How Various Types of Screening Motion Can Impact Performance

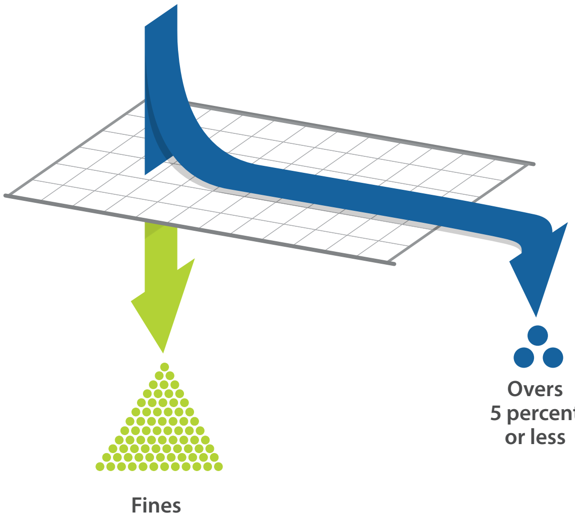
In simple terms, screening is the mechanical process of separating dry bulk materials based on particle size. Material is fed into a screener, which utilizes precision-woven screens configured to sort the material according to the desired size, as required for the application. Screener manufacturers employ different screening motions to accomplish the separation, and the screener's motion significantly affects the efficiency of the separation.

This paper will provide a brief overview of mechanical screening applications before exploring the different types of screening motion and their various levels of efficiency and efficacy.

Types of screening applications

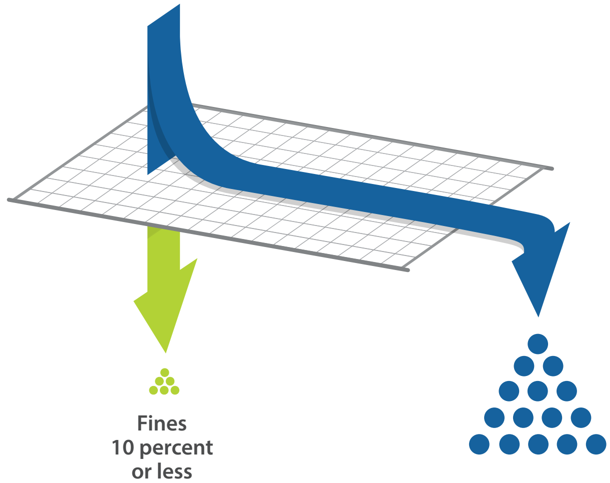
Screening applications are typically broken into three categories.

1. **Oversize removal**
The process of removing particles that are bigger than what is desired in the final product. Oversize particles are typically 5 percent or less of the incoming feed material's particle-size distribution. Consider a product like fertilizer. To achieve a desired distribution of particle sizes, oversize removal is performed prior to shipment, isolating and removing unwanted clumps that, in addition to negatively impacting the aesthetic appeal of the final product, could interfere with the delivery of the intended nutrient concentration and potentially clog the spreader.



2 Fines removal

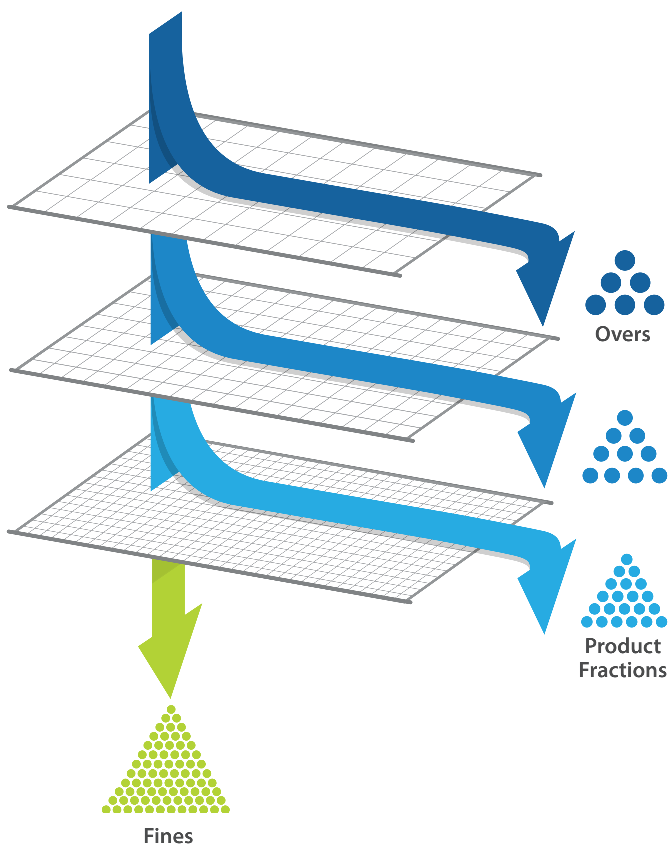
The process of removing particles that are smaller than desired. In this application, fine particles make up 10 percent or less of the particle-size distribution of the incoming feed material. Consider a cat litter product derived from bentonite clay. To ensure the final product does not include unacceptably small granules that could stick to a cat's paw, the manufacturer could perform fines removal before packaging.



Of course, many applications require both oversize and fines to be removed, which can be achieved in a two-deck screener. In this case, the final product is usually defined with an upper and lower size specification, with a small allowance for particles outside the size specification.

3 Product grading

The process of separating an incoming feed of material into several different product grades. Consider sugar, which could be broken into a coarser grade (to be sold as granulated table sugar), a finer grade (to be sold as powdered sugar) and a superfine grade (to be sold as baker's sugar). Grading is typically performed in one multiple-deck machine. It is more challenging than simply performing oversize or fines removal, because it involves meeting several different size specifications and handling a greater volume of particles that are of a similar size to the separation opening (near-size).



Motion function

The motion of a mechanical screener serves three main functions throughout the separation process. The screener must spread and convey material from the inlet to the outlet; it must stratify the material, with the smaller particles migrating through the bed depth of material toward the screen opening and the larger particles moving upward, thereby producing a graduation of particle size; and it must separate the material as particles are presented to the screen opening.

Additionally, it is important to ensure the screen openings stay open and don't blind, or become blocked. The screener's motion typically enables a method for controlling blinding, often by implementing mesh cleaning balls or slider rings under the screen clothing to flex or scour the screen wire and dislodge any particles that have blocked the openings.

Motion terminology

The motion employed by a particular mechanical screener can be broken down into three parameters

- **Stroke:** This is the amplitude of displacement that the screener moves during its operation. Typical strokes range from 1/8 inch (3 mm) up to 3 1/2 inches (90 mm) of displacement.
- **Frequency:** This refers to the number of cycles per minute the device moves. Frequency tends to range from 200 rpm on the low end up to 1,800 rpm on the high end, with some screeners operating as high as 3,600 rpm. Short-stroke machines typically have a higher frequency, while long-stroke machines tend to operate at a lower frequency.
- **Slope:** This refers to the angle of the screen deck relative to horizontal. Some screeners use screen decks that are at or near horizontal, while others can have the screen decks inclined as much as 35 degrees. If a short-stroke screener is used to process a high volume of material, it will typically have a higher degree of incline in order to move the material rapidly through the machine.

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Stroke, frequency and slope combine to influence the behavior of the particles on the screening surface. When considering how efficiently and effectively a mechanical screener will convey, stratify and separate the material being processed, it is useful to examine its stroke, frequency and slope. For example, consider the potential impact of slope. A near-horizontal screen deck will provide more accurate separation, because the openings that the particles encounter as they reach the screen deck are almost the exact same size as the openings in the screen wire itself. Conversely, a screen deck that is inclined at, say, a 20-degree angle will provide projected openings to the particle that are smaller than the actual openings in the screen.

Types of motion

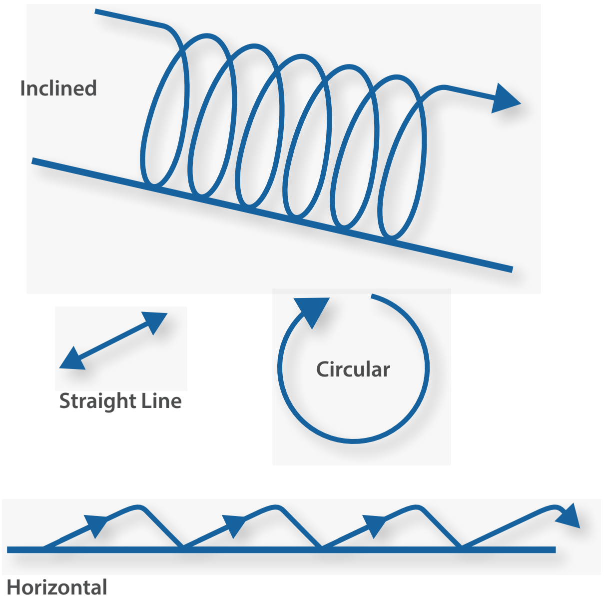
These typically fall into three categories.

1. **Vibratory motion**
By definition, "vibratory" means moving rapidly to and fro, or up and down. These machines are associated with a short-stroke, high-frequency motion and typically incorporate both horizontal and vertical components to their motion.

2. **Gyratory motion**
The screen deck moves in a circular fashion, as observed when the screener is seen from a plan view perspective. This motion is typically associated with a longer-stroke and lower-frequency screener.

3. **Gyratory reciprocating**
In machines that utilize gyratory reciprocating motion, the motion is gyratory at the feed end and is converted to reciprocating action at the discharge end. An elliptical shape to the motion occurs in the middle of the machine, as the motion transitions from gyratory to reciprocating. Like gyratory machines, gyratory reciprocating machines are typically associated with a longer stroke and lower frequency.

VIBRATORY MOTION



GYRATORY MOTION

GYRATORY RECIPROCATING MOTION

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How does motion affect performance?

It's important to consider the various differences between screening motions when selecting the right equipment for a particular application. For example, the vertical component of vibratory motion can be suited to disrupting surface tension in wet applications or working with a material that has surface moisture. However, vibratory machines tend to be less effective in more challenging dry product-grading applications, because the vertical component of their motion — which is necessary for conveying the material — tends to hinder the stratification process. When particles are launched from the screen deck by that vertical component of the motion, they are remixed rather than stratified. In addition, these particles are denied contact with the screen opening while launched, further reducing efficiency.

Gyratory motion is very effective at quickly spreading the material across the width of the screen deck and achieving a consistent bed depth of material. The horizontal nature of the gyratory motion is also effective at stratifying the material, with the smaller particles moving toward the bottom of the material bed depth and the larger particles moving toward the top, thus facilitating the separation process.

The reciprocating action of the gyratory reciprocating screeners excels at separating near-size particles, thereby boosting the screener's separation performance. As this reciprocating action changes direction every half revolution, the near-size particles settle down, remain in contact with the opening and separate.

Longer-stroke machines tend to provide better blinding control, because they enable a greater degree of mesh cleaning ball movement than those that use a shorter stroke. Another factor to consider: Longer-stroke machines can move material over a certain distance at a lower speed than shorter-stroke machines, enabling them to handle the product more gently. Finally, gyratory and gyratory reciprocating machines can process a relatively high volume of material at near-horizontal because of their longer strokes, whereas shorter-stroke vibratory machines typically must be inclined for high-capacity applications.

To best understand how a screener's motion affects the separation performance in a given application, it is useful to review the product recovery efficiency for the defined size range of the material. The product recovery efficiency is defined as the amount of on-size product that is recovered divided by the amount of on-size product in the feed that could be recovered. This important measurement should be highlighted on the lab reports provided by each potential screening vendor. In addition to product recovery efficiency, lab reports must state product yields, product quality and the motion parameters of stroke, frequency and slope used to achieve the stated results. The information listed above is critical data needed to compare different screener technologies for use in a given application.

Conclusion

Vibratory, gyratory and gyratory reciprocating machines are all available options for a production screener that performs a separation of dry bulk material by particle size. Selecting the proper screener for the application requires an understanding of the application type, the types of motion, the motion parameters and their respective strengths. Ultimately, these motion parameters, along with the application expertise of the potential screener manufacturer, will determine the screener's product recovery efficiency and performance in the production process.