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Design And Analysis Of Connecting And Clamping Link Of Kismis (Raisins) Sorting Machine

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Abstract - *Raisin's production is one of the leading agriculture industry but due to poor quality of raisins prices goes down and also it hamper the Indian raisins quality in global market. Poor quality of raisins due to the mixing of lower grade into higher grade, some impurities, moisture control not proper and its due to not properly sorting grades of raisins. The ability to sort raisins automatically is more efficient compared to the manual inspection which is slow, labour intensive, tedious and error prone. For that automatic, manual & S/W controlled raisins sorting machines available in market. In most of the cases sorting of right size of raisins has problem due to issues like wrong springs or over & not proper vibration due to wrong selection of vibration motor. One of the reason is linkages also. Lots of research's have already been done to address issues & improve performance. And most the vibratory feeder research papers had addressed the performance issues with help of computer vision approach. In this paper, will check vibration calculations and check also selection of vibration motor.*

Key Words: **Raisin sorting, Grading of raisin, production & quality of raisin vibration system motor**

1.INTRODUCTION

Raisins need processing like cleaning, removal of debris and grading into various sizes. Grading of raisins involves sorting raisins by size. Conventionally, this is done manually by women who worked for minimum wages. The grading has been done by them based on visual inspection and which is labor intensive, tedious and error prone. Now a day's manual to automatic sorting machines developed for this purpose called raisin grading machine and in most of the developed machine's sorting happen by vibrating the sieves. Vibrating sieves are common in food industries sorting equipment but most critical part in that is vibrating motor and good quality of sieves as per grade sizes for raisins its 9mm, 7mm & 5mm wire meshes. Combination of feeding and sorting of raisins machine consists of three motors, feeder, three sieves, blower, and belt and pulley mechanism. In this machine first raisins are fed through a feeder, which has a rotor with a rubber pad. A motor drives the mechanism. The rubber pad hammers the raisins to remove the twigs of raisins. These raisins are then passed through the blower, which blows the dust and twigs and cleans the raisins with the help of a high-pressure airflow. The raisins are further graded according to size with the help of vibratory sieves with different wire meshing (9 mm, 7 mm and 5 mm). Motion to vibratory sieve is given through a pulley-belt drive. The raisins separated and graded over each sieve are collected in a different chamber. So in existing machine vibration in sieve not proper its reduces the efficiency of machine i.e. it has less mass flow rate of raisin as expected from end user.

1.1 Construction

I studied various sorting machines available in market, also studied machines available from global manufacturer mainly China manufactured machines have cheaper due to local manufacture use of vibrator motor. Sorting machine which mainly contain sieves with vibration motor .

Fig -1: Existing Sorting Platform

Combination of feeding and sorting of raisins machine consists of three motors, feeder, three sieves, blower, and belt and pulley mechanism. Figure-1 shows the typical layout or construction of sorting platform of existing used machine. A 2 HP motor drives the vibrating sieve. Motion to vibratory sieve is given by connecting rod which is eccentrically connected to the motor shaft. Vibrating motion of sieve is guided by the connecting rod which is hinged to the foundation.

2. Calculations

2.1 Calculation for Transport Velocity of Raisin over the Vibrating Sieve:

Mass Flow rate required = 3 to 3.5 tonnes per hour

Density of raisin = 1200 kg/m^3

Length of vibrating sieve = 2.9m

Width of vibrating sieve = 0.6m

Now for sizer the raisin by size, each of raisins should come in contact with vibrating sieve.
Therefore, Average thickness of raisin layer over sieve (t) = average thickness of single raisin = 0.005m
Where,
m=ρ × Q
m = mass flow rate of raisin over the vibrating sieve in kg/s
Q = discharge of raisin from the vibrating sieve in m^3/s
ρ = density of raisin in kg/m^3

$$\frac{3.5 \times 1000}{3600} = Q \times 1200$$

$$Q = 8.1 \times 10^{-4}\ m^3/s$$

Q = A×V
Where,
Q = discharge of raisin from the vibrating sieve in m^3/s
A = cross-sectional area of raisin layer on sieve in m^2
V = transport velocity of raisin over the vibrating sieve in m/s
8.1 × 10-4 = 0.6 × 0.005 × V
V = 0.27 m/s

2.2 Calculation for Amplitude of Vibration

Average transport velocity of solid along the trough is given by

V= η × (2Πn/60) × A × cosβ × K1 × K2 × K3 × K4 …eqn.(1)
Where,
V = average transport velocity of solid along trough in m/s
n = speed of motor in rpm
A = amplitude of vibration in mm
K1 = material factor
K2 = factor to consider the effect of depth of bed of bulk
K3 = factor to take into account the amount of fines in the bulk material
K4 = factor to consider effect of slope of the trough on the average flow velocity
η = efficiency of transport
β = throw angle in degrees

Selection of β , η , K1 , K2 , K3, and K4

The usual range of throw angle β, adopted for vibratory conveyor is 200 to 550 For this system, β = 250 is assumed

Figure 2 shows graph of efficiency of transport against μtanβ

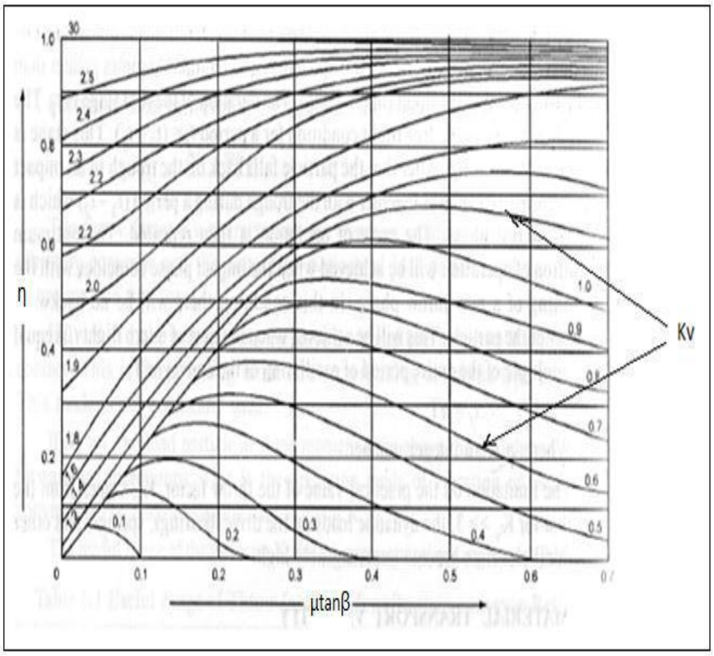

Fig – 2: Graph of Efficiency of Transport against μtanβ

For this system,
β = 250 and μ = Co-efficient of friction between raisin and sieve = 0.1 (assumed)
μtanβ = 0.05
For most of conveyor's value of throw factor (Kv) lies between 1.5 to 3 From Figure 2,
η = 0.85
K1 is the material factor which is to be determined by experimentation and may vary from 0.85 to 1.1.
For this system, assume K1 = 0.85 (assumed)

Figure 3 shows graph of K2 against bed depth. K2 is the factor to consider the effect of depth of bed of bulk material on trough. The value of this factor varies from unity for small depth to 0.7 for 300 mm depth of bed.

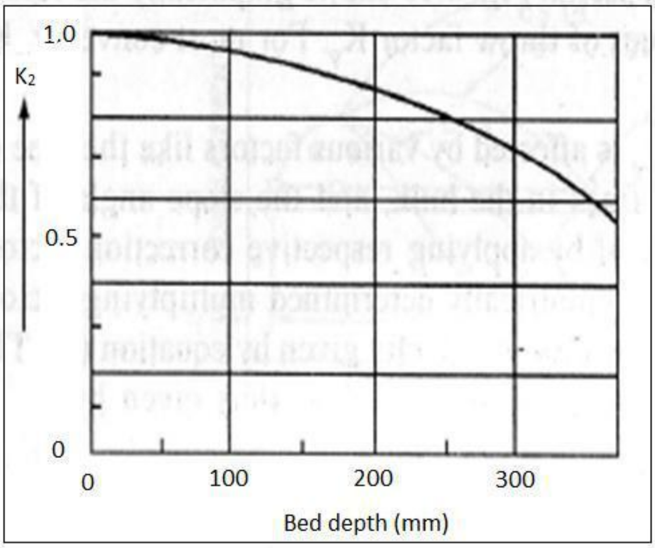

Fig – 3: Graph of K2 against Bed Depth

For this system, bed depth is 5 mm and therefore from graph value of k2 = 0.95

Figure 4 shows graph of K3 against percent minus 50 mesh. K3 is the factor to take into account the amount of fines particles in the bulk material. If the bulk material contains 20% of fine particles less than 0.3 mm (50 mesh), the factor is 0.85. If the bulk contains 60 % fine particles less than 0.3 mm, the factor is 0.4.

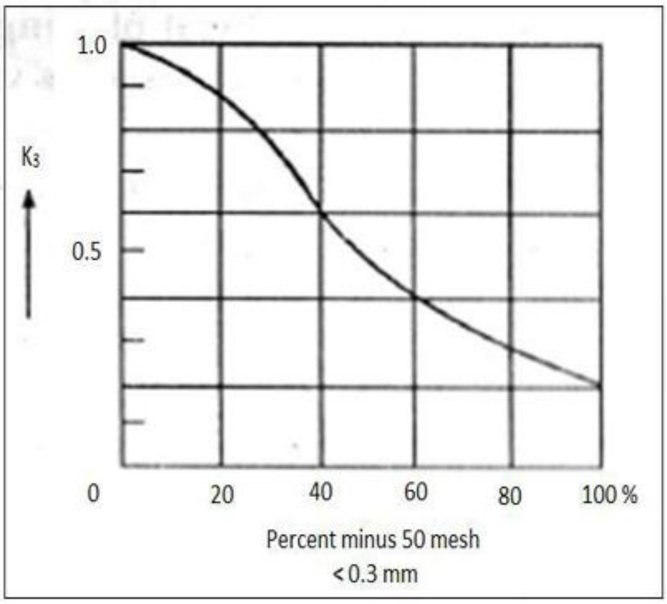

Fig – 4: Graph of K3 against Percent Minus 50 Mesh

For this system particles are raisins with thickness greater than 0.3 mm hence value of k3 is 1.

Figure 5 shows graph of K4 against slope angle. K4 is the factor to consider the effect of slope of the trough on the average flow velocity. The value is unity for horizontal conveying for upward conveying slope of about 100, the value of K4 is 0.6. The value decreases rapidly for steeper slope.

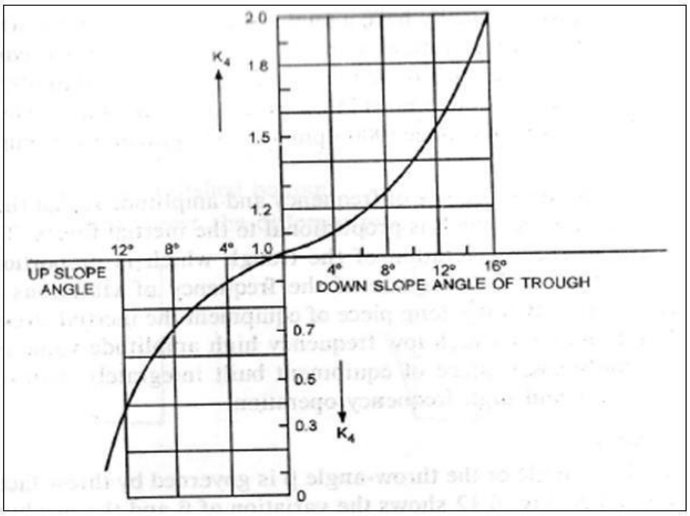

Fig – 5: Graph of K4 against Slope Angle

For this system, sieve is horizontal and hence,
K4= 1,
Now, for system of vibrating sieve,
K1 = 0.85, K2 = 0.95, K3 = 1, K4 = 1, = 0.85, n = 1440,

$\beta = 25^{\circ}$ Substituting all these values in eqn. (1),

0.27 =0.85 × (2Π×1440/ 60)× A × cos25 × 0.85 × 0.95 ×1×1
A = 2.9 mm

2.3 Calculation for Unbalance Force

$$A = \frac{\frac{m_0 e\omega^2}{k}}{\sqrt{\left\{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left[\left(2\zeta\frac{\omega}{\omega_n}\right)^2\right]\right\}}}$$

Where,
A = amplitude of vibration in meter
m_0 unbalance mass in Kg
e = eccentricity of unbalance mass in meter
M = mass of total system in Kg

$$\frac{A}{\frac{m_0 e}{M}} = \frac{\left(\frac{\omega}{\omega_n}\right)^2}{\sqrt{\left\{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left[\left(2\zeta\frac{\omega}{\omega_n}\right)^2\right]\right\}}}$$

Figure 6 shows Frequency Response of system subjected to centrifugal force type excitation. In this figure it has been shown that magnification factor becomes unity when frequency ratio is greater than 4

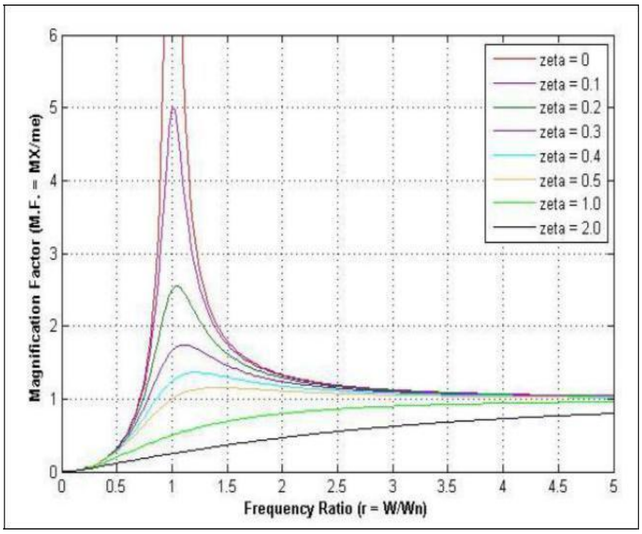

Fig – 6: Frequency Response of System Subjected to Centrifugal Force Type Excitation

Figure 7 shows phase response of system subjected to centrifugal Force type excitation. For our system frequency ratio is greater than 4 so phase angle should be greater than 120°

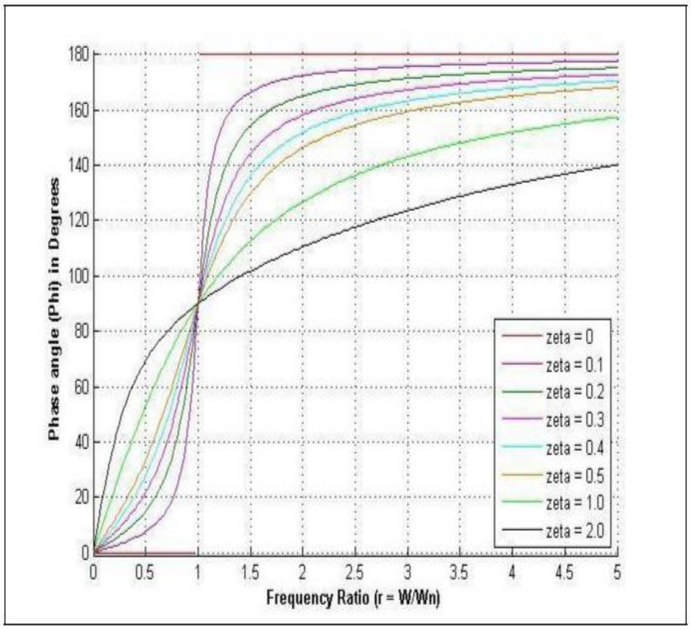

Fig -7: Phase Response of System Subjected to Centrifugal Force Type Excitation

Here, N= 1440 rpm so this is high speed machine
For high-speed machine,

$$\frac{A}{\frac{m_0 . e}{M}} = 1$$

Where,
A = amplitude of vibration in meter
m_0= unbalance mass in Kg
e = eccentricity of unbalance mass in meter
M = mass of total system in Kg

$$A = \frac{m_0 . e}{M}$$

$m_0 . e = A. M$ .....eqn.(2)

M Mass of total system is given by,
M = Mass of Vibrating sieve + mass of raisins on sieve
M = 174 + ρ.V

Where,
ρ = density of raisin in kg/m3
V = total volume of raisin over vibrating sieve in m3
Now, M = 174 + 1200 × 2.9 × 0.6 × 0.005 = 183 Kg
Substituting this value in eqn. (2),
= 2.9 × 10-3 × 183
= 0.531 Kg-m
Unbalance force required

$= 0.531 \times (2.\pi.1440/60)^2$
=12076 N

3. Selection of Vibration Motor

In this raisin grading machine when raisin and debris comes out from feeder it spreads all over width of sieve. So it is required to give only forward motion to them. For that purpose sieve should vibrate along its length and movement along its width is completely restricted. To restrict movement of sieve along its width, two motors should be selected which will rotate in opposite direction in order to balance horizontal component of unbalance force. Hence, raisins will get only forward movement on sieve along the length of sieve Total mass moment required = 0.531 Kg-m

For single motor mass moment required = 0.265 Kg-m
For 0.265 Kg-m moment following motor is selected from Wuerges catalogue of vibratory motors

Model	= H-V 12/4-301.5
Synchronous speed	= 1440
Centrifugal force	= 6822
Working moment	= 0.3 kg-m
Nominal current	= 1.43 to 0.83 A
Power	= 746 W
Mass	= 18.8 Kg

4. Position of Motors:

Motors are mounted such that the resultant unbalance force will act at the center of sieve. For this machine motors are mounted at bottom of sieve at a distance of 600 mm from backside of sieve. The motors are mounted such that the maximum unbalance force acts on the sieve at 250. For that purpose foundation of motor is welded to sieve at an angle of 65^0.

Comparison after changing vibration method by adding proper vibrator motor and its position

Parameter	Before modification	After modification
Mass flow rate of raisin	1.75 tonnes/hour	3.2 tonnes/hour

5. CONCLUSIONS

In this way modified raisin sorting machine is effective by selecting the proper vibrator motor and selecting proper unbalance weight. One more advantage observed that due to this modification unskilled worker can operate the machine easily. This machine can be used for other products also like cashew nuts, ground nuts & some beans but by changing the sieves. From above all observations & improved mass flow rate of raisin it proves that instead of old eccentrically connected pully and belt arrangement, vibratory mechanism is effective.

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The authors can acknowledge any person/authorities in this section. This is not mandatory.

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