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Maize Seed Separator

Mrs. Chayadevi VG[1], Prakash Bhattarai[2], Bimal Adhikari[3], Athul Das[4], Anamol Khatri[5]

[1]*Assistant Professor, Mechanical Engineering, Bangalore Technological Institute, Bengaluru, India – 560035*
[2,3,4,5]*UG Student, Mechanical Engineering, Bangalore Technological Institute, Bengaluru, India – 560035*

Abstract: Farmers face a lot of problems in extracting the grains from the crops. Framers need to do all the segregating process manually which is a cumbersome task for them and this also increases the cost of final product. Separating the corn grains is very difficult and time taking process when it has to be done on a large scale. This time consumption can be reduced to a considerably large extent by the use of maize seed separator machine. The machine deseeds the corn in mechanical way thereby reducing the time required. In this machine deseeding of maize/corn grain takes place by impact of chain that is attached to the motor driven shaft. These whole arrangement is enclosed in a cylindrical drum which has openings for hopper at the top, for grain at the bottom and for chaff at the one of its sides.

Keywords: Chaff, Deseed**.**

I. Introduction:

Maize, the American Indian word for maize, means literally that which sustains life. It is, after wheat and rice, the most important cereal grain, providing nutrients for humans and animals and serving as a basic raw material for the production of starch, oil, protein, alcoholic beverages, food sweeteners and more recently fuel. Maize as shown in Fig.1 is one of the most common cereal grain grown in the world. The plant prefers light, medium and heavy soils and requires well drained soil. It cannot grow in the shade and also requires moist soils. The period between planting and harvesting for maize depend upon the variety but in general the crop physiologically matures in 7 to 8 weeks after flowering, at that time kernel contains 35 to 40% moisture and has the maximum content of dry matter. Maize shelling is difficult at moisture content above 25%, with this moisture content, grain stripping efficiency is very poor with high operational energy and causing mechanical damage to the seed. A more efficient shelling is achieved when the grains has been suitably dried up to 13 to 14% moisture content as per Oriaku E C et al.[1].

Fig. 1 maize

Shelling is the removal or separation of maize grain from the cob and it is an operation that follows the harvest. It can be carried out in the field or on the farm by hand or machines. The grain is obtained by shelling, friction or by shaking the products. The difficulty of the operation depends on the varieties grown, the moisture content and the degree of maturity of the crop. Maize is shelled traditionally by hands. This is done in such a way that maize is rubbed against another until the grains are removed from the cob.

Maize seed separator or corn deseeding machine as shown in Fig. 2 is the mechanical device that uses the impact force to deseed the corn. The chain attached to the motor drive shaft applies the impact force on the corn and grains are separated from corn leaving only the chaff. The drum which encloses the shaft has three openings one for hopper, second for seeds outlet and third for chaff removal. As for as cost aspects is concerned, conventional methods of deseeding corn grains are not cost effective as they require many human labours. On the other hand, operating cost of the device is low as it requires only a single person to operate. In present scenario, there are machines for deseeding the corns but they are costlier and hence small scale industries and farmers cannot afford them. To overcome this problem, same purpose machine with minimum cost as far as possible is tried to fabricate.

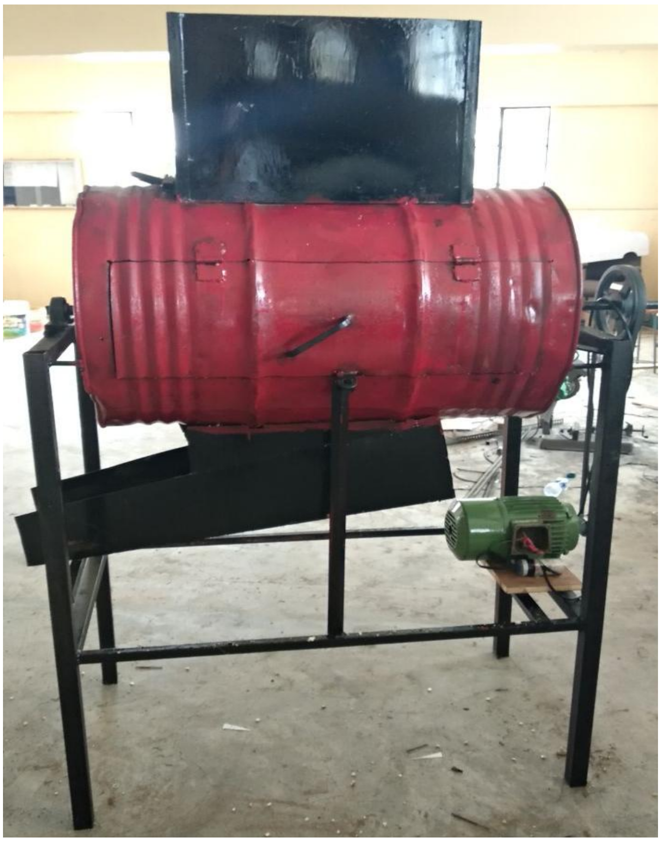

Fig. 2 maize seed separator

II. Objectives

The main objectives of maize seed separator is to separate maize from its Chaff when it is needed on a large scale and also helps to reduce the time consumption of separating maize as compared to older method of separating of maize.

III. Components selection

The maize seed separator consists of following main components:

- Drum,
- Hopper,
- Shaft,
- Chain,
- Belt,
- Pulley,
- Motor,
- Bearing
- Grain collecting system, etc.

3.1 Drum

Drum is the main body of the machine supported by frame which acts as housing component and it houses the chain attached to shaft. It has three holes, one for hopper at the top, another for chaff removal at the side and last one for grain outlet at the bottom. It acts as casing for deseed grains not allowing them to spread out except through grain outlet.It is made up of mild steel and has diameter of 23 inches and length of 35.5 inches.

3.2 Hopper

The hopper is designed to be fed in a vertical position only. The material used for the construction is mild steel sheet metal, which is readily available in the market and relatively affordable. The hopper has the shape of a frustum of a pyramid truncated at the top, with top and bottom having rectangular form.

3.3 Shaft

A shaft is a rotating or stationary member, usually of circular cross-section having certain diameter and length. The shaft of this machine has a chain attached to it (by welding) at 10 cm gap on each. It is supported on bearings. Shaft design consists primarily of the determination of the correct shaft diameter to ensure satisfactory strength and rigidity when the shaft is transmitting power under various operating and loading conditions. Shafts are either solid or hollow. The following presentation is based on shafts of ductile materials and circular cross-section. The length of the shaft has been pre-determined as 1.7 m long with diameter of 25 mm.

3.4 Chain

A chain is a serial assembly of connected pieces, called links, typically made of metal, with an overall character similar to that of a rope in that it is flexible and curved in compression but linear, rigid, and load-bearing in tension as shown in Fig. 3.4 . A chain may consist of two or more links. Here, chain is attached to shaft by welding. The impact force applied by chain to the maize will deseed the grains.

3.5 Belt

A belt provides a convenient means of transferring power from one shaft to another. Belts are frequently necessary to reduce the higher rotational speeds of electric motors to lower values required by mechanical equipment's. The belt driver relies on frictional effects for its efficient operation. When the belt connecting two pulleys is stationary, the tensions in the two portions of the belt are equal but when torque is applied to the driving pulley, one portion of the belt is stretched and the other portion becomes slack. The procedure for selecting a V-belt drive is dependent on the motor horse power and speed (rpm) rating. In this paper v belt is used to transfer power.

3.6 Pulley

A pulley is a simple wooden or metallic machine that uses a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and cable or belt.

3.6.1 Driver Pulley

A driver pulley is a pulley that applies force to the belt, cable, chain, etc. to drive the system it's attached to. A shaft connects the pulley to an engine or motor. A drive pulley drives the system it's attached to. The driving pulley is attached to a source of power like a motor. As the motor runs, it spins the pulley, and the pulley rotates an attached belt. The belt leads tothe driven pulley, which will rotate along with the belt. The speed of rotation depends on the diameters of the pulleys and their positions relative to each other.

3.6.2 Driven Pulley

A driven pulley is a pulley connected to a belt that moves in reaction to a driving pulley powered by a motor or some other energy source. It is a reactive component within a pulley system and is not capable of driving the system on its own. Many types of engines use driven pulleys to accomplish a variety of functions like controlling other components of a system. They can also be used for activities like rigging block and tackle devices for shifting heavy items.

3.7 Motor

Motor is the electrical device that drives the shaft. Single phase AC motor is used which has power rating of 1hp and runs with speed of 1400-1600rpm.

3.8 Bearing:

Bearings are highly engineered, precision-made components that enable machinery to move at extremely high speeds and carry remarkable loads with ease and efficiency. Bearings must be able to offer high precision, reliability and durability, as well as the ability to rotate at high speeds with minimal noise and vibration. Bearings are found in applications ranging from automobiles, airplanes, computers, construction equipment, machine tools.

3.9 Grain Collecting System

A shaped grain collecting system was made and attached with the opening provided in bottom cover for grain after deseeding. A hook on both side of the grain collection point was welded to mount a sack on the vertical collar. The height from ground of this unit at the grain collection point was 400 mm. This unit was mounted at an angle of 250 from horizontal to allow free flow of maize grain.

IV. Design and calculation

The design consideration taken for the fabrication of maize seed separator is shown below:

4.1 DESIGN OF BELT

Length of belt between driving shaft and driven shaft as perDr. C. C. Handa and Anirudha G. Darudkar [2].

d_1=diameter of driven pulley = 8.5inches = 215.9mm **---4.1**

d_2=diameter of driving pulley= 2.75inches = 69.85mm

C=central distance between driving & driven pulley= $d_1/2 + d_2/2 + l$

Larger angle of contact

$\Theta_L = \pi + \{2\sin^{-1}(d_1-d_2)/2C\} * \pi/180$ **---4.2**

Smaller angle of contact

$\Theta_S = \pi - \{2\sin^{-1}(d_1-d_2)/2C\} * \pi/180$ **---4.3**

Length of belt

$L = \{4C^2 - (d_1-d_2)^2\}/2 + (d_1 \square_L + d_2 \square_S)/2.$ **---4.4**

4.2 MOTOR RATING

A single phase motor of 1 hp running at 1450 rpm is chosen based on the load conditions. The motor is prime drive in our machine it converts electrical power in to mechanical power. It gives rotary motion to mechanism. The motor design is very important design aspect in machine design practice. For the device 1 hp motor with 1450rpm is chosen.

To calculate the power

Force required to deseed the corn/chain = 20N

Number of chain used = 11

Total force required to deseed the corn = 11*20 = 220N

The total force can be taken as the centrifugal force offered by chain i.e Centrifugal force (Fc).

Centrifugal force (Fc) = mv^2/r **---4.5**

Where, m = Mass of the chain = 0.254Kg

v = Velocity of chain = $\pi dN/60 = \pi*0.254*2*N/60$

r = Length of chain = 0.254m

$Fc = 0.254*(\pi*0.254*2*N/60)^2/0.254$

$N^2 = 220/(\pi*0.254*2/60)^2 = 238544.52$

N = 489rpm

Diameter of lager pulley (d_1) = 8.5inches

Diameter of smaller pulley (d_2) = 2.75inches

For Pulley, we have

$N_1 d_1 = N_2 d_2$ **---4.6**

Here, N_1 = 489rpm

$N_2 = 8.5*489/2.75$

N_2 = 1512rpm

Again, For belt drive

Torque ratio $T_1/T_2 = e^{\alpha\mu/\sin(\square/2)}$ **---4.7**

But initial torque T_1 = F*r = 220* 8.5*0.0254/2 = 23.749Nm

$T_2 = 23.749/e^{0.3*\pi/\sin(40/2)}$

$T_2 = 23.749/15.72$

T_2 = 1.51Nm

Power required (P) = $2\pi NT/60$

$P = 2*\pi*1512*1.51/60$

P = 239.08Watt

Considering all the losses, we took power P = 450Watt

P = 450/746 = 0.6hp

As the standard motor available is 1hp, hence we used 1hp motor.

4.3 DESIGN OF SHAFT

A solid shaft rotating at 1500 rpm is assumed to be made of mild steel. The shaft here is subjected to both bending moment and torsional stresses. The ultimate shear stress of a mild steel shaft from design data is 265Mpa. The safe load is 300N (Approx 30Kg). The shaft of length 170mm is subjected to bending moment and torsional stresses as perKedar Patil et al. [3].

Maximum Bending moment about bearing

M_b= 300 x 170

M_b= 51000N-mm

And torque

T= (P) x (60) / (2 x π x N)

T= (450 x 60) / (2 x 3.14 x1500)

T= 2.864 N-m

T= 2864 N-mm

The diameter of the shaft on strength basis is given by

$d^3 = \{[16 / (\tau \times \pi)] \times (Mb^2 + T^2)^{0.5}\}$ **---4.8**

where, τ = allowable stress = ultimate stress / (factor of safety * 2)

= 265 / (1.5*2) = 88.33 MPa = 88.33 N/mm^2

Now, $d^3 = \{[16 / (88.33 \times \pi)] \times (51000^2 + 2864^2)^{0.5}\}$

d= 14.33mm

The diameter of shaft taken is 25 mm which is safe.

4.4 DESIGN OF FRAME

Due to the load of the whole part of machine, the frame is subjected to buckling. For buckling in the vertical plane (i.e.in the plane of the links), the links are considered as hinged at the middles and for buckling in a plane perpendicular to the vertical plane, it is considered as fixed at the middle and the both the ends as per Anant J. Ghadi and Arunkumar P [4].

4.5 DESIGN OF BEARING

Depending upon the nature of contact the bearing lies in is contact bearing. Here contact is rolling one. The advantage of bearing here is that it has low starting friction due to this, we also call it an antifriction bearing.

V. Conclusion

A maize separating machine was designed and fabricated in this paper. Result obtained showed that the machine can efficiently deseed the maize grains. The moisture content and speed of shaft determines the efficiency of separating grains. As the moisture content increases and speed of shaft decreases the efficiency of separating grains will decrease. The machine simple to handle and does not require skilled labour to operate. Due to its lower cost than available machines it could address the need of ruler areas' framers. With increase in hopper capacity or using multi hopper the capacity can be increased to upscale the machine capacity for commercial purpose.

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