Pedal Operated Design and Fabrication of Groundnut Sheller and Crusher Machine

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Abstract— In India, most of land use for agricultural purpose which produces semi-finished product or goods. Groundnut also one of the agricultural semi-finished goods. Groundnut is grown on small scale farmers in developing countries like India. This paper describes about the design and fabrication of various components of groundnut Sheller machine. Hence in this design of various parts are necessary, and design of various parts due to which the design quality of those parts will be improved. Overall, this project involves processes like design, fabrication and assembling of different components etc. By keeping the point in our mind, we think that we should make such a machine, whose production capacity is more & machine gets operated on pedal operated of manual work. The new and small former or business man can start their business by investing less capital. So working on the above points, we design and fabricate a new medium production capacity machine and today we proudly present this machine called groundnut Sheller and crusher machine.

Key words: Groundnut, Sheller Machine, Efficiency, Design, Calculations, Fabrication, Assembling, Evaluation

I. INTRODUCTION

The purpose of this paper is to understand the knowledge of design and fabrication mechanism of groundnut Sheller machine. The design is an environment friendly and uses simple mechanism properties such as shelling system, blowering mechanism and crushing process etc. In this project, designing & development of a machine to crush or shell groundnut so the farmers can gain high profit by selling groundnut direct in market. As well as the study of manufacturing was very important in order to carry out this project to ensure that what are needs to do. This project involves the process of designing and fabrication of different parts of this shelling machine considering forces and ergonomic factor for people to use. This project is mainly about generating a new concept of groundnut shell (crush) that would make easier to bring anywhere and easier to crush groundnut. After the design has completed, it was transformed to its real product where the design is used for guideline.

II. PROBLEM IDENTIFICATION

In the beginning the peanuts were separated from its shells by the workers. They simply decoct the groundnut by their hands and separate the peanuts from its shell. The output got from this method, was very low and it does not fulfill the market demand because it was very time consuming process. It was also a boring work for the worker. Traditional method of separating nuts from groundnuts by Putting the peanuts in a cloth bag and rolling over it with a rolling pin. This technique did a good job of cracking the shells (deleting the painful fingers problem), but we still had to pick the peanuts out since they didn't come all the way loose. This is not a reliable method for shell a ground nut due to this crack the ground nut and nuts mixed with shell. Introduction gives knowledge that the traditional method is not a sufficient method for separating the groundnut. Due to this manual process, identify some major problem & to over-come this problem some idea or concepts generates. To facilitate the understanding of the present invention, the construction of the prior art pedal operated groundnut Sheller having the functions discuss below .The system been cost effective, has a wide applications which when implement can show good and effective result. It can be use deliberately in domestic applications, where the electricity is not available and where the load shading is continue in day time. Today electricity consumption rate is not economical so to overcome this problem we shows our innovative ideas in our project.

Fig. 1: Problem Identification

III. CONSTRUCTION

There are seemingly endless possibilities for pedal power tools. The list is long: Hand-driven machines, grinders, forge blowers, pumps, pottery wheels and drilling machines are just a few. This particular unit can shell two maize cobs at one time, and has been sold in some African countries. The work is done by a heavy cast-iron fan, which acts as both a winnower to clear away husks, and a flywheel.While pedal power is a great form of generating torque, there are some problems. Cyclic torque is one problem, another is rigidity. The pull of the chain can be as much as twice the rider's weight, so a sturdy strut is needed between the driving and driven chain (see prototype image at right).The chain must also have some sort of adjustment mechanism in order to take up the slack. An obvious necessity is the need to keep the operator cool while they are pedaling. The Chinese use a simple canopy to protect the person from sun and rain. A small portion of the power generated could also be used to power.

IV. WORKING PRINCIPLE

Groundnut SHELLER is operated on the shearing action bowering action and separating action. Firstly the inputs i.e. the groundnut are fed to the machine through the hopper. Then groundnuts come in contact with the two members, one is semicircular net and another is roll shaft. Semicircular net is a stationary member while the roll shaft is rotating member. When the groundnut comes in contact with these two members then the shearing action takes place here. Due to shearing action (crushing) the groundnuts gets shelled and divided into two parts. i.e. in the peanut and outer shell of the groundnuts. There clearance is provided between the net and roll shaft. The clearance provided is depends upon the size of the groundnuts which is to be decocted. After shelleing the groundnut the peanut and shells of the groundnut gets dropped from the semicircular net, in downward direction then a centrifugal force is applied by a fan on the peanut and shell of the groundnut. Due to more weight, the peanuts gets moved downward and collected in the separator. But due to lighter weight the shell of the groundnuts are thrown outside the machine and which are collected from the backside of the machine. From the shelling chamber the unshelled groundnuts also gets dropped in the tray (7% to 10%). This groundnut gets dropped from the clearance made among the grill. The three kinds of the nets can be used with different size of capsule slots, size vise small, medium and large for various size of groundnuts. In this way the "GROUNDNUT SHELLER" works.

V. DESIGN PROCEDURE

The aim is to design & develop a low cost ground nut shelling machine which will help farmer to sell finished (shelled groundnut) instead of unshelled groundnut. Considering the above problems we are going to design and fabricate such a machine that will eliminate most of the problems from previous available manually shelling machine, so human effort is reduced and getting more productivity, earn more profit to former. The machine shown in figure below is the modeling of groundnut Sheller machine.

VI. DESIGN PROCEDURE

A. Design Calculation

1) Step 1: Power Calculation,

$$T = F \times L$$
$$= 180 \times 180$$
$$T = 32400 \text{ N-MM}$$
$$P = \frac{2\pi NT}{60 \times 10^3}$$
$$P = 203.57 \text{ watt}$$
$$\tau max = \frac{16 \times 32400}{\pi \times D\text{^}3}$$
$$d = 13.45$$
$$d \cong 14mm$$

2) Step 2: Chain Design

$T_1 = 45$
$T_2 = 15$
$N_1 = 60$
$N_2 = 180$
$D_1 = ?$
$D_2 = ?$

$P_R = 203.57$watt
Design power,

$$P_d = P_R \times K_L$$
$$P_d = 203.57 \text{ watt}$$
$$N_1 T_1 = N_2 T_2$$
$$60 \times 45 = N_2 \times 15$$
$$N_2 = 180 \text{ RPM}$$

Chain no.35
Pitch =9.525
No of Teeth on Smaller Srocket T_2=15
No of Strands = single Dia. of larger sprocket.

$$Dp_1 = \frac{P}{\sin\frac{180}{T1}}$$

Dp_1= 140mm
Pitch line velocity,

$$V_p = \frac{\mu Dp1N1}{60}$$
$$V_p = 0.439 \text{ m/sec}$$

Power capacity of roller chain,

$$P = P^2\left(\frac{Vp}{104} - \frac{Vp^{1.41}}{526}(26 - 25cos\frac{180}{T})\right) \times 1$$

P/strands = 0.299kw
Calculate no. of strands

$$\text{No. of strands} = \frac{Pd}{power/strands} = 0.67 = 1$$

Calculate total power,

$$P_T = 0.299 \times 1$$
$$P_T = 0.299 > Pd$$

Design is Safe.
Design of shaft,

$$d_s = 15mm$$

Check,

$$d < \frac{T1 - T2}{4} \quad \text{for } P \leq 25.4$$
$$14 < 95.25$$

Design is Safe
Length of chain in pitches,

$$Lp = \left(\frac{T1+T2}{2}\right) + \frac{2C}{P} + P\left(\frac{T1-T2^2}{40C}\right)$$

Central distance c= 50P = 500MM .....for $\theta > 120°$

p = pitch = 9.525 $\theta = 180°$
Lp= 135.41mm.

Length of chain,

Lc = 135.41x9.525
Lc = 1300 mm.

Approximate dimension of roller chains

1) Roller dia. = 5/8 * Pitch p = pitch = 9.525 = 5.953MM
2) 2. Chain width W= 5/8 * P = 5.953MM
3) Pin dia. dp =5/16 * 9.525 = 2.976
4) Thickness of links plates = 1/8 * 9.55 =1.190mm
5) Max.height of pin links plates HP = 0.82*pitch = 7.810 mm
6) Max. Height of roller link plates = 0.95 * pitch = 9.04 mm

a) Sprocket dimensions,

- For single strand chain, t_o = 0.58p-0.15 =5.374 mm
- Corner relief, e = 0.125*9.525 =1.19 mm
- Chamfer radius, r = 0.54*9.525 = 5.143 mm
- Outside diameter, Do = P (0.6+cot180/T_1) = 142 mm
- Root or bottom diameter, Dr = Dp – 0.625 = 140 - 0.625x9.525 =134.046 mm

3) Step 3: Design of Shaft,

P = 20357×0.75

P_R= 193.03915 watt

$$P=\frac{2\pi NT}{60\times10^3}$$

T= 10.241× 10^3 N-mm

a) Tension ration,

$$\frac{T1}{T2}=e^{\mu\theta}=e^{0.2\times\pi}=1.87T_2$$

$(T_1-T_2)s_{procket}$ = Torque

$(1.87T_2-T_2)\ 25 = 10.241\times10^3$

T_1=470.85 N

T_z=880.49 N

b) Total Weight

$W= T_1+T_2+W_P$

W=1383.13N

c) Bending Moment,

$B_M= W\times L$

B_M=138.313×10^3N-MM

d) Torque Equivalent,

$$T_e= \sqrt{T^2+M^2}$$

$$=\sqrt{(10.259\times10^3)^2+(594.74\times10^3)^2}$$

T_e = 138.629×10^3n-mm

$$\frac{Te}{\frac{\pi}{32}\times d^4}=\frac{\sigma s}{\frac{d}{2}}$$

d = 17.90 mm

d ≅18mm

e) Bending moment equivalent,

$$M_e=\frac{1}{2}(M+T_e)$$

M_e= 138.50×10^3N-mm

$$\frac{Me}{\frac{\pi}{64}\times d^4}=\frac{\sigma b}{\frac{d}{2}}$$

$$\sigma b=\frac{Syt}{2}=182.5$$

d = 20 mm

Selecting max Diameter = 20mm.

Increasing size of diameter by 150%

d = 20 x 1.50

d =30mm

4) Step 4: Chain Design,

T_1 =15 T_2=15

N_1=180 N_2=180

a) Design power.

$P_d= P_R\times k_l$

P_d= 193.3915watt

P_d=0.259 watt

Selecting chain no. 35

Pitch = 9.525

Assume single strands.

b) Pitch dia. Of sprocket

$$D_{p1}=\frac{P}{\sin\frac{180}{T}}$$

D_{p1}= 45.81mm

c) $V_P=\frac{\pi DP1N1}{60\times1000}$

V_P= 0.431m/s

d) Power capacity of roller chain per strands, P/strand

$$= P^2\left(\frac{Vp}{104}-\frac{Vp^{1.41}}{526}(26-25\cos\frac{180}{T})\right)\times1$$

P/strands= 0.2941Kw

No. of strands

$$n=\frac{0.193}{0.294}$$

n = 0.65 =1

No. of strands calculated = No. of strands Assume Safe.

e) Calculated total power,

P_T = P/strands ×no. Of strands = 0.294×1

P_T = 0.294 KW

$P_T > P_d$

Safe

f) Dia. of shaft,

D_s=32 mm

g) Length of chain in pitches Lp,

$$Lp=\frac{T1+T2}{2}+\frac{2C}{P}+P(\frac{T1-T2^2}{40C})$$

C =50×9.525= 500 mm

Lp= 119.98 mm

h) Length of chain,

L=119.98*9.525

L= 1200 mm

i) Roller chain dimensions,

- Roller dia. = dr= 5/8xpitch = 6mm
- Chain width W= 5/8 x p = 3mm
- Pin dia. = dp= 5/16 x pitch = 3mm
- Thickness of link plates = 1/8 x 9 = 1.190mm
- Max. Height of pin link plate Hp= 0.82p Hp= 7.8105mm Max .height of roller link plate, H_P=0.95p H_P=9.04875 mm

j) Standard roller chain sprocket dimensions,

- For single strand chain

T_o= 0.58P-0.15 = 5.3745 mm

- Corner relief = e =0.125 x 9.52 = 1.19mm
- Chamfer radius = r = 0.54 x 9.525 = 5.1435 mm
- Outside dia. D_o= 9.525(0.6+cot ($\frac{180}{15}$)) = 50.52 mm

5) Step 5: Shaft Diameter of Crusher, d_s= 23mm

6) Step 6: Chain Design,

T_1 =15 T_2 = 17

N_1 =180 N_2 = 158.823 rpm

a) Design Power

P_R = 193.3915x0.95 =183.72watt

$P_d = P_R$ x K_L = 183.72 x 1 = 183.72WATT

P_d = 0.246HP

b) Chain No. 35 & no. Of strands = 1

c) Dia. Of smaller sprocket

$$Dp_1=\frac{p}{\sin\frac{180}{T}}=45.81\text{ mm}$$

d) Pitch line velocity,

$$Vp=\frac{\pi Dp1N1}{60}=0.431\text{ m/sec}$$

e) Power capacity of roller chain,

$$P/strands=P^2\left(\frac{Vp}{104}-\frac{Vp^{1.41}}{526}(26-25cos\frac{180}{T})\right)\times1=$$

0.294kwatt

f) No. Of strand,

$$N=\frac{Pd}{p/strand}=1$$

No. Of strands calculated = No. Of strands assume Safe

g) Calculate total power,

P_T = P/ strands x No. Of strands

P_T = 0.294

$P_T > P_d$

h) Dia. Of shaft = ds= 23mm

i) Select permissible

$d<\frac{T1-T2}{4}$ ……for P≤25.4

d < 24mm

7) Step 7: Design of Shaft Blower,

$P_R = 183.72 \times 0.95 = 174.534$watt

$$P = \frac{2\pi NT}{60\times10^3}$$

$T = 10.482 \times 10^3$ N-MM

a) Tension ratio,

$$\frac{T1}{T2} = e^{\mu\theta} = e^{0.2\times\pi} = 1.87t2$$

$(T_1-T_2)s_{procket}$ = Torque

$(1.87T_2-T_2)\ 28 = 10.259\times10^3$

$T_1 = 430.29$ N

$T_2 = 804.65$N

b) Total Weight,

$W = T_1+T_2+W_P$

$W = 430.29+804.65+9.81$

$W = 1244.73$ N

c) Bending moment,

$B_M = W\times L$

$B_M = 1244.73 \times 400 = 124.96\times10^3$N-MM

d) Torque equivalent,

$$T_e = \sqrt{T^2 + M^2}$$

$$= \sqrt{(10.482 \times 10^3)^2 + (124.96 \times 10^3)^2}$$

$T_e = 125.40\times10^3$n-mm

$$\frac{Te}{\frac{\pi}{32}\times d^4} = \frac{\sigma s}{\frac{d}{2}}$$

d = 17.38 mm

d = 18 mm

e) Bending moment equivalent,

$$M_e = \frac{1}{2}(M+T_e)$$

$M_e = 125.1856\times10^3$n-mm

$$\frac{Me}{\frac{\pi}{64}\times d^4} = \frac{\sigma b}{\frac{d}{2}}$$

$$\sigma b = \frac{Syt}{2} = 182.5$$

d = 20mm

Selecting max. Diameter = 20 mm.

Increasing diameter by 150%

d = 20x1.50

d = 30 mm.

VII. MODELING & FABRICATION

After that design complete pedal operated groundnut sheller and crusher machine, then regarding development done on shelling machine. Parameters will be selected according to objectives. Photos of each components and assembled machine and line diagrams with labeling. Main objectives of this project were to develop the first prototype of an easy to use, low priced and efficient ground nut decorticator and test its performance. Taking leads from previous researchers following design constraints were established. Design should be easy to maintain and should not require highly skilled labor, which is difficult to be found in rural areas. Design should be based on easily available material in rural areas. Manufacturing process should be simple and based on locally available machines in rural areas. The various instruments used for fabrication of machine. Following are the main components of machine:

- Frame Structure
- Pedal Drive
- Sprocket
- Self-Alignment Bearing.
- Hopper
- Rotary Drum.

VIII. ASSEMBLY

The arrangement of various component of "Groundnut SHELLER" is being done are as follows:

- The foundation frame is being selected which carry the entire load of the machine.
- The self-alignment bearing to rotating the machine component by using chain drive.
- The fan shaft is mounted at the back face of the foundation frame with the help of pedestals bearing which is fasten using nut and bolt.
- The semicircular the project are balanced and also center of gravity of the assembly is on axis as that of the center of gravity human body that is on spiral cord.net mounted on the support provided at inner side of the foundation frame.
- The hopper is mounted on foundation frame covering rolling shaft, and permantely fastened at one side using hinged, and other side is temporary fasten for time to time change of semicircular net.
- The chain drive and sprocket are connect pedal operated to crusher portion
- The pedal operated to connect crusher for chain drive.

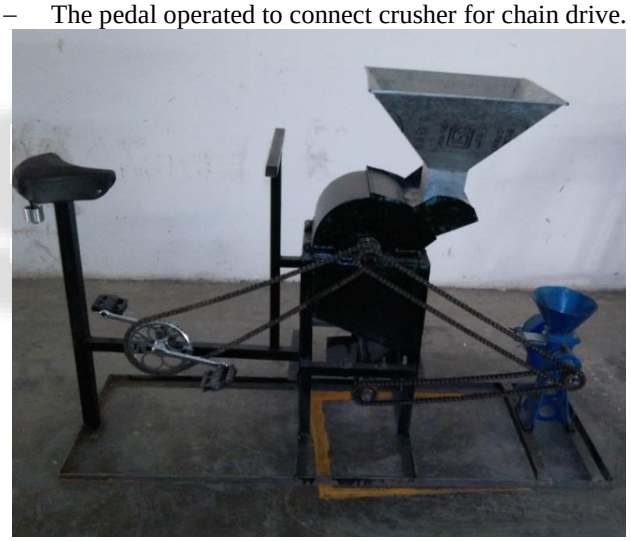

Fig. 2: Pedal operated Groundnut sheller and crusher Machine

IX. TESTING AND RESULTS

Sample is selected according to the research work done in previous chapter. The sample is brought from market (mandi). It is sun dried for one day to remove moisture contend. Sample contains unshelled groundnut and some soil adhered to shell. As we discussed about the working principle and experimental set up of testing Machine in the previous chapter, accordingly research we decide one sample & testing can done five times. After taking reading, calculating total sample reading and this total reading give mean reading. This mean reading help us to calculating result of Sheller machine. As the experimental set up of machine shown in the previous chapter regarding this, the sample reading are tabulated in the following table. In testing table following parameters are mention like, wt. of sample, wt. of shelled nuts and time required to shelled

groundnut. The testing of the system was done and the following results were observed:- Testing Table Sr. No. Total Wt. Of Groundnut In Kg. (Qt) Wt. Of Shelled Groundnut In Kg. (Qs) Wt. Of Undamaged Groundnut Seed In Kg. (Qu) Wt. Of Damage Groundnut Seed In Kg. (Qd) Time To Shelling Operation In Sec. (Tm) 1 1 0.83 0.645 0.185 23 2 1 0.81 0.655 0.155 21 3 1 0.8 0.64 0.16 20 4 1 0.82 0.65 0.17 25 5 1 0.8 0.655 0.145 23 Total 5 6.06 3.245 0.815 112 Mean 1 0.812 0.649 0.163 22.4 From testing we conclude that we can save the time and money, by using groundnut decorticator.

X. CONCLUSION

Proper evaluation of the design will be performed and created something even better instead of simply manually operated operations. Finally we conclude that manually operated machine is better option for consuming electricity. The demands very low cost shelling machine of farmer & other customers will be also considered while designing machine. Purpose of fabrication of the Sheller was to determine the suitability of machine for farmer‟s use. Five experiments were performed with peanuts. Since this machine is made for small businessman or for farmers, therefore the work carried out by this machine is less. The capital required for purchasing the bigger size groundnut decorticator is very high or the cost required for decorticating the groundnut on the job work is also more. In comparison these “Groundnut Sheller” is very cheap. We have selected the “GROUNDNUT SHELLER MACHINE” as our project work. The “GROUNDNUT SHELLER MACHINE” is the ideal equipment for decocting process.

XI. FUTURE SCOPE

Future scope of work is what is required to be delivered. It is importuned that future scope statement is clear unambiguous and easily to understand. It should also include details leaving the reader in no doubt what is being delivered as part of project. The groundnut Sheller, with sufficient market penetration, would offer a substantial in shelling efficiency. Most shelling is done by hand in groundnut producing region of the developing world. This type of task is usually done by woman. The low cost groundnut Sheller is a case of intermediate technology.

1) Shelled nuts are in different sizes. Per kg price of nuts varies according to size of nuts. For fetching premium quality nuts grading system can be attach at nuts outlet of Sheller machine.
2) If we provide the arrangement at the outlet of shells, we can better control the dust.
3) If we provide the arrangement at the outlet of shells, we can better control the dust.
4) In “GROUNDNUT SHELLER” if we connect the gear chain drive so we can operate it with the help of bull instead of motor operated operated.

REFERENCES

[1] A.A. Atiku, N.A. Aviara and M.A. Haque, “performance evaluation of a bambara ground nut Sheller,” Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript PM 04 002.Vol. VI. July, 2004
[2] F.A. Oluwole*, A.T. Abdulrahim, and M.B. Oumarou,“‟ Development and performance evaluation of impact bambara groundnut Sheller“‟
[3] Shelling Equipment for sample of Peanut, by James dickens, Agricultural Engineer U.S. Department of Agricultural
[4] Design for a pedal driven power unit by David Weightman, Lanchester polytechnic, United Kingdom.
[5] ShiwalkarB.D.,“‟Design data for machine elements“‟, 2010 Denett& Company.
[6] Rattan S.S, “‟Theory of machine“‟, edition 2012, S.Chand Publication.
[7] 7) Bhandari V.B., „„Design of machine elements“‟.3rd edition,2010 the Tata McGraw Hill Education Private Limited. J. R. Immer, Material handling, Mcgraw Hill book company pvt.Ltd.,Dec 1953
[8] R. S. Khurmi” and “J. K. Gupta”, Theory of machine by, S Chand and co ltd, 14 edition, Aug. 1, 2005
[9] Hajra Chaudhari S.K. and A.K., Workshop technology, Arnold Publication,1956
[10] Abubakar Mohammed & Abudulkadir B. Hassan, “Design & Evaluation of motorized & manually operated groundnut shelling machine,” international journal of Emerging trends in Engineering development Issue 2, vol.4 (may 2012)

