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Design and development of screw feeder

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Abstract: ***A screw feeder is a device that is mostly used to transport varieties of materials at a desired and controlled flow rate. Screw feeders are also called as screw augers. In many studies, there is no distinction between a screw feeder and a screw elevator. The difference between both of them is that a screw feeder is used to transport material in horizontal or inclined arrangement whereas in a screw elevator material is handled in a vertical manner. A screw feeder can transport varieties of particulate matter whether it is a chemical, semi-solid material, plastic, slurry etc. Apart from transportation screw feeders are used to measure flow rate as well as they are used to add small traces of materials (i.e. pigments) to powders. In this paper, design & manufacturing of screw feeder for achieving constant flow rate which is required to supply the material (in this application it is wheat) to the grinding wheels of the flour mill and hence will reduce non-uniform wear of grinding wheels and hence will increase its life.***

Keywords: ***Flow Rate, Transportation, Feeder, Elevator, Non-Uniform Wear.***

I. INTRODUCTION

Many mechanical feeding devices are been used in bulk solid handling and processing to feed a wide range of bulk solid. Experience has demonstrated that any successful application lies in the proper design or selection of the hopper or feeder system. Therefore numerous efforts have been made to investigate desirable feeding devices to cope with an increasing no of application. As a result, a different type of feeding devices is been developed continually. Among them, the most common once are belt feeder, apron feeder, rotary feeder, plough feeder, a vibratory feeder and screw feeder. [1]

Screw feeders can be classified in two type's i.e.

- U- shaped through feeders
- Fully enclosed feeders with casing

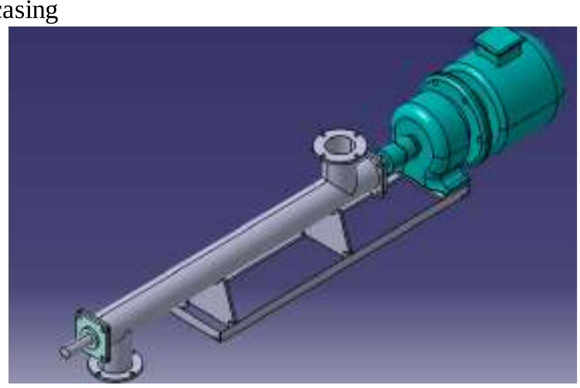

Fig 1. Fully enclosed Screw Feeder

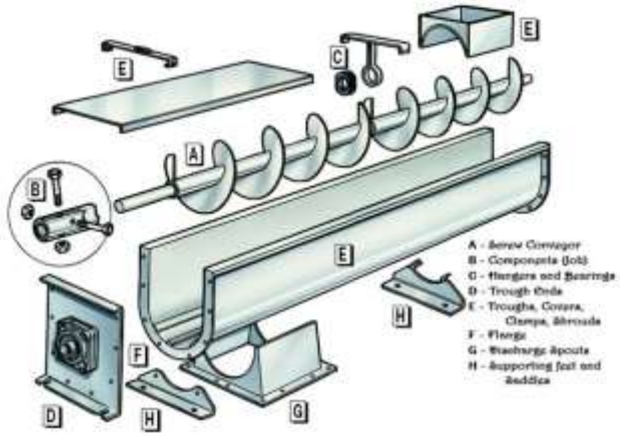

Fig. 2. U-Shaped Screw Feeder

II. LITERATURE SURVEY

A. Archimedes Screw

Archimedes screw also called the Archimedean screw or screw pump is a machine historically used for transferring water from a low-lying body of water into irrigation ditches. Water is pumped by turning a screw-shaped surface inside a hollow pipe. Archimedes 'screw consists of a screw helical surface surrounding a central(cylindrical shaft)inside a hollow pipe, as the shaft turns, the bottom end scoops up a volume of water. This water will slide up in the spiral tube until it finally pours out from the top of the tube and feeds the irrigation systems. The screw was used mostly for draining water out of mines or other areas of low-lying water.

B. Design consideration and performance evaluation of screw feeders. "Published by ALAN W ROBERT".[2]

This paper is focused primarily with screw conveyors with fully enclosed tubular casings. The throughput, torque, and power are significantly affected by the vortex motion of the bulk solid being conveyed. The vortex motion, together with the degree of fill, govern the volumetric efficiency and, hence, the throughput. This, in turn, influences the torque, power and conveying efficiency. A theory is presented to predict the performance of screw conveyors of any specified geometry. Screw feeders can be classified into two types i.e. U- shaped through feeders & fully enclosed feeders with the casing.

C. High capacity screw conveyor. Published by Krupp Fordertechnik and TuMunchen.[3]

Since 1996 Krupp Fördertechnik GmbH, St. Ingbert-Rohrbach, and the institute have been cooperating closely in research work on high-capacity screw conveyors. Mid-1997 saw the start of a collaborative research project between Krupp Förder-technik GmbH and the institute with the aim of distinctly improving the design reliability of large, high-speed screw conveyors as required for the continuous unloading of ocean-going vessels.

Under the project, the partners cooperated closely in the design and development of a test facility. In geometry and capacity, this unit was to be much bigger than previous test units. Thus in the concept phase, the volume flow of material to be conveyed was fixed at 100 m^3/h. The conveyor was designed using computational methods developed in the institute for vertical screw conveyor.

III. THEORY

A. Screw

The screw is the blades with a helical shape. These screws are welded to the shaft. Screw helps to transport the material. The material of the screw is similar as that of the shaft. The material used for both screw and shaft is C45.

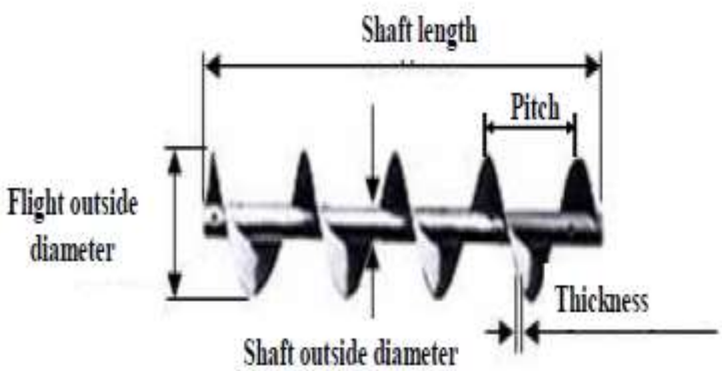

Fig 3. Schematic Diagram of a Screw.

Difference between a Screw conveyor and a Screw feeder. [2]

A feeder can control the rate at which the material is fed from a bin or hopper. As soon as a feeder stops, material flow should cease. When a feeder is turned on, there should bear close correlation between its speed of operation and the rate of discharge of the bulk material.

Mechanical conveyors are used to transporting bulk materials but, unlike feeders, they are incapable of modulating the rate of material flow.

Table 1. Difference between Screw Conveyor and screw Feeder

Attribute	Feeder	Conveyor
Mode of operation	100% full	Partially full
Speed of operation	Variable, relatively low speeds	Fixed, relatively high speed
Capable or rate control	Yes	No

IV. DESIGN

(All the formulas are referred from Design data handbook) [1]

- **Design of screw**

1) For the diameter of the screw (D):

$$\mathbf{Q = 15*\pi*D^2*S*n*\Psi*\varrho*C}$$

2) Pitch (p):

Pitch=0.55D mm

3) No. of washers required to accommodate the length of 1000mm (N):

$$N=\frac{1000}{\text{Pitch}}$$

4) Torque on screw shaft (M):

$$\mathbf{M= 975*\frac{Power}{n} kgf\ m}$$

5) Load propulsion speed (V):

$$\mathbf{V= S*\frac{n}{60}\ m/sec}$$

6) Load per meter length of the conveyor (q):

$$\mathbf{q=\frac{Q}{3.6*v}}$$

5) Axial thrust on the screw (W):

$\mathbf{W= q*L*\mu}$ Newton

Bearing: - pillow block bearing, UCF-206

- **Design of shaft**

1)As per ASME code.

2) Check the design of shaft:

Considering shaft subjected to shear stress.

$$\mathbf{T=\frac{\pi}{16}*d^3*\tau_{allow}}$$

$$\tau_{allow}<\tau_{per}$$

The design is safe.

- **Design of Key**

Design of square key by standard procedure

$\tau_{\text{per of key}} < \tau_{\text{per of shaft}}$

∴Design is Safe.

V. DEVELOPMENT OF CONTROLLED VOLUMETRIC FEEDER

Working of volumetric screw feeder
The Gain-in-Weight Feeding Process:
1. Volumetric screw feeders, containing a single raw material, feed their material collection/scale hopper that is mounted on load cells.
2. The receiving hopper is continuously weighed as an ingredient is fed. The weight measurements are compared to the set point.
3. When the required weight of a material reaches near its set point, the volumetric feeder goes into dribble mode so that the feeder does not over feed. When the set point is reached, material from that feeder stops feeding, and the next feeder is started. The motor uses cushioning effect to accurately control feeding. E.g. If set point is 50 kg that is feeding is to stop when 50 kg set point is reached, 90 percent feeding is done at full motor rpm. For next 8 percent, motor rpm is subsequently reduced .then for next 2 percent motor goes in dribble mode that runs at very low rpm and when the set point is reached motor is turned off thus preventing overfeeding.

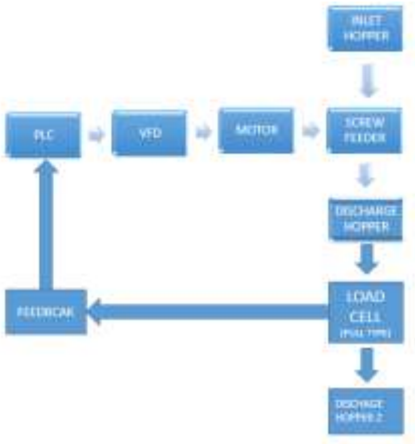

Fig.7. Volumetric Feeding Flow Diagram

CONCLUSION

A fully enclosed screw feeder has been developed after design, modeling and analyzing. The model is developed in CATIA software. The static model analysis was performed on ansys 12.1. The FEA modeling and simulated data were generated. The stresses and deformation developed in models are permissible. The proposed system has further been modified by implementing the variable feed drive for controlling motor speed and use of the volumetric feeding technique.

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