

STOPPING METAL CONTAMINATION, IMPROVING PRODUCT PURITY, AND ELIMINATING RECALLS

The responsibility for a clean end product is shared by both bulk solids processing plants and their suppliers. Every participant throughout the process must ensure foreign contaminants aren't present in the end products that companies deliver to their customers. This article discusses the best practices used today for achieving the highest product purity and avoiding costly damage from tramp metal.

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Product purity — ensuring your end product is free of any ferrous contamination — is achieved by incorporating magnetic separators and metal detectors into your bulk solids process. In this system, both the separator and detector locate the ferrous material, but the separator draws the ferrous material out of the process via magnetism, while the detector uses a rejection mechanism to remove the ferrous contamination. The magnet in the separator is chosen based on a number of factors, including the magnet's *pull force* (or highest possible holding power) in relation to the ferrous contaminants needing to be picked up and the material's properties, temperature, and flowrate. But incorporating one magnetic separator and one metal detector into your process isn't sufficient enough, as ferrous pieces can slip by the first magnet, and ensuring your material is clean shouldn't be a one-time occurrence in your process.

This article discusses the relationship between magnetic separation and metal detection, the importance of emphasizing product purity and equipment protection from your receiving dock to the shipping department, and why engaging in continuous training to stay updated on material safety regulations and process improvements is essential.

Magnetic separation and detection

Magnetic separators use magnets and a magnetic field to separate ferrous material from nonferrous material. As the material is conveyed past the *permanent magnet* — a magnet that creates its own continuous magnetic field, the magnet's force draws the ferrous contaminants out of the material stream. The cleaned

material stream continues down the process line and the drawn-out contaminants are disposed of when the magnet is cleaned. There are a variety of magnetic separator types, including drum, plate, pulley, tunnel, and tube, some of which are shown in Figure 1, and each comes with its own advantages and disadvantages, depending on the application.

As the name suggests, a metal detector detects metal contaminants entering a specific piece of equipment, such as a pipe, conveyor, or chute, as shown in Figure 2, and then activates a rejection mechanism to remove the intruding particle from the stream. Metal detectors also come in a variety of styles, such as tunnel, gravity,

FIGURE 1

These magnets work for a wide range of applications, including dry bulk materials and high-temperature applications.



FIGURE 2

A metal detector often incorporates a conveyor system into the process.



and flat, and can be custom built to fit into existing processes, as shown in Figure 3.

Magnetic separators and metal detectors are often paired together in an attempt to achieve the cleanest end product possible. Neither a magnetic separator nor a metal detector is going to catch every ferrous piece in the process stream, and the more separators and detectors that you can afford and have the space for in your process, the better off you'll be. Also, since the metal detector tosses out valuable material — albeit a small amount — when the reject mechanism detects a piece of metal, running your material through a magnetic separator before the detector will help you save material and avoid costly and time-consuming equipment damage down the process line.

Regardless of the separator and detector types, magnetic separators are most effective in applications where the goal is to extract ferrous and certain stainless steel pieces before the end product is passed through metal detectors. A wide range of dry bulk solids manufacturers use magnetic separators, an example of which is shown in Figure 4, and the magnetic separation industry is constantly evolving to meet customer demands. Magnetic separator manufacturers work to improve their equipment by applying material sciences, engineering developments, and manufacturing processes. Advancements in magnetic separators are made on a regular basis.

For example, a research team from Penn State Behrend, part of Pennsylvania State University, recently proved that new rare earth magnets are able to remove metal contamination with a pull-test strength that's 13 to 40 percent stronger than other commercially available models. In fact, Penn State Behrend determined which commercial tube magnet most effectively removed dangerous ferrous metal and magnetically

FIGURE 3

A tunnel metal detector can be custom manufactured to suit any inline processing application where space is limited.

**FIGURE 4**

A plate magnet is often used to improve product purity in food processing applications.



weak contaminants from process flows. Researchers tested 12 tube magnets that were provided by various suppliers and had their brand identity stripped.¹

According to Penn State Behrend's conclusions, the pull force of one tube circuit was substantially stronger (about 20 to 70 ounces stronger) than any of the other samples. The magnet was also among the best performers in terms of *magnetic flux density*, which is the total magnetic field that envelops the magnet's surrounding area, measuring in at 12 kilogauss. These rare earth magnetic separators — with their strong circuits — can improve product purity when incorporated into the appropriate application by removing more harmful metal than non-rare-earth magnetic separators.

Rare earth magnet circuits are now incorporated into tubes, grates, and liquid line traps. These advanced magnets incorporate a balance between high gauss and high pull force to influence the trajectory of any *tramp metals* (which are typically metal scraps that have accidentally gotten into the conveying line) and hold onto any ferrous particulates, even during a washoff process. As magnetic technology continues to improve, we'll continue to see advancements in the level of cleanliness we can expect from our end products as well as increased efficiency in plant operations.

Monitoring material from receiving to shipping

Many companies have installed a series of liquid line B traps or dry pneumatic radial field (RF) cartridge magnets at their plant's processing door. When the tanker truck comes to the side of the building and the operator hooks up the hose to transport the material, the B traps or RF cartridges on the other side of the building's wall ensure via magnetic separation that metal isn't entering the plant.

The safest bet for ensuring clean material is using magnetic separation and metal detection equipment throughout your entire process, especially at the beginning. Often, companies are most interested in the end product or final package, so some only incorporate a magnetic separator system and metal detector at their process' end, as shown in Figure 5. That focus may lead to a satisfactory end product, but consider the possibility of added protection from contamination when the material is monitored from the process' beginning.

Some companies don't have the resources or technical expertise on staff to understand what the requirements are to achieve a clean end product. However, the law doesn't view ignorance as a viable excuse when dealing with contaminated material. All companies who come into contact with bulk solids are responsible for doing their own due diligence to ensure

FIGURE 5

A metal detector is often positioned at the end of a packaging line.



clean material. For example, your plant relies on your suppliers to deliver clean, contaminant-free ingredients. However, once the material enters your plant, you assume responsibility for the ingredients.

There's great value in conducting an annual audit to see what changes are needed to improve product purity and protect equipment from ferrous contamination that could damage it. Based on the latest advancements in technology, there are new options to further improve material quality and protection. Plant-wide audits can also be valuable.

Metal detectors enhance purity

Plant operators shouldn't assume that every supplier is sending perfectly clean material. Realistically, there are many opportunities for contamination to occur before the material arrives at the processing plant. Metal can come off a railcar's wall. A fastener, nut, or bolt may fall off a truck. A clamp can fall through the grate in the floor. How often these things happen is quite surprising.

Even with safety regulations in place, many plant workers neglect to check items for contamination on arrival. Proactive companies never assume complete cleanliness, so they install magnetic separation equipment and metal detectors at the very beginning of their processes. Fortunately, the number of companies that invest in proactive measures is growing.

One interesting example of a proactive company takes place in the southern US. The company placed a vertical metal detector below the silo but didn't want the detector to reject contaminated material. Rather, management wanted the detector to count the number of metal pieces in the material coming into the plant from a major raw material supplier. Management then

used this information to hold the supplier accountable. In this case, one railcar had 10 metal pieces in the shipment, which was unacceptable to the company receiving the material.

Today's metal detection equipment, as shown in Figure 6, combines precise mechanical design with high-tech electronics, a wide frequency range, vibration immunity, and complex algorithms to detect the smallest metals in difficult-to-sort materials. Industrial metal detectors are also designed for harsh washdown environments.

In a survey of field representatives and processors, information was gathered regarding what they were looking for when considering today's metal detection systems. Here are the key findings.

- Customers seek metal detection systems for demanding applications. The systems must work in both extremely low and high temperatures and be able to withstand demanding washdowns and environments.
- In a world where material contamination results in recalls, processors stress the importance of monitoring, record keeping, and sophisticated electronics, as shown in Figure 7.
- Processors want to detect the smallest contaminant possible within the material while minimizing the number of false rejects.

FIGURE 6

A variety of metal detectors exist for light-industry applications.



Metal detector attributes

New metal detection systems have the ability to find smaller metal contaminants than previous metal detectors, even in difficult applications. This is due to metal detector technology that has advanced throughout the years. For example, metal detectors now ship with factory presets for various materials based on actual testing and the provided application data.

With the metal detection system's software and graphical interface, you'll be able to detect contaminants at levels never before possible, which means a purer material. With older metal detection technology, these contaminants went undetected since there wasn't an interface and the system's range would be automatically set up as conservative. Be certain to evaluate the software when you compare metal detectors before making a final decision.

Remote monitoring and record keeping

Governmental guidelines drive companies to create policies, procedures, and protocols to ensure safety. To keep up with governmental guidelines, most new metal detection systems provide reject log monitoring along with remote notifications to processors indicating when a problem exists. Both are critical when considering safety and existing food safety regulations.

Today, maintaining records confirming that your material was checked for metal contamination, along with regular reporting, is crucial to have as part of your process. Even round-the-clock monitoring from remote locations is possible. Remote monitoring and subsequent notifications free up valuable time for operators, allowing them to be elsewhere in the plant and not constantly stationed by the metal detectors.

FIGURE 7

A metal detector can feature a user-friendly touch screen interface to allow you to control the process.



This real-time monitoring also allows operators to tend to a problem as soon as they're made aware of it. Monitoring a material's cleanliness from the time the material enters the plant until the time it leaves and meticulous record keeping of this monitoring are vital to a successful operation. This continual data logging is imperative for both auditing and corrective actions should contaminants happen to be found in your material at any point but especially after your end product has left the plant.

Additional support

Magnetic separation and metal detection equipment manufacturers can help bulk solids processors with their toughest metal contamination challenges. A number of manufacturers are on the frontline when serious metal fines problems appear. Many times, as part of the magnetic separation system purchase, customers not only receive high-performance magnetic separators and metal detectors, they also have access to food safety training. Training takes a number of forms, including in-plant training, webinars, and mobile training units. Many manufacturers also provide tutorial videos, case studies, equipment literature, installation and operation manuals, and startup installation support.

Leading manufacturers work with customers to understand their goals. These companies will likely ask questions such as what the particular application is, what size metal needs to be removed, and if the process has a grinder or mill. For larger tramp iron pieces, a large ceramic magnet might work fine to separate the pieces from the material stream. In other cases, depending on the contaminants, a different solution, such as electromagnets or alnico magnets, may be in order.

Please note that magnet positioning is also important and something that manufacturers will want you to consider. For example, a rare earth magnet should be placed ahead of the mill. But on the other side of the mill, near the grinder, another rare earth magnet should be installed to remove the fine particles that may have escaped the first magnet.

Magnetic separator manufacturers must ask the right questions to make sure customers get what they need for their application. Customers can sometimes lack understanding or have serious misconceptions about metal removal and detection, which is why training is so important.

Conclusion

There are many reasons why new high-powered rare earth magnetic separators, metal detectors, and smart manufacturing techniques have raised the bar for

ensuring the cleanliness of the material and equipment protection. Each day, diligent companies avoid recalls and damaged reputations by making product purity a priority. Management must look at the best performing technology for their application to be certain they're achieving the highest product purity possible.

Proper support and training enhances value beyond the price of the purchased magnetic separation and detection equipment for years to come. Investing in metal detection equipment can reduce the chance for tramp metal contamination and improve the material's cleanliness. Educating employees and following these recommendations will help processors avoid material recalls, damaged equipment, and lost productivity. **PBE**

References

1. To download the full Penn State performance report, visit <https://www.eriez.com//RE7PennStatePerformance.pdf>.

For further reading

Find more information on this topic in articles listed under "Metal detection/separation" in the article archive on *PBE's* website, www.powderbulk.com.

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