Design and Fabrication of Mini Saw Cotton Ginning Machine

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Abstract

Cotton from time immemorial has held the highest place amongst the family of fibers - natural or man-made. Owing to the several rich and exceptional properties it has (including comfort and drape), cotton is also known as the King of Fibers and will continue to hold this place for centuries to come. In India large numbers of cotton ginning machines are available such as Saw ginning machine, roller ginning machine, double roller ginning machine etc. but they are of very high cost and large in shape and weight. Our aim is to design and developed a low cost saw cotton ginning machine which will help farmers and small scale entrepreneurs to remove the seeds from the cotton at their home level instead of going to big ginning factory. This paper describes about the design of various components of Mini Cotton Ginning 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. The fresher and small farmer or business man can start business by investing less capital.

Keywords: Cotton, Ginning Machine, Saw Ginning, Design Procedure, Lay Out, Fabrication Parts

I. INTRODUCTION

The sole purpose of this paper is to understand the fundamental knowledge of design and mechanism of machine. The design is an environment friendly and uses simple mechanism properties such as saw ginning system, raw cotton feeding mechanism and automation separating system etc. The design is so done that the knowledge of designing, mechanism and forces are increased. This project consists of designing and fabrication of an automatic saw ginning machine considering various important parameters. In this project, designing & development of a machine to gin the raw cotton into seed free cotton so the farmers and small scale entrepreneurs can gain high profit by selling seed free cotton 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 the different parts of this ginning machine considering forces and ergonomic factor for people to use. After the design has completed, it was transformed to its real product where the design is used for guideline.

II. CONSTRUCTION AND WORKING OF A MINI COTTON GINNING MACHINE

This mini cotton ginning machine consists of following Components

- Raw Cotton Input Hopper: Raw cotton is fed to brush 1 through this hopper.
- Lint Cotton Output Hopper: Seed free cotton achieved through this hopper.
- Roller Saw Ginning shaft (main shaft): Saws are mounted on this shaft.
- Brush1 Shaft: Brush is mounted on this shaft which feed raw cotton through rib.
- Bearings
- Foundation frame
- Pulley (7 Nos.)
- Belt (4 Nos.)
- Brush 2 Shaft

A. Working:

The raw cotton i.e cotton with seed are firstly fed into the machine through input hopper. In input hopper the hard iron wire brush is mounted on the shaft such that the brush will collect the cotton in input hopper and revolve the cotton with itself. The input hopper is a square box also provide with a 6 ribs. Ribs are so spaced that the cannot allow seed though it.

The next to input hopper there is square box consist of a shaft on which saws are mounted which are so adjusted that they are come in contact with the raw cotton in input hopper through ribs. These saws extract the cotton from brush through its teeth and drop it in the square box. The seeds are not allowed because of ribs space and it fall below the brush.

The seed free cotton is then collected through a brush which is mounted on a shft which rotates three times faster than saw shaft and bevel gear assembly is used to maintain brush speed. brush whipped off the lint in the outpt hopper which then collect by user.

The machine is automated with the help of a 1hp motor which drives the saw shaft, brush 1 shaft, brush2 shaft.

B. Design Procedure:

The aim is to give the complete design information about the Mini Cotton Ginning machine. In this, the explanations and some other parameters related to the project are included. With references from various sources as journal, thesis, design data book, literature review has been carried out to collect information related to this project.

The various components to be designed for a machine are as follows:

1) Design of a V-Belt
2) Design of a Ginning Shaft
3) Design of a Bevel Gear
4) Design of a Pulley

All the formulas and necessary values required to designed the above components are taken from Design Data Book.

1) Design of V-Belt:

$$\text{Design Power (Pd)} = PR \times kl$$

Where, PR = rated power, Load Factor, KL = 1.10

Selection of belt on the basis of design power.

Nominal width w, Nominal thickness t, Recommended Diameter D, Centrifugal tension factor KC, Bending stress factor Kb

Peripheral Velocity, $Vp=\pi D1N1 \div 60$

D1 = Diameter of smaller pulley i.e. electric motor shaft pulley, N1 = Speed of electric motor shaft pulley.

If this velocity i.e. VP is in range then, Ok.

Now, assuming Velocity Ratio, VR to calculate speed of driven pulley.

$$N1/N2 = VR$$

By using velocity ratio with neglecting slip,

$\frac{N1}{N2} = \frac{D2}{D1}$

D2 = Diameter of larger pulley Centre to centre distance for V-belt,

$$C = (D1 + D2) \text{ OR } C = D2$$

Angle of lap or contact on smaller pulley, $\theta 1 = \pi - \frac{D2-D1}{C}$

Angle of lap or contact on larger pulley, $\theta 2 = \pi + \frac{D2-D1}{C}$

Since the smaller value of' for the pulley will governs the design.

Belt Tension Ratio,

$$\frac{F1}{F2} = e^{\mu\theta COSEC\alpha/2}$$

α= Groove angle = 34^0

μ= Coefficient of friction = 0.3

F1 = Tension in tight side

F1 = Tension in slack side

Belt Tension, $(F1 - F2) = \frac{Pd}{Vp}$

$$\text{Power Rating Per Belt} = (FW - FC)\frac{e^{\mu\theta/\sin\frac{\alpha}{2}-1}}{e^{\mu\theta/\sin\frac{\alpha}{2}}} \times Vp$$

Working Load, FW

$$\text{Centrifugal Tension, } FC = KC \times \left(\frac{Vp}{5}\right)\text{^2}$$

$$\text{No. of Strands} = \frac{Pd}{POWER/BELT}$$

Length of the Belt,

$$L = \frac{\pi}{2} \times (D1 + D2) + 2C + \frac{(D2-D1)\text{^2}}{4C}$$

Bending Load, $Fb = \frac{Kb}{D}$

Kb = Bending stress factor,

D = Diameter of pulley i.e. smaller or large.

Initial Tension, $2\sqrt{Fi} = \sqrt{F1}+\sqrt{F2}$

Fatigue Life of Belt, $F = Fi + FC + Fbmax$

Since from all the above designing formulas and values we design a V-Belt Drive for Motor to Gear Box , Gear Box to Saw Shaft, Saw shaft to Feeding Brush Shaft.

2) Design of a Ginning Shaft:

Selecting Material as SAE 1030, For which Syt= 296MPa and Facor of Safety = 2

From Maximum Shear Stress Theory

$$\tau max = \frac{Syt}{2FS} = \frac{296}{2\times2} = 74Mpa$$

Now, we have

$$Td = \frac{60\times PR\times Kl}{2\pi N} \quad \ldots\ldots Table\ XI\text{-}1$$

$$Td = \frac{60\times0.746\times10^3\times1.5}{2\pi\times96} \quad \ldots\ldots.Kl\text{-}TXI\text{-}5$$

$$Td = 111.30\times10^3 N\text{-}mm$$

$$Now, \quad \tau max = \frac{16T}{\pi D^3}$$

$$74 = \frac{16\times111.30\times10^3}{\pi D^3}$$

$$D = 19.71\ mm$$

From Table XI-4 Standard Diameter is

$$D = 20mm$$

Similarly calculate the diameter of feeding brush shaft and output brush shaft.

3) Designing of a Bevel Gear:

Assume material Caste Iron for Both Gears

Select No of Teeths on Pinion and Assume velocity ratio VR

$$VR = \frac{tg}{tp}$$

Calculate Pitch diameter and Pitch line velocity

$$Dp = m\times tp \quad and\ Dg = m\times tg$$

$$Vp = \frac{\pi DpNp}{60\times1000}$$

Calculate design power Pd and Tooth Load Ft

$$Pd = Pr\times Kl \ldots\ldots\ldots Kl=1.25$$

$$Ft = Pd / Vp$$

Calculate Beam Strenth

$$Fb = So\times Cv\times b\times Ym\left(\frac{1-b}{L}\right)$$

Assume 20 degree full Involute.

Selecting High Grade Caste Iron for Both Pinion and Gear

So=105Mpa

Assuming Cv=0.5

Cone distance $L=0.5\sqrt{Dg^2 + Dp2}$

As L≥30 b=7m

Put all these values and calculate Fb

Selecting Standard Module m

Equate Fb to Ft

We get module m

Calculate Dp,Dg,Vp,Cv,Ft,Fb

4) Design of Pulley:

LP = 11 mm ; b = 3.3 mm; h = 8.7 mm e = 15 ±0.3;f = 9-12 = 10.5; α= 34;

Min. Pitch Diameter, DP = 75 mm

Types of construction – Web construction for pulley diameter below 150 mm

Types of construction – Arm construction for pulley diameter above 150 mm i.e. for bigger pulleys.

Rim thickness, $t = 0.375\sqrt{D} + 3$ (Heavy Duty Pulley) D = Diameter of pulley

Width of Pulley, W = (n - 1) e + 2f

Where 'n' is no. of belts = 1.

Hub Proportions

Hub diameter, Dh = 1.5 ds + 25 mm

ds = Diameter of shaft = 18 mm

Length of Hub, Lh = 1.5 ds

M= Moment on each Arm

n = no. of arms

Dh = Hub diameter

From all the above formules and parameters we design a proper pulley for a various shafts of mini cotton ginning machine.

C. *Selection of Motor:*

Calculation of power consumption,

- Power P = (2π x N x Ta) / 60
- N = speed of saw shaft in rpm
- Ta = torque required at saw shaft
- Total power required by the machine = (80 + 80 + 90) watt = 250watt.
- Hence, 1 hp motor selected.

III. LAY OUT OF MINI COTTON GINNING MACHINE

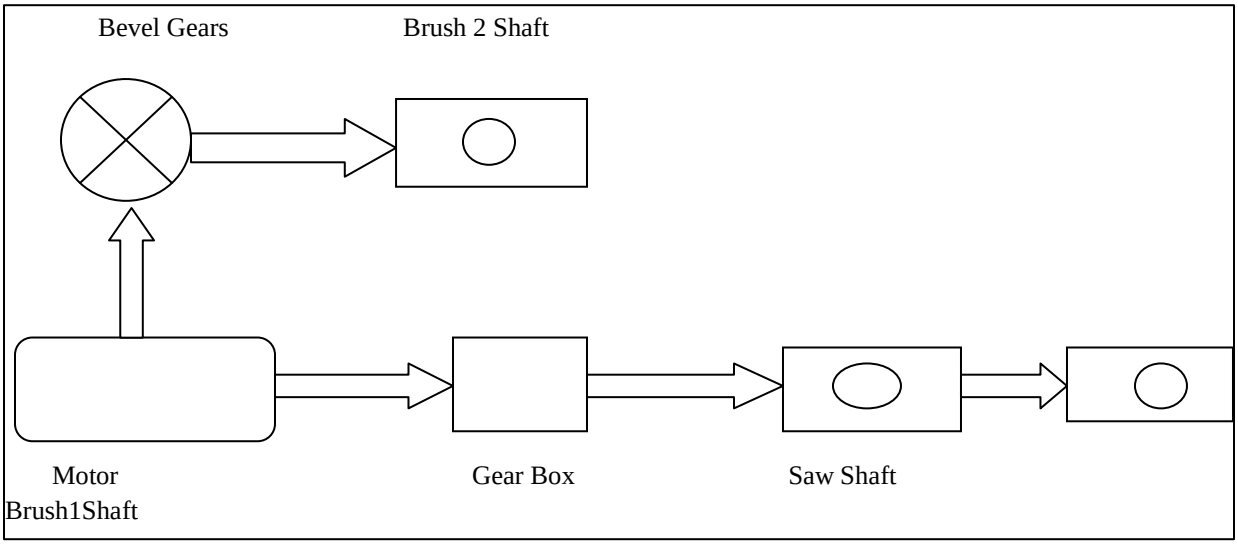

Fig. 1: Lay Out of Cotton Ginning Machine

IV. FABRICATED MODEL OF MINI COTTON GINNING MACHINE

Fig. 2: Fabrication of Mini Cotton Ginning Machine

V. CONCLUSION

The above design procedure is been adopted for the fabrication of Compaqt Size Cotton Ginning machine which will make the product durable for long time as well as make it efficient also helps to understand the concept of design. It can be used for both household and industrial purposes. The advantage to be derived from the use of this machine overcomes its shortcomings. This design gives major advantages in the case of power consumption. The required power for above stated capacity is 1 hp. After all process has been done, Ginning operation may help us to understand the fabrication and designing that involved in this project. Our designed machine is light weight compact and slim in construction. It is easy to operate and transport from here to anywhere.

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