Design And Fabrication of Spices Powdering Machine (SPM)

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Abstract
It is well known that small scale industries are growing day by day in India. Homemade spices making industries is one of them, so survey was made and observed that workers are manually powdering the spices by hand like turmeric, chilli etc. It had leads to problems like back, hand and shoulder pain to workers. To overcome all these kinds of problems, this further reduces man hours spent on actual production. It was decided to design and fabricate a small portable electric motor operated handed by single person. Such machine will support small scale cottage industries and reduce pains of workers and improve their health and thus increase productivity of industry. Such machines developed will reduces human efforts, increase rate of production and can work for 24 hours continuously. The major components of proposed machine are metallic frame, electric motor, power transmission belt, pulley, shaft, cam and bowl for powder. A completely new mechanism is formed which consist of three bar mechanism with two movable links with line contact and higher pair. The capacity of machine is 2 Kg/ Hr. Red chillies, Coriander, Cumin seeds, Fenugreek, Black pepper were powdered.

1. Introduction

Most of the machines which exist have the mechanism of rotary motion, hence complicated components are required.
Most of the machines are available in market having initial cost higher which is around 50,000 ₹ as a starting price. The machines are not portable and require large area. The machines require skilled person with proper technical knowledge. These machines consume more power. The following table 1shows comparison of existing machine & spices powdering machine.

Sr.No	EXISTING MACHINE	SPICES POWDERING MACHINE(SPM)
1.	All the machines available in market are in rotary type	The machine we design is a reciprocating type
2.	Initial cost of existing machine are very expensive and maintenance cost is also high	This machine having low initial cost and the maintenance cost is very low
3.	The existing machines are required large area for installation	This machine is required very small area for the installation
4.	The power required to run the existing machine is high	The power required for this machine is very low as compared to existing machine
5.	Complicated mechanism	Simple mechanism
6.	Skilled operator required	No skilled operator required
7.	Requires maintenance on daily basis	No maintenance required on daily basis

Table 1 Comparison between existing & spices powdering machine

2. Mechanism

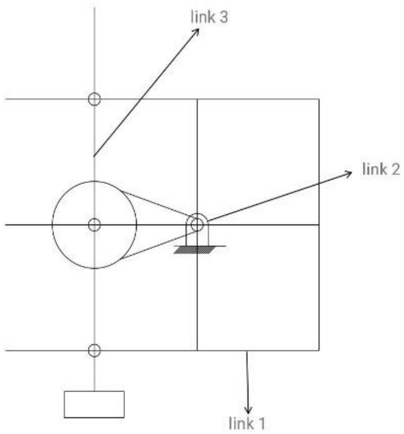


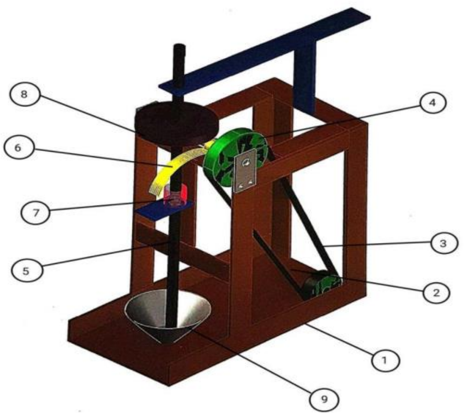
Figure 1 Line diagram of SPM

The figure 1 shows the systematic diagram of the completely new formed mechanism.. It consists of three links . Link 1 is a rigid frame, link 2 is a oscillating cam and link 3 is a hammering shaft. When the oscillating arm (link 2) starts oscillating it impacts the load on hammering shaft (link 3), the reciprocating motion is obtained. The contact between the link 2 (oscillating cam) and link 3 (hammering shaft) is line contact, which is a higher pair and that's the differentiating part of the project form, a completely new mechanism.

3.Design of components of machine

The various components of machine which are to be designed are disc, power, rotating shaft, pulley , belt, bowl, hammering rod

3D Drawing And Labelling Of Machine (AUTOCAD):



Sr No.	Name Of Part	Quantity Of Part
1	Metallic frame	1
2	Motor	1
3	Transmission belt	1
4	Pulley	2
5	Hammering shaft	1
6	Cam	1
7	Spring	1
8	Disc	1
9	Bowl	1

The Proposed Design are as follows,

1) Design of Disc

The yield strength of chromium nickel molybdenum steel is 670 N/ mm2. After applying factor of safety The allowable Stress is

Given data ⇒ P= 49.05 N
D= 300 mm
The disc is failed due to bending

$\sigma b = My/ I$

where
σb = bending stress
M =moment (bending)
y= vertical distance
I= moment of inertia

M = F x distance
M = 49.05 x 20
M = 981 N.mm

$I = \pi D^4 / 64$
$I = \pi \times 300^4 / 64$
$I = 397.60 \times 10^6\ mm^4$

Now,
$\sigma_b = 9.81 \times 150 / (397.60 + 10)$
$\sigma_b = 3.7 \times 10^{-4}\ N/mm^2$ or
$\sigma_b = 0.00037\ N/mm^2$
$\sigma_b < \sigma_{allow}$

Hence, design is safe.

2) Design Of Power

Required Design Of power required to lift the 5 kg.
we know, power = Force X velocity and
Force = weight = mass x acceleration due to gravity
g = 9.81 m/s^2(we assume g= 9.81 m / s2)

let we say
we have to lift 5kg of weight of velocity of 2m

P = F x V P = 5 x 9.81 x v
P = 49-05 x v P = 49.05 x 2 (v = 2 m/s)
P= 0-0981 KW (1 KW = 1000 watt)

so, 0.0981 kW power is required to lift the load of 5 kg.

3) Design Of Rotating Shaft

From the design data prop. B.D. shiwalkar page no. 41 The shaft is made up of chromium nickel molybdenum steel having yield strength 670

N/mm2 & due to F.O.S The allowable stress is 335 N/mm2.

The given data

P= 0.1 kN N=π rpm τ = 335 N/ mm^2
W_1 = 10 N W_2= 10 N
Now, we have to find the reaction
RA -10-10 + RB = 0 RA+ RB= 20 KN………1
Taking moment about A
RB= 10 put in equation 1
we get, RA= 10KN RB= 10 KN

The shaft is subjected to twisting &bending moment

Mc = 10 x10^3 N.mm
Now, P= 2πNT / 60 0.1= 2πx 17 xT/ 60

T= 0.056 N/m T= 0-56 x10^3 N/ mm

Now equivalent torque
Teq = (T2 + Mc2 $)^{1/2}$Teq = [(0-056 x $10^3)^2$ + (10 x10^2 $)^2]^{1/2}$
Teq = 10 x10^3 N/mm Teq =π/ 16 x D3 x τ
D 3 = 10×10^3 x 16 / (π x τ) D 3 =10×10^3 x 16 / (π x 335)
D 3 = 152.02
D =36.98 ~ 37 mm

For soaring shaft which is subjected to twisting &bending moment
D = 37 mm diameter of 37 mm have to be chosen for safe design.

4) Design Of Pulley
let we consider
D1 = diameter of driving pulley = 200 mm
D2= diameter of driven pulley = 600 mm
Above value taken from Prop. B.D. shiwakar Book page no. 163
N1= speed of driving pulley = 50 rpm (we assume this value)

Now, let find the speed of driven pulley
N1 / N2= D2 / D1 50 / N2 = 600/200
N2=10 rpm
Now, let find the velocity of driving pulley V 1 =π x D1x N1/60
V_1 =πx 200× 50/60

V_1 = 523.59 m/s

Now,
let find the velocity of driven Pulley
V2= π x D2 x N2/60
V2 ==πx600 x 10.68/ 60
V2 = 524 mIs velocity ratio = N1/N2 = 50/16.68 =3

5) Design Of Belt

Thickness of belt B= 1.33 X d.
[width of pulley is 1.33 of width of diameter from design data book by B.D. Shiwalkar, page no. 173]

B= 1.33 X 200 B= 266 mm

6) Design Of Bowl

α= 200 mm
surface area of bowl
A= $2\pi r^2$
A=2πx 100^2
A = 62.83 x 10^2 mm^2

Total surface area =$3\pi r^2$ =3πx 100^2 = 94.24 x10^3 mm^2

volume of bowl
V= ⅔ πr3 =⅔ πx 100^3

Ultimate compressive strength of cast iron is 4.27×103 N/mm^2
& allowable stress is 2.435 X103 N/mm^2
while applying FOS =2 (From design data book B.D. shiwalker)

The bowl in fail due to Compression
σc = P /(π/ 4 x d^2)
σc= 49.05 /(π/ 4 x 100^2)
σc=1.56 x 10^3
σc=0.00156 N/ mm^2

since $\sigma_c < \sigma_{allow}$
the design is safe.

7) Design of Hammering Rod
Design of hammering rod of yield strength of chromium nickel molybdenum in 670 N/ mm2 from B.D. shiwalker design data book page no. 41 & after

applying the FOS 2 the safe yield stress is
σ allowable stress = σ yt / F.O.S.
σas = 670/2
σas = 335 N /mm2

Now given data
P= 5 kg = 5×9.81 = 49.05 N
d= 50 mm (we check& consider whether the design is safe or not while considering d=50 mm)

The hammering rod fail due to compression
$\sigma c = P / (\pi/ 4 X d^2)$
$\sigma c= 49.05 /\pi/ 4 x 50^2$
σc = 0.0249 N /mm 2 since.
σc < σas Hence design is safe.

3.Working

SPM has following parts.
1) Metallic Frame 2) Motor 3) Belt 4) Pulley 5) Cam 6) Disc7) Spring 8) Bowl
When the power supply is given to the motor, the driving pulley which is mounted on the rotating shaft of the motor starts rotating at a speed of 1440 rpm. This power is transmitted to the rotating shaft which is slotted in the frame. Now when the rotating shaft starts rotating, the can which is welded on other side of rotating shaft also starts rotating and impacts the load on the disc, which is mounted on the hammering shaft. Due to impact loading of cam, the hammering shaft starts reciprocating inside the region of frame. Due to this reciprocating Action of hammering shaft, powdering operation gets completed. The powdered spices get collected into the bowl.

4.Fabrication
Following steps are carried out in order to fabricate the spices powdering machine.

1. Frame:
The frame is rigid structure which holds the machine components. The hole is made on the frame in order to insert the rotating shaft. The size of frame is 633 mm length, 479 mm breath and 658 mm height. the hole is made of diameter 25 mm from bottom height 630 mm. The frame is made up of MS material because of high strength, ductility and malleability properties.

2. Pulley:

The selected pulley has,
1) driven pulley = 180 mm
2) driving pulley= 60 mm
3) pulley ratio = 3:1
4) driving pulley speed = 1440 rpm

3. Rotating shaft :

The rotating shaft made up MS material whose length is 608 mm and diameter is 20mm which is inserted inside the hole of 25 mm diameter in the frame.

4. Hammering shaft:
The hammering shaft made up of cast iron whose length is 1112 mm and diameter is 35mm. The shaft is kept vertical to the frame in order to obtained powdering operation.

5. Disc: The disc is made up of MS material whose diameter is 300mm and fixed permanently on the hammering shaft through welding. The cam impacts the load on disc in order to obtained powdering operation.

Brief description of fabrication:
The frame is made in quadrilateral shape by using the angles through welding(arc) the Height 658 mm, breath 479 mm and length of frame is 633 mm. The hole is made of diameter 25mm in the frame at a height of 630 mm from the bottom of the frame. In order to insert the rotating shaft whose length is 608 mm and diameter is 20mm. The hammering shaft is kept vertically in order to obtained powdering operation. The shaft is made up of C.I material whose length is 1112 mm and diameter is 35mm.The disk of 300mm diameter is made up of MS material and fixed on the hammering shaft by means of welding. The cam which is made up of C.I material is welded on rotating shaft which impacts the load on the disc which helps to carry out the powdering operation.

5.Performance and testing

In order to evaluate the performance of spices powdering machine (SPM) following tests is carried out.

SR. NO.	NAME OF SPICES	QUANTITY	DURATION	REMARK
1	Red Chilli	1 Kg	30 min	✓
2	Coriender	1 Kg	25 min	✓
3	Cumin Seeds	1 Kg	20 min	✓
4	Fenugreek	1 Kg	20 min	✓
5	Black Paper	1 Kg	20 min	✓

Above spices were tested in a room which gives result successfully and fulfill the criteria. The optimization was continued till achieving the best one. This spices powdering machine(SPM) definitely change the era of spices powdering.

6.Cost analysis

The cost of SPM calculated on the basis of cost of materials available in market,
The total weight of spices powdering machine (SPM) including motor (60 kg). The frame of the SPM is made up of Mild Steel because of high strength, malleability and ductility property.

• The weight of the SPM = 60 Kg
• The Weight of the frame = total weight of machine -motor weight =60 -10 =50 Kg
• 1 Kg of mild steel =70 ₹
• The total cost of frame = total weight of mild steel of SPM ×per Kg of mild steel = 50×70 = 3,500₹
• Cost of Pulley (driven & driving) = 600 ₹
• Cost of belt = 200 ₹
• Cost of Container = 300 ₹
• Cost of single phase electric motor (0.5 HP) = 2,500 ₹
• Cost of Painting = 150 ₹
• Total Cost = Material Cost + Manufacturing Cost
• Cost of Material = 3,500 ₹
• Manufacturing Cost = 50 % of Material Cost = Material Cost / 2 = 3,500/2 = 1,750 ₹
• Total Cost = Material Cost + Manufacturing Cost + Cost of pulley + Cost of Belt + Cost of Motor + Cost of container + Cost of Painting = 3,500 + 1,750 + 600 + 200 + 2,500 + 300 + 150

Total Cost = 9,000 ₹

7.Result and Conclusion

1. The design of eco-friendly spices powdering machine can be used in small scale industry as well as for household purpose. As a simple mechanism is selected it consumes less power.
2. From the research it can be concluded that when the power supply is given to the motor, the driving pulley which is mounted on the rotating shaft of the motor starts rotating at a speed of 1440 rpm.
3. The powdering machine is safe, cheaper and efficient than another machine.
3. The powdering machine is easy to handle for one worker . It works very efficiently with respect to covering area& is very economical to use. It can provide job to uneducated person who is need such a job.
4. A completely new mechanism is formed. It consists of three bar mechanism with two movable links having higher pair.
5. The cost of mild steel required for fabrication of SPM is 9000₹. The capacity of machine is 2 Kg/Hr.

8.References

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