CASE STORY:

X-ray contamination detection - large products and packages

INTRODUCTION

X-ray systems are widely applied for numerous applications relative to foreign body contamination of products. Typically, inspection is aimed at un-packaged and minor products. The problem is, that large products requires a higher energy and the detector must cover a larger area. This leads to lower contrast and reduced resolution.

For years, InnospeXion has worked with a low-energy technology that offers a higher resolution and a higher contrast, while retaining a high speed of scanning.

This imaging principle has now been implemented into a large product X-ray inspection system. This system aims at detecting non-conforming products and integrates a reject system with full control of in- and out-feeding. The system is designed for packaged and unpackaged products and is hygienically designed, in conformity with EHEDG guidelines.

The system aims at inspection of large products (wrapped cheese blocks, stacked fish blocks, meat blocks, etc), carton boxes with multiple packages, large sealed bags and pouches, and similar.

LARGE PRODUCT X-RAY INSPECTION

There is a large demand for X-ray scanning of finished boxes with product/packages. The X-ray inspection of packaged carton boxes may provide very valuable information:

- the number of packages in the box;
- the integrity, completeness, and the weight of each package;
- the presence of non-conforming packages or objects in the box;
- any contamination in each package or outside the individual packages;
- the overall packaging integrity.

In the case of large individual products, e.g. large pouches, products in bags or sacks, or products in blocks (such as cheese blocks), the need is particularly to:

- assess the contents for contamination (foreign object detection);
- verify the overall structural conformity of the product (e.g. holes in cheese);
- verify correct product representation and correct product distribution;
- verify packaging conformity and integrity (e.g. seal inspection).

X-ray inspection is an obvious choice for these applications. However, the problem is that ordinary X-ray systems offers an X-ray image quality that compromises the detection capability, and which provides too poor contrast and definition to quantify the details of the imaged product.

InnospeXion provides solutions based on a low-energy X-ray technology with a detection level down to the pixel size of 0.1 mm, and with the highest sensitivity (i.e., ability to discriminate between different compositions and their quantitative distribution, inside the product).

InnospeXion has tailored this technology to facilitate a wide conveyor inspection capability and an X-ray source emission characteristic that matches the requirement to provide a high quality X-ray image of even tall and thick packaged items and products. The result is a system that detects non-conformities down to 0.2 mm even in thick and compact products (such as cheese blocks).

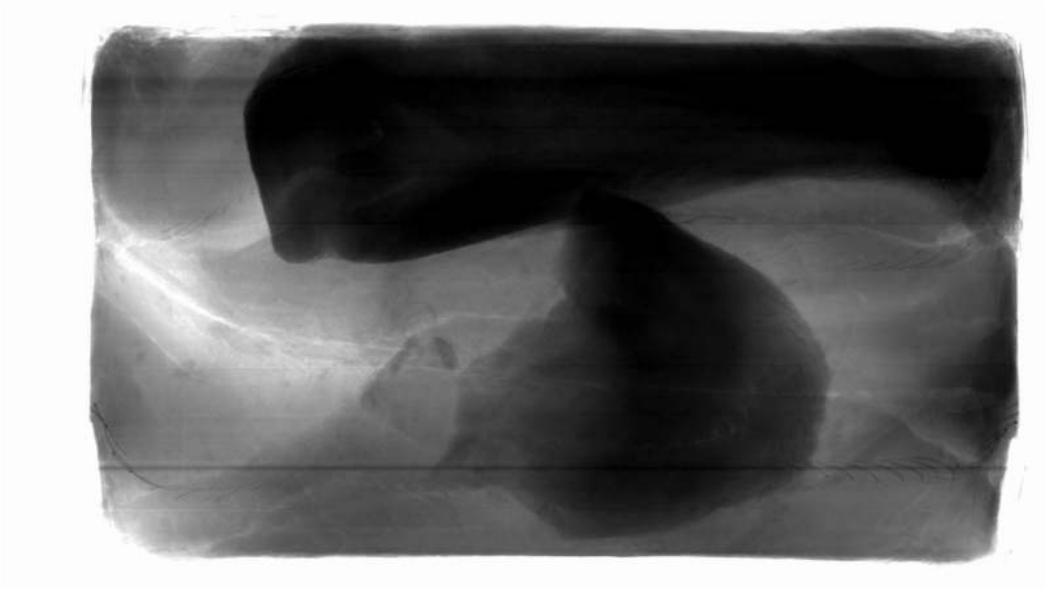

Fig. 1. X-ray image of two stacked large blocks of frozen fish, each block weighing approx. 4 kg. The purpose of the inspection is to identify possible foreign bodies contamination, such as fish bones. The X-ray scan revealed natural fish bones inside the two packages.

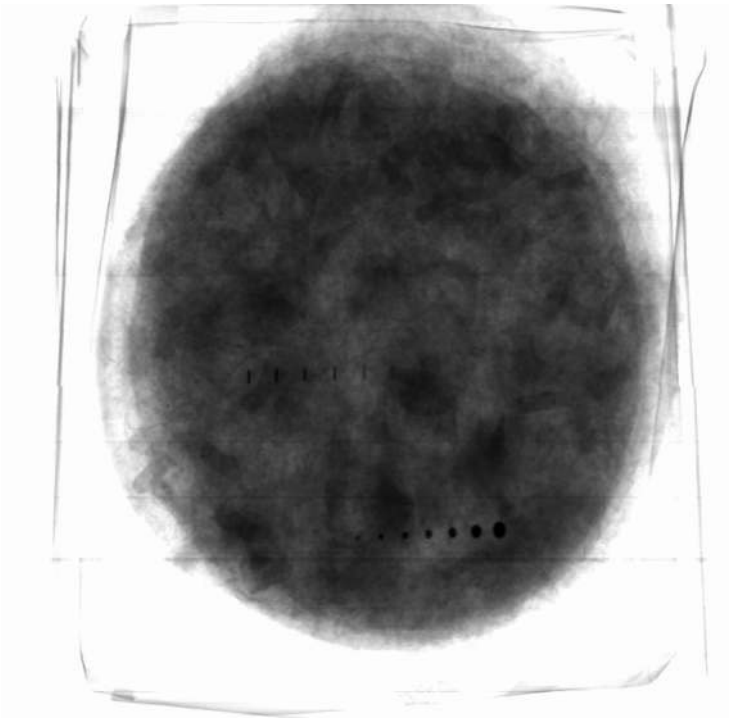

Fig. 2. X-ray image of two stacked frozen pizza packages, with three foreign objects test samples placed on top. The test samples in this case were: stainless wire (size 0.9 x 5.0 mm down to 0.2 x 5.0 mm), stainless (size 0.8 mm down to 0.3 mm), and glass (size 6.0 mm down to 1.0).

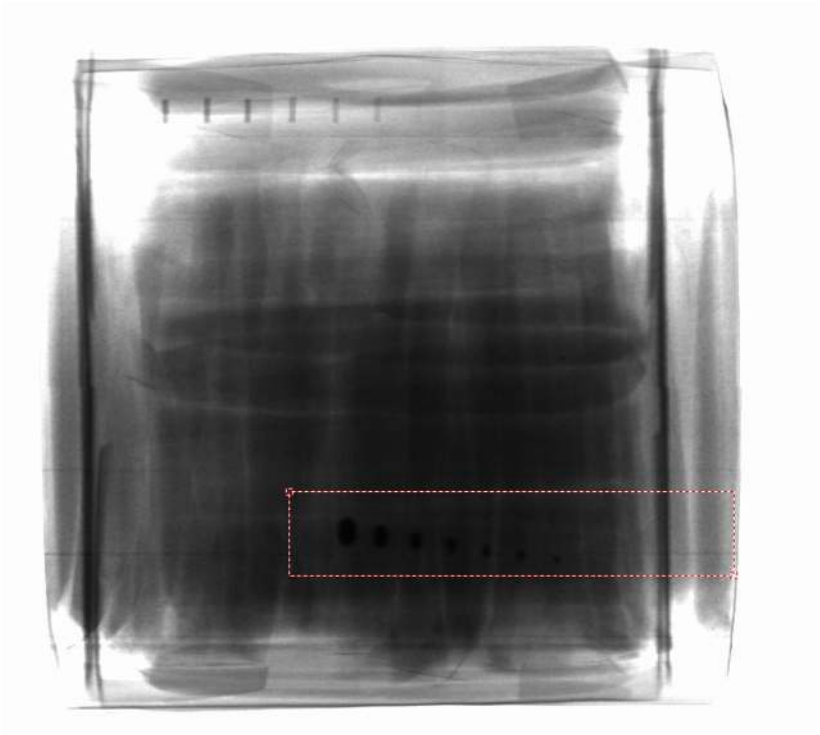

Fig. 3. X-ray image of two stacked carton boxes containing powder products, in this case instant coffee sachets. Three foreign objects test samples were placed on top. The test samples were: stainless wire (size 0.9 x 5.0 mm down to 0.2 x 5.0 mm), stainless (size 0.8 mm down to 0.3 mm), and glass (size 6.0 mm down to 1.0).

X-RAY SYSTEM AUTOMATION

A modern X-ray inspection system is not a stand-alone system. In most applications, it is a requirement that the X-ray system is integrated in the production line. This requires a very strict control of the in- and out-feed and careful consideration of the product flow relative to the X-ray system performance.

The X-ray system may be based on a specific timing control, which is overall devised and monitored by the production line central control. Therefore, there are handshakes and timing parameters in accordance with the numerous actions and sensors on other parts of the production line.

When the X-ray system encounter a non-conforming sample, it will be rejected. The reject reasons (X-ray image details) will be saved, and the sample is conveyed onto a reject conveyor. The reject conveyor status is monitored and reported to the X-ray system PLC for local action, and to the central line control. The latter may issue an alarm if multiple rejects occur, or if the reject lane is in risk of being full.

This automatic functioning can be tailored to any application and any line control lay out. In some applications, intelligent usage of the X-ray system product diagnosis may be used as early warning of processes that are in danger of reaching their outer tolerance boundaries. This functionality brings savings since defects are corrected for before they emerge.

Fig. 4. Layout of the InnospeXion X-ray system designed for large products and packages inspection. Facilitates detection down to 0.2 mm, tailoring to the production line, EHEDG guidelines conformity, proven technology, dedicated software solutions e.g. for cheese internal structure quantification and validation.

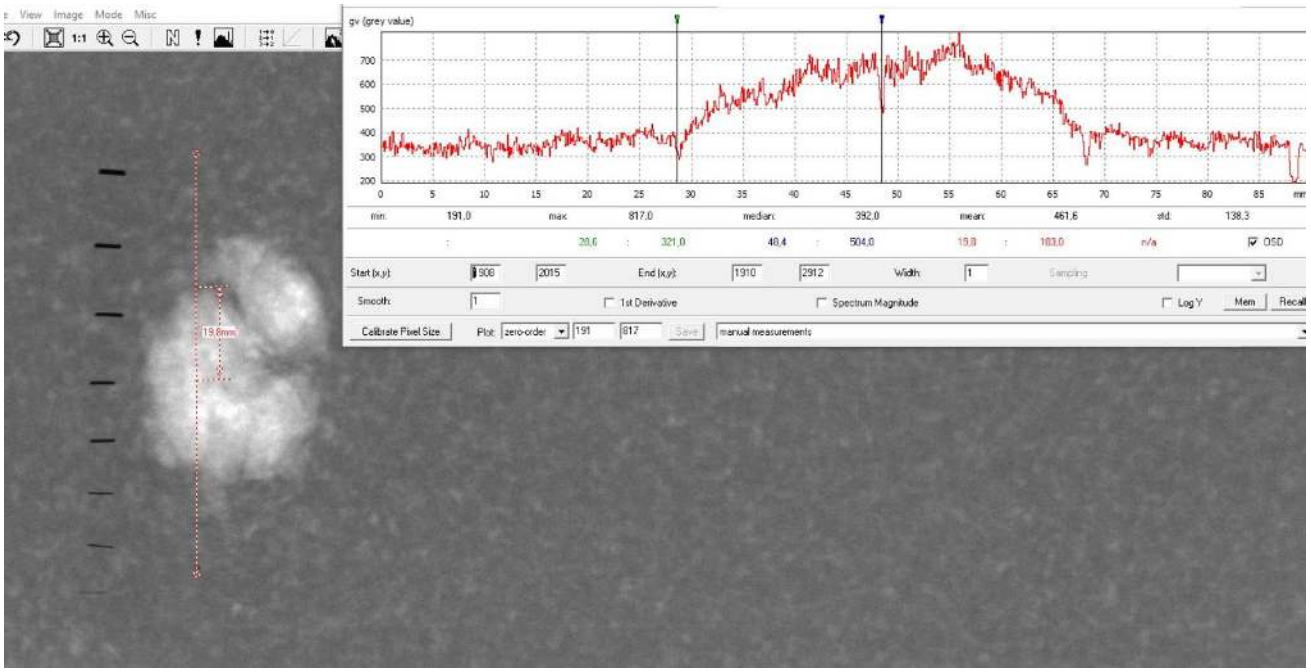

Fig. 2. X-ray image of a tilsiter **cheese**, showing anomaly large **void or cavity. Development** of such **voids** or **cavity** can be monitored by the **X-ray system** during **cheese maturation** and facilitate the release for sale.

PRODUCT INFORMATION OBTAINED BY THE X-RAY INSPECTION

An **X-ray system** image displays the attenuation of the X-rays having passed the scanned item. The attenuation depends on the composition and thickness (or density). Therefore, the grey level value of a pixel can be correlated to details in the item that are relevant to control, or monitor. This may e.g. concern the distribution of various compounds in a mixture, to ascertain the homogeneity of a product. It may also be used to quantify the **structure and the dimensions of holes, voids or cavities in cheese**, in order to to provide a measure of the **maturity development of the cheese**. Examples on the above is reflected by Fig. 2.

In general, the X-ray image information content is large and it can enable a close monitoring of the product tolerances being satisfied, and provide an alarm at the moment one or more parameters reach the boundary tolerance limits. This enables the on-time reaction and correction of a process, avoiding faulty production.

THE COST-EFFICIENCY OF X-RAYS FOR PROCESS CONTROL

X-ray systems placed on the production floor will today acquire a very substantial amount of information which relates to the products passed through the system.
Unfortunately, X-ray systems are mainly used for detection of foreign objects of various sorts, and typically used in the food sector where retailers impose a demand for inspection, owing to consumer safety and the costs of recalls. Traditionally, there has been very little interest in using information pertaining to the products, and the **X-ray systems** have not had significance for the **process control**, only for (final product) quality control.

The novelty is that the significant improvement in contrast and resolution has opened for new applications for X-ray systems. The special InnospeXion X-ray systems have thus proven their capability integrated to the production line, where non-conformities are detected, before they end up as a defect. In some applications, the ability to make a quantitative quality assessment has implied a better use of the raw materials, leading to a more rational manufacturing.

These benefits of new technology is that the X-ray technology no longer can be regarded as a final “go/no go” inspection tool, which only can be cost-wise appreciated if the rejected items can be connected with a price. The commercial gain on using the technology for control rather than discard is substantial. Deviations can be corrected for, before they end up as defects. This leads to savings, higher product value, less scrap, better use of resources, and less downtime.