

= $\frac{0.2}{4} = 0.05\text{m}^3$.

Efficiency = $\frac{V_{ap}}{V_{bp}}$ x 100% = $\frac{0.00091}{0.0012}$ x 100 = 75%

4.3 RESULTS

The results showed that peeling speed has the highest effect on efficiency of the machine. Moreover, other operating parameters also depend on peeling speed for real processing operation to be cmarried out.

4.4 Bill of Engineering Measurement and Evaluation

The cost estimate of the research work is summarized in Table 4.2

Table 4.2; Bill of Engineering Measure and Evaluation(BEME)

S/N	DESCRIPTION	QUANTITY	UNIT COST (#)	AMOUNT (#)
1	50mm by 50mm mild steel Angle Bar	2 length	7,000	15000
2	1.5mm mild steel sheet	$^1/_2$sheet	15000	15000
3	Ø25mm Pillow block bearing	2 pieces	6000	12000
4	Ø30mm Mild steel shaft (Long 500mm)	1 piece	18500	18500
5	Ø200mm by 450mm brush	1 piece	35000	35000
6	2HP electric motor	1	55000	55000
7	Gauge 12 mild steel electrode	1 packet	4000	4000
8	Cutting disc	3 piece	1000	3000
9	Grinding disk	1 piece	1200	1200

10	Switch	1	8500	8500
11	16mm cable wire	3 yards	1600	4800
12	Paint and spraying	Sum	13000	13000
13	Perforated sheet (1400mm by 700mm)	1	28000	28000
14	Contingency		5000	5000
	Total			**217,500**

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The main importance of this project work is that the red seed groundnut peeling machine is very applicable for small farmers and local business production. In some case the operation of this machine were manually and electrically. The operational and process performance showed that the machined peeled well over an average of 75 % of roasted groundnut seeds. Which can be used in various domestic application, food industries, oil industries and many more. It will save the time, energy as well as human efforts, also cost of machine fabrication is less, which will help for more production of peeled groundnuts. Besides, all necessary constraints have been taken into consideration to surely guarantee the reliability of the machine. Also these machine has been precisely designed at a very minimize cost as to been affordable by an average Nigeria that will be dealing with groundnut.

Due to the high technological capability of these machines it can be concluded that groundnut processing is dynamic in nature. On the whole, the level of technological processes is dependent on the economic significance of the products. This technological capability has helped in the solution of processing at large.

5.2 RECOMMENDATION FOR FURTHER WORK

This work, no doubt; is a positive step towards the realization of the much needed technological breakthrough in the country. The utilization of local materials, local technology and processes, tends to the technological breakthrough needed.

Though local materials and technology were extensively employed in the course of fabrication, it is evident on completion that design was not compromised for cost. The strength and efficiency of the machine attained a reasonable and acceptable degree of performance. Therefore, it will not be out of place to say that, this work responds favorably to the Federal Government clarion call for indigenous technology.

Producing this work on a larger scale will definitely not only act as the source of income to the producer and the individual but will create job opportunities to the teeming young graduates.

This research work is of great importance to the economic development of our Nation Nigeria, as it meets the aims of poverty alleviation programme put in place by the Federal Government of Nigeria.

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