Construction, Working and Maintenance of Electric Vibrators and Vibrating Screens

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The information contained in this booklet represents a significant collection of technical information about construction, working and maintenance of electric vibrators and vibrating screens. This information will help to achieve increased reliability at a decreased cost. Assemblage of this information will provide a single point of reference that might otherwise be time consuming to obtain. Most of information given in this booklet is mainly derived from literature on the subject from sources as per the reference list given at the end of this booklet. For more information, please refer them. All information contained in this booklet has been assembled with great care. However, the information is given for guidance purposes only. The ultimate responsibility for its use and any subsequent liability rests with the end user. Please view the disclaimer uploaded on http://www.practicalmaintenance.net.

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Content

Electric Vibrators and Vibrating Screens

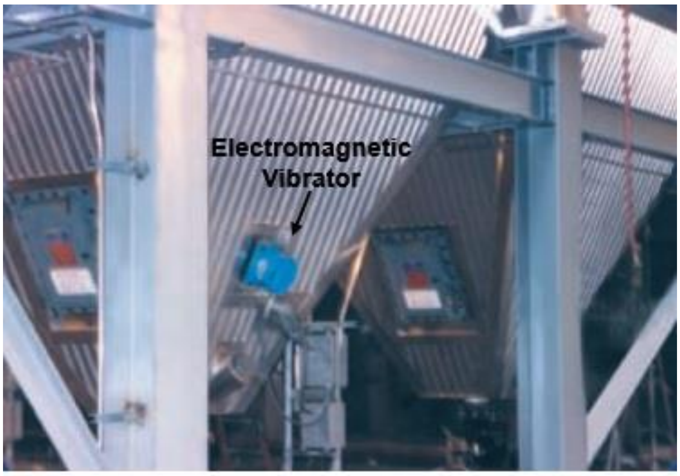
In many bulk material processing plants, the material is vibrated because the power of applied vibration energizes material reducing friction against container walls as well as internal particle-to-particle cohesion. As a result, the material moves more freely, feeds more effectively, sorts more consistently and compacts more efficiently.

Electric vibrators (electromagnetic vibrators and unbalanced motors) are used during emptying bulk materials from silos / hoppers and in various equipment like vibrating feeders and vibrating screens. In a bulk material processing plant, screening of material is carried out for various applications like scalping, classifying, dust removal, dewatering, deslurrying, etc. Many of these application use vibrating screens. In view of this, information about electric vibrators and vibrating screens is given in this booklet. It may be noted that electric vibrators are not autonomous functioning machines; they are designed to operate only with another machines.

Electromagnetic Vibrators, Unbalance Motors and Exciters

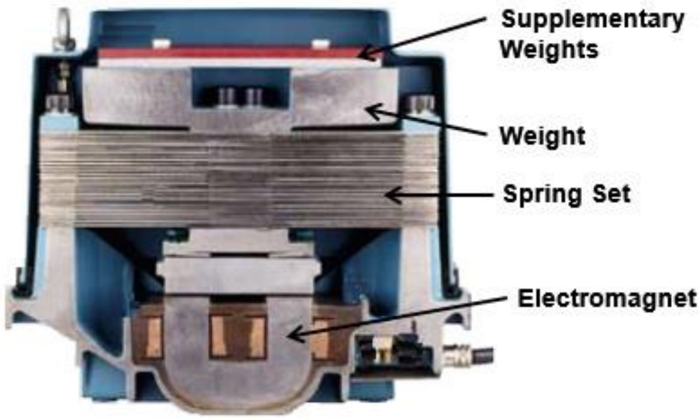
Information on electromagnetic vibrators, unbalance motors and unbalance exciters is given in this chapter.

Electromagnetic Vibrators



Use of Electromagnetic Vibrator

Electromagnetic vibrators, also called magnetic vibrators offer an economical means of maintaining the flow of bulk materials from bins, hoppers, chutes, feeders, conveyors, etc. Above figure shows use of an electromagnetic vibrator for maintaining flow of dust particulates from the collecting hopper of an electrostatic precipitator.

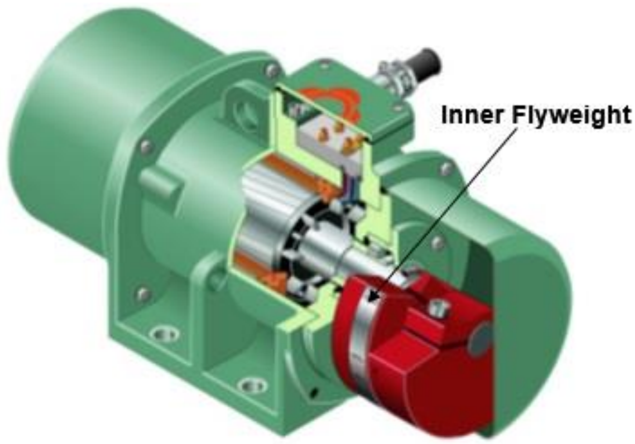


Construction of Electromagnetic Vibrator

Above figure shows construction of an electromagnetic vibrator. Because each voltage cycle exerts a pulling force on the electromagnet, the electromagnet generates a straight-path upwardly oscillation motion. Thus, electromagnetic vibrators form spring-mass systems that pass a linear vibration (perpendicular to the mounting plane) to the working unit/device (trough, screen etc.). Supplementary weights are provided for their adaption to the weight of the working device. They are virtually maintenance free because the electromagnetic design eliminates moving parts. They can be continuously adjustable via the connection voltage. By changing the voltage from the controller, the working stroke and hence the material throughput may be adjusted during operation from close to 0 up to 100%.

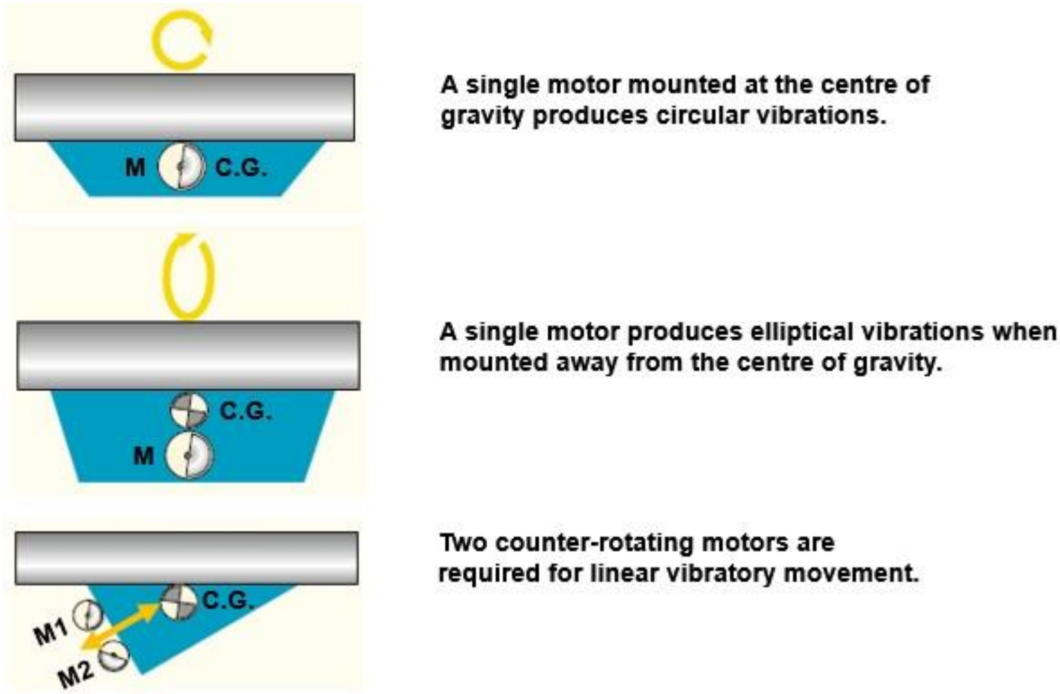
Unbalance Motors

They are also known as vibration motors. Unbalance motors are provided and are suitable for driving vibrating systems, such as vibrating pipes, vibrating feeders, vibrating screens, etc.



Construction of Unbalance Motor

Above figure shows construction of an unbalance motor. To generate the centrifugal force, flyweights are arranged on both sides at the ends of the motor shaft. The unbalance weights on the drive shaft produce an oscillating force which sets the spring-mounted working device (e.g. a vibrating screen) to vibrate in a defined direction.



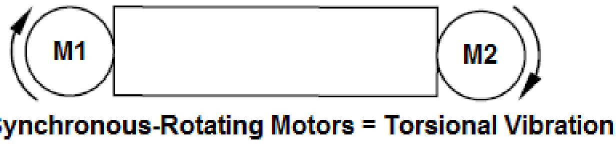
Vibrations Depending on Arrangement of Unbalance Motor(s)

As shown in above figure, it is possible to generate circular, elliptic or linear vibratory (oscillatory) movements.

If a single unbalance motor (drive) is located at the centre of gravity, it generates a circular vibration (oscillation). However, away from the centre of gravity, an elliptic oscillation movement is generated.

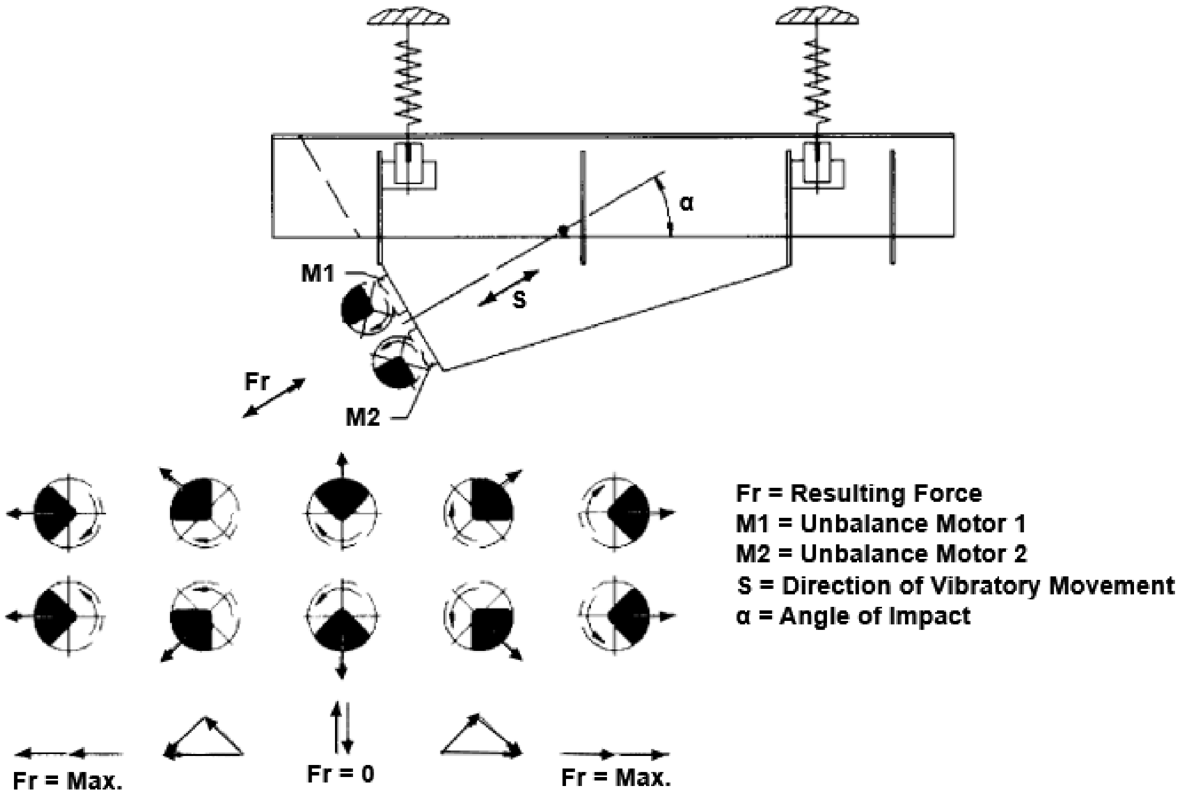
A drive consisting two unbalance motors rotating in opposite directions generates a linear (straight line) vibratory movement. This type of motion is used when it is required to transport the material horizontally i.e. with vibrating conveyors, feeders or when it is necessary to control the feed rate by variable speed controllers. This type of motion is also necessary for compacting materials.

However, as shown in the following figure, two synchronous motors rotating in the same direction will produce torsional vibration.



Generation of Torsional Vibration

The following figure explains how linear vibratory movement is generated by two counter-rotating unbalance motors at same speeds.



Generation of Linear Vibratory Movement

The centrifugal forces and so the capacity can be adjusted/altered, when the machine is standstill (not in operation), either by displacement, removing or by adding unbalance weights based on motor construction/design.

In case of motor having construction as shown in the figure given above, unbalance forces can be altered by displacing the inner flyweights.

Please note that the inner flyweight must be set to the same value and/or graduation mark at both sides of the unbalance motor.

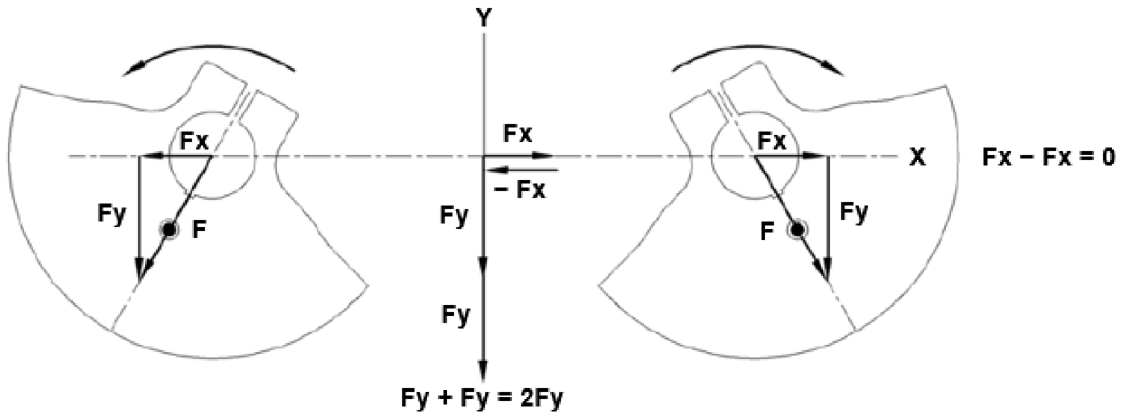
When using the unbalance motors in pairs, the same centrifugal forces must be set in both the motors.

Unequal setting of the flyweights will generate excessive uncontrolled transverse forces which may result in destruction of the unbalance motor and the vibrating machine.

Unbalance Exciters

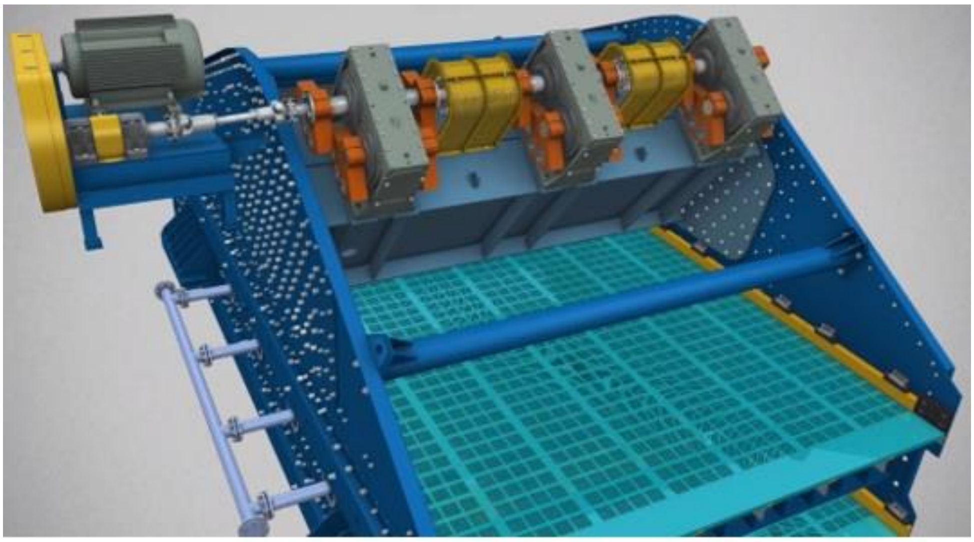
Unbalance Exciter

As shown in above figure, an unbalance exciter has two gearwheel force-synchronized shafts fitted with unbalance weights. Hence, unbalance exciter is often called geared exciter. As shown in the following figure, the circulating weights (masses) produce a circulating radial force F of the same frequency on both shafts. This produces an alternating force of value Fy + Fy = 2Fy in the direction of the exciter stand/base due to the inverse synchronous circulation of the imbalance weighs.



Generation of Alternating Linear Force in Unbalance Exciter

Thus unbalance exciters generate a linear vibratory motion. They are used to drive vibratory conveyors, screens and other vibration systems with very high load and/or very high flow rates. It may be noted that working of unbalance exciters is similar to use of two counter-rotating unbalance motors to generate linear vibratory movement. The vibration amplitude can be modified by adjusting the unbalance weights (by increasing or decreasing mass of the unbalance weights). To generate vibration in a vibration system, one of the shafts of the unbalance exciter is driven by stationary drive motor through cardan/propeller shaft (a shaft fitted with universal joints at each end).



Use of Three Unbalance Exciters in Parallel

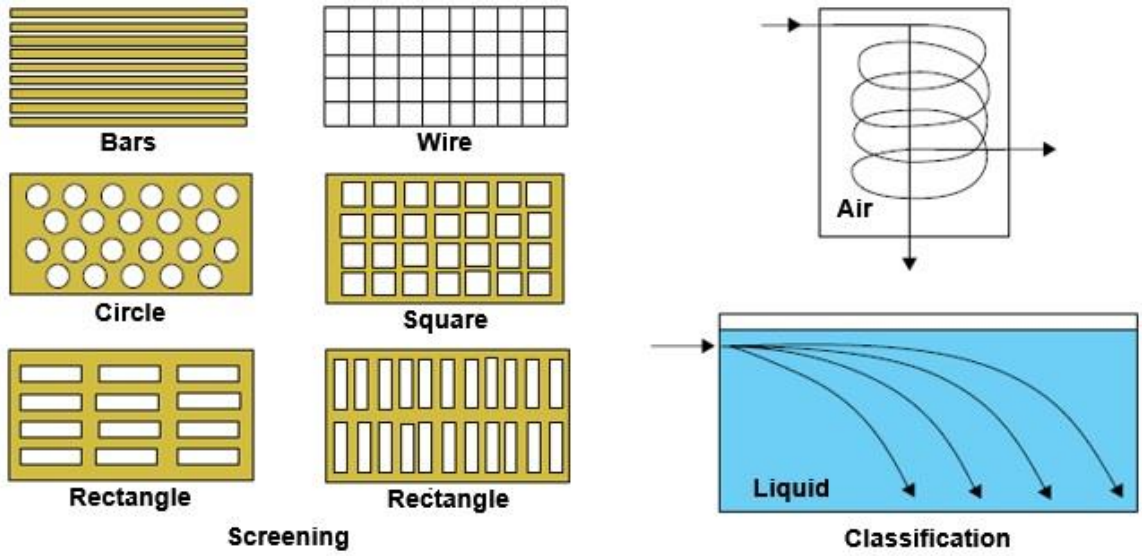
In case of extremely heavy vibrating conveyors and screens, several unbalance exciters can be used in parallel. Above figure shows use of three unbalance exciters in parallel to vibrate a double deck horizontal screen. Please note that guards are purposely not shown in above figure to show the use of three unbalance exciters.

Screening and Types of Screens

Information on screening and types of screens is given in this chapter.

Size Control

Size control is the process of separating bulk material into two or more products on basis of their size. In mineral processing practices, two methods dominating size control processes are: screening and classification. As shown in the following figure, while screening uses a geometrical pattern for size control, classification uses behavior of particle's (finer than 1 mm) motion in air or liquids (water) for size control.



Screening and Classification

Sizing is extensively used for size separations from 300 mm down to around 40 µm (micron), although the efficiency decreases rapidly with fineness. Dry screening is generally limited to material above about 5 mm in size, while wet screening down to around 250 µm is common. Although there are screen types that are capable of efficient size separations down to 40 µm, sizing below 250 µm is also undertaken by classification. Selection between screening and classification is influenced by the fact that finer separations demand large areas of screening surface and therefore can be expensive compared with classification for high throughput applications.

Screening Applications

Depending on process requirement, screening can be done dry or wet. The role of screening in a processing plant is primarily for the following end applications.

Scalping (Pre-screening)

There is often a fraction of raw material that is already properly sized. Scalping (pre-screening) the material is done mostly as relief screening before crushing in order to prevent the smaller particles going into the crusher. It reduces wear of the crusher parts and also reduces the power consumption. Scalping thus reduces unnecessary operation and maintenance costs.

Classification / Sizing

Following crushing, screens with two or three decks and different opening sizes separate the aggregate material into different size categories (classes) for further crushing or stockpiling as a saleable product.

Dust Removal

Dust removal is screening out the unwanted very fine particles.

Dewatering

Dewatering is straining of unwanted water. Dewatering is generally carried out after wet classification. It is also carried out to drain free moisture from a wet sand slurry.

Deslurrying

Deslurrying is aimed at removing certain particles range using water. For example, in order to reduce the ash content in coal or removal of dissolved clay from sand and gravel.

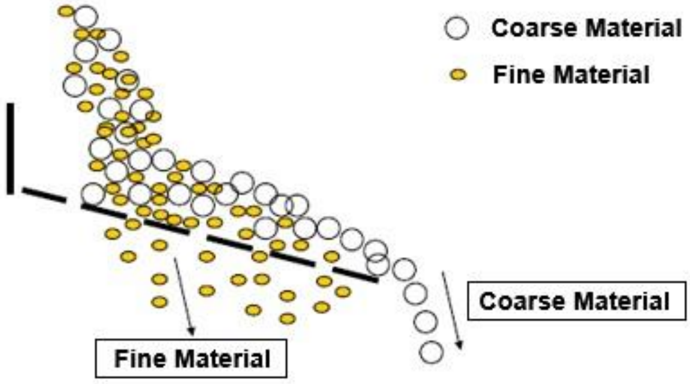
Types of Screens

A screen is a device which separates a mix of particles into two or more groups (also called grades) depending on size. In its simplest form, the screen is a surface having many apertures, or holes, usually with uniform dimensions. Particles presented to that surface will either pass through or be retained, according to whether the particles are smaller or larger than the governing dimensions of the aperture. The efficiency of screening is determined by the degree of perfection of separation of the material into size fractions above or below the aperture size.

There are numerous different types of industrial screens available. Following are the most common types of screens depending upon the principle of operation.

Fixed/Static Screens

Fixed screens are static steep inclined (35-50°) structures to assist material flow with desired screen openings for sizing of the material. In these screens, as shown in the following figure, screening is done by free fall, meaning that no particle layer can build up on the screen deck. The particles are sized directly via the screening media, giving a higher capacity (more compact installation), but low efficiency. A screen using parallel bars or rails is commonly called grizzly.



Free Fall Screening

These type of screens are used in scalping applications when a large amount of fines shall be removed fast (oversize material in the feed is small) and efficiency of screening is not important. Optimal free fall screening demands at least 70% of the feed through the deck (i.e. large % of fines in the feed).

Revolving / Rotary / Trommel Screens

Revolving screens are also known as rotary screens and trommel screens. They consist of a perforated cylindrical drum. The cylindrical drum is normally elevated at an angle at the feed end or use a series of internal baffles to transport material along the cylindrical drum. Size separation is achieved as the feed material is lifted up by the rotation and aerated as it falls back down on the rotating cylindrical drum. This action is repeated with each revolution along the length of the cylindrical drum. The material smaller than the screen apertures passes through the screen openings while the oversized (larger) material tumbles towards exits at the other end of the cylindrical drum. Revolving screens can be made to deliver several sized products by using screens in series from finest (at feed end) to coarsest (at discharge end) in the same cylindrical drum or using concentric cylindrical drums with the coarsest mesh being on the innermost drum.

Although revolving screens are cheaper, vibration free, and mechanically robust; they typically have lower capacities than vibrating screens since only part of the screen surface is in use at any one time, and they can be more prone to blinding.

Roller Screens

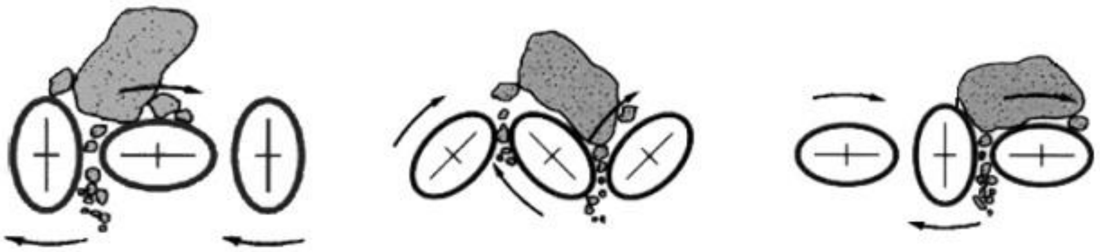
Roller Screen

Roller screens are suitable for sizing coarse, moist, sticky or clayey raw materials. They are used as scalping (pre-screening) for crusher relief as well as for control screening after the crushing process. These screens are used for screening materials like coal, lignite and limestone. They can be used for screening applications from 3 to 300 mm.

Roller screens are screening machines that have screening surface consisting of separate screen rolls with curved triangular discs or other configuration as per requirement which are driven in the same sense of rotation to transport oversize across and allowing fines to fall through the gaps between discs.

For separating material, the discs are arranged in a way that they are set either opposite to each other or with interstices. Thus, it is possible to form square or rectangular screen openings. The fine sized grains can now pass these screen openings. In case of very moist, sticky or clayey raw materials, the roller screen rolls are fitted with scrapers, which clean the bottom of the rolls. The part of the feeding material, that has not been screened is transported by the screen rolls to the roller screen discharge and then fed into the crusher.

Roller screens are preferred to revolving screens when the feed rate requirement is high. The material is subject to less impact. They also cause less noise than revolving screens and require less head room. Sticky materials are easier to be separated using a roller screen than with a revolving screen.



Working of Wobbler Feeder

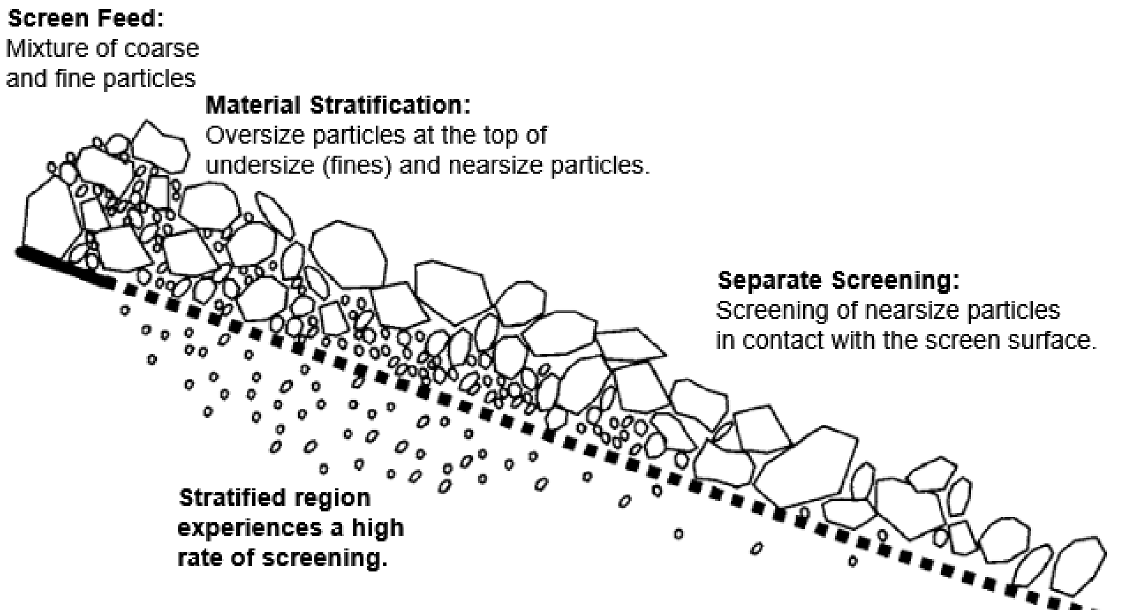
Working of a Wobbler feeder is similar to a roller screen. It is used for scalping out fines and feeding only oversize to a crusher. As shown in above figure, elliptical bars of steel are set in alternate vertical and horizontal positions in a Wobbler feeder. The elliptical bars rotate in the same direction, all at the same speed. Spacing between the bars remains constant throughout the rotation. As one bar turns down, the succeeding one turns up, imparting a rocking, tumbling motion to the load. Oversize is “wobbled,” working loose more fines. Pressure of the load and “wobbler” action moves the oversize forward, thoroughly removing the fines.

Vibrating Screens

Vibrating screens are the most important and versatile screening machines for mineral processing applications. They have a rectangular screening surface (called screening deck) with feed and oversize discharge at opposite ends. In a vibrating screen, the screening surface with desired screen openings (screening deck) is vibrated by a vibrator assembly/exciter.

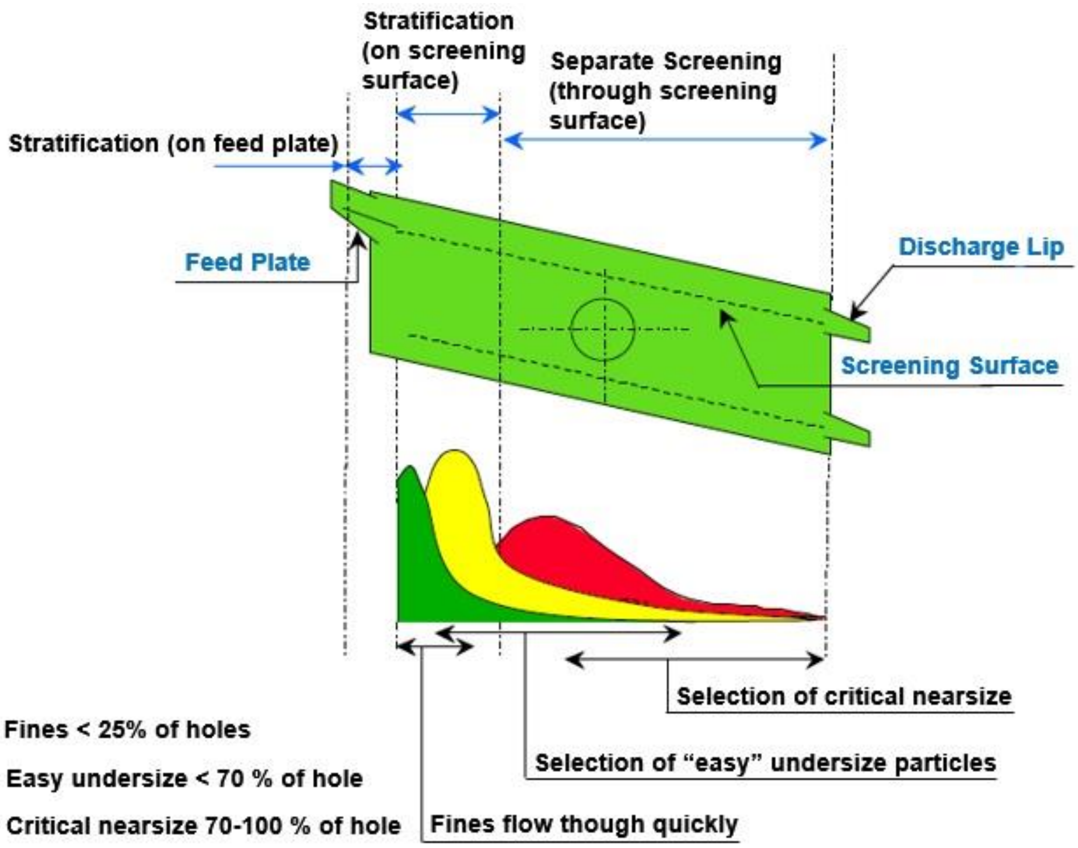
They perform size separations from 300 mm in size down to 45 μm and they are used in a variety of sizing, grading, scalping, dewatering, wet screening, and washing applications.

A vibrating screen is vibrated in order to throw particles off the screening surface so that they can again be presented to the screen, and to convey the particles along the screen. Vibration also lifts the large particles out of the holes (If the large particles are not lifted out, it will plug the screen). Vibration also agitates the material reducing the internal friction in the material. Hence as shown in the following figure, the right type of vibration also induces stratification of the feed material, which allows the fines and smaller particles to work through the layer of particles to the screen surface while causing larger particles to rise to the top. As a result, the larger particles remain on the screen deck and the smaller particles fall through the openings of the screening surface. Thus stratification increases the rate of material passage in the middle section of the screen.



Stratification of Particles on Vibrating Screen

The following figure shows typical throughput along the length of a vibrating screen.



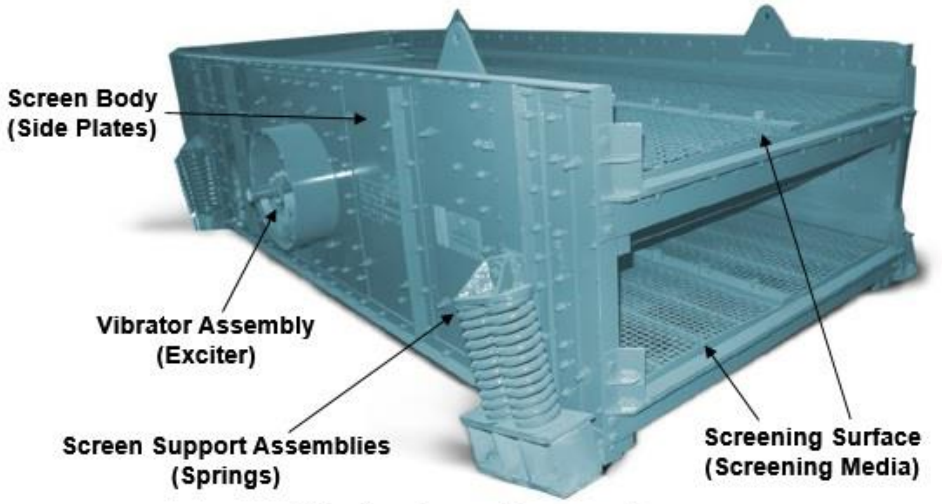
Throughput Along the Length of a Vibrating Screen

The vibration must be sufficient to prevent pegging and blinding. However, excessive vibration intensity will cause particles to bounce from the screen deck and be thrown so far from the surface that there are very few effective presentations to the screen surface. Higher vibration rates can, in general, be used with higher feed rates, as the deeper bed of material has a "cushioning" effect which inhibits particle bounce.

Vibrating Screens

Because, the dominant screen type in industrial applications is the vibrating screen, information on it is given in this chapter.

Vibrating Screen Components



Vibrating Screen Components

Vibrating screens consist mainly of: screen body (vibrating basket / live frame), vibrator assembly (vibrating unit), screening media, supporting frame and drive unit. Above figure shows components of a typical vibrating screen.

Screen Body

The side plates of screen body are reinforced with plates and angles or channels. The side plates are connected to each other by the screen deck (bucker-up-frame or trays) constructed of transversal tubular or channel beams, heavy duty angles and flats; by the feed box; the discharge lip and by the tube of vibrator assembly. The side plates and beams may be protected from abrasion by covering them with wear resistant material. Together these parts form the screen body. The screen body is generally of bolted construction.

The screen deck supports the screening media. Vibrating screens of most types can be manufactured with more than one screening deck. On multiple-deck systems, the feed is introduced to the top coarse screen; the undersize falling through to the lower screen decks, thus producing a range of sized fractions from a single screen. The screen shown in above figure has two decks.

Screening media (cloth or wire screen) is held in place by tension bars, which are attached to the side plates tensioning the screening media over the screen deck.

The tensioning bar on side tension screens also serves as wear protection. Other screen parts exposed to wear are also protected by wear plates / liners.

Screening Media

Separation of material is accomplished by means of screening media, commonly referred to as decks, which act like a filter. Screening media are made of wire, woven wire cloth, perforated plates, grizzly bar set, rubber or polyurethane.

Vibrator Assembly (Exciter)

The vibrations are given to a screen deck by vibrator assembly consisting of unbalanced masses. The vibrator assembly shown in above figure is made up of eccentric shaft contained in the shaft casing. The shaft is supported on two vibration screen duty self-aligning double row spherical roller bearings. The assembly is bolted to the two side plates. The stroke length of vibration can be adjusted by rotating the counterweights installed at the ends of the eccentric shaft. Instead of rotating the counterweights, some design provide arrangement to change mass of the counterweights.

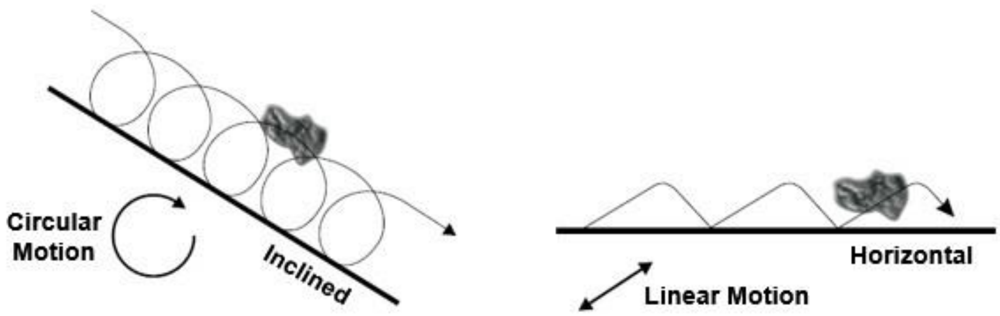
Generally, power is transmitted from the drive motor to the vibrator assembly by V-belt transmission. The speed of the vibrating screen (vibration frequency) can be adjusted by changing the ratio of V-belt sheaves. The eccentrically-bored screen sheave offsets the stroke, so that drive centers do not change during operation. Instead of V-belt transmission, drive motor with cardan/propeller shaft (universal coupling) is also used to drive the vibrator assembly.

Screen Support Assemblies

The screen is supported on all four corners by either steel springs (as shown in above figure) or molded rubber buffers (rubber springs), and it can either rest on the floor (as shown in above figure) or be suspended by rods or chain. Rubber buffers provide longer life and less maintenance than coil springs in wet applications. Marsh Mellow springs by Firestone are rubber springs with fabric. Rubber buffers cannot break, trap particles, corrode, or bottom-out. Bottoming-out under overload or surge load sends a large amount of stress to all of the screen's components. However, rubber buffers have an operating range. It is recommended that shielding should be used to protect the rubber from exposure to hot metal, petroleum base fluids (oil, grease), etc. These springs / rubber buffers absorb about 85% to 95% vibration of the screen, isolating the screen from the supporting structure. Many times, if screen is to rest on floor, the spring support brackets are bolted to the screen body by turnable mounts, allowing the screen to be installed in alternative inclinations.

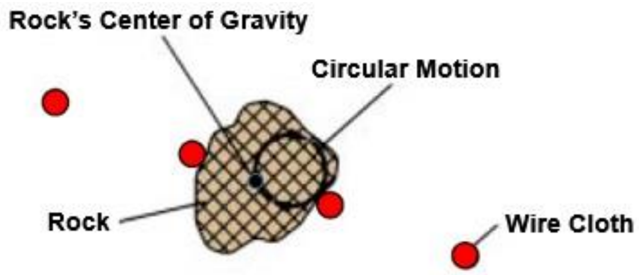
Types of Screen Motion/Stroke

The motion/stroke of a screen is the pattern it makes in space during one revolution. If a person put a dot anywhere on the side of the screen and recorded the path of the dot while the screen was running, the shape of that path would describe the screen's motion (circular, straight line and oval).



Circular Motion and Linear Motion

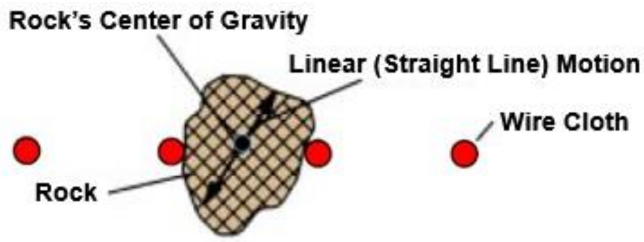
As shown in above figure, the two basic types of screen motions are: circular and linear (straight line).



Circular Motion Incline Screen

Circular motion require gravity to move material down the screen and hence it is employed on incline screens.

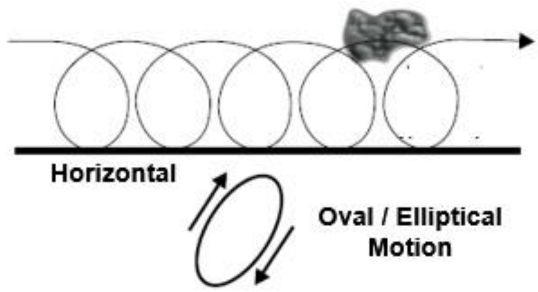
A circular motion along with the incline of the screen tends to tumble the material as it moves over the wire cloth. Tumbling helps to keep material from hanging in the openings and makes it possible for smaller material to pass through.



Linear Motion Horizontal Screen

Horizontal screens and very low degree incline screens employ linear (straight line) and oval motions. A linear motion imparts a back and forth action at some positive angle with respect to vertical. Hence, the wire cloth lifts the material and then drops away from it. This action conveys the material down the screen even though the screen is horizontal. Conveying velocity is constant on linear motion screens from feed to discharge end.

Since the wire cloth is horizontal, the openings, when viewed from above, present a full length opening for material to pass through. Undersize material has the best chance of falling through when the full length of the opening is used.

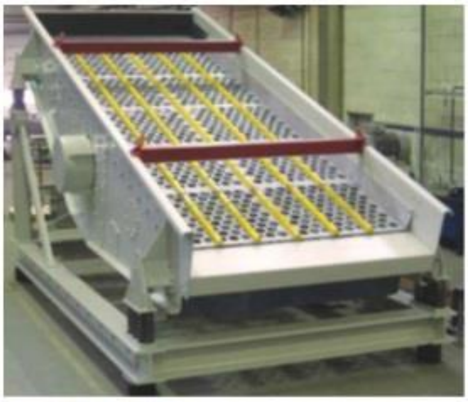


Oval / Elliptical Motion

An oval / elliptical motion is a combination of both the circular motion and linear motion.

Note: In a gyratory motion vibrating screen (called circular, gyratory, or tumbler screens), eccentric mass attached to a vertical shaft gives centrifugal force for horizontal vibratory motion of basket / live frame.

Circular Motion (Inclined) Screens

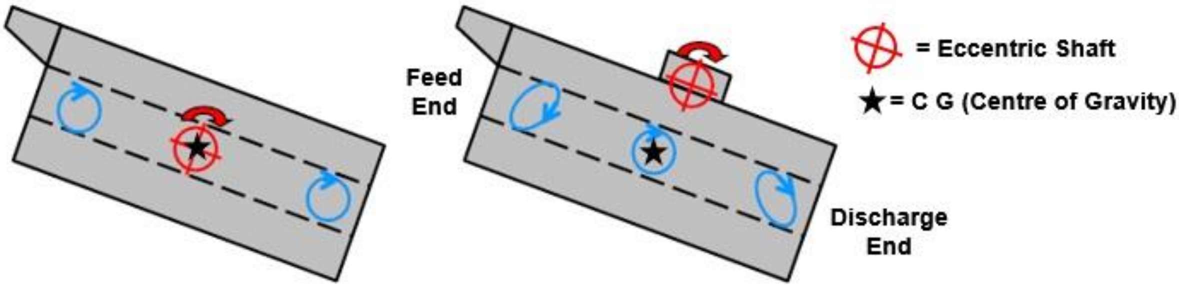


Screen with Single Eccentric Shaft

Screen with Single Unbalance Motor

Circular Motion Screens

Circular motion screens (also called inclined screens) are widely used as sizing screens. These screens must be installed on a slope, usually between 15° and 30° to permit flow of material along the screen. These screens are operated either by a single eccentric (unbalance) shaft or by a single unbalance motor.

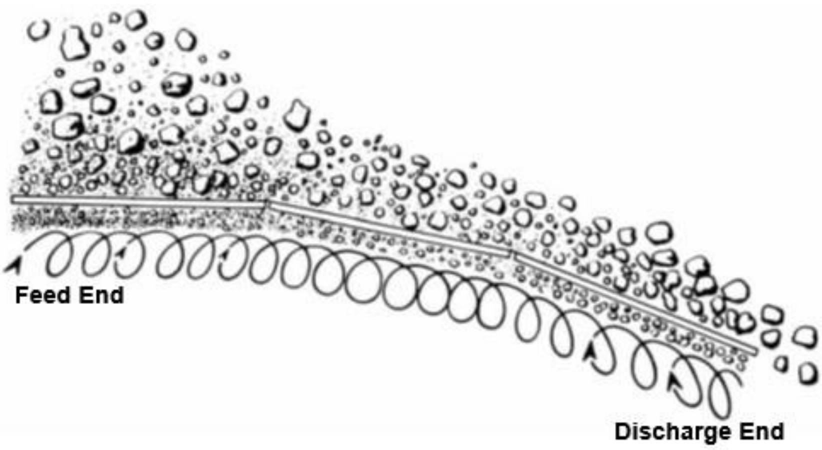


[A] Shaft at Screen's C G

[B] Shaft above Screen's C G

Circular Motion Screen Operated by Single Eccentric Shaft

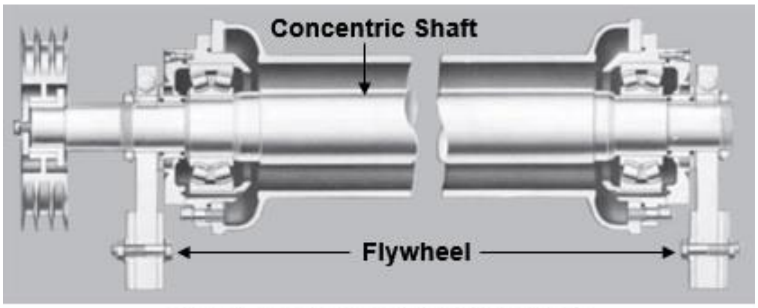
When the shaft of a circular motion inclined screen is located precisely at the screen's C G (centre of gravity), the entire screen body vibrates with a circular vibration pattern as shown at [A] in above figure. Occasionally, the shaft is installed above or below the C G as shown at [B] in above figure. This placement results in an oval / elliptical motion, slanting forward at the feed end; a circular motion at the centre; and an oval motion, slanting backwards at the discharge end.



Opposed Elliptical Throw at Feed End and Discharge End

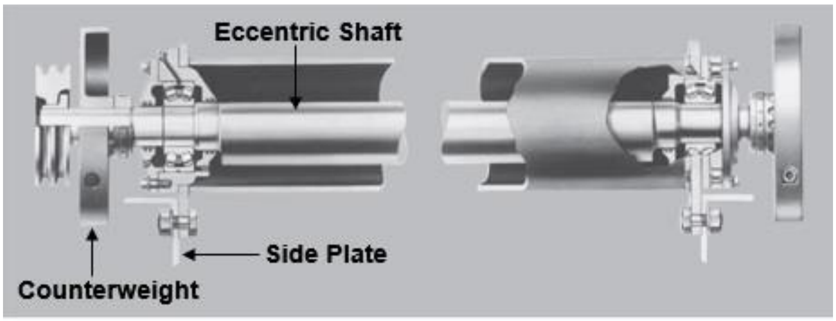
As shown in above figure (screen with adjustable slope panels), forward motion at the feed end serves to move oversize material rapidly out of the feed zone to keep the bed as thin as possible. This action facilitates passage of fines which should be completely removed in the first one-third of the screen length. As the oversize bed thins down, near the centre of the screen, the motion gradually changes to the circular pattern to slow down the rate of travel of the solids. At the discharge end, the oversize and remaining nearsize materials are subjected to the increasingly retarding effect of the backward elliptical motion. This allows the nearsize material more time to find openings in the screen cloth.

In these screens, circular or oval vibration is induced mechanically by the rotation of eccentric weights (flyweights/flywheels) attached to a single concentric drive shaft or eccentric shaft (eccentric mass) as shown in the following figures. The amplitude of vibration (stroke length) can be adjusted by adding or removing weight elements bolted to the counterweights. The rotation direction can be contra-flow or in-flow. Contraflow slows the material and permits more efficient separation, whereas in-flow permits a greater throughput. If two shaft lines are required for increased bearing life or carrying capacity, the shafts are normally timed via a timing belt. In this scenario the shafts rotate in the “same” direction.



Vibrator Assembly with Flywheels

Above figure shows construction of a vibrator assembly (exciter) with eccentric flywheels/flyweights installed on ends of the concentric shaft.



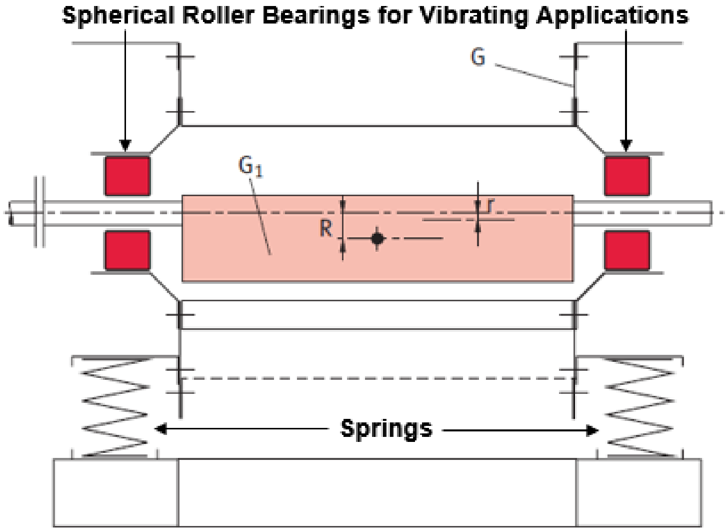
Vibrator Assembly with Eccentric Shaft

Above figure shows construction of a vibrator assembly with eccentric shaft (eccentric mass) and counterweights installed on ends of the shaft for adjustment of vibration amplitude.

Circular motion screens may be mounted on two bearings or four bearings.

Circular Motion Screens with Two Bearings

A two bearing screen is a freely vibrating (free-floating) screen that vibrates in a circular motion and is mounted on helical compression springs. The axis of the shaft traditionally passes through the centre of gravity of the screen frame.



Schematic of Two Bearing Screen

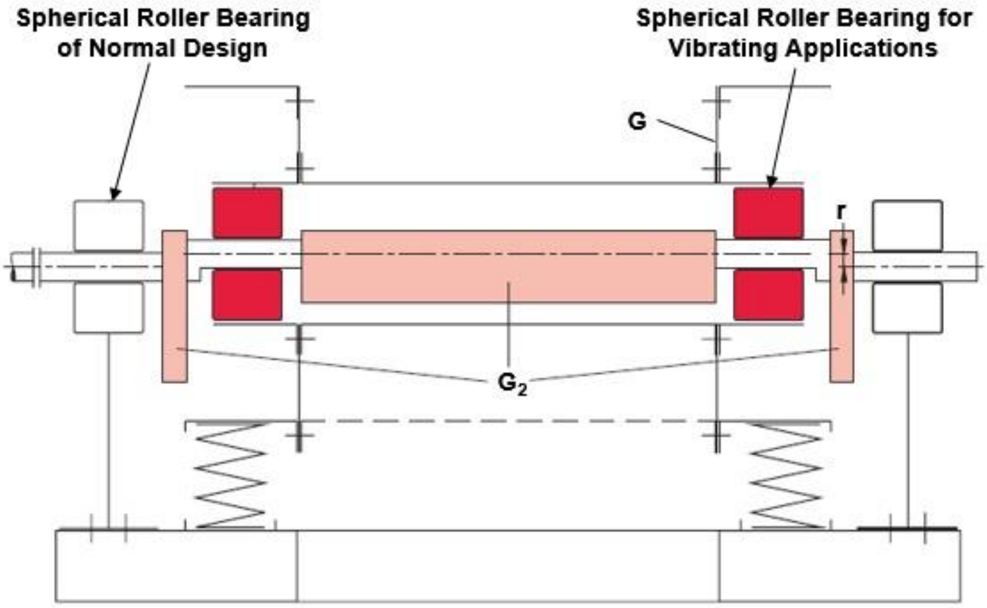
Above figure shows schematic of a two bearing screen. Where,
G = Weight of screen body (box)
G_1 = Weight of exciter
R = Distance between centre of gravity of exciter and bearing axis
r = Vibration radius of screen body (box)

The vibration radius r in a two bearing screen can be determined from the screen body (box) weight and the exciter weight as per equation: $G \times r = G_1 (R - r)$. The vibration radius is thus,

$$r = \frac{G_1 \times R}{G + G_1}$$

As vibrating screens induce acceleration in rollers and cages of the bearings, the bearings are spherical roller type designed for vibrating applications (C4 clearance).

Circular Motion Screens with Four Bearings



Schematic of Eccentric Screen

A circular motion screens with four bearings is called eccentric (excenter) screen. Above figure shows schematic of an eccentric screen. Where,

G = Weight of screen body (box)
G_2 = Weight of counterweights
r = Eccentric radius of the crankshaft

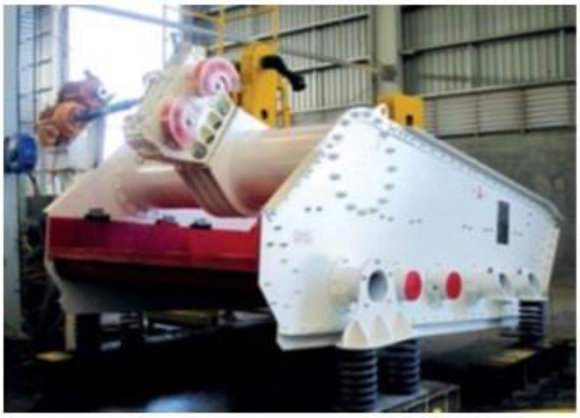
Unlike freely vibrating/floating (freely vibrating/floating means that the amplitude is self-regulating depending on the relationship between the weight of the screen body itself and the counterweight) two bearings circular motion vibrating screens, eccentric vibrating screens are rigidly mounted. They have fixed vibration radius (amplitude). The vibration radius of an eccentric screen is a function of the eccentricity (r) of the crankshaft.

As shown in above figure, eccentric screen consists of an eccentric shaft mounted on the outboard bearings attached to the stationary base frame (main frame) in addition to the bearing arrangement as in case of circular motion screen with two bearing system. The side plate (inner) bearings being eccentric to the outboard bearings, the eccentric shaft serves as both a crank arm and a counterbalance and produces positive action. Due to this positive action (fixed vibration radius), eccentric vibrating screens handle feed fluctuations or hard jolts caused by individual pieces of material easily. Eccentric vibrating screens are used in the mining industry or in applications where high surge loads are common.

Since the rollers and cages of the side plate (inner) bearings of the eccentric screen are subjected to considerably higher accelerations, like in a circular motion screen with two bearings, they are spherical roller type designed for vibrating applications. However, because the outboard bearings are only lightly loaded, they are spherical roller type bearings but of normal/standard design. It is estimated that 70% of the screen frame is supported by the springs and the remainder of the force is supported by the stationary base frame (main frame) bearings.

Linear Motion Vibrating Screens

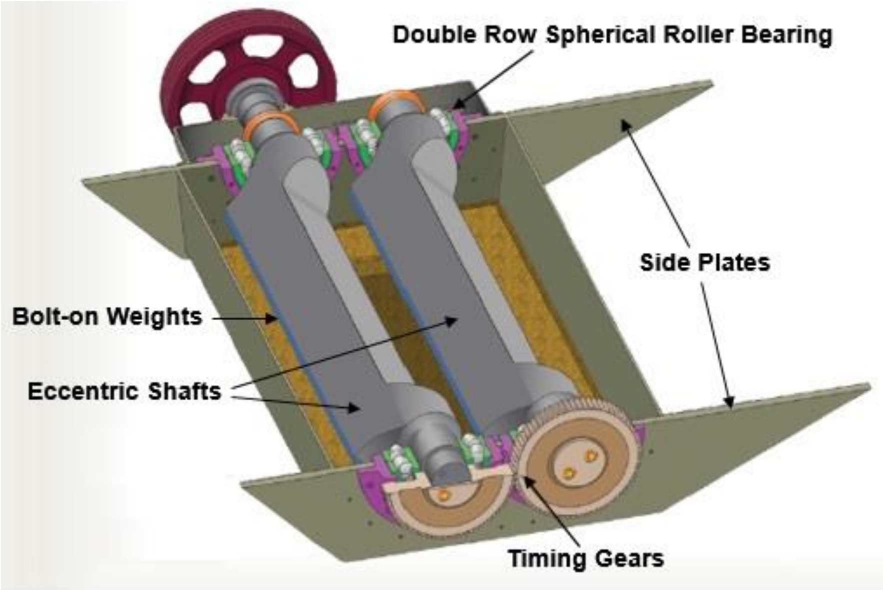
Screen Operated by Two Unbalance Motors



Screen Operated by Unbalance Exciter

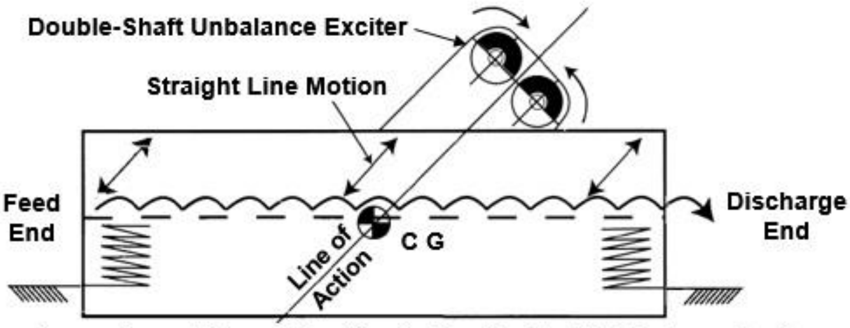
Linear motion screens

Linear motion screens are operated either by two unbalance motors or an unbalance exciter with two shafts (two gearwheel force-synchronized shafts fitted with unbalance weights). In both cases their shafts rotate in opposite directions to create linear vibration. Since a vibrator assembly of a linear motion screen consists of two shafts, these type of screens are often called double shaft screens.



Construction of Typical Unbalance Exciter with Eccentric Shafts

Instead of using two gearwheels synchronized shafts fitted with unbalance weights on ends of their shafts, an unbalance exciter construction may have two gearwheels synchronized eccentric shafts as shown in above figure (or eccentric shafts without gearwheels but driven by synchronized motors for their synchronization). The amplitude of vibration (stroke length) can be adjusted by adding or removing bolt-on weights installed on the eccentric shafts (or in case of construction with flyweights, adding or removing bolt-on weights installed on flyweights at ends of the eccentric shafts).



Generation of Linear Vibration by Double-Shaft Unbalance Exciter

As shown in above schematic figure, linear (straight line) vibration is generated in a linear motion vibrating screen by an unbalance exciter with its two shafts rotating in opposite directions (or by two unbalance motors rotating in opposite directions).

Linear motion screens can be installed on a downward slope, horizontally or even on a small up-hill incline. The angle of motion/stroke is typically between 30° and 60° to the screen deck. Linear motion exciters are used on horizontal screens and banana screens.

Dewatering screens are often installed with a slight up-hill incline [Typically, the screen deck is minus-3 degrees (negative slope)] to ensure that water does not flow over with the product. A thick bed of particles forms, trapping particles finer than the screen aperture.

Horizontal Screens

Horizontal screens (low-head vibrating screens) have a horizontal or near-horizontal screening surface, and therefore need less headroom than inclined screens. Horizontal screens must be vibrated with a linear or an oval/elliptical motion produced by a double-shaft or triple-shaft unbalance exciter.

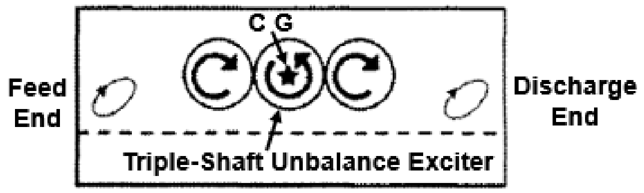
The accuracy of particle sizing on horizontal screens is superior to that on inclined screens. However, because gravity does not assist the transport of material along the screen they have lower capacity than inclined screens. Horizontal screens are used in sizing applications where screening efficiency is critical, and in heavy media recovery (drain and rinse screens) for reuse of media in the process (e.g. Ferrosilicon or Magnetite).

Screen Choice - Circular Motion v/s Linear Motion

Screens using circular motion are best suited for larger material, as finer material tends to blind on this style of screen. Also, wet, sticky material does not screen well with this type of screen, unless water spray is also used. Because they are inclined, circular motion screens provide a high travel rate.

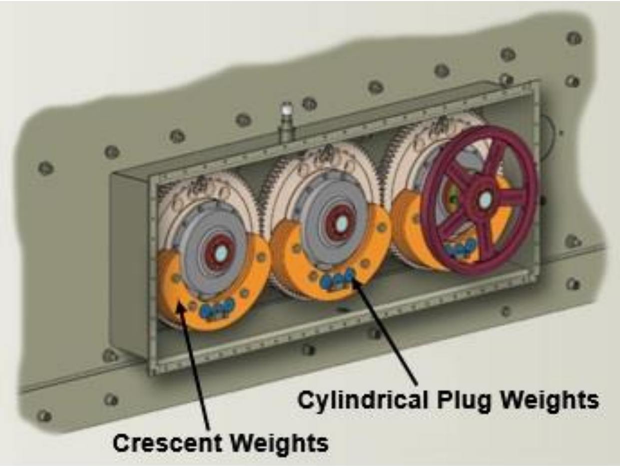
Linear motion horizontal screens typically generate less blinding and pegging of material on screen media because their straight-line motion, with high G-forces, can both dislodge material and convey it forward across the screen. This motion can be more effective than circular motion screens, resulting in a high efficiency screen that also operates at a fairly high speed. Linear motion screens also benefit through a lower installed cost because they require less headroom than circular motion screens.

Oval Motion (Triple-Shaft) Screens



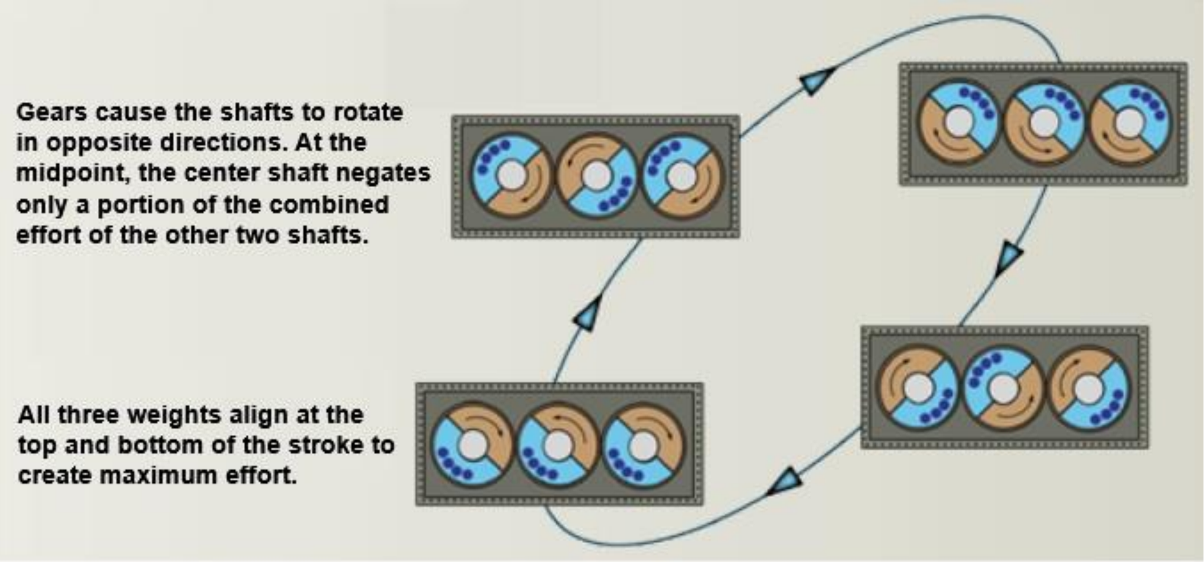
Generation of Oval Motion by Triple-Shaft Unbalance Exciter

A triple-shaft (three shafts) unbalance exciter design can be used to generate an oval/elliptical vibratory motion as shown in above figure.



Triple-Shaft Unbalance Exciter

Above figure shows construction of a triple-shaft unbalance exciter. While crescent weights are used for primary stroke setting, cylindrical plug weights are used to "fine tune" the stroke. Stroke angle can be adjustable by changing the gear timing.



Oval/Elliptical Stroke Generation in Triple-Shaft Unbalance Exciter

Above figure schematically shows how the oval/elliptical stroke is generated in a triple-shaft unbalance exciter.

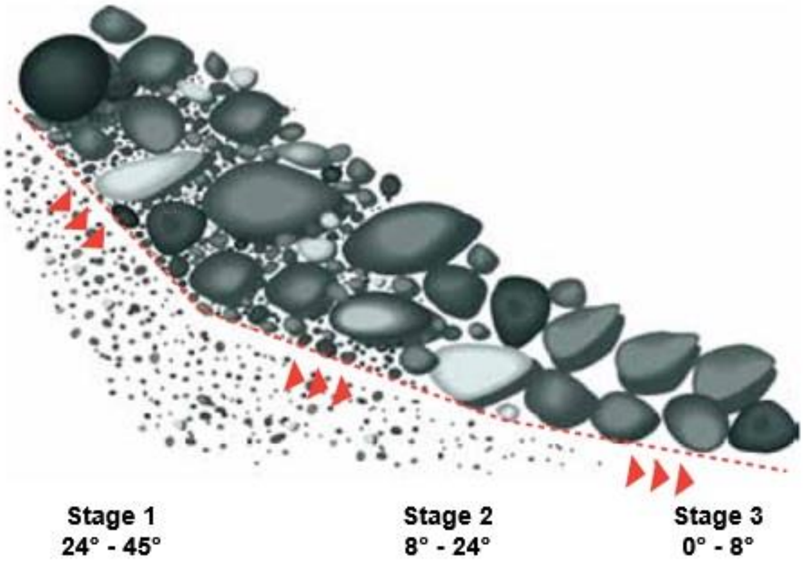
Oval vibratory motion can be used on horizontal and banana screens. The oval motion is claimed to offer the efficiency benefit of a linear vibrating screen with the tumbling action of a circular motion screen. Higher capacities and increased efficiencies are claimed over either linear or circular motion machines.

Banana (Multi-slope) Screens

Banana (Multi-slope) screens have become widely used in high-tonnage sizing applications where both efficiency and capacity are important.


Banana Screen

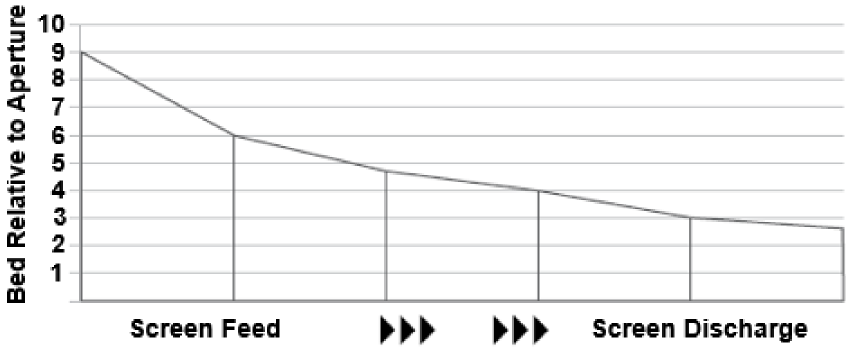
Banana screens typically have a variable slope of around 24°-45° at the feed end of the screen, reducing to around 0°-8° at the discharge end of the screen. Banana screens are usually designed with a linear motion/stroke vibrator.



Principle of Banana Screening

Stage 1: High velocity
The feed section (highly inclined) of a banana screen causes high velocity material flow which serves to quickly remove fine material.
Stage 2: Medium velocity
Midway along a banana screen, the resultant thinner bed stratifies quickly. The remaining fine material (below the cut point) is screened out more effectively than would be possible on a slower thicker bed.
Stage 3: Low velocity discharge
The lower screen slope slows the material down. More efficient screening of near size material occurs here.

As shown in above figure, the steep sections of the screen cause the feed material to flow rapidly at the feed end of the screen. The resulting thin bed of particles stratifies more quickly and therefore has a faster screening rate for the very fine material than would be possible on a slower moving thick bed. Towards the discharge end of the screen, the slope decreases to slow down the remaining material, enabling more efficient screening of the near-size material.



Bed Depth Profile on Banana Screens

Above figure shows a typical bed depth profile on banana screens.

The various slopes may also incorporate deck media with different apertures to meet the particular process requirements. The screens are commonly designed to fit modular rubber or polyurethane deck panels. However, woven wire or punched plates may also be used, depending on requirements.

The capacity of banana screens is significantly greater and is reported to be up to three or four times that of conventional vibrating screens.

Grizzly Screens

Very coarse material is usually screened on an inclined screen called a grizzly screen. Grizzlies are characterized by parallel steel bars or rails set at a fixed distance apart and installed in line with the flow of material. The gap between grizzly bars is usually greater than 50 mm and can be as large as 300 mm, with feed top size as large as 1 m. Vibrating grizzlies are usually inclined at an angle of around 20° and have a circular throw mechanism.

The bars are typically made from wear-resistant manganese steel, and are usually tapered to create gaps that become wider towards the discharge end of the screen to prevent material from wedging between the bars.

Flip Flow Screens

Flip Flow Screen

Flip flow screens use a system of flexible screen panels that are alternately stretched and relaxed to impart motion to the screen bed instead of relying only on mechanical vibration of the screen body. The throwing action can generate forces of up to 50 G (G is the gravitational force) on the screen surface, preventing material from blinding in the apertures. The screen body may be static or subjected to accelerations in the range 2 to 4 G.

Flip flow screens are an effective alternative to conventional vibrating screens (circular motion or linear motion screen using inflexible/rigid screens) for processing materials with inherent blinding characteristics that cannot be screened efficiently by them. They are particularly suited for efficient screening of moist, sticky, fibrous, wet bulk materials with a high percentage of fines or near size particles.

The basic principle of the trampoline-like movement is used in the screen panels of a flip flow screen.

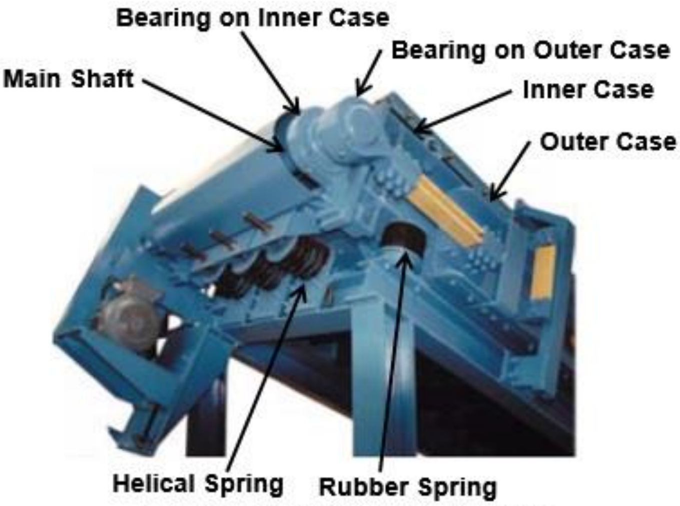
The Flip-Flow action stretches and slackens the elastic screen panels very quickly imparting high force (up to 50 G).

The elastic screen panel is not only tensioned but additionally stretched up to 10 mm. As a result, the shape of perforation is slightly changed and clogging and sticking of grain is prevented. This is an option which cannot be given by any conventional screening machine with inflexible screen panels!

Construction and Working of Flip Flow Screens

In this section, construction and working of a flip flow screen is explained using LIWELL's screening machine (by HEIN, LEHMANN).

The flip flow screen has two screen cases to which crossbeams are attached. A V-Belt from 1200 rpm motor drives the main shaft at about 600 rpm. The main shaft with machined excenters on the screen runs in large roller bearings. Two bearings are installed on the inner case and two on the outer case.



Flip Flow Screen Support System

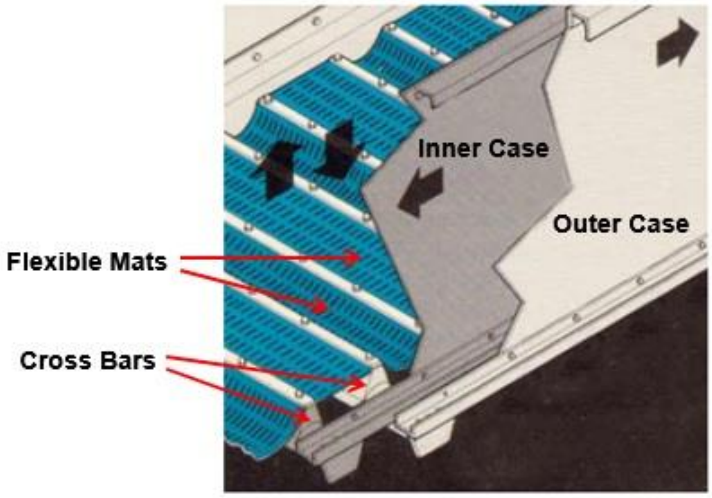
As shown in above figure, helical springs are arranged between the inner screen case and the supporting jack. They ensure that the screen is kept in the correct position according to the angle of inclination. The inner screen case is also supported on the supporting jack by means of rubber springs.

Suspension of Outer Case from Inner Case

As shown in above figure, the outer screen case is suspended from the inner screen case by fibreglass guide springs.

Transfer of Motion to Outer Frame

As shown in above figure, the circular motion of the excenters is transferred to the outer frame via fibreglass thrust rods.



Fixing of Flexible Screen Mats to Cross Bars

As shown in above figure, the flexible screen mats are mounted to cross bars alternately fastened to the inner and outer screen cases. In service, the outer and inner screen cases move against each other in a linear motion driven from the single shaft with excenters at approximately 600 rpm. The opposing action tensions and releases the flexible screen mats. The excenters ensure a positive movement, enabling the screen mats to be stretched at the end of each stroke. The change in shape of the mat and apertures and the high forces dislodge particles before they peg. The screen itself is subjected to only 2 to 3 G, while the material being screened is exposed to force (acceleration) of about 50 G.

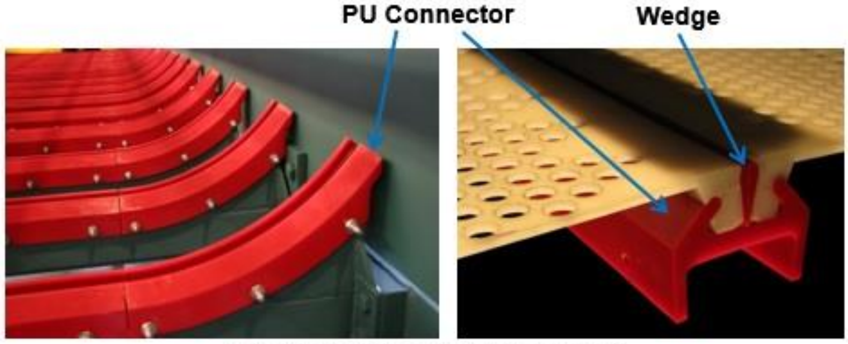

Tensioning and Releasing of Flexible Screen Mats

Above figure schematically shows the process of tensioning and releasing of flexible screen mats. An unbalanced shaft (main shaft) puts a circular motion into the machine frame (inner screen case) while simultaneously being used as an eccentric shaft to generate the changing rotation of the cross bars via rocker arms.

These units are typically in dual vibrations modes. The shaft thru the body (inner case) giving a 2-3 G range of accelerating force in a circle throw type of motion and the screen mats moving in its own orbit or mode of vibration at up to 50 G accelerating force INDEPENDENT of the vibrating body motion.

The flexible screen mats are made from low-wear special polyurethane materials with mechanical/dynamic properties that remain constant on a long-term basis. The mats are clamped to the cross bars with clamping bars by means of bolts and nuts.

The nuts should be tightened to the recommended torque only. The mats will be squeezed in and get damaged at higher tightening torques and at too low torques, the fixing holes will be widened during the tensioning phase and the mats cannot be tensioned according to the designed value.



Boltless Screen Mat Attachment

As shown in above figure, some manufacturers are offering boltless screen mat attachment for quick and easy change-out. They use semi-rigid, snap-fit interference wedge with PU connector. The PU connector is bolted to the cross bar.

Binder+Co is also a reputed manufacturer of flip flow screens.

For more information on flip flow screens, please visit websites of HEIN, LEHMANN (LIWELL's screening machine) and Binder+Co (BIVITEC screening machine).

Screen Media / Screening Surface and Accessories

Information on screen media / screening surface and accessories is given in this chapter.

Screen Media / Screening Surfaces

Screen media is a replaceable wear surface that can be made up of one or more removable sections on a single deck. Selecting the proper screen media for a given application is the key to screening efficiency (sizing accuracy) and maximum throughput. The selection of the size and shape of the apertures, the proportion of open area, the material properties of the screening surface, and flexibility of the screen surface can be critical to the performance of a vibrating screen.

There are many types of screening surface available for industrial vibrating screens. Screening surfaces are usually manufactured from steel, rubber, or polyurethane, and can be classified according to how they are fixed to the screen. Tensioned, bolt-in and modular fixing systems are used on vibrating screens.

Tensioned screen surfaces consist of cloths that are stretched taut, either between the sides of the screen (cross tensioned) or along the length of the screen (end tensioned). Maintaining the correct tension in the screen cloth is essential to ensure screening efficiency and to prevent premature failure of the screening surface. Tensioned screens are available in various wire weaves as well as polyurethane and rubber mats.

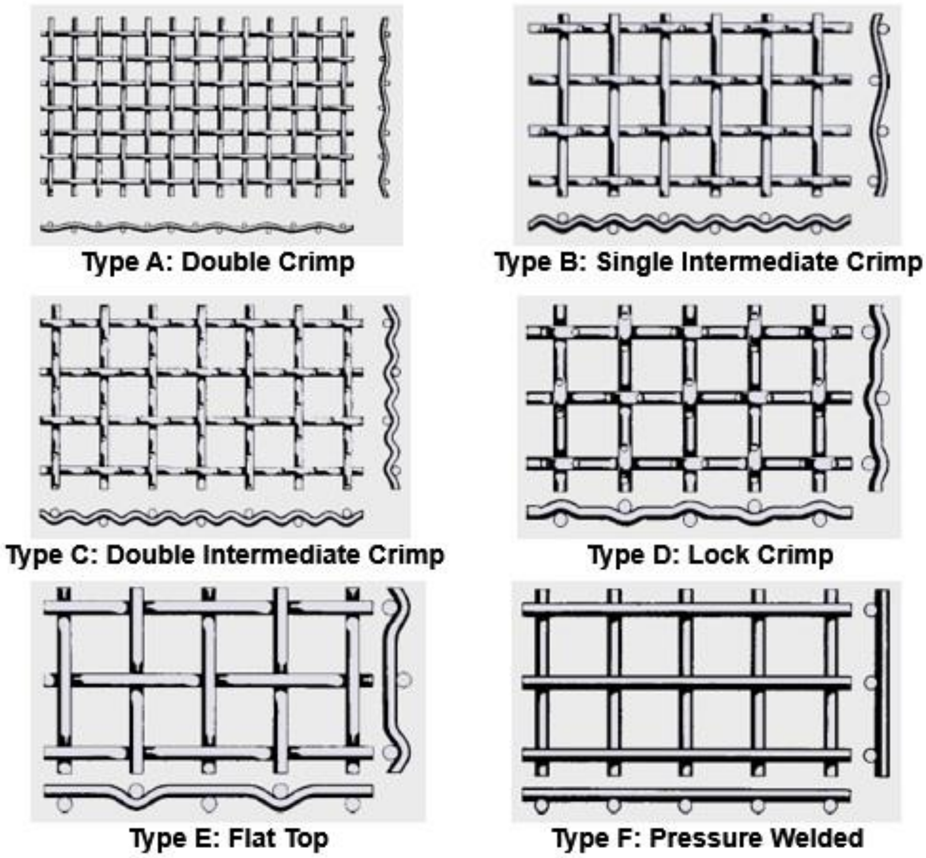
Wire cloths are the cheapest screening surfaces, have a high open area, and are comparatively light. The high open area generally allows a screen to be smaller than a screen with modular panels for the same capacity duty. Wire cloth screens are often preferred in relatively light screening duties. Increasing the wire thickness increases their strength, but decreases open area and hence capacity.

Wire cloth can be manufactured from any metal or alloy that can be drawn into wire which is suitable for weaving. The selection of the material is dependent on the intended usage and consideration of various factors including strength, abrasion resistance, chemical resistance, corrosion resistance, heat resistance or the suitability for use in food production etc. The most commonly utilized materials in wire cloth weaving are as under.

Material	Application
High Carbon Steel	High carbon (generally 0.5% C) hard drawn steel is used when resistance to abrasion and impact is required. This material is commonly utilized in agriculture, coal, gravel, mining, sand and stone separating, sizing and sorting applications.
Oil Tempered Carbon Steel	Oil tempered wire is specially tempered high carbon steel wire to provide high tensile strength with increased ductility, high impact resistance and longer fatigue life.
Stainless Steel Types 301, 304 and 316	These stainless steel are austenitic type. Austenitic stainless steels are used for resistance against corrosion. Typical applications include use with chemicals, food products, pharmaceuticals and exposure to moisture. • SS 304 has been called 18/8 stainless steel, because it contains nominally 18% Cr and 8% Ni. • In SS 301, as compared to SS 304, % of Cr and Ni is lowered to increase its work hardening property. • As compared to SS 304, in SS 316, Mo is added to increase its corrosion resistance.
Stainless Steel Type 430	This is ferritic stainless steel. It is magnetic. The lack of nickel in this type of stainless steel results in lower corrosion resistance than the austenitic stainless

	steels (chromium-nickel stainless steels). This type cannot be hardened by heat treatment (because of low carbon content) and can only moderately hardened by cold working.
Other Types	Popular types for the industrial market are: Low Carbon (for lower abrasion applications), Copper, Bronze, Brass, Aluminum, Aluminum Alloys, Nickel, Nickel Alloys and Monel.

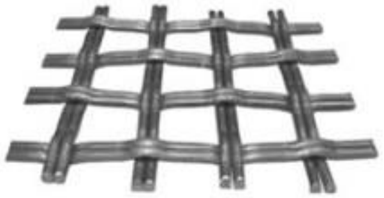
Efficient screening of materials requires the right weave. Following figure shows commonly used weaves types according to ISO 4783/3.



Weaves Types According to ISO 4783/3

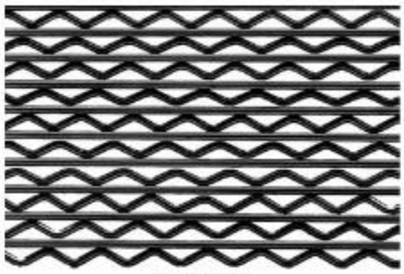
Weave Type and Description	Application
Type A: Double Crimp Woven wire cloth	A smaller opening weave type. All around efficient and long-wearing performance in a variety of applications.
Type B: Single Intermediate Crimp Woven wire cloth with intermediate crimps	Plain warp* wires, weft* wires with intermediate crimps between wire intersections.
Type C: Double Intermediate Crimp Woven wire cloth with intermediate crimps	Warp and weft wires with intermediate crimps. This type of weave is used for relatively thin wires or for oblong or slot mesh screens.
Type D: Lock Crimp Woven wire cloth pre-crimped on both sides	A larger opening weave style for scalping and heavy applications. Wire is locked in place for long wear and accurate opening sizes for the life of the screens.
Type E: Flat Top Woven wire cloth pre-crimped on one side only, leaving the other side flat.	May improve material flow with flatter surface than other weaves. Wear is equal over the whole upper surface of the screen.
Type F: Pressure Welded Pressure welded (spot welded) screen	Made from steel wires and immovably locked together by pressure welding. The intersections remain in place until the wires are completely worn.

* - Wires along length of the screen are called warp wires whereas wires along width of the screen are called weft wires.



"Twinwire" Screen

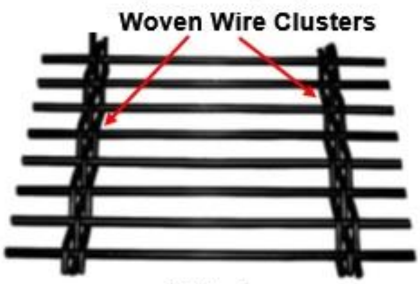
The proprietary "TwinWire" screen manufactured by Unified Screening & Crushing are designed for high impact, top deck applications. They are typically used for 1.5” openings and larger.



W Style

D (Diamond) Style

H (Herringbone) Style



T Style

FLOWMAX Clean Screens

Traditionally, blinding problems have been countered by using wire with long-slotted apertures or no cross-wires at all (piano-wire) but at the cost of lower screening efficiency. Self-cleaning (non-blinding) screening surfaces is a variation on this, having wires that are crimped to form "apertures" but individual wires are free to vibrate and therefore have a high resistance to blinding and pegging. As shown in above figure, individual wires are held in their position by woven wire clusters. Screening accuracy can be close to that of conventional woven wire mesh; and they have a longer wear life, justifying their higher initial cost. Above figure shows FLOWMAX Clean (Self-cleaning) Screens manufactured by Unified Screening & Crushing.

W Style

Alternating straight and formed wires vibrate at different frequencies to clean the screening surface. Triangular-shaped openings for accurate sizing.

D (Diamond) Style

Diamond-shaped openings for accurate sizing.

H (Herringbone) Style

Herringbone weave pattern. This pattern prevents roots, grass and other debris from clogging the screening surface. Recommended only for light applications

T Style

T-slot screens are an affordable alternative to high-cost piano wire screens.

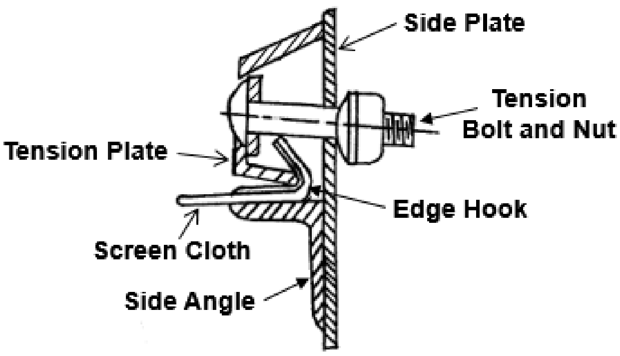
Diamond (D) Style with Polyurethane Strips

As shown in above figure, life of self-cleaning screens can be increased by replacing the woven wire clusters of a self-cleaning screen with durable polyurethane strips (called FLOWMAX SuperFlow Screens by Unified Screening & Crushing).

Tensioned rubber and polyurethane (polyether and polyester urethane compounds) mats that can be interchanged with tensioned wire cloths are also available. These mats are usually reinforced with internal steel cables or synthetic cords. Rubber and polyurethane can have significantly longer wear life than steel, although the open area is generally lower than wire. Because tensioned media are quicker to replace than modular screening systems, they are preferred where frequent deck changes are required to produce different specifications.

Screen Tensioning

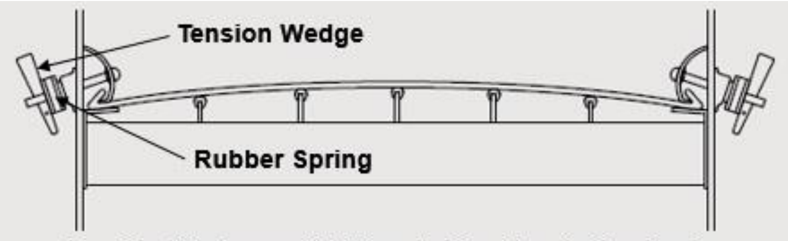
Proper screen tension is crucial for effective screening and longer screen life. Proper screen tension helps spread material across the full width of the screen. Uniform tension must be also maintained on the screen surface to prevent whipping and to maintain contact between the screen surface and the capping rubber (also called channel rubber, bucker-up rubber, etc.) on the longitudinal support (camber) bars for preventing damage to (breakage of) screen cloth.



Typical Screen Cloth Tensioning Arrangement

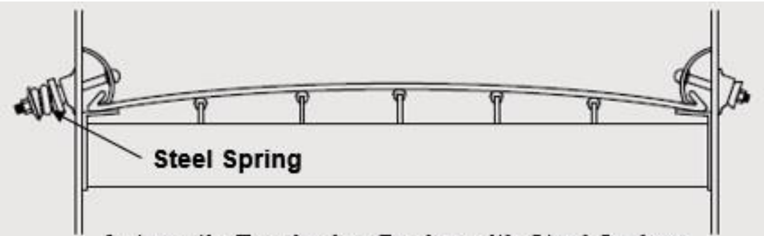
As shown in above figure, for proper screen tensioning; tension plates (also called tension bars, tension rails, clamp down rails, side hold down, etc.) and tension bolts with swivel nuts (or swivel/spherical/taper washer and hex nut) are commonly used for heavy wire cloth or perforated plate (screen cloth) with edge hooks (hook strips) on side tensioned vibrating screens. Tension plates, tension bolts, etc. are called screen accessories.

During operation, as the screen may become loose due to stretching (as the screen cloth wire wears thin) and loosening of the hooks, it is important to periodically check the screen, and retighten the hooks.



Tension Wedge and Rubber Spring Tensioning Device

Above figure shows the most common type of tensioning device for fine and medium weight cloth consisting of tension wedge and rubber spring. This tensioning device has the advantage of quick tightening or easy release, while at the same time providing constant tension through the action of the molded rubber spring. Because the wedges are held firmly in place by spring action, constant attention (retightening) is not required.



Automatic Tensioning Device with Steel Springs

Above figure shows other automatic tensioning device for fine and medium weight wire cloth or light weight perforated plate consisting of steel spring assembly. As the screen cloth gets stretched, the springs automatically keep the cloth in constant tension.

Edge Hooks

As shown in following figure, edges of screen cloth are hooked to provide even tensioning across the screen. Many times edges are banded to strengthen them. Following figure shows popular hooks made by Unified Screening & Crushing, USA (website address: www.unifiedscreening.com).

Popular Edge Hooks

US-1:
This type has plain formed edge. This type is used for screens of 5/16" and larger diameter wire. Edges are annealed by controlled heating before forming to eliminate cracking and breakage.

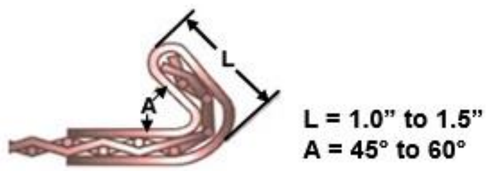
US-2:
Reinforced shroud banded edge is standard type. This type is used for screens of up to 1/4", and also available on diameters of 5/16" and 3/8" upon request. Standard shrouding is 18 gauge steel, however it is available with other thicknesses also.

US-3:
This type has inside reinforced formed edge. This type is used for screens of 1/4" diameter wire and larger to provide superior tensioning. A 1/8" steel angle insert is welded inside the wire hooks, strengthening the screen for uniform tensioning and ease of installation.

US-4:
This type has welded bent plate edge. This type is used for 5/16" wire diameters and larger. In this type 3/16" or 1/4" steel angle is welded on the screen edge.

Shrouding materials include stainless, galvanized and mild steel. Screens with rubber inserts are also available for additional pull-out resistance on 0.080 diameter wire and smaller.

As shown in the following figure, generally hook length (L) is 1" to 1 1/2" and angle (A) is 45° to 60°.



Hook Dimensions

Screen Size

While ordering a screen, specify its length and width as under.

Width of Flat Screen with Hooked Edges

Width of a screen can be specified as its OCW (outside clamping width) or ICW (inside clamping width). For this, you can either check the equipment manual, or measure an old screen, or if an old screen is not available, in case of flat (without camber) screens, measure the clear width between the side plates and subtract 1-1/2" to determine the OCW.

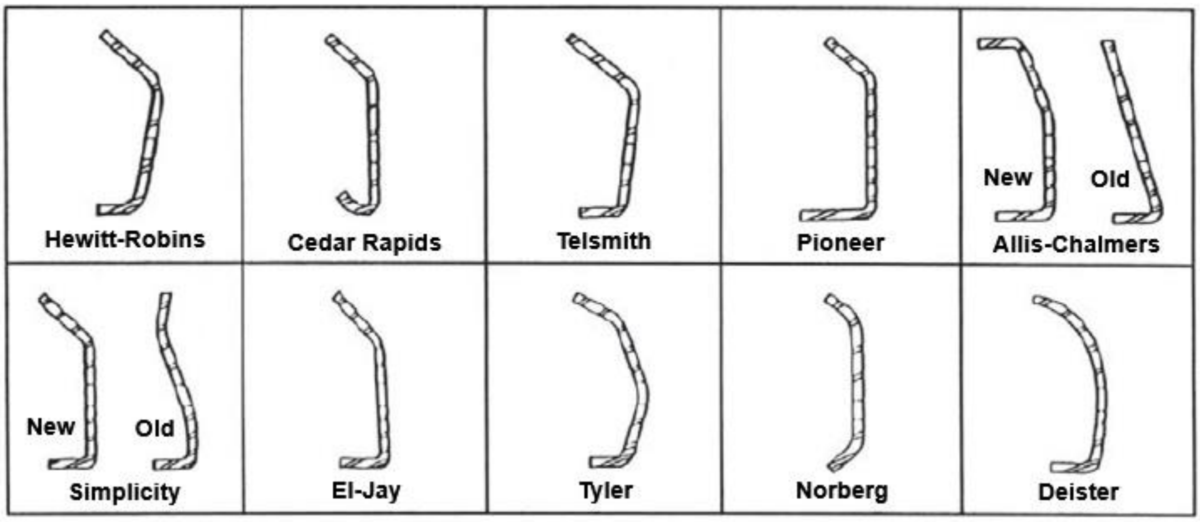
When specifying screen length, always measure along the clamping edge and be sure to indicate any screen overlap, if required.

Lapped ends eliminate any leakage of oversized materials where screen sections meet. Normally, laps are 1" to 2" and are typically ordered with screens having an opening size of 1/4" or smaller.

For ordering a screen, specify the overall width first, then specify the length of the hook and the amount of screen overlap (length of the screen without hook) you need.

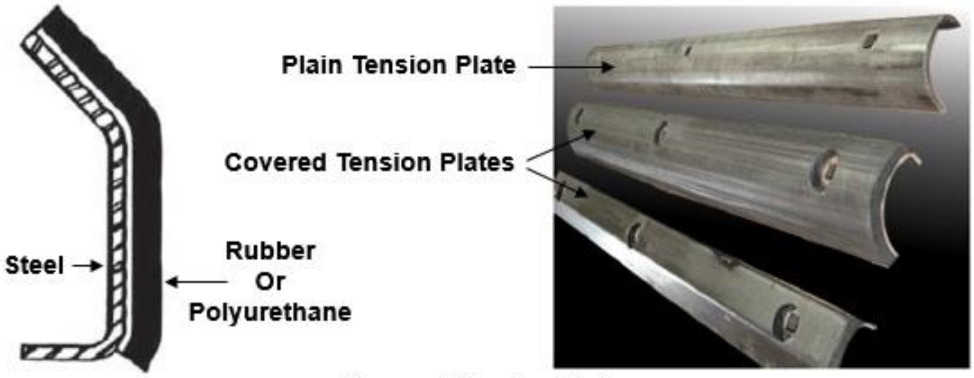
For example: 60” OCW x 96” long, 96” hook allowing for 2” lap (98" total length).

Tension Plates



Tension Plate Styles

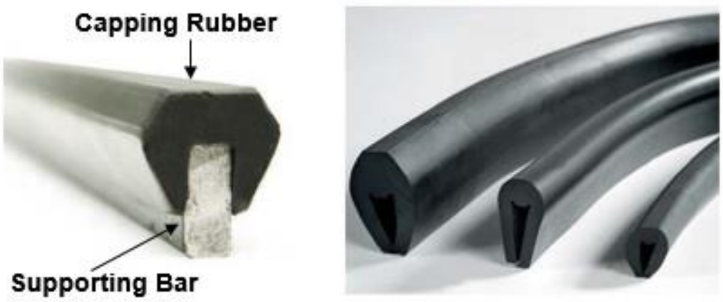
Tension plates are made in various styles/shapes. Above figure shows styles of tension plates manufactured by some original equipment manufacturers.



Covered Tension Plates

As shown in above figure, rubber or polyurethane covered tension plates are also available for highly abrasive screening applications.

Capping Rubber



Capping Rubber

Capping rubber (also called channel rubber, bucker up rubber, bucker up channel, bucker up strip, crown bar rubber, buffer strip, buffer channel, screen cloth protector, etc.) is installed on top of the longitudinal screen supporting bars (also called support bars, camber bars, bucker bars, stringer bars, etc.) underneath the tensioned media or pre-tensioned media, to protect them from abrasion.

Capping rubber protects both the underside of the screen cloth and longitudinal supporting bars by absorbing shocks caused by materials falling on the screen and preventing metal-against-metal wear and damage (screen wire breakage). Thus it acts as a sacrificial cushion to increase life of the screen. If this covering becomes worn, it should be replaced with new rubber.

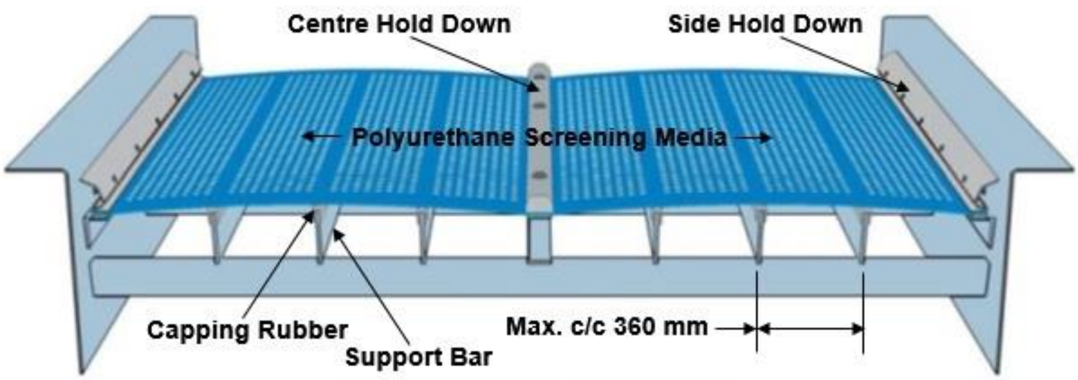
Capping rubber is available having round top or flat top in different widths and heights to suit different types of support bars. Their legs are tapered slightly inward to aid in gripping the support bar to prevent rolling. Capping rubber is available in hardness of 60 to 75 Shore A (Tensile Strength @ 80 Kg/cm^2 and Elongation @ 250%).

Tensioned Polyurethane and Rubber Screening Media

Tensioned Polyurethane Screening Media

A tensioned polyurethane screening media with moulded holes is primarily used for fine to medium coarse screening in wet applications. The media is generally used for separations between 1 and 45 mm and max feed lump size of 100 mm. The moulded holes and the flexibility of the polyurethane reduce the risk of pegging and blinding of the cloth. By using polyurethane media on the screens, the noise level in the plant is reduced, improving the working environment.

Above figure shows tensioned polyurethane screening media. It can be manufactured for both crosswise and lengthways tensioned screens. Following figure shows tensioned polyurethane screen with cambered (arc shape) screen deck, equipped with support bars.



Tensioned Polyurethane Screen

As shown in above figure, for wide screens (more than 1500 mm width), centre hold down bars are recommended to prevent the media from flapping.

It is recommended that if the feed drop height is over 1 m, either an impact pad or a thicker screen panel should be used at the point of impact.

Like tensioned polyurethane screening media, tensioned rubber screening media is also available. Tensioned rubber screening media with punched holes is used for fine to medium coarse dry screening applications. The media is generally used for separations between 5.6 and 63 mm and max feed lump size of 150 mm.

Tensioned wire cloth can be replaced by tensioned polyurethane or tensioned rubber screening media without modification of the screen.

Bolt-in Screening Surfaces

Bolt-in Screening Surface

Screening surfaces for screening duties with particles larger than around 50 mm frequently consist of large sheets of punched, flame-cut, or plasma-cut plate steel, known as perforated plates or punch plates. They are manufactured from mild steel to abrasion resistant (AR) steel, all the way up to the 400 to 500 Brinell (a measurement of the hardness of the steel plate), providing for longer wear life and durability. These sheets are bolted to the screen deck.

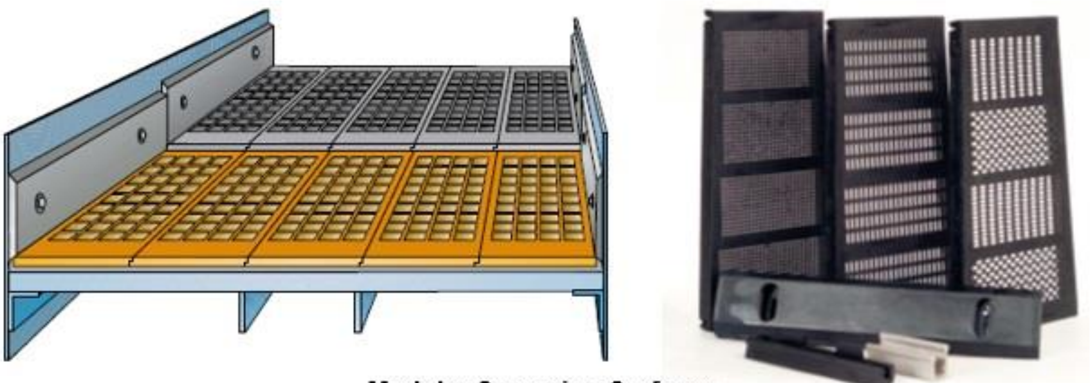
Impact and highly abrasive raw material are the primary reasons for using perforated plates. Unlike woven wire cloth, perforated plate has a level screening surface, free from high points, which rapidly wear away in many sever screening applications. The sliding material - oversized, near sized, and undersized - "sees" a uniform screening surface and 'freely flows" down the length of the screen deck, effectively separating the oversized material from the undersized particles.

Often they are sandwiched with a polyurethane or rubber wear surface to maximize wear life. Durable in impact and wear applications, these screening surfaces can out last metal screening surface. Rubber will absorb and bounce back from high impact that would break AR plate or comparable materials.

Rubber is used for scalping applications and coarse dry screening whereas polyurethane is especially good for wet applications and extreme wear life.

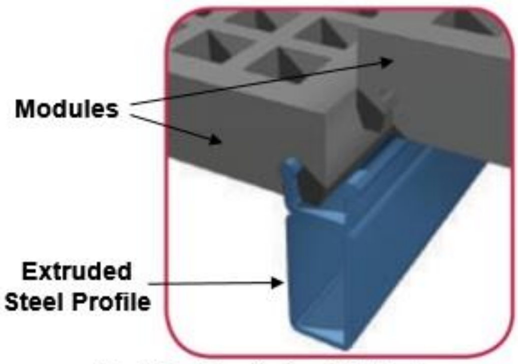
These screening surfaces are available with custom-designed aperture shapes and sizes.

Modular Screening Surfaces



Modular Screening Surfaces

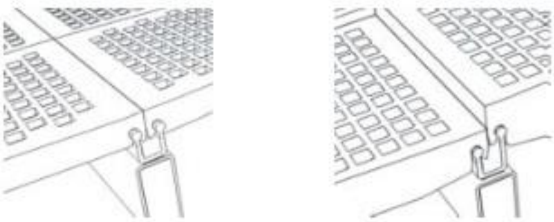
For harsh screening duties rubber and polyurethane screen decks made up of modules or panels that are fixed onto a sub-frame are very popular. Both materials offer exceptional resistance to abrasion. While rubber is used for dry screening applications, polyurethane is generally preferred for wet applications.



Modules Fastening Method

Modular screen panels are typically 1’ x 1’ (305 x 305 mm), 2’ x 1’ (610 x 305 mm) or similar in size. The edges of the panel typically contain a rigid steel internal frame to give the panel strength. Various methods are used for fastening these modules onto a sub-frame., In one of the methods, a double snap-on locks the modules onto extruded steel profiles as shown in above figure.

Modular systems allow for rapid replacement of the deck. It also allows installation of different panel types and aperture sizes at different positions along the screen to address high wear areas and to optimize any given screening task. Modular screens do not require tensioning and re-tensioning and damaged sections of the screen can be replaced in situ. They also allow for selective change out of individual worn panels, as opposed to a complete wire cloth panel that would need to be changed out if one section was worn.



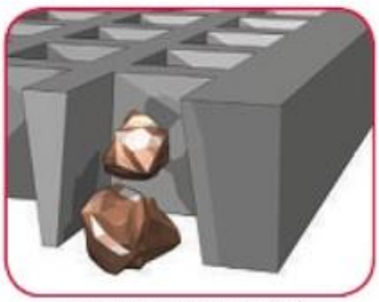
Flat Deck Stepped Deck

Snap-on Locks for Flat and Stepped Deck Configurations

When using modular system, the deck configuration can be either flat, stepped or high-low. A flat deck allows the material bed to be evenly distributed over the full width of the screen, increasing screen efficiency. Steps improve stratification and allow smaller particles to reach the screen surface quicker. For final screening, a high-low configuration can be used to reduce the material speed and increase screening accuracy.

The wear life of rubber and polyurethane screens is about 10 times more than wire cloth screens. Rubber and polyurethane screens are also quieter and the more flexible apertures reduce blinding compared with steel wire cloths.

Square, rectangular, and slot apertures are the most commonly used aperture shapes. Rectangular and slot apertures can be in-flow (usual for sizing applications), cross-flow orientations (usual for dewatering applications), or diagonal. Rectangular and slot apertures provide greater open area, throughput, resistance to pegging and efficiency with slabby particles compared with square apertures. Other aperture shapes include circles, hexagons, octagons, rhomboids, and tear-drops. Circular apertures are considered to give the most accurate cut, but are more prone to pegging. Slotted, tear-drop, and more complex aperture shapes are used where blinding or pegging can be a problem. The recommended hole size should be 1.25 to 2.5 times the screen panel thickness.



Tapered Apertures

As shown in above figure in case of molded openings, apertures usually have a tapered profile (typically tapered by 3 to 7 degrees per side), becoming wider with depth, thereby reducing the propensity of particles pegging in the aperture.

Sandvik offers modular screening media for a variety of applications: WM4000/5000 are for fine screening in difficult conditions with feed lump size between 10-50 mm, WM6000/7000H/7000HD for fine to medium coarse screening in dry applications with feed lump size between 20-150 mm and WM7000 polyurethane screening media in wet applications with feed lump size between 10-100 mm.

WM4000/5000 are anti-blinding modules made of a special soft rubber (50 Shore A for 2.5 mm thickness and 40 Shore A for thickness > 2.5 mm) with punched openings that prevents pegging and blinding in difficult conditions (screening small particles with high moisture content). They are used for separation between 2 to 16 mm and a maximum feed size of 50 mm.

WM6000/7000H/7000HD are modular screening media of rubber (WM6000 - 60 Shore A, WM7000H and WM7000HD - 70 Shore A) with punched or moulded openings primarily for fine to medium coarse screening in dry applications with a separation between 10 to 63 mm and a maximum feed size of 150 mm.

WM7000 is modular screening media of polyurethane with molded openings primarily for fine to medium coarse screening in wet applications with a separation between 1 and 31.5 mm and a maximum feed size of 100 mm.

For more information on above products, please view https://www.rocktechnology.sandvik

Hybrid Screen Decks

Rubber and Wire Cloth Screen Deck with Rubber Lined Tension Plates

As rubber offers excellent resistance to impact and abrasion it is ideally suited for scalping applications or on the feed panel of any top deck. In view of this as shown in above figure sometime a hybrid rubber and wire cloth screen deck is used instead of wire cloth deck to prolong its life.

Hybrid wire cloth can maximize open area and wear life. Urethane-encapsulated wire offers the advantage of urethane screen media (wear life and noise reduction) without the need to convert to a modular deck and without great sacrifice to open area.

Choosing Proper Screen Media

Screen media originated with the steel options of wire and plate. Now, the choices include wire, perforated and flame-cut plate, polymers (polyurethane and rubber), and hybrid media. Here's a closer look at each of those options.

The two most important factors for screen media selection are the screen panel life expectancy and open area. Designers should examine the issue of maximum open area versus maximum wear life - there has to be a tradeoff between the two in designing the configuration of screen panel openings. In general, wire cloth will provide the maximum open area with a sacrifice to wear life, and the reverse is true for polymer (rubber and polyurethane), screen media.

Wire cloth is the best option for an operation with frequent media change outs as a result of varying product specifications.

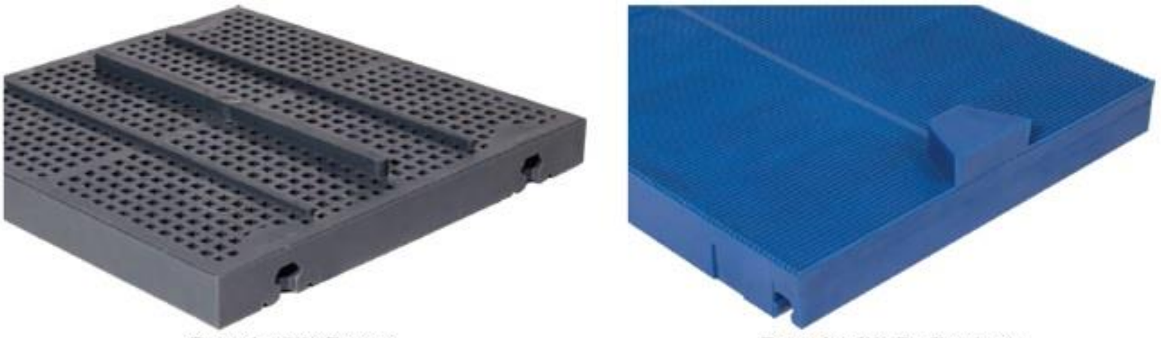
Perforated and flame-cut plate screens are a good alternative for providing longer wear life and durability.

Polymers are available in full panels, bolt-on and in modular system. Rubber is ideal in dry, high-impact applications and can often be used in place of plate screens, depending on the nature of the feed. Self-cleaning rubber (soft rubber) screens are used in fine, moist / sticky or near-size material applications to prevent blinding from fines buildup, and to gain greater sizing accuracy. It is recommended to use rubber having hardness of shore A 60 for dry feed > 35 mm and rubber having hardness of shore A 40 (soft rubber) for dry / moist feed < 40 mm. Natural rubber panels are often recommended as they retain open area even in very sticky materials. Polyurethane is available in different durometers and more frequently applied in wet applications though it does have its place in dry applications as well. Polyurethane is frequently used in wet applications where water is added or the feed is in slurry form. Polyurethane is also the best choice for dewatering screens.

Special surface features, such as skid bars, dams and deflectors can be used to enhance performance of modular systems. When produced by an injection molding process, these features can be molded into the surface as part of the original panel construction.

Panels with Skid Bars

Panels with skid bars reduce panel wear because the oversize material (large lumps) is kept off from the screen panel surface.



Panel with Dams **Panel with Deflectors**

Panels with Dams and Deflectors

Dams are used to control (slow) material flow rates and create a tumbling effect to intensify the dewatering and washing effect. Molded into the sides of screen panels, deflectors help redirect material toward the middle of the panels to maximize screening efficiency.

Ultimately when making a decision on screen media, the purchaser/buyer needs to consider the benefits realized and the overall costs over the life of the media panel. A panel with a higher upfront cost may provide significant wear life or throughput benefits, compared with one offered at a fraction of the cost. Therefore, cost per ton of material processed is a more accurate gauge of the cost of screen media.

Factors Affecting Screen Performance

Information on basic terms for screening, factors affecting screen performance and screen capacity / size calculation is given in this chapter.

Basic Terms

Stratification

This phenomenon occurs as vibration is passed through a bed of material. The vibration of the machine sifts the material bed so that finer material passes through the coarser material. This enables particles smaller than the mesh of the screen to pass through it.

Bed Depth

It is the depth of the material on any given screen deck. The depth of the material on the screen affects the ability of the screen to stratify the material and allow the fines to pass through the deck

Travel Rate

The speed at which material travels down the screen.

Open Area

Open area of a screen is defined as the ratio of the net area of the apertures (holes) to the whole area of the screening surface. Many times it is also expressed as a percentage of the screening surface area. It helps to determine the screen capacity.

Screen Efficiency

The percentage of material that falls through a screen compared in relation to the total amount of material in the product stream of that size.

Screen Stroke

The shape and amplitude of the motion of a screen. Usually screen stokes are circular, oval or strait line strokes.

Frequency - Measured in hertz (Hz) or revolutions per minute (RPM)

Frequency is the number of times the screen cloth peaks and troughs within a second. For a gyratory screening motion, it is the number of revolutions the screen deck takes in a time interval, such as revolution per minute (RPM).

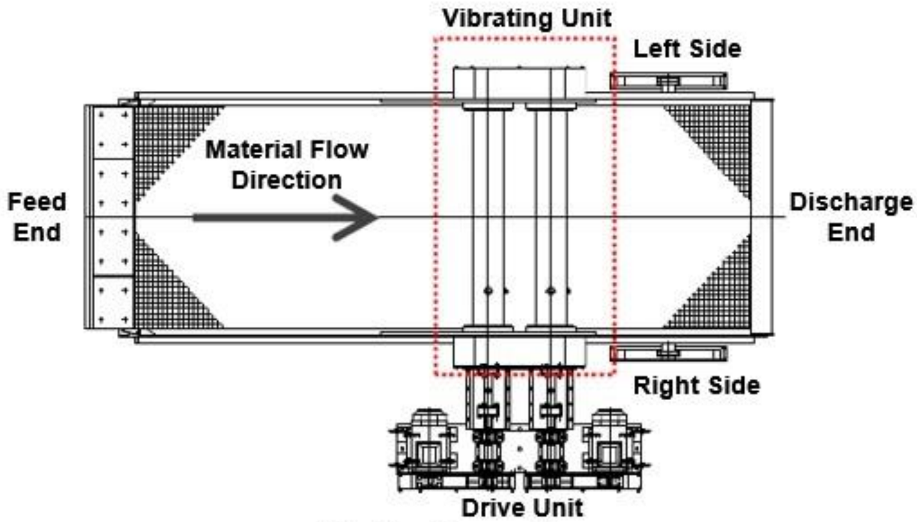
G-Force of a Screen

The force at which a screen moves to the top and returns to bottom of its respective stroke.

Plugging happens when near-size particles become lodged, blocking the openings.

Blinding occurs when moisture causes fine particles to stick to the surface media and gradually cover the openings.

Vibrating Screen Terms



Vibrating Screen Terms

Above figure defined terms like feed end, material flow direction, left side, right side, etc.

The hand of drive is determined by looking from feed end to discharge end (i.e. material flow direction). The screen shown in above figure is right handed.

Factors Affecting Screen Performance

There has been no universally accepted method of defining screen performance and a number of methods are employed. The most common screen performance criteria used is efficiency. The efficiency of screening is determined by the degree of perfection of separation of the material into size fractions above or below the aperture size. It is a measure of how much of the feed material should have gone through the hole versus how much really did go through the hole.

As per VSMA (Vibrating Screen Manufactures Association) Handbook,

$$\text{Efficiency} = \frac{\text{TPH of Undersize in feed which actually passes}}{\text{TPH of Undersize in feed (should pass)}}$$

It is also referred to as “Efficiency of Undersize Recovery”.

Screen effectiveness must always be coupled with capacity as it is often possible by the use of a low feed rate and a very long screening time to effect an almost complete (100%) separation. However, most screening applications do not require 100% size separation and the lower the requirements in that regard the higher the capacity of a given system. Hence, for calculated capacities many manufacturers use an efficiency of 90% or 95%, when not otherwise specified.

Following factors affect screen performance / efficiency

Particle Size

The process of screening is a series of probabilistic events, where particles are presented to a screening surface many times, and on each presentation there exists a given probability that a particle of a given size will pass.

As the particle size approaches that of the aperture, the chance of passage falls off very rapidly ("Half Size" and smaller particles pass/go fairly easily whereas "Near Size" takes a lot more time). Hence the overall screening efficiency is markedly reduced by the proportion of these near-mesh particles. The effect of near-mesh particles is compounded because these particles tend to "peg" or "plug" the apertures, reducing the available open area.

Particle Shape

Most granular materials processed on screens are non-spherical. While spherical particles pass with equal probability in any orientation, irregular-shaped near-mesh particles must orient themselves in an attitude that permits them to pass. Elongated and flat particles will present a small cross-section for passage in some orientations and a large cross-section in others. Hence elongated or flat shapes particles does not pass easily. Even they hinder passing of other particles also. The extreme particle shapes therefore have a low screening efficiency.

Feed Rate

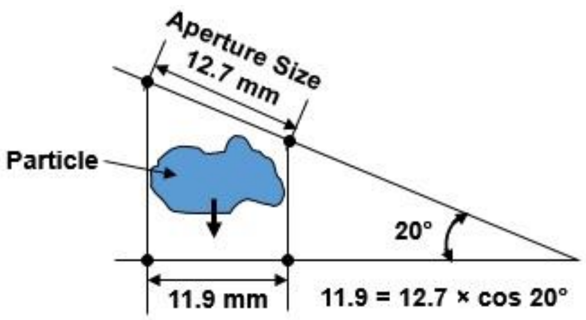
Feed rate affects material bed depth. Sieve sizing analysis use a low feed rate and a very long screening time to effect an almost complete separation. In industrial screening practice, economics dictate that relatively high feed rates and short particle dwell times on the screen should be used. At these high feed rates, a thick bed of material is presented to the screen, and fines must travel to the bottom of the particle bed before they have an opportunity to pass through the screen surface. The net effect is reduced efficiency. High capacity and high efficiency are often opposing requirements for any given separation, and a compromise is necessary to achieve the optimum result.

For efficient screening, recommended height of the material bed depth (for dry screening of material weighing 100 pounds per cubic foot) is as under.

Feed End: Maximum = 10 × aperture size
Discharge End: Less than 4 × aperture size (Example: For a ½" aperture, a bed depth of no more than 2") [Less than 3 × aperture size for material weighing 50 pounds per cubic foot].

Minimum bed depth is 1 × aperture size. If bed depth is too thin, material can bounce, stay suspended and thus reduce accuracy.

Screen Angle



Effect of Screen Angle on Aperture

The screen angle changes the size of the aperture relative to what the particle sees. That is, when viewing a screen opening from above, the more horizontal the screen deck lays, the larger the opening appears (size of opening seen will be largest when screen is horizontal).

As shown in above figure, if a particle approaches an inclined screen, it will "see" a narrower effective aperture dimension (11.9 mm instead of 12.7 mm) and near-mesh size particles are less likely to pass.

In view of this, horizontal screens are selected where screening efficiency is important.

The screen angle also affects the speed at which particles are conveyed along the screen, and therefore the dwell time on the screen and the number of opportunities particles have of passing the screen surface.

Open Area

The chance of particle passing through the aperture is proportional to the percentage of open area in the screen material which is defined as the ratio of the net area of the apertures to the whole area of the screening surface. The smaller the area occupied by the screen deck construction material, the greater the chance of a particle reaching an aperture.

Open area generally decreases with the fineness of the screen aperture. In order to increase the open area of a fine screen, very thin and fragile wires or deck construction must be used. This fragility and the low throughput capacity are the main reasons for classifiers replacing screens at fine aperture sizes.

When considering maximum open area, it is important to understand that the percentages of open area listed in conventional wire cloth media catalogs are based on all the openings in a section of the screen. Yet, a good portion of those openings are blocked by tension plates, support bars. capping rubber and center hold downs.

Moisture

The amount of surface moisture present in the feed has a marked effect on screening efficiency, as does the presence of clays and other sticky materials. Damp feeds screen very poorly as they tend to agglomerate and "blind" the screen apertures.

Vibration

Screens are vibrated in order to throw particles off the screening surface so that they can again be presented to the screen, and to convey the particles along the screen. The vibration also induces stratification of the feed material.

Generally, coarse separation (screening with larger apertures) is performed using larger amplitudes (strokes) and lower frequencies (speeds); whereas for fine separation (small/fine apertures), small amplitudes and high frequencies are preferred.

The vibration must be sufficient to prevent pegging and blinding. However, excessive vibration intensity (vibration G-force) will cause particles to bounce from the screen deck and be thrown so far from the surface that there are very few effective presentations to the screen surface. Higher vibration rates can, in general, be used with higher feed rates, as the deeper bed of material has a "cushioning" effect which inhibits particle bounce.

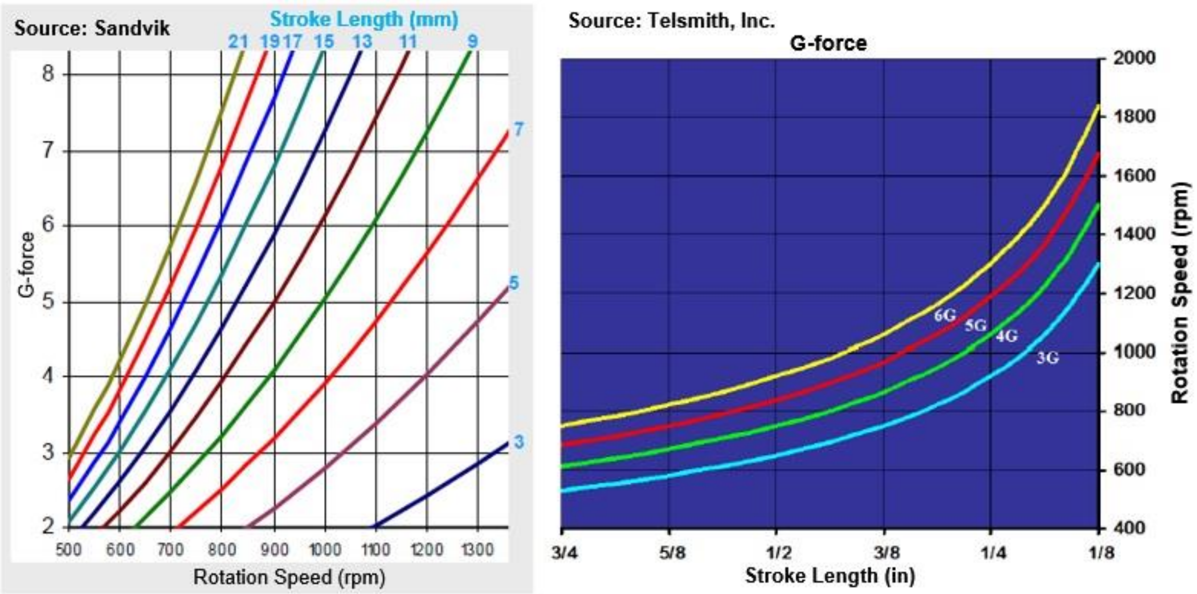
Vibration intensity can be characterized by the vibration frequency, f cycles per second and amplitude, a metres. The term "stroke" is commonly used and refers to the peak-to-peak amplitude, or $2a$.

The intensity of vibration is defined by the vibration G-force as under:

$$\textbf{Vibration G-force} = \frac{a(2\pi f)^2}{9.81}$$

It can be seen from above formula that vibration frequency (rotation speed) and amplitude (*a*) or stroke (2*a*) affects the vibration G-force. Hence, G-force of a vibrating screen can be altered/changed by changing speed and/or changing amplitude of the vibrating screen.

Vibration frequency (*f*) can be changed by changing drive's V-belt pulleys or inverter parameters. The change in rotation speed will not have any effect to the amplitude (stroke length). The amplitude can be changed by altering (adding or removing) the counterweights.



Relationship between G-force, Rotation Speed and Stroke Length

Above figure shows relationship between G-force, rotation speed (stroke frequency) and stroke length.

Speed and Stroke are selected based on the application. Vibrating screens typically operate with a vibration G-force between 3G to 7G (3 to 7 times the force due to gravitational acceleration).

Following are the typical G-force levels as per one of the leading vibrating screen manufacturer.

- Inclined Screen: 3.3 to 4.0
- Horizontal Screen: 4.5 to 7.0
- Feeders: 2.0 to 5.0

Inclined Screens (VSMA) Stroke, Speed and Slope Selection For dry 100 lbs per cubic foot material and shaft rotating with the flow.															
			Top Deck Opening												
Stroke (in)	Speed (rpm)	G-force	35 Mesh to 50 Mesh	20 Mesh to 35 Mesh	10 Mesh to 20 Mesh	4 Mesh to 10 Mesh	4 Mesh to 1/2”	1/2” to 1”	1” to 2”	2” to 3”	3” to 4”	4” to 6”	6” to 8”	Above 8”	Slope Range (Degree)
0.03	3500	5.2													24-30
0.05	2600	4.8													24-30
1/16	2100	3.9													22-28
3/32	1800	4.3													22-26
1/8	1600	4.5													22-26
3/16	1400	5.2													20-25
1/4	1000	3.6													18-25
5/16	900	3.6													18-25
3/8	850	3.8													18-25
7/16	750	3.5													18-25
1/2	700	3.5													18-25

Preferred   Acceptable

Above table may be used to select stroke, speed and slope for inclined vibrating screens.

Horizontal Screens (VSMA) Stroke and Speed Selection For dry 100 lbs per cubic foot material and shaft rotating with the flow.							
			Top Deck Opening				
Stroke (in)	Speed (rpm)	G-force	4 Mesh to 10 Mesh	4 Mesh to 1/2”	1/2” to 1”	1” to 2”	2” to 4”
3/8	950	4.8					
7/16	900	5.0					
1/2	850	5.1					
5/8	800	5.7					
3/4	750	6.0					

Preferred   Acceptable

Above table may be used to select stroke and speed for horizontal vibrating screens.

Since high G-force level leads to higher stress, higher wear and reduction in bearing life, it is recommended that G-force should be as kept as small as possible. It also reduces energy costs.

- Doubling of speed quadruples stress.
- Doubling of stroke doubles stress.
- 10% increase in speed halves the bearing life.

Screen Capacity / Size Calculation

Screen capacity models aim to predict the required area of screen and are frequently used by screen manufacturers. Most aim to predict the quantity of undersize that can pass through the screen. The theoretical screen area required is calculated by the following equation.

$$\text{Theoretical screen area} = \frac{\text{Total t/h undersize in feed}}{C \times F_1 \times F_2 \times F_3 \times \dots \times F_n}$$

where,
C is basic screen capacity in t/h of undersize per unit area.
F_1 to F_n are correction factors.

Common correction factors include corrections for the following.

Quantity of oversize material (material larger than the aperture) - If most of the input is larger than the mesh size, a significant portion of near size material will be suspended above the big particles on the wire cloth and have no chance of passing through an opening.

Quantity of half-size material (material less than half the aperture size) - The higher the percentage of small size feed material, the greater the screen capacity. The faster the material passes through a screen, there is more open area left on the screen for the remaining material.

Density of material - A heavy undersize material is likely to pass through an opening while a light undersize material tends to bounce around on top of the oversize material and the wire cloth.

Deck factor (whether the screen is a top deck or a lower deck on a multi-deck screen) - This factor takes into account that on lower decks not all the length of the screen is being used. By the time material has passed through an upper deck it has traveled part way down the length of the screen.

Open area of the screen cloth - This factor is a measure of how much of the screen area has actual “holes” versus how much is wire. Obviously, wire cloth manufactured with thicker gauge wire has less open area. The open area factor is based on the percent of area available for material to pass or the area of the screen deck minus the cross sectional area of the wire. The greater the percent of open area and the larger the openings the greater the screen capacity.

Shape of the openings - This factor is based on the shape of the openings (square or slotted) in the wire cloth and the ease with which material may pass through. Slotted wire has an increased capacity over square opening wire. Of equal importance is the fact that slotted wire cloth is less likely to blind over.

Spray (whether wet-screening is employed) - The spray factor, is meant to account for the effect that a spray system has on screen capacity. A spray system will almost always increase the capacity of a screen. How much depends on how well the system is designed and on the opening size of the wire cloth. It also depends on the relationship of the wire opening to the material sizes. Spray systems are most effective on wire cloth opening sizes from 1/8” to 1”. Type of spray pattern and volume of water also plays a role in the spray factor. Spray systems which introduce all the water at the feedbox are generally less effective than sprays which distribute the water over a greater area of the deck. Another prerequisite for an efficient spray system is an adequate supply of water. Insufficient water volume may turn fines to sticky mud causing blinding. Blinding reduces the percent of open area, which reduces capacity.

Desired screening efficiency - Most screening applications do not require 100% efficiency (size separation) and the lower the requirements in that regard the higher the capacity of a given system. For calculated capacities many manufacturers use an efficiency of 90% or 95%, when not otherwise specified.

Quantity of near-size material - Near size material is defined as being within plus or minus 10% of the size of the given opening. The closer a material size is to the wire cloth opening size, the harder it is to screen. Such material tends to momentarily lodge in the wire cloth, reducing capacity by blocking off the smaller material.

Bed depth - This factor is based on the observation that the greater the depth of material in relation to the wire cloth opening, the less the capacity of the screen. Using the feed rate, density of material, conveying speed and width of the screen, the theoretical depth of material can be calculated.

Type of feed material condition - This factor is meant to account for moisture, clay, etc. in the feed material. Moisture can affect separation as it presents problems with blinding of the screen surface. Clay and mud in feed material tend to bond to materials reducing the speed at which under size material will pass a given opening or move down a screen deck.

Product shape - Shape factor is meant to account for the effects on screen capacity of deviations in product shape from cubical or spherical to elongated. Elongated material, “slivers” in aggregate jargon, is that which has a length three or more times its major thickness. The more elongated material there is in the feed the greater the tendency for material to hang in the openings, or simply bounce around on top of the screen without falling through.

The values of the basic capacity and for each of the factors are available in the form of tables or charts.

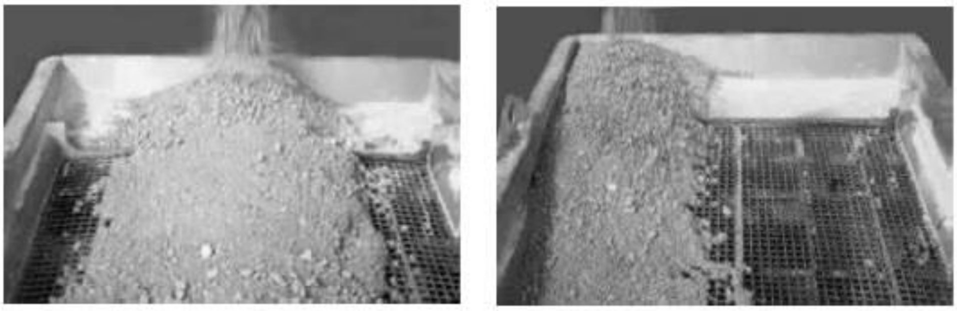
To select the size of a screen, first determine, from the bed depth calculations, the width that will maintain the proper bed depth for efficient screening and then choose the length that together with the width, provides a minimum total screening area equivalent to that arrived at in the screen area calculations.

While above theoretical screen area required calculations are popular, they have been generally developed for a specific type of screen - inclined circular motion/stroke vibrating screens using standard wire-mesh screen cloth.

Though the screen area calculations deal with a mathematical formula, there are several factors unaccounted for in this formula. It is impossible and impractical to assign a numerical value to all of the uncontrollable variables present in separating materials. That is why it important that the formula be considered as only a guide. Experience and common sense must be applied after completing capacity calculations.

Now numerical computer simulations are being increasingly used to model the behavior of particles in various processing equipment including vibrating screens. It is expected that numerical simulation techniques such as the Discrete Element Method (DEM) will gain wider application in the modelling of industrial screens, and assist in the design and optimization of new vibrating screens.

Feed Chutes



Right Way Wrong Way

Feeding a Vibrating Screen

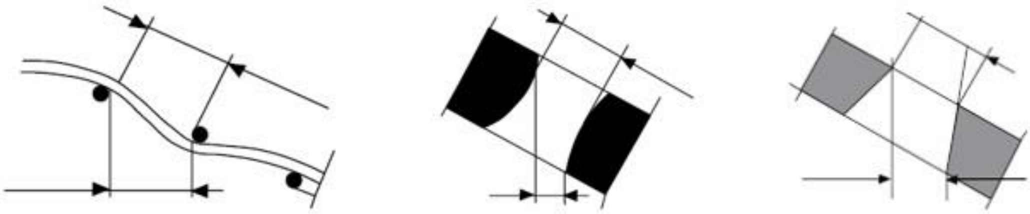
Proper material feed to a vibrating screen is very important in maintaining desired performance and efficiency. Feed chutes should be designed and constructed to result in an even feed across the entire width of the screen. Tensioned screen surfaces also should be adequately tensioned to maintain proper camber (arc shape). The arc shape also helps in spreading the material across the entire width of the screen. Precautions should be taken to prevent fines and coarse material from segregating to opposite sides of the unit, due to feed chute configuration. Feeding material off center, on a corner, or in a segregated manner can result in undesirable side motion, twisting of the frame and eventual metal fatigue and cracking. It will also mean that each square foot of screening surface is not being used to its best ability. Ideally, all material should be fed so that it is falling straight down from as short a height as possible. Sometimes a small amount of velocity towards the discharge end is desirable. However excessive side velocity results in the momentum of the material being transferred to the vibrating frame. This may cause side motion, twisting of the frame and eventual metal fatigue and cracking.

Many times screens are provided a feed box and A/R steel or steel backed rubber replaceable liner are bolted to it. Ideally, all material being fed to the unit should land on the replaceable liner. Failure to do so can result in premature cloth and support panel wear.

Aperture / Hole Size and Type

The nominal **size of the mesh** is the actual diameter of the opening on the deck. The cut / effective size (The particle size at which equal proportions of material report to the oversize and undersize) is the size of the product that the mesh produces. In a given application, the chosen nominal mesh size will produce product size smaller than the nominal size.

Choosing the proper hole (aperture) for a given application is the key to delivering screen sizing accuracy and maximum throughput. Following is recommended by a leading international screen manufacturer for selection of the correct size of hole related to “cut size” (for inclined deck).

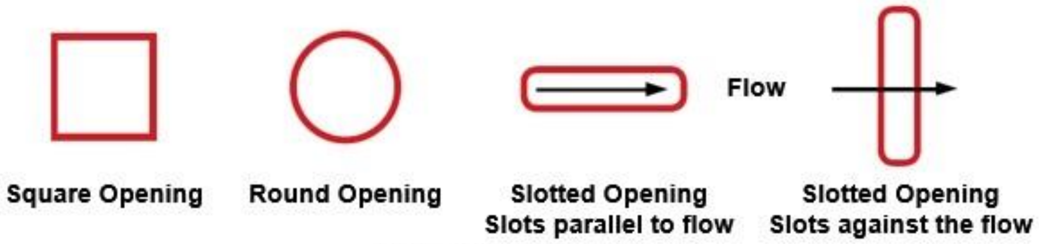


Wire Mesh Rubber Panels PU Panels

Hole Size for Inclined Deck

As illustrated in above figure, recommended hole size for an inclined deck is:

Wire Mesh - Required product size plus 5% to 10%
Rubber Panels - Required product size plus 25% to 30%
PU Panels - Required product size plus 15% to 20%



Common Hole Types

Above figure shows common types (styles) of hole. Select the hole type as per the following.

Square Opening - The standard choice.

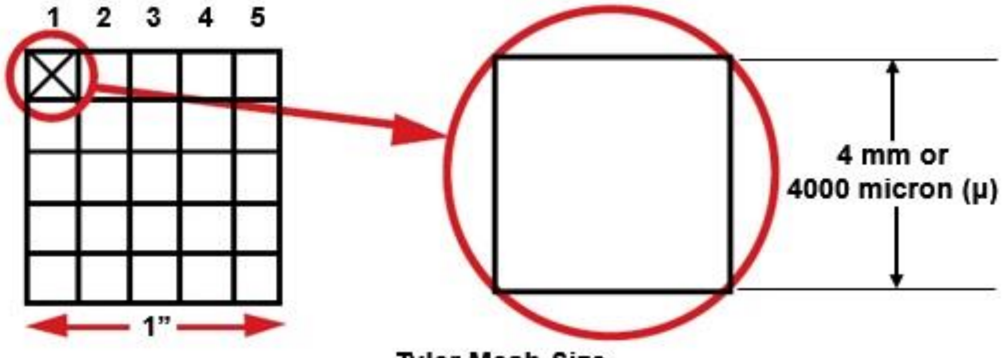
Round Opening - This opening is highly effective in primary scalping operations to minimize plugging or pegging.

Slotted / Oblong Opening, slots parallel to (with) flow - For improved capacity.

Slotted / Oblong Opening, slots against (right angle) the flow - For improved accuracy and dewatering.

Particle Size – Mesh or Micron?

Two scales that are widely used to classify particle sizes are the ASTM (US) Sieve Series and Tyler Equivalent, sometimes called Tyler Mesh Size or Tyler Standard Sieve Series.



Tyler Mesh Size

The mesh number system is a measure of how many openings there are per linear inch in a screen. As shown in above figure, the mesh number used in Tyler Mesh Size is the number of wires per inch or the number of square apertures per inch. As nominal wire diameter is fixed for each Tyler designation, mesh number gives size of the sieve opening. The size of the sieve openings is used to classify particle sizes.

The most common mesh opening sizes for these scales are given in the following table and provide an indication of particle sizes. US sieve sizes differ from Tyler Screen sizes in that they are arbitrary numbers.

ASTM (US) Sieve Size / Designation	Tyler Equivalent	Sieve Opening	
		mm	in
5/16 in	2 1/2 Mesh	8.00	0.312
0.256 in	3 Mesh	6.70	0.265
No. 3 1/2	3 1/2 Mesh	5.60	0.223
No. 4	4 Mesh	4.75	0.187
No. 5	5 Mesh	4.00	0.157
No. 6	6 Mesh	3.35	0.132
No. 7	7 Mesh	2.80	0.110
No. 8	8 Mesh	2.36	0.0937
No.10	9 Mesh	2.00	0.0787
No. 12	10 Mesh	1.70	0.0661
No. 14	12 Mesh	1.40	0.0555
No. 16	14 Mesh	1.18	0.0469
No. 18	16 Mesh	1.00	0.0394
No. 20	20 Mesh	0.850	0.0331
No. 25	24 Mesh	0.710	0.0278
No. 30	28 Mesh	0.600	0.0234
No. 35	32 Mesh	0.500	0.0197
No. 40	35 Mesh	0.425	0.0165
No. 45	42 Mesh	0.355	0.0139
No. 50	48 Mesh	0.300	0.0117
No. 60	60 Mesh	0.250	0.0098
No. 70	65 Mesh	0.212	0.0083
No. 80	80 Mesh	0.180	0.0070
No.100	100 Mesh	0.150	0.0059
No. 120	115 Mesh	0.125	0.0049
No. 140	150 Mesh	0.106	0.0041
No. 170	170 Mesh	0.090	0.0035
No. 200	200 Mesh	0.075	0.0029
No. 230	250 Mesh	0.063	0.0025
No. 270	270 Mesh	0.053	0.0021
No. 325	325 Mesh	0.045	0.0017
No. 400	400 Mesh	0.038	0.0015

Recommended Wire Gauges (Diameters)

The following table contain recommended wire gauges (diameters) for wire cloth having standard square openings by Unified Screening & Crushing for light, medium and heavy use. For more information on wire cloths, please view their website.

Clear Opening (Opening Width), in	Light		Medium		Heavy	
	Gauge & Actual Diameter, in	% Open Space to Area	Gauge & Actual Diameter, in	% Open Space to Area	Gauge & Actual Diameter, in	% Open Space to Area
1/16” (.063)	-	-	#18 (.047)	-	-	-
3/32” (.094)	-	-	#18 (.047)	44.4	#16 (.063)	@ 29.0
1/8” (.125)	#16 (.063)	44.2	#14 (.080)	37.2	#12 (.105)	29.5
5/32” (.156)	#16 (.063)	50.8	#14 (.080)	43.0	#12 (.105)	35.8
3/16” (.188)	#16 (.063)	56.0	#14 (.080)	49.1	#11 (.120)	37.2
7/32” (.219)	#14 (.080)	53.6	#12 (.105)	45.7	#10 (.135)	38.2
1/4” (.250)	#12 (.105)	49.6	#11 (.120)	45.7	#10 (.135)	42.2
5/16” (.313)	#12 (.105)	56.0	#10 (.135)	48.8	# 9 (.148)	46.1
3/8” (.375)	#12 (.105)	61.0	#10 (.135)	54.1	# 8 (.162)	48.8
7/16” (.438)	#10 (.135)	58.4	# 8 (.162)	53.3	# 6 (.192)	48.3
1/2” (.500)	#10 (.135)	62.0	# 8 (.162)	57.0	# 6 (.192)	52.2
9/16” (.563)	#10 (.135)	@ 65.0	# 8 (.162)	60.3	# 6 (.192)	55.6

5/8" (.625)	# 8 (.162)	63.1	# 6 (.192)	58.5	# 4 (.225)	54.1
3/4" (.750)	# 6 (.192)	63.4	# 3 (.244)	56.9	5/16" (.313)	49.8
7/8" (.875)	# 6 (.192)	67.2	# 3 (.244)	61.1	5/16" (.313)	54.3
1" (1.00)	# 6 (.192)	70.4	# 3 (.244)	64.6	5/16" (.313)	58.0
1 1/8" (1.125)	# 3 (.244)	67.5	5/16" (.313)	61.2	3/8" (.375)	56.3
1 1/4" (1.250)	# 3 (.244)	70.0	5/16" (.313)	64.0	3/8" (.375)	59.2
1 3/8" (1.375)	# 3 (.244)	72.1	5/16" (.313)	66.4	3/8" (.375)	61.7
1 1/2" (1.500)	5/16" (.313)	68.5	3/8" (.375)	64.0	1/2" (.500)	56.3
1 5/8" (1.625)	5/16" (.313)	70.3	3/8" (.375)	66.0	1/2" (.500)	58.5
1 3/4" (1.750)	5/16" (.313)	72.0	3/8" (.375)	67.8	1/2" (.500)	60.5
2. 0"	5/16" (.313)	74.8	3/8" (.375)	70.9	1/2" (.500)	64.0
2 1/4" (2.250)	5/16" (.313)	77.1	3/8" (.375)	73.5	1/2" (.500)	66.9
2 1/2" (2.500)	3/8" (.375)	75.6	1/2" (.500)	69.4	5/8" (.625)	64.0
3. 0"	3/8" (.375)	79.0	1/2" (.500)	73.5	5/8" (.625)	68.5
3 1/2" (3.500)	3/8" (.375)	81.6	1/2" (.500)	76.6	5/8" (.625)	72.0
4. 0"	1/2" (.500)	79.0	5/8" (.625)	74.8	3/4" (.750)	70.9
5. 0"	1/2" (.500)	82.6	5/8" (.625)	79.0	3/4" (.750)	75.6
6. 0"	1/2" (.500)	85.2	5/8" (.625)	82.0	3/4" (.750)	79.0

Vibrating Screen Installation, Start up and Adjustments

Information on vibrating screen installation, start up and adjustments is given in this chapter.

Installation

The supporting steel structures on which the screen and drive motor are mounted must be sufficiently strong and braced to accept without deflection the dynamic loads caused by the vibration of the screen.

Adequate clearances must be allowed between the screen and the fixed structure, chutes etc., to allow enough space because the movement of the screen is large in the so-called resonance areas when starting and stopping the screen.

Check that the height difference of separate springs pedestals (in the same end of the screen) are not more than ± 3 mm. Transparent water hose and water may be used to check the height difference. Pedestals surface must be horizontal.

Tighten all bolts in the recommended sequence if any and to the recommended torque.

Check the screen's installation angle.

Check that all of the spring axes are vertical.

Check rotation directions of the motor/s.

In case of screen driven by motor and cardan shaft, the vertical position of the motor must be fixed so that the centre line on the screen’s shaft is approx. 5 mm higher than the centre line of the motor shaft. During running with material, cardan shaft should be close to horizontal. In case of belt drive, tension the belts as per manufacturer’s recommendation.

Make sure that all guards are properly fastened and all the safety devices are installed and they are working properly.

Earth the motor connection at the mains.

Have qualified electrician install overload, short-circuit and ground-fault protection.

If unbalance motor is installed onto a vibrating screen, leave slack in electrical cable so that cable does not become taut during vibration cycle and cause stress on wire connection.

In case of a linear motion vibrating screen, interlock the two unbalance motors rotating in opposite directions and install separate overload protection. The screen’s control circuit must be arranged so that if one unbalance motor becomes de-energized, the other unbalance motor will automatically and immediately become de-energized. Failure to properly interlock screen’s unbalance motors could result in damage to the screen if one unbalance motor fails (if only one unbalance motor of a pair is powered, the bearings in the unpowered unbalance motor will get damaged within a very short time).

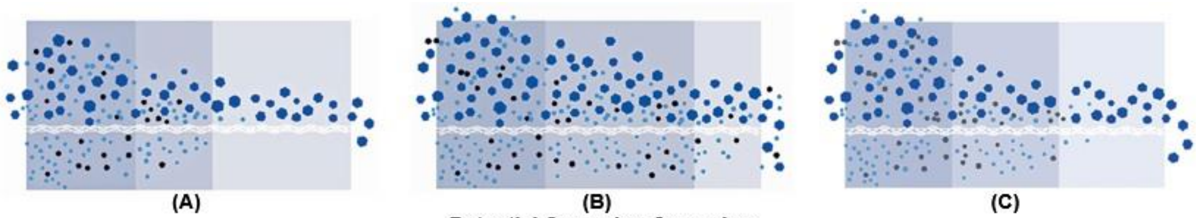
If the unit is going to be stored before start-up, once a month, the shaft should be rotated several times to re-lubricate the upper bearing portion.

Start up

After start (first 1-2 minutes) make sure that screen is starting and running properly.

Check the feed of the material. It must spread to whole width of the screen.

Check screening result.



Potential Screening Scenarios

Above figure shows three potential screening scenarios. Screening finishes early on the deck at (A), which results in a loss of production; screening not completed (B), which results in carryover and contaminated material; and optimal screening (C), which provides for higher production with less contamination.

Check stroke length and stroke angles in each corner. Stroke length must be within one mm to each other in the same end of the screen!

Check for oil/grease leaks in the mechanism.

After 4 to 6 hours, check that bearing temperature is even in each bearing. Normal running temperature can be about 70°C when ambient temp is 20°C.

After running the screen for about 50 hours, check the following:

- Fastening / tightness of mechanism bolts.
- Fastening / tightness of counterweight.
- Fastening of screening medias.
- Alignment / tightness of V-belts.

Mechanism has tendency to leak a little bit after few operation hours or days. This leak is mainly extra grease coming out of sealing. Leaking should stop in few hours or days.

The first oil change for the mechanism must be done as per manufacturer's recommendation (in case of gears, after about 100 hours of operation).

Screen Adjustments

If the screening performance is not satisfactory, check first that the screen meshes are correct for the application and that the feed and discharge arrangements are satisfactory. Feed to the screen must be arranged so that the material is fed uniformly across the entire width of the screen.

As feed material is a mixture of varying sizes, oversize material will restrict the passage of undersize material, which results in a build-up, or bed depth, of material on the screen surface. Bed depth diminishes as the undersize material passes through the screen openings. For efficient screening, the material bed should not reach a depth that prevents undersize from stratifying before it is discharged. Hence for maximum screening efficiency depth of bed should be proper. As stated earlier, depth of bed (in dry screening) should not exceed four times the opening size at the discharge end of the screen. Depth of bed can be changed by adjustments in speed, stroke length, rotation (or throw) direction and angle of inclination. However, always make only the minimum adjustments necessary to achieve the desired result.

If adjustments are necessary, they should be made in the order given below.

- Stroke length adjustment
- Stroke frequency adjustment
- Adjusting the inclination of the screen body

Try the action of each measure separately and singly. Try one action at a time and observe the result before taking on the next one.

Adjustment of the stroke length is done by adding or removing counterweights. At both ends of the same shaft there has to be exactly the same number of counterweights. Higher stroke delivers a higher carrying capacity and travel rate, while reducing plugging, blinding and enhancing stratification. Always check the screen speed/stroke length combination so that the maximum allowed acceleration (G-force) of the screen is not exceeded.

Stroke frequency adjustment can be done by changing V-belt pulleys or inverter parameters. Higher frequency/speed may decrease depth of bed. Rotation speed affects the G-forces. More speed, more G-forces with same counter weights.

Always ask manufacturer before changing rotation speed. Wrong speed can run the screen near to its natural frequency leading to screen body failure.

Also remember that increased G-forces shortens the bearing life time!

Adjusting the inclination of the screen body is done by lifting or lowering other end of the screen or feeder. Increasing the angle of inclination causes material to travel faster, which can be advantageous in certain dry screening applications. Although, there may be a point where too much incline will hinder efficiency as fines may roll over the media rather than passing through.

Do consult the manufacturer for advice on the selection of the optimum speed, stroke length, angle and frequency, if mesh sizes are changed or different material is fed to the screen.

Operation and Maintenance of Vibrating Screens

Information on operation and maintenance of vibrating screens is given in this chapter.

Operation of Vibrating Screen

Clear away dust and stones from the base of the springs daily.

Listen / notice the abnormal sound. If screen is not running normally (uneven strokes, broken springs, loose/missing bolts, cracked screen body, broken media, material built-up in vibrating equipment & hitting to structures, loss of V-belts tension, noisy bearings, bearing temperature too high, etc.), stop it immediately and report it to service people.

If possible, always empty the screen before stopping it. Empty screen starts easier.

Do not load screen too heavily. It leads to a carryover problem and less screening efficiency.

If the vibrating frame is bottomed out on the springs due to the weight of backed up material, (unusually due to heavy feed surge, plugged chutes, etc.) shut down the screen immediately. The back-up should be cleared by hand. Attempting to clear the back-up by running the unit will lead to spring and frame breakage. Worn paint or bare metal between coils is hard evidence that the spring has been totally collapsed.

Maintenance of Vibrating Screen

Weekly Checks

- Oil level/s
- Condition of screening media (Check damage / wear of media cloth / module plates. Check apertures blockage due to plugging and blinding.)
- Condition of wear parts (liners)
- Condition of springs (Check physical condition / damage due to wear, corrosion, cracks etc. Clear away dust and large particles / stones from the base of the springs so that springs are free to compress & expand freely.)
- Bolts joints (Visual inspection for tightness)
- Stroke lengths and angles

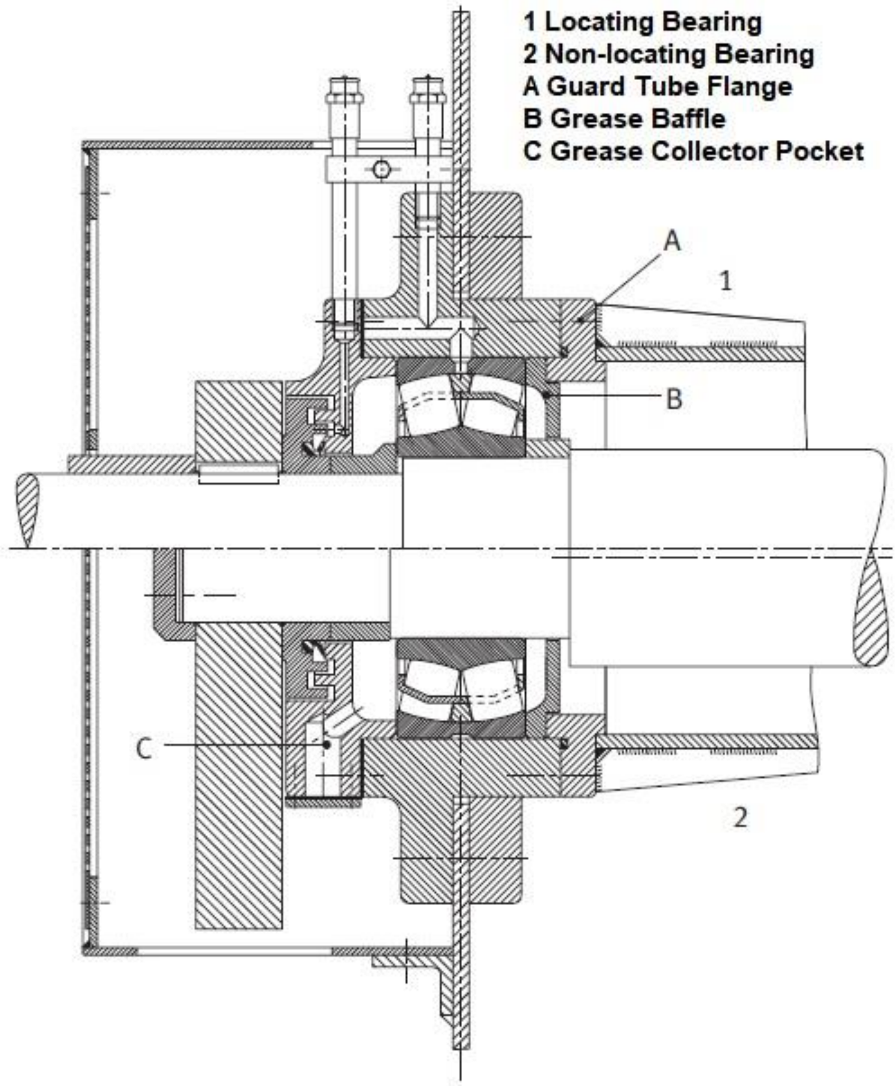
Bearings

It is advisable to change the bearings if one or more of the following symptoms appear in the screen.

- The bearings overheat.
- There is unusual noise in the bearing during operation.
- The bearing has many operation hours or the clearance between the outer ring and the rollers is too significant.

Rolling bearings in vibrating screens are stressed by high, mostly shock-type loads. Moreover, the bearings, while rotating about their own axis, perform a circular, elliptical or linear vibrating motion. This results in high radial accelerations which additionally stress the bearings, and especially the cages, considerably. In view of this, always use bearings recommended by screen manufacturer (standard bearings with C4 clearance may not be suitable!). Compared with grease lubrication, oil-bath lubricated bearings run cooler, require less attention, last longer and adapt better to temperature extremes.

Bearings for vibratory applications in the 223 series are made as standard with the C4 radial internal clearance. For the bearings in the 222 series it is necessary to specify the bearing internal clearance. The choice of spherical roller bearing depends on the vibration level (G-force) developed by the vibrating screen. The SKF standard E design spherical roller bearing has proved to be effective at lower vibration levels, <5G. For higher vibration levels and demanding applications, SKF has specially developed spherical roller bearings for vibratory applications with suffix VA405 or VA406. For more information on it, please view their website.



Bearing Arrangements for Two Bearing Screen with Circle Throw (Grease Lubrication)

It is recommended to change both the bearings of one shaft at the same time. Above figure shows the essential bearing arrangement design of a two bearing screen with circle throw and grease lubrication. The imbalance shaft is supported in two special spherical roller bearings. The bearing on the drive side is fitted as a locating bearing while the opposing bearing is a non-locating bearing.

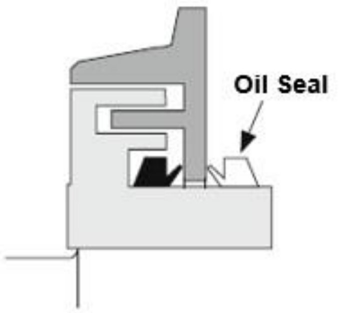
After inspection of the adjacent parts (Always measure bearing housing and shaft before installing new bearing), the bearing is mounted in the housing bore. Smaller bearings can be pressed in while cold. For larger bearings, the housing is heated uniformly to the point where the interference between the bearing outer ring and housing bore is eliminated. As the housing cools down, the interference fit is achieved. The bearing and housing are then slid onto the shaft.

A favourable option for lubrication is to feed the grease as shown in the figure via the circumferential groove and the lubrication holes in the bearing outer ring. In this way, the fresh grease is fed directly to the rolling and sliding surfaces of the rolling bearing, ensuring uniform lubrication of both rows of rollers.

The fresh grease displaces the old, possibly contaminated grease from the interior of the bearing. On the inner side of the bearing arrangement, the old grease escapes via the gap in the grease baffle and collects in the guard tube. On the outer side, it collects at the grease collector pocket, from which it is periodically removed. The bearing is sealed against external influences by a labyrinth that can be relubricated and whose sealing action can be further increased by a V-ring on the innermost labyrinth passage.

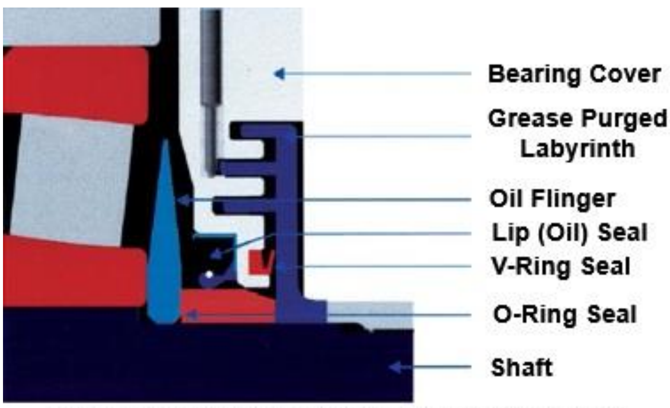
For information on design of bearing with other arrangements like two bearing screen with circle throw (oil sump lubrication), two bearing screen with circle throw (recirculating oil lubrication), etc. please view “FAG special spherical roller bearings for vibratory machinery X-life quality” published by Schaeffler KG (website address: www.fag.com).

It is recommended to use new seals / sealing kit recommended by screen manufacturer.



Labyrinth Seal with V-ring Seal

Since vibrating screens usually operates in harsh environments (dust, dirt, moisture etc.), it is recommended to use labyrinth seals to prevent the entry of contaminants and reduction of bearing service life. The labyrinth should always be filled with grease. As shown in above figure, a V-ring seal is recommended to prevent contaminants from entering the bearing and excess grease to escape. When oil lubrication is used, an extra V-ring seal can be fitted to prevent oil leakage. If provided, clean or change the air breather regularly.



Triple Layer Oil Sealing Protection Arrangement

Above figure shows triple layer oil sealing protection arrangement.

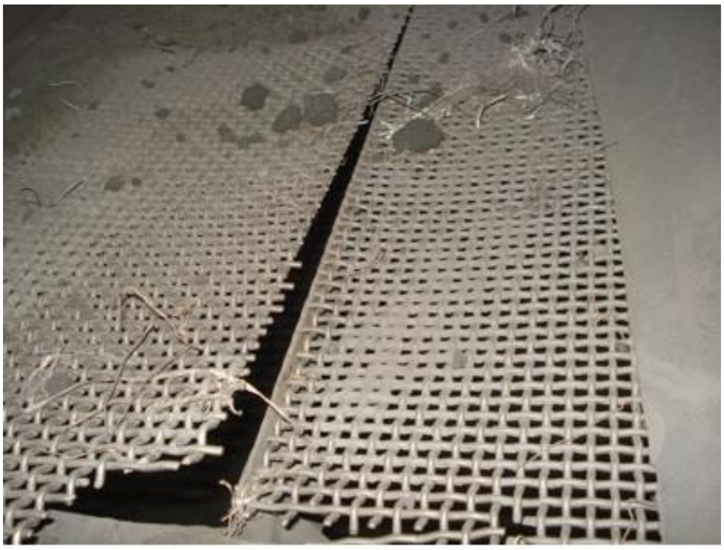
Oil Change

Regular oil change for the mechanism should be carried out as per manufacturer's recommendations.

Change of Screening Media

Remove capping/channel rubber to inspect all supporting (camber) bars for corrosion and wear. There should not be high and low spots on them. Make sure that the bars are not warped or worn to the point that they cannot provide even, tight tension.

Changing capping/channel rubber is recommended every time, or at least every other time, the screening media is replaced. Remember that capping rubber will wear from the bottom up, as well as from the top down. Check both sides. Mixing capping rubber sizes or styles such as flat-top and round-top on the same deck will result in improper tensioning.



Damaged Screening Media

As shown in above figure, absence of capping/channel rubber or worn out one may damage the screening media.

Inspect all nuts and bolts. Replace all worn or stripped parts in the screen assembly. It is recommended to use new tension bolts and nuts. Tension all bolts equally on both sides of the vibrating screen. All hole positions on tension plates/bars must be used.

Worn tension plates/rails should be replaced to assure proper tensioning.

Tension plates must be exact length of the screen panel being installed. Never overlap tension plates.

Make certain that butted screen panels are tight together and overlapping screens are properly installed to avoid oversized material leakage.

Check cushion and spread of material feed. Cushioning of feed to the screen deck is essential to maximize screening media life. Use feed plates so that materials do not hit the wire cloth directly. For maximum screen life and production, material should be spread out to feed evenly over the entire screening surface. This also reduces uneven equipment wear as the vibrator is operating in a more balanced condition.

After four to eight hours of operation, retighten the screening media to take up any stretch that might occur.

Emergency Repair

In general, excessive heating (torching) of screen body is not allowed!

Welding in vibrating equipment body is not recommended, but sometimes it is the only alternative to be able to run the equipment before the proper maintenance. If welding is required:

- Try to find (and document) the reason of cracks before taking up the repair work.
- If no time for welding is available, just drill a hole at the end of the crack.
- Ensure that the earthing is not transmitted through the bearings.
- Open the crack by grinding.
- If possible, weld on both side of the plate.
- Grind the surface of the weld to the "plate" level. If possible, use additional stiffeners.
- After the repair, check the free movement of the units and the stroke parameters.
- Proceed to order the repaired parts.

Application Problems and Solutions

The main obstacles to efficient screening are plugging/pegging, blinding and carryover. Each can be minimized with a variety of solutions.

Plugging

Plugging/pegging happens when near-size particles become lodged/wedged, blocking the openings. Generally, if loose particles/rocks (“Carrots” Shape) get stuck in the media holes it is called plugging whereas if particles get jammed in the openings, it is called pegging. Solutions may include increasing stroke, changing opening shape (using long-slotted openings instead of standard square openings), using urethane or rubber media, using self-cleaning (non-blinding) screening surfaces having wires that are crimped to form openings but individual wires are free to vibrate and using ball trays (also called bouncing ball decks).

Ball Trays

As shown in above figure, the ball trays consist of compartments with perforated plate or wire cloth with relatively large openings placed beneath the screen cloth. Generally, rubber balls are placed in each compartment that freely bounce during the operation of the screen. They strike the underside of the screen surface and therefore randomly knock out the clogged material. The secondary vibration generated in the screen cloth due to striking of the balls also prevents fine particles from sticking and building up on the wires. In most cases, a ball tray will be effective with material containing as much as 5% moisture. The material that passes through the screen cloth passes through the perforated plate or wire cloth at the bottom of the ball tray where it can be collected.

Ball trays are generally used for coarse meshes which can withstand higher impact energy from the balls. Balls are not recommended for fine screen meshes because they may damage the screen cloth.

Blinding

As a rule of thumb, screening at less than around 5 mm aperture size must be performed on perfectly dry or wet material, unless special measures are taken to prevent blinding.

Blinding occurs when moisture causes fine particles to stick to the surface and gradually cover the openings. In this case, changing stroke and increasing speed may help. Use of different surface media also may be considered. The other options are to consider ball trays and heated decks. Heated decks have an electric current in the wire that heats and dries the material so that it easily knocks itself loose as the screen vibrates. Heated deck is a more effective method of preventing blinding in damp materials (1.5 to 6% moisture) than the ball tray.

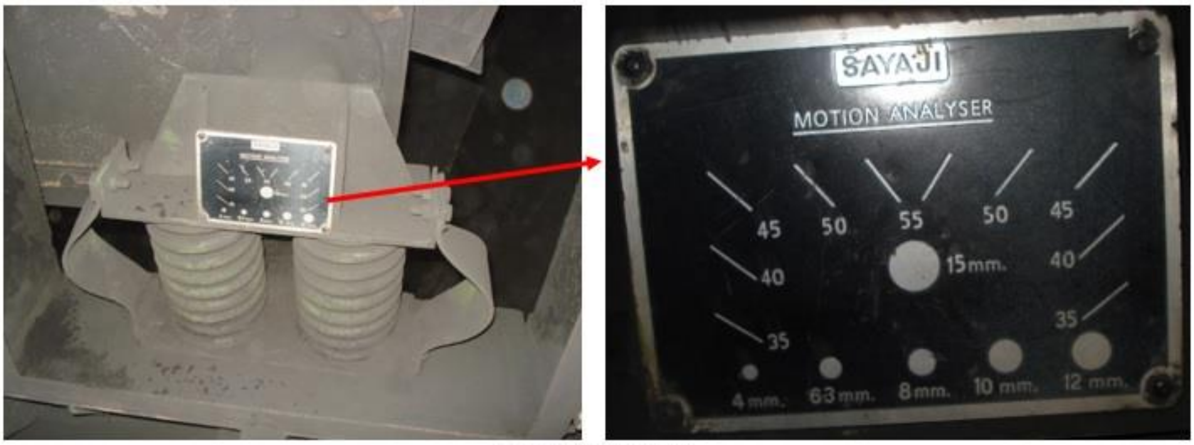
Heating transformers, consuming from 2 to 3 KVA per foot of screen length, can be used with any screen cloth weighing less than about 1.5 lbs. per square foot. The current flows at a low voltage (1 to 12) and a high amperage to produce temperatures on the screen wires ranging from 80 to 150°F. This heat is not intended to dry the material being screened, but only to dry the interface between the wire and adhering particles (e.g. clay particles) sufficiently to break the adhesive bond holding the particles to the wire. The screen vibration does the rest.

Wet screening allows finer sizes to be processed efficiently down to 250 µm and finer. Adherent fines are washed off large particles, and the screen is cleaned by the flow of pulp and additional water sprays.

Carryover occurs when excessive undersize particles fail to pass through the openings. Solutions may involve changing stroke, speed or reversing screen rotation; changing wire diameter or the shape of the opening to increase open area; changing the angle of inclination and changing feed tonnage.

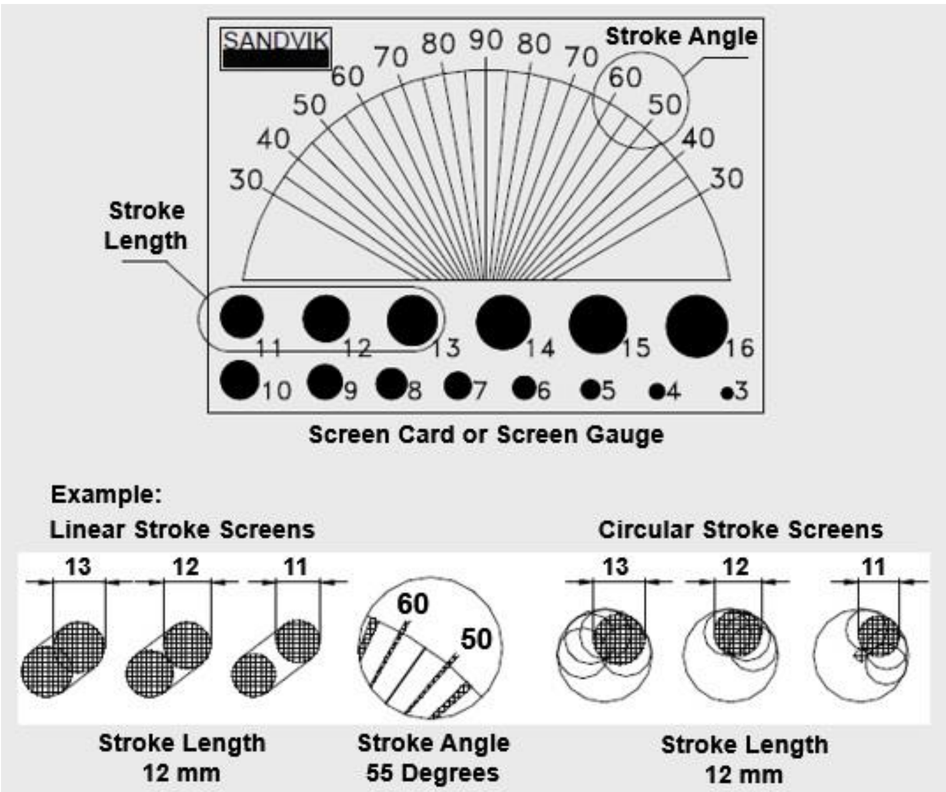
Checking of Stroke Length and Stroke Angle

One of the most important activity in start-up (commissioning) and maintenance is to check the stroke length and stroke angle in each corner of the vibrating screen. In view of this information on it is given in this chapter.



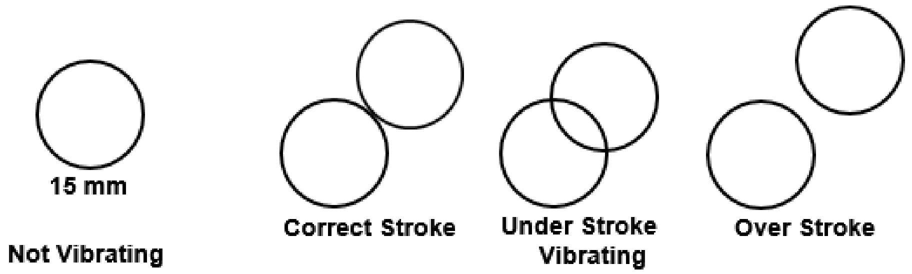
Motion Analyzer

As shown in above figure, the stroke length and stroke angle measurement can be accomplished with a sticker or magnetic screen card also called screen gauge or motion analyzer.



As shows in above figure, a screen card is a rectangular sticker or magnetic card that has several black circles of varying diameters on it. It also has several straight lines all being at a different angle from the edge of the card. This card is placed squarely on the screen. While the screen is running the circles will appear as an oval. The oval with the two circles just touching each other for linear stroke or with the most solid center for circular stroke (12 mm, for the example given in above figure) is the correct throw of the screen. The straight line that is clearest (55 degrees, for the example given in above figure) is the proper stroke angle of the screen.

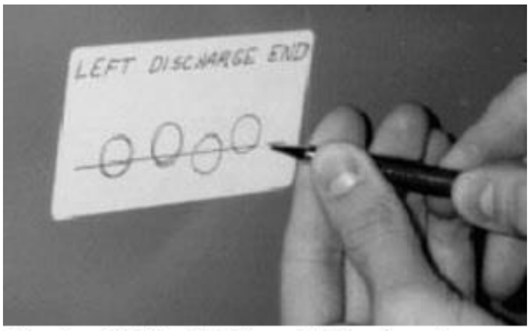
Stroke Interpretation



Stroke Interpretation

Above figure shows for this example a stroke plate for a vibrating screen designed for 15 mm stroke, as shown by 15 mm diameter circle on it (when screen is not vibrating). When the vibrating screen is put into operation, two circles are seen, one for the bottom and another for the top/peak of the movement. Based on position of the two circles when the vibrating screen is operating, stroke of the vibrating screen can be interpreted as under.

If the two circles are touching in one point, the vibrating screen is operating at correct/design stroke, equal to the diameter of the circle on the stroke plate (15 mm). If the two circles are intersecting (over lapping each other), the vibrating screen is operating at stroke below the design - under stroke condition. If there is a gap between two circles, the vibrating screen is operating at stroke above the design - over stroke condition.



Tracing Orbital Motion of Vibrating Screen

As shown in above figure, to get an idea of the orbital motion of the screen a white sticker is applied to each corner of the screen. A pen or pencil, held firmly, lightly applied to the sticker, allows the motion of the screen to be traced onto the sticker. The resulting “plot” is the motion of the screen, and the length of the long axis of the oval is the screen’s “throw”.

It is recommended to check stroke length and stroke angle at least once a month (most preferably weekly) and after following activities:

- After screen installation.
- When springs has been replaced.
- When weight of the screen changes (e.g. replacing screening media).
- When V-belts’ pulleys are changed for adjusting rotation speed.
- If there is any change in screening parameters like feed capacity and material or the screen’s performance has changed for some reason.

To find out intensity of vibration, the vibration G-force, the speed of the screen can be assessed with a contact tachometer or strobe light.

Natural Frequency and Resonance

Information on natural frequency and resonance is given in this chapter.

Free Vibrations

A body or a system capable of vibrating, when displaced from its position of rest by an external force and then released, vibrates with a certain definite frequency. This frequency is characteristic of the body or the system. Such oscillations are called free oscillations or free vibrations and the frequency of such oscillations is called natural frequency of the body or the system.

The amplitude of vibration for free vibration is large. The vibration continues for a little more time after the external force is removed. However, due to frictional force, the amplitude of oscillation decreases continuously and finally, the body stops vibrating.

For example, when the bob of a simple pendulum oscillates, its frequency of oscillation depends on the length (characteristic of the pendulum) of the pendulum.

Forced Vibrations

Forced vibrations are the vibrations produced in a body by applying an external periodic force having a frequency, normally different from the natural frequency of the body.

A body or a system, capable of vibrating can also be made to vibrate at any desired frequency. The body can be made to vibrate with the same frequency as the frequency of the applied periodic force. When the external force is applied, initially the body tends to vibrate with its natural frequency. But very soon, the natural vibrations die out and it begins to vibrate with the frequency of the applied periodic force.

The amplitude of forced vibrations depends on the difference in frequencies of the external force and the natural frequency of the body, the amplitude of the applied force and damping. The amplitude of forced vibration is small.

The amplitude becomes zero as soon as the external force is removed.

Resonance

As stated above, the amplitude of the forced vibrations depends on the difference between the natural frequency of the body and the frequency of the applied periodic force. However, when the difference between the two frequencies is large, the response of the body is poor or the forced vibrations are of small amplitude. But, when the frequency difference becomes smaller, the body vibrates more readily or the amplitude of the forced vibrations increases. Finally, when the frequency of the applied periodic force becomes the same as the natural frequency of the body, the amplitude of the forced vibrations becomes maximum and the phenomenon is known as resonance.

In short, if anybody is made to vibrate, by an external periodic force, with a frequency which is same as the natural frequency of the body, the body begins to vibrate with a very large amplitude. This phenomenon is called resonance.

Resonance in Vibrating Screen

Every vibrating screen or feeder has its natural frequency. Natural frequency is a feature that reflects how stiff a vibrating screen / feeder body is.

Vibration frequency of a vibrating screen is the feature of a vibrating screen that comes from rotational speed of mechanism shaft.

If the vibration frequency of a vibrating screen and its natural frequency are too close to each other, the vibrating screen is called in resonance zone (critical speed area).

In view of above, if a vibrating screen is operated in the resonance zone, screen body, typically the screening decks will crack and can break down in few hours eventually!

Natural frequency for each vibrating screen is checked in factory before delivery. However, its natural frequency can change if its weight changes (installation of screening media having different weight, addition of rubber, etc.), frame is worn out or joints are loose.

It may be noted that during start-up and shut down, the vibrating screen's body (vibrating basket / live frame) experiences a brief period of much larger movement because the vibrating screen's body passes through the resonance zone of the support springs.

Following are the symptoms of resonance:

- Uneven stroke in one corner (Stroke lengths should be the same in the same end of the screen but can be different to each other in feed end and in discharge end).
- Material flow is not in middle of the screen deck (If material flow is in the other side of the screen, first check the screen's installation level).
- Cracks in screening deck, in side plates, etc.

Optional Design Features

Information on various optional design features that can be provided to a vibrating screen is given in this chapter.

Oil Lubrication

Manufacturers will design grease lubrication systems because it simplifies sealing, making it the most economical choice. In addition, the grease acts as an additional barrier against contamination. However, grease is not suitable for all applications due to its inability to operate at higher speeds.

Oil Lubrication allows the bearing to operate at higher speeds, dissipates heat quicker, improved control of lubricant quantity, use of a filtration system to remove contaminate and moisture.

Oil lubrication can be applied by several methods, splash and circulating oil being the most common. Splash systems are most popular and normally provide adequate lubrication in most cases. In high speed & load applications where the heat generated cannot be dissipated by a splash system, circulating systems are used. Circulating oil not only carries away heat, but also any contaminate that may have entered the bearing. Oil coolers may also be added for additional heat extraction.

Selection of an oil is based upon the viscosity required to generate the proper film thickness at the bearing operating temperature. For vibrating mechanisms an ISO 220 grade is normally used during the spring, summer and fall (Ambient > 50°F), and ISO 150 grade during winter operation (Ambient < 50°F), Lower grades may be required in extreme cold conditions.

Huck Bolted Joints

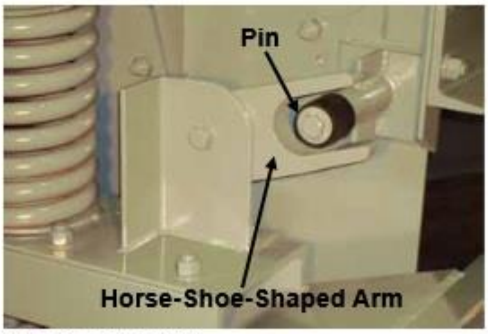
To avoid the stresses created by welding (unless they are stress relieved after welding), many manufacturers are making all permanent joints of the screen's body using huck bolts.

Huck Bolt

Use of huck bolts is a more efficient fastening method than standard nuts and bolts. They are a pin and collar combo that are permanently clamped together making them ideal in applications that require vibration resistance fasteners.

Snubbers (Friction Check Assemblies)

Any vibrating frame that is supported by resilient springs has a resonance zone (critical speed area) at which the frame can jump and lurch very erratically. During start-up and shut down, the unit must pass through this phase as quickly and as smoothly as possible. For this, screen manufacturers provide snubbers, also called friction check assemblies. The snubbers restrict large movements that could damage the vibrating frame and chutes or any stationary structure members yet do not hamper the normal oscillating motion of the unit. In addition, it also provides dampening of the excessive vibration from getting it transmitted to the supporting structure / foundation.



Snubber Assemblies

Above figure shows typical construction of two types of snubber assemblies. In case of assembly with retaining straps, the retaining straps restrict large movements of the unit while in the case of assembly with the spring-loaded horse-shoe-shaped arm, it comes in contact with the pin extension to restrict the unit's movement. However, for proper functioning of the snubber, the spring-loaded horse-shoe-shaped arm of the snubber assembly should be snug tightened as per manufacturer's recommendation.

Adjustable Slope Panels

Many times inclined screens with sectioned support decks that enable the sections to be arranged in an arc shape (banana screens) are provided with adjustable slope panels at the feed and discharge ends. To improve the efficiency, these panels can be adjusted as per the process requirement. Raising the feed end section will increase the velocity of the feed and thin the depth of bed. Whereas raising the discharge end will decrease the velocity and increase the depth of bed.

Pivoted Motor Base and Belt Tension

In case of V-belt drive, drive motor may be provided with pivoted motor base to provide uniform belt tension at all times (to take care of belt's normal stretch and stretch due to start/stop bounces).

For more information on pivoted motor base, please view the article "Construction and Working of Pivoted Motor Bases for Belt Drives" at www.practicalmaintenance.net.

Be careful. Belts that are tensioned too tightly can cause much more serious damage. If belts are over-tightened, the vibrating frame gets pulled out of square with the support frame. Operating in this twisted position introduces stresses that can lead to spring failure, metal fatigue, cracking and broken welds in the vibrating frame.

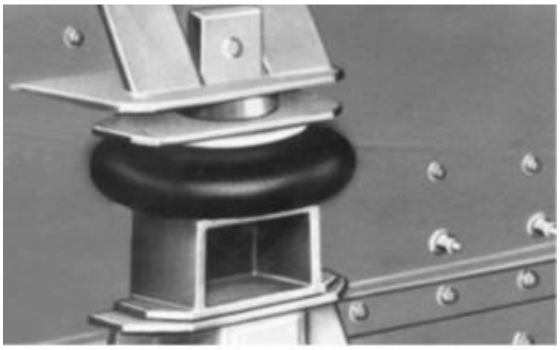
In addition, the twisting will affect the stroke amplitude, thus affecting material flow and screening efficiency.

Over-tightened belts put an extra load on the mechanism bearings that is unnecessary and may damage motors and motor bases. Ideally, the belts should only be tight enough that they do not slip during start-up.

Dust Enclosure

Vibrating screens are available in partially or fully enclosed models if dust or noise is a problem, or where regulations require such control.

Air Springs



Air Spring

Air springs provide maximum isolation of vibration for structures supporting vibrating screens. Their action is like that of a bellows, silently expanding or contracting with variations of load. These air springs are made of the same rugged nylon cord and high strength rubber used in tubeless automotive tires. Any convenient air supply can be used for inflation.

Sub-frames (Isolation Frames)

Vibrating Screen with Sub-frame

Sub-frames (additional anti-vibration frame) are used to reduce the vibrating force transmitted to the support structure. They are highly recommended for larger screens. Above figure shows a vibrating screen with the sub-frame.

References

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