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Design and analysis of cam operated vibro sifter

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Abstract - *Vibro sifter is a device which is used to separate the various grade powders into different stage level in food processing industries. It is worked by unbalanced mass, their processing time and overall cost is high. This project is overcoming above problems by developing new mechanism. This mechanism has been done by structural analytical solution.*

The design modification of this device is known as cam operated vibro sifter. By using cam, the reciprocation movement is given to the wire mesh frame and separation process is carried out. In cam operated vibro sifter of wire mesh moves similar to the traditional separation method. This project indicates that to compare between processing time and overall cost of the two mechanisms.

***Key Words*: cam shaft, wire mesh, pushing rods, vibro sifter**

1. INTRODUCTION

Vibro sifter is a device used to separate the various grade grinded powders in the micron level. In this device cam and pushing rod are used to get the reciprocation motion. This device is a fully mechanical with pollution free device. This device is worked by the same mechanism of engine valve opening mechanism.The cam and pushing rod work together to get the zigzag reciprocation motion of wire mesh frame. It is being published for producing the low cost efficient device.

These devices are used for separate product like grains, Turmeric powder, chilly powder, rice powders and chemicals used in pharmaceutical industries. By using less components and less working elements. The current devices are two types that are horizontal type and vertical type, both they are spring loaded. This device is working by motor, springs and unbalanced weight. When motor is turned ON the stem will rotates due to the unbalanced mass on the stem, the stem will vibrated. And this vibration given to the inner sieve. With the help of spring the vibration in the inner sieve will increased. Then the vibro sifter separates the various grades powders.

2. WORKING PRINCIPLE

The current devices are two types, that are horizontal type and vertical type. both they are spring loaded. The entire inner sieve is connected with a stem coming out from the motor output. The top of stem is unbalanced in weight. And the sieve is placed on the compression spring.

When motor is turned on the stem will rotate. Due to the unbalanced mass on the stem, the stem will vibrated. And this vibration given to the inner sieve. With the help of spring the vibration in the inner sieve will increased. Then the vibro sifter separates the various grades powders

The cam operated vibro sifter as name implies its main working element is the cam. The output of single phase 10 hp motor is given to the cam shaft through the gear assembly. There are two cam shafts to reciprocate the right and left pushing rods. Its working is similar to the valve opening in the engines. The pushing rod is connected with wire mesh frame

With the help of hopper the grinded powder is feed to the wire mesh. The continues reciprocation movement in the wire mesh helps to separate the various graded grinded powder at various stations.

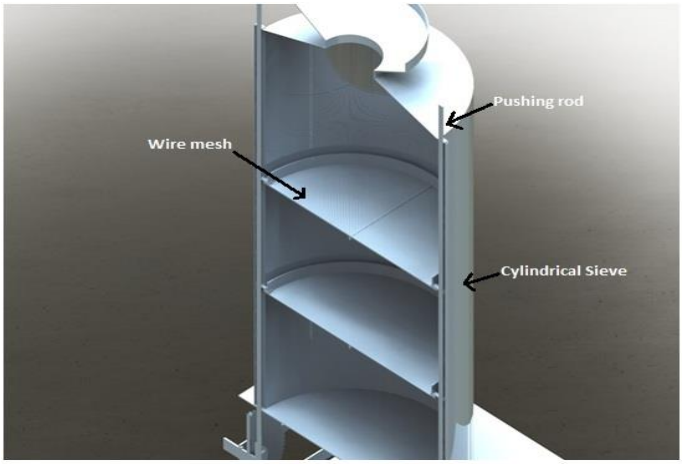

Fig -1: Cross sectional view of cam vibro sifter

Fig -2: isometric view of cam operated vibro sifter

3. DESCRIPTION OF PARTS

Cam shaft is the main working element of this device. Cam is mechanical structure is used to make kinematics in machineries such as they are used to control the timing of reciprocation motion of links attached to it. Based upon the profile of cam the timing and action of motion may be varied. A shaft with one or more cams attached to it, example: working of valves in an internal combustion engine is controlled by cam shaft. Cam shaft is called as the brain of machines.

3.1 Cam

A projection on a rotating part in machinery, designed to make sliding contact with another part while rotating and to impart reciprocal or variable motion to it.Schematic diagram for cam is given below.

3.1.1 Base Circle: The smallest circle centered on the cam rotation axis, and tangent to the cam surface. The size of the base circle is dictated by spatial restrictions of the application

3.1.2 Home Position: The orientation of the cam that corresponds to 0° on a displacement curve.

3.1.3 Reference Circle (or prime circle): A circle centered at the cam axis whose radius is equal to the distance to the trace point. It is the smallest circle from the cam center through the pitch curve

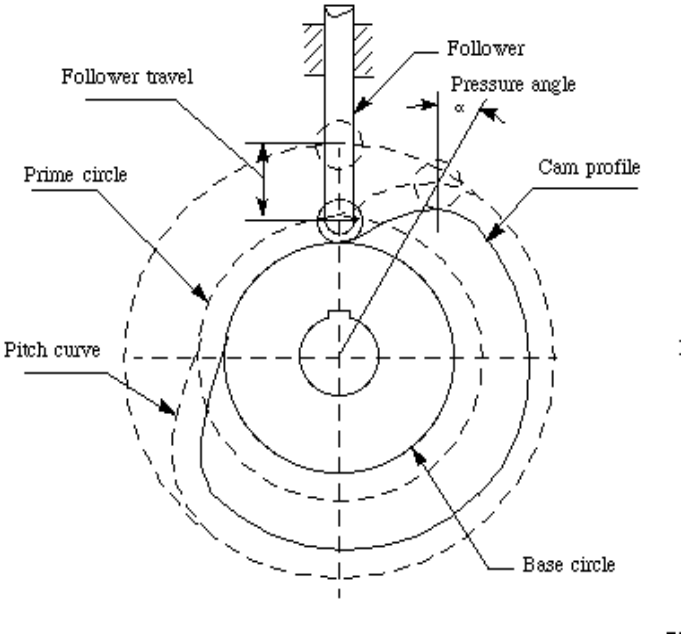

Fig-3: Schematic diagram of cam

3.1.4 Pressure Angle: The angle between the direction of motion of the follower and the direction of the cam contact force is called pressure angle. Pressure angle should not exceed 30°.

3.1.5 Pitch curve: The path generated by the trace point at the follower is rotated about a stationary cam.

3.2 Cam shaft

A shaft with one or more cams attached to it, (eg. working of valves in an internal combustion engine is controlled by cam shaft). Cam shaft is called as the brain of machines.

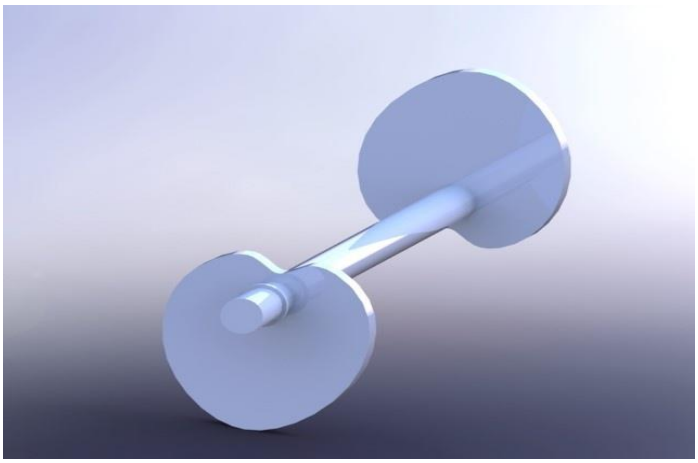

Fig-4: Cam shaft

3.3 Wire mesh

Wire mesh is a material that is made from various strands of interconnected metal, usually steel or aluminum. These strands can be welded together, extruded, or even connected by pins or other devices. They are used to extract or separate the various graded powders into different stages.

Fig-5: Wire mesh

3.3.1 Materials used for wire mesh

- Stainless steel AISI 304,
- Brass wire,
- Phosphor bronze wire
- Copper wire
- Aluminum wire mesh

3.4 Gear

A gear is a rotating machine part having cut *teeth*, or cogs, which mesh with another toothed part to transmit torque. The speed, torque, and direction of a power source is controlled by speed ratio. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine.. Two or more meshing gears, working in a sequence, are called a gear train or a *transmission*. A gear can mesh with a similar tooth part, called a rack, it producing linear movement instead of rotation.

4.4.1 AVAILABLE GEAR MATERIALS

- Numerous nonferrous alloys,
- Cast irons, and plastics
- Steels are most commonly used because of their high strength-to-weight ratio and low cost

Fig-6: Gear

3.5 Three phase motor

Motor is used to provide the rotary motion to the cam shaft. In this device three phase 10HP motor is used. Because of there is no need oh high speed and need high torque in here just only apply maximum of 4kgf of powder to separation process.

Fig-7: Motor

4. DESIGN PARAMETER

Table -1: Design parameters

Parts	Dimensions
Sieve diameter	400mm
Cam shaft diameter	20mm
Pushing rod length	890 mm
Wire frame thickness	2mm

Wire mesh thickness	1 mm
Sieve thickness	2mm
Ac motor speed	975rpm
Push rod diameter	12 mm

5. CALCULATION

5.1 Gear calculations

$$\frac{N_A}{N_B} = \frac{D_B}{D_A}$$

$$\frac{200}{45} = \frac{D_B}{40} \Rightarrow \mathbf{177mm}$$

$$\frac{D_B}{D_A} = \frac{T_B}{T_A}$$

$$\frac{177}{40} = \frac{T_B}{16} \Rightarrow \mathbf{71.8 = 72}$$

Where

N_A -Speed for driving wheel

N_B – Speed of driven wheel

D- Diameter of gear

T- Number of tooth on gear

5.2 Load calculations

Volume of push rod = $\frac{\pi}{4} \times d^2 \times$ length of rod

= $\frac{\pi}{4} \times 12^2 \times 890$

= 100656.62mm^3

Weight of push rod = Density × Volume

Density of cast iron = 0.072N/cc

= 7.33×10^-6 kg/ mm^3

Weight of the push rod = 7.33×10^{-6}×100656.62

= 0.738 kgf

Weight of two pushing rod = 0.738×2=1.477 kgf

Force acted by push rod = 1.477×9.81 =14.49 N

Weight of powder applying = 3kgf = 3×9.81

= 29.43 N

Total force acted on the cam = 29.43+14.49

= 43.92 N

Maximum load can applied = 60 N

For applying maximum load of 60 N the cam is safe in its structure and design .so the design is safe.

6. COMPUTATIONAL RESULT

6.1 Equivalent (Von-Mises) Stress

Von mises stress is used to check whether their design will withstand a given load condition. By using von mises stress information an engineer can say his design will fail, if the maximum value of von mises(equivalent stress) induced in the material more than strength of the material

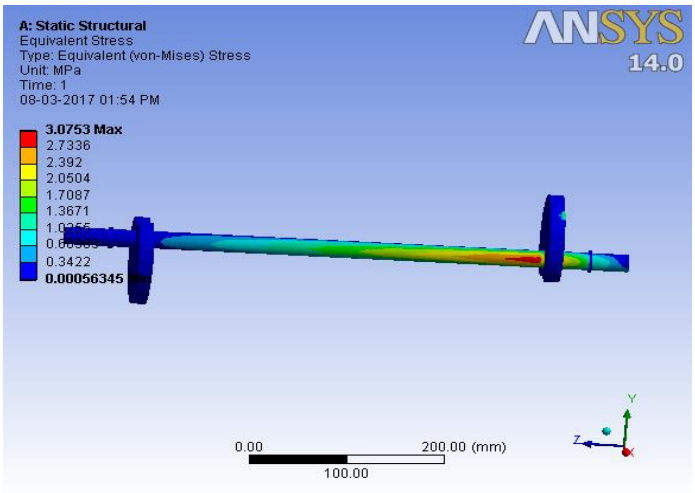

Fig-8: ANSYS Result for Equivalent stress

6.2 Result for Shear stress

A shear stress is denoted by τ (Greek: tau), is defined as the component of stress coplanar with a material cross section. Shear stress arises from the force vector component parallel to the cross section.

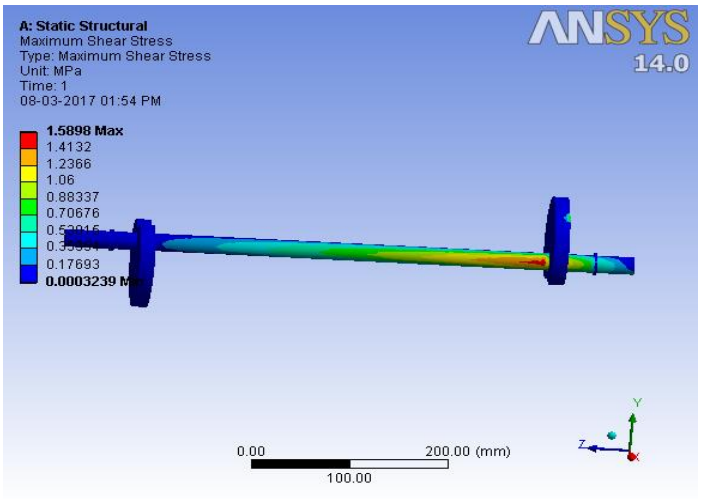

Fig-9: ANSYS Result for Shear stress

6.3 Result for Principal stress

Principal stress is the maximum normal stress a body can have on a single point. It represents purely normal stress. If at some point principal stress is said to have acted it does not have any shear stress component.

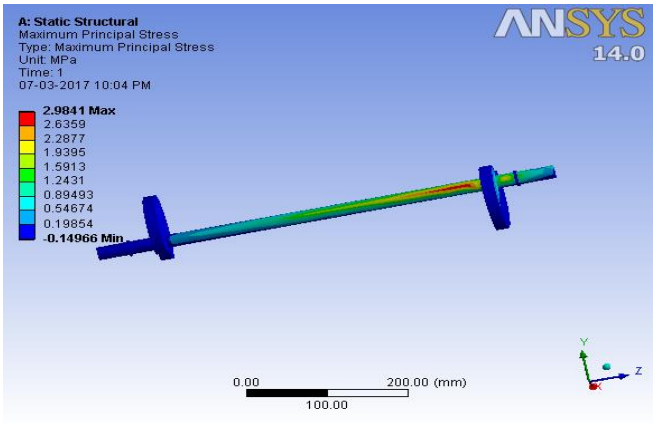

Fig-10: ANSYS Result for Principal stress

6.4 Result for deformation

Change in the shape of a body by the application of a force (stress). Deformation is proportional to the stress applied within the elastic limits of the material.

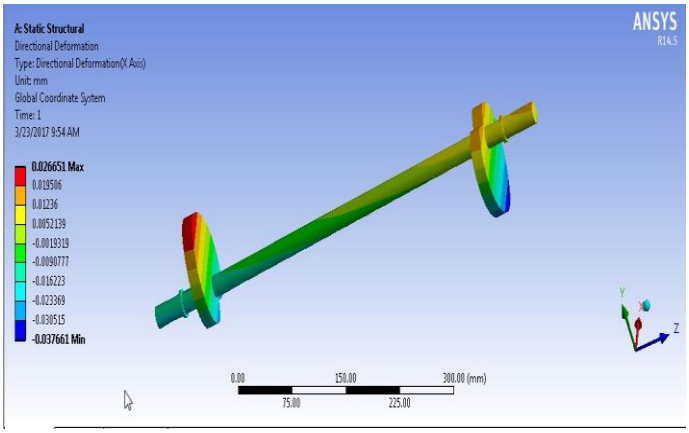

Fig-11: ANSYS Result for deformation

7.RESULT AND DISCUSSION

Thus our device is fully analyzed by the ANSYS 14.5 and ANSYS Workbench 16.0 software. And the device is safe in structure by applying maximum load. In the computational analysis the cam shaft shows 3.0753 Mpa of equivalent stress(von mises stress), also the cam shaft shows maximum principle stress of 2.9841 Mpa and 1.5898 Mpa of maximum shear stress. By concidering all this stresses, the cam shaft withstand the applied load so the design is safe and applicable.

7.1 Advantages

- Used for Industrial and domestic purpose
- Low installation cost
- Easily transportable
- Various grade powders can be separated
- Less power consumption

7.2 Disadvantages

- Maximum load can withstand by the device is 4 kg
- Frequent maintenance required.

7.3 Applications

- Applicable in pharmaceutical industries.
- Small scale grinding mills.
- Food processing industries.
- Domestic purpose.

8. CONCLUSIONS

Thus the positive result of the design is safe. By this result reduces the overall cost of the device by reducing the less number of working elements and also by using reciprocation motion, the processing time of the process is reduced. By applying maximum load, the device withstands and the design is safe. By changing the mechanism the device got the new look in the market. The device can be manufactured with overall production cost of 17,000 and it can be sale by approximate market retail price of 30,000, low cost compared to other existing device

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