Food Safety Signature SERIES

Metal Detection versus X-Ray Inspection

By Bob Ries, Thermo Fisher Scientific

Since the basic Hazard Analysis and Critical Control Point (HACCP) principles were developed 50 years ago, upwards of one-half million metal detectors and X-ray systems have been installed worldwide. These systems are the first line of defense to protect the food supply from foreign objects such as metal, glass, rocks, plastic and bone. Although food safety issues such as *Salmonella*, *E. coli* and melamine may be grabbing headlines, foreign object detection is still a critical step in keeping food safe.

New improvements in detection are being developed and deployed to avoid food contamination. For food quality professionals, process engineers and corporate food safety executives who decide which technology will best protect them from contaminants, choosing a detection system is based on three things: the optimum detection point, overall application capability and total cost/benefit.

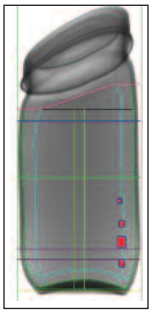
The Basics

If you've been through security at the airport, you've seen metal detectors and X-ray systems in action. Metal detectors use radio frequency signals to react to moving metal, like coins in your pocket. X-ray systems produce density images that are analyzed for irregularities by computers and people.

Food applications are more complex. The size and type of anomaly being detected is more challenging and the speed of the inspection is much faster. In many cases, the real challenge isn't finding the contaminant, it is ignoring the product, packaging or environment. False detections add up to big costs and high frustrations. Food safety metal detectors and X-ray systems must be very sensitive, easy to use, fully automatic, fast, extremely robust and reliable and cost effective.

Foreign object detection performance is determined in three ways: detectable contaminant types, minimum contaminant size and probability of detection. Here is a basic summary of detectable contaminant types by technology (Table 1).

Minimum contaminant size depends on the system design/technology and the product effect, which is how much the food itself "looks like" a contaminant to the system. Probability of detection means in real production with real products running at real speeds, what is the chance of missing a contaminant? The only way to address this is to build in margin for error, set periodic mandatory audits and perform preventative maintenance. Policies, procedures, training and discipline are the order of the day.



Selecting the Detection Point

Once you identify which contaminants are most important to you (Hazard Analysis), then determine the best detection point (Critical Control Point). CCPs can be in multiple places: at the beginning of the process; after a cutting, sifting or mixing process; immediately after a bag or box is filled; or at the end of the line.

The optimum detection point can influence the best technology to employ. Metal detectors can be installed almost anywhere, but their performance depends on the size of the aperture, or the hole the product passes through. In general, they work best for bulk conveyed or piped product or products in small packages.

X-ray systems are dependent on product size, too, but are more sensitive on large products than metal detectors. Due to the basic detector sensor scanning

rate, X-ray systems are limited by speed. They are typically found closer to the end of the line. Because X-ray systems need a constant, known speed to construct images they cannot be used in gravity flow applications. Metal detectors are ideal for these applications.

Determining Application Capability

Before making a decision, answer these fundamental questions: What contaminants do you want to find and where do they come from? See Table 2 below for a guide.

Given all the factors that affect application performance, the best way to select a technology and specific system is to run a test. Try everything to make the system fail. Strive for near 100% probability of detection with no false detections. Make sure you have enough margin so the system can run trouble free for hours on end without adjustment or calibration.

Understanding Product Failure and Total Lifetime Costs

Small incidents can cost millions of dollars and lead to total business disruption. How much you are willing to risk? Weigh this against the total cost of ownership for the metal detection or X-ray system including installation, training, maintenance, repairs and the cost of downtime.

In general, metal detection systems are less expensive than X-ray and last 2–5 times longer. If your main concern is metal contamination in small, dry products, choose a metal detector. If you want to find glass, rocks, bones, plastic, or have metallic packaging, an x-ray system can be the best return on investment.

Conclusions

Metal detector and X-ray systems have been deployed for decades. Deciding which to use when can be difficult. Find vendors with both technologies and long, successful trackrecords. They can easily provide you with the confidence you need. Finally, make sure you fully educate your staff on use and operation and audit the system regularly to assure your policies and procedures are being followed. ■

***Bob Ries**, Lead Product Manager, Metal Detection and X-Ray Inspection Process Instruments Thermo Fisher Scientific.*

Metal Detection	***X-Ray Inspection***
Detects metal including aluminum and wires	Detects most metals and many other solid contaminants
Can be used almost anywhere in a process; conveyors, drop through and pipelines	Conveyor, bulk and pipeline; not for gravity applications
Operates at just about any speed	Speed must be constant and may be limited
Conductive (wet/salty) products most difficult	Dense products with a lot of texture most difficult
Performance dependent on aperture size, coil configuration and software	Performance dependent on X-ray source, receiver, power and software Long life in harsh environments
Long life in harsh environments	Controlled environments best, shorter life
Metal only usually > 1 mm in size	Typically can find smaller contaminants than metal detectors and also non-metallic contaminants
Dry products, small products, piped or bulk products have best sensitivity	Large packaged products and cases can be inspected; cans and bottles too
Sensitive to metallic packaging	Ideal for metalized film and foil packages

Table 2: Key Detection and Application Differences

Detectable Contaminant Type	***Metal Detectors (MD)***	***X-Ray Systems (XR)***	***Comments***
Ferrous metal	XXX	XXX	Ferrous, non-ferrous and stainless steel different for MD, the same for XR
Non-ferrous metal (e.g., brass or bronze)	XX	XXX	
Stainless steel	X	XXX	
Aluminum	X		Not dense enough for XR
Wires	XX	X	Depends on orientation for MD and diameter for XR
Glass		XX	Depends on composition
Rock		XX	Depends on type and density
Bone		X	Calcified bone only
Plastic		X	Depends on type and size
Wood, Pits, Shells, Insects, etc.			Not conductive for MD or dense enough for XR

Table 1: Detection Capability