Why Multiscanning Technology Improves Metal Detection and Food Safety

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Introduction

Metal detectors are ubiquitous in food processing facilities. They are most commonly used at the end of the line and as the last line of defense to support food quality and safety before a packaged product is on its way to the consumer. The core technology has always had its limitations and compromises such as noise that can interfere with signals and product effect that can confuse a wet product with metal.

While metal detection technology has slowly evolved over the years, the challenges facing food processing have changed considerably. There are increasingly demands such as new regulations, retailer detection mandates and greater productivity demands. The stakes are higher too: the potential for a costly recall and collateral damage via social media.

No company is immune. Just visit www.fda.gov, and click on "recalls" to get an idea of the plethora of food safety problems reported every day.

Bear in mind that while some companies are transitioning to X-ray inspection to find foreign objects, it is not necessary in many applications due to the low risk of non-metallic contaminants and a cost that can be prohibitive for smaller producers.

Why Metal Detection is Not Easy

Why is it so hard to detect metals in food? A simple analogy may help: why does a coin or piece of jewelry set off a metal detector on your outbound flight but not your inbound flight? Why the inconsistencies?

The same unpredictable performance can exist when trying to detect metal in food. Metal detection is easy – when it works – but it doesn't always work. Audits can fail, detectable metal types and sizes may not be what the quality manager wanted and, worse yet, a piece of metal may have escaped inside a product and a customer finds it.

Clearly, an on-again, off-again contaminant detection approach is not acceptable.

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There are key barriers to achieving 100% metal-free products. 1.) The metal detector must find anything, anywhere in any product all the time. That can be daunting considering the volume of production from just one line in a day and all the different types of metal pieces that might be part of your factory or in the ingredients;

2.) Metal detectors use electromagnetic fields to find things that are magnetic and conductive. Most food products are wet, have salt or contain minerals which when subjected to electromagnetic fields also look magnetic and conductive. Ignoring the product and finding the metal is not as easy as it seems.

3.) Small metal foreign objects have very small signals and the metal detector is operating in a factory that has many possible noise sources that can confuse the metal detector electronics and software. For example at any given time:

- Large motors are turning on and off,
- Electronics boxes are broadcasting wide spectrums of radiated noise,
- Production equipment is vibrating and causing the antenna in the metal detector to move ever so slightly,
- Electrical power is surging and dropping, and
- Temperatures are going from freezing to boiling and back again.

A new approach: Multiscan Metal Detection

As you can see, finding the needle in the haystack or a shard of stainless steel in a package of meat can be a formidable challenge.

Multiscan technology in the all-new Thermo Scientific™ Sentinel™ Multiscan Metal Detector platform overcomes many of these challenges and can dramatically increase the probability of detection and lower the chance of an escape to almost zero.

There is no "best" frequency for a metal detector

It is widely understood that ferrous is the easiest metal to detect due to its magnetic properties. Magnets attract iron. An electromagnetic field reacts most when a ferrous metal is in it, and the lower the frequency the greater the reaction. (Remember picking up nails with a magnet as a child?)

Results of each package at each Multiscan frequency are shown clearly on the Run screen

Conversely, stainless steel, which contains only a small amount of ferrous metal, has little or no magnetic property. (Think back to when you tried to put refrigerator magnets on your new stainless steel appliance.) To find stainless steel with a metal detector requires running a high frequency because the high frequency field induces a current in the stainless steel which creates a new field that interacts with the original field in the metal detector to create a signal.

While a logical conclusion is that the best metal detector would run one low frequency and one high frequency, unfortunately it's not that easy. Different sizes of the same metal have different magnetic and conductive reactions. Alloys of metals have different reactions too. And the shape, orientation and position of the metal can change the resulting signals in a metal detector.

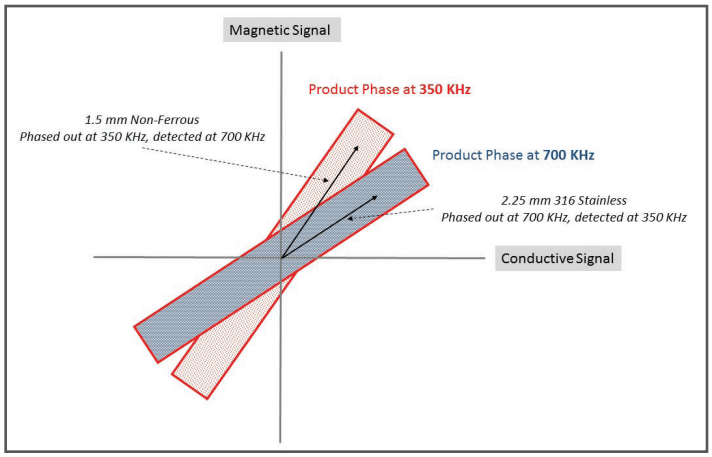
What then is the "best" frequency for any metal detection application? The answer is: as many as you can get all at once! This is the premise behind Multiscan technology. You pick a set of up to five frequencies from 50 kHz to 1000 kHz and Multiscan scans through each frequency at a very rapid rate, effectively acting like five metal detectors in one. You get the benefits of running a frequency close to ideal for any type of metal you might encounter. The result is that the probability of detection goes up exponentially and escapes disappear. Sensitivity is optimized since you also have the optimal frequency running for each type of metal of concern.
By way of example, using Multiscan, the Thermo Scientific Sentinel Multiscan Metal Detector can find metal spheres that are up to 50% smaller than the previous-generation Thermo Scientific™ APEX 500 high-sensitivity metal detectors. Via a simple graphical user interface and report, the user can easily see which frequency(ies) are doing all the work.

Phasing out products AND metal contaminants too

Conventional metal detectors use a technique to ignore magnetic and conductive product effects called “phasing.” Anything passing through the metal detector with a known ratio of magnetic to conductive signal below a threshold is ignored because it is the product and not a piece of metal.

The problem is that the signals generated in a metal detector by random pieces of metal can vary a lot. Eventually, their phase angle exactly matches up with the product phase angle. Because the metal signal is so small in relation to the product this means the metal goes undetected.

If looking for a piece of stainless steel hidden in a piece of cheese, for example, you could vary the frequency a bit (this separates the product and metal phase angles) and detect it, but that could mean that you won’t see a different size of stainless steel because this contaminant phase angle lines up exactly with the cheese. So, the problem isn’t fixed; it just moved somewhere else. It is sort of like patching a hole in your roof and then drilling a new hole in a different place. Water still comes in. This is a very subtle but important real-world problem because no single-frequency metal detector ever has perfect detection. Adding a second fixed frequency makes things a little better but in the end you still have holes in your roof.



Stainless and non-ferrous phased out at one frequency but detected at another.

This is where Multiscan overcomes the challenge. If one frequency means a piece of metal is phased out, another frequency detects it and vice versa. Because there are many frequencies running at one time there are always back-ups. Think about visually inspecting a used car. Do you just stand in front of it and look at the hood, windshield and bumper? Of course not! You walk all around it scanning as many angles and areas as possible to see what types of problems you can find. You “multiscan” the car before you buy it.

Overcoming Noise to Detect Small Metal Pieces

We all know what audible noise is because we deal with it in our lives every day. Someone talking on the phone next to our office, a lawnmower running in our neighborhood when we are sitting outside on our patio or a washing machine running when we are trying to watch TV. The noise gets in the way of what we want and impacts our performance. The drawbacks of noise are clear.

The same is true in any instrument trying to detect very small signal changes such as a metal detector trying to find a 1mm diameter fragment of metal in a loaf of freshly baked bread. It has to have a “quiet” background so it can focus on finding the metal “signal”. Engineers call this the signal to noise ratio. The bigger the better.

The Sentinel with Multiscan technology addresses this challenge in many ways to maximize performance. It embodies high quality, thoughtful design. The metal detector coils or antenna are cast in an extremely rigid material so they do not move in relation to the stainless steel case. This means there are no small, false signals created. The internal electronics are protected by multiple levels of shielding assuring fields from the outside do not get inside effecting detection. The power supply is designed to reject noise in the electrical supply and an extra line filter is included for good measure. And, finally, a software filter is run on the detection signals to remove noise entering the aperture that is not at the frequencies of interest.

Of course in extreme cases there may still be some situations where there is noise you can’t eliminate, so then all you do is modify the frequency being effected and tune it out. This can be easily accomplished via the graphical user interface.

The Sentinel’s design rejects all forms of noise for optimum detection performance

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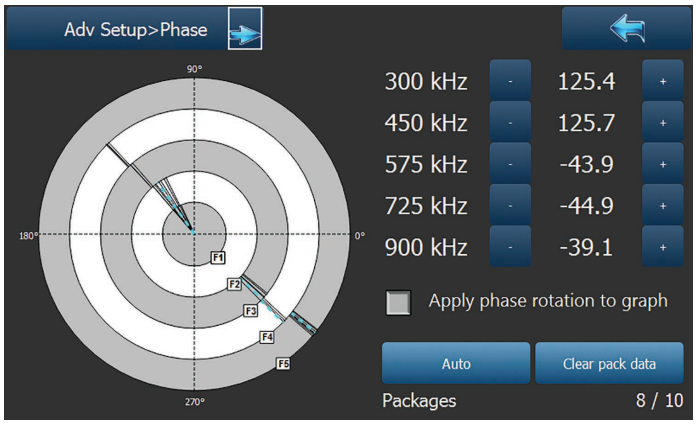
Other Important Benefits of Multiscan

While metal detection can be challenging, even with five frequencies, Multiscan technology is easy to use. And using up to five frequencies does not mean Multiscan will create five times the number of false rejects.

To make the Multiscan technology easy to use, the Sentinel metal detector has wizards, graphical displays and reports to help with set-up and adjusting performance. The auto-learn wizards allow you to pick any set of frequencies, capture data from one to 10 packages and automatically set gain, phase and thresholds, among other things. You get immediate feedback during and after these operations so you can see what happened.

When running, Multiscan allows you to view all the selected frequencies in real time and pull up a report of the last 20 rejects to see what caused them. If any of these rejects was false you can quickly jump to the controls that need adjustment.



Phase learn for all five frequencies

Furthermore, if you see high levels of noise on any frequency you can quickly change it in the software. If a frequency seems not to be detecting anything you can disable it. All of this occurs with a few clicks on the user interface; no service call is needed.

Experienced metal detector users know that balance is also a key parameter for good metal detection. There should be no signal when no metal is in the aperture. With Multiscan, all of the frequencies you are using should be balanced, too. To accomplish this, the Sentinel also automatically balances frequencies electrically. While it takes a few minutes the first time, it has a big impact on performance. To save time, the last balance data is used unless you add a new frequency. The software also runs an autobalance process continuously to remove the final errors caused by very small imbalances. There is even a balance diagnostic screen for advanced users to make sure balance is correct and there isn't an internal problem with the metal detector.

Conclusion

How good is good enough when it comes to food safety? This is a difficult question to answer because we are all hoping for complete safety. The cost of failure can be enormous and cause serious damage to a brand or company, not to mention risking consumer health.

Until Multiscan metal detection, single or dual frequency metal detectors came with compromises and the risk of escape. This is no longer the case. This new, innovative technology enables five times the protection with unprecedented, almost unlimited, flexibility. Now, it is fast and easy to achieve the best real-world metal detection performance the market has ever seen.

Find out more at **thermofisher.com/SentinelMD**

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