Design and Fabrication of Coconut De-Shelling Machine

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Abstract— India being the 2nd largest producer of coconut, lack in technology of processing industry. Till date there were many techniques involved to peel the coconut. But most of them involved, lead to failure. Even now the basic conventional process is being followed. Most of them are not aware of the importance of processing industry in India. Some projects were designed in recent times but the required target was not achieved. The traditional way of de husking a coconut was manually done. Day today the coconut de-husking remains untold miseries to farmers and coconut vendors due to high labour demand and labour cost. This further reflects on the end cost of the coconut in shops that will be bought by the consumers. Also the manual de-husking involves high risk and consumes more time. To overcome this, there is a need to automate the de-husking process. Over decades many steps were taken to automate the de-husking process but all were in vain due to lack of knowledge and interest, fear for breakage during the process, etc. Now is the time to look into the great scope for the future in the field of agriculture. Our machine will be great boon to the farmers and coconut vendors who always depend on the labours for peeling the coconut.

Key words: Coconut Vendors, Coconut De-Shelling Machine

I. INTRODUCTION

Coconut palm is known as Kalpa Vriksha‟ in Sanskrit, which means the tree that gives all that is necessary for living. Coconut plays an important role in the economic, social and cultural activities of millions of people in our country. India is a major producer of coconut in the world. Coconut provides food, edible oil, industrial oil and health drink to humanity. All parts of coconut tree is useful in one way or other and the crop profoundly influences the socio-economic security of millions of farm families.

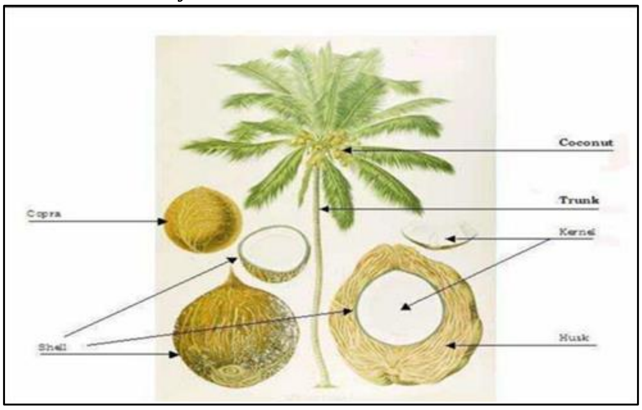

Fig. 1: Coconut

Coconut oil, which comes under edible-industrial group, is used as a cooking oil, hair oil, massage oil and industrial oil. Coconut oil can be blended with diesel, straight in an adapted engine or turned into biodiesel. Amount of coconut oil exported to the world market during 2011 was 2.06 million tonnes (up from 1.10 million tonnes in 1980), of which the European market absorbed about 44.5 per cent and others such as US and Asia Pacific received 23.3 per cent and 24.7 per cent, respectively. In Current scenario the manual de-husking and de-shelling involves risk due to injury and consumes more time to de-husk (peel) the coconut shell and labour fatigue. This leads to less productivity and more labor cost.

II. DESIGN CALCULATION

A. Design of Shaft

P=373 watt N=65 rpm
Ds=65 mm Dc=150 mm

1) Step 1: Selection of Material

From Design Data Book (DOB)
Table 2-7 Properties & uses of typical plain carbon steel
For the application of shaft 1 an selecting is c-30 (SAE 1030) Soft material
Se = 527 Mpa Syt = 296 Mpa
Sys =183 Mpa G = 79 Gpa

2) Step 2: Permissible Shear Stress (Z Max)

According to ASME Code
The permissible shear stress Z max for shaft 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
Zind = 0.3; Syt = 0.3 * 296 = 88.8 N/mm2
Zind = 0.18; Sut = 0.18 * 527 = 94.86 N/mm2
Take (Zind = 88.8 N/mm2)

But the cutter & sprocket are keyed on the shaft therefore according to the ASME code Zind value reduced by 25%
Zmax = 0.75 N/mm2; Zind = 0.75 * 88.8
Zmax = 66.6 N/mm2

3) Step 3: Torque Transmitted (T)

P= 2π N Tmean / 60
7373= 2π * 65 * Tmean / 60
T = 54.78 N-m
As the sprocket and cutter are mounted on same shaft
Ts = Tc = 54.78 N-m
Ts = Fs * Rs → 54.78 = Fs * 0.065 / 2
Fs = 1685.53 N
Tc = Fc * Rc → 54.78 = Fc * 0.15 / 2
Fc = 730.4 N

4) Step 4: Bending Moment (M)

Calculate the resultant bending moment from dig.
Vertical Loading Diagram (VLD)
Vertical Load acts due to only cutter.
Ra + Rb = 730.4 N
Ra = Rb = 730.4/2 (Due to Symmetric Loading)
Ra = Rc = 365.2 N
Vertical Bending Moment Diagram (VBMD)
VBMD = Ra x Ld = 365.2 x 0.16
VBMD = 58.423 Nm
Horizontal Loading Diagram (HLD)
The horizontal load acts due to only sprocket
Fs = 1685.53 N

Ra + Rb = 1685.53 N (1)

Taking moment about point A)

O = 1685.53 * 0.08 – Rb * 0.32
Rb = 1685.53 * 0.08 / 0.32
Rb = 421.38 N
Ra = 1685.53-421.38 from equation 1)
Horizontal Bending Moment Diagram (HBMD)
HBMC = Ra * Lc = 1264.14 * 0.08
HBMC = 101.13 N-m

5) Step 5: Resulting Bending Moment (M)

Select max. Value of BM from the VBMD & HBMD.
Note - Select always the Like BM
We get from diagram
$M = \sqrt{(58.4.32^2 + 101.13^2)}$
M = 116.79 N-m

6) Step 6: Diameter of Shaft (d)

As per ASME Code
Kb = 1.5; Kt = 1 (For gradual Load application)
Te = M + T
Te = √(M2 + T2)
π/16 * Zmax * d3 = √ (M*Kb)2 + (T * Kt)2
π/16 * 66.6 * d3 = √ [(116.79000 * 1.5)2 + (1* 54.78000)2]
D = 24.12 mm
D = 25 mm
So the diameter of shaft is 25mm.

B. Design of Chain Drive

- It is required to design of chain drive to connect 1/2 HP 65 rpm D.C. motoR the speed reduction is 2: 1 the center distance should be approx. 260 mm.
- Select a proper roller chain for the drive.
- Determine the number of chain lines.

Specify the correct center distance between the axes of sprocket

1) Solution

Note: for the design of chain drive. I have taken all the related data from the design book by B.D. shiwalkar and design of machine elements third edition text book by V. B. Bhandari
Given
P = ½ HP = 746/2 = 373 Watt.
N = 65 rpm
I = 2

a) Step 1: Power rating of chain

The number of teeth on the driving sprocket is selected as 17 its fother assume that the chaine is simple roller chain with only one strand

From table 14.3: service factor (Ks 1.3) ______ for moderate shocks
The service factor is taken as 1.3 assuming moderate shocks condition for single strand chain

Multiple strand factor = K1 _________ from
Tooth correction factor = K2 ________from

Power rating of chain = (p*Ks / K1 * K2) = 393 * 1.3 / 1*1 = 484.9 Watt.
Power rating of chain is 484.9 Watt.

b) Step 2: Selection of chain

Referring to table 14.2 the power rating of the chain 10 A at 65 rpm is 0.484 KW therefore the chain no. 10 A selected.

c) Step 3: Number of chain links ___________ (L)

The pitch dimension (p) of the chain
From
Z1 = 17 teeth
Z2 = 17*2 = 34 teeth ______ {Z2 = I * Z1}
P = 15.875 mm
A = 260 mm
(Ln) = 2* (a/p) + (z1+z2)/2+ [(z2-z1)/ 2π]2 * (p/a)
Ln = 2* (260/15.875) + (17+34)/2 + [(34-17) / 2π]2 * 15.875 / 260)
Ln =59 links

III. MECHANICAL COMPONENTS

A. Ball Bearing

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Fig. 2: Ball Bearing

B. Cross Cutter (TCT-Saw Blade)

The main function of sawing is cutting wood to size (cutting to length, trimming, cutting to width) and cutting to shape parallel to and perpendicular to the grain. Circular sawing is used for primary processing and secondary processing of sawn timber. Compared to primary processing, considerably smaller cutting heights are required in the secondary processing of sawn timber. As a very universal method, circular sawing fulfils the following requirements and target parameters to a very large extent during secondary processing:

- High surface quality
- Possibility of small cutting losses through the use of thinner saw-blades
- High dimensional accuracy through the least possible "untrue cutting" by the saw tools Large cutting capacity and from there high feed speeds are possible

1) Advantages

- Relatively inexpensive.
- Virtually any length chain can be obtained (splicing).
- Large selection of chain and sprockets, especially for #80 and smaller chain.
- Positive drive provides synchronization of two shafts (Synchronous belts such as Poly Chain also possess this characteristic).
- Bearing loads are generally lower than for belts (no slack side tension).
- Chain drives are 95¬99% efficient (Poly Chain is 98¬99% efficient).

2) Disadvantages

- Lubrication is critical ¬ unlubricated drives can wear 300 times faster than lubricated drives (difficult to properly re¬lube chain).
- The lubrication attracts dirt which leads to wear problems.
- Life is usually low since an estimated 90¬95% of chain drives are improperly lubricated.
- Frequent maintenance is required due to wear and stretch.
- Necessary lubrication is messy (may be a problem in food/beverage industry).
- Alignment is important as it affects life and stability.
- Chain drives are noisy (proportional to speed) due to metal to metal contact.

C. Chain Drive

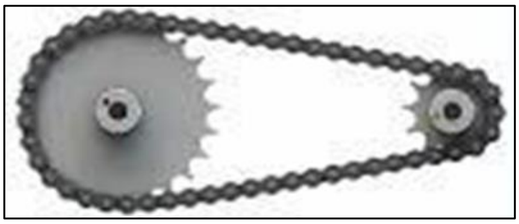

Fig. 3: Chain Drive

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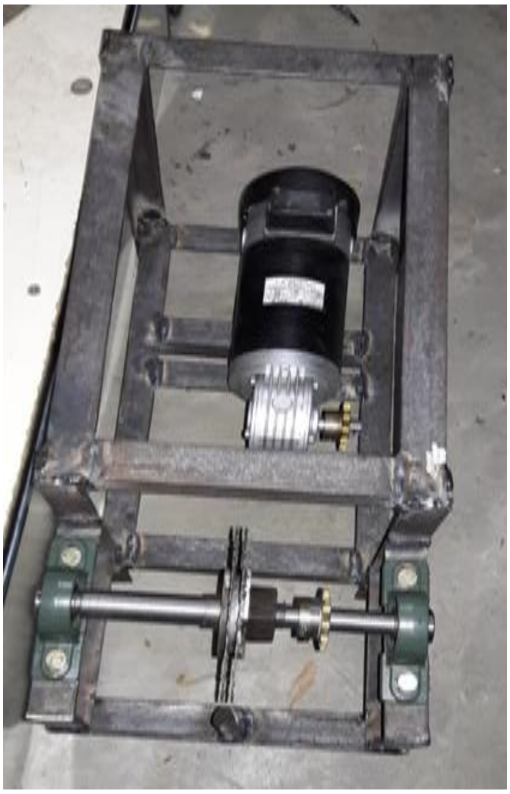

Fig. 4: Actual model of coconut de-shelling machine

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