Steps to screening success

Charles Sonnenschein, George Hicks and Alex Edwards, J&H Equipment, Inc., USA, examine the benefits of high-frequency incline screening machines for today's granular fertilizer production facilities.

High-frequency incline screening machines are available in a variety of sizes (length and width) and wire mesh surface (deck) configurations. Single, double and triple deck options are available depending on operational needs. Decks are used to separate material based on size and capacity requirements (Figure 1).

These screening machines are suitable for first cut scalping to remove the largest particles, removing oversized particles, producing on-size product, removing fines, and a final clean-up after production or storage (known as polishing). The common goal of high-frequency screening machines is to maximise the amount of passing or near-size material that contacts the wire mesh which optimises sieving.

High-frequency incline screening machines only vibrate the wire mesh and not the screen body, resulting in a significantly lower operational power requirement. Typically, each wire mesh screen section is vibrated using a single 1 kW vibrator motor. Multiple wire mesh deck configurations can provide greater process capacity utilising minimal power, resulting in a more efficient screening operation and economic use of screening equipment.

Vibrator motors on the multiple wire mesh deck configurations can be operated independently, allowing the remaining machine motors to continue running if one of the motors trips or faults. This motor configuration ensures that the screening machine continues to process material in order to avoid plant back-up or shutdown.

High-frequency screening machines offer maintenance access during operation. Given that the screening machine is a static body, and that only the internal wire mesh vibrates, maintenance personnel can open access doors, and inspect and perform running time operational checks. Increased access becomes advantageous for plant operations where the highest efficiencies are required.

These screening machines utilise low-amplitude, high-frequency vibration to 'fluidise' the flow of the granules on the wire mesh/screen media. This has three important effects on the material. First, the movement reduces friction between the granules, improving the flow characteristics of material while maximising segregation and sieving. Second, high-frequency, low-amplitude vibration reduces friction with the wire mesh, which in turn reduces blinding. Most importantly, high-frequency, low-amplitude vibration causes the different particle sizes in the material feed to stratify, with smaller particles dropping towards the wire mesh and larger particles moving upwards. This action forces the particles that should be screened to maintain contact with the wire mesh, increasing screening efficiency as a result (Figure 2).

Optimising efficiency: Screen considerations

Screen angle

Incline screening machines are designed to take advantage of the natural angle of repose of the material being screened, in addition to material acceleration from gravity. Gravity assists in the screening process by improving the material flow characteristics on the inclined wire mesh.

The angle of the wire mesh is typically slightly less than the angle of repose of the spherical, granular fertilizer product being processed. The product fluidisation from high-frequency vibration creates a live material and an active angle of repose, allowing the product to convey and screen efficiently.

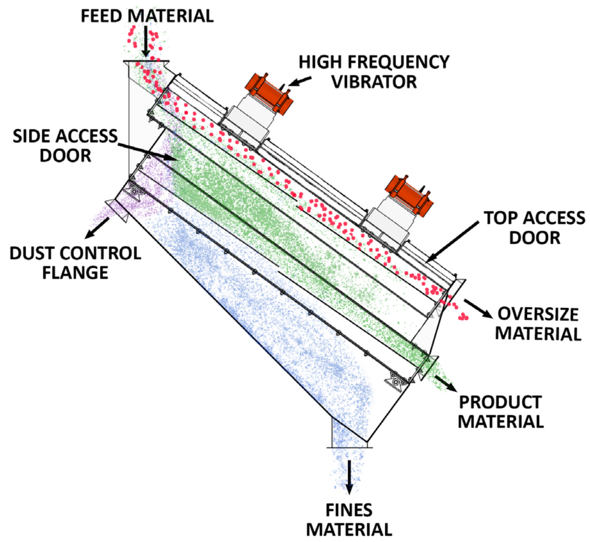

Figure 1. Screen layout with material flow.

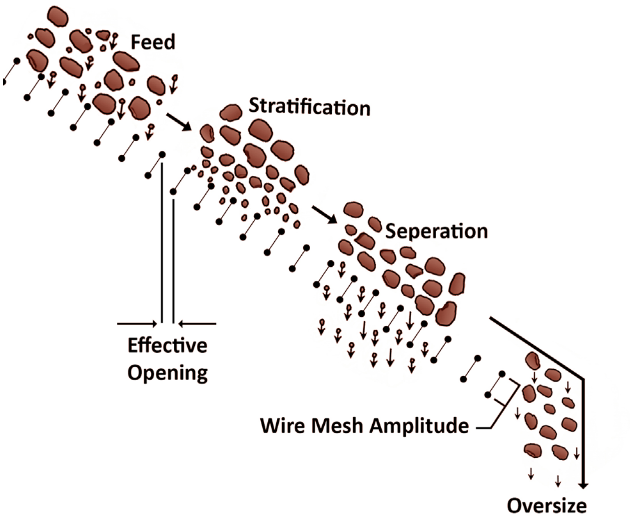

Figure 2. High-frequency screening through material stratification.

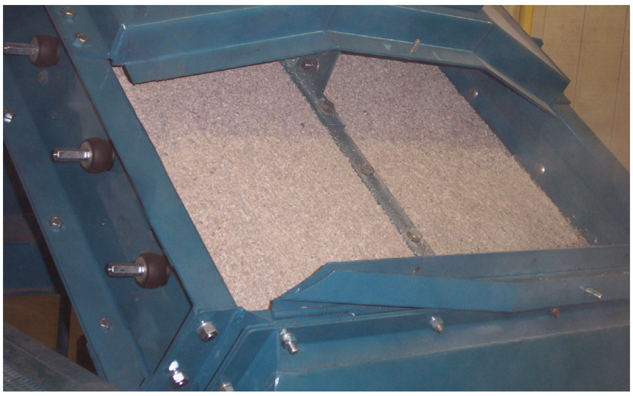

Figure 3. Screen with good material distribution.

Adjustable output force, vibration, RPM and amplitude

Historically, high-frequency incline screening machines have utilised totally enclosed non-ventilated (TENV) vibrator motors to produce the vibratory force required to fluidise material. Such vibrators have a minimum and maximum output force that is variable by adjustable eccentric weights. These eccentric weight settings in the vibrator motors can be arranged to optimise the vibration force transmitted to the wire mesh. This leads to increased amplitude, which remedies excessive material bed depths, unequal distribution, and moisture. For most applications, high-frequency vibrators operate optimally at 3000/3600 revolutions per minute (RPM) (50/60 Hz).

Material distribution

Material distribution and velocity should be considered when seeking maximum efficiency and capacity. Utilising the full width of the wire mesh screening area is necessary (Figure 3) and often is achieved with a screen feeder/distributor that mounts directly to the high-frequency screening machine inlet. Modern feeders receive a stream of material from a feed chute, elevator or conveyor and spread the material evenly across the full width of the screen wire mesh (Figure 4). Screen feeders not only distribute and equalise product flow but also alter material velocity for optimal sieving performance.

Wire mesh and proper tension

Selection of the wire mesh is critical to achieving maximum screening efficiency for the material being processed (Figure 5). High-frequency incline screening machines are focused on maximising the screening surface area, vibration transmission and uniform tension across the entire area of the wire mesh. Wire mesh opening, wire diameters, weave type and materials of construction all play a vital role in screen performance.

Theoretical effective wire mesh opening is a function of the vibration amplitude, wire mesh angle and wire mesh opening. The effective wire mesh opening is smaller than the actual opening because of the wire mesh vibration amplitude and the wire mesh slope. An effective opening should be considered when determining the wire mesh sieve requirements.

Additionally, uniform wire mesh vibration and amplitude is needed and is dependent upon proper and consistent tension. Modern high-frequency screening machines incorporate wire mesh tensioning systems to achieve the necessary stretch and proper tension.

Screen cleaning and blinding reduction

Wire mesh blinding is a natural and inevitable result of screening product with a distributed size range. If the appropriate wire mesh opening is chosen for the application, a small percentage of the material will be approximately the same size as the opening. Some of these 'on-size' particles will wedge into the wire mesh. In fact, a small amount of blinding – around 10% – is a signal of satisfactory material contact with the screen. However, without a means to dislodge these particles, blinding can increase rapidly and obstruct the screening area. Screens that experience excessive blinding cannot operate efficiently, impacting their capacity, process control and product quality.

High-frequency incline screening machines often utilise a frequency inverter to create an intermittent, higher frequency 'cleaning cycle'. This change in frequency disrupts the vibration pattern in the wire mesh, activating blinded zones and dislodging near-size material captured in wire mesh opening. Cleaning intervals are programmable and should be optimised to plant conditions. As the cleaning cycle occurs during normal operation, production is not interrupted, and blinding is alleviated as it develops. With a high-quality product, inverter screen cleaning can assist in minimising the amount of blinding observed.

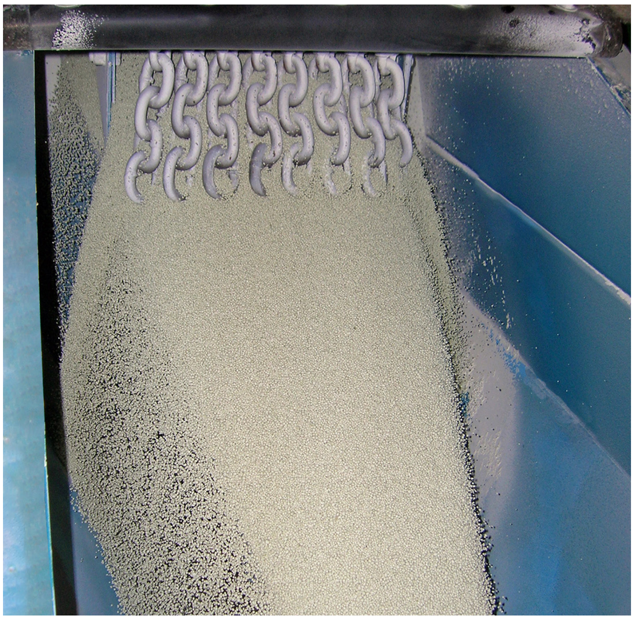

Figure 4. Screen feeder distributing material across the full screen width.

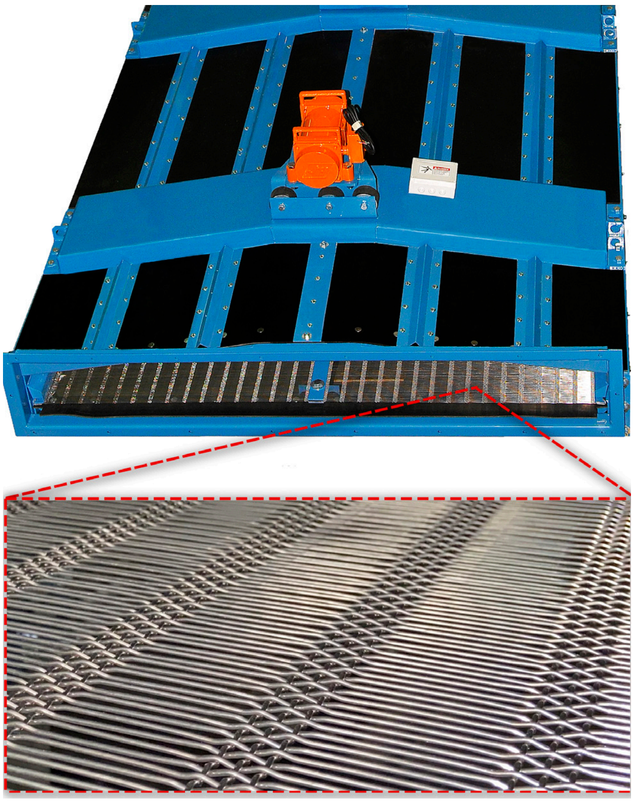

Figure 5. Wire mesh for screening fertilizer.

Optimising efficiency: Process considerations

The ability of any screening machine to operate efficiently depends significantly on the material being processed. External factors, such as plant geometry, can cause distribution or velocity issues. Screen accessories – such as distribution screen inlet material feeders, velocity reduction inlet boxes and frequency inverter systems – are intended to remedy conditions that negatively affect screening, providing the best possible conditions for the operation and efficiency of the screening machine.

Material quality

Poor material quality is difficult to compensate for and must be carefully monitored and corrected when detected. Feed rate, granulometry, and moisture content outside of the acceptable ranges will negatively impact screening. It is critical that surface moisture is kept to a minimum. Best results are achieved with a constant feed rate, spherical granulometry and low surface moisture.

Plant configuration

The design of the screen feed chute can have a significant impact on the screening process. Improper slope or excessive vertical height in the chute above the screen can cause the material to enter the screening machine with poor material distribution and/or with excessive velocity. Material velocity on the screen can be a critical factor that affects screening efficiency. If the velocity of the material is too slow it can cause blinding, product build up, and plant backups. If the velocity of the material is too fast it can cause excessive carryover of product and excessive material bouncing. Both scenarios reduce screening efficiency.

A screening machine inlet feeder is one recommended solution to slow down the material to an optimal velocity. The feeder will assist in properly distributing the material across the full width of the screen wire mesh. In cases of extreme material velocity, a velocity reduction inlet box and/or baffles in the inlet chute are necessary to slow or redirect the material.

Dust collection

Utilising a dust collector system with the collection point located in the fines hopper just below the screen feed end improves screening efficiency. The draw of air below the screen effectuates a negative pressure in the hopper, which assists with pulling the smaller and near-size material through the wire mesh. Because the high-frequency incline screening machine is a static body application, dust collection can be achieved using simple rigid connections, eliminating the need for flexible dust-control bellows.

Conclusion

High-frequency incline screening machines have proven to be a successful option for today's granular fertilizer process plants. Screen design has evolved over time to achieve maximum screening efficiency through technological advancements and real-world experience. Many of the world's largest producers rely on high-frequency incline screening machines to meet their operational demands. As such, serious consideration should be given to high-frequency incline screening machines in today's fertilizer production facilities. **WF**