28 Feb 07

18 Note

X–ray Detection of Extraneous Matter

Dairy manufacturing operations have traditionally relied on metal detection devices in an attempt to reduce the risk of physical contamination in product reaching the marketplace. X-ray systems offer an alternative technology that can be used to screen for a range of physical contaminants in addition to metals, or in dairy products that are unsuited to the use of metal detectors. In some cases both systems can be used in conjunction to further minimise the chances of extraneous matter reaching the client or consumer.

The need for having a detection system

Legal: Manufacturers of dairy foods are obliged to demonstrate "due diligence" in their production, handling and sale of safe food. In Victoria, the Food Act 1984 prescribes considerable financial penalties that can be applied to individuals or corporations that sell food that is "unsafe"[1]. The type of contaminant and the possible health effects it has caused or may cause would be used to define whether the product was unsafe.

Economic: Extraneous matter in product is likely to pose potential product failure costs to the business. These costs may be considerable, and can include: [2]

- Loss of business (either wholesale clients or consumers at the retail level)
- Product recall
- Replacement of product stock
- Product rework or disposal
- Adverse publicity
- Potential law suits

Strategies that can be used by manufacturers to minimise the chances of product becoming contaminated with extraneous matter can include:

- Stringent ingredient supplier specifications
- Personnel clothing, jewellery and stationery restrictions within the production areas of the plant
- Product filtration and sieving steps
- Installation of in-line high intensity magnets
- Routine plant maintenance procedures
- Staff awareness training, particularly for maintenance personnel and plant operators

Making the decision as to whether a detection device should be installed in any particular operation will be dependent on a number of factors. Considerations should cover what are the: [3]

- Likely hazards
- Possible risks
- Types of process operations, and the potential dangers to consumers if adequate checks and controls were not in place

This assessment must include an examination of previous customer complaints, which will help identify what type of contaminants (if any) have been a problem.

The decision whether to adopt an extraneous matter detection system as a Critical Control Point (CCP) or as a Control Point under the company's HACCP-based food safety program will be determined through the hazard analysis process, such as described in the Guidelines for Food Safety: Dairy Food Manufacturers.[4]

The process

The production of X-rays for detection devices is provided by a generator applying high voltage current to an X-ray tube. The rays produced are converted from a conical beam into a thin, flat, fan-shaped beam. Electronic photodiodes are used to detect the amount of X-ray light being emitted from the beam, which is recorded on a scale of 0 – 100% (0 = black; 100 = white).

When product passes through the beam, a proportion of the X-rays are absorbed, dependant

A PROJECT SUPPORTED BY | GARDINER FOUNDATION

X–ray Detection of Extraneous Matter

on the product density, and the resultant "grey colour" penetrating is measured by the diodes. The rapid scanning and recording of the diodes is converted through computer software to produce a 3-D image of the product. Contaminants can be highlighted by exhibiting a difference in the "grey scale" (density change) generated and then detected by the computer.

As with all equipment used for the detection of foreign matter, an automated product rejection device is also used to isolate any contaminated product.

The critical operational parameters that will be used on a day-to-day basis are set up during the installation and commissioning of the system.

Regular validation checks of the detection capability and rejection accuracy are carried out using certified test samples of various materials with known dimensions.

Adjustment of the detection sensitivity limits should be restricted to authorised staff or maintenance personnel only. Regular servicing of equipment must be carried out to verify efficient operation, and identify any potential faults.

Limitations

Although X-ray detectors will generally have an advantage over metal detectors in being able to identify contaminants such as glass, stones, calcified bones, high-density plastics and ceramics, there are still particular materials which have densities close to that of the product which make them indistinguishable to X-ray detection. These include:[5]

- Low-density plastics, such as polyethylene (perspex) and wound dressings (Bandaids)
- Thin glass, such as fluorescent tubes
- Low-density stones
- Insects
- Wood
- Hair
- Cardboard and paper

Additionally, rubber fragments from seals and gaskets commonly used in dairy plants will generally not be picked up.[6]

As with metal detectors, the likelihood of detection is affected by the orientation or way the contaminant is positioned within the product.

Detection sensitivity is reduced as the size of the product is increased, making detections in bulk products more difficult than in small consumer packs.

An increase in product size also requires more power to generate X-rays able to pass through the product. Higher energy costs can also be expected for cooling the generator in such cases.

With bulk products, there is a small proportion of the product along the top outer edges that is scanned at much lower levels of sensitivity, due to the fan-like spread of the X-ray beam from above.

Although not affected by the conductivity of product such as metal detectors are, products that are naturally variable or not homogeneous increase the degree of difficulty for detecting contaminants.

Finding the balance

The need for installing any method of extraneous matter detection will be influenced by the hazard analysis described above.

Although the technological advances, reliability and user friendliness of X-ray detectors have improved in recent times, they are still an expensive investment in comparison to metal detectors. Overcoming the problems of incomplete product coverage, and minimising the orientation effect can be achieved by including a second X-ray beam from a different angle, however this will add considerably to the cost.

Extra capabilities of X-ray systems that may be useful include:

- Seal defect detection
- Check weighing
- Counting capabilities

Some products, such as cheese, are not ideally suited to metal detection due to their conductive composition. Such product conductivity does not affect X-ray detection systems. X-rays are similarly not affected by the environmental conditions such as plant vibrations, electrical interference and temperature fluctuations that metal detectors are prone to.

A metal detector used in conjunction with an X-ray system is an option in some cases. Although

Dairy Food Safety Victoria
A PROJECT SUPPORTED BY | GARDINER FOUNDATION
Victoria The Place To Be

X–ray Detection of Extraneous Matter

expensive, it provides greater assurance by utilising the advantages offered by both systems.[7]

Additional factors that should be considered include:

- The capital cost for all equipment required (including rejection equipment)
- On-going operational costs (particularly energy, plus the replacement of X-ray tubes and detectors)
- Maintenance/service time, frequency and cost
- Space available for installation
- Suitability of the operating environment
- Training of operators, maintenance, and management staff
- Product composition, plus package size and dimensions

Knowing the capabilities, practicalities and limitations of the various systems available needs to be understood, so that objective comparisons between equipment suppliers can be made. Where possible, "in-house" trials should be carried out, so that a more realistic assessment can be made prior to purchase.

Summary

Dairy manufacturers need to evaluate their operations using hazard analysis to determine whether there is the need for a system to detect extraneous matter.

An X-ray detection system offers some distinct advantages over other methods, such as metal detection. There needs however to be confidence that the system selected will be suited to the product(s) manufactured, and can consistently perform to the levels expected.

Regular verification testing of the detector effectiveness using certified test samples must be carried out, along with routine maintenance and calibration checks by authorised personnel.

Keeping records of all checks, calibrations and rejections will assist in identifying any contamination trends within the process. It will also provide evidence that "due diligence" is being undertaken to prevent the sale of "unsafe" product to consumers.

Further information

For further food safety information, please contact:

Dairy Food Safety Victoria

info@dairysafe.vic.gov.au

(03) 9810 5900

PO Box 840

Hawthorn 3122

www.dairysafe.vic.gov.au

References

1. Government of Victoria - Department of Premier and Cabinet, (1984), 'Food Act 1984'. Act No.10082/1984. Section 11 (2)

2. Lock, A. (1996) 'The Guide to Reducing Metal Contamination in the Food Processing Industry'. Safeline Ltd., Montford Street, Salford. UK

3. Campbell, A. (1995) 'Guidelines for the Prevention and Control of Foreign Bodies in Food - Guideline No 5.' Campden & Chorleywood Food Research Association. Chipping Campden Gloucestershire GL55 6LD UK

4. Dairy Food Safety Victoria (2006) 'Guidelines for Food Safety: Dairy Food Manufacturers.' Section 4 – The application of the HACCP System

5. Loma Systems (2006) Spectrum Inspection Systems. Southwood. Farnborough. UK. 'X-ray Inspection Systems'. Available at: http://www.loma.com/lo_xray_guide.shtml

6. Irwin, D. (2006) 'Dairy Processing Engineering Centre newsletter.' Issue 33, December 2006 – Inspection systems for detection of extraneous matter in foods. Dairy Processing Engineering Centre. 671 Sneydes Road, Werribee, 3030.

7. Higgins, K. (2006) 'Beam me through Scotty' Food Engineering. Jan, 2006. Available at: http://www.foodengineeringmag.com/CDA/Archives/be6e90115c2f8010VgnVCM100000f932a8c0

A PROJECT SUPPORTED BY | GARDINER FOUNDATION