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glass SERVICE NEWS

How will the glass industry evolve?

"Staying up to date on technologies and industry news is the first step to **becoming successful in today's market"**.

N.1 YEAR 2021
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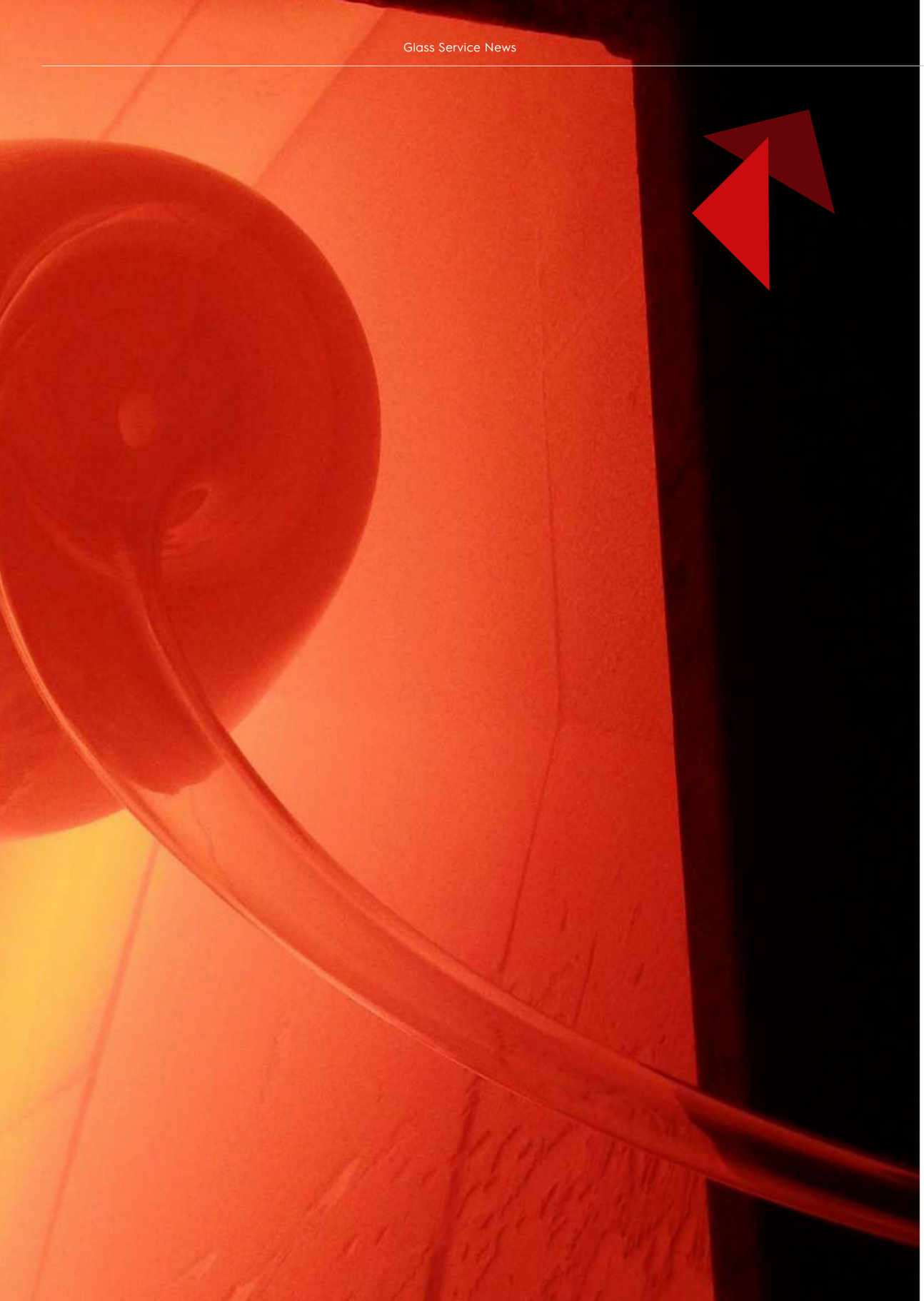


Glass Service News

Editorial

How will the glass industry evolve?

by Fulvio Puccioni
CEO Glass Service

Staying up to date on technologies and industry news is the first step to **becoming successful in today's market**.

Yet, we all know that it is not that easy for an entrepreneur or a professional to stay up to date. After hours of work every day, they lack the resources and enthusiasm to find and collect all useful communications. **Also, the information sought is not always usable or available to everyone because the glass industry is a somewhat "niche" sector**. It is not easy to find data on how competitors move in other countries, look at the innovations proposed at sector fairs, surf the internet in search of driving stimuli. Nevertheless, without knowing all this, there is a long-term risk of offering stale and obsolete solutions to those who turn to you, thus driving away potential buyers looking for fresh innovations and more cutting-edge partners.

Reflecting on these needs, we wondered how we could help our customers more. Collecting ideas with our team, we have assessed that those who know us know what our added value is, our customers know that we are always available to share all the experience we have and we are always ready to solve any problems, thanks to our efficient **after-sales support**. But how can we do more? How to guide them in the choice of anything related to glass and furnaces before any purchase or choice?

This was a turning point for us: w**e decided to renew** our communications and do everything possible to become a point of reference when it comes to facilities with furnaces for glass processing.

This is where the idea started: the "**Glass Service News**" magazine. A semi-annual resource, easy to read, convenient to keep at hand and that keeps you up to date on the news of the glass production industry. A tool with which to **share our knowledge** and increase awareness of how the sector is evolving and of the innovations that will follow in the coming years.

This magazine is just **one piece of our new communication plan**, but it is a really important starting point because it will help us create a **network where information can be shared between people from all over the world**. We will not only talk about news in the glass industry, but there will also be articles dedicated to solving technical problems, how to optimize a production line, tips on how to contain costs and much more. In each edition you will also find a case history, in the form of an exclusive interview, dedicated to those who work in this world, and face everyday challenges like you do.

I can assure you that with Glass Service News you will have **a real manual full of news and valuable information** in your hands, which will help distinguish your company and keep it always on the wave of success.

Happy reading.

Residence Time Distribution Curve analysis and interpretation.

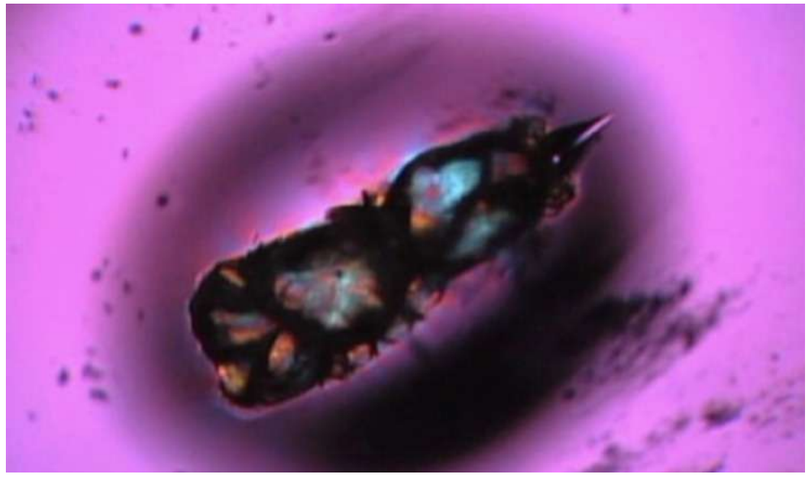
Article by Oliver Bellina

Independently of the type of glass we are going to produce, or which kind of furnace we are going to install, the final quality of our glassware product might be rejected due to dimensional instability or cosmetical defects, which are both linked to the quality of the glass melt in terms of physical and chemical homogeneity, thermal stability, aging of contact glass refractories and turnover time of the melt inside the refractory tank (furnace).

Temperature profile is brought under control by continuous monitoring with strategically placed thermocouples at precise spots along the furnace and distributors. Also the pull rate is continuously monitored, directly and indirectly by the production ratio, but concerning turnover inside the furnace, homogeneity of the melt and how it is distributed from the loader to the throat, and if some stagnant zones or short circuits have been created not any additional info are available or linked to continuous check.

Glass Service News

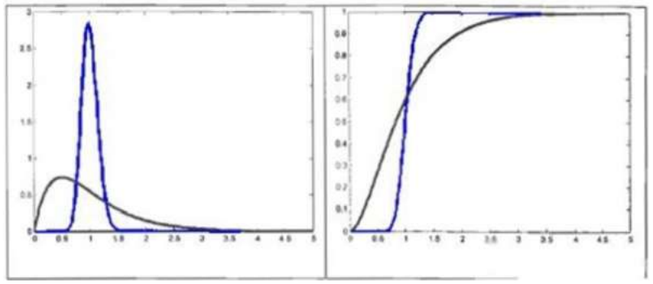
A powerful tool to monitor the "health" of glass melt and the furnace, and to prevent unwanted effects on the quality of the final glassware product.



Even combining temperature profile and pull rate parameters together with chemical analysis of the glass, would not be enough to ensure the quality of our glassware product in the majority of the situations.

A powerful tool, called the "Residence Time Distribution Curve" can be used to evaluate the behavior of the glass melt in the furnace (related to furnace type, shape, aging, profile).

As the name states, a **Residence Time Distribution Curve (RTDC)** is a curve which traces a concentration of a certain element **(tracing agent)** in a series of glass samples collected throughout the process (generally cold end samples).



On the left RTDC piston flow (blue) and mixed (black). On the right Transiction Function.

First of all, it is important to create a RTDC using a suitable tracing agent (Ta) to add to the molten glass. As a Ta, it is preferable to use a chemical element that does not compromise the batch pack, and in a correct quantity to be detectable while not affecting glass properties, avoiding:

- Modification in flux inside the furnaces,
- Problems in forming zone,
- Variation of typical characteristics of the final product (transition metals are to be avoided due to colouring properties, even in low concentrations; in addition, Iron is usually already present around 100 – 150 ppm as baseline,

Another plus would be if the relative raw materials available were as simple as possible (oxides being the best choice).

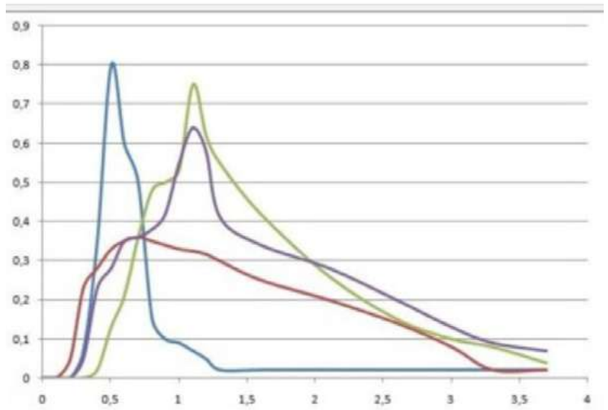
Depending on detection methods, it is possible to use alkali or earth or metallic oxides such as Sr2O, ZnO, MgO (when not used as a modifier or where Dolomite is not a batch component) or SnO2; all of them are relatively cheap, easily melted, do not change glass colour, are easily detectable by chemical analysis and do not contribute to variations in glass properties in the quantities needed.
ZrO2 is not a good choice because it is hard to melt and could give inclusions revealed as defects in the cold end and then be rejected; and secondarily because it is the main component of contact glass refractories, so it would not

be effective as a Ta. A good choice is CeO2 as it shows an intense fluorescence activity in glass placed under a special lamp, which helps to quickly obtain an RTDC. Regarding best practices for obtaining a valuable RTDC, first consider the detection limits of available analytical techniques and then the total quantity of the molten glass bath; a generally acceptable stating point is 10 kg of oxide / 100 tons of melt that correspond to 100 ppm (part per million) if the total melt is immediately conditioned by the total Ta.

Ta has to be introduced directly in the loader while it is as empty as possible just to prevent unwanted dilution and/or delay. After the introduction of a Ta into the loader, it is then necessary to start collecting samples from the cold end following a scheduled plan, labeling each sample with the date, time and line. Frequency of sampling is not fixed but instead is decided based on experience (low frequency until the first showing, high frequency until the peak, then low frequency is once again possible); the same applies to the total time of RTDC, even if it is always good choice to do at least 3 turnover times (depending on total molten glass and pull rate). Each of those factors could affect the resolution of the RTDC and of course, the depth of possible analysis and the reliability of results. Clearly, the pull rate should remain as stable as possible for the entire duration of the RTDC test.

One last piece of advice is related to the cullet: for the entire duration of the RTDC test, it is imperative to not reuse the cold end cullet. This will prevent cross contamination and confusing results. In theory it is also possible to use a combination of Ta, (two is more common) especially when there is more than one loader, to trace different loading zones flux and effects.

Once we have obtained RTDC it is necessary to analyze and “translate” the results to uncover all available data. A typical RTDC has the following shape:



The shape of a curve immediately gives information about the molten glass mixing grade: piston flow shaped curve (blue curve in figure) is typical for an unmixed process (quantic flow) where the packet of batch and the glass flows along the tank without mixing. The shape associated with a well-mixed process is instead a broadly shaped curve (red curve in figure), in this case the relative concentration of **Ta** is lower and also the peak is less pronounced, this is due to the mixing process (convective backflow, etc.) that promotes the conditioning of the entire molten bath.

The two main parameters to best interpret the **RTDC** are:

- the timing of the first appearance of **Ta**, referred to as **First Show or Minimum RT**
- the timing of the appearance of the maximum concentration of **Ta**, referred to as **Peak or Maximum RT**

The relative position of these two data points, compared throughout the process, could give the initial qualitative information regarding furnace mixing process and flows. Going deeper into the analysis, it is important to consider other factors such as:

- **Normalized time**. To have a repeatable and comparable RTDC, time has to be normalized taking into consideration the geometrical resident time or turnover time (τ) obtained by considering the total amount of molten glass in the tank and the pull rate. For example, (100 tons of melt) divided by (2 tons/h of pull rate) is equal to τ = 50 h. By converting time into % of τ, it is possible to discover much more information from our RTDC; like, for example, a preferential track in the tank, some stagnant zones, more flows (more spikes) and also if the real process is a combination of flows (piston + mixed) and if so, to what ratio.

- **FWHM (Full Wide at Half Maximum)**. The final suggested parameter is not a common one, but it is based on my experience and I have verified how it might be very useful. The above mentioned FWHM is a typical parameter used in spectroscopy or Physics and Chemistry to evaluate a peak or a “spike” in optical or electronic analysis, and gives information on the shape of the spike and consequently on the “resolution” of the signal. This number is obtained by marking two points at approximately half the height of the curve (spike) and measuring the time delta between them. The benefits of applying this concept to **RTDC** include an excellent evaluation of what happens before the Peak (with First Show mainly) and also after the appearance of the maximum concentration of **Ta**. This parameter can give a Technologist all relevant information regarding why the eventual spike is thin and resolute (piston flow ideal) or if the peak is broad and the magnitude of this effect. It is also possible to better understand preferential tracks associated with stagnant zones, mixing grade, delay, or some unwanted cross contamination.

In effect, the process to obtain **RTDC** is a sort of Chromatography, where stationary phase and mobile phase are both in the form of molten glass. **Ta** is the component that is carried by the mobile phase into the stationary one. The interactions and mixture between **Ta** and glass determines the shape of **RTDC**. In much the same way that chemical affinity between component and stationary phase in Chromatography defines the detection time and peak (spike) shape: in **RTDC** *affinity* is replaced with *mixing* grade and is strictly correlated to melting process, technical parameters and furnace situation (design and aging).

How tubular glass manufacturing processes can affect the final product stability and technological improvement to mitigate it. Al – Epinephrine interaction: a related example.

Article by Oliver Bellina

Al2O3 is one of the primary constituents of Type I glass, commonly used in pharmaceutical glass container manufacturing. The presence of Al2O3 in the glass formulation has a double impact: as a glass network former (together with SiO2 is a part of "refractory constituents") and as a network stabilizer giving to Al2O3 containing glass a higher chemical resistance lowering the alkaline release.

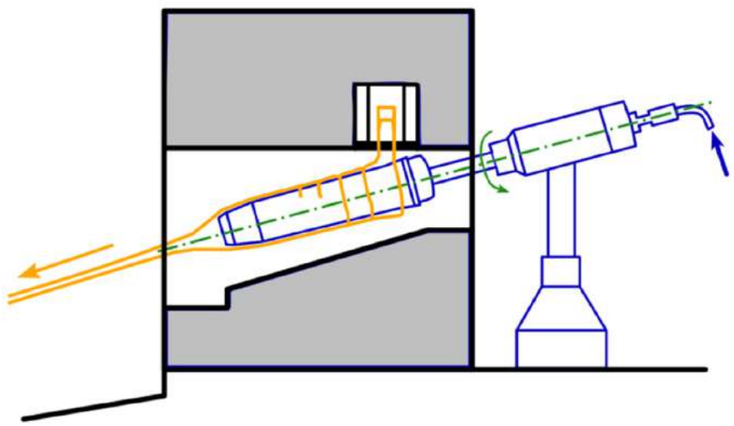
Clearly Al2O3 is a necessary constituent in Alumino-Borosilicate glass, and as Biavati et al.[1] showed, Type I glass may produce a sensible release of Al ions in specific conditions.

One interesting API is the Epinephrine / Adrenaline commonly used in combination with Lidocaine in dental anesthetics. Studies on factors that could affect the degradation of Epinephrine stored in glass containers do not give relevant results regarding the role of Al (III) released from the inner surface of glass containers[2][3], but periodical checks of control samples in storage showed that Epinephrine effects had been strongly reduced after only a few months, with as little as 0,5 ppm of Al in the solution: the result is a marked reduction of anesthetic shelf life (around 1/3) linked to high costs and loss of market appeal.

There are factors that can mitigate glass chemical release and Al as well, such as a correct forming/converting process of the glass and the washing of the container before filling.

As far as Al release from converted tubular glass containers is concerned, it has been found that one of the crucial parameters not usually considered, is the tubular glass manufacturing process and consequently, the materials the molten glass came in contact with.

In the Danner process, the tubing form is obtained rolling a glass flow on a rotating sleeve generally made of refractory materials such as ones with a high Zirconia and/or high Alumina content.



The more advanced technologies improved the production process in terms of glass quality by using a surface coated sleeve (metalized with Noble metals). Comparing different tubular glass containers obtained in different ways, a model based on Thin film Theory has been hypothesized and then confirmed by experimental data, to explain differences in terms of Al release between coated and uncoated refractory sleeves used.

In particular, the experimental data collected showed that during glass tubing production, it is reasonable to presume a thin film formation at the interface between the molten glass that flows over and the refractory sleeve that is rotating underneath (SEM analysis of glass/sleeve interface and EDS analysis of refractory section at various distance from interface shown a distance based Al concentration gradient).

This thin film is constituted by a Na and Al enriched glass. Na moving from the glass where is the more mobile ion which occupy the glass network free spaces, Al moving from sleeve surface. The driving force, in both cases, is associated with a concentration gradient (Fick Law).

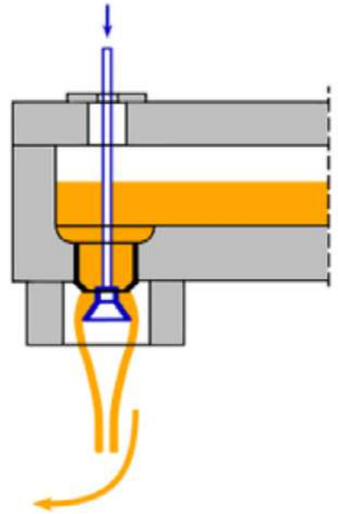
Considering the common Type I glass and refractories composition (Al_2O_3 content is around 5-7% in the glass and up to 60% in High Al content refractories), it appears clear how the Al migration could create a time based porosity of the sleeve surface that increases the aggression rate. The Alumina, migrated from refractory to the glass, tends to occupy the free space present in the structure (considering the relative low viscosity of the glass at the forming point $\approx 10^4$ poise), instead of linking with an existing network[4]. The result is the formation of a thin glass film enriched in very mobile Na and Al that slide on the sleeve, that concur to create the inner surface of glass tubing and consequently of the glass container in contact with the contained solution.

Glass tubing produced this way shows a higher Na release and, in time, Al release.

The implementation of a metal (noble) coated sleeve technology, is effective not only in terms of Na release (strongly demonstrated by experience) but also concerning Al release, avoiding the formation of the above mentioned contact between glass and refractory and the Al migration at interface.

Comparison tests, made on tubing glass containers obtained with coated sleeves, showed a reduction close to 90%, in terms of Al release.

By the abovementioned consideration, it is reasonable to expect that the Glass Tubing production technology commonly known as “Vello”, based on static metallic (metalized) sleeve (no refractory/glass interface at the inner tube surface formation), can give the best performance in terms of Al release and containers obtained from above mentioned tubes could guarantee a long term stability of contained Epinephrine.



(1) Alberto Biavati; Paolo Amadei – “Significance of Aluminium Release from Type I Borosilicate Glass Containers” – Pharmind 2010.pdf

(2) David Stepensky; Michael Chorny; Ziad Dabour; Ilana Schumacher – “Long-term Stability Study of L-Adrenaline Injections: Kinetics of Sulphonation and Racemization Pathways of Drugs Degradation.pdf”

(3) O’Conceanainn M; Hines MJ – “The kinetics and mechanism of the reactions of aluminium (III) with gallic acid, gallic acid methyl ester and adrenaline” – J Inorg Biochem, 2001 Mar; 84 (1-2) : 1-12

(4) Balconi “Esperienze di attacco sui silicati di alluminio” – Rend. Soc. Min. It. – vol.1, pag. 236

Glass Service News

Determining Al release from dental cartridges and glass tubing. An effective and convenient tool to discriminate among diverse glass tubing manufacturing processes.

Article by Oliver Bellina

As described in the previous article titled, “How tubular glass manufacturing process can affect the final product stability and technological improvement to mitigate it. Al – Epinephrine interaction: a related example,” the Aluminum release from inner surfaces of glass containers becomes a key factor when the shelf life (or activity) of the contained API results to be highly sensitive to Aluminum concentration, and in many cases, the release of this element could be dramatically correlated to the glass tubing manufacturing process. To be able to discriminate which glass manufacturing process might guarantee best performance, it is necessary to define a strong enough analytical protocol (routine) starting from sample selection, sample preparation and correct manipulation (to avoid any unwanted contamination), passing through the definition of correct analytical set points (reagents, temperatures & times, instrument choice) and finally, the definition of an evaluation grid with limits and an acceptability range.

In general, to obtain an effective analytical method optimization, it is necessary to define a correct Design Of Experiment (DOE) considering all the possible direct variables that could affect the results or performance and then, determine levels of variables to be investigated (reasonably based on experience and knowledge of process variability); the result will be a Design Matrix for the factors being investigated which gives the number of trials needed.

The described methodology, voluntarily reported as a general overview and not as a detailed procedure, has been developed after testing different sets of glass tubing, produced with 3 different manufacturing processes (Vello, Coated Danner, Uncoated Danner) and the respective sets of cartridges, performing analysis with different analytical equipment and different extractable solutions (more than 180 different samples analysed). Conditions set up in order to simulate the aging and consequently to promote the release in acceptable time, involved the sterilization cycle, performed by using an autoclave in the following conditions: 60 min, 121 +/- 1 °C, 1 bar, commonly used to test the Hydrolytic Resistance of Glass Containers (Eu.Ph. 3.2.1).

Critical factors being faced are:

- The addition of concentrated acid to the extract solution in order to stabilize the signal over time.
- Pre-handling of reusable tools and equipment (silicone stoppers and auxiliary glassware must be preventively autoclaved at least 3 times) to avoid undesired contamination.

Reagents and tools (minimum requirements)

- Autoclave with temperature control and certified logger, able to perform Eu. Ph. Sterilization cycle as following described: 60 min; 121+/- 1 °C; 1 bar
- Water R1 as per Eu.Ph. definition.
- AAS with Al dedicated lamp (ICP techniques also investigated)
- Water solution of EDTA (500 ppm chosen)
- Stoppers for Glass dental cartridges Concentrate Acid (Acetic preferred)

Tools pre-handling

Tools and glass equipment that will be in contact with the extraction solution have to be washed and rinsed with Water R1 and consequently autoclaved 3 times, under Eu.Ph. conditions.

Sample preparation and manipulation

- **Glass Tubings**: from each glass tubing obtain 2 samples, of approx. 440 mm length, bottoming on end by using a medium flame to avoid high transforming stress in the glass. Wash samples as per Eu.Ph. and fill with EDTA Solution up to 20 mm under the neck. Group sticks with rubber rings and cover with glass beakers, identifying different samples.

- **Glass cartridges:** select randomly from an adequate number of cartridges, close the bottom with appropriate 3-times autoclaved stopper and wash as per Eu.Ph. and fill with EDTA solution. In pencil, identify the sample by writing on the beaker's external surface, cover the beaker with glass stopper (plate).

Once the autoclave is filled with samples, introduce a data logger and start a sterilizing cycle. At the end of the process, open the autoclave and let the sample cool at a natural rate.

- **Glass Tubing:** collect 10 ml of extract from each tube in a separate glass beaker, add some drops of Acetic Acid and analyze by AAS
- **Glass cartridges**: collect 10 ml from the set of cartridges, add some drops of Acetic Acid and analyze by AAS

An appropriate set of calibration standards have to be put in place, in the same manner as the final sample also considering the addition of acid.

Limits
The results obtained from the experimental routine identified a realistic limit of leached Al concentration, valid for AAS and especially for the ICP technique, which allow to discriminate among different glass tubing manufacturing processes.

Based on experimental data and repeated tests, the inner surface leaching of Al appears to be not as affected by the converting process (cartridges have not a closed glass bottom) and consequently, if applied correctly, the described methodology results effective on the glass tube and on the cartridges in the same way.

How batch stones appear under a microscope in polarized light, a fast identification method.

Article by Oliver Bellina

The Batch stones are a sort of defect and they have to be recognized as soon as possible; in fact they are a very important indicator of the "health" of the melting and fining process, or in other words, of the back side of the glass furnace.

Typical batch stones essentially consist of unmelted SiO2 sand grains that, due to their lower density, float over the melt and "run fast" to the throat. Consequently the presence of these inclusions in the final product, could generate a high level of rejection associated with decrease of process yield (pack to pull) and increase of scrap.

The Batch stone appears as a deep, white matte conglomerate, although it can sometimes be glossy, other times porous. Thus, observation is insufficient as a means to distinguish it from other types of inclusions resulting from cracked refractory material (SiO2 or high mullite construction materials).

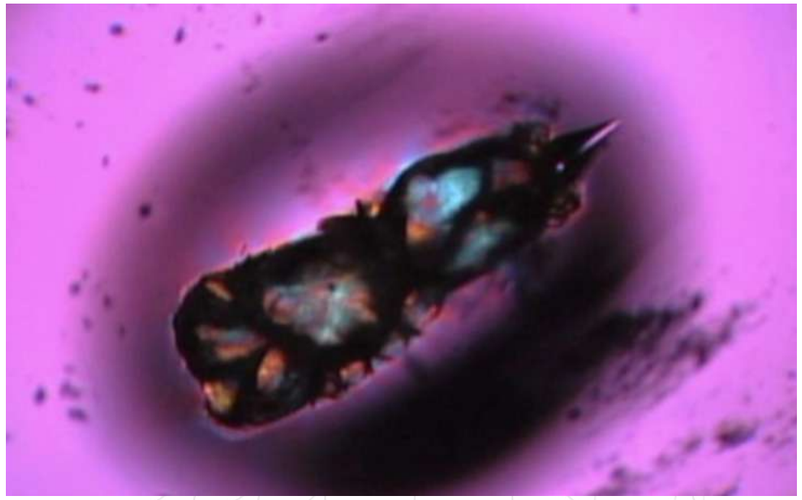
To obtain a clear identification of a stone's nature it is necessary to perform an EDS analysis by SEM, but frequently the timing of identification is a key point to take into consideration in order to speed up the problem solving process and obtain an effective Non-Quality cost saving.

With experience, it is possible to reliably recognise this sort of stone through a quick defect observation with a petrographic microscope (microscope in polarized light).

The reasonable identification of batch stones can be performed keeping in mind:

- The stone appears as a deep white matt inclusion of various dimensions;
- Batch stone inclusions are always surrounded by a high number of bubbles, a result of the melting process due to degradation of raw materials (mostly carbonates and water evaporation);
- The stone is included in Silica enriched glass pockets that generate a "compression stress" visible in polarized light: pockets could be stretched by the production process (as in tubular glass) becoming cords;
- The Batch Stone inclusions are often associated with an increase of rough knots and chemical cords that show a compressive stress in polarized light.

When those defects are correctly identified, the problem resolution could be reached by managing a series of set points including thermal profile, bubble rates and other parameters.



Neutral borosilicate furnaces for pharmaceutical tube hydrolytic class I (alfa50)

Article by Fulvio Puccioni

The global demand for glass is quickly increasing and, therefore, requires the installation of a number of new plants worldwide. Glass Service Italy is assisting its clients in meeting this increasing demand by designing furnaces optimised with Danner or Vello technology for the production of hydrolytic Class I pharmaceutical glass containers, and installs them all over the world.

To date, GS Italy has installed 14 furnaces in Belarus, Iran, China, Russia, Pakistan, and India.

CRITICAL PARAMETERS FOR PHARMACEUTICAL GLASS

Pharmaceutical glass production, with glass batch based on boron content, has the following critical points:

- high melting temperature, 1600°C;

- elevated boron evaporation from the batch, leading to a high corrosion rate in chimney and waste ducts, and production of silica salt knots in the glass;

- increased viscosity of glass;
- greater energy consumption;
- instability of glass quality;
- greater risk for batch pollution.

These issues, combined with the demand for high quality glass, require specialised furnace design that allows for correct production and stability in glass quality.

MARKET REQUIREMENTS FOR FURNACE PERFORMANCE

Stability of production

Every year an increased demand is reported for both quantity and quality from glass tube producers. Currently, standards are requesting for glass tubes with increased stability in:

- OD (outer diameter) and ID (inner diameter);
- TH (thickness);
- bending;
- absence of bubbles and air lines;
- absence of stones;
- stability of batch and chemical/ physical characteristics.

To achieve this high stability performance, full control over the melting process and the forming process is required. To that end, furnace design should be tested in several applications and over long-term operation. Correct design of the electric booster system, bubblers, and all the furnace equipment, as well as the furnace design for melting and forehearth, are very important for good production and stable quality.

Low energy consumption

GS furnaces are low consumption units, meeting the market requirements for reduction in both cost and CO_2 footprint.

The preferred fuel is natural gas and oxygen because the furnace is a high temperature unit (1600°C). The use of natural gas and preheated air is also possible, as well as HFO and preheated air, but is not recommended due to energy consumption. In several oxy/gas 20 TPD (N.2 Danner line) installations, GS furnaces have already achieved the targeted energy consumption of 1250 Kcal/kg fossil + 0.46 KWh/ kg electric booster.

Growth and development in the pharma industry combined with the stress related to the worldwide pandemic emergency has pushed the entire sector into an overproduction of hydrolytic Class I neutral glass pharma containers, such as vials, ampoules, and syringes.

Long-term operation

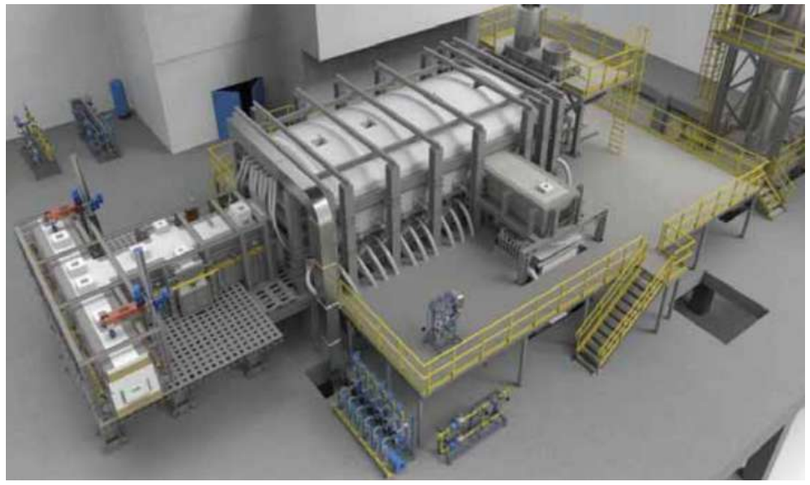
Correct design combined with the correct refractory material can ensure a four-year run for the furnace melting area and forehearth. Growth and development in the pharma industry combined with the stress related to the worldwide pandemic emergency has pushed the entire sector into an overproduction of hydrolytic Class I neutral glass pharma containers, such as vials, ampoules, and syringes. Achieving this level of performance requires accurately engineered: refractory design, burner design and positioning, booster electrode position, water cooled bubbler tubes, temperature management, special throat cooling technology, and special side cooling technology. After a four-year run, 65 per cent of AZS and refractory materials should be changed, while the steel structure and equipment can be used for a second run.

Easy maintenance and management

Easy maintenance is quite important for four-year glass production stability and GS furnaces are designed for this scope because the furnace and its equipment require very low maintenance. This includes several solutions for cleaning the burners and unclogging the bubbler that require very little maintenance time as all these activities can be done while the furnace is in production.

GLASS SERVICE SOLUTIONS

GS furnaces have a number of special solutions regarding refractories as well as for complete design. These special solutions guarantee glass quality and stability, low energy consumption and a four-year run. GS has designed Danner furnaces with two or four lines and Vello furnaces with two lines. Standard sizes are 20 TPD pull for Danner furnaces with two lines, 40 TPD pull for Danner furnaces with four lines, and 32 TPD pull for Vello furnaces with two lines (pull is limited by the speed of the tube cutting device). GS has also developed some unique equipment the furnace refractory design.



Special batch chargers

Batch charger devices have a fundamental role in the melting process. The combination of the batch charger machine and the batch charger-area furnace design should guarantee low dust in the chimney, low boron evaporation, high machine life, stability of glass level, and correct batch distribution in the melting area. GS has developed a special machine design coupled with the furnace batch charger area. The machines are screw-type batch chargers and can operate in 2-, 3- or 4 units, according to furnace size and pull. Batch charging screw rotation speed and charger ton/h rate are automatically managed by the process control system. Moreover, the batch charger machine has been engineered to have complete electrical insulation from the supporting structure.

Special bubblers

Bubblers fundamentally affect glass quality and furnace life.
Expert design and positioning of bubblers are essential to avoid long term issues.

An error in bubbler positioning could result in poor glass quality, while bad bubbler design may result in bottom drilling, reducing the life of the furnace bottom to only one year. With bottom temperatures reaching as high as 1550°C in this furnace, bottom corrosion is a very real issue.

Aiming to produce better quality glass and extend furnace lifetimes, Glass Service has engineered solutions to meet these industry-wide needs. To address the devastating effects of high bottom temperatures, GS has developed water-cooled bubbler tubes designed to reduce the AZS bottom temperature in the bubbler area and avoid the corrosion of bubbler tubes AZS bottom blocks.

GS has also developed constant flow technology for the bubbler device; this technology can guarantee a constant flow rate in the event of bubbler tube nozzle clogging. Additionally, in the case of irreversible clogging, the water-cooling bubbler tubes can be easily changed while in operation. The bubbler can also operate in both oxygen (recommended) or compressed air. These innovations should guarantee a continued bubbling service for the entire furnace life.

Special molybdenum electrodes holder

Electrode holders also require specialised design and cooling due to high temperatures (1550°C) in the furnace bottom. GS has developed its own molybdenum electrode holders with a strong, high-temperature resistant cooling head, and integrated double high efficiency cooling technology + compressed air. The high-temperature, stress resistant head allows the electrode holders to operate at very high temperatures. Meanwhile, the use of high cooling rate water technology reduces the temperature of the electrode AZS block, avoiding glass leakage and block corrosion. The double cooling (water and air) electrode holders can be used separately; with water during normal operation; and with air in emergency conditions.

Special burners and burner oxygas skids

Oxy-gas burners have a special role in the borosilicate glass melting process, they have to guarantee: correct flame pattern distribution, low boron evaporation from glass surface, and easy maintenance.
GS oxy-gas burners, their size, their number, their position in the combustion chamber, and the burner blocks are designed as one unique system. The burners also have double impulse technology allowing for adjustable flame length.

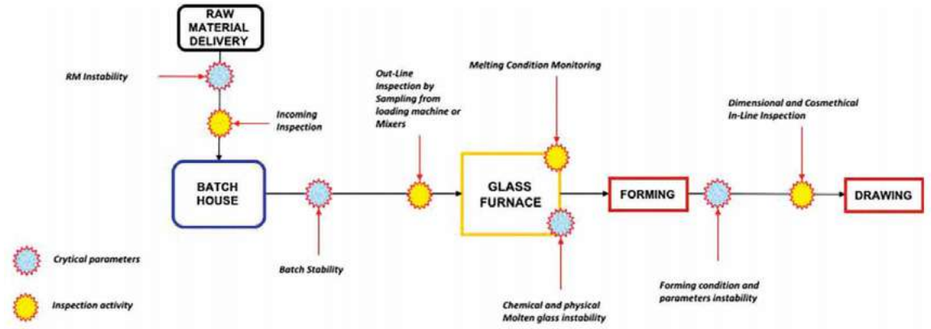
Burner skids and gas/oxy rate stability are two of the most important devices for borosilicate furnaces. The combustion skid should guarantee the correct combustion ratio of natural gas and oxygen. The melting process and the redox value of the batch, as well as boron evaporation, are very sensitive to the stability of this parameter.
GS developed the skid as a standard unit, each controlling three burners sections with independent flow control for natural gas and oxygen. The flow control has a high accuracy rate integrated with mass flow calculation for both gases. The design also includes a compressed air section to cool burner nozzles in the case of a shut-down due to maintenance or an emergency.

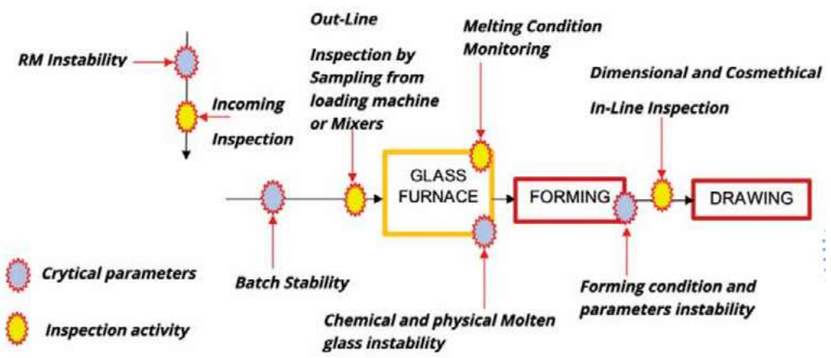
Process control system

The process control system allows real-time monitoring of: high precision temperature reading, stability of process control loops, high precision in mass flow control, advance capability calculation, trend advanced management for all process variables, management of historical and real time alarms, easy and intuitive HMI (Human Machine Interface), and main loop redundancy for emergency control in case of a DCS failure.
Performance of these functions is managed by the DCS HC900 Edge from Honeywell with integrated PC Scada Citec with double screen (single or multiple PCs) and two local displays; a group of P108 Eurotherm instruments is installed for redundancy.

The process control system also manages all the furnace machines: batch chargers, glass level, bubblers, electric boosters, combustion, furnace pressure control, cooling, etc.
All machine controls and control loops are integrated into a single process control system. With this solution, the advanced and integrated furnace process control strategy is managed as a whole.
Strict safety protocols are in place for operators and furnaces in the event of an emergency, including restarting after a black-out. Additionally, the SIL2 capability safety level has been designed to meet EU and USA market standards.

Full process control procedure
Any mismanagement of raw materials or melting conditions can introduce persistent defects in the glass. Glass quality can only be guaranteed if there is strict control over the entire production process. As such, training is an integral part of GS customer service process.
To ensure customers are fully trained in process control procedure, GS has assembled a team of specialists with many years experience working with borosilicate glass tube hydrolytic class I glass. GS training services include: assessing the actual status of customers' internal procedures, training on quality control procedures, ranging from raw materials to final products, and training on chemical and physical laboratory tests and procedures.





CONCLUSION

Glass Service Italy, with more than 15 fully successful installations worldwide, is the only furnace manufacturer with longterm experience in borosilicate pharmaceutical glass tubing hydrolytic class I (alfa 50). GS designs specialised equipment/machines and technology for these unique furnaces, engineered for low energy consumption and minimal maintenance. GS is also able to provide technological training as part of customer service, ensuring high quality support and excellent success rates.

Tradition, technological innovation and sustainability.

Article by Fulvio Puccioni

WHEN GLASS IS THE GREENEST CHOICE

The union of tradition, technological innovation and sustainability has never been so Italian. Glass is an ecological and recyclable material and, with the growing global awareness of sustainability, the market is choosing to use this resource more and more, thus offering development opportunities to production companies. But how can the relationship between production efficiency and consumption be maintained, and possibly improved?

GLASS SERVICE AND ITS INTERNATIONAL ACTIVITIES

Fulvio Puccioni, CEO of Glass Service Italy, talks about the activity of the company in the international market: "Developing combustion technologies and optimization of the 'Channel Distributor' section allows to reduce consumption and increase the production efficiency of the plant.

This is why Glass Service collaborates with customers all over the world to create innovative technologies to reduce energy consumption, and to extend the life of the plants and reduce emissions." Glass Service Italy is a 100 per cent Italian company priding itself on excellence that produces, designs and installs highly specialized technologies and systems for the glass industry, offering innovative and specific technological solutions for the various needs of the sector.

Founded from the merger of two companies already active in the glass production sector, Glass Service has over 40 years of experience to its credit.

Over time, the company has increased its know-how thanks to numerous collaborations with research centres and prestigious Italian universities, and by investing in the future through the inclusion of young and highly specialized engineers in the team. The flagship products of the company are its furnaces:

- special customised furnaces; • regenerative and recuperative furnaces;
- low energy consumption oxyfuel furnaces.

Glass Service also installs systems and automation that have been meticulously designed and manufactured down to the small est details in dozens of countries around the world.

Glass Service's ability to offer technology and training for the management of the production process is a further added value for its customers.

METHODOLOGY

Phase 1 – study
Glass Service's specialized team of engineers first performs a detailed analysis of the context and needs of each client, then compiles a detailed estimate and proposal for delivery time and cost of design, production and installation.

Phase 2 – creation
The company creates a plant, or a portion of it, completely turnkey, studying every detail based on the specific requests and needs of the customer. In addition, the company's engineering team is always studying new solutions to improve the life of the furnaces and their functionality by designing, creating and testing each component of the system.

Phase 3 – training
In addition to the installation of the product, Glass Service takes care of training the client's team in the necessary know-how to use their system to its fullest.

Phase 4 – assistance
Complete after-sales assistance for the entire life of the plant. Glass Service remains fully available, remotely or on site, to manage any system problems.

FIELDS OF APPLICATION

Glass Service has acquired vast experience working in a variety of sectors in which glass production finds its greatest expression. These include:
- container glass;
- tableware;
- pharma glass;
- fiber glass;
- sodium silicate;

as well as numerous turnkey projects installed all over the world.

Glass Service News

Meet the team: Francesco

My name is Francesco Montagnani, Glass Service's Financial manager and member of the board of directors.

Our vision is to grow our international market exponentially. We have had an international presence since the year 2000, exporting more than 90% of our production to all the world markets, from China to the US, from Africa to the Middle East, and to the countries of Eastern and Western Europe.

As a financial manager, my goal for each client is to find the right financing and financial solution in order to meet their needs and move forward with their project.

We collaborate with export credit agencies all over Europe, in particular with SACE, and for my part, I try to make up for the lack of liquidity that is now common in all the countries of the world.

Our strength is to customize both the product and the contract to the specific needs of the customer. Which means that one person is assigned to each customer, following their project from start to finish, taking care of all that customer's needs.

Meet our clients

Andrea Varacca for Bormioli Luigi

What is your name and role and what does your company produce?

"Hello, I'm Andrea Varacca and I'm technical director of Bormioli Luigi.
Bormioli Luigi is a hollow glass factory that mainly produces bottles for perfumes and hollow glass for houseware items, such as goblets, glasses and plates."

What problems did you encounter with your work before starting to work with Glass Service?

"Bormioli Luigi, in the glass world, is somewhat in a niche for which our main difficulty has always been to be able to find technological solutions, that is to say, ready-for-use for our needs. What is on the market, rightly, is aimed at the part of production that is predominant today, so those who produce bottles for beer, wine, water.
Our needs are quite different and therefore what we generally find available on the market by visiting trade shows is never exactly what we are looking for. On paper it is easy to find what is needed for the glassworks that make the lion's share in the production of hollow glass today, therefore above all, glassworks that produce bottles, in particular for beer, water, and wine. We have quite different needs, so we were struggling to find ready-made solutions for us. We always need customization."

Specifically what was the thing that led you to opt for our service / product?

"Glass Service definitely gave us flexibility and attention to our needs that we struggled to find on the market, so we were able to have a dedicated representative with whom we could put our problems on the table and have a person on the other side willing to listen to our demands and to try to find solutions, as they say, tailor-made."

Have you encountered any problems in using Glass Service systems, plants or products?

"Surely starting a new system is not easy but it is part of the game, let's say. In general, I would say that we found ourselves well-taken care of, their systems are based on reliable components, managed by experienced people, so we did not find any particular difficulties, indeed I would say that we enjoyed working with them."

Much like Glass Service, Bormiolo Luigi has a structured and organized technical office: do you believe that, on a technical level, the integration between these two structures, aimed at obtaining customized and highly efficient solutions, works correctly?

"Certainly the integration between these two structures is the key move for the success of our projects. We need to deal with an interlocutor. As I always say, we make glass, we are not the greatest plant experts but we know what we need, what our needs are.
On the other hand, having people who are technically competent and willing to listen and are willing to find solutions with us, I believe is the winning move for the success of a product."

How do you rate the assistance from the Glass service team?

"Fortunately, we did not need a great deal of assistance, but when it was needed, it was always available. Then, thanks also to the possibilities that exist today with remote connections, remote access directly on the plants, we have always managed to solve our problems quickly and effectively."

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