

Foreign object detection challenges in meat processing

How Multiscan Metal Detection can improve food safety and operational efficiency

Processing meat products is inherently fraught with risks that present product quality and safety challenges to food processors. First and foremost is to avoid the possibility of biological contamination. This requires diligence in following sanitary processes including harsh and frequent cleaning procedures with wide temperature swings. A rigorous sanitation process such as this creates expensive, albeit necessary downtime. In addition to preventing biological contamination, food processors must also ensure the right processes and equipment are in place to avoid the possibility of unwanted foreign objects entering their process at any stage, including when supplier ingredients are added.

Detection of such physical contaminants can be difficult with metal detection technology because meat products have high product effect that can mimic a foreign object, often necessitating a compromise in sensitivity to avoid false rejections. With temperature, salt content and product size changing during processing, product effect can vary, too, making consistent foreign object detection difficult. It also poses an ongoing challenge to avoid excessive false rejects which increase the potential for costly scrap or rework.

Fortunately, new metal detection technology can help overcome these meat inspection challenges. Multiscan metal detection scans using five user-adjustable frequencies at a time, making it possible to raise the probability of detection and thus improve overall sensitivity. When multiscan is coupled with a design to survive thermal shock, harsh chemicals and software to adapt to constant product changes, food processors can achieve a new level of food safety previously unattainable in meat applications. This new technology is available exclusively in the Thermo Scientific™ Sentinel™ Multiscan Metal Detector.



Flexibility to compensate for high product effect

Most meat-based products will exhibit high product effect in an electromagnetic field resulting in metal detection performance significantly worse than detecting contaminants in dry, inert products. Some examples of challenging meat applications are:

- Spiced and salted processed products
- Deli-style layered slices
- Sausages
- Moist or bloody whole muscle cuts
- Ready to eat meals containing meat

A package of meat can be highly conductive due to its moisture content. If salt is present conductivity is even higher. When this product passes through a metal detector the

excitation signal can create a strong product effect that requires compensation. All metal detectors must ignore this product effect to avoid a false rejection.

A common approach to reducing product effect and thereby improving detection performance is to utilize low-frequency, low-energy excitation. The Sentinel multiscan metal detector makes this easy because frequencies can be selected from 50 to 900 kHz at the push of a button. When a difficult product is encountered, a technician can set up a low frequency

schedule better suited to a highly conductive product and optimize performance. Since this technique is not always required, the flexibility to be able to run any frequency on any product is a plus with multiscan.

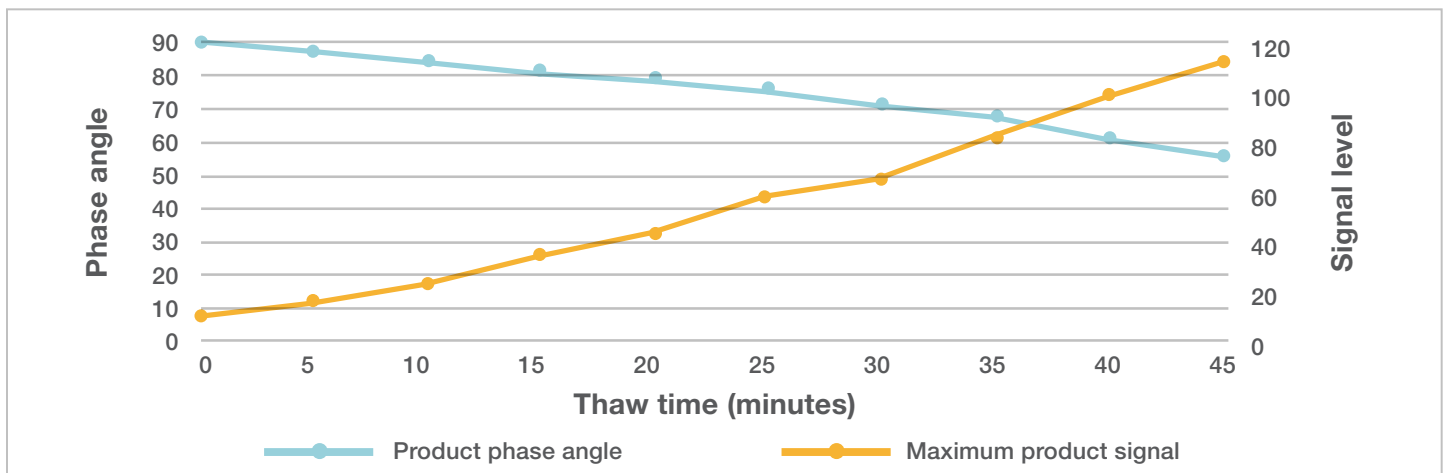


Product type	Ideal frequency range	Fe size	Non-Fe size	Stainless steel size
Garlic herb pork	100 – 300 kHz	1.4	1.9	3.25
Sliced roast beef	100 – 300 kHz	1.1	1.8	3.0
Angus loin	300 – 900 kHz	1.1	1.6	2.25
Packaged bacon	300 – 900 kHz	1.2	1.6	2.25
Mediterranean chicken	300 – 900 kHz	1.2	1.6	2.25

Sensitivity examples when using the Sentinel metal detector with multiscan (350 X 150 mm aperture size).

The Sentinel multiscan metal detector typically exceeds the performance of single frequency metal detectors by 10-30%. Because the frequencies are completely adjustable, the Sentinel multiscan metal detector is more flexible and can cover a wider range of applications, too.

Beef and pork often arrive at processing facilities in slabs: large, frozen, uneven chunks. The slabs require inspection because they can include buckshot, hooks or other large metal contaminants that will damage grinding and slicing machines downstream. Large-aperture metal detectors make a great first line of defense for coarse inspection and are commonly used. A challenge with this approach, however, is that the incoming slabs may not be consistently frozen before inspection, which can change the product effect seen by the metal detector. Without addressing this “drift”, the metal detector will eventually produce a false reject, requiring the detector to relearn the product. This causes downtime and intervention by a skilled operator. To illustrate the product effect changes during thaw, data was gathered on a 3 lb beef slab that began frozen solid and was then thawed for 45 minutes. The results are summarized below:



Example of variable product signal during thaw of beef.

The graphic shows that as the product signal increases over time the phase angle used to compensate for it changes too. These changes could result in false rejects over this time period.

Software to learn variability and adapt to changes

The auto learn routine in the Sentinel multiscan metal detector can adjust to the change in product signal. It accepts multiple products at various temperatures both clean and with the target contaminants. To optimize set up, the data from this product then automatically sets all the operating parameters. By teaching the metal detector in this way it is possible to quickly arrive at a set up that could otherwise take a skilled technician many hours or even days to complete. Once in production, it is a fast process to review recent reject data to see if it is necessary to adjust a parameter to eliminate false rejects. To handle phase changes over time, the Sentinel multiscan metal detector includes a phase tracking capability. Tracking works by automatically adjusting the product phase in real-time as the meat is inspected. Information from uncontaminated meat is fed back using a proprietary algorithm, maintaining performance as the ratio of conductive and magnetic product signals change.

The result of this smart, adaptive software is that user intervention is eliminated and throughput is maximized. This is true even in difficult variable product effect meat applications.

Designed to survive thermal shock and harsh chemicals

Washdown requirements in the meat industry can be very demanding. The USDA calls for sanitation standards that can include high-temperature and pressure spray-down and use of caustic cleaners. Many metal detectors today are built to the IP69K rating (80°C water at up to 1450 PSI), but this alone does not provide long-term defense from water intrusion into the metal detector case. In a typical meat processing plant, the equipment is used at a 40°C ambient temperature but may be cleaned, sometime several times a day, using 80°C water. Such thermal shock cycling can cause cracks in the seal between the epoxy aperture and metal case such that water can leak into the detection coils. The result is a permanent imbalance that only an expensive factory repair can address and it is typically required every few years.

The Sentinel multiscan metal detector offers a unique HD (Heavy Duty) option for the meat industry to maximize uptime in harsh environments. It was tested and survived up to 10,000 thermal shocks with no degradation in performance. The HD design enhancements are:

- Soft epoxy fill and liner resistant to separation from the metal case
- Complete fill with epoxy eliminating space where water could be trapped
- Welded aperture flanges to reinforce the liner seams



Example of high pressure washdown.

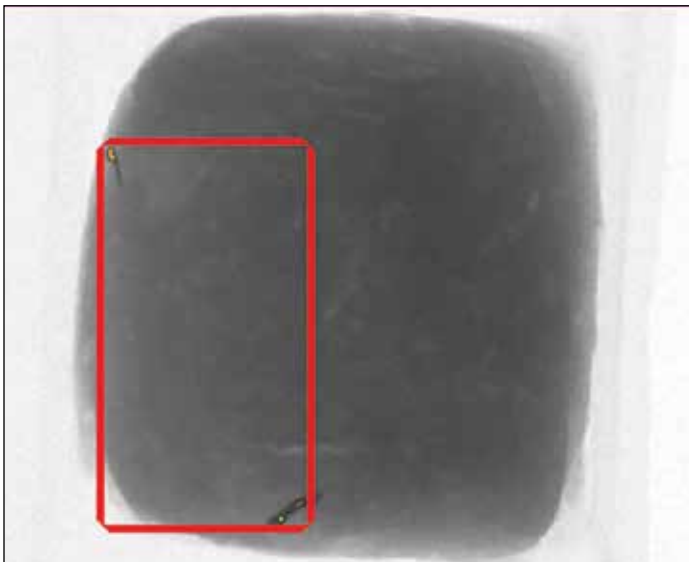
In addition to these design features the HD option also upgrades the metal detector case to anti-corrosive 316 stainless steel (medical grade). This ensures that it cannot rust if harsh cleaning chemicals are not 100% removed during rinsing.

The result is that the system has maximum uptime, performance does not degrade and the elimination of long-term repair costs.

How to detect non-metallic contaminants

Not all contaminants found in the meat processing environment are metallic. Sometimes bones, stones, plastics and even glass can be present. In these cases, the foreign objects will pass through a metal detector undetected because the contaminants are not metallic. X-ray inspection is therefore the only possible option for foreign object detection.

X-ray inspection works by detecting differences in density and thickness within the product. It can find many common conductive AND non-conductive contaminants. Sensitivity, however, requires a detailed product test because some contaminants like bones and plastic can be challenging due to their low density. Metal detection performance with X-ray may also exceed that of a metal detector. Finally, as described earlier in this note, many times the inspection equipment must be IP69K rated. Fortunately, the Thermo Scientific™ Xpert™ series of X-ray systems is available to meet the need for X-ray inspection in a meat application.



X-ray can detect bones where metal detectors cannot.

Key takeaways

Metal detection applications for meat-based products are some of the most difficult and important food safety challenges. The risks and returns are high. Thermo Fisher Scientific has specifically designed the Sentinel multiscan metal detector to achieve a higher level of detection standard in this market. Multiscan technology increases both the sensitivity and probability of detection while offering an unprecedented level of flexibility. A smart Autolearn function makes set up simple and fast while a unique HD construction option reduces the chance of failure in harsh environment. The result is a new level of food safety and operational efficiency.

Given the challenges to meat processors in protecting consumers and their brand, it is prudent to ensure that the most effective metal detection technology is in place to avoid recalls and ensure the products they deliver to market are safe.

The best way to determine how much your meat inspection program can benefit from multiscan technology is to request a complimentary product test or arrange for a demo at your location. Contact sales.packaging.us@thermofisher.com to request assistance from an application specialist.

Find out more at thermofisher.com/productinspection

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