Automatic detection and rejection of sealing imperfections, seal contamination, packaging integrity and package content conformity

Low-Energy, High Contrast, High Resolution X-ray Technology

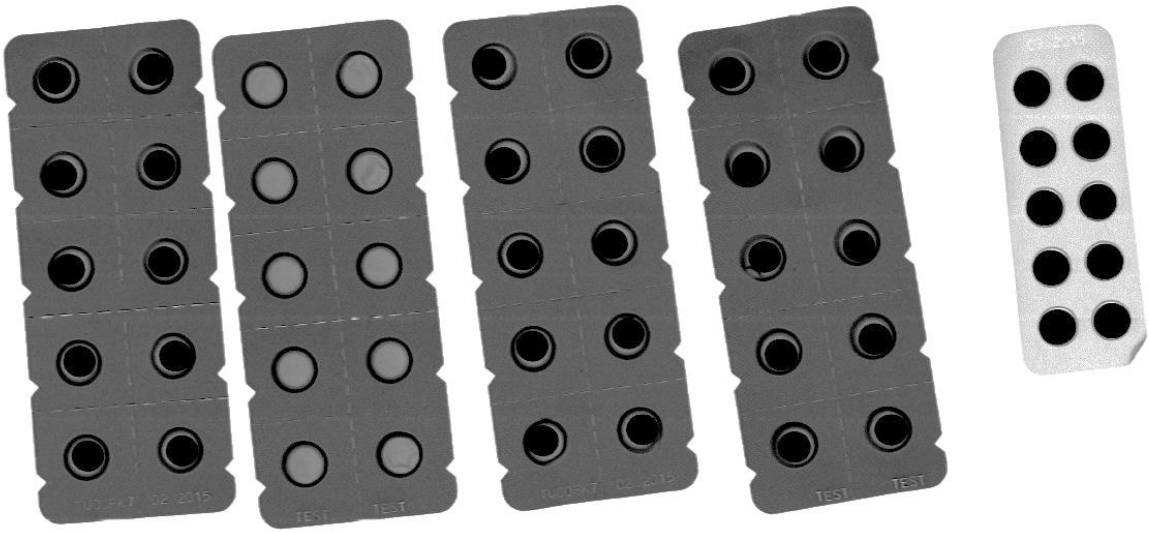
The InnospeXion packaging integrity assessment system is based on the **newest and most effective X-ray technology**.

The high quality X-ray imaging is a necessity for **the automatic identification and detection of seal defects** and packaging irregularities, on-line, of pouch, blister and plastic canned products.

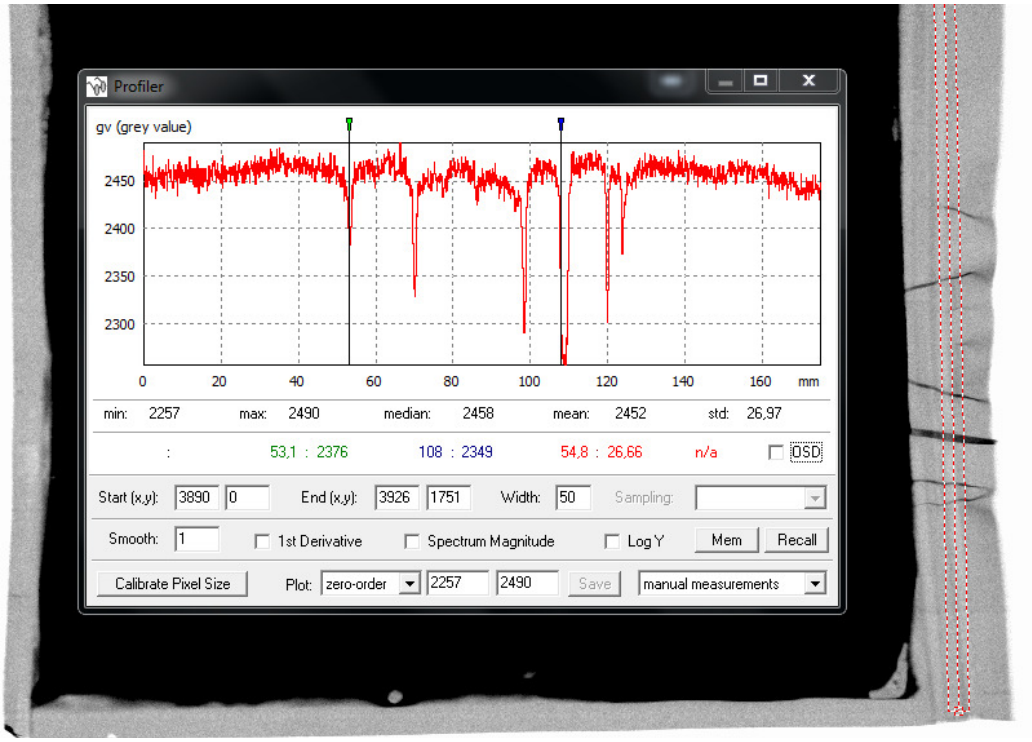
The unique technology has been **proven in numerous applications** during many years, e.g. for fish bone detection in the fish processing industry. Since 2008, the technology has been used for on-line packaging integrity assessment in the food sector.

The value creation relates to:

- Instantaneous signal-giving upon detecting deviations of conformity of the packaging integrity;
- Avoiding production of defective packages
- Eliminating call-backs;
- Avoiding leaking products during transport;
- Extending product shelf life;
- Safe-guarding the consumer safety.



The system **automatically detects and rejects** seal imperfections of nanometer thickness, down to less than 2 x 2 mm, packaging imperfections, can imperfections and foreign object contamination of the product. Packaging materials are plastic cans, pouches, blister packages, aluminium trays, carton trays, and similar.



A typical scenario for product packed in pouches: folds in the seal zone (at the right side) may cause leaks or weak points where a product leak may arise with handling and/or time. The red lines at the right are taken across the seal. Deviations from a uniform level (here around 2450 GV's) denotes folds or leaks. Upon scanning, these zones are automatically detected and the pouch is sorted according to the criticality of the deviation identified by the system.

An automatic X-ray seal inspection system installed on a dual conveyor line, with plastic can products running 150 and 120 cpm. The can sealing is verified with a total reject rate of around 1 per cent, of which product irregularities constitute the vast part. Real seal errors (product in seal) is typically < 0.2-0.4%.

Detection Capability

The HYMCIS system allows the **on-line, automatic and real-time assessment** of:

- Determination of the aluminum jar/can/pouch being undamaged
- Determine that the plastic/aluminum foil is correctly placed within the acceptance seal zone
- Determine that the seal zone conforms to the defined area for the welding
- Determine that the plastic/aluminum foil is free of folds and other similar defects
- Determine that there is no product lying in the seal zone
- Determine if there is product lying outside the seal zone
- Determine that there is no contamination of the product
- Determine that the right amount of product is filled into the plastic/aluminum jar/can or pouch
- Determine that the distribution of the product within the jar/can/pouch is homogeneous
- Determine that the density of the product corresponds to acceptance criteria
- Determine that the homogeneity of the product meets acceptance criteria

Probability of Detection (POD) and False Reject Rate (FRR)

The probability of detection (POD) and the false reject rate (FRR) is not simple to generalize, since it heavily depends on:

- Speed of production
- Dimension of the cans or pouches
- In-feeding of products, i.e. the positioning of the product on the conveyor (the product must ideally arrived aligned with the conveyor central axis, i.e. in the middle of the conveyor)
- Reject arrangement used and distance to the inspection area
- Precision and tolerances of the production line (i.,e. the variation of products placement, speed variation, etc.)
- Tolerances of the suppliers of cans/jars/pouches and foils
- Tolerances of the product, natural variations, etc.
- The location of the system relative to the sealing station (a long separation may result in failure to detect, as the moisture trapped in the heated seal zone will evaporate in short time)
- In-feeding control: the HYMCIS systems are idle for a period of up to 0.35 seconds each 29.5 seconds. During this idle time, the system does not detect objects. Objects passing during the 0.35 seconds must thus be handled, or the in feed speed control shall provide a gap of 0.35 seconds and a signal is sent to the HYMCIS PLC so that the idle period is handled accordingly.

The FRR for seal failures concerns the system response solely towards seal faults. A failure/defect by positioning will lead to a reject, but this is not a FRR relative to seal detection.

The text box below summarizes typical application constraints that are relevant for on-line applications.

General application constraints (the list is not necessarily complete):

- For the inspection to be effective and valuable, the products must arrive dry and the belt must be clean.
- Cans may arrive top down or top up on conveyor belt.
- The products must be centered relative to the conveyor central axis
- Pouches must be free of folds (the pouch seal area must be straight)
- The products must arrive separated from each other (w/o overlap).
- For cans with pull tap: defects at or under the lift-off flip will not be detected.
- Maximum product elevation from conveyor (depends however on specific geometry) is about 40 mm for standard solution
- Typical maximum seal length 400 mm
- Foreign object detection not possible simultaneously with seal inspection, if the product height is > 25 mm

The POD and FRR can be established relative to the following **generalized results for on-line system on seal inspection,** based on the low-energy X-ray image being acquired at a line speed of 120 jars/cans/pouches per minute (typical production 40-50.000 cans per shift):

Total reject rate can vary between <1 up to 4 %.
The rate depends on line tolerances, etc.
Rejects are typically represented as follows:

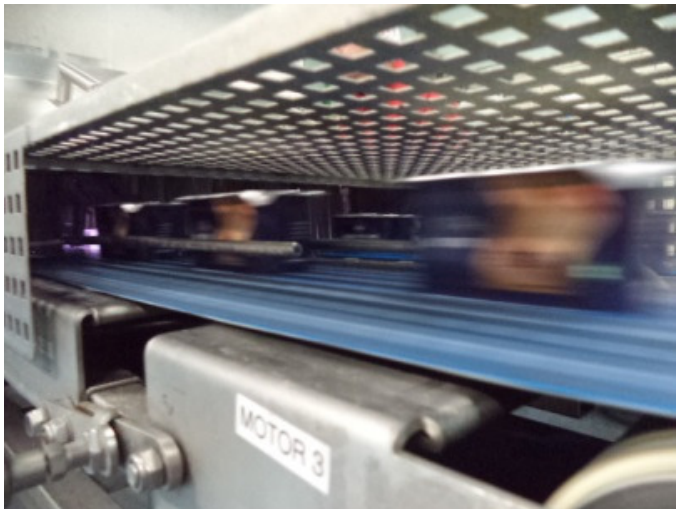
- Misaligned 70-80 %
- Damaged cans 10-20%
- Dirt/water on cans 10-20%
- Real defects in seal 10-20%

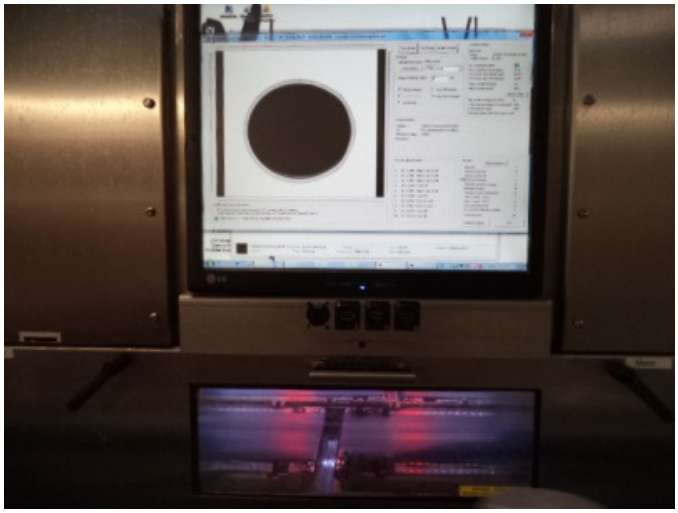
The rejects are typically sorted (rejected) into separate bins or to side conveyors

The seal defect rejects are typically caused by real seal contamination cases in 60-70 % of the rejected.

For foreign object detection, the HYMCIS technology will provide a detection capability down to 0.2 mm in diameter, with a detection POD of above 99% for contaminants (steel) larger than 0.5 mm. FFR is less than 0.5 %.

Seal errors generally have to have an extension > 4-5 mm in at least one direction to be detected at typical production speed (25 m/min).





*The **seal integrity assessment systems** are a variety of the "HYMCIS" products, which have been on the market since 2006. The applications range from raw material quality control and sorting, to fish and chicken bone detection and rejecting, in real time.*
Award winning, robust, and reliable technology. Developed, Engineered, and Made in Denmark

General specifications

Detection capability:	< 2 x 2 x 0.01 mm seal irregularity, or seal contamination
False reject rate:	Typically < 0.2 to 2%, depending on actual production and inspection task
Typical “hit” rate:	From <1 up to 4 % of production
Validated detection performance:	98 to 99 out of 100
Inspection capability:	120 – 150 products per minute (25 m/min production speed)
Product height (seal inspection):	40 mm maximum
Product thickness (product inspection):	25 mm maximum
Product minimum height:	10 mm (typical)
Distance between products:	25 mm minimum
Pouch presentation:	Flat lying, non-folded
Active detection width:	200 (220) mm. Optional 450 mm.
Conveyor width:	350 mm
Conveyor belt:	FDA approved ultra thin structure-less polymer belt (Patented).
Belt cleaning:	NA
Conveyor elevation from base:	950 +/- 50 mm
Tunnel entrance/exit opening:	400 x 50 mm (wxh)
Maximum conveyor speed:	450 mm/s (27 m/min)
System dimensions:	2026 (W) x 765 (D) x 1900 (H) (mm)
System weight:	300 - 350 kg
Reject distance:	Between 0 and 1000 mm from X-ray conveyor outlet
Reject sorting:	Up to 16 outputs (3 sorting classes defined as standard)
Cooling system:	Top mounted air condition system, closed circuit
X-ray source cooling:	Closed water circuit
Radiation emission limit:	< 5 uSv/hr
Radiation compliance:	Acc. to the Council Directive 2013/59/Euratom of 5/12 2013 concerning basic safety standards for the protection of the health of workers and the general public against the dangers from ionizing radiations. The HYMCIS systems are registered and comply with the US FDA according to CFR21 Sec. 1020-40.
Tunnel scattered radiation shielding:	Removable stainless steel curtains (if necessary, typically none)
Main inspection volume radiation shielding:	Interlocked retractable stainless steel curtains (if necessary, typically none)
Shielding material:	Stainless steel
Conformity declaration:	CE declaration 2006/42/EF with subsequent revisions, and hygienic design specifically relative to food contact materials (EU & FDA compliance)
Cleaning agents:	Specific usage of strong acids and bases must be agreed on. Cleaning guidelines provided.
System IP rating:	IP 65 (splash proof). System can be high pressure water jet cleaned, subject to local protection.
System hygienic design:	According to EHEDG and HACCP principles. Omissions are highlighted.
System power rating:	115/230 VAC single phase, 20/10 A.
Compressed air:	2-4 bar. 8 mm PVC tube (push-in fitting)
System control:	PLC, OMRON
X-ray specifications:	18 – 30 kVp, 1-12 mA
X-ray detector resolution:	0.05 to 0.1 mm
Human-Machine interface:	GUI located at the system RIGHT side looking from the infeed belt, into the system inspection volume. Minimum 600 mm sideward clearance needed for service and repair, plus emergency evacuation clearance
Access for service:	Service hatch on the LEFT side looking from infeed belt. Clearance needed is 750 mm minimum side-wards – plus emergency evacuation clearance.