

**PS6.02      Detection of foreign bodies in meat and meat products 93.00**

*Takashi Abe (1) tabe@us.anritsu-industry.com, E Brainard( 1)*

*(1)Anritsu Industrial Solutions USA Inc., United States of America*

**Abstract—** Food safety globally has received significant media focus due to many recalls and high profile consumer incidents. There are many aspects to food safety with physical contamination as one critical aspect to this overall category. Systems and technology must be in place and properly used to effectively reduce physical contamination prior to packaging or after packaging; detection goal dependent. X-Ray technology continues to improve on the detection of many dangerous and hard physical contaminants. Installing a system in the proper location has seen reductions in consumer complaints on bone as much as 98% in some applications. Further, the technology provides additional packaging analysis benefits simultaneous to contaminant detection. X-ray technology continues to advance and is beneficial to any food production line's HACCP or GMP program. This presentation will summarize the benefits of x-ray technology in detail.

F. Takashi Abe is Anritsu Industrial Solutions USA Inc of Illinois Buffalo Grove 60089 USA (e-mail: TAbе@ us.anritsu-industry.com)

S. Erik Brainard is Anritsu Industrial Solutions USA Inc of Illinois Buffalo Grove 60089 USA (e-mail: ebrainard@us.anritsu-industry.com)

**Index Terms—**Foreign Bodies, Bones, X-ray

## I. INTRODUCTION

WE often hear the news of accidents related to foreign bodies in food products which harm and displease consumers and result in expensive recall costs for the manufacturer. Food Safety is one of the most important issues for the food industry globally. Administrations and government officials are also raising the level of interest to a higher position within their governmental strategies. Understanding the various technologies that are available to improve food quality and assure overall consumer satisfaction is paramount to any food manufacturer. X-Ray technology is fast becoming one the technologies that provide benefits beyond traditional inspection methods in both food safety and food quality arenas.

Consumers and fast food restaurants expect safe food. This concern directly justifies the importance of foreign body detection machines which is further proven by the active investment in such equipments even at this time of world economic depression. The increase in the use of x-ray technology is directly related to its ability to

detect contaminants that are harmful to people and children and ultimately to company brand images. Additional benefits of the technology beyond foreign body detection are also evident with processors using the technology to assure package integrity and fill level concerns.

## II. ACTIONS AGAINST FOREIGN BODIES AND BONES

In the meat market, which is the theme of this paper, broken pieces of bones, metals from the processing machines, stones, and rubber gasket materials are found by consumers. X-Ray technology prevents many of these foreign body items from reaching the market using the following methods.

### 1. PREVENT THE INTRODUCTION OF FOREIGN BODIES

- a. An exhaustive quality inspection of raw materials
  - i. Confirmation and guidance of quality management to the raw material producers
  - ii. Identifying the possibility of mixing foreign bodies at the time of transfer and establishing means of transfer and reliable practices
  - iii. Establishment and practice of the inspection and storing methods after receiving raw materials
- b. An exhaustive strategy to avoid foreign bodies during manufacturing
  - i. Damage and fall away caused by the metal fatigue
  - ii. A part (e.g. a nut) falls away from the factory machines
  - iii. Falling objects (e.g. rust and dust) from the ceilings
  - iv. Dusts piled up in the flow of conveying
  - v. Invasion of insects from outside
  - vi. Operation errors during the process of deboning

### 2. REJECT PRODUCT THAT HAS FOREIGN BODY INCLUSIONS

- a. Visual inspection: It is possible to reject bones, livestock fur, stones, etc.
  - i. Advantage:
    - Possible to remove cartilage, livestock fur, and vinyl which cannot be detected by the current inspection machines
  - ii. Disadvantage:
    - Missing those foreign bodies very often
    - Cannot remove small foreign bodies
    - Need many working-hours
    - High demands on workers

- b. Metal Detection: Rejecting metal foreign bodies using metal detectors

Rejecting contaminants at various locations within the facility is critical to success of a good metal detection strategy. Inspection should be located at the raw materials, during processing, after individual packaging process, and at the final process of wrapping

- i. Advantage:
  - Possible to guarantee detection of some metals with small investment
- ii. Disadvantage:
  - Cannot detect non-metal materials such as bones, stones, and glass
  - Poor sensitivity of non-magnetic metals such as SUS in products which contain a lot of sodium and juice in meats or within big products
  - Weak in product temperature drift as the possibility of false reject rate gets higher

- c. X-Ray Inspection: Rejects foreign bodies such as metals, bones, stones, glasses, etc. from raw materials or finished products

- i. Advantage:
  - Stable detection of ferrous, SUS and almost metals in small sphere or wire shapes, bones, stones, glasses, etc. are possible
  - Additional product integrity benefits are available
- ii. Disadvantage:
  - Larger investment than metal detection is necessary

### III. EXPLANATION OF X-RAY TECHNOLOGY INTEREST

The following section is an explanation of X-ray Inspection Machines that are receiving more attention and are gradually being recognized and accepted by the market.

The history of X-ray Inspection Machines for the food market is more than 20 years. The year 2000 was a major turning point. In the year 2000, new x-ray technology was introduced solving many of the concerns or problem of previous (and still existing) x-ray inspection machines as indicated below.

- 1) Expensive or not of value (approximately US\$300K),
- 2) Poor Sensitivity or not to a level beyond standard metal detection
- 3) Large Footprints

- 4) Poor Stability
- 5) The need for constant calibration during operation
- 6) Reliability Concerns as many systems had a high probability of failure.

After committing to the new X-ray Inspection Machine Technology and the inherent value, the market increased its sales from 50 machines per year to 300 machines per year in Japan. It especially became an important and necessary addition for sausage production lines. Prior to the introduction, there was no effective way of detecting and removing small bone fragments. Vendors managed the concerns by apologizing whenever they had claims from customers about bone. Due to the ability to detect bones with high probability, the market of X-ray machines increase significantly in a very short period of time.

The incidence of bones in a product is many times more than other types of foreign bodies. For example, if there is a single detection of metal per week in the production line, there are 10+ cases of finding a bone per day. Since the advent of these reliable machines to detect those bones and other contaminants, the market of inspection machines has changed drastically. After that, it became necessary to do the quality inspection using the X-ray Inspection Machines in Japanese markets and the markets importing to Japan. Soon after, the technology gradually spread out to Europe and North America.

Today, the product performance and line-up of the X-ray Inspection Machines continues to expand and add even more value through reliability and features. It is clear that x-ray technology is here to stay. It provides manufacturers with a solid solution of protecting their brand, their consumer and provides a possible marketing advantage over their competition.

#### X-Ray Technology vs. Metal Detection

As you can see in the chart above, X-ray Inspection Machines are significantly superior to Metal Detectors in the performance of detection sensitivity; however, there is a case that X-ray Inspection Machines cannot be equal to metal detector in a few part of metal bodies (such as powder metal, very thin sheet metal, etc.). Ideally, it is desirable to use both X-ray Inspection Machines and metal detector.

### IV. X-RAY INSPECTION MACHINES APPLICATIONS

X-ray Inspection Machines can be used installed in

the following positions on a production line.

1. **AFTER PACKAGING:** Inspection after packaging makes it possible to maintain the quality of products which are directly consumed by the purchaser. It is also possible to detect smaller foreign bodies by inspecting small amount of products. Therefore, when you think about installing X-ray Inspection Machines, it is ideal to set it up in this process because it is possible to use the standard machines which use curtains to prevent X-ray leakage, can inspect for small bits of contaminants, can calculate a weight, can inspect for missing items and other product issues making the overall solution price effective.

2. **BULK MEAT OR BULK INGREDIENTS:** The effective methods of detecting small foreign bodies are to inspect a thin layer of ground meats or ingredients or to pass them through pipe type of X-ray Inspection Machines. Applying these methods, the product imaging effect becomes flat or smooth maximizing detection capabilities. This control assists with the identification of small signals of small foreign bodies providing improved accuracy. These methods also reduce recycling meats and wasting packaging materials.

3. **RAW MATERIAL INSPECTION:** This is also an effective position which inspects and removes big bones in raw materials. If a big bone is in a block meat, the big bone is crushed during the next processes and the pieces of the bone are scattered over a wide area. As a result, contaminant bone inclusions increase and deteriorate the manufacturing efficiency by increasing the reject rate using X-ray Inspection Machines at the next processes. You cannot expect to detect small bones in this application.

## V. CONCLUSION

X-ray Inspection Machines are making constant progress. Examples are; improvement of X-ray generators and X-ray detector in order to take clearer images and development of special Image Processing software mainly food products in order to decrease the product effects and to extract the effect of foreign bodies. In addition to the inspection of foreign bodies, the X-ray is adding other inspection functions such as inspections of mass measurement, fat-lean analysis, quantity check, missing item check, seal condition check, etc. It is also important to consider sanitation in manufacturing production line of meat and cheese products. It is hopeless if the inspection machines cause the growth of bacteria by itself. Especially, it is necessary to introduce machines with the ability to be sanitary in design to effectively clean it from residual meat accumulated during the process of unpacked flow. This decision is critical and important as incidences of listeria and other bacteria increases.

Current X-ray Inspection Machines do not solve all quality concerns as the market demands additional increases in detection capabilities for items such as smaller and soft bone, very thin metal, and plastics to name a few. I believe that it is necessary to establish methods of making contaminants stand out with distinction between the characteristics of meats and foreign bodies (such as bones) at the stage of X-ray penetration images. The industry of food inspection promises a technological revolution based on the original ideas which are free from the existing technology and methods and offer high performance machines to the market.

## REFERENCES

- [1] Takashi Abe (2002). Presentation document for the seminar of International Food Machinery and Technology Exhibition 2002

Item	X-ray Inspection Machines	Metal Detectors
Detectable Materials	Metal, stone, bone, glass, hard plastics, rubber, ceramic, cement	Metal with stainless steel being a difficult metal to detect
Metal detection sensitivity	Detection sensitivity becomes higher as an atomic number becomes bigger. Ferrous and stainless steel are detected with almost the same sensitivity, and it can detect small ones as well. The sensitivity remains almost the same at any positions of the foreign bodies.	Magnetic metals such as ferrous can be detected with good sensitivity because a magnetic field is changed a lot. Detection sensitivity of non magnetic metals such as SUS is poor than magnetic metals as smaller effect for magnetic field. The level of sensitivity depends on the position or the shape of foreign bodies.
Wet material detection sensitivity	Since X-ray penetration is not changed by the amount of sodium content, the detection sensitivity is high and constant.	The detection sensitivity is low because the inspected item with more sodium or wet makes a huge effect to the magnetic field.
Frozen food detection sensitivity	Since X-ray penetration is not changed by the temperature, the detection sensitivity is high.	There is almost no effect for magnetic field in perfect frozen foods, so the sensitivity is high. However, defrosted foods have large effect. It is necessary to keep the perfect frozen conditions.
Aluminum packaged foods detection sensitivity	Since X-ray penetration is not changed by aluminum packaging, the detection sensitivities of both ferrous and stainless steel are very good.	The magnetic field is change by aluminum packaging as huge effect. It is almost impossible to detect non-magnetic metals such as stainless steels. Only large magnetic metals can be detected.
Machine size	To prevent X-ray leaking to outside, the size of machines becomes big. Approximately 0.8m~2m.	Magnetic field is harmless, so the size of machines is compact. Approximately 0.5m ~ 1m if the technology is advanced enough to reduce the 'metal free zone'
Price	Approximately US\$40k-150k but the overall value is justified with the many features.	Machine structure is simple and detection is limited so price point is less than X-ray @ Approximately US\$10k-30k
Maintenance fee	X-ray components have a life based on use. A good estimate of ownership costs is approximately US\$2k-10K annually amortized over 7 to 10 years.	There are no high cost consumables parts, so it is easy to maintain.

1. Pork Sausage

		Fe ball / SUS ball	SUS wire	Pork bone
	X-ray Inspection Machines	φ0.5/φ0.5mm	φ0.2x2.0mm	t 1.0mm
	Metal Detector	φ1.0/φ2.0mm	φ2.0x2.0mm	Undetectable

2. Retort-packed curry

		Fe ball / SUS ball	SUS wire	Pork bone
	X-ray Inspection Machines	φ0.5/φ0.5mm	φ0.2x2.0mm	t 1.0mm
	Metal Detector	φ2.0mm/undetectable	Undetectable	Undetectable