Research lays foundation for single-stage forming

A research project undertaken by German mechanical engineers along with Germany's Technical University Bergakademie Freiberg has established the theoretical principles for a single-stage forming process. The principles are hereby presented by Hubert Kischel on behalf of the German Engineering Industry Federation, VDMA.

Today, container glass such as bottles or glass jars for preserves are produced in a two-stage forming process. As part of a research project, the theoretical principles for a single-stage process have now been worked out. This process makes it possible to substantially decrease raw material and energy consumption. Instrumental to this project were German mechanical engineers, as well as the Technical University Bergakademie Freiberg.

"If we want to remain competitive on the packaging market we have to make our glass thinner," says Michael Kellner, who is responsible for product development at Heye International, a company specialised in manufacturing glass production lines. Dr Kellner is well-versed in container glass and, more specifically, the machines required for producing it.

Heye International is part of the Ardagh Group, one of Europe's largest producers of container glass products employing some 6500 staff. In addition to his job as a product developer, Dr Kellner also heads the project 'EinFormGlas' – a research project funded with €2 million from Germany's Federal Government, aimed at developing a single-stage forming process for hollow glass products.

Reducing glass weight

Some 50 - 60% of the costs incurred in hollow glass production are directly related to the weight of glass. It was this key detail that also formed the basic idea for the research project according to

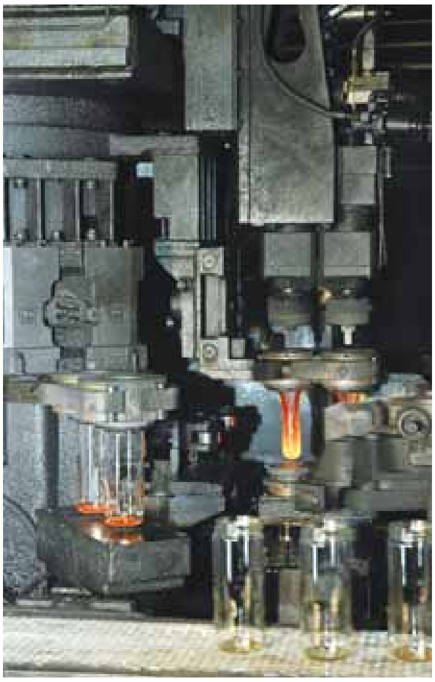

Photo: Heye International.

▲ The picture shows a parison, that, in order to reach its final form, has to be transferred to the mould. On the left hand side and in the foreground ready-blown glasses can be seen.

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Professor Hessenkemper, Chair of Glass and Enamel Technology at Bergakademie Freiberg Hessenkemper, who initiated the EinFormGlas project. "If we want to bring down costs," he says, "we have to reduce the weight and increase the strength of glass."

However, this is only possible on an industrial scale to a very limited extent with the technology currently available. The reason for this is the two-stage forming processes that have been used so far. In the first step of this process, the longitudinal, molten glass drop is formed, either by mechanical or pneumatic means, into a parison, which is then blown into a bottle as a secondary step.

An advantage of this process is that defects in the glass surface caused by the first forming step can be remedied. Since the glass walls are thick enough, they store sufficient heat to melt cracks and scratches, especially on the surface, before the parison is blown into its final shape. However, this only works as long as sufficient hot glass is available inside for re-heating. "If this is no longer the case, we are automatically left with a single-stage process," explains Dr Kellner.

Optimum batch preparation

It is true that a wide variety of glass products are manufactured in a single-stage process. Since the damage does not 'cure' here, the surface strength of these products is far lower than with glass

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made in a two-stage process. One example is incandescent lamps, of which the glass bulbs can quickly break, even with minimal impact.

The project was designed to identify solutions that make the glass tougher overall, specifically while keeping surface damage to a minimum. To this end, says Dr Kellner, it was necessary to put not only the forming step but also the entire glass production process to the test.

It was especially important here to find the most ideal preparation of the batch later molten into glass in the tank. This needs to be as homogenous a mass as possible with an even spread of all components.

In this respect, the quartz sand must ideally be compounded with the soda that acts as a melting accelerator. Furthermore, batch segregation, dust formation and sand accumulation in the tank must all be prevented.

Input from mixing specialist

The machine factory Gustav Eirich, an internationally recognised specialist in mixing technology involved in the project, solved this problem through granulation among other things. "Our new processes," explains Harald Eirich, who is in charge of the company's glass division, "make for significant energy savings in the melting process."

The machine manufacturer ran initial melting trials in its in-house laboratory in order to achieve the best possible batch quality. According to Mr Eirich, the results were "impressive". The engineers wanted to understand the entire manufacturing process in order to introduce the required improvements. This involved "looking beyond one's own backyard" and required some "lateral thinking".

Mr Eirich is unable and unwilling to give precise figures since processes are too complex "and not really calculable as yet." Concrete data still has to be established as part of the industrial manufacturing process.

The German Engineering Industry Federation (VDMA), of which several member companies are involved in this research, explicitly welcomes the project. Timo Feuerbach, VDMA Officer also responsible for the glass machinery association, said: "This kind of research contributes to further consolidating and expanding the outstanding international position of German glass machinery manufacturers."

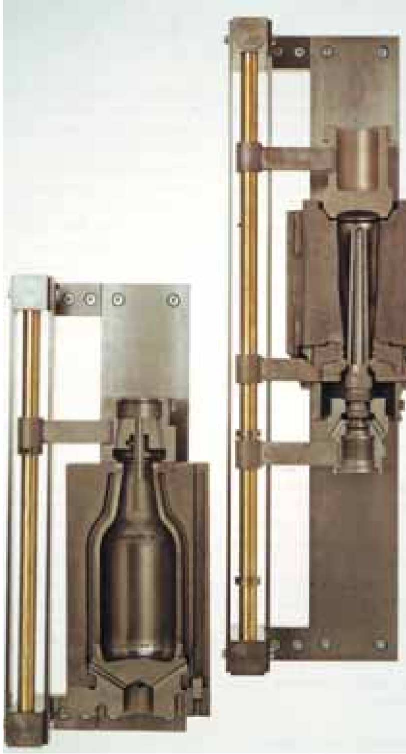

Photo: Heye International.

▲ A set of moulds for narrow-neck extrusion-blow-technology: On the right-hand side there is a pre-mould with the extrusion die, where the parison is made out of the drop; on the left-hand side there is a mould into which the molten glass is blown to obtain its final shape.

Asymmetries must be avoided

In addition to proper batch preparation, another key task was to post-treat the molten glass drops as a way to avoid adverse asymmetries, as these have a negative impact on quality. This issue was tackled by supplier Waltec Maschinenbau, Professor Hessenkemper confirms.

The prerequisite for precise forming in this case was a homogeneous temperature situation within the drop, he confirms, adding that this was the only way to avoid fluctuations in glass wall thickness, which today stand at between 30 and 50%.

The key to the project overall, however, is an aluminium-based lubricant invented by Professor Hessenkemper himself. It is applied as a 'wash' to the inside of the moulds into which the molten glass is blown to obtain its final shape. As soon as the glass comes into contact with the lubricant its surface is enhanced.

According to Professor Hessenkemper, this stage in the process increases bursting pressure resistance by approximately 50% and doubles chemical resistance.

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The aim: A modular system

Still missing is a moulding/forming machine appropriate for putting the single-stage process into practice. This will probably take another five to 10 years, admits Dr Kellner, who adds that the theoretical foundations for the complete process have now been laid.

Developing the necessary processes and machinery would require some more time, though. In Dr Kellner's view, success here will be determined by the way these new technologies are introduced to the market. The aim should be a modular kit with individual modules that can be integrated into existing production lines without major expense. At present, wall thicknesses of 1.1 millimetres are state-of-the-art, explains Dr Kellner. "Initially," he says, "we want to come down to 0.7 to 0.8mm."

The lubricant invented by Professor Hessenkemper is now available on the market. It can be used not only for the surface treatment of container glass but – when suitably modified – also for producing flat glass.

Great promise

There is already high demand from this sector, particularly from the solar systems industry. However, the introduction of the single-stage forming process on an industrial scale promises to provide even greater savings potential than this lubricant. "Overall," says Professor Hessenkemper, "an extra 15% return on investment is certainly possible here." ■

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