Design and Development of Corn Chaff Peeling Machine

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ABSTRACT - Since there are more maize peeling techniques in India which are used in our day to day life. The main problems with these techniques are that they are getting more loss in production rate because of using old methods. So now day's farmers are required to use the new techniques to increase the production rate and also reduce the man power. But these machines are not affordable to farmers who are having fewer amounts of farms and which not require these big machines.

Many farmers in India not have lot of money to invest for purchasing the machines because of their cost. So most of the farmers are resort to use hand operated method or old methods which gives low profit, more damage of corn seeds from cob, which is very oasis work. Since inventions is going on machines which reduced the work for farmers and also provided the saving of cost. These machines are automatic operated, fuel consumption. So by sing the relation of man machine system which establish the simple mechanical design.

I. INTRODUCTION

Corn crop is another world's largest resourceful seed crop. The techniques used in old days are removing the leaf by hand or by chopping the corn by wooden rod. In this process the kernels is get damaged and the rate of production get reduced. Thus, the mission for a satisfactory removing of the leaf of corn is important to the small and even small size farmers in the country. Now a day's a few motorized industries, PTO operated machines have come into market but their prices of the machines are not affordable to the farmers. So the low cost designed machines should be developed for removing the corn leafs, which have been help for farmer to get more production.

Sweet corn is an annual with yellow, white, and bi-colored ears. A long, frost-free growing season is necessary after planting. Sweet corn is wind-pollinated, so it should be planted in blocks, rather than in single rows. Early, mid, and late-season varieties extend the harvest. If you miss the optimal harvest time, corn will go downhill fast as sugars convert to starch.

- **Need And Scopes Of Project**

Scope of project for this project includes literature review from the last project and all the results of the last project, engineering material, designing and development of mechanism.

In this project we have considered scrubber and developed screwed shaft arrangement. Also it is portable according to requirement we can able to transport this machine as per required location. In this project we have only taken task to remove the leaf not a corn. Corn Sheller is not in scope of this project work. The screwed guide shaft modification and its development will help for smooth running process and will remove leaf easily and properly.

II. OBJECTIVE

i. To Improve and optimize the present procedure by doing analysis of screw guide ways.

ii. To improve simplicity by selecting the proper shape and size of guide ways.

iii. Minimize the existing blockage of corn due to improper pitch and threads of screwed guide shaft.

iv. To do analysis of various critical components of the machines like shaft & other rotary members.

v. To minimize the customers problem during handling of the corn peeler machine. The main problem they are facing related to guiding of corn on screwed guide shaft.

III. METHODOLOGY

Phase I : Literature Survey

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Phase II : Concept Generation

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Phase III: Design calculations

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Phase IV: Structural Analysis of the Critical Components like shaft & Preparation of Drawings.

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Phase V: Fabrication of modification in the existing machine.

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Phase VI : Trials and Errors Methods testing

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Phase VII : Experimental Investigations of screwed guide shaft

Fig 3. flow chart of methods

IV. MATERIALS AND METHODS

1. List of Parts:

- Shaft with spikes
- Bearings
- Maize discharge spout
- Cob discharge spout
- Structural frame work
- Electric motor
- Pulleys
- V-belts
- Body cover
- Bolts and nuts

2. Principle of operation:

The electric motor provides the primary motion required to power the machine. The motion and torque are transmitted via pulleys, v-belt and bearings to the shaft carrying the spikes

Both the de-cobing spikes and blower impeller rotate in a clockwise direction. The whole maize (together with the cobs) are introduced into the machine through the inlet hopper. They reach the rotating spikes inside the de-cobing barrel by gravity. The spikes give continuous impact force on the whole maize, thereby removing the grains and chaff. Because the spikes are arranged in a spiral form, the whole maize moves along the length of the barrel in the forward direction until they reach the cob exit spout. Before the whole maize reaches this point, almost all the grains (seeds) are removed thereby letting the cob go out of the machine clean.

Due to the impact of the spikes some of the cobs may be broken, though both broken and whole exit through the exit spout. The air generated by the blower impeller is channeled to flow against the maize grain exit spout via a wire mesh. The air blows off unwanted chaff that exit together with the maize grains thereby keeping the maize grains very clean. The clean maize then run into the receiver where they are collected for further processing operations. [1]

V. DESIGN CALCULATION

- **Design Considerations**

When designing our attachment, the following considerations were taken into account

1. The device should be suitable for local manufacturing capabilities.

2. The attachment should employ low-cost materials and manufacturing methods.

3. It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power

4. It should be simple to manufacture, operate, maintain and repair.

5. It should employ locally available materials and skills. Standard steel pieces such as steel plates, iron rods, angle iron, and flat stock that are locally available should be used. Standard tools used in machine shop such as hack saw, files, punches, taps & dies; medium duty welder; drill press; small lathe and milling machine should be adequate to fabricate the parts needed for the machine.

6. Excessive weight should be avoided, as durability is a prime consideration

- **Calculation**

The corn load and machine hollow rollers load = 25 kg = 250N

The screwed dimension or diametric radius = 100mm

Total torque on shaft T = 250 x 50 = 12500N-mm

Speed required in the range 150 to 300rpm.
Considering average speed so, N = 175 rpm
P = 2x 3.14 x175 x 12500 / (60x1000)

P = 228 watt
So we have selected 1 hp motor.

Motor speed = 1440 rpm
Motor supply 230 V single phase

- Drive shaft Design :

Material selection is a step in the process of designing any physical object.

Chemical composition (%) of steel C40 (1.0511): EN 10277-2-2008

S_{ut} = 630N/mm², S_{yt} = 350N/mm²,

T = Max Torque generated to rotating drive shaft.

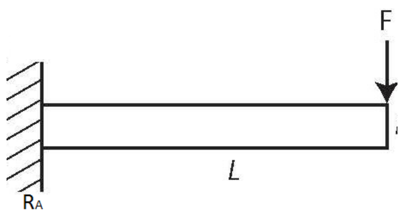


Fig . Drive shaft loading condition.

As per ASME code

The permissible shear stress τ_{max} without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material whichever is minimum. Therefore,

$$\tau_{max} = 0.30 \times S_{yt} = 0.30 \times 350 = 105 N/mm^2$$

$$\tau_{max} = 0.18 \times S_{ut} = 0.18 \times 630 = 113.4\ N/mm^2$$

As the keyways are present, the above values are to be reduced by 25%.

$$Therefore, \tau_{max} = 0.75 \times 105 = \mathbf{78.75 N/mm^2}$$

By using equation drive shaft dia

d = 9.33mm……………..A

Tension in belt drive

T1 = Tension in tight side

T2 = Tension in slack side

We know

P = v (T1 – T2)

$$V = \frac{\pi DN}{60x1000} = \frac{\pi\ x\ 0.125\ x\ 1440}{60x1000}$$

V = 9.42 m/ sec

0.5 x 735 = 9.42 (T1 – T2) …………………(I)

$$\frac{T_1}{T_2} = e^{0.20 \times \frac{140}{180} \times \pi} \quad \text{as assume } \mu = 0.2 \ \&$$

$$\theta = \text{Angule of wrap} = 140^0$$

$$T_1 = 1.7\, T_2 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (II)$$

From I and II

T2 = 55N T1 = 94 N

Total load on pulley = 55 + 94 = 149 say 150N……………..a

Maximum bending moment acting on the input shaft

From eq (a) the tension due to belt is = T = T1+T2 = 150N

$$R_A + R_B = 150$$

Taking moment about moment A,

$$150 \times 100 - R_B \times 1000 = 0$$

$$R_B = 15N$$

$$R_A = 135N$$

Maximum bending moment,

$$\boldsymbol{M_a} = R_b \times 1000 = 1500N - mm$$

we know,

$$M = \frac{\pi}{32} d^3 \sigma$$

6 = 157 N/ mm2 considering factor of safety = 4

By using above equation drive shaft dia d = 4.60mm ……………..B

From equation A and B we have selected the diameter of shaft = 20mm considering extra jerk and for safe design.

According to maximum shear stress theory,

Equivalent Torque :-

$$T_e = \sqrt{(K_b M_A)^2 + (K_t T)^2}$$

From design data book service factor K_b & K_t = 1.

Equivalent bending moment

$$Me = \frac{1}{2}\left[M + \sqrt{(K_b M_A)^2 + (K_t T)^2}\right]$$

Te = 116297 N-mm

Me = 83148 N-mm

we know,

$$T_e = \frac{\pi}{16} d^3 \tau$$

we know,

$$M = \frac{\pi}{32} d^3 \sigma$$

ځ = 73 < 74 N/mm2 and

6 = 105 < 145 N/mm2

By using above equation we have checked the allowable shear stress and allowable bending stress and it is seen that the both values are within limit hence design is safe.

- Bearing selection

For spur gear drive, axial load is negligible.

Hence deep groove ball bearings are suitable for this type of gear box..

Equivalent dynamic load (P)

The bearing is subjected to pure radial load F_r (Reaction at A). therefore,

$$P = F_r = 150N$$

The life of the bearing in million revolutions is calculated as below:

$$L_{10} = \frac{60nL_{10h}}{10^6} = \frac{60 \times 175 \times 15000}{10^6} = 157.5\ million\ rev.$$

Therefore, dynamic load capacity,

p - 3 for ball bearing

$$C = P(L_{10})^{1/p} = 150 \times (157.5)^{1/3} = 796N$$

For a shaft of diameter 20mm Summary [8]

Referred from page no 324 SKF catalogue Single row deep groove ball bearings

- Key Design :

For key design, 30C8 is used [Machine design Data Book by V. B. Bhandari, McGraw Hill Education (India) Private Limited, pp. 2.13]. S_{ut} = 610 N/mm², S_{yt} = 400 N/mm²,

Design of Key used for Pinion and input shaft

Permissible compressive stress

$$S_{yc} = S_{yt} = 400\ \text{N/mm2}$$

$$\sigma_c = \frac{S_{yc}}{fs} = \frac{400}{2} = 200\text{N/mm2}$$

$$\tau = \frac{S_{sy}}{fs} = \frac{200}{2} = 100\text{N/mm2}$$

Key dimensions

$$b = h = \frac{d}{4} = \frac{20}{4} = 5\ mm$$

Shear stress in the key is given by

$$l = \frac{2M_t}{\tau db} = \frac{2 \times 2438}{100 \times 20 \times 5} = 0.5mm$$

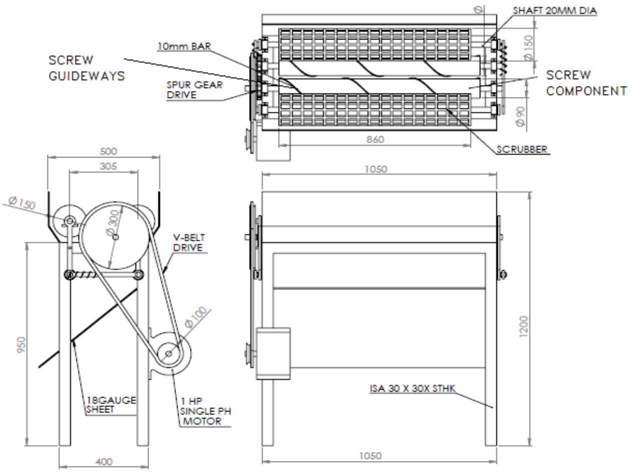
Also, crushing stress in the key is given by

$$l = \frac{4M_t}{\sigma_c dh} = \frac{4 \times 2438}{200 \times 20 \times 5} = 0.5mm$$

The minimum length of the key should be 0.5mm. It is taken as 70mm. [8]

The load on shaft is not more so a section V belt is selected.

- **Conceptual Diagram of corn chaff peeler machine.**

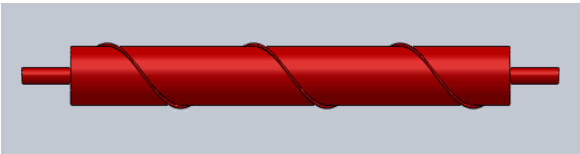


VI. CONSTRUCTIONAL DETAILS

- **Rubber scrubber**

In this part the rubber layer is provided at outside of the its shaft. In which for scrubbing action the rubber has given some irregular size and shapes. The diagram shows the schematic arrangement but there may be some changes will occur during the practical testing of the project

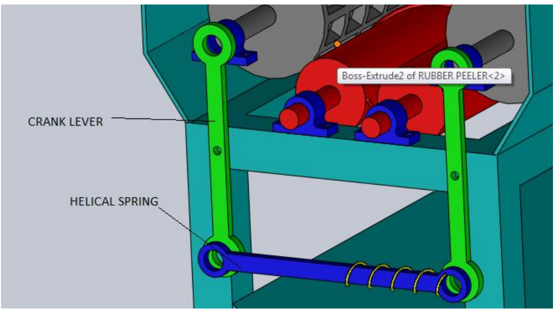
- **Screwed Shaft**



This part is used for to guide the corn and also it gives some forward motion because the solid metal bar is welded outside the shaft as shown in fig. Because of its screwing nature the corn may move forward with rotating motion because of screwed shaft.

The power from motor is received to screwed shaft through Gear and V-belt pulley drive.

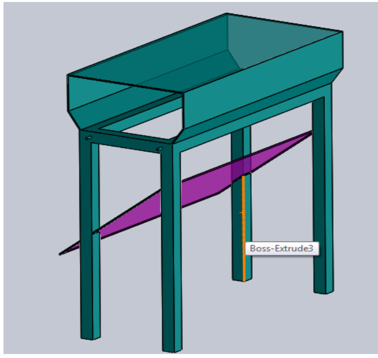
- **Crank lever and spring loading arrangement:-**



This mechanism is developed to apply the continuous compressive load on the scrubber and because of this load the scrubber will press on screwed shaft continuously as shown in figure and because of this advantage or help of compressive load the corn leaf will sandwich in between scrubber and screwed shaft and due to continuous rotary motion the leaf pulled out and separated from the corn.

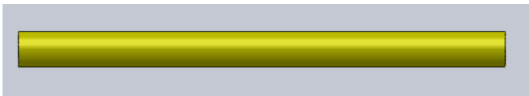
VII. OPERATION SHEET

1. Structural frame.



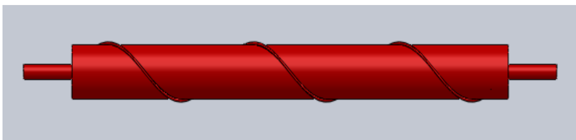
Description of Step	Fixtures or Gauges	Tools and Equipments
1. Cutting of SQ 30 x 30 x 3thk as per drg	Chap saw machine	Measuring tape, 14 inch cutting wheel
2. Sq pipe for control button	Chap saw machine	Measuring tape, 14 inch cutting wheel, Dia 20mm drill
3. Fabrication / welding of structure as per drg	Welding machine	Measuring tape Welding machine, 10 number welding rod

2. Vertical shaft



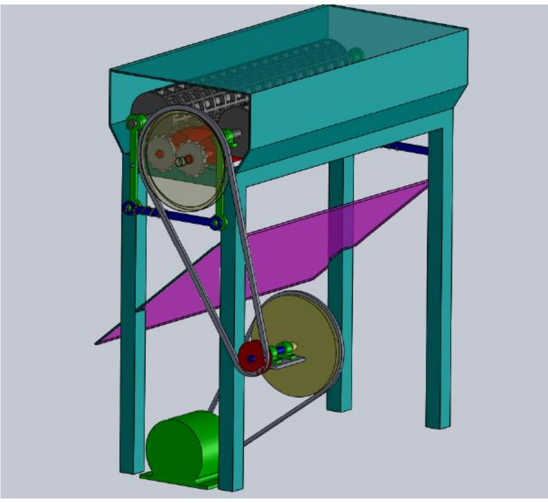
Description of Step	Materials	Safety Equipment
1. Facing of stub shaft	EN8	Safety glasses
2. Turning of shaft with dia 20 mm	EN8	Safety glasses

3. Screwed roller sheet



Description of Step	Fixtures or Gauges	Tools and Equipments
1. Cutting of 80mm dia 3mm thk round pipe	Chap saw machine	Measuring tape, 14 inch cutting wheel, Dia 20mm drill
2. Round bar 10 x 10mm	Chap saw machine	Measuring tape, 14 inch cutting wheel, Dia 20mm drill
3. Fabrication / welding of structure as per drg	Welding machine	Measuring tape Welding machine, 10 number welding rod

3. Assembly and installation of Machine



Description of Step	Fixtures or Gauges	Tools and Equipments
1.Fabrication / welding of structure as per drg	Welding machine	Measuring tape Welding machine, 10 number welding rod
2. Fitment of bearing	Spanner 22 -24 Measuring tape	Measuring tape,

VIII. TESTING OF MACHINE

To test and confirm the working of developed mechanism for corn peeling, we have taken practical demonstration at various small scale industry. Also we have collected the feedbacks and improvements points in developed model.

Testing Report and concluded points:

Lot size considered = 100Kg

Points observed	Existing manual method Manual marking method	New developed method mechanism
1 . Labor requirement Per day	02 LABOUR 02 = Unskilled labor	01 LABOUR 01 Unskilled labor
2. Time required	Totally depends on manual experience	½ hours
3. Space required	NA	Storage space required for machine
4. Electricity required for mechanism or accessories	Not required	Required but 230V single phase
5. Material handling	More than developed mechanism	Material handling is very less
6. Manual effort	More required	Very less required
7. Maintenance	15Rs per person hospitality charges	Maintenance cost considered 10% annually of total cost

- **Pay back period analysis:-**

Payback period is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment positions.

Calculated as:

Payback Period = Cost of Project / Annual Cash Inflows

Initial cost:- 21500 /- with fabrication material and labor cost.

Maintenance cost:- 10 % of initial cost = 21500 x .10 %= 2150 /- Per year

Payback Period = 21500 / 20300

= 1.05 year

So from above analysis it is seen that the pay back period for developed Drilling indexing mechanism is **1.05 year.**

We have designed and developed the mechanism for small scale industry.

Labour Cost:

Labor requirement = 01 numbers

Cost for Unskilled labor = 300 per day

Total cost = 300 x 1 = 300 Rs

Maintenance cost:

10 % of initial cost =2150 Rs per year

Working days considered 100

Per day charges = 21.5 = 22RS

Electricity charges:

15 unit per 100Kg corn

15 x 7 Rs per unit = 105

Labor charges of Production per day:

427 Rs per day

IX. CONCLUSIONS

In this work redesign the components and assembly by considering extreme loading conditions.

Only one operator required for this machine and no need to required skilled operator to operate this machine.

The total saving by this work is 20,300 Rs/yr. The energy consumption is reduced upto 15 units/100kg.

This work is more safe than manual methods, as operator not directly contact with peeling process. Material handling is very less for this work.

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