From zero defects delivery to zero defects production

According to Paul Schreuders, the application of XPAR Vision's forming process control tools and accurate measurement at the hot end brings dramatic improvements within reach, resulting in reduced variation, sustainable production and perfect containers.

Enormous challenges are faced in the world of glass container production. Customers are demanding more flexibility, higher quality and lower cost. The environment is pressing for lower energy usage, reduced carbon emission and lower raw materials use. Last but not least, competition with other packaging materials is tough. In recent decades and despite its superiority, glass has lost market position to plastics, cans and cartons (figure 1).

The glass container industry's response to these challenges should be a strong focus on 'faster', 'less energy', 'lighter and stronger' and 'more reproducible'.

ZERO DEFECTS DELIVERY

Huge amounts of money are invested to create a high level of quality selection at the cold end to meet the customer expectations of zero defects delivered. Despite these massive investments, every glass container manufacturer still receives complaints from customers.

In the meantime, the average forming process has a poor efficiency and effectiveness. Pack-to-melt is somewhere between 80% and 90%, the weight/volume ratio is too high, the speed of production too low and the resorting level too high. The root cause behind these indicators for poor process performance is the high level of process variation, resulting in a high level of product variation and thus, a lot of waste.

The good thing is that there is enormous room for improvement. Drastically improving the efficiency and effectiveness of the forming process is a necessity for improving competitiveness.

ZERO DEFECTS PRODUCTION

Forming process variation has many underlying causes. In the process from cutting the gob to placing the bottle on the conveyer belt, variations can occur in such 'primary' variables as gob shape, gob temperature, gob weight, gob speed, gob length, gob diameter, gob time of arrival, gob trajectory, temperature blank mould, plunger, neck ring and parison, all having an effect on the glass distribution of the container produced.

In addition to these 'primary' variables, forming process variation is also introduced by such 'secondary' variables as material change, swabbing, job changes and factors like day/night rhythm and the IS machine configuration itself, again having an effect on the glass distribution of the container produced.

To be most effective, the focus should change to zero defects production. This is a necessary precondition for 'faster', 'less energy', 'lighter and stronger' and 'more reproducible'.

Because the amount of variables is huge, reducing process and thus product variation is not easy. Where to start? A focus on zero defect production requires the introduction of measurement systems to the glass forming process. Measuring the 'primary' variables as mentioned previously, including glass distribution and using these measurements replaces opinions with facts and is a big step forward towards reducing forming process variation.

HOT END PLATFORM

Throughout the last 10-15 years, suppliers to the glass container industry have developed and are installing measurement systems to support the focus on zero defects production. Within the same time frame, XPAR Vision from The Netherlands has developed from a developer/supplier of infrared camera systems to a developer/supplier of solutions for hot end inspection and forming process control.

Today, the company's product portfolio consist of the InfraRed Dual camera system (IR-D), Infrared Gob weight Control system (IGC), Gob Assist, Blank side Temperature Control system (BTC) and SQL database (XMIS).

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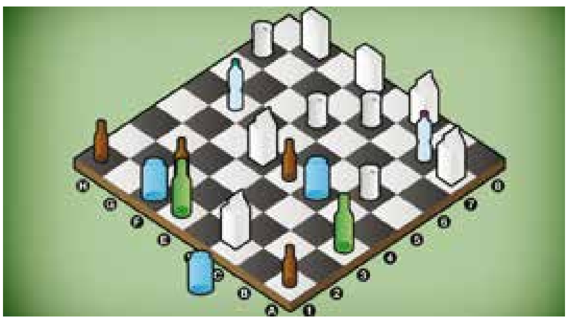

Figure 1: Glass has lost market position.

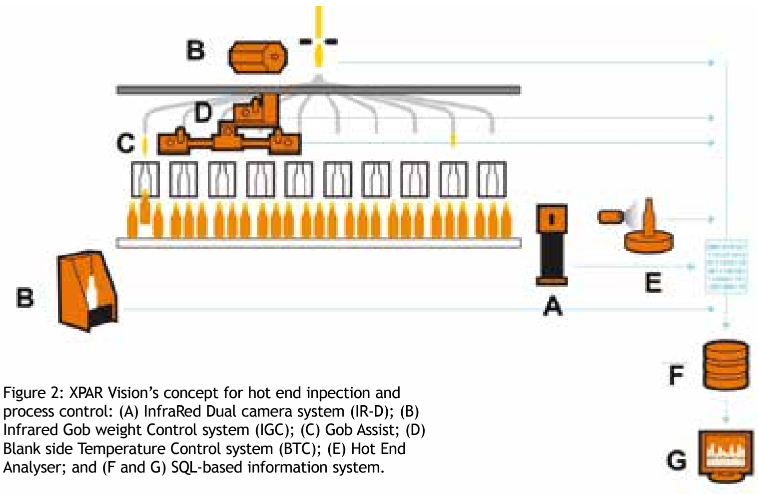

Figure 2: XPAR Vision's concept for hot end inpection and process control: (A) InfraRed Dual camera system (IR-D); (B) Infrared Gob weight Control system (IGC); (C) Gob Assist; (D) Blank side Temperature Control system (BTC); (E) Hot End Analyser; and (F and G) SQL-based information system.


Figure 3: With two cameras positioned at an angle on each side of the conveyor belt directly after the forming machine, a thermal images is made of each passing bottle.

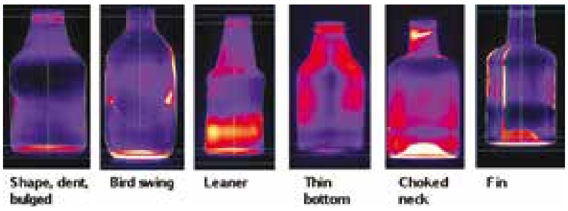

Figure 4: Critical defects are visualised by means of thermal images.

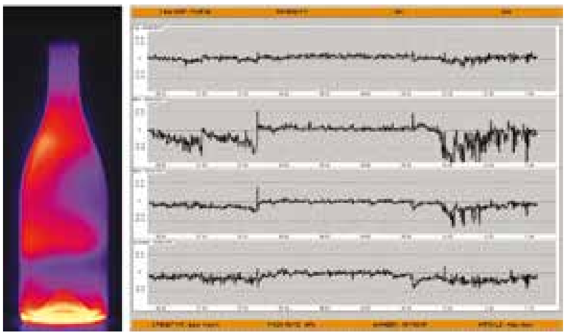
Figure 5: Example of how the forming process is visualised in terms of variations in intensity. The graph represents intensity values of different zones of bottles produced for one hour on one single cavity; the less variation, the less problems, the fewer defects produced.

The IR-D is the basis of the XPAR Vision hot end platform. With the IR-D, glass distribution is measured. Through the factual measurement of glass distribution of all containers produced, all primary and secondary variables mentioned earlier are measured as well. As such, glass distribution is the best indicator for quality of both the forming process and container. Knowing that there are so many variables affecting product and process and understanding that everything relates to glass distribution, measurement of the container is the logical starting point for reducing process and product variation.

With the IGC, Gob Assist and BTC, individual 'primary' variables are measured (and controlled) directly and with the highest level of accuracy.

Combining measurements of all 'primary' variables including glass distribution allows effectively for visualising and analysing the effects of raw materials changes, swabbing, job changes and such factors as day/night rhythm and the IS machine configuration itself. This allows for fast learning and actually improving on these sub-processes and thus on the forming process and the container.

XMIS is a central and open database and is a crucial part of the platform. Measurements are related through the database. Relating measurements is a necessity for being effective in lowering process and product variations. Relating measurements and building up knowledge based on facts is a precondition for automation.

Last but not least, the Hot End analyser allows for dimensional measurement of containers produced. Correlating the measurements of the HE Analyser with the IR-D allows for matching all containers produced with the customer's absolute dimensional requirements.

As shown in figure 2, each of these solutions is put in place along with the IS machine.

INFRARED DUAL CAMERA SOLUTION

Because the IR-D is the basis of the XPAR Vision hot end platform and as the container is the logical starting point for creating a focus on zero defects production and reducing process and product variation, it deserves clear explanation.

The two cameras are positioned at an angle on each side of the conveyor belt, directly after the IS machine (before the coating hood). With the cameras, a thermal image is made from each passing bottle. The thermal image is an accurate representation of glass distribution within the bottle; more red/yellow means more infrared radiation (= more glass), more blue/ dark means less infrared radiation (= less glass) (see figure 3).

Automatically analysing images gives factual information about both the container and forming process. Based on this information, such critical defects as birdswings, freaks, thin bottom/neck/walls, chocked necks, stuck ware, inclusions, shapes, inclusions, verticality and fin are detected and rejected. Examples are shown in figure 4.

Eliminating these critical defects at the hot end ensures a smooth process at the coating hood, annealing lehr and cold end, dramatically increases total inspection performance and reduces breakdowns of cold end equipment. As such, using this solution contributes towards meeting customer expectations for zero defects delivered.

Using this critical defect information allows the hot end operator to inform the cold end operator of any critical defect produced, as such becoming more effective at the cold end and reducing blocked ware and resorting.

Besides visualising critical defects, this infrared information allows for visualising forming process behaviour in terms of variations in intensity, asymmetry, shape, verticality and transport (figure 5). The infrared information represents a fingerprint of the process failure and provides direct information on which process variables have failed (such as thermal condition, human interaction, IS machine etc). Furthermore, with the infrared information being in real-time and cavity-related, it is relatively easy to execute root cause analyses for any detected defect.

With the infrared information, factual inputs for optimising and improving the forming process are available and the result of any interference action is immediately visible.

Experience and continuous customer feedback have shown that the main factors for forming process variation (and the production of critical defects) are (a) variations in gob weight, (b) variations in gob loading and (c) variations in temperature distribution at the blank side. Generally, it is believed that these sub-processes are responsible for 90% of the bad quality of both the forming process and finished product. Therefore, XPAR Vision has developed its hot end platform.

Applying these forming process control tools and accurate measurement at the hot end brings dramatic improvements within reach, resulting in reduced variation, sustainable production and perfect containers, resulting in a much improved competitive position in comparison to other packaging materials (figure 6). ■

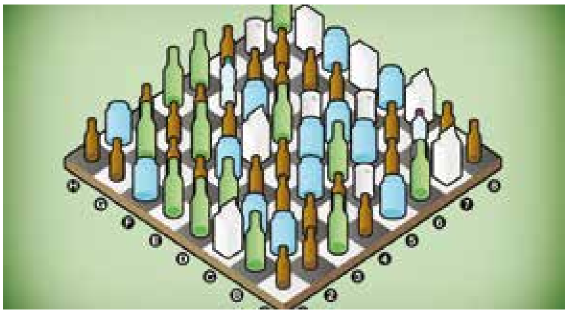
Figure 6: Glass can regain competitiveness.

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