An in-depth look at vibratory sieves and separators for dry bulk powders

By Ray Singh, Sales and Marketing Director, Russell Finex Ltd.

In today's fast-paced, high-tech world, vibratory sieves and separators for screening dry bulk powders are sometimes perceived as rather low-tech and old-fashioned. However, they are actually still powerful tools for companies focused not only on achieving the highest levels of product quality, but also the bottom line.

Vibratory sieves and separators, also commonly referred to as gyratory separators or screening machines, are a traditional part of processing dry bulk powders. They classify materials by separating them by particle size through a screen mesh. Using a combination of horizontal and vertical movements, they spread the material over a screen in controlled flow patterns and stratify the product.

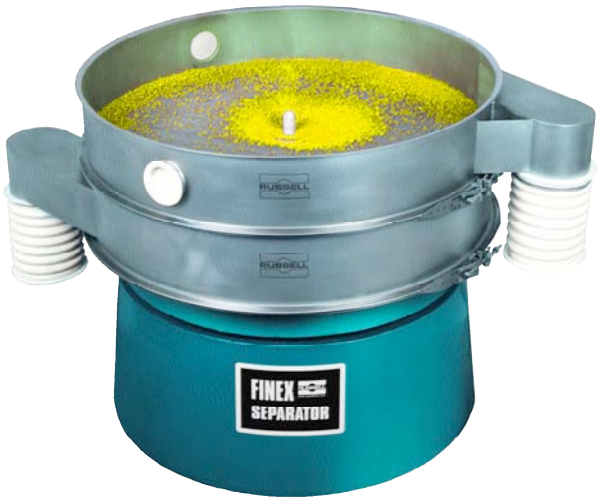
There are several functions a vibratory sieve or separator can achieve:

- Check/safety screening- used for quality assuance by checking for foreign contaminants and oversized material and removing them from the product.
- Grading/sizing screening - used to grade or classify material into different particle sizes.
- Recovery screening - used to recover valuable materials in the waste stream for re-use.

For many years, the majority of vibratory separators had a rectangular or square design and employed a simple reciprocating movement to classify the powder.

During the early 1930's, machines that used gyratory motion, i.e. small circular orbital movements, were introduced. This then led to the use of circular screens, which offered a much better usage of screen area, and therefore an increased capacity per unit mesh area.

Since then, in addition to the outward appearance of sieving machines evolving, there have been major advances in their component parts and in developing machines for specific applications and/or industries.



Finex Separator™

Achieving faster speeds

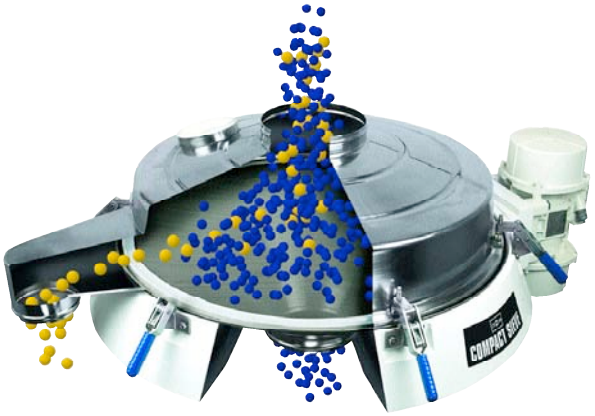
Over the years, a few basic designs of vibratory separators designed for grading materials have been developed.

One design incorporates a vibratory motor mounted on a spring suspension. Because this design is quite simple to manufacture, it is one of the most commonly available type of separators.

An alternative is to employ a standard drive motor (i.e. not vibratory) with a separate vibrator housing mounted on a rubber suspension. Examples of such machines are the Finex Separator™ and Finex 22™ from Russell Finex.

Most machines vibrate at 1400 rpm, but by separating the motor from the rubber suspension in this type of design, it became possible to increase the operating speed of the machines up to 2800 rpm with high out-of-balance forces.

This development led to increased efficiency of the sieve, enabling smaller diameter machines to be used without adversely affecting performance. For example, a 22” diameter machine operating at 2800 rpm can significantly out-perform a 48” diameter machine operating at 1400 rpm on materials which are traditionally difficult to screen.



Compact Sieve®

Seeking smaller footprints

One of the biggest developments in sieving technology has taken place in an effort to minimize space usage and to allow sieving machines to fit into process lines more easily. While most major companies realise sieving is an important step in their process, there still remains concern about the availability of floor space for this function. Suppliers have therefore strived to produce smaller units that can still meet demanding throughput requirements. An example of such a machine is the Russell Compact Sieve®, which is a low level machine that offers the same if not better performance as standard sized machines.

These smaller sized sieves are now one of the most widely used screening solutions across numerous industries. Companies appreciate having units with a small footprint as space requirements are often limited, but capacity levels must remain high to ensure there are not bottlenecks in the process which would compromise profitability.

Industry-led developments

Although manufacturers quickly adopted small machines like the Compact Sieve as they could help maximise production by freeing up valuable square footage, many producers have started seeking out more specialised sieving solutions customised to fit the needs of their industries.

For example, many food manufacturers experience difficulty safely sieving bagged ingredients. Operators face significant strain when lifting sacks of ingredients to the sieve. Added to this is the fact that many ingredients, flour being the most common, create a lot of dust during the screening process. This not only causes discomfort for operators inhaling the dust, but it poses a safety risk as charged flour particles are volatile by nature and can cause explosions if not safely handled.

The sieving industry responded by offering vibratory sieves with low-level bag-tip stations, incorporated into the design of the machine, as well as dust hoods to contain airborne particles.

Russell Finex's 3in1™ Compact Sieve is a prime example of such a system. By combining the Compact model with a dust-hood, tip station and magnet to remove ferrous particles, it provided food manufacturers with an ideal solution to their problems.

Another case of a particular industry requiring tailored sieving solutions is the pharmaceutical industry. For the past 10 to 15 years, pharmaceutical manufacturers have started to focus their attention on the need for contained handling and processing of their products and ingredients. An increasing focus on health and safety, coupled with the development of new highly potent active ingredients, has resulted in containment levels being more important than ever. Suppliers to the industry have had to adapt their equipment to reflect this new variable, and sieve manufacturers are no exception. Russell Finex launched their Russell Compact Airlock® specifically to provide pharmaceutical companies with the highest containment levels available in the industry. With a patented, inflatable clamping system, the sieve achieves OEL containment level 5 in independent tests.

Pneumatic conveying and how sieving fits in

One of the most popular ways of transporting solids at manufacturing sites is through pneumatic conveying systems. Pneumatic conveying is often selected because it is totally enclosed and dust-tight, ideal for dusty or dirty materials. These systems can also be installed anywhere a pipeline can be fitted within a site.

Sieving manufacturers have had to innovatively develop machines to allow producers to sieve ingredients before, during and after pneumatic conveying. Sieving ingredients before they enter the system ensures a product free of contaminants, which could otherwise lead to rejected products or potentially damage other equipment. Screening material within or after the systems allows for a high level of quality control.

There are two main types of pneumatic conveying - by positive pressure or vacuum. Simply explained, positive pressure systems can achieve longer distances at higher rates as jet blowers push air through the pipes. Vacuum systems, on the other hand, use suction technology to draw air and displace materials, and cannot generally achieve the distances and high levels of pressure systems. Different sieves must be used depending on the type of conveying system employed. For example, Russell Finex's Blow-Thru Sieve™, a certified pressure vessel, is specifically designed for positive pressure pneumatic conveying and is suitably rated for use up to 2 bar/29 psi in Europe. On the other hand, a manufacturer using a vacuum system can select a Compact Airswept sieve, whose design is tailored for vacuum pneumatic conveying systems.

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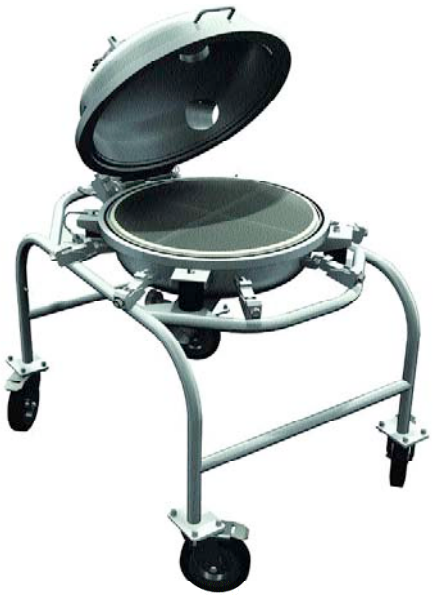

Blow-Thru Sieve™

High quality mesh - what to look for

Any company using a sieve needs to carefully consider the quality of mesh being used, regardless of the exact type of sieve model. A poor quality mesh can easily break, resulting in not only unnecessary downtime but also compromised product quality. Mesh screen material, mesh size and mesh tension must all be looked at.
The most common screen material is woven stainless steel wire mesh although more exotic metals, such as bronze, can be used if required for a specific application. Stainless steel is a reliable, durable material and is suited for most applications. Synthetic woven meshes are also available, where chemical compatibility is a concern. In general they are made of polyester or nylon.

Historically, and particularly in the USA, mesh count, which is the number of apertures per linear inch, was used to specify the screen opening size of a mesh. However, this method often led to a false measurement. Nowadays, it is more common to use microns to define opening size, i.e. by measuring the number of microns per aperture, which provides a much more precise and accurate measurement.

To ensure the optimal operating efficiency of the screen, it is crucial the mesh is properly tensioned, otherwise the screen will not give its best performance. In the past, the mesh was tensioned by hand and fixed to the screen frame by clamps or screws. However, this led to variability in the tension of the screen, and therefore in the operating efficiency of the machine. Using this method, the screen frames can also have loose wires, which are sharp by their very nature. They can be a source of contamination if they break off, and can cause injury to operators when handling the mesh frames. In more recent years, the mesh is automatically tensioned to the correct level on a stretching table. Furthermore, adhesives which have been specially developed are used to fix the mesh to the screen frames, removing the need for clamps or screws.

Overcoming mesh blinding when sieving fine powders

One common problem encountered during vibratory screening is mesh blinding. This occurs during the processing of powders, especially those with small particle sizes.

Simply explained, powder particles can become blocked in the mesh apertures, reducing the sieving machine's operating efficiency and increasing maintenance requirements.

Over the years, a number of methods have been devised to prevent this from happening. These include:

- Rubber balls placed under the screen mesh. These bounce when the machine is operating, and dislodge particles when they hit the screen.
- Slider/circular discs located under the screen mesh, which scrape the screen clean.
- Rotating brushes located above the screen, which brush over the mesh.
- Air jets located beneath the mesh, which blow a jet of air under the screen to try and dislodge particles.

A major drawback with the first three methods is they involve direct impact with the mesh screen. Over time they can lead to the wear and tear of the mesh. This is especially true of fine separation meshes, which are relatively delicate. This then leads to a decrease in mesh life and a decrease in screen tension.

Wear and tear can also happen to the cleaning components themselves. For example, rubber balls or plastic discs may wear or a brush bristle may break off and end up in the product.

Furthermore, the use of air jets requires a clean dry air supply. It is generally difficult to set up and a method for evacuating the air is required.

In the mid-1980s, realising there was a gap in the market for a more reliable, effective deblinding solution, Russell Finex pioneered the first commercially available product to use ultrasonic waves to prevent screen blinding, the Vibrasonic® Deblinding System.

The system operates by applying an ultrasonic wave directly to the mesh through an acoustically coupled transducer. The ultrasonic frequency causes the screen to vibrate at a very high frequency (34 000-35 000 times per second) and breaks down the surface tension. This effectively makes the wires frictionless, allowing the powder to pass through the mesh, and therefore preventing product build-up on the screen.

Ultrasonic technology has allowed vibratory screening manufacturers to enter new markets, particularly the classification of fine powders. Traditionally, fine powders have been separated using air classification, which uses the density of the material to separate it.

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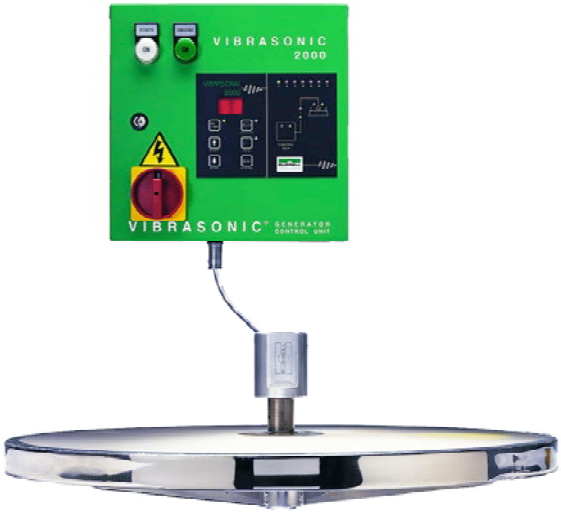
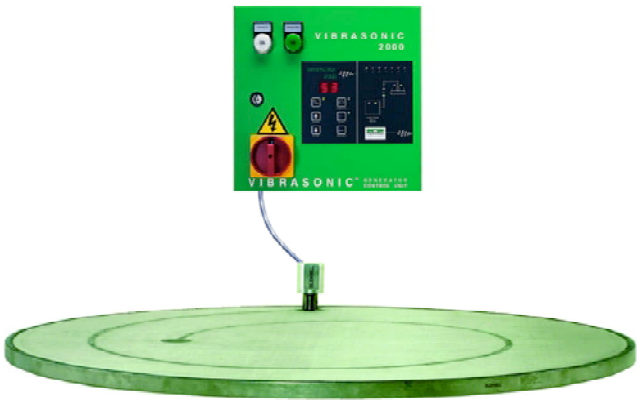


Vibrasonic® Deblinding System

However, through the combination of high quality woven wire mesh screens and ultrasonic screen deblinding technology, vibratory separators are now able to separate much finer materials and offer an alternative to air classifiers for many applications.

In recent years, a new development has been the launch of the Spiroscreen™, a mesh frame designed with a spiral shaped ultrasonic element. For companies using screens 900mm in diameter and above, it can sometimes be difficult for the ultrasonic frequency to be evenly distributed across the entire mesh frame. The Spiroscreen effectively eliminates this problem by allowing the frequency to be dispersed across the whole surface, allowing for maximum sieving efficiency across the whole mesh area. This technology allows the use of one single resonator, transducer and Vibrasonic® generator system to drive mesh frames up to 2m in diameter while maintaining even ultrasonic activity across the whole mesh frame.



Spiroscreen™

ATEX regulations and the sieving industry

ATEX is the name commonly given to the legal requirements for controlling explosive atmospheres and the suitability of equipment and protective systems used in them. First rolled out in July 2003, and mandatory as of July 2006, all organisations within the EU where explosion risks exist must adhere to ATEX Directives. Explosive atmospheres can result from the presence of flammable gases, mists or vapours or from combustible dusts. If these substances exist in high enough proportions and are mixed with air, an explosion can potentially be triggered by any source of ignition. The directive therefore affects almost all industries, including food, metal powders, powder coatings, pharmaceuticals, and chemicals.

Prior to the introduction of the ATEX regulations, companies generally only considered the risks of explosions from electrical components such as motors and starters. The ATEX regulations have added a new dimension whereby mechanical equipment also has to comply with strict guidelines to prevent the possibility of sparks being created and causing an explosion during use.

Two actions can be undertaken to reduce risk of explosion: preventing the release of dangerous substances and preventing any source of ignition. Selecting the right equipment, which has been specifically tested to eliminate ignition risk, can help companies achieve both of these. It is therefore of critical importance that companies needing to comply with ATEX Directives only select equipment and protective systems designed to meet these specific product regulations.

Selecting a sieve that complies with ATEX is especially important as the mechanical movement of the machine electrically charges ingredients. Sieves that are ATEX certified are designed to ensure there are no ignition sources that could propagate an explosion. All of Russell Finex's sieving equipment is available with ATEX certification, ensuring they are safe to use in potentially explosive gaseous or dusty environments.

Other considerations

There are many different types of vibratory sieves and separators available. They can usually be customised to suit specific requirements, such as Clean-in-Place environments, applications requiring several inlets or outlets or any other non-standard specification. The best course of action in these cases is to consult a reputable supplier who has the necessary experience to understand your application and recommend a solution.

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Additionally, sizing of equipment is not done based on any simple mathematical formula. Many variables, including particle size, density, moisture content, temperature and space available, must be considered. Most suppliers will use product testing and/or past experience to specify the right size of machine for the application.

In conclusion, though vibratory sieves and separators might on the surface appear to be quite simple machines, they represent years of development, testing and research to ensure they meet the needs of dry bulk powder manufacturers. Any company concerned with the quality of their products should place a vibratory sieve or separator high on their list of priorities.

Russell Finex has over 70 years of experience in fine mesh separation solutions.

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