CEIA Multi-Spectrum Metal Detectors

Introduction

Metal Detectors for the inspection of food products are used to detect fragments of metal that are accidentally present in those products.

The Metal Detector detects the presence of metal by exploiting alterations in the electromagnetic inspection field.

The electrical conductivity of the product produces an alteration in the detection signal, proportional to the quantity of product present within the transmitted field. This effect increases with the operating frequency of the Metal Detector.

According to industrial practice, the Metal Detectors are checked using three different types of sample: Ferrous, Non-Ferrous and Stainless Steel AISI316.

Ferrous material is mainly detected due to its magnetic properties, which remain practically constant with variations in frequency. The other two materials (Non-

Ferrous and Stainless Steel AISI316) are conductive, but do not possess magnetic properties, and therefore the signal they generate is similar to that caused by conductive products (Fig. 1).

In these cases it is necessary to reduce the operating frequency to limit the interference signal due to the product, with significant reductions in performance when dealing with Non-Ferrous metals and AISI316-type Stainless Steel.

Multi-Frequency Metal Detectors

In 1998, CEIA put the first three-frequency Metal Detector, the THS/3F model, on the market. This device was able to selecting the best frequency for each product, completely automatically, during the Autolearn procedure: it was a totally innovative technology, in that it made the inspection of products with different characteristics possible on the same line.

The employment of a conventional Metal Detector when there are both neutral and conductive products on the same production line (a typical example is snack lines, where some products have plastic packaging and others metal) led to limited overall performance due to the conductive product, penalizing the neutral products for which much better detection results could have been achieved.

Single-Frequency and Multi-Frequency Metal Detectors nevertheless employ a single electromagnetic field, fixed in the former and selectable from a list of 2 or 3 frequencies in the latter, but still a single electromagnetic field. This characteristic imposes a technical limit on the performance that can be obtained in food product applications.
From the above, we can see that, ideally, a Metal Detector should operate with differentiated inspection fields, each at one or more suitable frequencies, acting simultaneously on the product being inspected.

**New CEIA Multi-Spectrum Metal Detectors**

CEIA Multi-Spectrum technology has finally produced the solution by using several frequency spectra simultaneously: this allows simultaneous optimization of sensitivity to metal contaminants and maximum rejection of the product effect.

By using the different frequency response of conductive products and metals, this innovative technology cancels out the product effect but maintains high performance levels for all types of metal contaminants, both magnetic and non-magnetic.

The new Autolearn procedure adopted in the CEIA MS21 Metal Detectors equates to the repetition of hundreds of conventional transits, exploring the whole spectrum of available frequencies in order to determine the best operating frequencies to make up the product inspection spectrum.

The chosen operating frequencies will then be transmitted simultaneously and continuously within the Metal Detector.

**Compensation for non-homogeneous food products**

It is a well-known fact that conventional Metal Detectors experience great difficulty in inspecting non-homogeneous products.

These devices minimize the product effect, generally, by choosing the stage at which the signal generated by the product has the minimum amplitude.

Unfortunately non-homogeneous products are characterized by a range of minimum signal phases, not just one; what is more, these are not stable, since they vary according to the conditions of the production process. For these reasons conventional Metal Detectors are unable to find a point where it is possible completely to cancel out the product effect, which is usually selected as the best compromise between various products of the same type analyzed during the Autolearn procedure.

CEIA Multi-Spectrum Metal Detectors, on the other hand, are equipped with a spectrum of simultaneous frequencies which allow them to compensate for any variations in the product effect, as they are not limited to a mean point but use interpolations of multiple, simultaneous work points.

This, obviously, means that they are extremely efficient in cancelling out the product effect.

An immediate result of using this technology is an increase in productivity, deriving from the reduction in false alarms and, therefore, of products which have been ejected unnecessarily. There is also a substantial reduction in line arrests due to continual Autolearn procedures which are usually necessary to compensate for non-homogeneous products.
This obviously results in significant cost savings.

We can therefore conclude that there are two immediate results to be obtained by using the Multi-Spectrum technology:

1. **Increase in sensitivity performance**

   The graph below clearly shows the gain in terms of the diameter of the detectable sample. The histogram shows the results for Stainless Steel AISI316 contaminants, since this is the most difficult metal to detect (there are analogous results for the Ferrous and Non-Ferrous samples):

   **AISI 316 StSt detected sample diameter rapport:**

   ![Graph showing detectable sample diameters for different products]

   - **Competitors' Multi-Frequency Metal Detectors**
   - **CEIA Multi-Spectrum Metal Detector**

2. **Increase in productivity / cost savings**

   Long-term stability is much appreciated by all those customers who have Metal Detectors that maintain their standards following acquisition of the product, but these can create false alarms as soon as the product starts to alter its characteristics, even slightly.

   Improving stability when there is product variation is probably the most coveted objective that a technology applied to Metal Detectors could achieve, perhaps even more important than sensitivity.

   Stability has a direct impact on cost savings: installation experience has shown that all the customers who have adopted CEIA Multi-Spectrum Metal Detectors on their production lines have obtained the following immediate benefits:

   - ✓ *Increase in detection sensitivity*
   - ✓ *Reduction in product waste*
   - ✓ *Reduction in the number of operator interventions on the device*
   - ✓ *Reduction in the product acquisition procedures*
   - ✓ *Increase in productivity*

   **Vibration Immunity Function**

   Using the same principle applied to non-homogeneous products, the CEIA Multi-Spectrum Metal Detector can also select the operating spectrum taking into consideration the vibration interference effect.

   In this case the composition of the spectrum has a double objective: cancelling out the product effect and increasing immunity to vibrations, while maintaining extremely high sensitivity performance.

   The above-mentioned benefits also apply in this case.
Continuous embedded Autotest and Self Calibration control

In the CEIA series 21 Metal Detectors, specific control signals are continuously sent to the transmission and reception detection channels of the Metal Detector, constantly monitoring the detection characteristics with consequent compensation for any variation caused by environmental factors.

The result is the extreme stability of the system, the invariability of its detection performance and the cancellation of the product effect.

- No periodic calibration
- No line arrest
- Elimination of product waste

Continuous Auto-Test function ensuring maximum Production Safety

In the CEIA series 21 Metal Detectors, in addition to its self-test functions, specific electronic signals are sent to the reception and transmission channels so as to generate variations in the received signal of calibrated amplitude, which provide direct and indirect checks of the detection characteristics. These variations are compared with the reference values stored in the factory at the moment of the calibration test.

This procedure provides for a complete, certified check-up, revealing any deviation from the permitted tolerances.

Any anomaly is signalled and recorded as an event. As a result, the following benefits are obtained:

- **Reduction in the frequency of tests carried out by the operator**
- **Reduction in product waste**
- **Increase in productivity**

Fabio Bennati 06/04/2012