Webology (ISSN: 1735-188X)
Volume 18, Number 6, 2021

Design And Fabrication Of A Groundnut Oil Expelling Machine

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Abstract

A misconception exist between groundnut oil and other vegetable oil used in Nigeria because of the inefficient processes of producing groundnut oil in commercial quantity. This work, design and fabrication of an automated groundnut oil extractor was aimed to produce pure groundnut oil which would be better than the common vegetable oil due to its natural process of extraction this machine this machine designed to the power a by 0.75kw electric motor with 1400 rpm and 50Hz single phase. The machine components are: the electric motor, expellant unit, drains collector, belt, driving and driven pulleys, and the hopper. The expelling unit consists of a screw expellant shaft with expellant barrel. The maximum crushing stress of the groundnut was determined experimentally as 23.1KN\m2. A heater of 1500W was used to preheat the groundnut before crushing. The groundnut was heated for 15mins which resulted to the production of 0.23kg quantity of oil with improved quality. When heated for 10mins the quantity produced was 0.019kg which contained some impurities. The result showed that at 15mins preheating of the groundnut the quantity and quality of oil produced were better than the one produced when heated for 10 mins. Therefore, the rate of oil extraction was effective and efficient at 15 mins heating time. At a regulated heater temperature of 100 oC the quality of the oi l and groundnut cake was pleasant and edible. Based on the efficiency and the quality of the oil produced, this machine was recommended suitable for the production of groundnut oil for commercial use.

1. INTRODUCTION

Groundnut oil expelling machine is an important device for oil recovery from groundnut seed in a roller mill, direct firing of barrel and pressing with an engine driven oil expeller. Expeller use a horizontal rotating metal screw, which feeds oil-bearing seeds into a barrel shaped outer casing with perforated walls. The seeds are continuously fed to the expeller, which grinds, crushes and presses the oil out as it passes through the machine The pressure ruptures the oil cells in the product and oil flows through the perforation in the casing and passes through the oil outlet and is finally collected with oil receiving container underneath. Expeller are power driven, and are able to process 8 to 300kg of groundnut per hour or even more depending upon the type of expeller used Bigger units which process greater quantities of oil are available for use in larger mills. The percentage of oil extracted by expellers is nearly 90% depending upon the type and kind of products as well as the expeller being employed. The friction created by the products being pressed wears down the worm shaft and other internal parts, and also have the tendency of creating problem or causes failure of main shaft.

1.1 Statement of Problem

Groundnut oil expeller has been developed and constructed by some researchers in different sizes,shapes and materials, mostly for industrial uses. Such expellers are expensive, involve high level technology which cannot be afforded by small scale and low income oil millers. In order to assist the small scale oil miller in the local communities, small scale groundnut oil exp ellers need to be designed, and constructed with locally sourced materials.

1.2 Objective of the Study

The main objective is to design and fabricate of an improved, durable groundnut oil expeller, using local sourced materials.

Other specific objectives are:

- To develop a machine that can extract oil from groundnut, within a minimum time frame.
- To design, develop and test expeller that is affordable to small scale oil millers.

2. DESIGN METHODOLOGY AND ANALYSIS

2.1. Material selection

For an intelligent and resourceful design, the designer must clearly know the material which are available and the properties they possess. Selection of material depends on many features such as the intensity and type of stress to which the components are subjected to, whether it is flexible or rigid or it is to ex perience high temperature or corrosive action and how it leads itself to processes of manufacture, i.e . forging, machine etc. Therefore the designer's selection will influence the following factors:

1. Strength
2. Weight
3. Appearance
4. Manufacture
5. Cost of production

These will also determine the variation between success and failure of the machine. We can further classify the above factor into four main classes:

a. Service Requirements
b. Construction Requirement
c. Economic Requirement
d. Maintenance Requirement

2.1.0 Service Requirements

Before a material is chosen for construction, it must possess some distinct properties which it exhibits when put to play. These properties are generally referred to as the service requirement. Some these properties which should be appreciable while the material is in service are:

a. Strength
b. Toughness
c. Hardness
d. Stiffness
e. Resistance to corrosion
f. Conductivity and heat resistance

2.1.1 Fabrication Requirement

For fabrication process, a material must possess some distinct properties, these are mainly forge-ability, malleability, ductility and weldability. Materials undergoing forgeability are heated to a temperature close to its
melting point then shaped to desired structure. For malleability, it's required that the material should be made
into a sheet like form while ductility requires the material to be drawn into a wire form. Finally, weldability which is the ability for the material to be welded. Therefore the materials must be able to be joined by the process of welding.

2.1.2 Economic Requirement

This is about the most important factor for the material selection because it determines the total cost of production which in turn affects the price of the product or retail cost and consumer choice. It the total cost of production is high, variably the price of the finished product will also be high. When the price of a product is high, consumers will seek for alternative cheap but similar goods. Bearing in mind that the two aims of production is satisfying consumer wants and needs and also to make maximum profit. As a producer one must
judiciously select relatively cheap but reliable and appropriate materials for production. This will reduce the overhead cost of production therefor making it cheap in respect to other si milar materials. Then we can comfortably harmonize the cost of production with the real price. One of the major consideration in engineering design is to design machines that are reliable, cost effective and the ability of the machine solving human problem. This was one of our consideration in this project work.

3. MATERIALS USED FOR THE FABRICATION

A list of the material selected for the major components of the design is shown in table 1.0 below. The table also shows the values of the useful properties of the material use

COMPONENTS	**MATETIAL SELECTION**	**SELECTION CRITERIA**	**VALUEOF USEFUL PROPERTY**

Expeller Screw	**Medium carbon steel**	**Conventional and stronger than mild steel and its locally available**	**Yield strength: $Sy=248M/M^2$ Tensile strength: Su=399MN/M 2**
Pressure cone	**Medium carbon case hardened stee**	**Hard water resistance material and it is locally available**	**Yield strength: Sy=289MN/M 2 Tensile strength: $Su=413MN/M^2$**
Bearing supporting bar	**Mild Steel**	**Easily machined**	**Yield strength: Sy= $230MN/M^2$ Tensile strength: $Su=205MN/M^2$**
Hopper	**Mild steel plate**	**Easily machined**	**Yield strength: Sy = $230MN/M^2$ Tensile strength: $Su=205MN/M^2$**
Speed reduction system	**Electric motor, belt and pulley**	**Single phase electric motor of 1hp**	**Good serviceability and relatively Cheap to maintain**
Angle iron	**Mild steel**	**Locally available**	**Yield strength: Sy= $230MN/M^2$**

			Tensile strength: Su=205MN/M^2

Design of the Component parts of the Machine

The major component parts design of the machine is as follows:

Hopper Design

The hopper design is based on the volume of frustum of a pyramid. The volume of the pyramid is obtained by subtracting the volume of a smaller pyramid from that of a larger one as given by Khurmi and Gupta (2004)

Where:

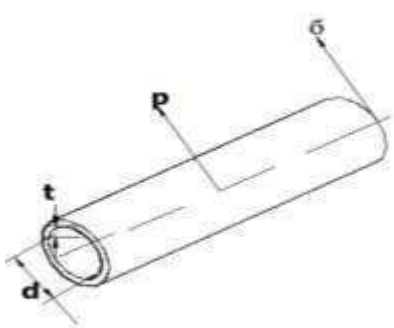
V = volume of the hopper, R = outer radius (100mm), H = external height (200mm), r = inner radius (39mm), h = inner height (126mm), π = 3.142

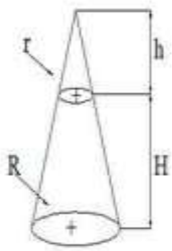
$V = 1/2\ \pi\ (100^2 200 - 39^2 126) = 1.571\ (2000000 - 191646) = 2840924.134 \times 10^{-9} = 0.003$ m3 ans

Cylindrical Barrel or Extracting Chamber Design

The extracting chamber is design based on internal pressure in the chamber, the extracting chamber is treated as thin walled cylinder or vessel as given by Khurmi and Gupta (2004), the tangential stress perpendicular to the axis of the cylinder

$\sigma = \rho d/2t$ (Mpa) ---2





$V = \frac{1}{3}\pi(R^2H - r^2h)$ ……………………………………………1

Where:

σ = perpendicular or hoop stress, d = internal diameter (50mm), t = thickness (5mm), ρ = internal pressure = force/area of cylinder= F/A.,

Where:

$area\ of\ a\ cylinder, A = \pi R^2 = 3.142 X 25^2 = 1963.75(m^2)\ ans.$

Force, F = Torque T/ Length of the element --------------------------3

Where:

Length of the chamber, l = 398mm

Torque, T=HP 5252/N---4

Where:

HP = horse power (1), N = shaft speed (1400rpm)

T = 1 5252/1400= 3.75(NM) ans

F=T/l=3.75/398=0.00949(N) ans

ρ=F/A=0.0094/1963.75= $4.8X10^{-6}$ ans

σ=pd/2t=$4.8X10^{-6}$X50/2X5=$2.4X10^{-5}$MPA

Power Required for Crushing

The power required for crushing is determined from

the equation 5 as given by Khumi and Gupta (2004)

$P_e = 2\pi NT/60$ ---5

Where:

$P_e = power\ required\ in\ watt$ ($750w = 0.75kw$)

T = torque = ?

If average N = Shaft speed = 60rpm

π =3.142

rom the equation 5 above

$T = P_e 60/2\ \pi N$ = 750X60/2X3.142X60 = 45000/377.04=119.04 NM ans

The power required for crushing is given by

$P_{e\ =}$ 2x3.142x60x119.4/60 = 45018.576/60=750W ans

The value of 0.75kw of power is an estimate of the required crushing power at expeller full load. In this work an

electric motor of 0.75kw was used which implies that the motor will power the machine effectively without

failure

Principle of Operation of the Groundnut Oil Expelling Machine:

The principle of operation involve powering the machine and allowing it to run for about 10 minutes without any load on it. At the end of the 10 minutes, the machine should be loaded with the groundnut seeds well dried, through the feed hopper having adjusted the pressure cone to 1.0mm clearance. The adjustment should be done with the aid of hand. Finally the groundnut oil flow through the oil outlet and the cake through he cake outlet.

RESULT DISCUSSION

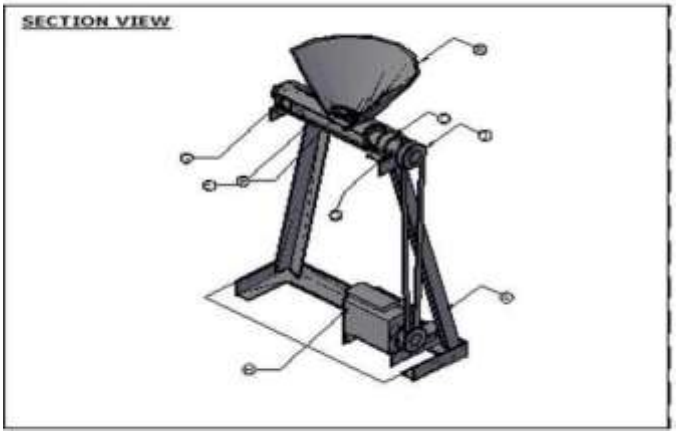
From the test result, it was observed that the quality of oil obtained when 8 minutes time was allowed for the machine at motion to generate heat before pouring the groundnut was impure. But when the time was increased to about 15 minutes, the quality of oil was improved.

CONCLUSION

We have designed, fabricated and tested a groundnut oil expelling machine. The relative performance test result shows that the machine maintained high level of oil extraction characteristics in terms of cake quality and oil quality. The machine is cheap and could easily fit into medium and large scale industry for the production of groundnut oil in commercial quantity. The machine is easy and safe to operate, has a low energy consumption rate and do not pollute the environment. Finally, we have realized our aim. Though the machine has a higher oil extraction rate, there exist some need for improvement on it.

RECOMMENDATION

We recommend that more work be done on the extraction efficiency of the machine in other to improve its oil extraction rate. Also the incorporation of sensors in the feed screw in other to avoid the ov er loading of the machine should be duly considered. As a result of the observation made during the test run, we also recommend that in subsequent design, the oil extraction rate and residual oil in cake should be analyzed to improve on the machine effectiveness. Finally we recommend that subsequent design should include Automation system



nother to reduce human labour and heating element which will heat the groundnut for efficient oil production.

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