White Paper

Advanced X-ray Product Inspection in the Poultry Industry

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Advanced X-ray Product Inspection in the Poultry Industry

There are many differing levels of variability to consider when it comes to detecting bone in poultry and managing hygienically controlled environments but with x-ray inspection technology, poultry processors can take into account these poultry processing variables and locate the critical control points on their line.

Poultry processors know the challenges they are faced with on a daily basis to produce sanitary, high quality, contaminant and bone-free poultry products. X-ray inspection technology helps to alleviate and simplify the production process with easy to use, hygienically constructed, robust equipment that adheres to strict sanitary design standards. This technology makes managing poultry production and bone or contaminant detection easier, letting poultry processors focus on greater quality output and their bottom line.

This white paper takes a look at poultry processors' challenges in bone detection and walks through the process of selecting and placing the right x-ray inspection system for your production line at critical control points. It also looks at the broad levels of variability within bone detection and what to consider before integrating x-ray inspection equipment into your line.

1. Detecting Bone and Hard Cartilage in Poultry Manufacturing

For poultry processors, the detection of bone is a daily challenge. Product with bones entering the retail supply chain which should be boneless have the potential to harm a customers' brand and create a negative consumer experience or worse, a product recall. Bones, in some instances, can also damage processing equipment downstream, therefore detection as early as possible in the production process is highly desirable.

The main contributor to these challenges is the fact that birds are routinely slaughtered before they reach maturity, meaning the density of the bones is very low as calcification has not had a chance to fully occur. The majority of birds slaughtered do not have highly calcified bones – particularly when it comes to the rib, fan and wish bones - which are the hardest to detect. Calcification hardens bones, allowing them to create a greater disturbance within an x-ray image, therefore the older the birds the easier they are to inspect in terms of bone detection.

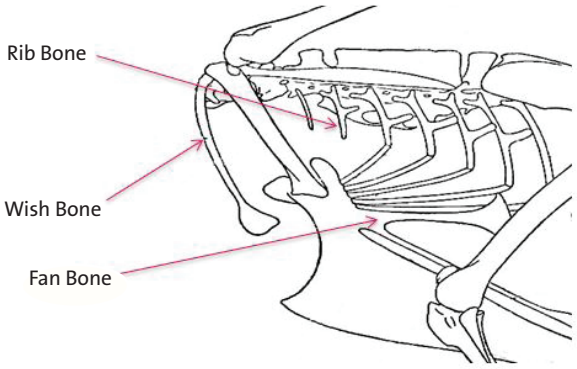

Figure 1: Chicken bone diagram

Increasing the lifecycle of the birds, in order to allow a higher degree of calcification to occur, is often not viable due to supply and demand, and cost issues. Therefore processors are increasingly turning to x-ray inspection systems in order to bolster the detection of physical contaminants such as bone. At the same time, the many benefits of inspecting product inline can be realized, such as increased throughput speeds, minimized wastage and fast return on investment (ROI).

2. What Should You Think About When Choosing an X-ray System?

There are many variables to consider when making bone detection an inline process from manual inspection:

2.1 Type of Poultry

Chicken is the most commonly processed bird in the poultry industry – followed by turkey. Each has a different density that must be taken into consideration, as this will have a direct effect on the power settings of an x-ray inspection system.

X-ray generators have two main settings, which results in an overall power setting. One is voltage, which is expressed in terms of kilovolts (kV) - the other is current, which is measured in milliamps (mA). The concept is similar to that of a tuner. To increase the sound you turn up the volume, but if you want more fidelity you adjust the gain. It is very similar in x-ray systems and the challenge is that most poultry – particularly chicken – is not very dense, so the settings must be fine-tuned to achieve the best results.

At a conventional setting of 100kV, which is a typical setting for many packaged products, your chicken, which by nature is not very dense, would most likely not even present an image as you are using so much voltage it simply blasts through everything. The solution is to turn down the "volume" - using less voltage in order to produce the image. But, as you are using less voltage, you have to turn up the "gain" using more current in order to present an image with a resolution and clarity which is conducive to contaminant and bone detection. As an example, a standard setting for packaged product would use 100kV and a current of 1mA. For poultry, with its low density, the voltage may be turned down to 50kV and the current increased to 5mA in order to improve the resolution of the image to be able to detect bones.

2.2 Age of Chicken Bone

Less calcified bones are far more challenging to inspect and most, if not all, processors will understand that they are slaughtering underdeveloped birds. Detection of bone down to 2.0 mm thickness is commonly claimed by x-ray inspection systems providers, however it is important to understand that this measurement relates to

calcified bone. For birds within 6-7 weeks old, this width increases to around 5.0 mm. Therefore, it is very important to ask the questions: are the bones you are hoping to detect likely to be calcified given the age of the birds you are inspecting? And would it be cost effective to switch to an older bird to gain better detection readings?

2.3 Where the Bone May Be Located and What Type of Bone It Is

In poultry processing, the majority of product inspected will be chicken filet or breast, meaning the most common bones encountered will be the rib bone, the fan bone and the wish bone – all of which have different detection levels. The wish bone is the easiest to detect as it is denser than the rib bones, followed by the fan bones. The fan bones are very thin, almost like cartilage, in young birds.

Figure 2: Packaged chicken breasts

2.4 Depth of Poultry On the Belt

Ordinarily, when you are processing breast meat they will be presented in a relatively orderly fashion. It is when processing the rest of the chicken – secondary product – that there may be instances where the product is a little thicker than usual on the belt. This means that system may need to be adjusted, including generator and detector settings. It is important to work with experts in order to determine the correct machine set-up for your particular application and for each type of product presentation. As an example, if product is too thickly piled onto the conveyor as it passes through the x-ray system, the x-ray may not be able to pass completely through the product, meaning an image will not be captured.

2.5 Infeed & Reject Systems – Working with the Correct Integration Partner

Deciding to employ an x-ray system is a leap forward in terms of contaminant detection. The entire process is quite simple; the filet is removed on an illuminated trim table which is then placed on a conveyor that is transferred to the x-ray system where it is inspected for contaminants and bone. If neither are detected, the filet continues on for further processing. However, if either are detected a signal is sent to a reject device - typically a retracting nose reject - where the product is removed from the good path and delivered to a rework station for reprocessing. The reworked filet is then placed back on the conveyor and re-inspected by the x-ray system. If no contaminants or bones are detected, the filet continues on for further processing. The entire system is designed to be efficient while minimizing waste.

To execute this program, the purchase of the x-ray system will also require replacement or modification of existing adjacent up and downstream devices. While it is critical to work with the very best equipment supplier, it is also important to work with a qualified integration partner for implementation to ensure individual requirements of the full system are understood and met. Many users have preferred integration partners; in these instances having them engaged early on in the process with the x-ray system supplier is important. Where there is no existing preference your x-ray system supplier can provide a list of qualified integration partners that can put the necessary equipment together, execute the installation and fully commission the system.

2.6 Manual Inspection

As highlighted in section 2.5, there are labor savings to be had by using an x-ray system for primary inspection and manual for secondary inspection. Some manufacturers rely on visual inspection and touch alone to identify contaminants and bone, which is a much slower process than using inline x-ray inspection. If you rely solely on manual inspection, it is a very subjective labor intensive process that also has a wider margin for human error. Employing an x-ray inspection system becomes cost effective in terms of return on investment (ROI) as it requires very little human interaction and inspects 100% of product as it moves along the line.

2.7 Detection Rate

Line speeds are critical to maintain if production schedules are to be met, therefore your contaminant detection operation should ideally not interfere with

your productivity. X-ray systems designed specifically for the detection of contaminants in poultry applications can run at speeds of up to 120FPM (36MPM), ensuring consistent product quality while minimizing manual handling. 100% of product is inspected inline, ensuring operations remain as seamless as possible.

3. What Can You Reliably Expect from an X-ray System?

Poultry is processed in a number of ways, and your particular application will determine the placement of x-ray detection systems on the line and how they are expected to perform. The following are common presentations:

3.1 Pumped Products

Poultry presented as a pumped product – such as breasts, ground meat or trim - can be reliably inspected prior to packaging or processing by employing a pipeline x-ray inspection system. While pipeline systems are designed so that they fit the existing piping system, it is also important to have an assembly which delivers the best opportunity for detection while also minimizing any effects on product flow. In a pipeline system the place where the x-ray beam intersects the pipe is termed the "manifold". Experienced x-ray companies realize that inspecting product through a "round manifold" that has the same geometry as the pipe means that contaminants in the center of the pipe will be harder to detect than those on the edge of the pipe because the x-ray beam has to potentially penetrate the full pipe diameter of product.

The aim of any x-ray system is to present the same inspection window or area for the product. It is critical for pipeline applications that the x-ray supplier provides a system which has a rectangular manifold where the round pipe transitions to a rectangular inspection manifold and then transitions on the exit side back to the round pipe diameter. Additionally the supplier must ensure that their transition from round to rectangular and back to round does not increase the pressure placed on the product or system as it is being processed. Detecting contaminants at the very beginning of the process protects downstream machinery from potential damage, ensures no further value is added before a product is rejected and, most importantly, protects consumers from potential harm.

3.2 Bulk (loose) Product

Bulk-flow (or loose) poultry is the most common presentation in the industry and can also be inspected early in the production process, before further value is added. Bone fragments can make their way into product via the manual deboning process and also via automated deboning systems. The use of knives and machinery also leaves the product open to metal contamination – such as knife tips or machine parts that may have sheared during the pro cess. X-ray is the ideal solution when detecting for multiple sources of contamination – such as calcified bone, metal, glass and some rubber and plastic components. Bulk poultry offers good sensitivity for detection as it is presented unpackaged at a shallow depth – typically 25 mm or less. Its homogeneous texture also aids x-ray inspection.

3.3 Packaged Products

Packaged products, such as chicken breasts in trays, kievs or nuggets, can be inspected using x-ray inspection systems. Calcified bone detection down to 2.0 mm is achievable and a wide range of other potentially harmful contaminants can also be detected. In addition, mass can be measured to ensure no under or overweight packages are sent into the retail supply chain, components can be counted and seal integrity inspected – all simultaneously - which adds considerable value in terms of productivity. Installing an end of line x-ray system gives poultry manufacturers and retailers peace of mind and can help to mitigate the risk of costly and potentially brand-damaging product recalls.

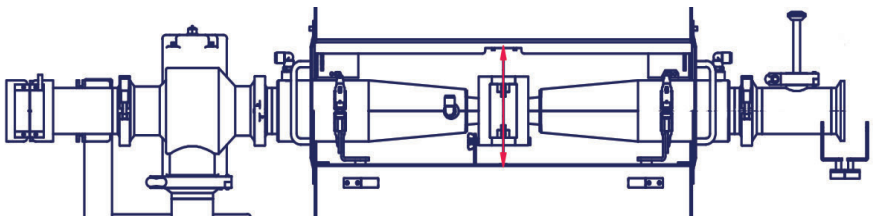

Figure 3: Pipeline manifold inspection area

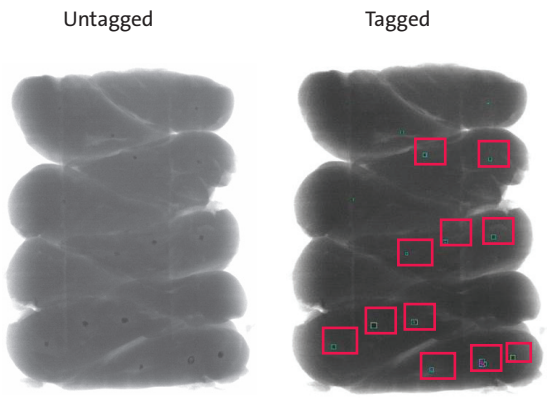

Figure 4: Detected bone contaminant in chicken breasts

4. Elements to Consider When Choosing an X-ray System for Poultry Inspection

Aside from the product itself, there are various other elements that are vital to take into consideration when choosing an x-ray product inspection system:

4.1 Sanitary and Robust Design

Poultry plants can minimize the risk of pathological contamination and enhance food safety by installing equipment that has been designed to prevent bacterial growth and promote effective cleaning. X-ray systems are available which conform to IP69 ingress standards, enabling them to withstand the poultry industry's rigorous, high-pressure, high-temperature wash down procedures. They are also designed according to the 10 Principals of Sanitary Design, outlined as follows:

1. Cleanable to a microbiological level
2. Made of compatible materials
3. Accessible for inspection, maintenance, cleaning and sanitation
4. No product or liquid collection
5. Hollow areas should be hermetically sealed
6. No niches
7. Sanitary operational performance
8. Hygienic design of maintenance enclosures
9. Hygienic compatibility with other plant systems
10. Validate cleaning and sanitizing protocols

4.2 Hygienic Construction

Systems installed at poultry processing plants should ideally be built to meet North American Meat Institute (NAMI), NSF/ANSI/3-A 14159-1 & 3, and European Engineering & Design Group (EHEDG) standards for sanitary construction and operation - ensuring that complete design due diligence has been performed so that HACCP critical operations are met.

Systems should be welded together, rather than bolted, to ensure food debris collection points are eliminated, and additions such as interlocked hinged louvers can allow easy access to the conveyor, eliminating the need to dismantle traditional heavy louvers in order to clean inside the machine. This, coupled with simple, single person belt removal, reduces the time and labor required for daily sanitization and assembly.

Figure 5: Hinged louvers allow easy access to the conveyor

4.3 Small Footprint

Processing lines have often expanded as demand has risen, making space on the floor a genuine premium in some instances. X-ray inspection system design has evolved to incorporate a space saving element into the construction of machines, making them ideal for areas where line space is limited. This flexibility allows x-ray systems to be placed easily where a critical control point (CCP) has been identified, wherever that may be on the line.

4.4 Ease of Use and Construction Attributes Relating to TCO

Ease of use is an essential aspect to research when looking at product inspection systems – particularly in the harsh environment of a poultry processing plant where wash downs must be carried out frequently. Streamlining the processes related to

product inspection enables operators to focus on other areas of the operation, rather than dedicating more time than is necessary to contaminant detection. There are key areas where productivity can be enhanced – contributing greatly to Total Cost of Ownership (TCO) figures due to the labor hours saved throughout the system's operational life.

- Convenient touch screen operated systems allows operators to interact easily with the x-ray system. The system should be intuitive to simplify product set-up to facilitate fast changeover, reduce downtime and impart flexibility on the product inspection process. The software should also allow the simultaneous x-ray inspection of different products, without the need for manual changeovers, minimizing wasted production time.

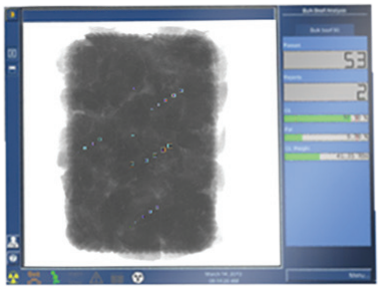

Figure 6: Contaminants tagged on a poultry image

- Easy machine disassembly and access to critical components such as the belt, rollers, motor and drive assemblies allows maintenance cycles to become shorter. Standard motors, gearboxes and bearing assemblies also allow for ease of routine servicing.
- For fast and thorough sanitation routines, disassembly should be achieved in just a few minutes by a single person - with easy reassembly to minimize production downtime.
- Unobstructed sightlines to enable operators, supervisors, cleaning and maintenance personnel quick inspection of machines and associated processes for maximum uptime.
- Producing a lower power output increases tube and detector life, which is ideal for bone and contaminant detection in poultry products.

4.5 Generator lifespan, wear parts and consumables

The x-ray generator is typically the single most expensive component in an x-ray system. Further for most x-ray generators when you increase the power required it causes the generator to work harder which can reduce its effective lifespan. So it is important to factor in the expected longevity and replacement costs of the generator as well as other wear parts and consumables into the project and the system's overall total cost of ownership.

5. Conclusion

The poultry industry remains one of the harshest production environments in the food sector, with food safety at the very top of its priority list. Demand and production schedules continue to be challenging, therefore systems that can increase safety and productivity simultaneously can add tangible value to a processing operation.

Deciding to allocate capital for contaminant and bone detection is not a decision that is taken lightly, and it is vital that processors are armed with all of the facts necessary to make an informed and practical decision when looking to invest in automated systems. As the regulatory landscape continues to evolve and food safety remains a top priority for consumers and retailers worldwide, they will continue to demand a higher level of rigor and consistency in the inspection process. This demand includes the use of x-ray systems, therefore planning how best to integrate these automated solutions is highly advisable.

As detailed prior, there are many elements to consider along with differing levels of variability when it comes to detecting bone in poultry and hygienically controlled environments. The challenge lies in looking closely at what is being processed, identifying the variables of the product and locating the critical control points on the line. By working closely with trusted partners, processors can be assured of a product inspection program that is exactly in line with their individual needs and requirements. A partner that truly understands how to make a system work hard for its money and its owner.

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The Eagle Webpage

Our engaging and user-friendly corporate website, www.eaglepi.com is the place to go for industry knowledge. The site equips food processors, manufacturers and packaging professionals with expert information on food quality and safety, and is supported by an easy-to-use product finder that will help you find the best product inspection solution for your needs.

The Knowledge Base

The Eagle website is packed with current industry relevant information. You will also find a knowledge base with white papers, webinars, videos, essential user documentation, animations, data sheets and case studies that showcase the latest issues, trends and innovations in food inspection technology.

As experts in product inspection technology, we will continue to develop our knowledge base to serve as a reliable source of information for industry professionals, providing a variety of data that will help you understand product inspection technology and applications specific to your industry.

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