Backlight concept to help hot end monitoring

A new development in quality control is to be unveiled at Glasstec.

The idea of monitoring bottle quality at the hot end has attracted growing interest recently, fuelled by bottle manufacturers' desires to improve efficiency and profitability. Consequently much effort has been devoted to the research and development of a viable hot-end inspection solution. Since 1991, JLI vision a/s has concentrated its efforts on developing NIR and visible light vision systems for the hot end.

JLI hot end work over the years

Under the direction of Jørgen Læssøe, JLI began initial development of a hot-end imaging technique using NIR and background lighting in 1991. The following year, JLI received a grant from the Danish Development Fund to further develop these techniques for container production, with the initial goal of producing a system that could provide 100% inspection of the bottle. The result of this development produced a functional system incorporating nine cameras using both NIR and white light techniques.

Extensive trials were run at several glassworks. The system performed adequately and greatly improved inspection at the hot end, but was too large. Total inspection also proved to be elusive because of the close proximity of bottles to each other at this point.

In the years since, JLI has continued to refine techniques and work with glass container manufacturers to develop an optimum approach for the hot end. These efforts have proved that the big multi-camera system did not offer significantly better value than a background lighted two-camera system, the approach that JLI is currently following.

Inspection vs monitoring in the hot end

The question of whether you can effectively perform 100% inspection in the hot end continues to circulate. Experience is proving that hot-end systems offer much greater potential for process monitoring with critical fault rejection rather than total inspection.

NIR vs visible light

There are two approaches currently in use for hot-end inspection and monitoring; 1) using NIR to measure the mass and temperature of the container; 2) using visible, back lighting and accurate dimensional measurement. JLI has embraced the latter due to the limitations of NIR in handling uneven cooling of containers as well as radiation from neighbouring containers.

Using visible, background lighting

JLI has developed a technique that relies on background lighting and the limiting of camera sensitivity in the NIR range, which provides a very sharp image for analysis of both dimensions and critical faults.

Precise dimensional measurements

With the advent of modern mega-pixel cameras, measurement accuracies of up to 0.03 mm in a 400 mm tall picture can now be obtained. With this type of resolution, very small changes in IS machine operation and temperatures can be detected.

If a cavity is running hot, the container will sink slightly more than cooler containers after forming. This difference can help to identify hot zones and monitor overall temperature.

Wrong glass distribution will make a container lean. By using two cameras, lean can be detected in all directions and the related distribution problem identified.

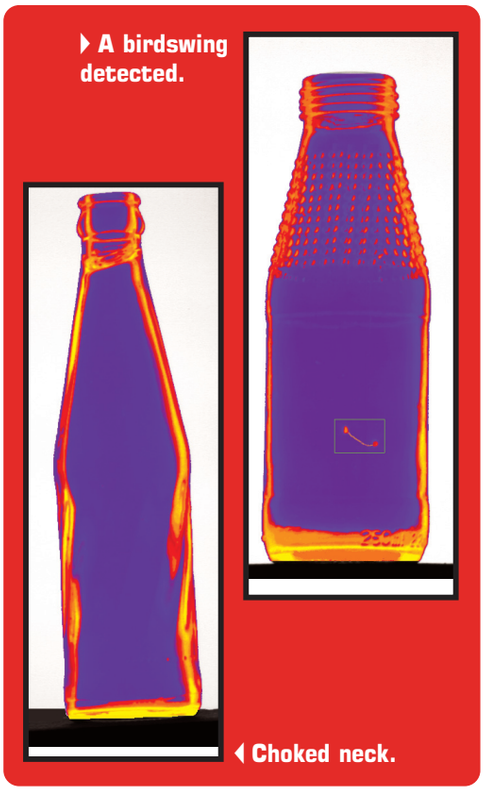
Container alignment can affect accuracy. The JLI approach compensates for this by using a second camera to measure details of the top and perform distance calculations.

Using background lighting for distribution

It is not necessary to use expensive NIR cameras with cooling and other complications to monitor material distribution. Recent developments have demonstrated that distribution can also be measured using background lighting. When light from the light box passes through the container it is reduced depending on the wall thickness. Green and amber glass reduces the light significantly; flint also gives a detectable reduction. Cameras with a high dynamic range and special software can generate images resembling those from NIR cameras. These images give a much more accurate wall thickness estimate than NIR techniques. The benefits of background lighting for measuring distribution are:

- No need for section number temperature compensation
- No faults for asymmetric cooling
- No limitation on container spacing
- No reflection from neighbouring containers
- Works on both hot and cold containers

Using this technique, the container is divided in sectors vertically and horizontally; and each sector is monitored. If a shift in glass distribution is detected, it can be documented in the system software and used to provide trending information. The operator can then view the images in sequence and see how the problem developed.



Reducing critical defects

Backlighting and mega-pixel cameras are quite effective in identifying critical defects. Since these cameras give sharper images than NIR, defects of a much finer detail can be detected with a high rate of accuracy. Birdswings can be detected with near 100% certainty. Other critical defects such as stones, blisters, large seeds, choked bore and so forth can be detected as well. Detecting defects at this stage not only eliminates problem containers but also alerts the operator to process related problems early on.

Conclusion

Over the past 10-15 years, hot-end systems have seen significant evolution. The industry has learned that 100% inspection of every container might never be truly possible due to the nature of the hot end. Instead, highly sophisticated monitoring systems are being introduced that measure and document the trends of key process indicators, providing hot-end operators with the information they need to manage the forming process efficiently and minimise the creation of defects.

JLI's latest system is undergoing beta trials at a glassworks in Europe. It uses the backlight concept with high-precision dimensional measurement, defect detection and thickness distribution monitoring. The operator interface, menus and data presentation have been developed in conjunction with hot-end operators to meet their particular needs. Formal market launch for this product is scheduled for Glasstec 2004 in Düsseldorf in November.

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