quality

Identifying the right magnetic separator for removing ferrous contaminants

Bill Dudenhoefer
Eriez

Magnetic separators remove ferrous contaminants to preserve quality and prevent process upsets. This article discusses how the physical properties of materials and the nature of the process affect selection.

Ferrous metal contamination, no matter the source, damages process equipment and creates an impure product. The product's ingredients—liquid or solid—can pick up contaminants from several sources, including the quarry where some ingredients are mined and processed. Contamination can also originate at the plant, be it from material handling equipment, reactors, holding tanks, filling-packaging machines, or anywhere that abrasion occurs, such as a carbon steel or stainless steel chute that handle dry material.

If not caught quickly, even fine ferrous contaminants can cause problems, many of them harmful, such as breakdowns that lead to costly downtime. They may also cause you to violate Hazard Analysis and Critical Control Point standards. They certainly decrease product purity.

All these problems can be reduced, if not eliminated, by using magnetic separators, which do just what their name implies: remove ferrous materials (fines, shavings, machining pins, flakes, screws, washers, etc.) from dry or liquid process streams. Alnico (an alloy of aluminum, nickel, and cobalt) and ferrite (an iron oxide-ceramic) were two of the first varieties of magnets used in separators. Today, magnets can be made with rare-earth elements, which make them substantially stronger than alnico and ceramic.

Selecting a magnetic separator

Which magnetic separator best suits your application depends on several factors, including the operational temperature, flow rate, flow characteristics, and other process attributes.

Temperature. Magnetic materials lose strength at high temperature. Although some strength returns when the temperature reverts to normal, permanent magnets heated beyond certain temperatures may irreversibly lose strength. That's why it is important to determine the ambient, or operating, temperature, as well as the temperature reached during cleaning.

Rare-earth magnetic separators—although more expensive than conventional magnets—capture contaminants better at higher temperatures. Standard rare-earth magnets work in temperatures as high as 150°F, while others operate in temperatures of 250°F or even 400°F.

Flow rate.. Magnetic separators perform best when the contaminants pass close to the surface of the separator's magnet. Therefore, seek a design and size that accommodates the process flow rate, ideally one that thins the material into a shallow stream as it passes over or under the magnet.

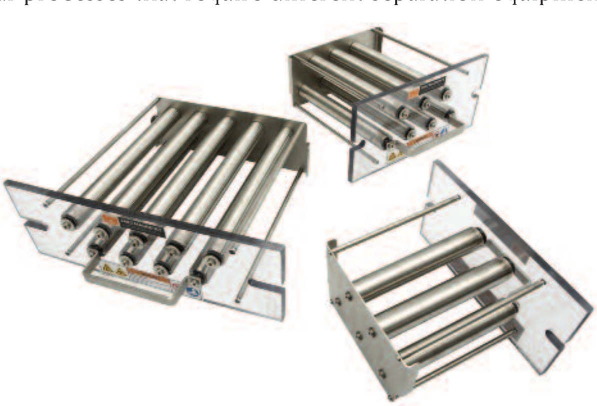
Flow characteristics. The are several characteristics to account for, including moisture, which can change the flow properties of otherwise free-flowing dry materials Some materials contain chunks that will plug an opening or gap in the separator. Other materials may flow freely through one separator design but not others. For example, some pharmaceutical powders with significant moisture will not flow through the 1-inch gap between the tubes of a grate magnet.

Process attributes. Among the process factors to consider are how the material will be presented to the separator; whether the material requires metering; whether you will stop the process to clean the separator or use a self-cleaning magnet; how much access is available for cleaning; whether ferrous materials or equipment in the area could create a hazard when exposed to a high-strength magnet; the amount of contaminants to be removed; and the degree of product purity required.

And that is only a partial list. It is also important to decide where in the process to install the magnetic separator. Should it be placed upstream of a filling/packaging machine? At the discharge of a conveyor? Beneath a hopper? Before the material drops into a bulk bag? The answers are not always obvious, and it is best to work with a design engineer knowledgeable about magnetic separators before you purchase and install one.

Match the magnetic separator to the material

Assessing the material being processed is a key step in selecting the right magnetic separator. Materials fall into one of three general categories: dry, moist, or liquid. But that is only a start, since materials vary widely within those categories. Dry materials, for example, range from powder flowing down a chute to tablets or capsules moving along a high-speed conveyor. These are vastly dissimilar processes that require different separation equipment.



Grate magnets fit into closed chutes and at the bottom of hoppers.

Dry and free-flowing. If the material is dry, contains small particles or granules, and flows freely, a grate magnet (photo above) provides the best opportunity for ferrous contaminants to be removed. Grates are especially well suited to vertical flows and are easy to clean; plate magnets (photo below) are also suitable for use with materials that flow vertically or cascade through an inclined chute. If the material is traveling through a pneumatic conveyor, a magnetic hump or radial-field cartridge magnet is the best option. It's also important to decide how you will clean the contaminants from the magnet. For grates, plates, humps, and cartridges, cleaning requires suspending material flow.

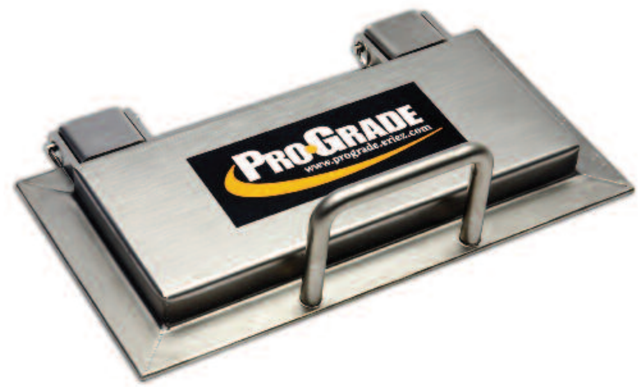
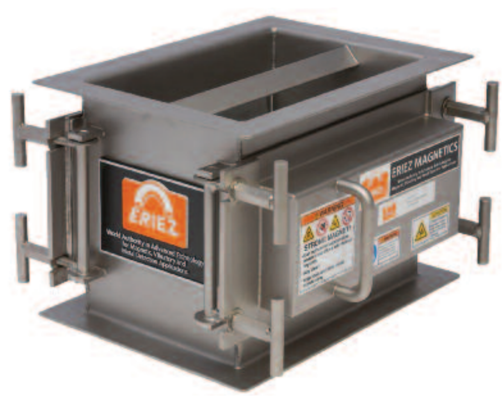


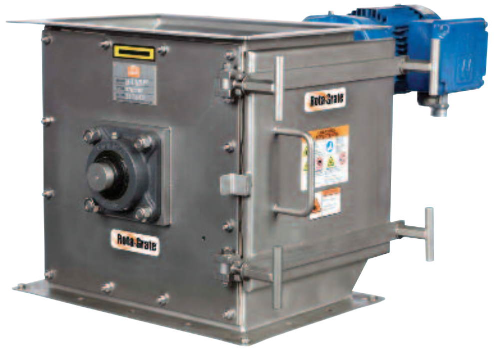
Plate magnets don't interfere with material flow.

Dry with some bridging. While grates efficiently remove fine contaminants, they do not work if the material cannot flow easily between the magnetic tubes. Plate magnets, however, do not restrict flow and are thus a better option. Magnetic humps will also work with less-than-free-flowing materials as long as the material flows enough to cascade down a sloped chute.



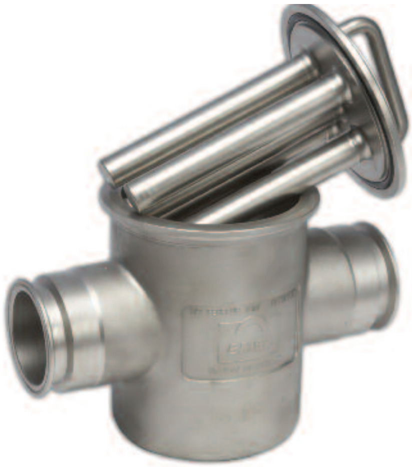
A Deep Reach separator divides and guides moist materials to the magnet.

Moist or lumpy. These materials do not flow through grate assemblies because their high angle of repose causes them to bridge (arch) over the openings. The best option here is a separator that divides and guides the material to the magnet, such as the Deep Reach separator (photo above). Another option is the Rota-Grate separator (photo below), which uses a reel-like element of magnetic tubes that continuously rotates through the material to eliminate bridging.



A Rota-Grate separator continuously rotates magnetic tubes through the material to eliminate bridging.

Liquids and slurries. These require a magnetic separator called a trap (photo at right), which uses either a series of 1-inch-diameter magnetic tubes or a plate within a cast housing. If a plate is used, the trap is U-shaped, with a shallow body that prevents the material from striking a series of magnets and thus minimizes damage to the material. U-traps work well with liquids that include chunky material, too.



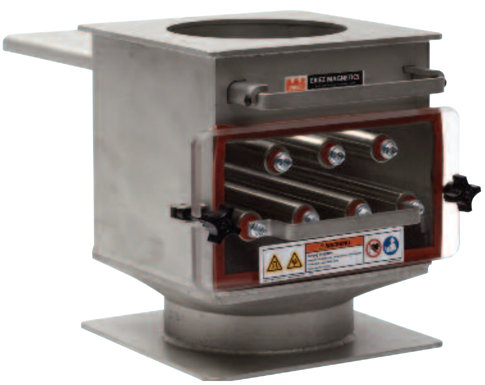
A trap separator removes ferrous contaminants from liquids and slurries.

Plates, grates, and traps

Plates. Plate magnets are simple devices, economical to install, and very efficient at removing occasional tramp metal. They work best when installed at the bottom of an inclined chute or suspended above a thin stream of material traveling on a belt conveyor or vibratory feeder.

In a typical chute installation, the contaminants cling to the magnet's face as the material slides over it, holding the contaminants until the plate is removed for cleaning. For convenience, the magnet is usually hinged to swing away from the chute. The Deep Reach separator is a variation on the plate magnet and can be installed in a vertical chute that handles sticky, poorly flowing materials.

Grates. Operations that include odd-shaped, round, oval, or round-cornered hoppers often call for grate magnets Typically, they use 1-inch-diameter magnetic tubes spaced 1 inch apart, thereby spreading magnetic protection over the cross-sectional area of the pipe, chute, or hopper. As noted above, these are ideal for use with small-particle, free-flowing granular or pelletized material. Several designs are available. The simplest uses a single layer of magnetic tubes to remove contaminants from materials discharging from a hopper.



A grate separator can include several flights within its housing.

To offer more protection, grate separators can include several flights within a housing. The housing can also include a drawer that slides open (photo above), giving you access to inspect and clean the unit. A drawer is the best option for installations within vertical chutes and ducts. To facilitate cleaning, use an easy-to-clean grate design that uses a push-pull motion to strip accumulated tramp metal from the grates. The units can also be designed to operate automatically.

If the material tends to clog or bridge instead of passing through conventional grate magnets, consider the Rota-Grate. Its tubular magnets rotate through the material, allowing it to remove both large and minute ferrous particles from fine, cohesive materials. Examples include pharmaceutical granulations and powders, gypsum, barium carbonate, fuller's earth, and lime.

If a grate magnet cannot fit within the confines of your operation, use a series of tube magnets, which are just as effective as a standard grate but enable you to design grates for unique requirements.

Traps. Magnetic trap separators are positioned inline and remove ferrous and heavy non-ferrous contaminants from flows of liquids and slurries. They protect pipelines, prevent abrasive wear, reduce jammed pumps, and ensure products are free of iron contamination.

They accommodate lines as small as 2 inches in diameter and as large as 18 inches in diameter or more. Standard traps function in temperatures of 150?F, but can be made to operate at temperatures as high as 850?F. There are also magnetic traps for pipeline diameters of 2 inches and smaller and that can withstand pressures as high as 150 psi. Some magnetic traps can also remove rust, scale, or screen wire from poorly flowing and chunky materials. Those are used in cases where finger-style traps would become clogged by large particles or where delicate materials would break if forced against a baffle. *T&C*

Bill Dudenhoefer is manager of separation products at Eriez, 2200 Asbury Road, Erie, PA 16506. Tel. 800 300 3743, fax 814 838 4960. Website: www.eriez.com.