Is Trinity the holy grail of hot end inspection technology?

Peter J Firth* discusses a hot-end inspection system, which he describes as the holy grail of this technology.

Hot-end infrared inspection of glass containers produced on the IS Machine is nothing new. I recall proposing a hot-end inspection system using infrared technology in a paper presented at a glass conference in around 1992.

One of the first such systems also hit the market around that time, from Danish company JLI.

Other similar systems then followed from Xpar Vision, Tiama with its I-Care system, and recently, the system from Cortex Glass called IS Watch. The original JLI system has dropped out of the market.

Konatic's latest offering

The latest entrant to this market is Konatic, with its Trinity hot-end inspection system.

Knowing what I know about these GUYS, you'd not be surprised if they weren't able to bring a serious challenge to the marketplace for hot-end inspection. (To see exactly what I mean by "GUYS", check out my previous article "The GUYS and GIANTS of the Glass Industry"[1]).

Their marketplace challenge is not only a commercial one, by Konatic offering very competitive pricing, but it also brings a technological challenge. I am not a salesperson so I find the technological aspect more interesting. Ironically, that turns out to be also potentially the most financially rewarding, rather than just a potentially lower purchasing price.

The holy grail?

Why might Konatic's Trinity system be considered the Holy Grail of Hot End Inspection Technology? Quite simply because it has been designed to overcome the main challenges that we have come to know (even accept?) about hot-end inspection systems.

Pic 1. Konatic Trinity at hot end with new electrical cooling and small footprint.

Pic 2. Image from Trinity with the HDR sensor, high dynamic for an accurate control from bottom to finish.

These main challenges are:

1. The traditional systems only perform as well as they are set up by trained personnel.

2. The hot environment puts demands on the cooling systems that regularly fail.

3. The images captured are not adequate for detailed 'quality control' purposes.

Therefore, overcoming these three limitations could easily put Trinity in the Holy Grail category of modern hot-end infrared inspection.

How has this been achieved by Konatic?

1. An Artificial Intelligence (AI) vision engine is used to automatically set up the inspection settings by training it on good production versus bad production images.

2. A new way of cooling the camera electronics positioned close to the hot bottle conveyor is used, meaning no water cooling chiller is required.

3. The new camera technology deployed takes high-resolution images with the widest dynamic range of infrared measurements (***Pic 1***).

There you have it, three main reasons to take the claims from Konatic about its Trinity system as being the 'gospel truth' (***Pic 2***).

Here are a further three areas for consideration.

Cost of ownership reduction

As we all know, there is not only the price of the systems that are a 'cost' to the glass plant operation. With any online inspection system, there is a cost associated with the good ware that is rejected automatically. I have seen similar systems rejecting around 0.5% to 1.0% reject rates in the glass plants. Lower than 0.5% overall reject would be a target for me, and the lower the better (assuming the defect reject performance remains acceptable).

Some of the rejects will be good ware, as well as the bad ware needing rejecting. It is hard to think that 1% is a figure truly representing bad ware, otherwise the plant has a quality or production problem.

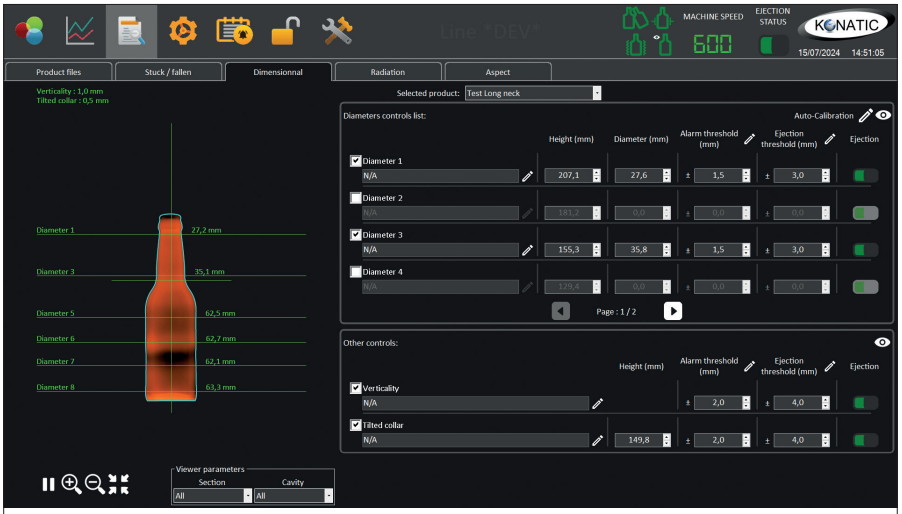
In reality, the overall reject rates are representative of the 'good ware' that needs to be rejected to ensure the bad ware is reliably rejected. Hence this cost of ownership can easily dwarf the cost of the investment over several years in operation simply from false rejections

Reductions in such 'commercial ware' losses come from two areas in which Trinity scores well. Firstly, the high resolution and wide dynamic range camera ensures a detailed image upon which to run the AI image analysis software. Secondly, the automatic AI tuning of the system means the settings are not reliant upon an expert coming to set up the algorithms, meaning it is always set well for reliable inspection.

This is not to stop further intervention from the operator who can fine-tune the system when there is an opportunity, by further educating the AI system on what is considered good and what is considered bad. This can be achieved to the finest degree possible according to the high-resolution camera systems. Fine-tuning of AI auto-tuned parameters is also possible to allow human intelligence to have the final say in the matter.

Performance improvement

Perhaps one of the main current benefits of having a hot-end infrared inspection is the ability to see most critical defects more clearly than at ambient temperatures at the cold end.



▲ Pic 3. Accurate dimensional control with Trinity

The Trinity system continues to deliver this critical defect rejection feature, typically detecting bird-swings, spikes, hollow necks, slugged necks, sharp mould seams and such like, together with a high resolution to detect the smaller of these critical defects. It also has the lowest minimum measured temperature meaning dark (thin or low-temperature defects like glass 'strings' or short and thin 'mould fins') can be detected more easily.

The cost to a glass plant to resort difficult-to-see critical defects which have not been detected, will be significant over a year. Not to mention the costs associated with any small such critical defect reaching the marketplace, either by way of product recall or customer complaint.

In addition to the sidewall inspection detecting flaws based on infrared variation, the higher resolution images also mean the dimensional inspection is accurate.

Konatic claims that dimensional measurements are accurate to 0.1mm, which, if true, would outperform any of the past experiences I have had with hot-end inspection on bottle dimensions. (One of the keys that is claimed to achieve this is that the image capturing system is not prone to be affected by the slight 'rocking' movement of the container on the hot end conveyor.)

As well as measuring spot diameters at specific points on the container, it is also capable of inspecting for the lean (eccentricity) of the container as well as inspecting for bent necks. If this is half as good as it is claimed to be, maximising high-production machine speed versus the weak point of producing leaning bottles is an opportunity not to be missed (***Pic 3***).

That means higher output can be facilitated more quickly than relying upon such information to come back from the cold end, as is normally the case. Do I even dare to consider a future automatic regulation of the machine cooling and even machine speed optimisation if the measured container eccentricity information proves to be accurate enough?

The loss of production speed (not running at the highest possible speed for good production), is perhaps the largest of all losses I have seen when visiting the various glass plants throughout the world. Imagine a glass plant making say 2 – 5% more output for the same fixed costs. Any technology that can help optimise machine speeds is therefore of high financial value.

Also, dimensional defects have so far only been reliably inspected at the cold end, but a reliable hot-end inspection gives a much earlier warning for the correction of such defects. This results in preventing filling the lehr full of defects by hot end inspection feedback giving fewer rejects and a higher pack-to-melt. This reduces the cost of poor quality.

Standard hot end inspection features

As well as the benefits of the Trinity system already discussed, a third area to note is that none of the basic features of hot-end inspection systems have been overlooked.

Such features include:

- Hot conveyor container spacing

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monitoring which also identifies which cavities are drifting out of line.

- Rejection of stuck and fallen ware on the IS Machine conveyor extension.
- Standard settings data capture features, ready for reloading at the start of the next production run.
- Saving reject images can help in diagnosing potential problems during or after a production run.
- Automatic synchronisation with the IS Machine is possible after simply setting up the conveyor order and instructing on how many active sections there are.

Configuration options

Thus far we have only discussed the Trinity system as a single-camera system. But as you might guess by now, all things with the Trinity come in threes!

The configuration options are no exception. It is possible to have up to three sidewall cameras positioned around the hot-end conveyor for better coverage of the containers to be inspected.

You can always incrementally add additional camera systems and each such system only takes up 25cm by 25cm of shopfloor space.

Future developments

For the Trinity system there has been some testing already carried out for an overhead inspection of the container finish.

In the case of NNPB production, this would be ideal to detect the internal flange defect synonymous with an NNPB quality control focus. Although not commercially proven yet, the concept has been tested and results look promising, according to Konatic. They are just awaiting any commercial interest in the development of this feature.

The overhead position of an additional camera will also be able to detect any alignment problems with production as regards centralisation of the ware on the machine conveyor.

Summary

A combination of using the latest hardware and coupling that with the latest AI software has enabled new features and feature enhancements to be implemented in the Trinity hot end inspection system.

The resulting improved performance offers glass plants the opportunity to correspondingly improve their quality control technology and give production process improvements that would otherwise not be so easily achievable. ■

The Trinity hot end inspection system will be on display at Konatic's booth Hall 13 stand C15 at Glasstec.

References:

1. The GUYS & GIANTS of the Glass Industry, Glass International November 2022, P J Firth. See the short link bit.ly/GUYS-AND-GIANTS

***Principal Consultant, Glass Container Manufacturing Consulting.**
Email:
peter.firth@GCMC-Worldwide.com

Further information from Konatic, contact:
Gregory Duez, Sales Director, Vourles, France
Email: contact@konatic.com
www.konatic.com