WHITEPAPER

DETECTABILITY
OF BELTING MATERIALS

Siegling – total belting solutions

MOVEMENT SYSTEMS

Abstract

To protect consumer health, food producers and processors must guarantee compliance with stringent regulations.

Pursuant to (EC) regulation no. 852/2004 and equivalent food directives in countries outside the EU, food manufacturers must apply the principles of a HACCP system (stands for: Hazard Analysis Critical Control Point). This system involves performing a hazard analysis to identify critical points in the production process and then applying control mechanisms to eliminate them.

In addition to meeting hygiene standards, detecting foreign bodies in food is another important factor. Foreign bodies can enter the production chain in all sorts of ways. In isolated cases, for example due to delamination, or rupture, particles of the conveyor belt used during production can also get into the food.

This whitepaper sets out to explain how the detection systems normally used in the food industry work and assesses their ability to detect belting materials that are foreign bodies.

The attachment explains which conveyor belts can be used for conveying products in the systems concerned.

Whitepaper
Detectability of belting materials · 09/23

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Various detection systems used in the food industry to identify foreign bodies

In the food and pharmaceutical industries, the purpose of detecting foreign bodies dynamically is to improve safety and ensure product quality. On a consistent and non-destructive basis, inspection systems with integrated conveyor belts check packaged or non-packaged products, which are discarded if contamination by foreign bodies is suspected. In the case of packaged products, renewed contamination is ruled out.

Various detection methods are used in these inspection systems which differ fundamentally in the way they work and each has its own strengths and weaknesses:

- Metal detectors
- X-ray detectors
- Optical detection systems (not dealt with in this brochure)

Forbo Movement Systems tested the first two processes extensively to examine their suitability for detecting belting materials too.

Inspection systems are used for quality control in the following food segments:

- Pet food
- Convenience food
- Meat/poultry/seafood
- Dough processing
- Dairy products
- Cereals
- Confectionery
- Fruit and vegetables

They are also used for different purposes in other industries, for instance:

- In airports, they screen passengers' baggage
- In the plastics-processing industry (e.g. at Forbo Siegling) and during wood processing (chipboard industry), metal detectors are used to protect machinery and equipment, as well as for quality-assurance purposes

1 Metal detectors

Metal detectors are designed to detect ferrous and non-ferrous metals as well as stainless steel in unpackaged and packaged food. Stainless steel is the most difficult metal to detect as it's usually not magnetic and a poor electrical conductor.

Metal detectors are increasingly being supplemented by x-ray inspection systems in the food and pharmaceutical industries. In addition to metals, these also detect impurities such as glass, bones or stones.

Metal detector on a production line

1.1 How they work

A metal detector normally consists of a field coil, two receiver coils and a control unit. The field coil is positioned between the two receiver coils and excited by an adjustable frequency.

The receiver coils are connected in opposite series so that no voltage is measured in the state of equilibrium. If a ferromagnetic, paramagnetic or diamagnetic body is passed through the magnetic field, the induced voltage in the receiver coils changes. The control unit detects these changes and the phase shift, which depends on the material to be detected and the particle size. Interference from vibrations etc. are usually filtered out. However, this reduces the sensitivity of the detector.

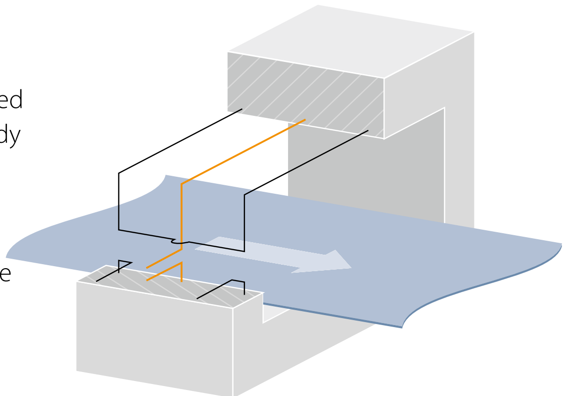
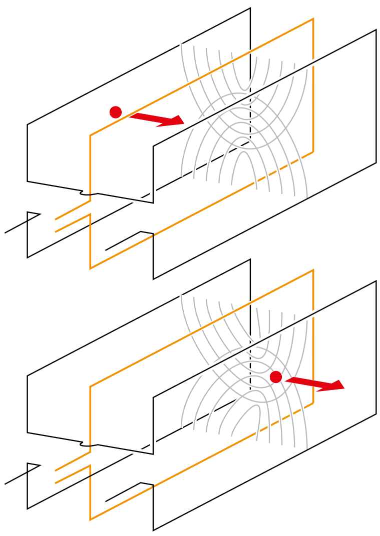


Diagram of a metal detector
Orange: field coil
Black: receiver coils

The products requiring control are often electrically conductive (e.g. due to dissolved salts, dissociated acids or ion-forming substances) and often cause voltage changes in the receiver coils (called the product effect). Detecting foreign bodies is harder in these cases. To be detected, they need to induce voltage that exceeds the product effect significantly or produces a different phase angle.

Metal detectors are usually taught about the product conveyed. The alarm is only triggered when a voltage state no longer corresponds to the voltage amplitude learnt or to the phase angle of the product effect.



Detectable deflection of the magnetic field when a metal particle passes through

1.2 Influencing factors

In addition to the device's basic settings, the magnitude of the product effect and the detector's filter options, the level of detection depends on other factors:

Position of the foreign body
The detector's sensitivity at its lowest in the middle of the tunnel (relative to the cross-section).

Speed and orientation of the foreign body
The induced voltage primarily depends on the area of the body perpendicular to the field lines and on the velocity with which it passes through. The greater the velocity, the higher the induced voltage.
A long piece of metal (e.g. a hypodermic needle) might not be detected if it's pointing towards the magnetic field lines (see figure on previous page).

The foreign body's phase angle
The phase angle depends on the material to be detected and the particle size. The greater the difference to the product effect, the better foreign bodies are detected.

Test objects for metal detectors: plastic strips with a spherical piece of iron embedded in them

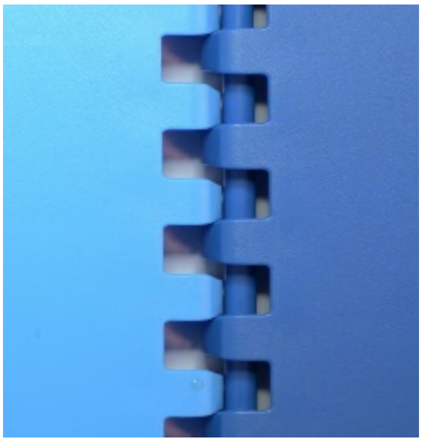
The detector is often required to find a spherical piece of iron 2 to 2.5 mm (0.078 to 0.098 in) in diameter and a stainless steel ball 2.5 to 3.5 mm (0.098 to 0.138 in) in diameter reliably.

1.3 Detectability of belting material

Electrically conductive substances (metal detectable compounds) have to be added to plastic belting materials so that metal detectors can spot them at all.

The level of detection depends on the proportion of electrically conductive substances. However, this proportion can't be increased to any amount as it would alter the properties of the underlying material in the belt too much. The amount of additive used, for example, in Siegling Prolink MD materials (MD = metal detectable) induces a voltage with a phase angle of approx. 180° and is therefore comparable with small spherical pieces of iron. MD materials are dark blue to set them apart from standard materials.

Identifying metal detectable belting material always depends on lots of parameters (the detector type, detector settings, the type and quantity of products conveyed, the conveying velocity etc.). Consequently, how easily defined particle sizes will be detected can only be decided on a case-by-case basis.



Siegling Prolink series 6.1:
On the left – POM standard material
On the right – POM-MD (metal detectable)

2 X-ray detectors

The technology behind x-ray detectors is much more sophisticated than in metal detectors, but alongside metals, they also detect impurities such as glass, bones and stones and their exact position. What's more, further product characteristics such as its completeness, composition, form or mass can also be established.

2.1 How they work
X-rays are generated in an x-ray tube and deflected onto a line of photodiodes. The x-rays pass through the product to be tested and are attenuated and scattered onto the diode field where they are turned into electric signals.

The more a material scatters or absorbs the radiation, the higher the black level of the corresponding diode. In the case of large products or those with significant scattering, the anode voltage can be increased in order to screen the product nevertheless, but this also reduces the detector's sensitivity to foreign bodies.

With the aid of visualization software, a digital x-ray image (black-and-white image of the product being x-rayed) is created from the electrical signals, which can be interpreted by appropriate software. Metal that's allowed – such as aluminum clips on the ends of sausages – can be filtered out.

The systems on the market operate according to the same principle but are designed very differently.

X-ray detectors for use on production lines

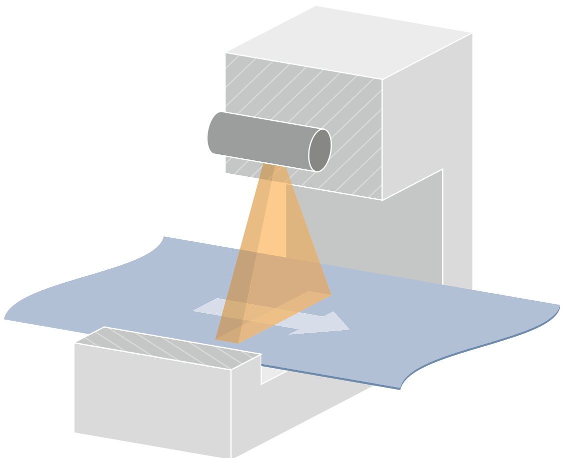
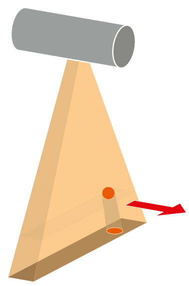


Diagram of an x-ray detector
Orange: Screening field



Detectable absorption of rays when a foreign body passes through

2.2 Influencing factors
In addition to the device's basic settings (tolerance and sensitivity/calibration attuned to the product being conveyed and acceptable products, zero adjustment for the conveyor belt when it's not conveying any products) and the performance of the software downstream, the level of detection also depends on other factors:

Shape of the foreign body
Foreign bodies whose projected surface has a vastly different shape to the products being conveyed are easier to detect. Detection is facilitated when a product is conveyed that's homogenous or has recurrent patterns.

Size of the foreign body
Foreign bodies whose projected surface is larger than that of the product conveyed are easier to detect. Diameters of more than 0.8 mm (0.031 in) are easier to detect because this is the most commonly used diode diameter.

Other characteristics of the foreign body
The more different the scattering and absorption properties as well as the densities of the conveyed material and foreign bodies are, the greater the level of detectability.

Experience has shown that spherical pieces of iron with a diameter of approx. 1.4 to 1.6 mm (0.055 to 0.063) can be reliably detected in a box of food.

2.3 Detectability of belting material
If there is sufficient difference in density and scattering capacity to the material being conveyed (e.g. flour), conveyor belt particles made of standard materials can be detected.

Adding electrically conductive substances increases the absorption or scattering capacity of the belting materials and improves the level at which unstable products conveyed are detected.

Identifying x-ray detectable belting material always depends on lots of parameters (the detector type, detector settings, the type and quantity of products conveyed, the conveying velocity etc.). Consequently, how easily defined particle sizes will be detected can only be decided on a case-by-case basis.

3 Conclusion

To ensure food safety for consumers, metal detectors or x-ray equipment are often used in the food industry to identify foreign bodies.

By using appropriate belt types, belt particles (foreign bodies) can be identified by metal detectors or x-ray equipment.
However, it's hard to say what the minimum detectable particle size in food is because this depends on lots of factors.
For instance, the type of food, sensitivity settings and the detectors' data-processing capabilities, on the position, setting or speed of the particles and, of course, the concentration of the detectable compounds added to the plastic.

Reliable results are only possible by carrying out in-depth analyses under real-world conditions on a case-by-case basis.

However, preventative measures can minimize the risk of food contamination by belting particles considerably.

- Using high quality belting material, which is carefully chosen for the process concerned, reduces the risk of delamination and breaks.
- Frequent maintenance and preventative maintenance of the production machinery and correctly tracking the belts prevents chafing, which causes belt abrasion or other damage.

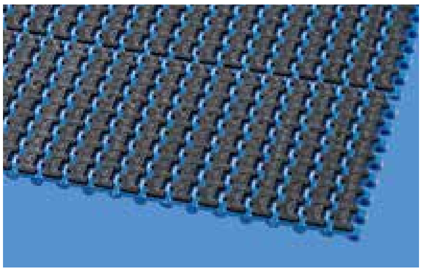
Why not ask your Forbo expert for more information about this?

ATTACHMENT

Requirements of belts used in metal detectors

Siegling Prolink: All standard materials without MD/XD and, of course without any steel hinge pins, can be used in the metal detector.

Siegling Transilon: Most Forbo Siegling belts are antistatic, i.e. an antistatic filament is woven into the fabric to prevent the belt from creating electrostatic build-up due to friction over the slider bed or rollers. As regards Z-splices, this antistatic filament is interrupted where the fingers of the Z-splice have been punched in. This can cause the metal detector to register an incorrect pulse. Modern metal detectors can ignore the recurring influence of the splice. A splice at a 60° or 80° angle can minimize the impact of the antistatic filaments punched through. However, it's advisable to use non-antistatic belts (NA versions) in many metal detectors.



Examples of patterned conveyor belts that can be used in x-ray detectors

Requirements of belts when used in x-ray detectors

There are usually no special requirements for the belts when they are used in x-ray detectors for the food industry. However, a high friction coefficient on the top face often makes sense as positioning stability is easier to guarantee when the belt passes through the lead or lead substitute curtain.

Siegling Prolink: In the case of Prolink belts, a high friction coefficient can be achieved if FRT (Friction Top) types are chosen.

Siegling Transilon: In the case of Transilon belts, numerous belt types with a suitable surface coating (e.g. R-coating, silicone) ensure the necessary friction coefficient. However, the belt must suit the shape of the conveyor (for example, it must comply with the minimum drum diameter). An NA type isn't necessary.

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