Hot end tableware inspection innovation

Jørgen Læssøe describes a hot end vision system, developed specifically for the inspection of glass tableware.

Tableware production is a skilled task. At the hot end, massive rotating machines blow and form the glass, mount the stem and burn off the rim, requiring the operators to control hundreds of different settings. Many tools are involved and for each step in the process, numerous adjustments are required. It is no easy matter to gain an overview of production, requiring operators to rely on reports from the cold end to finetune production machinery.

To address this limitation, a vision system has been developed for the hot end, where it is installed at the hot conveyor, just before the lehr.

HOT END INSPECTION
The system receives timing pulses from the burn off and can calculate where each glass passing to the lehr has been made. The system builds up trend graphs, making it possible to obtain an overview of production at a glance. The operators can therefore direct their attention to the tools giving trouble and see the result of their adjustments immediately thereafter. This represents a vast improvement over the subsequent 90 minutes’ annealing time.

The hot end is typically an extremely cramped place, where it is hard to install additional equipment. It is therefore important to keep the footprint down to a minimum. The vision system takes up only 400mm of space along the conveyor and just 1.5m across.

ILLUMINATION PATTERNS
When analysing tableware with a vision system, many different background illuminations are required. These would normally be placed along the conveyor so the tableware can pass several light boxes and cameras. This takes up valuable space, making the solution impractical.

Instead, the system has a dynamic light box. This background illumination is in principle a very powerful LCD monitor. These are not available in the market, so JLI had to build its own backlighting.

When a glass passes between the camera and the light box, patterns of stripes are generated by the vision system. These enhance the different features of the glass. Glass distribution, mould rings, cord, cracks and other surface defects are found. Other illuminated patterns are used for precise dimensional measurements including base and rim thickness and uniformity. JLI can actually measure the dimensions with an accuracy of 0.1mm. Because two cameras are used, it is possible to measure in three dimensions and the glasses do not need to be aligned on the conveyor. In fact, off centre alignments up to +/- 20mm can be accepted.

Each glass is subjected to five different illuminations and 20 analyses are performed by the vision system. Environmental protection is essential. The hot end of a tableware production line is a particularly hot place, so the camera and light box containing the electronics are water-cooled. Powerful fans cool the LCD screen, which is mounted behind specially treated and coated layers of glass protection.

A pusher can be activated and faulty tableware diverted, where it can be examined by the operator. Because it keeps track of the tools used for each glass, the system can be set to reject a glass from a particular tool so the operator can adjust the tool, remove the glass and inspect it.

PRODUCTION SETUP
The system collects data and stores images of the last 50 rejected glasses. This data can be transmitted over the factory network and permits production to be analysed remotely.

During installation and commissioning, JLI software engineers monitor performance and adjust programme parameters. Remote access is essential when...
running a system of this kind, allowing ‘running in’ to be reduced to a few days. And after acceptance, the company continues to follow the system from Denmark, suggesting modifications to the setup and commenting on general system use.

The Hot End Tableware Inspector samples the glasses from one angle only, analysing only half the surface of the glass. Because the glass is formed under rotation, however, faults and misalignments in the tools will also show up when the glass is inspected from a single viewpoint.

The system is a tool used to build up production statistics and generate trends highlighting any drift in the settings of the forming machines. The display can be set to show an overview of the whole production or to follow such specific features as rim quality, base slope, lean, glass distribution and dimensions from selected process tools. Changing the display is realised on a touch screen.

Defective glasses can be rejected to a side conveyor, where the defects can be picked up and studied. Rejection has three levels. It can be set to remove glasses from a specific cavity every time, regardless of inspection. Alternatively, it can be set to reject gross defects only or to reject tableware just outside of tolerance.

The reject device also serves another important function: It removes broken or fallen ware, which can create transfer jams to the lehr.

YIELD IMPROVEMENT
The background to this development is the tableware inspection work performed by JLI vision at the cold end, where multi camera systems can make the final check before packing. These systems also transmit data to the hot end but because of lehr times, it is not possible to offer instant feedback.

Moving inspection to the hot end is an immense improvement. Generating data within one minute reduces waste and reduces the chance of faulty ware reaching the customer. Initial production data shows that the system can improve yield by up to 5% and will give a payback of a few months.

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