Application note

Product inspection

Reverse Metal Detection – Detecting the presence of required metallized components in food products

Author

Yuanjun Chloe Lu, Application Specialist, Thermo Fisher Scientific

Keywords

reverse detection, metal detector, metallized film packaging, missing components, product effect, food safety, brand protection, product inspection, foreign object detection

Introduction

Industrial metal detectors are most commonly used for detecting unwanted metal contaminants that are accidentally introduced into products at various stages of the production process at food and other manufacturing facilities. The metal contaminants can come from pieces broken off from blending and molding devices within the production process, as well as personal items such as hairpins and equipment hardware such as screws and bolts. If foreign contaminants are not properly detected and removed prior to products hitting the shelf at retailers, it will potentially lead to consumer complaints, or worse, consumer injury, and could ultimately damage a brand's reputation overnight. A typical industrial metal detector can pick up the metal signal and reject the product or batch that are contaminated, preventing massive product rework or even a product recall. The ability to detect metal in a product also creates an alternative application for industrial metal detectors, defined as reverse detection application. Reverse detection capability is most useful for applications in which a metal or metallized component's presence is key to quality control of the final products. For these applications, instead of detecting and rejecting the product or package that contains metal, manufacturers want to make sure the components that are made of, or contain, metal are present in the product.

This application note will discuss the principle of regular metal detection in comparison to reverse detection in industrial metal detectors, as well as provide insight on applications and operations.

Metal Detector contaminant detection and reverse detection

Modern industrial metal detectors are designed to fit into any production process. Products move via conveyor belt and pass through the aperture of the metal detector. Metal detectors find small particles of ferrous, non-ferrous, and stainless steel using coils wound on a non-metallic frame and connected to a high frequency transmitter.

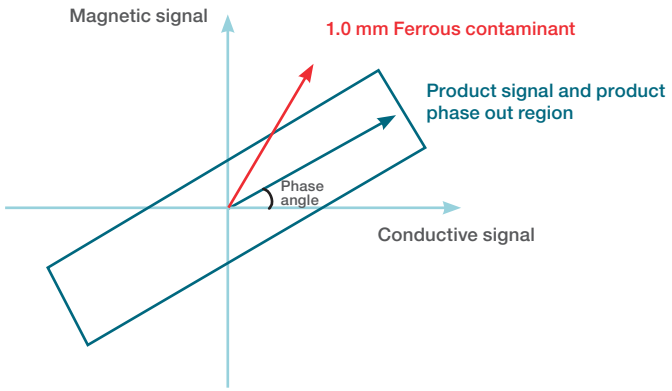

Figure 1. Metal detector principle when used for contaminant detection applications.

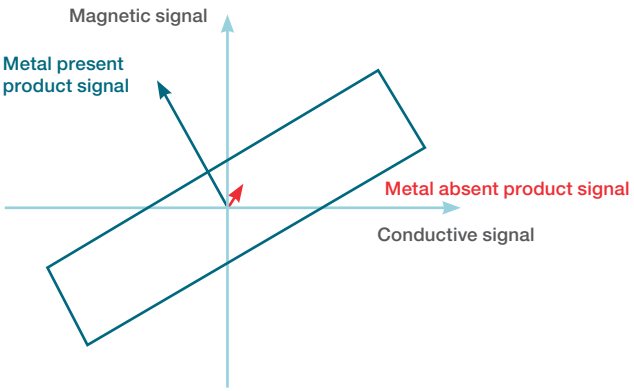

Figure 2. Metal detector principle when used for reverse detection applications.

The transmitter coils are located in the center of the detector housing (aperture), and multiple receiver coils reside on both sides of the transmitter coils with equal number and spacing. It should be noted that reverse detection is a capability of industrial metal detectors enabled by the software, meaning there are no hardware modification required on a metal detector used for contaminant detection to also be used for reverse detection applications.

When a metal detector system is balanced, the signal seen at the receiver coils on both sides of the transmitter coils is the same. As a metal piece gets closer to one of the coils, the signal on that coil changes and the difference in between the two receiver coils is detected. This is when a metal presence is confirmed.

A product learn feature is generally included in the metal detector software to allow the establishment of a baseline/threshold. In the case of contaminant detection, the baseline is created by passing clean products without any metal contaminants through the metal detector. For a reverse detection application, the baseline is established using products with the metal/metallized component present. One example of a reverse detection application would be a pack of ramen noodles which contains flavor seasoning packaged in a metallized film packet. The metallized film flavor packet will create a strong signal when passing through the metal detector. If a pack of ramen noodles without the flavor packet is passed through the metal detector, the signal will be well below the baseline, therefore the package will be rejected as required by the manufacturer. A simplified version of regular metal detector principle and reverse detection principle are shown in Figures 1 and 2 below. For contaminant detection applications, the signal within the threshold (purple rectangle) is acceptable, which is the opposite in the case of reverse detection applications. If the product signal falls within the threshold (purple box), it means the signal is too weak and there is little to no metal presence detected, therefore it will be rejected.

Below are screenshots of the intuitive HMI from the Thermo Scientific Sentinel 5000 multi-frequency metal detector. In this example, the reverse detection capability has been activated. The detection threshold has been set to 36 dB at all five frequencies. A signal above this threshold is considered to be caused by the presence of metallized component and is highlighted green. A signal below this threshold is considered to be caused by the absence of metallized component, and is highlighted red. As long as one frequency is green, the package will be accepted, shown in Figure 3. If signals at all frequencies are below the threshold, the package will be rejected, shown in Figure 4.

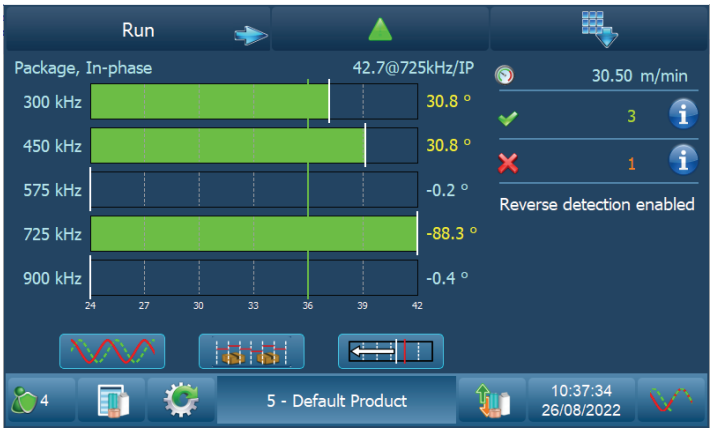

Figure 3. Screenshot of product with metal component present.

Figure 4. Screenshot of product with metal component absent.

Reverse detection applications

In reverse detection applications, the metal presence is usually in the form of packaging material or small parts that are included in a multicomponent product or finished good. Some typical applications that would benefit from reverse detection capability include:

- Ramen noodles with flavoring packets
- Baked goods mix with flavoring or icing packets
- Children's meal kit that contains toys or stickers at fast food restaurant

The various ingredient packets that can be found in ramen, muffin and biscuit mixes generally use metallized film packaging, which is essentially a thin layer of aluminum deposited on polyester film to minimize moisture and oxygen permeating through and changing the consistency and texture of the ingredient. This thin layer of aluminum, although it can be in the nanometer level of thickness, will still generate a strong enough signal in the field of a metal detector. Without the ingredient packets, the package signal will come entirely from the dry noodles or flour in the mix, which typically possesses little to no product signal in the presence of a metal detector's field. This will lead to the overall package signal to fall below the set detection threshold of reverse detection, causing the product to be rejected for rework or scrap.

Children's meals at fast food restaurants sometimes come with stickers or little toys. In order to make sure that these components are included in every package, some manufacturers will choose the design with a small piece of metal built-in or use metallized film to package the toys, and or stickers, so that the reverse detection metal detector can confirm the presence of these components on the production line.

In addition to food applications, reverse detection can also be beneficial in non-food product applications. For example, a nail polish manufacturer that includes a small metal ball in the nail polish bottle. When users shake the bottle, the ball moves around and stirs the nail polish to make it more homogenous. Another example is residential power outlet cover plates that generally come with screws in the kit for easy installation. Since all other components are made of plastic, using a metal detector to confirm the presence of the screws is an important step in the manufacturer's quality control program. There are many more applications that would benefit from the use of reverse detection technology. Whenever there is a need to ensure a metal presence within a product or package, reverse detection should be considered as a top choice.

Important notes on utilizing reverse detection

There are several points to consider when utilizing reverse detection to confirm the presence of metal or metallized components within a finished product.

Reverse detection:

- Cannot be used simultaneously with contaminant detection
- Cannot be used when the final packaged product is also packaged with metallized film
- Requires sufficient pitch (distance) in between products as they pass through the aperture of the metal detector

Due to the large signal generated by the metallized component within the final packaged product, small foreign metal contaminants may not be successfully detected. If a manufacturer requires contaminant metal detection and reverse detection within the same manufacturing line, it is recommended to have a second metal detector installed prior to the packaging line, to inspect unpackaged products without the interference of the metallized film. The metal detector installed post packaging is then solely responsible for confirming the metallized component is present.

Similarly, when metallized film is used as packaging material for the product itself, it could generate too much signal to overshadow the small, metallized component within this product. Therefore, it is not recommended to use reverse detection post packaging. If reverse detection is critical, it is best to install a metal detector prior to packaging the products in the metallized film pouch.

Additionally, sufficient pitch (distance) in between products is needed for the signal of the adjacent package to completely dissipate before the next product runs through the metal detector. Figure 5 is an illustration of how insufficient distance between products can cause false acceptance. Products one and three are good products with the metal component present, whereas product two does not include the metal component. Although product two should be rejected, the metal detector observes the ripple signals from products one and three and considers product two to be a good product with a strong metal signal as well, therefore it is accepted. This situation can be avoided by increasing the distance in between the products on the conveyor. The exact distance required depends on the metal component signal strength, belt speed, product orientation and size. Consult with your metal detector manufacturer to determine the best configuration for your specific application.

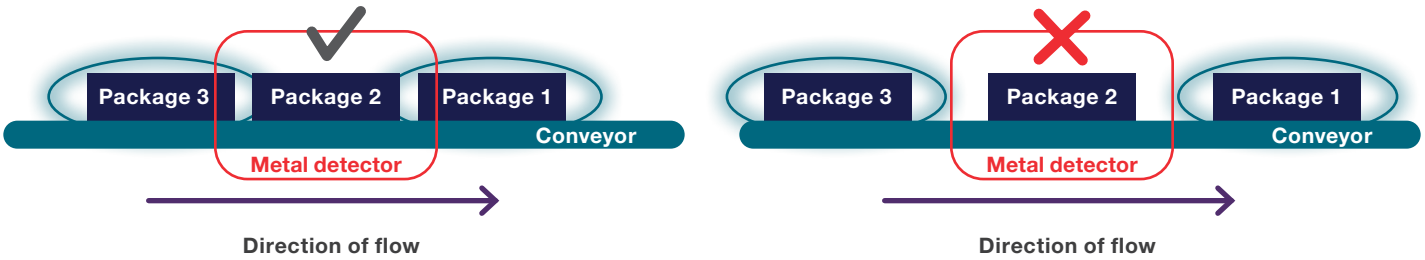

Figure 5. Illustration of how insufficient distance between packages can cause false acceptance.

Conclusion

Reverse detection is a well-established application, yet less commonly used feature of industrial metal detectors. It benefits numerous applications that require the confirmation of a metal or metallized components' presence. This capability highlights how metal detectors can be a key part of a manufacturer's quality control program, saving on expensive product rework time and ensuring consistent high-quality products for their customers.

Learn more at **thermofisher.com/metaldetector**

CAD.PI.APPNOTE.JEFFREYGROUP.0922