

Maximize Productivity and Brand Protection

Metal Detectors in Food Manufacturing



METTLER TOLEDO



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Introduction

Metal detection systems support food processors' quality and production goals. This guide is intended to help you get the most out of your metal detector to protect brand reputation and increase profit margins.

In this guide, we explore how to maximize metal detection performance to improve productivity, increase overall equipment effectiveness (OEE) and reduce downtime. We focus on the potential causes of false rejects that can slow down the production line, waste product, and ultimately reduce profits.

Before getting into the details, we discuss the basics of how industrial metal detectors work.

The guide then explains the influence a product's shape, size, orientation or characteristics can have on the effectiveness of your metal detector.

At the end of this guide, we highlight two innovative metal detection solutions designed to reduce or virtually eliminate false rejects.



Basics of Metal Detection



Basics of Metal Detection

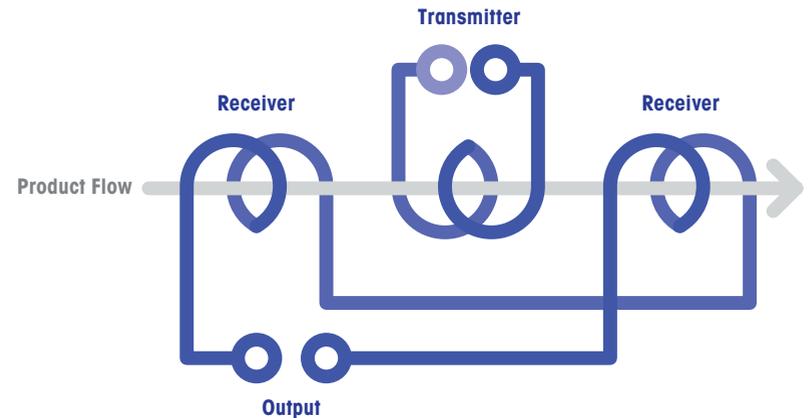
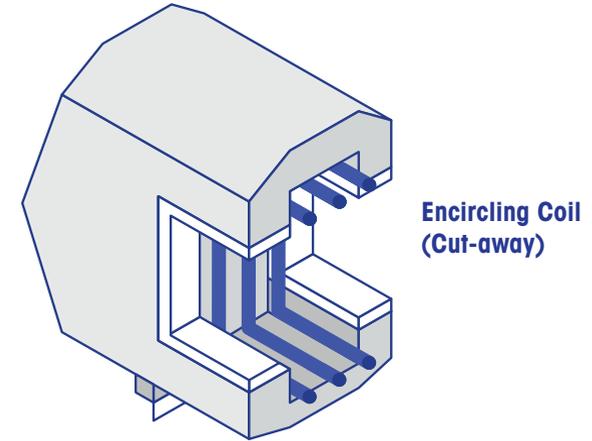
In order to understand how to maximize metal detection performance, you must first understand how a metal detector works.

Metal detection systems are designed to detect very small metal contaminants, bits of wire, metal slivers and swarfs, in products that are often thousands of times larger than the contaminant. The most common type of industrial metal detector uses a balanced coil system design. A coil arrangement with a transmitter coil loop runs parallel with and between two receiver coil loops.

The field generates electrical signals in the receiver coils and since they are

connected in opposition, the resultant signal is close to zero. In this state it is referred to as "balanced".

When anything magnetic or electrically conductive passes through the coils, it interferes with the magnetic field. This causes a signal to be detected by the receiver coils. The metal detector interprets this as the presence of a metal contaminant and identifies the product for rejection.



What Food Processors Need to Know



What Food Processors Need to Know

When a characteristic of a product is able to affect a metal detector to the same extent as a metal contaminant, it is known as "Product Effect".

Foods that have a high moisture/salt content, (sometimes called "wet" products) can produce what is known as "product effect". This can cause unwanted false readings in metal detectors and lead to costly product waste due to false rejects.

These products include fresh meat, poultry, seafood, jams, preserves, dairy, bakery and ready meals.

An effective metal detection system can remove the influence of product effect. This enables the smallest metal contaminants to be identified and removed from the production line, without suffering from a high false reject rate. A professionally commissioned and validated modern metal detection system should operate at a zero or near zero false reject rate.





How to Reduce False Rejects

Managing cost, or more specifically reducing cost, is something all food producers are focused on. However, the installed metal detector should effectively discriminate between product effect signals and metal contamination signals.

Without this, the system will produce a high number of false positives, i.e. rejection of uncontaminated product. This is primarily due to the metal detector either not being set up correctly, or not set up to manage the potential variation in product effect signals.

This is typically seen when inspecting fresh products such as meats, cheeses and different types of bakery products.

Historically the way to overcome this was to reduce the on-line performance of the metal detector to effectively ignore the product effect. However, this increases the risk of allowing actual contaminants to pass through the system undetected and potentially reach retailer shelves and the end consumer.



Fortunately there are advances in metal detector technology such as Product Signal Suppression technology. Modern metal detectors can discriminate, to a far greater level, the difference between product signals and those signals generated by real metal contaminants. This removes the need to reduce on-line performance.

A correctly specified and commissioned metal detector with the latest technology should be able to maximize on-line sensitivity, whilst at the same time, eliminate the occurrence of false rejects.

By getting the best out of the metal detector, enhanced brand protection, productivity and overall equipment effectiveness (OEE) can be achieved.

Ultimately, by choosing the correct solution for the application, food manufacturers can be confident they are implementing a far more cost effective and reliable metal detection program.

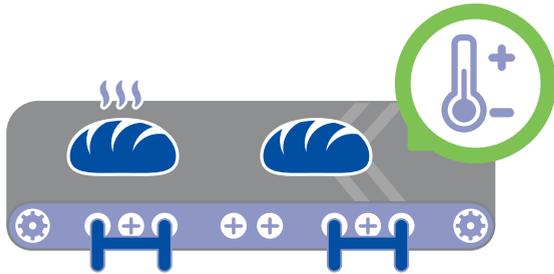
Six Factors That Influence Performance



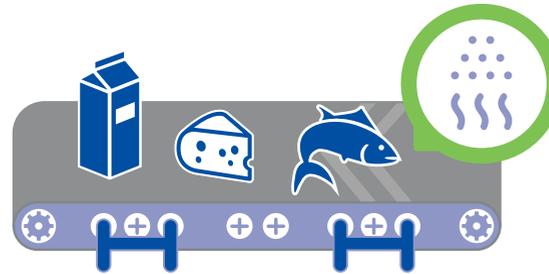
Six Factors That Influence Performance

Here are six key factors that can influence the effectiveness of the metal detector's ability to detect metal contaminants.

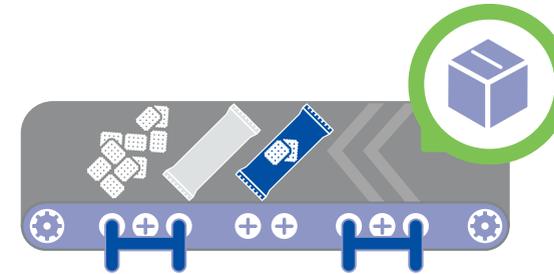
1 Product temperature



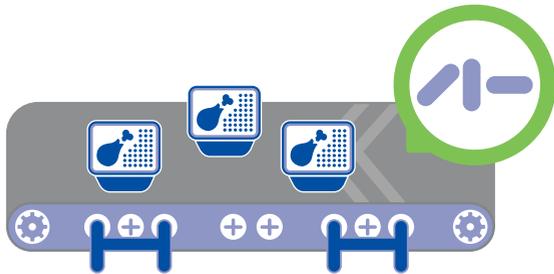
2 Moisture or salt content



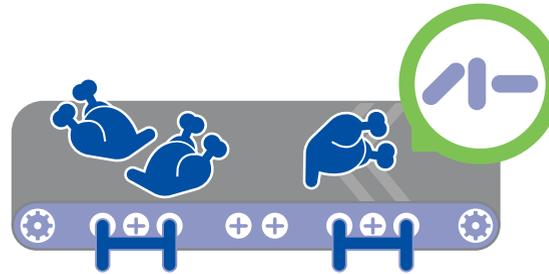
3 Product format



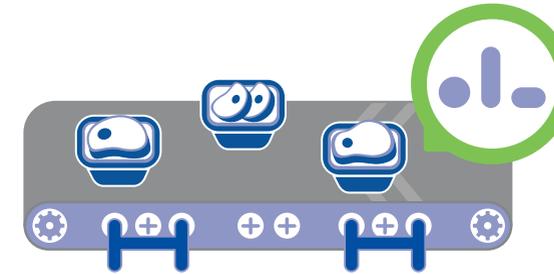
4 Product consistency



5 Orientation on the production line



6 Product size and shape





Six Factors That Influence Performance

1. Product temperature

As warm products cool down and frozen products begin to thaw, their product characteristics create a change in the magnetic field and imitate the product signal created by a metal contaminant. This can be problematic should the line slow or stop. Baked bread that begins to cool has a lower product effect than warm bread straight from the oven.

Deep-frozen products typically act like a dry product. However, when exposed to warm, damp air, the frozen products thaw.

Condensation forms on the outer packaging increasing its conductivity. This thawing converts a dry product into a wet one. This changing of product signal requires a solution for high product effect to get the best results.

An even greater effect is the way that changes in temperature alter the phase angle of the voltage in the metal detector's receiver coils. A change of just 5 °C (41 °F) will create a shift that is significant enough to make detection of contaminants much harder.



2. Moisture or salt content

Depending on the ingredients and the amount of moisture or salt (which can vary significantly from one product to the next), false positives may occur. Beef, for example, will have variations in moisture and the salt content based on the cut of the meat and from where the meat originated.

If the product is marinated, the amount of marinade is not always consistent. These factors can very quickly change the conductivity and permeability of the product.

3. Product format

Products packaged in metallized film, such as chocolate bars, nuts and crisps have a product effect. This has a big impact on achieved sensitivity, so the influence of product effect needs to be removed to accurately and consistently enable the detection of small metal contaminants.

Product Signal Suppression technology plays its part to overcome product effect in challenging applications, irrespective of the packaging type.



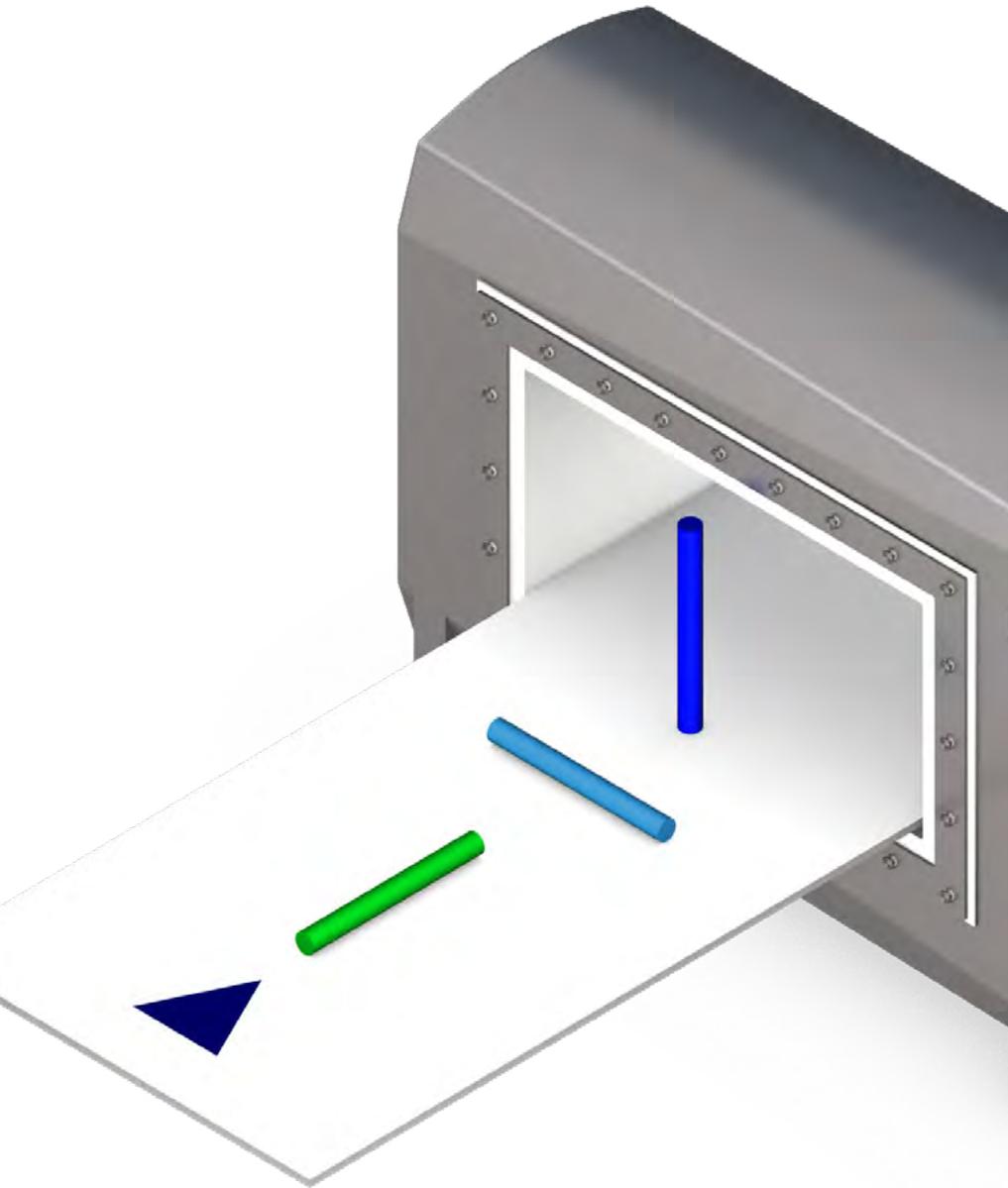
4. Product consistency and density

Different ingredients and products exhibit varying levels of permeability and conductivity. Their impact on the magnetic field in the detector's aperture can also vary significantly. For example, ready meals often have variations in the quantity and what's inside the package, with different densities and consistencies.

Mashed potatoes, sausages and gravy in the same tray present very different product signals as they pass through the metal detector's aperture.

Similarly, certain ingredients such as bone content in meat or fish, affect the density and consistency. This creates product effect and reduces the ability of the metal detector to detect metal contaminants.





5. Orientation on the production line

Orientation of the product complicates the detection of metal contaminants. Sensitivity should always be measured as near to the center of the metal detector's aperture as possible, as this is the least sensitive point.

A product passing through the center of the aperture is therefore exposed to a weaker magnetic field than a product passing near the sides. A fish that passes through a metal detection system with its short edge leading (head first) vs sideways (long edge) would make a big difference.

6. Product size and shape

Uniformity in the shape and size of products is another consideration. Generally, with packaged products, there is a good degree of uniformity, and the packs give a consistent product signal.

However, a conveyor belt of whole fresh chickens could vary in some or all of these features. A bigger chicken typically gives a stronger product signal than a smaller chicken, potentially confusing the metal detector as it looks for contaminants.

How Metal Detectors Support Food Safety

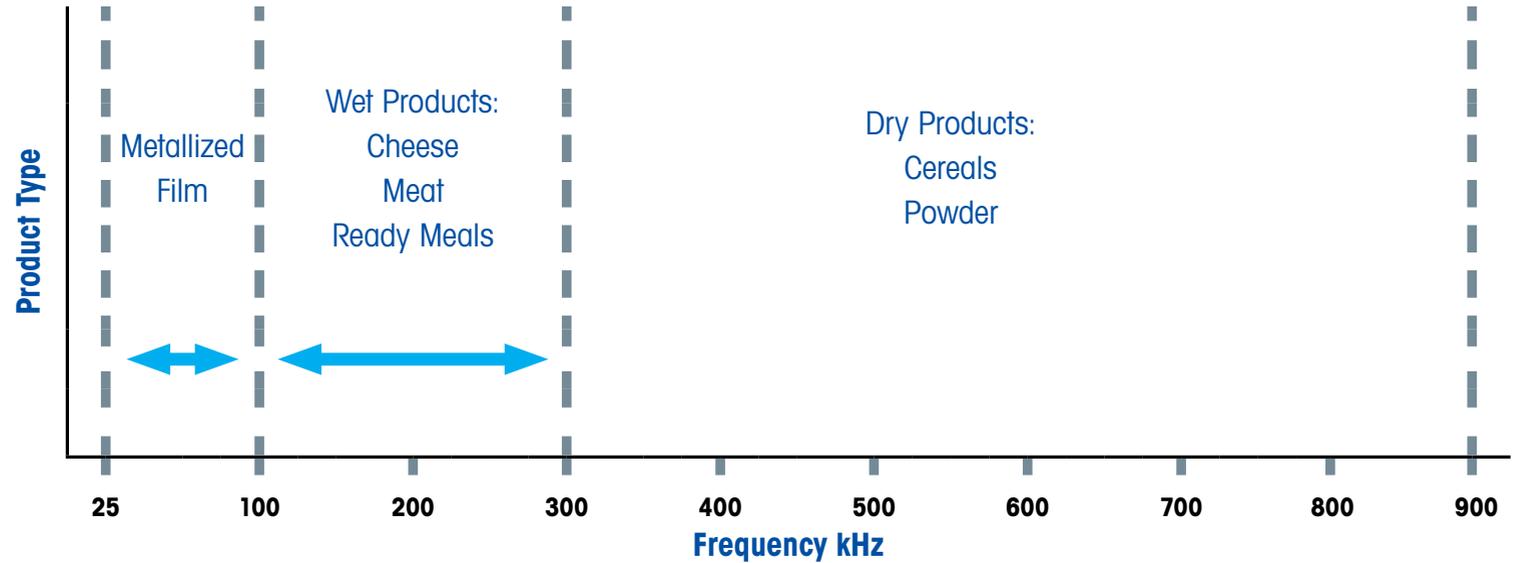


Delivering Sensitivity Performance

Sensitivity is a big factor when understanding how to choose the right metal detector.

Products that are non-conductive, low in salt or moisture are referred to as being a "dry" product. E.g. fine powders, cereals, confectionery, sugar, flour, dried pasta, and biscuits.

These products have little effect on metal detection when passing through the detector, making it easier to detect metal.



How Metal Detectors Support Food Safety

The correct metal detection technology can overcome product effect and have a significantly positive impact on operational efficiency.

As a general rule, high frequency metal detectors are more sensitive to small metal contaminants. However, they are also more sensitive to product effect, which can compromise detection capability. Historically lower frequency metal detectors tend to be used to inspect product effect applications.

Lower frequencies tend to be used as product effect increases with a smaller compromise in detection capability.

Some modern metal detectors are specifically designed to increase detection sensitivity for products that are more difficult to inspect.

The most sensitive metal detectors for product effect applications operate at more than one frequency, simultaneously, known as Dual-Simultaneous Frequency (DSF) or Multi-Simultaneous Frequency (MSF). They can deal with product variations in a very effective manner to deliver and maintain high levels of detection capability.



The Importance of Frequency

Numerous choices of technologies are available, depending on application and budget.

Options include single frequency, dual frequency or multi and variable frequency systems. More recently we have seen the development of Dual- and Multi-Simultaneous Frequency systems.

The table opposite shows which system is best suited for which application when looking just at achievable sensitivity, other factors should of course be taken into consideration.

Technology	Number of Frequencies Available	Dry Product Sensitivity	Wet/Challenging Product Sensitivity	Future Proofing
Tuned, single, low to mid-range frequency	1	***	***	*
Tuned, single, high range frequency	1	*****	**	*
Tuned, dual, low range frequency	2	**	***	***
Tuned, dual, high range frequency	2	*****	**	***
Tuned, multiple, low range frequency	3	***	***	****
Tuned, multiple, high/wide range frequency	3	*****	**	****
Multi-Simultaneous with Intelligent Inspection Algorithm	10	**	*****	****

Product characteristics and frequency

* = Poor, ** = Average, *** = Good, **** = Very Good, ***** = Excellent

Metal Detection Solutions



Advanced Metal Detection

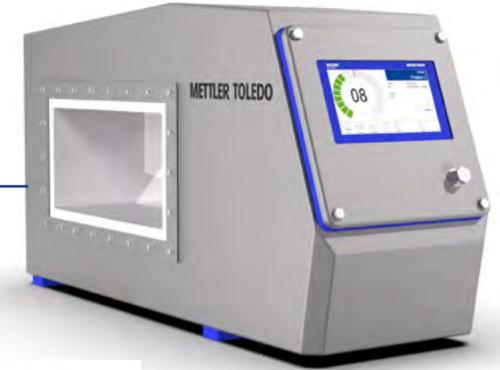
The most sensitive metal detectors for inspecting product effect applications operate at more than one frequency simultaneously.

Dual-Simultaneous (DSF) or Multi-Simultaneous Frequency (MSF) metal detectors use a combination of high and low frequencies simultaneously. The more sophisticated models include intelligent software algorithms to further enhance detection capability.

They suppress the active product signal, known as Product Signal Suppression.

Put simply, the detector learns the characteristics of the products, and then removes the product effect from its results. The improvement in detector performance from traditional single-frequency metal detectors to DSF or MSF metal detectors is as much as 25% and 50% respectively, in product effect or metallized film applications.

M30 R-Series



Profile Advantage

Metal Detection Solutions

When you need to reduce false rejects, there are a number of solutions to suit your performance, compliance and productivity requirements, for a wide range of conveyORIZED challenging/wet product applications.

M34R PlusLine Metal Detector

The M34R balances inspection performance with total cost of ownership. Achieve up to 25% improved spherical detection sensitivity vs tuned frequency metal detectors thanks to a combination of Dual-Simultaneous Frequency technology and the 3S algorithm.

► [Learn more about M34R PlusLine](#)



Metal Detection Solutions

For wet, hot, chilled, cooling or packed in metallized film applications.

Profile Advantage Metal Detector

When you need to achieve the highest sensitivity, Profile Advantage overcomes product effect and virtually eliminates false triggering. Thanks to Multi-Simultaneous Frequency and Product Signal Suppression, it can deliver up to 50% improved sensitivity to detect smaller metal contaminants.

► [Learn more about Profile Advantage](#)



Summary





Summary

An effective metal detection system can remove the influence of product effect for the smallest metal contaminants to be identified and rejected from the production line.

Wet products or product effect applications, mimic metal contamination and can cause the metal detector to false trigger.

Six factors that influence product effect are:

- Product temperature
- Moisture or salt content
- Size and shape
- Position and orientation
- Consistency or density
- Packaging material

Dry products have a much lower product effect and are easier to inspect. These include flour, dried pasta and powders. Some wet products that exhibit product effect, such as seafood or meat, act like a dry product when in a frozen state.

For expert advice on specific product effect applications, contact your local METTLER TOLEDO Product Inspection sales person who can help you choose the best solution for your application.



Additional Information

If you are concerned about product effect and false rejects, the answer may be to install either Dual- or Multi-Simultaneous Frequency metal detectors combined with Product Signal Supression technology. This advanced technology supports food processors to enhance productivity, protect brand reputation and increase profit margins.

Along with meeting the required quality control standards, metal detection systems also facilitate compliance with industry legislation and codes of practice. These include IFS, BRCGS, SQF and FSSC 22000 standards.

When choosing the most suitable metal detection system for your product effect applications, suppliers should offer an effective solution that meets all your needs.

In addition to offering high performance metal detection systems, METTLER TOLEDO also offers comprehensive [service support](#) globally, including preventive maintenance and effective user training to support maximum uptime of your systems.

Global Service Support

Keeping Your Production Running

With local presence in most industrialized countries, as well as selected partners in other regions, we are ready to serve you globally. Our service offering covers four areas:

Uptime

- Regular preventive maintenance
- Professional repairs using genuine METTLER TOLEDO spare parts and kits
- Dedicated service contracts to minimize risks and allow equipment to operate at peak performance

Performance

- Professional equipment setup and configuration
- Regular performance verification
- Regular updates and upgrades

Compliance

- Professional documentation and certification of compliance-related service activities
- Expert startup to help meet food and pharmaceutical standards with IPac (Food) or EQPac (Pharma)

Expertise

- Training for operators, quality control and maintenance staff
- Comprehensive literature and technical documentation
- Trusted expert advice



