Heading for perfection!

Paul Schreuders describes the pioneering development work of XPAR Vision to create hot end inspection and forming process control solutions for the glass container industry.

For more than a decade, XPAR Vision has served the global glass container industry with hot end equipment for inspection and process monitoring based on infrared technology. Subsequently, the XPAR Vision InfraRed Dual camera solution (IR-D) has rapidly become an industry standard. Experience, continuous customer feedback and the enormous potential for process improvement in the glass container industry are driving XPAR Vision continuously to improve the IR-D and to extent the product range with more solutions for hot end inspection and forming process control.

Today, the XPAR Vision product portfolio comprises the InfraRed Dual camera system (IR-D), Infrared Gob weight Control system (IGC), Gob Assist and SQL-based information system (XMIS). Besides and in order to complete this range, the Blank side Temperature Control system (BTC) and the Hot End Analyser are in development.

Figure 1 illustrates all these solutions in place, along with the IS machine. As will be explained, these solutions form a logical range and are the answer for the industry to further optimise the forming process in terms of quality and efficiency and to produce lighter and stronger containers at higher speed, using less energy, reducing emissions and enhancing the competitiveness of glass against other packaging materials.

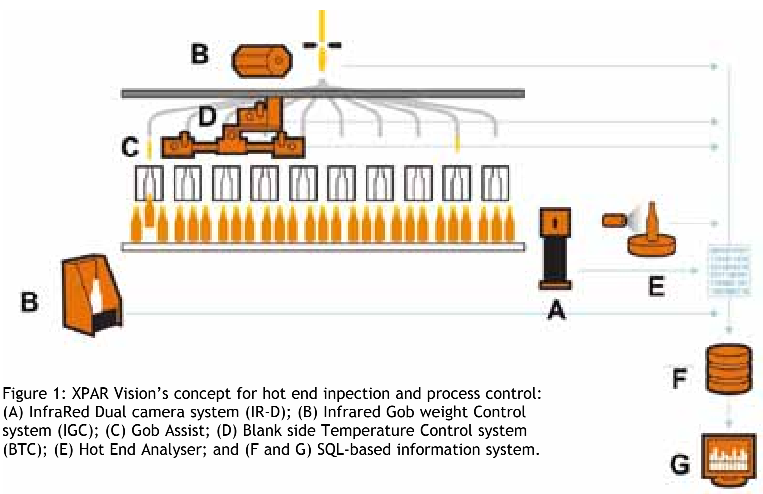


Figure 1: XPAR Vision's concept for hot end inpection and process control: (A) InfraRed Dual camera system (IR-D); (B) Infrared Gob weight Control system (IGC); (C) Gob Assist; (D) Blank side Temperature Control system (BTC); (E) Hot End Analyser; and (F and G) SQL-based information system.

Figure 2: With two cameras positioned at an angle on each side of the conveyor belt directly after the forming machine, a thermal image is made of each passing bottle.

INDUSTRY NEED

Enormous challenges are faced in the world of glass container production. On the one hand, the industry has to deal with increasing customer quality/cost demands while on the other, production efficiency and effectiveness are low and external pressures regarding environmental issues (energy usage, emissions) and alternative packaging solutions are high.

Being more normalised in other industries, the glass container industry is still far away from producing defect-free products. Huge amounts of money are invested to create a high level of quality selection at the cold end in order to meet customer expectations of zero defects delivered. Despite these huge investments, every glass container manufacturer receives complaints from customers.

To achieve long-term sustainability from different perspectives (customer, economic, environment and competition), it is a necessity to focus on zero defects production at the hot end, where the quality is made.

Focussing on zero defects production at the hot end is a challenge in itself. By design, a forming process (IS machine) is not stable; and with bigger IS machines, even more process variation is introduced. The fact that these machines are operated on the basis of experience and that the glassmaking expertise at the management level is not always so high certainly does not help. Instead, it seems that daily operating practice is one of firefighting rather than implementing structured improvements. Focussing on zero defect production at the hot end requires a move from art to science (read data orientation).

The logical range of hot end solutions presented here contributes to the strategy of zero defects at the hot end.

INFRARED DUAL CAMERA

The two cameras are positioned at an angle on each side of the conveyor belt directly after the IS machine, before the coating hood (see figure 2). With these 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).

As can be seen from figure 3, this infrared information allows for the visualisation of critical defects at the hot end.

The latest software version effectively detects (and rejects if required) birdswing, freak, thin bottom / neck/ wall, chocked neck, stuck ware, inclusion, shape, verticality and fin. Once set up has been performed, detection and rejection are automatic. Eliminating these critical defects at the hot end ensures a smooth process at the coating hood, annealing lehr and cold end and dramatically increases the total inspection performance. As such, using this solution contributes towards meeting customer expectations for zero defects delivered. >

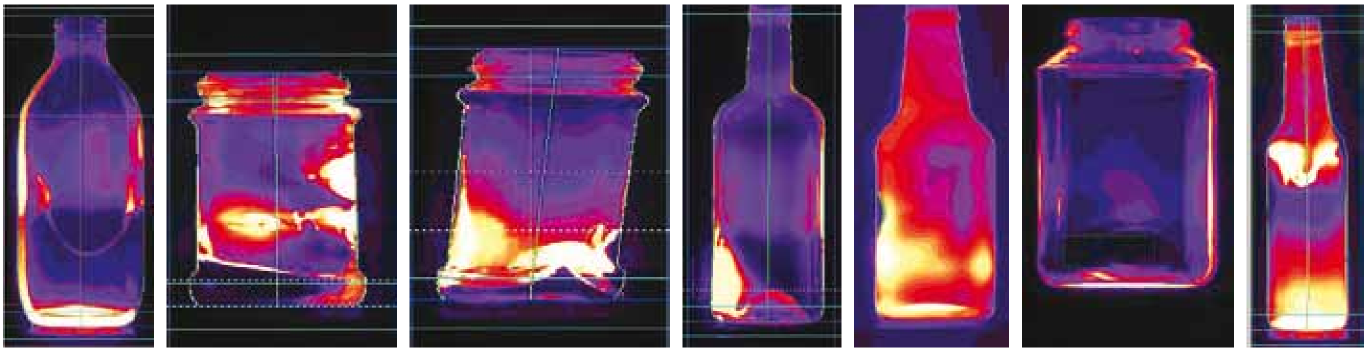


Figure 3: Critical defects are visualised by means of thermal images.

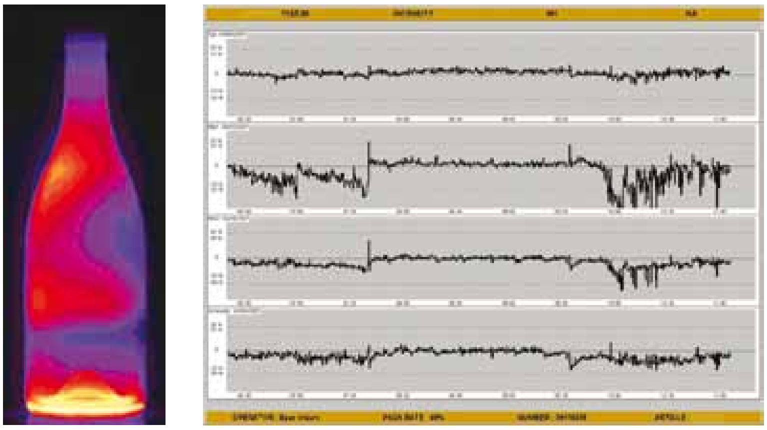


Figure 4: Example of how the forming process is visualised in terms of variations in intensity. The graph represents intensity values of different zones of bottles produced for one hour on one single cavity. The less variation, the less problems, the less defects produced.

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 4). The infrared information represents a fingerprint of the process failure and provides direct information on which process variables have failed (eg thermal condition, human interaction, IS machine etc). Also, with the infrared information being in real-time and cavity-related, it is relatively easy to execute root cause analyses to 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 confirmed that main factors for forming process variation (and the production of critical defects!) are (a) variation in gob weight, (b) variation in gob loading and (c) variation 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 forming process and finished product. To monitor and/or control these sub-processes, specific solutions are at hand/being developed.

Figure 5: With the Gob Assist, images of the gob are made from the moment it leaves the deflector until the moment it has fallen completely into the blank mould.

INFRARED GOB WEIGHT CONTROL

The Infrared Gob weight Control solutions (IGC) monitors the weight of the products and automatically corrects the weight by adjusting the tube height (plunger). The ICG is an add-on to the InfraRed Dual camera solution and as such forms an integrated system.

The intensity of the total amount of emitted infrared light as measured by the InfraRed Dual camera solution is an important factor, as it tells us everything about the mass of the product. In theory, the total intensity has a linear relationship to the total mass. When, for example, the mass of the product rises over time, the measured intensity will also rise. This information forms the input to a control loop, which calculates the ideal position of the tube (plunger) for that moment. The control loop forms a robust and reactive concept that can recognise weight variations of less than 0.5%.

The self-regulating capabilities of the system reduce the operator's workload, while reducing variance in the weight of the individual gobs over time. Low variance in gob weight leads to less glass usage, fewer defects and a more stable production process.

GOB ASSIST SOLUTION

The Gob Assist comprises a camera module with two optical cameras in an angle that glides along a rail system, which is robustly attached to the IS machine and enables the camera module to move to all different sections (figure 5). The cameras take images at a speed of 500 frames per second from the moment the gob leaves the deflector until the gob has fallen completely into the blank mould.

The software then processes this sequence of images in near real-time. The images from both cameras are combined to reconstruct a three-dimensional image of the gob, allowing for measurement of the speed, length, position, shape, orientation, time of arrival and trajectory of the falling gobs. With this information, it is possible easily to find and maintain optimal gob loading and to retrieve optimal gob loading after equipment and/ or job change.

A user-friendly user interface allows the most effective steering on gob loading and thus on reducing process variation due to gob loading considerably (figure 6). The fact that the Gob Assist is not measuring all gobs of all sections in time (remember there is one camera module that moves from section to section) is not a problem; via the infrared dual camera solution, all bottles are measured and bad loading at a certain cavity will be notified immediately. Thereafter, the Gob Assist will be moved to that specific section for remedial action. >

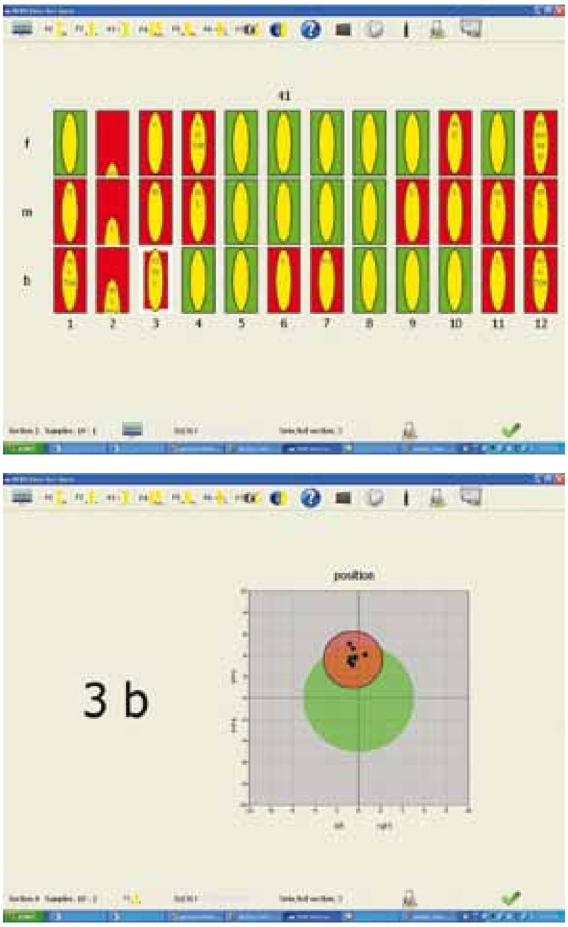


Figure 6: The user interface allows for easy recognition of a problem and easy execution of a remedial action.

BLANK SIDE TEMPERATURE CONTROL

The BTC will be an add-on to the Gob Assist and glides along the same rail system (figure 7). It contains two different temperature sensors and will be able to perform contactless temperature measurement at the blank side.

At the blank side, the gob is transferred into a parison. During this forming process, an amount of heat is extracted from the glass to realise a stable parison with a good temperature profile, which is a precondition for obtaining even glass distribution at the blow side. By measuring the temperature of all components at the blank side (neck ring, plunger, gob, blank halves and parison) the consistency of heat transfer from the glass to the mould components will be shown.

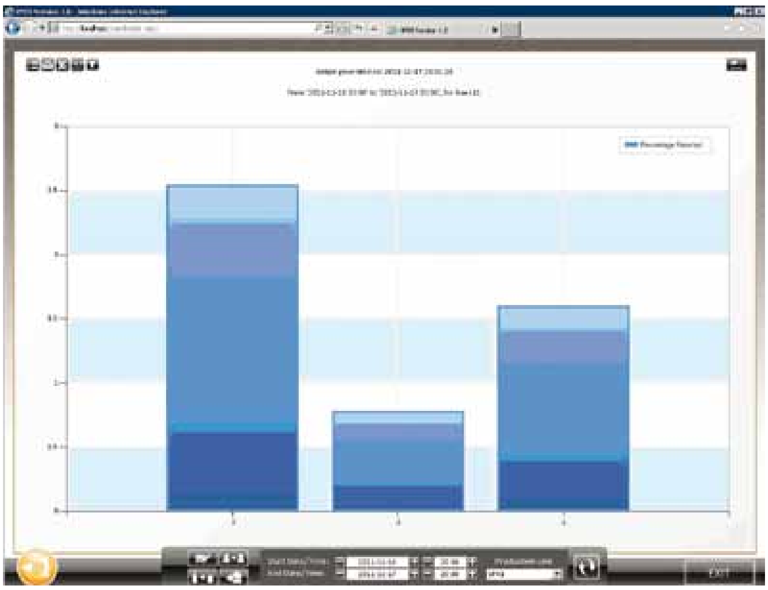
The advantages of the BTC are numerous: Valve problems will be visible; plunger tip problems (spikes) will be spotted; cooling set-up can be evaluated in short time; timing difference will be visible in the temperature profiles; the design of mould components can be tested on efficiency; and determination of ideal working temperatures of components is possible. As such, the BTC will be the source to create a higher level of sustainability of the forming process at the blank.

The IGC, Gob Assist and BTC allow for the most effective handling of forming process variation (and the production of critical defects) due to (a) variation in gob weight, (b) variation in gob loading and (c) variation 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 forming process and finished product.

Applying these solutions in combination with the InfraRed Dual camera solution allows for increasing the level of process control and making a drastic move towards zero defect production at the hot end (heading for perfection!), thus opening the door to getting lighter and stronger containers at a higher speed, as such

Figure 7: The BTC is an add-on to the Gob Assist and glides along the same rail system.

Figure 8A: (Above) gob behaviour is different for all gobs (front, middle, back); (below) gob behaviour relates to defects and rejects.



using less energy, reducing emissions and enhancing competitiveness against other packaging materials.

HOT END ANALYSIS

Customer requirements nowadays go beyond 'zero defects'. In most cases, customers also set the specification for bottles in terms of absolute dimensions for wall thickness. To complete the concept described in this article, a so-called hot end analyser is being developed.

With the Hot End Analyzer, it will be possible to measure absolute wall thickness and dimensions quickly and automatically at the hot end. Initially, this system will be an off-line sampling system. The idea is that measurements from the Hot End Analyzer will be related to the IR-D solution. As such, it will be possible to relate IR-D intensity data to absolute customer requirements like wall thickness. Consequently, it will be possible to monitor every bottle closely, according to absolute customer requirements.

CENTRAL DATA COLLECTION

The logical range of solutions presented here have one thing in common; factual data. Factual data is a must for working on improvements in terms of quality and efficiency consistently. As mentioned earlier, focussing on zero defects production at the hot end requires a move from art to science (read data orientation). Experience might be used but only as an add-on to factual data.

The solutions presented and the data they produce and present can be used independently. However, in order to maximise usage for different purposes, a centralised database has been developed called XMIS.

XMIS allows all process data collected by all different solutions to be stored on a centralised server for longer periods of time. It also provides a web-based user interface to retrieve this data in an intuitive way by generating user-defined graphs and dashboards and pre-defined reports and queries. As such, XMIS enables the user to analyse for critical defects, perform process improvements and perform benchmarking between lines, sections and cavities etc. It also provides access to historical data for traceability in cases of customer reclamations. On top of this, XMIS includes a mail service which can deliver standardised hot end reports on a daily bases.

Needless to say that the main advantage and huge power of the data orientation is the fact that everyone involved in glass forming (operator, specialist, process engineer, maintenance, quality control, management etc) speak exactly the same language. As a result, data analyses are effective and allow for the increased knowhow of glassmaking and step-wise structural improvements. When used, the future of glassmaking will change dramatically.

The three examples shown in figure 8 demonstrate the power of having factual data available. ■■

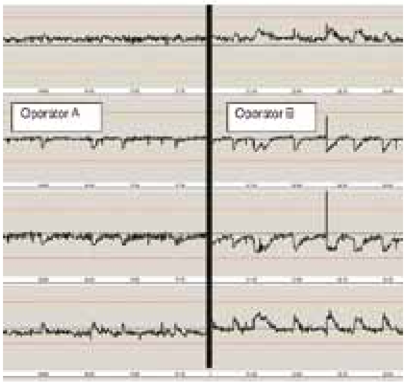


Figure 8B: Swabbing behaviour and thus swabbing performance is different per person; the relevant question and opening towards improvement is 'Why?'

Figure 8C: A standardised report allows everyone to speak the same language which, in turn, makes working on process improvements extremely effective.

ABOUT THE AUTHOR:
Paul Schreuders is CEO of XPAR Vision

FURTHER INFORMATION:
XPAR Vision BV, Groningen, The Netherlands
tel: +31 50 316 2888
email: contact@xparvision.com
web: www.xparvision.com