Design of Multipurpose Grating Machine

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Abstract- A grating machine is for grating the various vegetables and fruits in it. It is an much faster method than the available methods in India. The main target of machine is to perform grating operation for the variety of products but in more safer way. The aim is to produce a machine that can be easily operable by most of the people. The objective of this grating machine is that it could help society in better way by reducing time and by making it safer. This machine is produced to reduce the human effort. Objective of study is to design and fabricate grating machine affordable for small scale industry.

INTRODUCTION

Grated fruits and vegetables are used in varies activities, so it need to be produced. There has been a traditional way of grating fruits using blades or manual grating tool, so it need to be improved as it needs more time and human effort. Using this creative design for the machine the job can be completed in lesser time. It can be use for grating at cheaper rate which can be affordable for maximum people. It is useful for producing more grated powder by selecting number of fruit or vegetables at single time. It can be useful for higher production rate; it consumes much lesser power for grating. These machines have multifunctional capabilities, by changing the type of sieve type of grated product can be change. If there is an requirement of chips of fruits by changing the Type of sieve it can give desired results. In this way by changing the sieves of different pattern desired product can be changed. Hence it can be useful for production purpose; it can be beneficial for small scale production.

LITERATURE REVIEW

There are various methods of grating, which are not useful for variety of materials, also they are time consuming and less safe. The surveying of literature regarding this ecosystem is listed below.

Sajil Raj PR, Anshodh A, Samuel BT Raj, Ahsana AN designed a machine for coconut grating, it is very compact design as comparing with other grating machines but it needs many components for the working and it needs human interaction to move the movers towards coconut, hence it is less safer method for grating.

Dharwa Chaitanya Kirti Kumar (2) developed and designed a multipurpose machine, this machine is powered by human force, and its gear drive runs using human force. Using some attachment it can totally work using electricity.

DESIGN PROCEDURE

The following are the calculations for Design of V-Belt

D1= 101.6mm
D2= 203.2mm
PR= 1HP

1. DESIGN POWER
PD= PR×Kl
PD=0.746×1.1
PD=0.8206 KW

SECTIONS OF BELT
As per suggested range of power we select ‘A’ section belt
Width=w=13mm
Thickness=8mm
Dmin=75mm
Kc=2.52
Kb=17.6×10000

2. DIAMETER OF PULLEYS
D1=101.6mm, D2=203.2mm
As D1>Dmin
Hence design is safe

3. CHECK VELOCITY
\[ V_p = \pi D_1 N_1 \]
\[ V_p = 478.7787 \text{ m/min} \]
\[ V_p = 7.979 \text{ m/sec} \]

Hence \( V_p \) is in range that is 300-1500 m/min
Hence design is safe

4. CENTRE DISTANCE
\[ C = D_1 + D_2 \]
\[ C = 101.6 + 203.2 \]
\[ C = 304.9 = 305 \text{ mm} \]

5. ANGLE OF LAP
\[ \theta_1 = \pi - \frac{D_2 - D_1}{C} \]
\[ \theta_1 = 2.808 \]
\[ \theta_2 = \pi + \frac{D_2 - D_1}{C} \]
\[ \theta_2 = 3.4749 \]

6. COEFFICIENT OF FRICTION
\[ \mu = 0.3 \]

7. BELT TENSION RATIO
Assume \( \alpha = 28 \)
\[ F_1/F_2 = 13.296 \text{ (for } \theta_1 \text{)} \]
\[ F_1/F_2 = 24.58 \text{ (for } \theta_2 \text{)} \]
Select lower value
\[ F_1/F_2 = 13.296 \]

8. POWER RATING PER BELT
\[ = (F_w - F_c)xe^{\mu \theta_1 / 2} \frac{1}{e^{\mu \theta_1 / 2}} x V_p \]
\[ F_c = k_c x (V_p / 5)^2 \]
\[ F_c = 4.617N \]
\[ F_w = w^2 = 169 \]

Power Rating/Belt = 1199.68W

9. NUMBER OF BELT REQUIRED
Number of belt = \( P_d / \text{power rating per belt} \)
\[ = 820.6/1199.68 \]
Number of belt required = 0.684 = 1

10. LENGTH OF BELT
\[ L = \pi / 2 x (D_1 + D_2) + 2C + (D_2 - D_1)^2 / 4C \]
\[ L = 1097 \text{ mm} = 1.097 \text{ m} \]
Assume negligible slip
\[ D_1 N_1 = D_2 N_2 \]
\[ N_2 = 750 \text{ rpm} \]

Following are the calculations for Design of Pulley
1. TYPE OF CONSTRUCTION
Diameter of pulley = \( D_2 = 203.2 \text{ mm} \)
Width of pulley = \( w = 1.1b \)
Width of belt = \( b = 13 \text{ mm} \)

2. DESIGN OF KEY
For shaft diameter, \( ds = 25 \text{ mm} \)
Key crosssection
\[ b = 8 \text{ mm} \]
\[ h = 7 \text{ mm} \]
Length of key = \( L = 18 \text{ to } 90 \text{ mm} \)

3. Design of Hub
Hub Diameter = \( Dh = 1.5ds + 25 \text{ mm} \)
\[ Dh = 62.5 \text{ mm} \]
Length of hub = \( Lh = 1.5ds \)
\[ Lh = 37.5 \text{ mm} \]

Following are the calculations for Design of shaft

PR = 1HP
1. DESIGN POWER
\[ P_d = PR \times K_l \]
\[ P_d = 0.8206\text{KW} \]

2. DESIGN TORQUE
\[ T_d = P_d \times 60 / 2 \pi N_2 \]
\[ T_d = 10.448 \times 10^3 \text{ N-mm} \]

3. Shear stress in shaft
\[ = T_d / Z_p = 5321.227 / ds^3 \]
Assume shaft material as SAEi030
\[ Syt = 296\text{MPa} \]
Assume FOS = 6

4. Permissible shear stress
\[ = 24.667 \text{MPa} \]
Increases shaft diameter by 50% due to bending load
\[ ds = 12.92098 \text{mm} \]
\[ ds = 19.38947 \text{mm} \]
As standard diameter for shaft is 25mm
\[ ds = 25 \text{mm} \]
Moment on each arm= (F1-F2) × (D2-Dh)/Number of arms
M=3.617×10³ N-mm
Bending stress in arm= M/Z
Select elliptical cross section of arm
Assume allowable bending stress in arms
βb=15MPa
As allowable stress= M/Z
h=17mm
Space available on hub=πDh= π×62.5= 196.349mm
Space required for accommodation of 4 arms
=4×h= 4×17= 68mm
Space available > Space required
Arms can be accommodated on hub

5. DESIGN OF RIM
Rim Thickness= t= 0.25× (D2)½+1.5
= 5.0637mm
As C= 1mm in 100mm face width of pulley
As W= 14.3mm
We required c= 0.143mm.

WORKING PROCEDURE

➢ Choose the appropriate size of sieve of desired hole size.
➢ Fix the sieve on cylindrical type drum which is mounted on shaft
➢ Plug the machine, when we switch on the machine the motor at bottom starts rotating and thus the shaft rotates which is connected to motor via pulley and V-Belt
➢ Put the grating material in the hopper, press the grating material against the rotating drum by using wooden rod
➢ Press the grating material till the whole material grates
➢ Grated material is collected in collecting pan
➢ And use it for required purpose

ADVANTAGES

➢ Safer for the operator.
➢ Easy to setup anywhere.
➢ Simple in construction.
➢ Easy to operate.
➢ Useful for multiple fruits and vegetables

CONCLUSION

While designing a machine cost is an major issue to deal and this machine can come over it, this multipurpose grating machine have safer design, it consumes less time and it is really cost effective. It can grate fruits and vegetables in very short time and produced quality is also very good. While manufacturing the machine the components are easily available and the machine does not need any special component. As of design it can be easily manufactured within less time period and thus due to low cost it can be beneficial for the consumers. There is no specialized skill required to run the machine. It can be very useful for those who want to start an startup within limited budget.

REFERENCES

[7] A design databook by B.D. SHIWALKAR