Tableware processing

Werner Paszukiewicz* discusses hot versus cold laser cutting for tableware, and a range of technology dedicated to helping glassmakers achieve the best results on rim edges.

In 2000, rather than take inspiration from flame cut-off technology, Biebuyck approached laser hot cutting technology from the point of view of an extension of the cold cut, which is traditionally superior.

Hot cutting

Ten years ago, after feasibility research and before the launch of a prototype, the majority of the acquired data concerning the laser, such as the precision of positioning, environment for the operator, efficiency, and geometrical tolerances, were understood thanks to the accumulated experience of laser applications in the tableware industry since 1996.

After carrying out thousands of tests on the experimental station, it became clear that hot laser cutting was an economically preferable alternative to cold laser cutting, but did not rival it in terms of the quality of the edge or productivity.

On the experimental station we built in 2001 for hot laser cutting, we obtained lab results close to the cold cutting. However, we knew that the conditions applied on glasses in a laboratory, which could be selected and treated in an individual way, were far from the industrial conditions when considering the standards of the forming machines and the oily and dusty environment of the hot end of glass factories.

Consequently, we had to indicate to potential buyers the definition of the edge which would be obtained, as well as the geometrical and maintenance requirements.

There is no doubt that this hot laser technique was the logical result of our policy to find successful and economic solutions, without forgetting the performance demands of equipment supplied worldwide.

The edge

Four types of tableware rim are now globally established.

The Burn-off rim

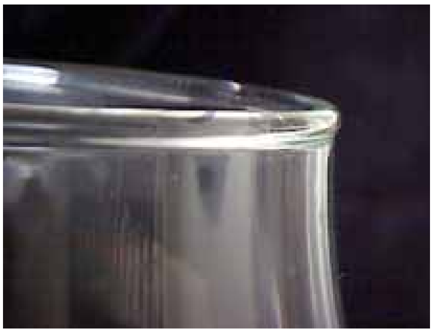

Fig 1 - Typical burn-off rim

Burn-off cutting creates the fusion of the edge by means of an annular burner, with the glass item being suspended downward. This technique creates an edge with a fairly prominent roll, or so called bead (fig 1).

The efficiency depends on the performance of the forming machines upstream, and on the quality accepted by the market. The issues are often the symmetry, the size of the bead and the presence (or not) of a so-called tear drop (fig 2).

Whether or not this technology is chosen is dictated by the level of investment and the segment of the chosen market.

The pulled rim

A variant of the burn-off, the pulled rim is used in some cases to reduce the size of the bead. Again, this process can be heavily affected by the overall efficiency. During separation from the parison, the moil is taken in sustenance but not maintained.

This cutting is not realised in an individual way for each article, so the approach towards a thin edge affects the efficiency.

The Federal rim

In this less wide-spread version (fig 3) the glasses, which are placed on the foot, move in front of a series of burners. A

Fig 2 - Tear drop of a burn-off rim

Fig 3 - Federal style but laser cold cut with direct fire polishing

Fig 4 - Biebuyck laser Generation 2 cold cutting

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cold pin touching the heated area causes the separation of the moil, but not in a well guided way.

The edge is then directly fire polished, giving a beaded rim which is more or less prominent depending on the intensity of the burners.

Here again the glasses are processed in mass without any attention to their single forming tolerances.

The cold cut rim

This technique differs from the burn-off cutting due to a better individualisation of glasses (figs 4, 5 & 6). The separation of the moil and the finishing of the edge are not combined, but are carried out sequentially in different specific operations which are optimised independently.

The scribing, whether made by a scribing wheel or made by the laser (generation 2), defines the exact place of separation of the moil perfectly parallel to the foot. The processing by the diamond tools gives a perfect geometry and a remarkable flatness to the edge.

Using the laser generation 2 instead of mechanical scribing gives the advantages of a constant digital system independent from the human error factor, and allows the high efficiency processing of sophisticated designs such as cocktail glasses.

The high flexibility of the cold cutting production lines type S2/S3 with G2 lasers allows for the processing of the most common tableware shapes.

Even complex items can be processed with symmetrical high quality edges, with the most demanding customers requiring a bevelled fire polished edge or a regular rounded edge for higher production volumes.

Laser hot cutting

Our first trials of moil cutting with laser in the hot-end were carried out in 2000, in cooperation with Zwiesel Kristall (ZKG) in Germany.

The methodology of laser hot cutting was established after hundreds of trial-and-error tests in the laboratory, and was applied in an industrial way in 2004 by ZKG.

After positive feedback from the market, the key points applied in this technique on blow-blow glasses were then extrapolated for the hot cutting of glasses with thicknesses such as those produced with press-blow machines.

Today we consider this technique to be well established, with stable results that match the market requirement.

Fig 5 - Regular cold cut edge.

Fig 6 - High end cold cut glass showing accurate bevel.

Fig 7 - Vase with polished rim.

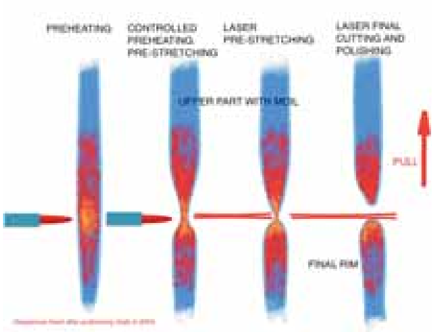

Fig 8 - The 'modus operandi' of hot laser cutting, applied to all the machines in production today.

Several Delac hot cutting units have been in operation for years in famous glassworks.

While having obtained relatively good results in the hot cutting of articles with big diameters such as vases, we did not place this as a priority in our development as the quality of the edge obtained was not able to compete with a cold cut and mechanically polished edge, (fig 7).

Modus operandi

The 'modus operandi' of hot laser cutting, determined in 2001 and applied to all the machines in production today, is described below (fig 8).

The glass position on its foot was an unavoidable choice, as it ensures the absence of bloom condensation in the gob. The risk of fragments of glass in the gob is extremely limited, and generally results from bad formation of the moil.

This position also allows the gripping, stabilisation and controlled separation of the moil. The accurate gripping and stabilisation mechanics being on the top require less maintenance than when placed at the bottom.

The bottom part of the cutting machine is also well protected from both cullet and dust resulting from eventual broken glass from upstream processing.

The glass is brought to the machine in variable temperatures according to its shape and weight. The path has to be as short as possible to avoid the appearance of uncontrollable thermal stresses. It can be compensated by a small stabilisation lehr that can be delivered with the machine.

A sequence of preheats brings the cutting place to a temperature close to the transformation temperature. At the last station upstream of the laser position, the controlled motion of each burner individually harmonises the temperature of the cutting area according to the variations of the wall thicknesses from one article to another.

The processing temperature is given as data from the glassmaker according to the composition of the glass, and then adapted and optimised to become the instruction memorised by the system. Each item is thus individualised.

The position of the glass on its foot allows the equipment to precisely grip the moil of each article. The holding is done in a way that obtains the best axial separation and reduces the side offsets

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which would result from a lack of precision.

The vertical motion of each upper head is exactly guided and the pulling force is servo controlled. This allows the option for an adapted mode of pulling to obtain a controlled thinning down, a sort of stretching, of the wall at the place to be cut.

Each article is optimally maintained and individually processed to compensate the blowing geometrical variations.

This preliminary stretching sequence before the laser cutting can be selected or not depending on the nature of the edge or the type of item. In some cases it allows the preforming of the cutting edge, creating a necked region which will then be completed by the laser beam.

The cut is then achieved by a laser beam in a programmable sequence which controls the laser power used during the process, as well as the beam shape, its position and its intensity. Each successive phase of processing is also customisable in terms of time or in relation to the position of the upper head during the pulling sequence.

The 'cut' sequence ends with the separation of the moil individually from each article. This sequence is variable according to the geometrical data of those in the frame of the cycle.

The question of implementing multiple successive beams was raised in the early stages of our development, but was quickly eliminated due to the complexity of keeping the precise positioning of each beam in relation to each other; the complexity of maintenance; for safety reasons due to the beam direction; and to avoid the installation of laser resonators directly in the processing environment.

Our lasers are deported and installed in a cell separated from the operational cutting area of the machine. This configuration is also much more favourable in respect to safety standards, maintenance, and for ease of adjustment.

The optics are installed in a pressurised box on a robust structure.

A phase of edge polishing with the laser can be selected with the downstream burners if necessary. In most cases, this stage is not required.

Industrial application

It is indisputable that it is advantageous to install the rim processing before the lehr. But it remains a challenge for glassworkers to present to the market an edge that is rounded differently to a burn-off rim but not comparable to a cold cut edge with bevels, and to concentrate on a more rigorous forming of articles.

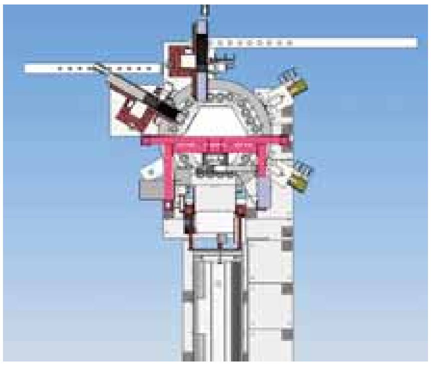

Fig 9 - D4-24T04 single.

Fig 10 - Delac 16T04 Twin version.

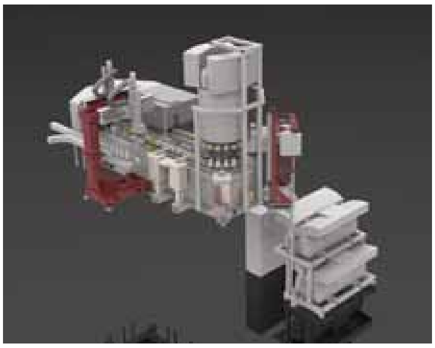

Fig 11a - Delac 57T16.

Fig 11b - Delac 57T16.

It is utopian to believe that this technique is as versatile as the cold cutting. The geometrical variations and the irregularity of the blowing, and the possible imprecision of the forming machine are a few of the factors which influence the efficiency and result on the quality.

Having surpassed the possible obstacles above, the glassworker will find a compatible and well established range of machines dedicated to blow/blow and press/blow glasses.

The configuration will vary, naturally, according to the speed of the blowing machine upstream.

Beyond the process, the handlings are also optimised by trying to follow the well-known rule in the glass industry that each handling is a potential vector breakage.

The programme divides into two groups. The first type, are machines with a turning table (figs 9 & 10) and linear chain transfer machines (fig 11a & b, for example) designed for higher speeds and/or for additional systems or process integration.

The first machine with a turning table was installed in 2004 at Schott Zwiesel.

The second, more compact, version adapted to a speed of production of 28pcs/min was installed at Rona in 2007. This version already integrated many innovations, and shows an original lay-out that certainly inspired some other suppliers.

A wide range of Delac generation 3 laser cutting machines is now available, covering a speed of 20 to 60 pieces per minute.

All the machines are driven by powerful torque motors with a regulated transfer cycle, so as to transfer articles with a thin leg in the optimal conditions and with the least possible distortions.

The configuration also allows the user to complete the operation of moil cutting by additional operations such as the marking or the quality control. ■

Contact
***Sales Director, Biebuyck, Belgium**
http://www.biebuyck.com