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DESIGNING OF A VIBRATING SIEVE

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Abstract

This report presents the development of proto type of a Vibrating Sieve. The preliminary objective of this project is to design a prototype of a vibrating sieve to be used for clay refinery process, which can be easily maintained with available materials in the market and cost effective. Secondary objective of the project is to gather knowledge, practice and experience on technology, equipments and methods available in the mechanical designing activities in the workshop and develop skills and experience in team work spirit..

Introduction

Sieves are used in many industries mainly for separation of particles depending on their size. Most of the industrial scale sieves are vibrating sieves. Vibration is provided mainly for the effective separation. With this vibration process separation makes effective in two ways.

1. By moving the ore all over the sieve area, so that separation process is done quickly

2. Avoiding blinding effect, this will be up to some extent with the vibration.

In large scale processing plants normally series of vibrating sieves are arranged to do the separation. Many sieves are used in plants because in many processing plants sieving is relatively a slow process. So to cope up with the speed of other equipment the processing plant should be planned with series of sieves.

Basic designing and modeling

Out of so many types of sieves circular type is selected since it has several benefits over the other types when sieving slurry. With closed circular type retention time is increased and a uniform distribution of feed over the wire mesh can be achieved. Spillages are less with this type. An apparatus with flat sides may accumulate material in corners, but that problem is also eliminated in circular type.

Single deck vibrating screen can be easily extended to multiple deck, by fixing a simple extension units with sieves of different aperture sizes.

No 80 Stainless Steel wire mesh is used in this unit as the sieve. Clay is usually having particles less than 180μm in size and this unit is designed to separate clay fraction from much larger particles (usually sand), where the feed is a slurry.

Issues to be addressed at designing stage

Vibrating mechanism

Main body fixed with the sieve is suspended on coil springs and a motor fixed with an eccentric weight is coupled to the main body which gives the vibration. In order to get a uniform vibration, and for increased stability six coil springs are used to suspend the sieve, and these springs are fixed to a base plate at the bottom, which is fixed to a heavy basement.

Sieve

Several sieve designs were considered before selecting the one used in the unit. It had to be designed in such a way that the over sized material and the under flow is discharged automatically without any accumulation and the blinding of sieve apertures is minimized.

Sieve must be able to be replaced easily if damaged, or with a sieve of different aperture size in less time without affecting the production process.

Reducing the blinding effect

Second wire mesh with larger apertures is placed just below the screen and small plastic balls are placed in between, these balls are to minimize blinding effect by hitting the screen.

The discharge mechanism

Main body of the instrument is made as a cylinder out of metal sheet. Sieve is fixed to the main body in a slight angle to the horizontal for easy discharge of the over flow. An angled metal sheet is placed below the screens to collect and discharge the under flow. Over size and under size materials discharge through the discharge ports fixed to the main body.

With this basic design a model was made out of aluminum sheets and cardboard to get a clear understanding of what is to be made. With the help of the model it was decided how each part must be made and fixed together.

Material selection

For durability main body of the instrument must be made out of stainless steel for abrasion resistance and ware and tare resistance. Coil springs must be selected with proper strength, diameter for adequate vibration and a motor with adequate torque and speed must be used for efficient operation.

To meet the requirements above as close as possible a basic estimation was prepared, considering the availability of materials in the market.

In order to comply with the available budget, materials were selected to keep the cost within the limitations.

Materials used for fabrication

- Galvanized metal sheet – for the construction of the main body and the discharge ports
- Exhaust fan motor – for vibrating mechanism
- Six Coil springs – to suspend the main body (sieve)
- No 80 Stainless Steel wire mesh – as the sieve
- Thick mild steel plate – as the base plate
- L-Iron, Nuts and Bolts of various sizes, paint, anti corrosive paint
- Cement, sand and metal – for the concrete base

How the vibrating sieve is assembled

The main body

A rectangular strip (94cm×20cm) was cut from Galvanized metal sheet and made in to a cylinder with 30cm diameter by welding the edges. Two rectangular openings were cut on the opposite sides of the cylinder for discharge ports of overflow and under flow. Discharge parts were made out of the same metal sheet as shown in figures and fixed to the openings by welding. A circular metal sheet was welded inside the cylinder with an angle to the horizontal for collection and easy discharge of the under flow.

Six L-angles were welded to the main body in 60°, with drill holes for bolts, and nuts welded to the under side. These are to hold the sieve and the screen for tapping balls.

Another six L-angles were welded to the bottom edge of the cylinder with holes for bolts, and nuts welded, to fix the main body on the spring arrangement.

Sieve

Three circles with a width of 1cm and 30 cm diameter were cut from the galvanized sheet. Sieve cloth was placed in between two metal circles with a rubber padding in between to avoid leakages from the edge, and fixed together by means of pop rivet.

Tapping ball arrangement

Galvanized wire mesh with apertures of 2mm was fixed to one circle by bronze welding, which serve as the screen for tapping balls. Six L-angles with descending heights and holes for bolts, were welded to the circle to hold the sieve with an angle to the horizontal.

Fixing the Sieve

Screen for tapping balls was placed on the L-angles fixed inside the main body and the sieve is rested on the L-angles fixed to the Screen for tapping balls. Screen and the sieve are fixed to the main body by the bolts driven through the above arrangement, so the sieve is at a slight angle to the horizontal for efficient discharge of the over size material.

The Base

The base plate is circular and made out of thick mild steel, which can be fixed to any strong and heavy basement by five nuts and bolts. In here a heavy circular concrete block was used. Six posts with a height of 10cm made from L-Iron were fixed on the base plate by nuts and bolts and on top of each post coil springs were fixed by means of nuts and bolts. Each of these coil springs have a bolt welded on the top which were fixed to the nuts welded to the L-angles at the bottom of the main body.

Vibrating Mechanism

The motor was fixed to three arms and suspended on three of the coil springs fixed to the base in 120°. A small steel arm is fixed to the axle of the motor eccentrically which gives the vibration on rotation.

Vibration Controller

Rotating speed of the motor is controlled through an electronic speed controller. This controls the vibrating action of the sieve, so it can be adjusted to get the optimum sieving efficiency according to the material, particle size and the thickness of the slurry.

Mechanism of the Vibrating Sieve

Vibration

The motor is suspended on coil springs and fixed with an eccentric weight which gives a vibrating action to the motor when it is rotated. This motion is transferred to the main body through the arms holding the motor. Since the main body is rested on the coil springs, it vibrates horizontally and vertically.

Slurry containing clay and sand is directly fed on to the sieve which is fixed with a slight angle to the horizontal. Moisture gives a drift velocity to particles to cover the greater area of the sieve deck. Particles which are smaller in size than the aperture size (mostly clay and some sand) pass through the sieve and fall on the plate at the bottom fixed in an angle to the horizontal and discharged through the underflow discharge port.

Particles which are larger than the aperture size retain on the sieve and with the help of the slope of the sieve and mostly the vibration, discharged through the overflow discharge port.

Reduction of blinding effect

A wire mesh with apertures much larger than that of the sieve is placed just below the sieve and small plastic balls, which are called *tapping balls* are placed in between them. These balls hit the sieve when the apparatus vibrates and set free the particles trapped in sieve apertures, hence reduces the blinding effect and increase the sieving efficiency

Screening Efficiency Calculation

Efficiency of the screen was calculated by comparing the underflow fraction of both vibrating screen and standard sieve as follows:

Boralasgamuwa clay mineral was used as feed pulp for the experiment. 250gs of Clay mineral was weighed in a balance and it was thoroughly mixed with water. The pulp was fed in to vibrating screen while it was working. Both under flow and over flow were collected separately in buckets. Then the under flow fraction was carefully filtered and kept in oven at 110°C until the constant weight was obtained. The dry weight of an under flow was noted.

Again 100gs of clay mineral was taken and the pulp of this clay mineral was tested for standard sieve. And the dry weight of an under flow was obtained.

For Standard sieve:

Weight of a Feed (W) = 100 g

Dry weight of the under flow (W1) = 53g

Clay fraction from standard sieve $= \frac{W1}{W} \times 100$

$= \frac{53}{100} \times 100$

$= \underline{53\ \%}$

For vibrating sieve:

Weight of a Feed (w) = 500 g

Dry weight of the under flow(w1) = 244.8g

Clay fraction from vibrating sieve $= \frac{w1}{w} \times 100$

$= \frac{244.8}{500} \times 100$

$= \underline{48.96\ \%}$

There fore the machine efficiency $= \frac{48.96}{53} \times 100\%$

$= \underline{92.37\ \%}$

Assumption

Standard sieve is 100% efficient

Conclusion

Designing and fabricating of Vibrating sieve was a great opportunity for us to experience and practice what we learnt during our undergraduate curriculum. Being an Earth Resources Engineer, the experience we gain through this project would be important in our future carrier.

During the training and designing stage of the project, we had the opportunity to learn more mechanical work shop techniques which will definitely be helpful for our future. We also familiarized with manual and Computer Aided mechanical drawings. During the fabricating stage we were exposed to different techniques and environments in the mechanical workshop. All the operations were carried out by the group members and each person could familiarize with the tools, equipment and techniques. Decision making and problem solving regarding the work shop operations were handled by the group members thereby it sharpened our knowledge as well as team work skills which will be beneficial for us to become better Engineers in the future.

The present design of the vibrating sieve is a prototype and this design can be improved for industrial scale with very less modifications. The inclined sieve, blinding reduction method and simple structure which allows easy part replacement would be more attractive at industrial scale operations. Fabrication of such equipment for industrial scale is very easy and less labor and time consuming when carried out in a workshop with modern equipment and tools. This vibrating sieve can be easily coupled to a production line with crushing and grinding machinery and if the fines are to be further separated, under flow can be sent to a cyclone.

For reference the vibrating sieve was tested for clay excavated from Boralesgamuwa clay deposit and the efficiency of the design was measured with respect to the standard laboratory sieve. In both cases the same conditions were applied and, the prototype vibrating sieve showed an efficiency of 92.37% compared with the standard laboratory sieve.

References

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