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Technical information note

Metal detection

This note provides guidance for dairy manufacturers to help them determine the practical benefits and possible need for a metal detection system.

The need for a metal detector

Dairy food manufacturers must ensure the production of safe dairy food, as prescribed under the *Code of Practice for Dairy Food Safety*[1] and in accordance with their food safety program (FSP). The need for a metal detection system will then be based on a hazard analysis.

Product contaminated with metal objects may render it 'unsafe'. There are a number of preventative measures that manufacturers may adopt to minimise the likelihood of product becoming contaminated with metal objects. These can include:

- stringent ingredient supplier specifications
- personnel clothing, jewellery and stationery restrictions within production areas of the plant
- product filtration and sieving steps
- installation of magnets in production lines
- routine plant maintenance procedures (including equipment inspection at assembly and dis-assembly)
- staff awareness training, particularly for maintenance personnel and plant operators.

Between 2003 and 2012, there were 126 food recalls due to foreign matter in Australia. Metal, comprising 35% of all recalls, was the most common type of contaminant.[2]

This indicates that despite the most rigid Hazard Analysis Critical Control Program (HACCP) or quality assurance systems, product contaminations with metal objects can, and still do occur. Product failure costs can be considerable, and may include: [3]

- loss of business
- product recall
- replacement of product stock
- product rework or disposal
- liability for inability to supply to customers
- adverse publicity (perceived threat to public safety)
- potential law suits.

Making the decision as to whether a metal detector should be installed in any particular operation will depend on a number of factors, including consideration of the: [4]

- potential hazards and the risk they present
- types of process operations, and the potential dangers to consumers if adequate checks and controls are not in place.

Whether or not to adopt a metal detection system as a critical control point (CCP) or as a control point under a company's HACCP-based food safety program will be determined through the hazard analysis process, such as that described in the *Guidelines for Food Safety: Dairy Food Manufacturers*.[5]

The process

Although advances in metal detection equipment have improved in reliability and automation in recent years, the principles of operation remain basically unchanged. Product passes through an opening (aperture), which is encircled by three coils connected to a signal processor. One (transmitter) coil generates a field that will 'illuminate' any metal particle present. The two other (receiver) coils combine to detect the metal through its conductive and magnetic properties. A user interface converts the outputs analysed by the signal processor into data to activate the rejection systems, produce records for analyses, calculate sensitivities and perform other operations.

Additional to the detection device are specially constructed conveyors, and a product rejection system. The effectiveness of this process is just as critical as the detection itself.

When selecting the ideal stage of production to install a detection device, areas where product is exposed prior to packaging and the potential for deliberate adulteration should be taken into account.

The installation and commissioning of any system will be a critical factor. The effectiveness of the day-to-day operations will be dependent on this being set up correctly.

The detection capability and rejection accuracy needs to be monitored regularly by operators using test samples of various metal compositions, and with known dimensions. The ability to adjust detection sensitivity limits should be restricted to authorised staff or maintenance personnel only.

The frequency of checking should be relative to the volume of product throughput, with consideration given to the quantities of product that may need to be held or re-checked in the event of a detection/alarm, or other failure within the process.

Regular servicing of equipment is necessary to verify efficient operation, and to identify potential faults.

Limitations

Metal detectors will not detect all metal contaminants in all products. Machine operating capability is generally referred to as the sensitivity. Careful consideration needs to be given to sensitivity specifications quoted by suppliers, to ensure figures are appropriate for the intended application.

Detectors have limitations in the size and shape of metal particles that can be detected. Because detection systems rely on the magnetic and conductive properties of contaminants, metals low in ferrous metal content, such as stainless steel, can be difficult to detect. This is of concern to dairy manufacturers, where stainless steel is universally used, and may be a major source of metal contamination.

The orientation or direction a contaminant is facing within the product, (e.g. wire), will cause variations in its ability to be detected. The position of any metal within the product will also have an effect, with the centre of the detector aperture the least sensitive area of detection, and the outer edges (e.g. on the bottom) are the most sensitive. Consistent product orientation and positioning as it passes through the aperture will also allow for better sensitivity settings to be used on the detector.

Different detection systems are available for fluids (in-line) and solid products (conveyor systems). Products that are high in moisture, particularly with added salt, such as cheese, make detection of metal difficult due to the product itself being highly variable in conductivity. Detector sensitivity in such cases is significantly reduced. Metallised wrappers or metallic-based inks will also significantly reduce detection efficiencies. Changes in product formulations and pack sizes will generally require machine re-calibration (usually pre-programmed) to maintain optimal sensitivity of the detector.

Environmental conditions such as plant vibrations, electrical interference, power supply fluctuations, variations in humidity and temperature fluctuations can also affect the reliability of detections. A 'metal free zone' is also required within defined surrounding areas of the detector aperture to provide consistent performance.[6]

Timing of the product rejection system needs to be accurately set up and maintained. If this is not the case, contaminated product can be detected but not rejected, and uncontaminated product rejected unnecessarily. A secure collection system is recommended to ensure product can't be returned back into the process without passing through the detector again.

Further considerations

The affordability and practicalities of installing and maintaining a functional metal detection system must be taken into account. Factors to consider may include:

- the capital cost for equipment (including conveyors and rejection equipment)
- ongoing operational costs
- maintenance/service time, frequency and cost
- space available for installation
- suitable operating environment
- training of operators, maintenance, and management staff
- product composition and dimensions
- package suitability
- ongoing commitment of management.

Records

Keeping records of all checks, calibrations and rejections will assist in identifying any trends in metal contamination within the process operations. Any necessary corrective actions can then be implemented, which will minimise the likelihood of unsafe product entering the marketplace.

Key points to consider

- Dairy manufacturers need to evaluate their operations using hazard analysis to determine the practicalities and possible need for a metal detection system.
- Metal detection systems have limitations. Consideration of the production operations, product composition and size, and other factors, may indicate another type of foreign object detection system such as X-ray detection may be more suitable, or could be used in conjunction with metal detection.[7]
- Where the decision is made to install a metal detector, it is essential to ensure that it has been specifically designed for the product(s) involved to ensure maximum sensitivity can be achieved.[8]

References

1. Dairy Food Safety Victoria, Code of Practice for Dairy Food Safety, Section 5.2.1 – Physical contaminants, DFSV, Melbourne 2002.

2. Food Standards Australia New Zealand, Food recall statistics, May 2013

3. A Lock, *The Guide to Reducing Metal Contamination in the Food Processing Industry*, Safeline Ltd., Salford, UK 1996.

4. A Campbell, *Guidelines for the Prevention and Control of Foreign Bodies in Food - Guideline No 5*, Campden & Chorleywood Food Research Association, Gloucestershire 1995.

5. Dairy Food Safety Victoria, Guidelines for Food Safety: Dairy Food Manufacturers, Section 4 – The application of the HACCP System, DFSV, Victoria 1996.

6. Mettler-Toledo Safeline Ltd, *Reduction of Metal Contamination – Building an effective programme*, Mettler-Toledo Safeline Ltd, Salford, UK 2007.

7. Dairy Food Safety Victoria, Technical information note X-ray detection of extraneous matter.

8. Loma Systems, A Guide to Metal Detection in the Food Manufacturing Industry, Spectrum Inspection Systems. Southwood, Farnborough UK 2006.

Further information

Further food safety technical information is available at **www.dairysafe.vic.gov.au**

Or contact Dairy Food Safety Victoria on **(03) 9810 5900** or **info@dairysafe.vic.gov.au**