A REVIEW AND DESIGN OF SPIRAL AERATOR FOR EARTHEN MAKING PROCESS.

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Abstract- Aerators are mainly used for mixing of air to water or soil by using spiral pattern or screw pattern. Spiral aerator follow the spiral or screw pattern for mixing of soil, pulp for earthen making process and clay mixing. Different structures are used for different purposes. The purpose of this paper is to present a critical review explaining the current working concept of spiral aerator. Also experimental and numerical studies related to screw pattern are included in this paper. DEM method to predict the performance of screw conveyor as used by some researchers is also discussed.

Keywords- Aerator, DEM, Screw Conveyor, Earthen Making.

1. INRODUCTION

Spiral aerator and screw conveyor are virtually indistinguishable from each other only the gap between flights and shaft separate both present in spiral aerator, so by considering screw conveyor reference we can conjecture application of spiral aerator. Spiral aerator consists of shaft mounted flights and drive unit for running shaft are indispensable for spiral aerator which rotates in trough. The material is moved forward along the axis of shaft by spiral or screw flights. Fig shows the schematic representation of system helical blade is attached to drive shaft which is integrated to drive unit. The shaft is supported by end bearing. The loading and discharge points can be located anywhere along the trough. As the aerator rotates due to their structure materiel move linearly. Clay feeding needed when the clay of multiple densities is processed through crusher and magnetic screening machine. Instead of typical feeder we are going to find the spiral flight structure mounted on shaft.

2. LITRETURE SURVEY

There is number of articles are published on Screw conveyor. Not all the articles are directly related to our concept, especially, those articles which were focused on numerical work. Many articles addressed experimental findings and remaining discussed various theories explaining effect of working parameter on performance of screw conveyor. In this subsection, we are going to discuss only those articles (experimental and/or theoretical work) which are directly related to current work. First screw conveyor was invented by Archimedes (circa 287–212 B.C.) for elevating water from the hold of a King Hero of Syracuse ship. [1]

Alma Kurjak, 2005 has been investigated the effect of powder property on screw conveyor performance and capacity. Powders with coarse particles will flow into a screw easier than powder with fine particles. This results in a greater mass flow. The screw capacity will also be higher if dense powder is used. Round powder, have lower internal friction that results in a greater screw capacity. Hausner Ratio and angle of repose are most likely efficient methods to measure if powder is free owing or not. Particle size has innocence on flow ability of a powder. In general, fine particles with very high surface to volume ratios are more cohesive than course particles. Particles larger than 250 µm are usually relatively free owing, but as size falls below 100 µm powders become cohesive and flow problems are likely to occur. Powders having a particle size less than 10 µm are usually extremely cohesive. Particle shape has a large influence on flow properties. A group of spheres has minimum inter particle contact and generally optimal flow properties, whereas a group of takes have a very high surface-to-volume ratio and poorer flow properties. [2]

Alan W. Roberts concluded that the performance of screw conveyors is significantly influenced 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. The flow properties of the bulk material being conveyed are shown to have a significant influence on the performance. [3]

S.S.Patil and S.M.Jadhao designed, analyzed and compare shaft less and with shaft screw for their structural behavior. Outcome shows that "The deformation result is too much hence it cannot be accepted. Because of the design will be failed due to too much deformation. Hence we need to provide central support for whole flight weldment. Instead of shaft it will work to occupy in smaller volume this central support we will call as ―Central anti bending plate‖". As shown in fig.

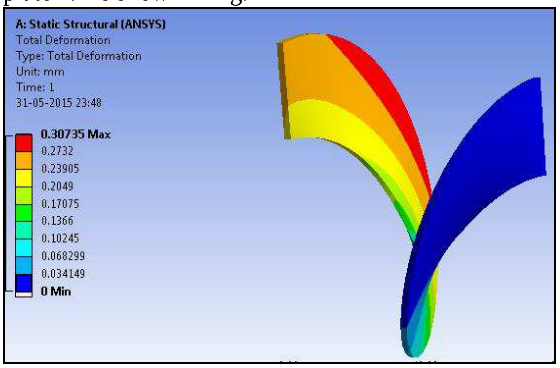

Fig.1 Deformation result

Fig.1 shows deformation result for shaft less structure by using central support instead of shaft. Research end with conclusion of the deformation for shaft less flights is too much more hence we give central support shaft. The results for central support shaft or central anti bending shaft are maximum stress 3.6821 Mpa and the deformation is o.30735 mm. Hence design is safe. By using this type of screw conveyor feeder system the weight will be reduced and the required torque to push the feeding material is less. The output of volume will be more. This screw conveyor feeder system is simple Compared to conventional screw conveyor feeder. [4]

Maton reviewed the hopper and screw geometry to predict the normal running power load requirement and in particular the initial loads to enable the screw to breakaway under the theoretical loads imposed by the bin geometry. In his paper both an empirical method and a more analytical method were discussed and design examples are given to compare the empirical and test work approach. [5]

Philip J. OWEN and Paul W. CLEARY - DEC 2009 were carried out comparison of descript element modelling with laboratory experiment of screw conveyor performance. In this paper, they use the Discrete Element Method (DEM) to examine how variations of particle properties (such as: particle shape, particle-particle and particle-wall friction) influence the performance of the screw conveyor.

The primary focus of our study is comparing measured values. The secondary focus is to study how other performance measures (such as: particle speeds and power consumption) vary due to changes in the properties of the particles. The particles are coloured by their speed: from blue to red for 0.4 to 0.9 m/s respectively. Fig. 3.4 shows particle flow patterns inside the screw conveyor for three different particle shapes after the simulations had reached steady state operating conditions. These steady state conditions were reached within 2–3 turns of the screw, when the power draw became quite stable. The screw conveyor operating conditions are the same for all 3 cases, namely: 30% by volume fill level, and the screw is rotating at 1000 rpm.

They found that increases in non-sphericity have negligible effect on the particle flow patterns. The particle velocities and their axial and tangential (swirl) components were invariant to changes of particle shape and particle–particle and particle–wall friction. However, there were two notable exceptions. The first exception is the swirl velocity for the blockiest particles (case SQD), which was an outlier when compared to all other cases. As the blockiest particle is likely to be a more extreme shape than that of the Japanese millet seed used in the experiment, we can concluded that all particle speed components are invariant to realistic variations in particle shape. The second exception is that the swirl speed in a horizontal screw conveyor, which increases modestly with increasing particle–boundary friction.[6]

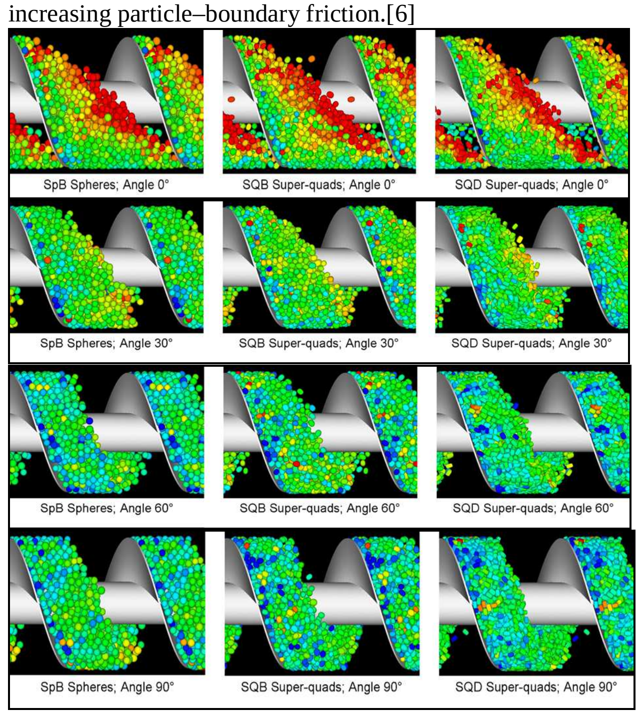

Fig.2 Particle flow patterns within the screw conveyor inclined at various angles for different particle shapes. The particles are coloured by their speed: from blue to red for 0.4 to 0.9 m/s respectively.

3. EXISTING TECHNOLOGY

Vertical aerated system in commonly used in practice. Apart from screw feeder separately installed in cylindrical gable, Vertical axle of rotation, Separate quantity pallets to process time by time. It has 12mins cycle time for 1000 liter volume, 400 RPM working, 600 Nm Torque. But due to leakage and sealing maintenance in vessel joints and separate feeder body for passing material to screw feeder is required. Due to vertical axis it has limited output if we want to increase output we have to increase overall assembly which causes increase in space and cost.

Fig.3 Vertical aerator separately installed in cylindrical Gable

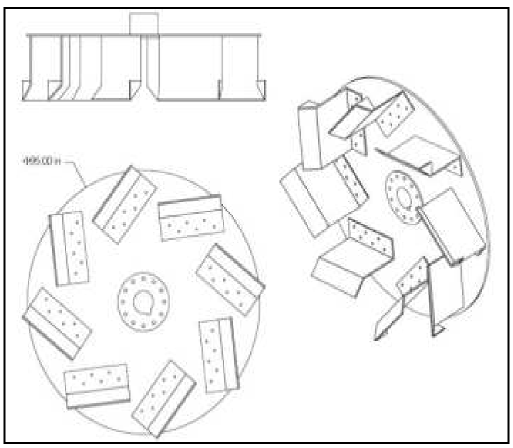

Fig.4 flights mounted at bottom of vertical aerator

3.1 *Problem in existing technology?*

- Additional fabricated structural fixture for vessel mounting needed.
- Bottom scraper required at bottom, after every 3-4 cycles to clean the material collected at bottom.
- Separate feeder body for passing material to screw conveyor.
- Leakage and sealing maintenance in vessel joints.
- Separate feeder body for passing material to screw feeder.
- Bulky structure.

4. DESIGN OF SPIRAL AERATOR

As we are designing aerator for mixing of thick pulp with soil in powdered form. Pulp is medium density fiber(MDF) mainly crushed soil mixture wet thick Mdf 40 % + 60% soil and additives with water. This mixture is to be passed to the outlet to feed towards next processing plant , we have focused on Horizontal setup instead of vertical setup with rotary packed drum shaped housing will be rest on its mounting . Inside drum screw shaped mechanism is rotating to mix pulp with soil with additives liquid. Approx 700 liter material processed for ~7-8 minutes in 200 rpm, Automated hood open able door at outlet will activate after end of cycle time and speed will be 20 RPM to feed bottom screw feeder.

4.1 *DESIGN OF SHAFT*

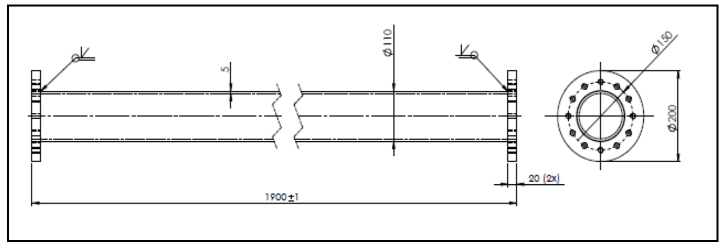

Fig.5 Front and top view of shaft

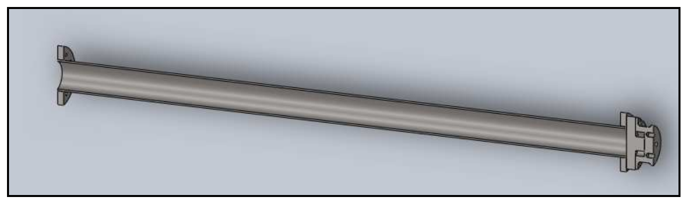

Fig.6 CAD model of shaft

4.2 *DESIGN OF FLIGHTS*

We consider the following parameters to design the flights.

Pitch = 300 mm

Thickness 4mm

Bore diameter = 110mm

OD= 600 mm

Type : Left hand

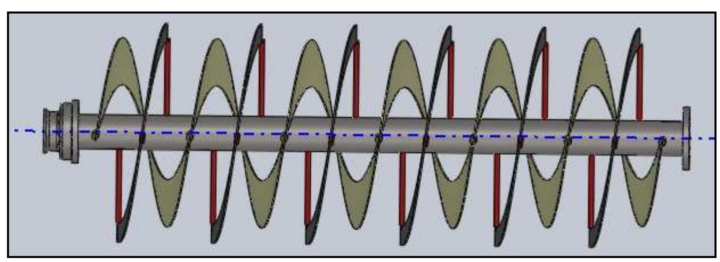

Fig.7 Rotary spiral aerator

Assembly of shaft and flights look like as shown in fig.7. It will eliminate the problems in existing technology.

5. CONCLUSION

From the cited literature it is found that only a fewer literature is available on the spiral aeration technology used in earthen pot making process. Also the results on how the design of aerators effects the material flow patterns and effectiveness of mixing is still not fully understood due to different aerator model designs used by different researchers. This area can be highlighted in the near future. Also with the help of Computational Fluid Dynamics the flow and mixing patterns and design considerations for a robust and agile design of aeration mechanisms can be made. Also the proposed design in this work shows potential merits and will be elaborately presented in subsequent work.

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