TECHNICAL BULLETIN

FILL LEVEL

HOW TO CHOOSE THE RIGHT TECHNOLOGY

PRODUCT FILL LEVEL INSPECTION IS IMPORTANT

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Choosing the right inspection technology or deciding when to change it, is not an easy task. Depending on the nature of the product and its packaging; camera, high frequency, infrared or X-Ray technology can be used to accurately identify fill variations. The use of outdated technologies in the filling process can lead to an unsafe process and thus to a loss of quality of the overall package. This article is meant to help you choose the best fill level inspection technology.

WHAT'S INSIDE THIS ISSUE:

WHY IT IS IMPORTANT

Most filling lines are equipped with fill level inspection systems, since manufacturers are legally obligated to guarantee that the volume of the product mentioned on the label is delivered to the customer. The detection of underfilled containers helps to avoid recall campaigns and the associated organizational image damage. Not to be underestimated, is the avoidance of product loss due to overfilling. This can lead to overpressure containers and in the worst case, bursting containers during transport, at the POS or even at the consumer's location. This may result in legal action.

miho lets you choose between different fill level inspection solutions. Each of them integrating cutting edge technology based on over 40 years of experience of inspection in the food, beverage, pharmaceutical, cosmetic and homecare industries

Rejecting products which do not conform to the required quality standards is good, but avoiding the appearance of such products is even better. Modern inspection systems provide statistical information, helping the manufacturer analyze what happens on the line. This allows them to act proactively to decrease the risk of producing bad product. The miho Filler Management System is a typical example of this approach, as we will highlight later in this article.

LOOKING FOR ALTERNATIVES TO GAMMA-RAY

Gamma-Ray fill level inspection systems were popular as they offered relatively good inspection accuracy. The "secret" of this performance lies in the fact that the high energy gamma photons used in these systems had the capability to traverse any bottle / container material and any liquid, being less influenced by factors like the product and packaging. Our modern world is influenced by environmental and safety consciousness, making the use of Gamma-Ray fill level inspection less popular. Regulatory pressures are another element which tend to push the technology in to the past. It is expected that Gamma-Ray inspection will vanish in the near future.

HF High Frequency
Fill Level Inspection

Working principle

To measure the level of fill, bottles pass an inspection bridge where they are submitted to a High Frequency Electromagnetic Field (HF). The water molecules have their transient dipolar properties change. The inspection system uses this phenomenon to measure indirectly, the volume of liquid passing the inspection head and consequently the fill level in the bottle. The operation principle of the HF inspection bridge is one of a resonant circuit, where a variability of capacitive reactance, due to the presence of liquid, changes the impedance of the circuit.

Factors influencing measurements

Measuring liquid fill level in a bottle using HF can be influenced by a number of factors, like product temperature and foam on top of the liquid. In miho inspectors the compensation of temperature fluctuations is done via an integrated self-calibration circuit.

HF measurements can also be influenced by distance between bottles and bottle centering under the inspection head. To guarantee optimal performance, miho systems are installed following strict installation procedures, allowing us to minimize the influence of potentially disturbing factors.

The presence of metal in the measuring area of the fill level should be avoided. It is therefore not recommended to use HF fill level measurement for metal containers or glass bottles fitted with a metal muselet…

The installation site is typically downstream side the filler, if it is a non-foaming product, or downstream of the labeler. If the HF level control is the right choice, there are two influencing factors to take into consideration:

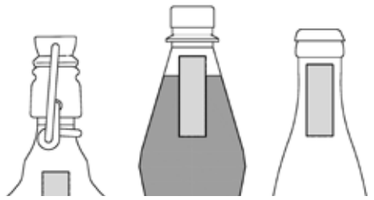
- the nature of the label present in the inspection area
- the type of product being inspected

Paper labels have no negative influence on the precision of the inspection. However, when metalized labels, plastic sleeved bottle necks or swing top bottles are used, miho recommends other inspection head options.

Viscous products, non-aqueous based liquids or products with high alcohol may be more difficult to inspect. Other inspection technologies should be considered in these cases.

Typical inspection performances for underfill inspection with the miho Newton HF are (*):

Product	Accuracy	Detection rate
Mineral Water	±1,5 mm	≥ 99,5%
Cola	±2,0 mm	≥ 99,5%
Beer	±2,0 mm	≥ 99,5%
Orange Juice 100% Fruit Content	±2,0 mm	≥ 99,5%



HF can be used on any type of transparent or opaque glass or PET bottles. The typical inspection area of 20mm is shown in the diagram to the left.
Under and overfill can be measured with the same inspection head.
Cap presence detection can be integrated in to the head.

For more info:
miho Newton HF 2
Fill Level inspection System

Fill level inspection with HF is durable, robust and economical in terms of level of investment and maintenance cost.
Technical features and potential limitations have to be analyzed to guarantee long term satisfaction and compliance.

IR Infra-Red
Fill Level Inspection

Working principle

The physical property of materials used, determines the different absorption levels of IR wavelengths. The technology provides the possibility to detect the presence or absence of liquid in a bottle. A typical inspection set-up consists of an infrared source installed on one side of the bottle and an IR receiver on the other, that is able to measure the intensity of the infrared beam that went through the product.

Factors influencing measurements

Factors influencing measurements
The container may be clear or opaque, but must be transparent to the IR wavelength used by the inspection system. A low signal at the receiver will indicate the presence of liquid at the low fill level measuring point height of the inspection head.
The container should typically not be labelled or foiled, as the presence of those elements could interfere with the measurement. The difference in absorption levels between the container only and the product should be large enough to clearly distinguish the presence of liquid at the point of measurement. This inspection is typically performed at the exit of the filler.

IR fill level technology is a cost effective and radiation free alternative to X-Ray technology.
It is particularly useful in near opaque containers and non-conductive liquids such as oil.

The miho Newton IR inspection head is fitted with a dual IR sensor system, allowing it to detect under and overfilling bottles.

For more info :
miho Newton IR 2 Fill Level Inspection

Practical considerations

The infrared level control can be used on glass, PET or plastic containers filled with aqueous or non-aqueous solutions. Fill level measurements of emulsions, oil or spirits are also possible. The system could also be used to inspect bottles filled with beverages like juices, highly viscous or even solid product

IR technology is also suitable for opaque PE bottles. For high-viscosity products, a middle fill level can be determined by multipoint determination.

RX X-Ray
Fill Level Inspection

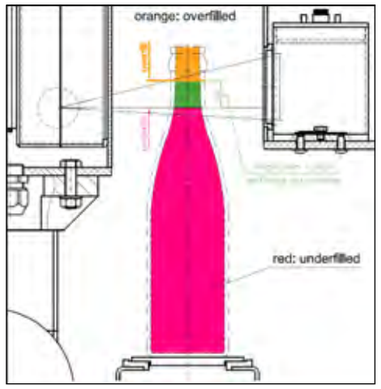
Working principle
An X-Ray generator uses a pair of electrodes which are submitted to a high voltage inside a glass vacuum tube. The high voltage difference between the cathode and the positively charged tungsten anode, generates a flow of high energy electrons. When hitting the anode, they provoke a shift in energy levels between the anode electrons, which leads to the generation of X-Ray photons.
When using the X-Ray level control, minimizing radiation exposure is of utmost importance. miho implements a modern X-Ray technology for its fill level control which only achieves an additional radiation output of less than 0.5 mSv! The system uses a unique pulsed X-Ray source generating X-Ray photons only during the time required to measure the fill level. The radiation emission is thus below the naturally occurring values in enclosed spaces such as the workplace at 15 mSv !

Practical considerations
miho offers two approaches to the fill level measurement:

- The X-Ray is emitted through a pinhole that allows it to perform overfill or underfill detection – a combination of 2 heads may be required to inspect both underfill and overfill
- The X-Ray is emitted through a vertical line that allows it to, perform overfill and underfill detection in an inspection area of about 20 mm in height

Considering the fact that the X-Ray measuring approach is less sensitive to elements like foam presence or label type, the inspector can be installed after the filler or labeler, regardless of the nature of product and container; including swing top bottles.

For more info: :
Fill Level & Cap Control miho Newton X2Z
Fill Level & Cap Control miho Newton X2P



Typical Inspection performance for underfill in glass bottles with the miho Newton X2Z or Newton X2P are (*):

Fluid	Accuracy	Detection rate
Mineral-Water	±1,5 mm	≥ 99,4%
Cola	±1,5 mm	≥ 99,4%
Beer	±1,5 mm	≥ 99,4%

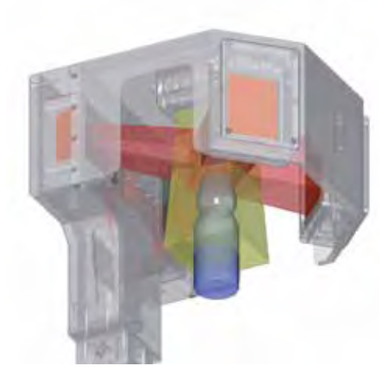
The X-Ray fill level technology is most suitable to inspect cans, U-shaped bottles, opaque containers or containers with metal foils.

Factors influencing measurements

Since the energy level of an X-Ray photon is much higher than that of HF or IR, it is less dependent on environmental conditions and more capable of crossing a greater variety of packaging materials (metal, glass, plastic…). Package transparency or product properties, like conductivity, are of less importance.

CAM Camera
Fill Level Inspection

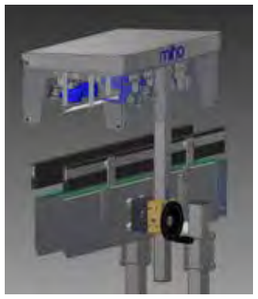
Working principle
Measuring for under and overfill, plus closure inspection of the bottle (crown, cork and / or screw cap) may also be carried out with a measuring method in the visible wavelength range. State-of-the-art color cameras and lighting technology (SMD-LED) are used, which work with several optical axes and variable illumination. By installing multiple staggered cameras and possibly additional mirror systems, one can achieve up to 360 ° inspection coverage. Several images can be created per bottle and evaluated according to various criteria using real-time image processing systems.



Factors influencing measurements
High quality images acquired by the color cameras are analyzed by sophisticated algorithms. They typically use transitions in image pixel intensity levels to measure fill level and cap defects.

To accurately measure the fill level, the liquid meniscus has to be clearly identified and should not be hidden by a lack of bottle transparency, label or excessive foam presence at the liquid surface; especially if the foam is similar in color to the product (lack of contrast). Any excessive water should be removed from the bottle area prior to being inspected, as the presence of droplets can negatively impact the system accuracy. miho offers a specially designed bottle blowing device for this purpose.

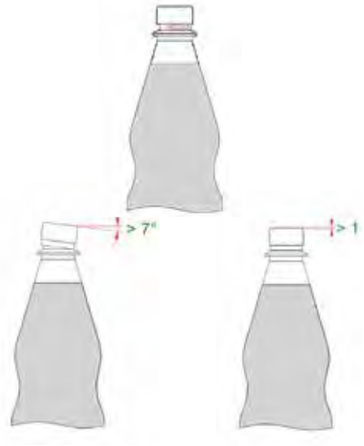
Bottle stability during inspection will favor a stable meniscus, improving the fill height measurement.



Dark objects like black caps, can be more difficult to inspect, since it is difficult to illuminate and certain details may not be as visible on the image.

The miho Newton Optics inspection head has been specially engineered to take into consideration the previously mentioned factors. The system does not simply take an image of the bottle against a backlight but offers a full 360° inspection in which multiple combinations of back, front and top lighting is possible to provide optimal inspection in all operational conditions.

Practical considerations
The unit is typically installed downstream of the filler. If the fill level is not covered by a label, the system may also be placed downstream of the labeler.
The Newton Optics is ideal for inspecting under and overfill levels in transparent or translucent containers which are filled with transparent, cloudy, opaque, foaming and non-foaming liquids; provided the fill level is not covered by a label. The lighting can be optimized with direct, reflected and / or diffused light sources.
Closure inspection (cocked cap / high cap / bullnose) as well as inspection of the tamper band are part of the standard inspections. Wrap-around label presence and position can be verified. The presence of a printed: “Use By Date” can also be inspected



For more info:
miho Newton Optics 2
Fill Level Inspection

Typical inspection performances
for underfill inspection in glass bottles with the miho Newton Optics are (*):

Control	Accuracy	Detection rate
Fill level too high / low	>1mm (diagr. 5)	≥ 99%

for Twist lock with tamper band are (*):

Control	Accuracy	Detection rate
Missing Cap	>1mm	≥ 99,9%
High/Short Cap	>1mm	≥ 99,5%
Cap Angle	>7°	≥ 99,5%
Tamper Band 100% absent	>1mm	≥ 99,5%
Tamper Band 70% absent	>1mm	≥ 99%
Tamper Band 50% absent	>1mm	≥ 95%
Tamper Band 30% absent	>1mm	≥ 80%

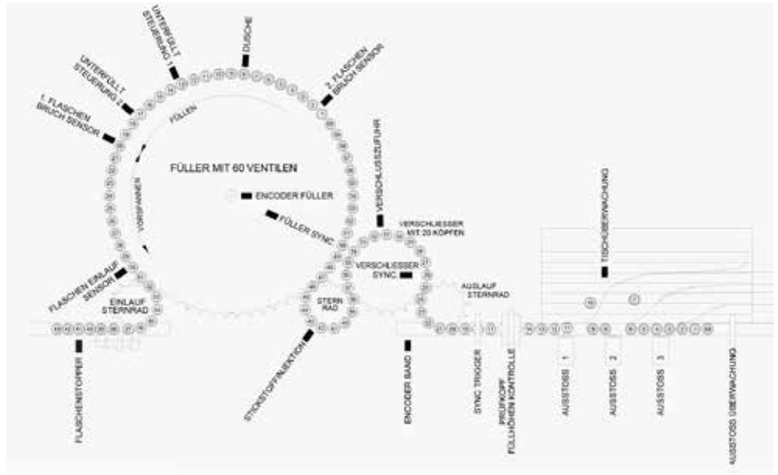
FM Filler Management System

A Smart Extension of Fill Level Control

The Filler Management System provides important insights into the entire production quality and efficiency. Through its continuous filler monitoring, it delivers accurate statistical data on each filling valve and capper / seamer head. Malfunctions that lead to repeated incorrect fills are detected at an early stage. Defective valves or capper / seamer heads are localized, even prior to a failure.

If a glass bottle filler is equipped / upgraded with the appropriate sensor technology, bottle burst detection can also be implemented to minimize the risk of glass contamination in the product. A sequence of valves can be forced to underfill around the burst bottle location and the appropriate bottles subsequently rejected.

For more info:
miho FM 2 Filler Monitor



The valve trip sequence and shower flushing system can be programmed. Comprehensive filler and capper / seamer management improves efficiency, prevents high rejection rates and lengthy production stops.

Faults can be detected in the early stages and rectified sooner. The miho FM2 Filler Monitor offers comprehensive statistics and the ability to connect to a separate or external data acquisition system utilizing the Weihenstephan protocol

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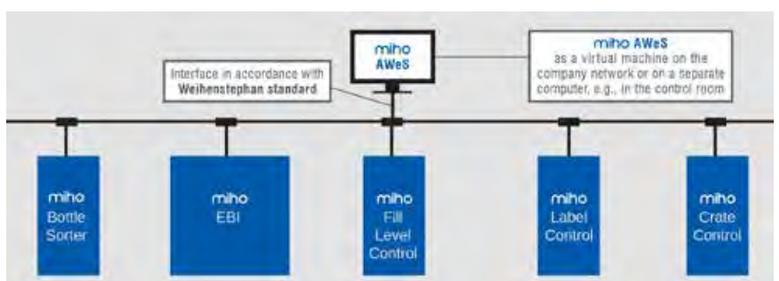
GOOD TO KNOW

When adjusting the fill level inspection system, it is important to remember that every bottle filler is subject to certain tolerances (green area) in terms of liquid volume delivery. This process tolerance must be combined with the notion of the measuring system tolerance (orange area), partially reflecting the accuracy or sensitivity of the inspector used. Being aware of these two concepts, should help the person in charge of quality control, to clearly define inspection system settings which provide the correct balance between fill level inspection accuracy and risk of false reject.

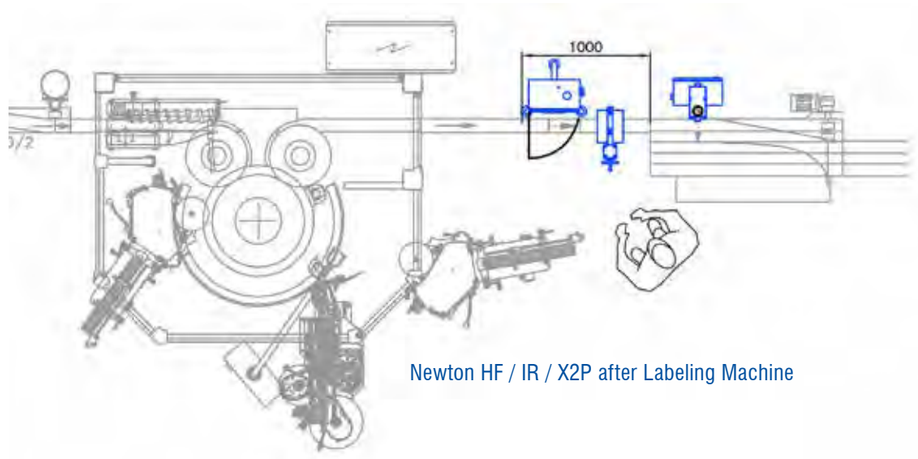
AW miho AWeS

Tailor Made Monitoring Solutions and Control

The production data acquisition software: miho AWeS, automatically records all production data following the Weihenstephan protocol. Inspection results are not only documented but also fully traceable over time.

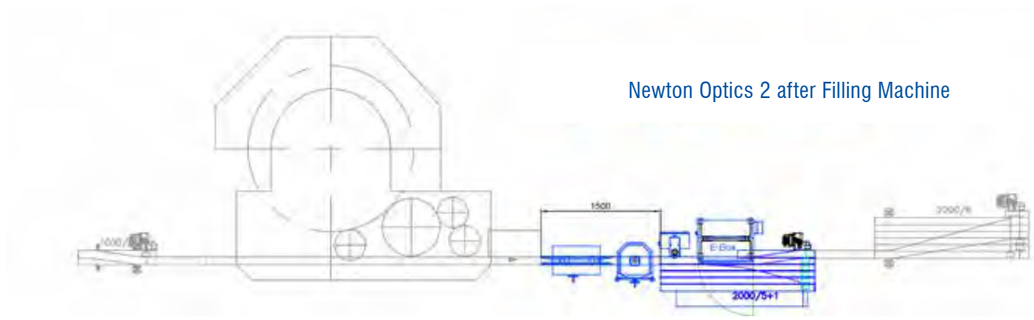


INTEGRATION EXAMPLES



Newton HF / IR / X2P after Labeling Machine

Creative miho engineers help you to find the optimal integration of your inspection equipment, guaranteeing optimal product handling during the inspection process and ideal stability at rejection.



Newton Optics 2 after Filling Machine

TESTIMONIAL

Nicolas Rinnert, Technical Director of Sources de Soultzmatt, France.

"Choosing a supplier of critical production equipment, which has to serve the company efficiently for many years, is difficult and stressful. Our project team is relieved and happy that we took the decision to choose Miho Inspektionssysteme for the renewal of all our inspection systems on our glass filling line.

We experienced professional support from first sales contact to project finalization. Miho engineers had a creative and efficient project approach. They offered a line layout where the new inspection equipment could be integrated with minimum changes to the existing line, while succeeding to optimize product flow and bottle reject conditions. The installation process was seamless and thanks to an open and constructive collaboration between our respective teams, small issues and problems typically encountered during such projects, were quickly solved. All these aspects had a positive impact on costs but also on line efficiency."

TO CONCLUDE

Fill level and cap inspection are important functions of a filling line. Due to differences like container materials & shapes, product types, container closures or line characteristics, it can be challenging to choose between different inspection technologies; with each having its own strengths and weaknesses. One may consider implementing a combination of different measurement methods to cover a wide product portfolio in an effective way and to accommodate for future product variations.

miho project engineers can discuss your application and run trials on your products to help you choose the best solution(s) for your application.

For more information we invite you to visit our website www.miho.de or contact us directly by email at: info@miho.de or at: ltricot@miho.de

About the Author

Luc Tricot - Regional Director, miho Western Europe - With 20 years' experience, is passionate about automation applications and their associated product quality control challenges.

Discovering new applications, collaborating with leaders in the industry, finding creative solutions and building up pleasant working relationships with customers, are a pleasure for him.

**Detailed inspection performance data can be provided on request*

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