XPAR VISION

forming process automation for lightweight glass containers

Paul Schreuders, CEO at XPAR Vision, speaks about how the container glass sector needs to make some important changes to its production methods. Working to reduce carbon footprint also involves glass – by recycling of course, but also by reducing its weight in containers.

TODAY'S GLASS CONTAINER INDUSTRY

Today's glass container forming industry clearly shows us the following:

- overall efficiency is too low - 85-90 per cent;
- the overall (quality) feedback loop is at best very slow (cold end and hot end are still acting very independently, where the hot end focus is production and the cold end focus is quality), except for those having hot end infrared camera systems installed;
- health and safety is still an important concern;
- it is becoming more difficult to hire and retain good hot end operators and/or specialists and, therefore, the workforce is ageing;
- hot end forming is highly human-dependent (based on experience and not on fact).
- containers cannot remain competitive as preferred packaging as they are (designed to be) too heavy.

CONTAINERS ARE TOO HEAVY

After research on this topic, it is clear that bottles in general are 40 per cent too heavy because of the relative glass thickness fluctuations horizontally. The actual figure depends on the production process used (blow-blow versus narrow-neck-press-blow), and even on the colour of the bottle (green, amber, flint). It is also important to consider that there are also vertical glass thickness variations.

On average, bottles are at least 50 per cent too heavy and, these bottles are usually designed to be this heavy: This oversizing is performed on purpose to avoid the risk of producing faulty bottles. The same oversizing compensates for the low level of forming process control and is generally accepted by glass container manufacturers and their customers.

Even if glass container manufacturers say that their customers want heavy bottles, we all know that the reason is that food and beverage packing companies want to avoid the risk of break-

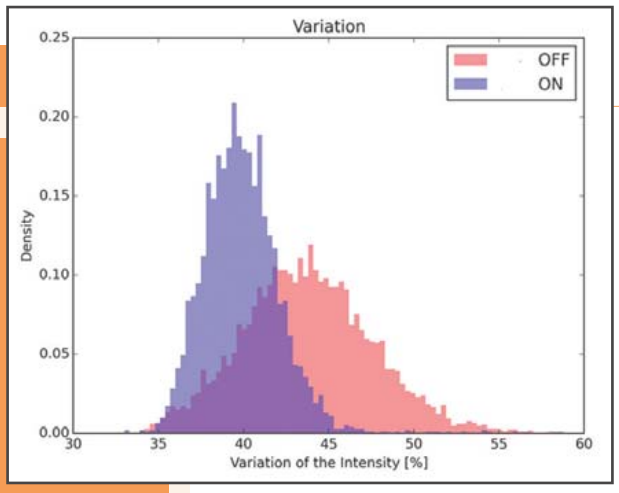
age on their filling lines, which is absolutely logical but different from simply wanting heavy bottles.

LOW FORMING PROCESS CONTROL

The low level of forming process control is caused by a number of process disturbances during container forming and its surroundings. Unpredictable changes in cullet quality, viscosity, temperature, glass homogeneity, ambient temperature, deterioration and wear of material, along with swabbing and/or stop/starts of sections, can have an effect on the glass forming process, making it unstable and the outcome often unpredictable. This, in turn, leads to variations in gob condition (weight, temperature, shape), gob loading (speed, length, time of arrival, position), temperatures (parison, moulds, plunger, neckring) and, consequently, to low efficiency and bottles with variable glass wall thickness and critical defects. Deterioration and wear of material (neckring, deflector, trough, moulds, plunger) is mostly cavity-related, highly unpredictable and cannot be avoided.

Moreover, the industry relies mostly on the experience of operators and/or specialists to observe, analyse and control the process, made ever more difficult due to its complexity, lack of tools, time constraints and last but not least IS machines that have become bigger. And last but not least consider the harsh environmental conditions in which operators must work. Manual processes, such as swabbing, can easily be counter-productive, as it increases process variation instead of reducing it, because every operator swabs differently, with different results.

We need a different approach to improve competitiveness with other packaging materials, as well as giving the industry a truly 'green' image.



The application of hot end sensors and control loops (blue = 'on') leads to more narrow working ranges, more stability and predictability. This results in higher efficiency, less glass wall thickness fluctuations (which allow for reducing weight) and less defects produced

PROCESS STABILITY FOR OPTIMISATION

Dealing effectively with unpredictable changes in cullet quality, viscosity, temperature, glass homogeneity, ambient temperature, deterioration and wear of material and even swabbing and/or stop/start sections are fundamental. Minimising the effect of these changes on gob condition (weight, temperature, shape), gob loading (speed, length, time of arrival, position), temperatures (parison, moulds, plunger, neckring) and, consequently, efficiency and the quality of bottles should be the next step.

Timely and consistent information about gob condition, gob loading, temperatures and the quality of bottles are also important to handle these unpredictable changes.

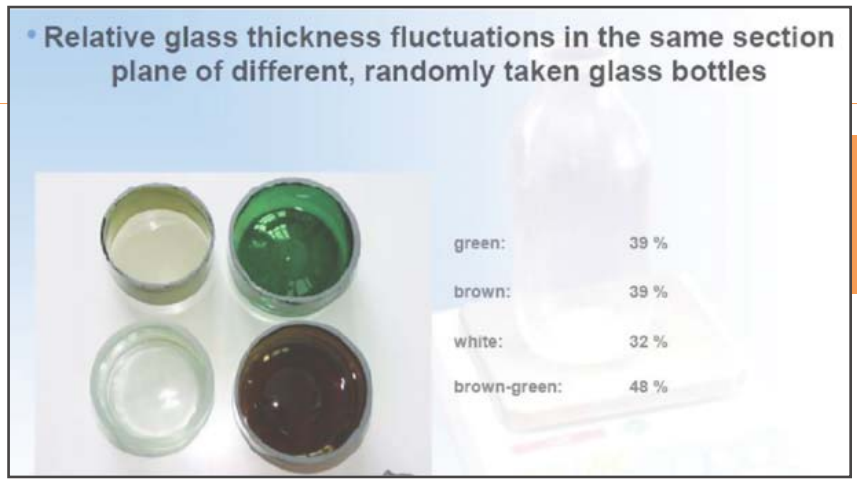
The use of hot-end sensors to monitor and analyse bottle cavity variations, loading variations, temperature variations and forming variations leads to consistent information and observations for all operators. Customer quality improves thanks to the elimination of the critical defects at the hot end. Process deviations (including gob forming and gob loading temperatures) are visible in real-time, thus allowing fast remedial actions, enabling operators and specialists to focus on finding solutions.

Furthermore, production improvements with regard to swabbing, job changes, section stop/starts, gob forming and gob loading lead to improved stability, resulting basically in higher efficiency and fewer defects during production. Once sensors have been applied, process variation is reduced and output becomes more stable and predictable.

Even if these sensors bring considerable benefits, their use is not always easy to organize by even the most strongly motivated management and shop floor operators/specialists. Cavity-related variations especially (deterioration and wear of material, swabbing), also remain difficult to control to the highest level.

AUTOMATION USED FOR PROCESS STABILITY

Automation is needed especially to create the best circumstances for the most effective forming process control. In this context, the sensors observe and analyse and, by means of feedback to the IS timing, necessary adjustments can be made – within milliseconds. These actions are therefore extremely effective in minimising the negative effect of the unpredictable changes in cullet quality, viscosity, temperature, glass homogeneity, ambient temperature, deterioration and wear of material, swabbing and stop/start of



Source: Prof Dr-Ing H Hessenkemper, Glas- und Emailtechnik (TU Bergakademie Freiberg

sections, achieving important benefits.

Over the past five years, (hot end) automated control loops have become available to control gob weight, ware spacing, mould temperature, plunger process and vertical glass distribution, and more control loops will become available in the near future. The same positive effect can be obtained from all different control loops: reduced process variation and more stable and predictable output.

VERTICAL GLASS DISTRIBUTION

Glass distribution within the bottle basically has two angles: horizontal and vertical. Glass distribution can drift over time due to fluctuating ambient temperatures (day and night rhythms) and/or changes in the cooling capacity of IS machines due to weather changes.

Unwanted changes in the forehearth, changes in positions of loading and deterioration and wear of materials are also common causes of changes in glass distribution. Fewer variations in glass distribution mean fewer quality problems related to glass distribution, as there are thick/thin bases, thin spots, thin necks etc. Moreover, the IS machine will run more smoothly, since the number of outliers reduces due to more stable glass distribution.

A well developed and tested control loop works as follows: For every single bottle, vertical glass distribution is measured by means of an infrared camera system at the hot en. Any change in comparison to a defined setpoint (= optimal vertical glass distribution) is compensated for by an automated algorithm. This automated algorithm makes changes in the IS timing for contact and cooling time, as such changing the actual vertical glass distribution back to the setpoint.

Controlling vertical glass distribution achieves stability across all cavities and makes glass distribution independent from ambient temperature fluctuations (day/night) and from feeder (glass) temperature fluctuations, excluding human interaction.

Automatically controlling vertical glass distribution brings the forming process as a whole to a higher level of control. As such, this and also other control loops are key towards the future of operating an IS machine.

Actual changes in vertical glass distribution (blue, red and green lines), without and with automated control (automated control = green area). The variations left are due mainly to manual swabbing

Bottles are 40 per cent too heavy due to the relative glass thickness fluctuations horizontally

THE INDUSTRY CAN (AND MUST) DO BETTER

All food and beverage packing companies are actively working on reducing carbon footprint and packaging is a substantial part of this carbon footprint. This means that glass container manufacturers and their suppliers need to act.

Introducing hot end sensors and automated control loops will enable the industry to make stepwise changes in performance. According to the author of this article, with the right sensors and control loops in place and rightly applied, industry performance in terms of higher efficiency, fewer glass wall thickness fluctuations (which allows for reducing weight) and fewer defects produced can be 25 per cent better or more.

In addition, the glass container industry should make its own plans for COP21 and take its social responsibility. Applying different sensors and loops individually but especially in combination can lead to huge savings. It is therefore possible to produce much lighter and stronger containers with (almost) zero defects at higher speed, with minimal human dependency. ■