Understanding the chemistry of contaminant detection

Relearning product characteristics when inspecting food applications is a common challenge for manufacturers. Density, water concentration, storage temperatures, heat, thawing and even seasonal and soil variations, are among the many factors that could affect the performance of food inspection machines.

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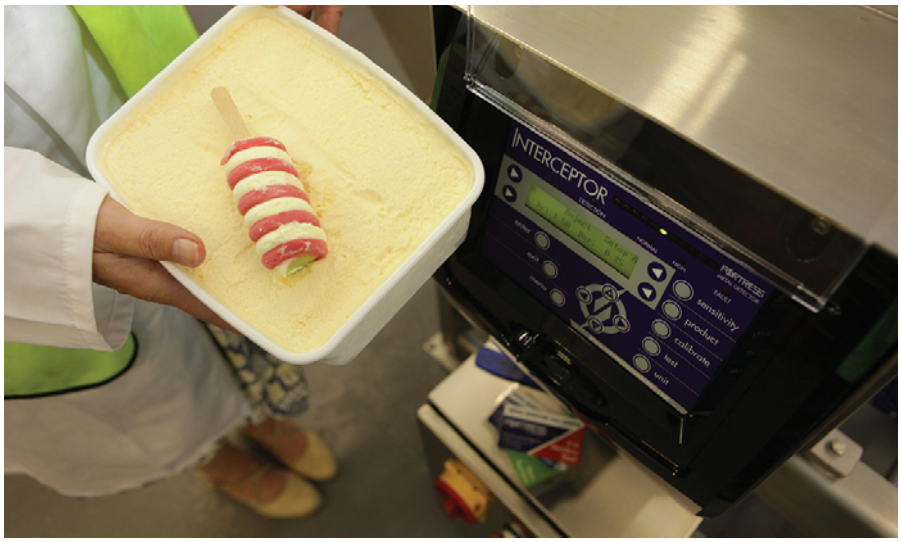


A change of just 5°C is enough to affect product characteristics and disrupt product signals, but can be overcome by metal detectors running multiple frequencies simultaneously.

This article explains the science and shares several examples of smart technologies, including AutoPhase that adapt to changing food characteristics.

Digital technologies have quickly transformed how we all run processes. Machine learning especially is pushing the innovation boundaries in food manufacturing and streamlining production processes. It is a science which requires a deep understanding of the chemical makeup and molecular structures of foods.

How fats, proteins, carbohydrates and sugars change during processing and storage will initiate a chemical reaction. To the naked eye, and even taste buds, these changes are barely noticeable. Yet, for wet and conductive foods, such as bread, meats, dairy products and ready meals, to a sensitive metal detector inspecting the same foods over an eight hour shift, they can appear like completely different products.

Farming practices, regional soil structures and natural crop cycles, although rare, can influence the nutrient content of fresh produce.

Thermal changes and water content are the main factors that can interfere with metal detector signals.

Dealing with higher amplitudes of product signal can be especially pronounced in meat processing plants inspecting varying weights and sizes of joints, some boneless and others boned.

With boneless joints there is a greater concentration of meat, which means they are denser and consequently weigh more. This water content, which could be intensified by 'plumping' – a common practice to maintain tenderised meat products by injecting salt water or stock – disrupts and mimics the metal detector signal causing traditional systems to react as if there is a metal contaminant present and reject the product.

Known as 'product effect', these false rejects more often than not result in perfectly good food being discarded.

The power of ARM

To identify a metal contaminant within conductive products, a metal detector must remove or reduce this 'product effect'. The

solution is to change the frequency of operation to minimise the effect of the product. But there is a trade-off. Doing this can impact the ability to find different metals. Dropping the frequency tends to enhance ferrous metal detection.

Yet this limits performance when it comes to non-ferrous metals, since the lower end of the frequency is more responsive to magnetic effects of the contamination. By the same token, the reverse happens when the frequency is taken higher – it starts to limit the ferrous detection capability but enhances the non-ferrous detection.

Simultaneous frequency is the most reliable way to remove product effect without compromising the sensitivity of a metal detector.

Fortress uses ARM microprocessors to adapt to these changing product characteristics. This processing technology powers the Fortress Interceptor, enabling it to run real-time analysis of the low-frequency and high-frequency signals in parallel.

By the same virtue, as products travel through processing facilities, environmental conditions change. Factory temperatures rise and dip. For example, bread dough can warm causing moisture to gradually evaporate. Alternatively, frozen food can thaw. A change of just 5°C is enough to affect the product characteristics and disrupt product signals.

Both Fortress and Sparc have a couple of technologies in their armoury to counteract changing food characteristics as they pass through the processing chain.

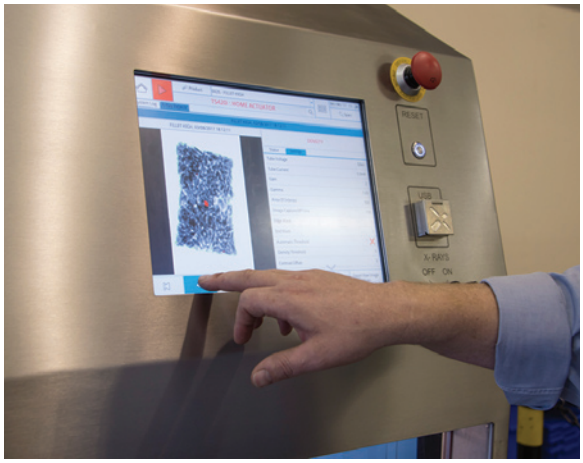
Automatic alignment

AutoPhase is a useful tool available on Fortress Phantom, Stealth and Interceptor metal detectors that tracks long term changes within wet products, adapting and syncing to new characteristics. For example, batch conditions in baked bread can vary very slightly between recipes. Technologies like AutoPhase accommodate this gradual change without compromising metal detector sensitivity. Even products that look different to the metal detector will not be rejected.

Packaging is another common example where AutoPhase can help. Whereas inert plastic presents minimal signal, metallised films and the application of print can vary between rolls and just a small change can present itself as a big signal to a sensitive metal detector.

Although once deemed a major challenge for metal detectors, today's advanced simultaneous frequency systems are much more reliable inspecting pre-wrapped products.

For food packaged in cans, tins or foil, x-ray inspection systems can play a critical complementary role. Often, a system like Sparc's Apollo bridges the gap in inspection capabilities and ensures the most robust screening process for contaminants. If a product has been mispackaged, an x-ray can pick this up, ensuring absolute quality of the end product.



For food packaged in cans, tins or foil, x-ray inspection systems can play a critical role alongside metal detection.

Cause and effect

The presence of xenobiotic compounds is routinely monitored and tightly controlled by regulatory bodies. However, farming practices, regional soil structures and natural crop cycles, although rare, can also influence the nutrient content of fresh produce. Inspecting potatoes grown, for example, in iron rich soils might require a slightly different calibration setting to those grown the other side of the country.

Changeable protein levels in flour are another example of seasonal variations. Seldom would these changes directly impact the performance of inspection systems, however the raw ingredient changes can influence the chemical composition of a baked product like bread. These changing attributes must be considered.

Butter samples can even test scientific wisdom. Butter is usually categorised as a wet product, however, when butter samples were run through a Fortress metal detector it automatically calibrated to a dry product.

No one understood why. Further investigations tracked the cause down to the cattle feed and geographical environmental factors.

The milk produced was influencing the butter characteristics causing it to present to the metal detector as a dry product.

A metal detector that can run multiple frequencies simultaneously, such as the Fortress Interceptor, is ideal as it can accurately inspect a variety of conductivities at the same time.

Features like single pass product learning and automatic calibration also help, as operatives are not constantly resetting the machine to accommodate different product effect, shapes, sizes and orientation.

Environmental factors

Never underestimate the influence of environmental factors. When it comes to food safety, there is always a cause and a consequence. Having deep rooted experience about how different food products behave and change, the conditions that cause these reactions, and the relearning limits of inspection equipment is critical.

With expertise in metal detection, x-ray, weighing, bulk and combi systems, Fortress and Sparc have together got the whole food safety matrix covered. ■

Cattle feed and geography can influence the characteristics of butter samples presenting as dry to the metal detector.