White Paper

10 key facts food processors should consider before purchasing and installing X-ray inspection systems

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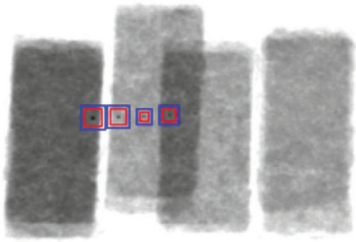
Key Words

Food safety, X-ray inspection, probability of detection



X-ray contaminants detected

Objective

The objective of this white paper is to provide 10 top X-ray facts to help food manufacturers understand the attributes and benefits of this technology before making a purchasing decision and installing a system.

Overview

In medical or airport baggage screening applications, X-ray systems produce density images (generated by ionizing radiation) that are analyzed by people for irregularities. The scanning and display techniques are different from food X-ray but the goal is the same–find things that are not as expected.

Deploying these technologies for food applications is more complex. The small size and anomaly type being detected is more challenging and the rapid speed in which the detection needs to take place means a computer, not a person, must make the decision. In fact, in many cases, the real challenge isn't finding the contaminant; it is ignoring the product, packaging or environment. False detections caused by improper use or specification can add up to big costs and high frustrations.

The ideal X-ray system for food applications must be very sensitive, easy-to-use, fully automatic, fast, extremely robust, reliable and cost effective. This is a tall order for any automated system that must run for many years in a harsh factory environment and make reliable pass/fail decisions on literally millions of products.

Foreign object detection performance is determined in three ways: detectable contaminant types, minimum contaminant size and probability of detection.

Foreign object contamination detection continues to be "top-of-mind" for the vast majority of food processors, regardless of geographic location or product type. It is a critical part of an overall food safety program because threats can never be totally eliminated.

Most raw foods and ingredients originate in a natural environment – a field, an orchard, a farm, etc. As the food is harvested, foreign objects such as stones or glass can end up comingled and transported into the processing plant. Additionally, objects found in manufacturing facilities – such as metal and plastic – can also find their way into the processing stream as the result of machinery or process failures. Lastly, fragments of bones, pits or shells that are removed during processing can end up hidden in the final products. These risks, and the costs associated with them, have led to more demanding detection policies worldwide.

In addition to more stringent food safety policies, some retailers have also started to make product inspection demands on food processors – even refusing to do business with those not employing the latest technologies. The primary way to address this issue is to install sophisticated detections systems – such as X-ray – close to the end of the line augmenting a metal detection program upstream.

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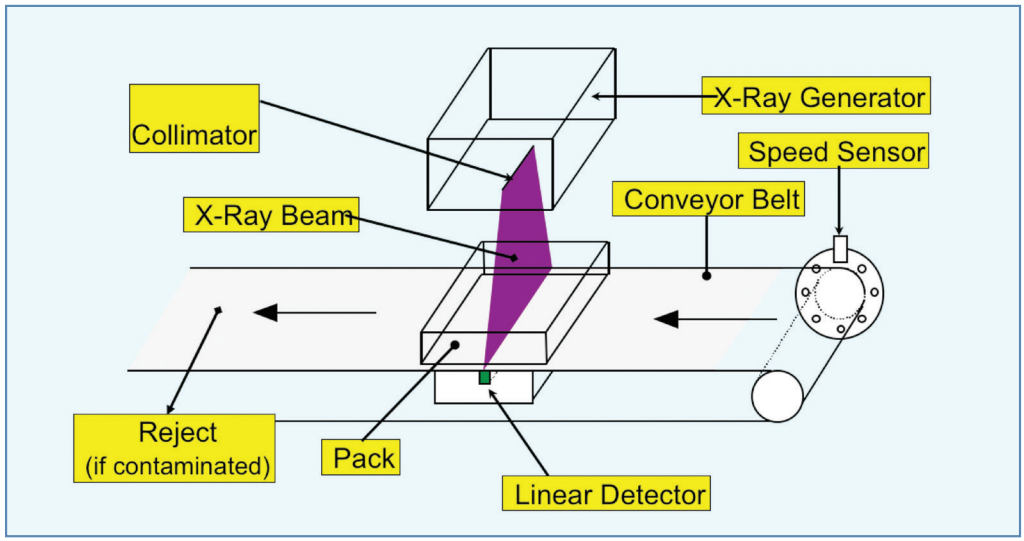
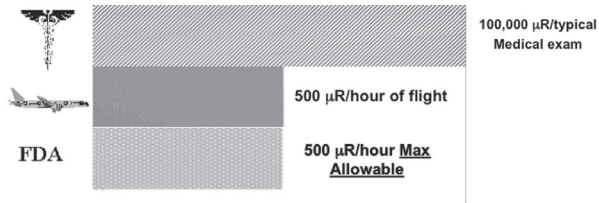


Typical foreign objects

Basic principles of X-ray operation

Shown above is a simplified block diagram of a typical food X-ray inspection system. An X-ray beam is generated and passed through the product being inspected as it is conveyed through the system. A detector creates a line-by-line image of the product which is sent to a computer for vision analysis. Before the product leaves the system, the computer makes a good/bad decision which automatically rejects contaminated product. Although there are many other possible configurations for X-ray systems, the fundamental operation is always the same. Products are scanned, analyzed and passed or rejected.

By understanding the most important elements of an X-ray inspection system users can easily and quickly deploy them in their factories. As with most technologies, many times just a few key decisions can mean the difference between success and failure.



Fact #1: X-ray systems are safe

X-ray units meet or exceed safety standards such as the Food & Drug Administration Code of Federal Regulation 21 Part 1020.40 and the more stringent United Kingdom IRR 1999 limits. Please note many countries have their own standards in place, but in general if a system meets the US/UK requirements it will pass the other tests.

X-ray systems have a number of safety features engineered into their design. These include door safety interlocks, radiation shielding curtains, emergency stops, lockable power and X-ray key switches, on-screen X-ray warnings and an off button, and an annunciation lamp.

Manufacturers typically conduct radiation surveys at the factory and after installation usually to the most stringent test levels. Additionally, some manufacturers provide X-ray meters so customers can verify safety periodically on their own, which local regulations may require.

Fact #2: Source and detector selection is critical

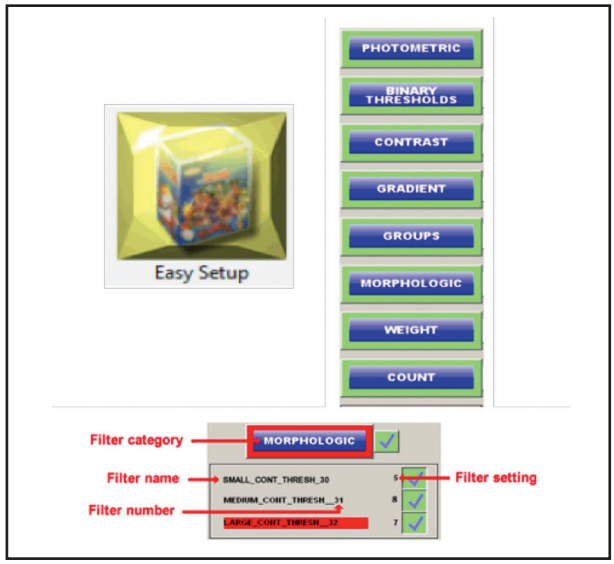
The X-ray beam should be wide enough to pass through all portions of your largest product. Additionally, thicker products need more kilovolts (kV) for “punch through;” milliampere (mA) just brightens the image. kV x mA = x-ray power (watts). Usually this aspect of the X-ray system must be determined by the system vendor during a product test. Without sufficient X-ray power detection, performance will suffer and false rejects will occur.

Detectors vary in pixel size (0.4 to 0.8 mm) and sensitivity to X-ray exposure. Smaller pixels are not always better though; they need more X-ray power and slower line speeds to assure a proper image is acquired.

The bottom line with the X-ray source and detector is that they must be chosen correctly and be of high quality to assure good detection performance. The higher fidelity the X-ray image the better your results will be.

Fact #3: Not all software is created equal

It's important to do a thorough evaluation of X-ray software to determine capability and ease-of-use. Most systems are PC/Windows-based, so make sure to ask about remote support tools and capability.



Fact #4: A thorough product test is mandatory

X-ray performance is affected by product density/texture changes, line speed, contaminant type/position/density, packaging variations and more. To get accurate results, test five or more packages of each type. Vary the contaminant type and its position. If possible, also vary the product position inside the package and its position on the conveyor belt.

Real world performance should be expressed as "probability of detection" or POD. No detection system is perfect, so you should try to understand what is always detectable and what may or may not be. A thorough product test should generate performance numbers as shown here.

- 2 mm stainless steel—100% POD
- 1.7 mm stainless steel—90% POD
- 1.5 mm stainless steel—50% POD

Fact #5: Maintenance maximizes system uptime

It's critical to make sure that your X-ray system is properly maintained. Heat, friction and water are your enemies. Preventative maintenance visits every six to 12 months by your manufacturer's X-ray system technician are recommended.

Things to check or change regularly are:

- Cooling air filters
- Conveyor bearings, rollers and belts (must be flat and seamless)
- Door gaskets and locks
- Gland fittings for wires
- Safety switches and radiation-shielding curtains
- Detector diagnostic screens and run-time hours for X-ray source

Fact #6: Training/learning is critical to success

X-ray is intuitive, but the basic principles of use must be understood. These include:

- Product inspection triggering
- X-ray power setting
- Detection algorithm set-up and adjustment
- Reject timing
- System auditing with test pieces
- X-ray system calibration
- Reviewing rejected product images
- Password systems to restrict access
- Network access for statistics, remote control, etc.
- Save and restore for product/machine settings

Make sure the technician installing the system provides training to operators and other technicians in all of these areas. Many times the best place to deliver detailed training for new users is in a classroom, not a noisy factory floor.

Fact #7: X-ray components have limited lifetime

Several of your X-ray system components have a limited lifetime. For example, the X-ray tube has a filament and vacuum similar to that found in a light bulb. Typical internal temperature is 50 degrees Celsius, so overheating can limit life, which is typically 10,000 hours, depending on power settings and on/off cycling.

Additionally, detectors degrade from constant X-ray exposure which is also dependent on power setting and use. Diagnostic screens can be used to warn you in advance of this occurring.

Most vendors offer lower-cost refurbished replacement sources and detectors which can be easily changed out in less than 30 minutes.

Fact #8: X-ray can have added benefits

X-ray systems are “visual” and easier to understand than metal detectors. You actually see the product displayed on the screen, which enables you to easily see the contaminant or other anomalies. The technology also allows you to save rejected product, which facilitates record keeping, system adjustment or fine tuning.

In addition to finding contaminants, many X-ray systems can also inspect for:

- Mass estimation for presence/absence
- Counting
- Area measurement
- Missing, broken pieces

The use of X-ray inspection can also improve the perception of your company by those to whom you sell your product. It is an indication that you have invested in state-of-the-art technology. Those benefits are passed along to the retail and consumer levels.

Fact #9: Closely evaluate total cost of ownership

The lowest priced system is not always the best choice. You need to consider all of the projected costs over a five to 10-year timeframe. Here are some metrics that should be on your checklist:

- Purchase and installation
- Preventative maintenance and wear items
- Possible repairs and associated downtime
- Source and detector replacement
- Redeployment to another line or factory location

You should get price estimates in advance and talk to another user about reliability, service response time, upgrades, etc. Seriously consider extended warranties; they can prove to be a good investment.

Fact #10: Not all vendors are created equal

It's also important to take a good look at the company manufacturing the X-ray equipment and their commitment to the customer.

What experience do they have? Do they have a long history of manufacturing X-ray equipment and can point to several generations of continual improvement. Do they have a range of systems available from which to select? Do the systems have unique and valuable features/capabilities?

How many systems has the manufacturer installed over the past decade? Are they national or international? Can they offer detailed test results and performance guarantees? Are field service technicians well trained and responsive? Do they offer extended warranties?

Conclusion

Before you commit to an X-ray equipment purchase, make sure you fully educate yourself on use, operation and total projected costs. Also make sure that you partner with a company that can support you through the life of your system.

If you do these things you can join the thousands of food X-ray inspection users achieving high levels of foreign object detection with a minimal amount of effort and cost. X-ray technology has evolved to be a mainstream food safety defense tool utilized in many different applications around the world, so embrace it!

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