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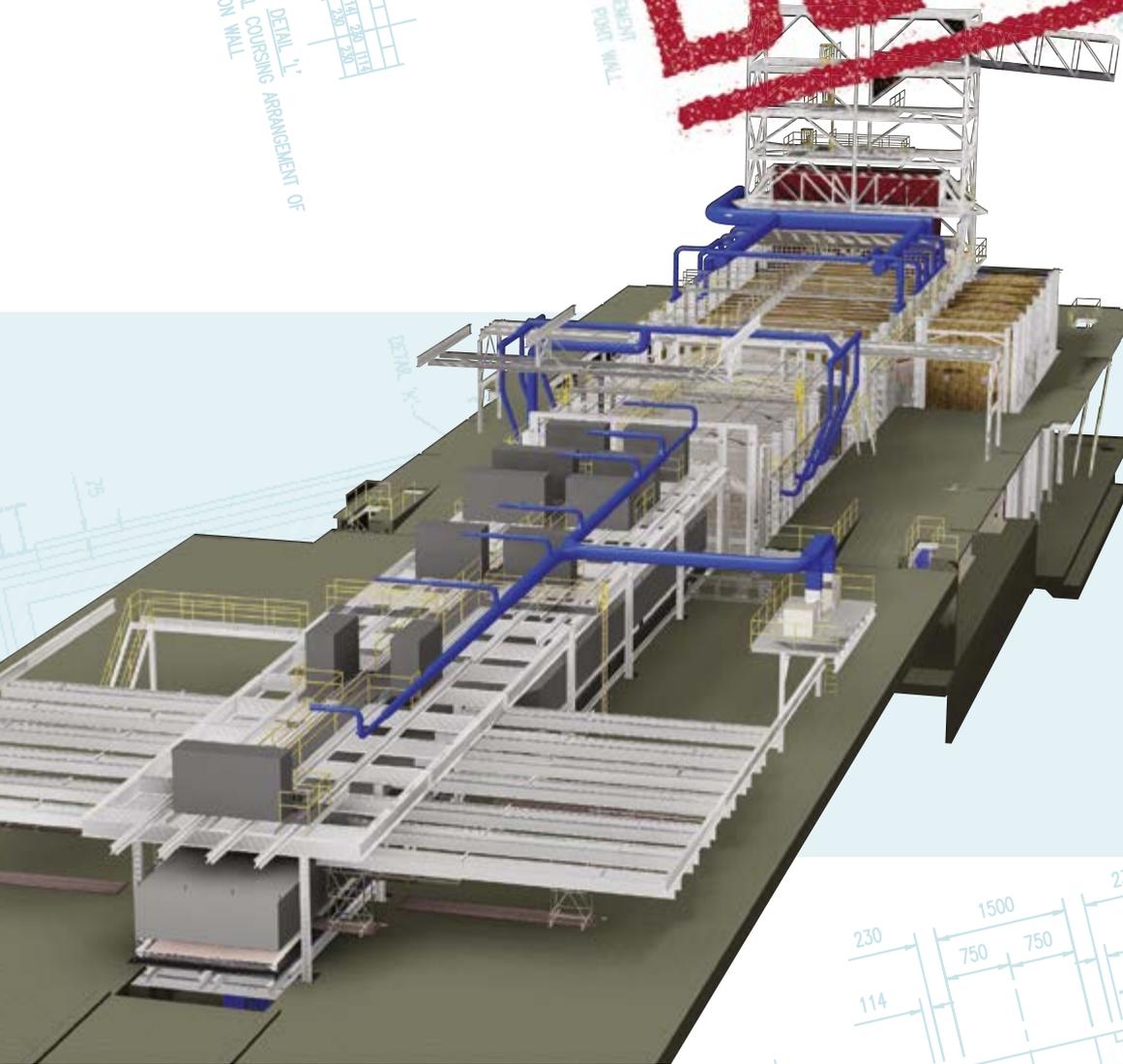


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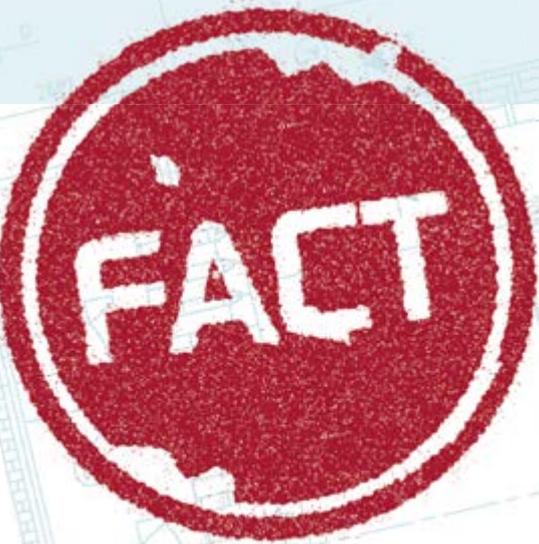
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Welcome



Against the vastly contrasting backdrops of the triumphant International Year of Glass and the dispiriting continuation of unprecedented global challenges, the glass industry continues to deliver game-changing developments that are positivity influencing international economies, markets and communities.

In recent issues, *Glass Worldwide* has published exclusive interviews with prominent glassmakers and processors making momentous investments into their hollow, flat and speciality glass factories, as well as reporting how pioneering advances from their suppliers of plant, equipment, materials and services are assisting in optimising the manufacturing processes. The theme continues prominently in this issue with industry figureheads from key global players including AGI glaspac, Borosil, Cristalerías Toro, O-I, SGD Pharma, Siseecam and Verallia all speaking to *Glass Worldwide* about their ambitious plant upgrades, product innovations, sustainability goals and strategic plans to ensure that glass is well positioned as the material of choice in all sectors served.

Additionally, a Focus CIS report examines the possible long-term impact of the conflict in Ukraine and subsequent sanctions affecting the region's glass industries, while the Japan Glass Bottle Association presents a packaging materials review in a special Focus Japan feature. The Chinese flat glass industry is also the subject of a detailed market report.

Complemented by a diverse collection of Supplier Focus and Technology articles from industry experts including individuals and organisations aiming for technological revolution in the glass melting process, our 2022 series of Buyers Guide features continues with no fewer than seven contributions rounding-up the latest progress from leading technology suppliers in the vital field of ware handling. Part two of this feature will follow in the next issue.

Don't forget, other recent Buyers Guides focusing on melting technology, decoration, process control and inspection can be accessed free of charge in our digital archive of current and back issues at www.glassworldwide.co.uk. Visitors to the website can also find the latest Hot Topics news, highlights from this issue, up to date event listings and the Virtual Marketplace, a digital showcase featuring many of the companies profiled in this issue.

We hope you enjoy reading this issue of *Glass Worldwide* and look forward to receiving your feedback, together with any recommendations for future editorial coverage.

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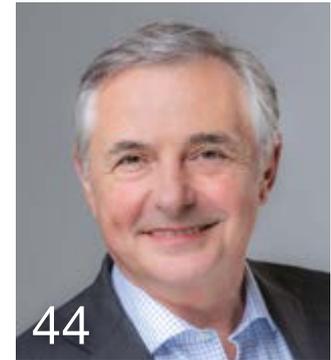
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22 Hartfield Rd, Forest Row,
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DAVE FORDHAM
Publisher
Tel: +44 (0) 1342 315032
Email: davefordham@glassworldwide.co.uk



REBECCA COLEGROVE
Editorial Consultant
Email: rebeccacolegrove@glassworldwide.co.uk



ALISON SMITH
Designer for Blue Daze Design Ltd
Email: copy@glassworldwide.co.uk



GRAHAM LOVELL
Senior Sales & Marketing Manager
Tel: +44 (0) 1342 321198
Email: grahamlovell@glassworldwide.co.uk



FRAZER CAMPBELL
Publisher
Tel: +44 (0) 1342 322278
Email: frazercampbell@glassworldwide.co.uk



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News For the latest news, visit the Hot Topics section at www.glassworldwide.co.uk

Şişecam breaks ground on first glass packaging production site in Europe

Turkish glass giant Şişecam has held the ground-breaking ceremony for its new €255 million glass packaging facility in Kaposvar, Hungary. The ceremony on 17 March was attended by Hungarian Minister of Foreign Affairs and Trade Péter Szijjártó, Kaposvar Deputy Attila Gelencsés, Kaposvar Mayor Károly Szita, Şişecam Chairman Prof. Dr. Ahmet Kirman, and Şişecam CEO Görkem Elverici.

"Our Hungarian investment will further strengthen Şişecam's position in glass packaging," said Şişecam Chairman Prof. Dr. Ahmet Kirman in his speech at the event. "With this new facility, we aim to bolster both the development of the region and our presence in the European glass packaging market by continuously investing in Kaposvar."

"We plan to commission our Hungarian glass packaging facility in 2023," added Şişecam CEO Görkem Elverici. "It is scheduled to reach its full annual production capacity of 330,000 tons in 2025."

The new glass packaging production facility will create direct employment for over 330 employees and once the facility is commissioned, Şişecam's total employment in Hungary will be approximately 650 people, with further employment of about 1,000 supported via sub-producers.

The Hungarian plant will use electric melting technology along with natural gas to assist with Şişecam's sustainability activities and carbon footprint reduction targets.

www.sisecam.com.tr/en



Şişecam held the ground-breaking ceremony for its €255 million greenfield glass packaging facility in Kaposvar, Hungary on 17 March.

Saint-Gobain makes €120 million glass wool investment

Through its insulation subsidiary ISOVER, Saint-Gobain is investing €120 million to expand its insulation production capacity in France and support the acceleration of the energy renovation market. These investments will involve increasing the capacity of existing ISOVER production lines and creating a new line.

ISOVER has three glass wool plants in France, located in Chalon-sur-Saône, Chemillé and Orange. In response to very strong demand driven by energy renovation, by 2025 Saint-Gobain plans to bring more than 70,000 additional tons of glass wool insulation to the French market, which will enable the equivalent of 100,000 additional homes to be renovated each year.

Of the €120 million, €20 million will be specifically dedicated to the decarbonisation of production and the development of the circular economy. This will enable the installation of a treatment unit for deconstruction waste to be reincorporated into the production process as a substitute for virgin raw materials, and an increase in the proportion of recycled glass used in the production process to 80% by 2025.

www.isover.com

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FEVE's Glass Hallmark pioneered by Vidrala

Glass container manufacturer Vidrala is one of the first packagers to make use of FEVE's new Glass Hallmark on its bottles. The symbol was created by the European Container Glass Federation to champion the benefits of glass and to encourage better recycling levels across the continent.

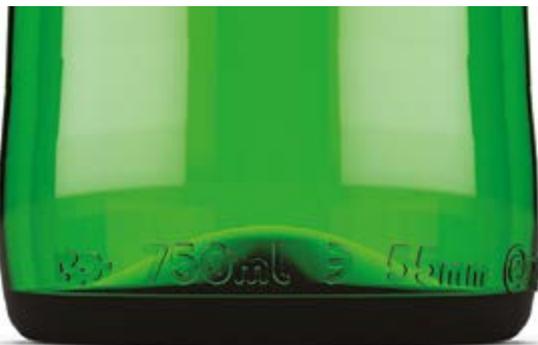
At its Encirc plant in Derrylin Northern Ireland, Vidrala has been able to emboss its 75cl BD glass bottles with the seal. Communicating the infinitely recyclable and reusable nature of glass on the bottles themselves, the Glass Hallmark symbolises a commitment to create a sustainable future using glass. The initiative aligns closely with Vidrala's 'Glass Made Good' sustainability strategy.

FEVE has set its sights on Europe achieving a 90% container glass recycling rate by 2030 and the hope is that the Glass Hallmark symbol will play a key role in reaching this goal by reminding people to recycle their containers.

"Although it is one of the oldest materials, we believe, along with FEVE, that glass is the sustainable packaging choice of the future," said Fiacre O'Donnell, Director of Sustainability at Vidrala. "With 2022 being the UN's International Year of Glass, now is the perfect time to champion its incredible benefits: [from] recyclability, to its health advantages and its ability to keep produce fresher for longer.

"Increasing the amount of glass being recycled is a vital step towards creating a truly circular economy in packaging, and initiatives and the Glass Hallmark gives us a unique opportunity to remind consumers to recycle their glass on the bottle itself," he added.

www.vidrala.com



The Glass Hallmark embossed on a 75cl glass bottle from Encirc Derrylin.

Glaston cuts cycle times at German glass firm

In December 2020 family-run firm Glas Herzog, which offers a full range of functional and insulating glass to window manufacturers in Germany and neighbouring countries, took delivery of a Glaston SPEED BOX IG line to replace a Lenhardt insulating glass line that had been operating for 26 years.

Glaston's SPEED BOX IG is an individually configurable production line for insulating glass units with conventional spacers. By combining three components: SPACER'FILLER AT (automatic desiccant filling station), SPACER'BUTYLAPPLICATOR (butyl coating robot), and FRAME'POSITIONER (automatic frame setting station), the SPEED BOX makes frame processing almost fully automated.

"Without any manual intervention, prefabricated spacer frames are automatically filled with desiccant, precisely coated with butyl and then automatically positioned onto the glass," explained Thomas Herzog, joint Managing Director – along with his father, Andreas Herzog, Sr., and brother Andreas Herzog, Jr. "The shortest possible cycle times are achieved by parallel filling and transport processes. We can produce different frame dimensions, profile widths and glass thicknesses in any sequence. Insulating glass unit thicknesses of 80mm are now possible."

Starting production in January 2021, the new line is reportedly running smoothly alongside two Bystronic (acquired by Glaston in 2019) glass insulating lines that run fully automatically. Together, they enable Glas Herzog to produce more than 1,000 insulating glass units daily.

www.glaston.net



The Herzog family.

SCHOTT and Hungarian government invest in syringe production

A €76 million investment at SCHOTT's site in Lukácsháza, Hungary is designed to meet the growing global demand for prefillable syringes made of glass. The company is planning to build an entirely new production line for high-quality prefillable glass syringes (PFS).

"The added capacity will greatly benefit the global market and strengthen supply security for major pharmaceutical companies and contract manufacturing organisations," said Andreas Reisse, Executive Vice President of SCHOTT's Pharma business unit.

The double-digit million euro amount is supported by the local government with about €9 million. The expansion is scheduled for completion in 2024 and is designed to create 120 new jobs.

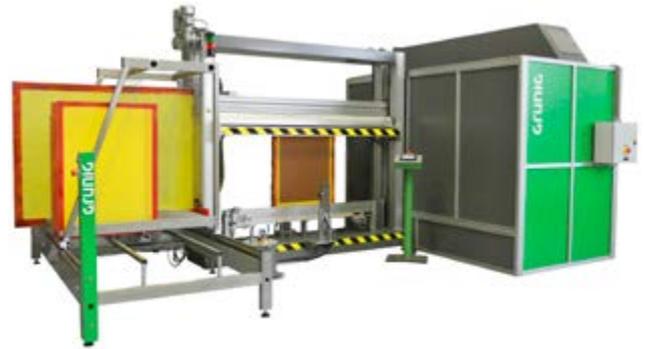
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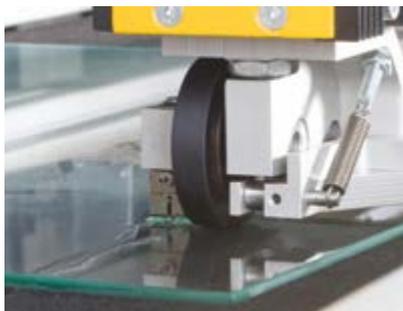
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Chemetall creates sustainable cutting fluids

To enable glass manufacturers and processors to achieve exact cutting and perfectly cut edges, the Surface Treatment global business unit of BASF's Coatings division, operating under the Chemetall brand, now offers a new generation of cutting fluids: ACECUT ECO. Based on sustainable raw materials, the cutting fluids ensure a green footprint as well as enabling high performance, improving cut quality and the environmental impact of the overall process.



Chemetall's cutting fluids help to improve cut quality as well as the environmental impact of the overall process.

ACECUT ECO reportedly offers the following ecological advantages: low aromatic and naphthenic content to allow better biodegradability; the cutting fluids are not based on raw materials refined from crude oil, and their lower ecotoxicity and lower photochemical reactivity produces fewer pollutants.

Chemetall develops solutions for the float glass and the optical industry, primarily in the areas of cutting, grinding and separating. The company embraces environmental responsibility and awareness for environmentally sound products and processes.

www.chemetall.com

CelSian marks 10th anniversary with €10,000 charitable donation



Harmen Kielstra, Managing Director of CelSian.

Rather than sending a branded gift all around the world for its 10th anniversary, glass technology and knowledge provider

CelSian chose to donate €10,000 on behalf of its customers to three different charities: JustDiggIt, Aflatoun International and Engineers Without Borders Netherlands.

CelSian's Managing Director Harmen Kielstra attributed the independent company's first decade to "the trust that our customers worldwide [have] showed us." He continued: "That is why we wanted to show them our gratitude in a meaningful way that echoes our core identity and values: education, clever solutions for a better world, and the environment. We are very proud to support on their behalf the chosen charities that we feel closely aligned with."

At the start of February, all CelSian customers received an email inviting them to vote for one of three selected charities. Based on the results of the votes, CelSian donated €3,700 to Aflatoun International, €3,200 to JustDiggIt and €3,100 to Engineers Without Borders Netherlands. The initiative was reportedly praised by many of CelSian's customers who were 'very happy' to be involved.

"This celebration is an important milestone in our history," underlined Mr Kielstra. "We are optimistic that the glass industry has many bright years ahead, and that we will keep on being part of our customers' journeys and vice versa. We will continue to support them with their sustainable initiatives and goals, be it with our modelling and control software, laboratory services, or through our Academy. Our team is well-positioned to help them tackle all the challenges the glass industry will have to face in the coming years".

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CEO of Verallia Michel Giannuzzi chaired the Reuse Lab.

Verallia publishes white paper on glass reuse

Producer of glass packaging for food and beverages Verallia has published a white paper “Reimagining reuse for the circular economy of glass: Stakeholder Perspectives Series,” exploring the challenges and opportunities around reuse through the testimonies of leading experts.

Throughout 2021, Verallia exchanged ideas and worked with stakeholders to advance the debate on glass packaging reuse. The white paper (available on Verallia’s website) brought together the state of the field on reuse through a range of perspectives and proposes ‘seven action areas for scaling glass reuse’ offering rich ground for collaborative action among reuse stakeholders.

To deepen the debate, the Group launched its first ‘Reuse Lab’ event – a forum to accelerate the development of local and sustainable glass packaging reuse solutions. Chaired by Michel Giannuzzi, CEO of Verallia, the Reuse Lab brought together some of the white paper’s contributors, in the presence of the Group’s customers, partners and employees, to discuss ideas and calls to action presented in the report.

“Because reuse is part of the answer for the future of the glass industry, we need to understand the complex challenges: from changing consumer behaviours and relevant product design, to the logistics of glass collection and cleaning, and developing new business models for reuse in different policy environments across our markets,” explained Mr Giannuzzi. “Our core belief is that glass packaging reuse can only be a viable model if it is understood and treated as a systemic challenge, thus prompting us to work closely with all stakeholders in the entire ecosystem.”

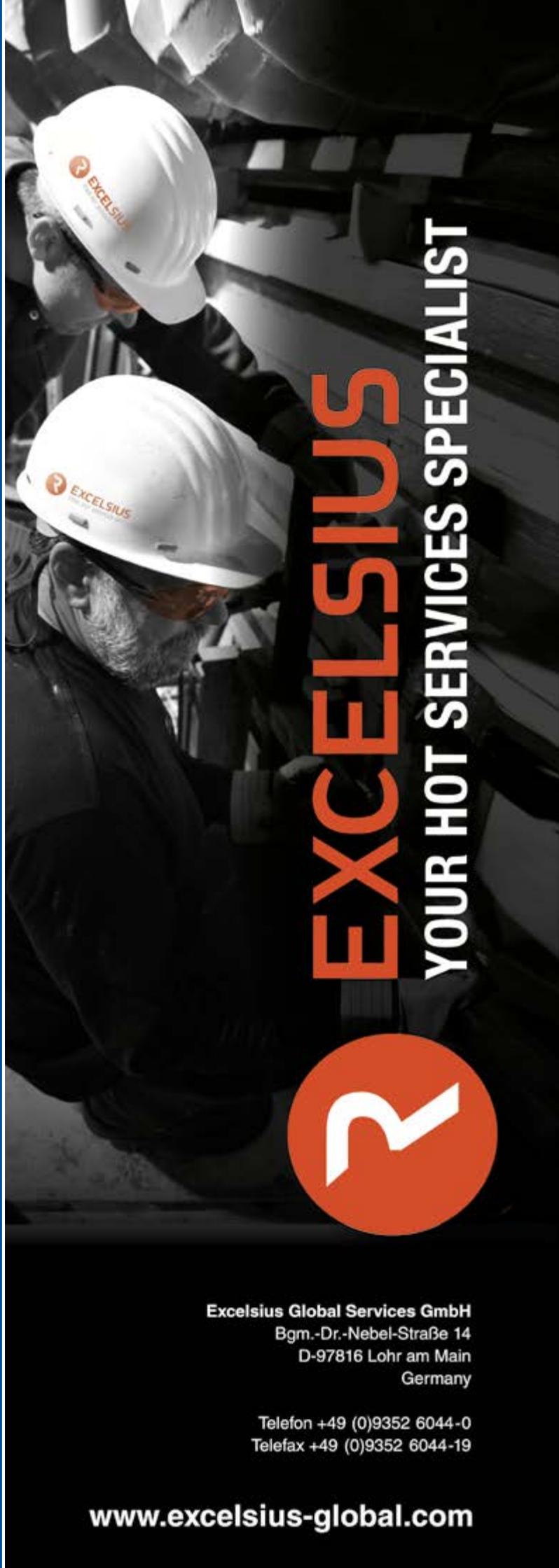
To help make reuse a viable solution, Verallia is making three major commitments: to push for experimentation, to partner to stimulate innovation, and to share experiences and best practices.

www.verallia.com

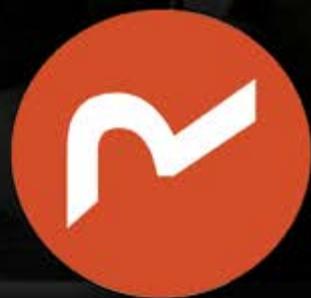
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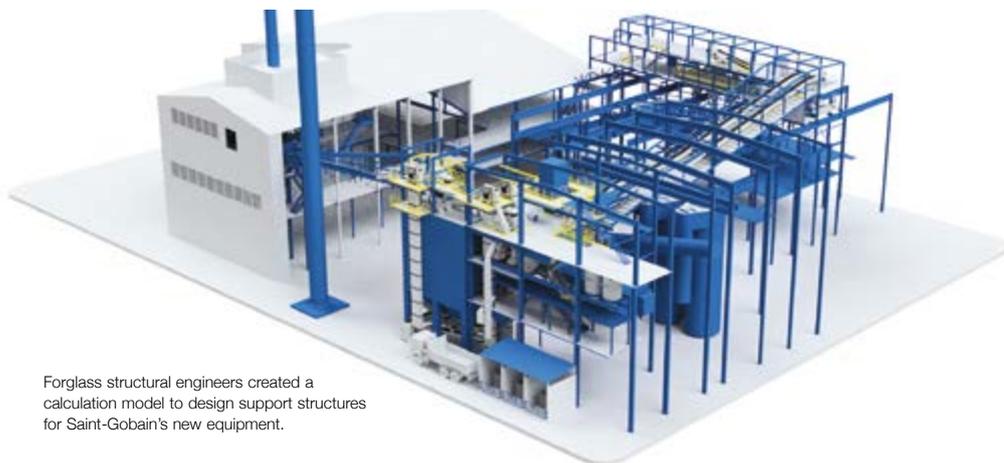
Forglass takes on Saint-Gobain ISOVER modernisation challenge

Furnace specialist Forglass is developing a complex engineering solution to modernise the Saint-Gobain ISOVER glass wool plant in Orange, France. The crux of the project is the replacement of the current batch transport system. Owing to the fact that the building housing the glassworks is over four decades old and has undergone

many modernisations, accurate documentation (blueprints) are in short supply, and sometimes 'non-existent'. Forglass structural engineers have had to scan the building to create a calculation model that enables them to determine the loads and design support structures needed to accommodate the new equipment.

Posing an additional challenge: all the testing and switching over to the new batch transport system is required to be completed on the run, without interrupting production.

www.forglass.eu ●



Forglass structural engineers created a calculation model to design support structures for Saint-Gobain's new equipment.

Vidrala commits to 12MW renewable power installation at Spanish plant

As part of its sustainability and energy efficiency strategy, intended to demonstrate its commitment to the environment and to the communities where the group operates, Vidrala is building a solar photovoltaic power generation plant that will be used for consumption in the industrial process, partially substituting fossil and electrical energy from the grid. The facility will be located at the Crisnova plant in Caudete, Castilla La Mancha, Spain and will have a capacity of 12MW using cutting-edge ground-based technology.

Engineering, technical and economic viability work, urban planning, administrative and environmental procedures, as well as the engineering project were carried out by Vidrala under the guidance of Norvento Enerxía. Construction has started, with Norvento as project manager and Grupotec for the installation and commissioning of the project, which is designed to reduce CO₂ emissions by about 9,000 tonnes per year.

This initiative is part of an ambitious investment plan launched by the Vidrala Group and is part of its multi-year green agenda focused on improving the sustainability of the glass container production process.

The Vidrala Group has already implemented this type of technology to supply its facilities with green energy in Portugal, where it installed a solar plant at the logistics facilities in Marinha Grande in 2018.

www.vidrala.com ●

Stoelzle joins ZeroCO2Glas project

Funded by the German Ministry for Economy and Climate, BMWK, the ZeroCO2Glas project aims to develop a revolutionary glass melting process in connection with a new type of CO₂-neutral and energy saving glass melting furnace.

The project's funding (maximum of €8.38 million with a total project volume of approx. €14.94 million) is dedicated to increasing energy efficiency, expanding renewable energies and significantly reducing greenhouse gases. ZeroCO2Glas focuses on the glass melting

process, opening up the possibility of saving a particularly large amount of energy and greenhouse gases. An innovative melting technology aims to reduce energy consumption by 15% compared to conventional furnaces, and to allow CO₂-free glass melting. Energy savings will be achieved by using alternative and CO₂-free raw materials, avoiding unnecessary humidification of the batch, as well as reducing the dwell time of the glass in the furnace due to a special melting process and the improved new furnace design.

The furnace will be set up in Aachen, Germany, as a hybrid furnace with hydrogen-oxy and natural gas-oxy firing, as well as electrical heating. All approaches have already been tested on a laboratory scale; the project thus represents the second stage of upscaling.

www.stoelzle.com ●



Stoelzle brings its expertise in glass container manufacture to the ZeroCO2Glas project.

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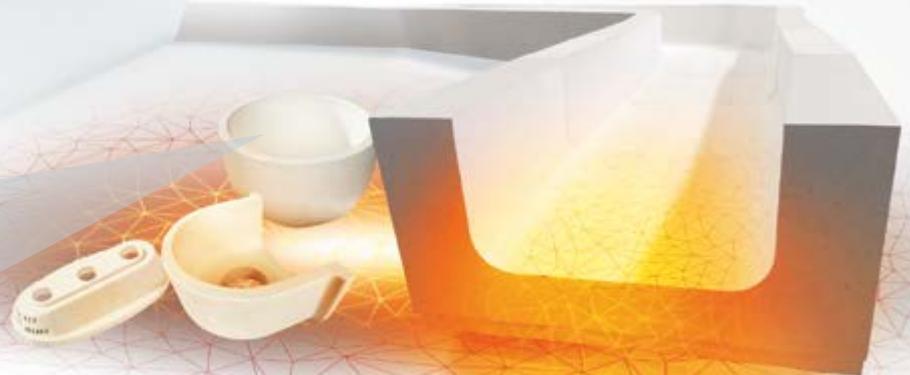
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IRIS upgrades inspection facilities for Mexican glassmaker

Inspection specialist IRIS is carrying out a major upgrade and expansion of Mexican glass manufacturer Vidrio Formas' inspection facilities this year. With over 50 job changes a month in its main glass plant, Vidrio Formas requires accurate and flexible inspection machinery which can easily be adapted to the parameters of a rapidly changing production run.

IRIS is retrofitting the glass manufacturer's first machine, installed in 2013, with new hardware and the latest NEO intelligent software systems designed to bring significant cost and environmental savings. This is the first step in a scheduled programme of upgrades across all Vidrio Formas' machines.

"We have total confidence in [IRIS] and their excellent local technical support team, as we expand our production for customers in Mexico and beyond," said Alex Schneeweiss, Vidrio Formas COO. "Just like our original EVOLUTION machines, the new ones will never go out of date."

IRIS' EVOLUTION inspection machines are modular, so components to inspect different defects can be swapped in and out as customer needs dictate. "Each inspection module can be upgraded as we develop new technology, so every one of the customer's machines remains as efficient, fast and intelligent as our latest model," explained IRIS CEO Jen-Luc Logel.

Vidrio Formas is one of the first IRIS customers to send defect images taken by EVOLUTION machines, directly to the cold end through its own information system.

By the end of 2022, the company will be operating 22 IRIS inspection machines across all its production facilities.

www.iris-im.com ●



IRIS' EVOLUTION 12 NEO is an intelligent sidewall inspection machine with 12 HD cameras.

New members for GPI

Stoelzle Glass Group and Special Shapes Refractory Company (SSRC) have joined the Glass Packaging Institute (GPI), the trade association representing the North American glass container industry.

Stoelzle Glass Group has more than 200 years of expertise as a manufacturer of high-end glass containers for the prestige spirits, pharmaceutical, and food industry as well as for perfumery and cosmetic goods. Stoelzle recently acquired the former Anchor-Hocking plant in Monaca, PA and has plans to further invest in the North American glass industry.

"Glass is the ideal packaging, as it is endlessly recyclable, and working with the Glass Packaging Institute is therefore a natural partnership for us," said August Grupp, President of Stoelzle Glass USA and Head of the Spirits Business Unit. "One of our biggest current focuses is our target to reduce CO₂ emissions by 50% by 2030 and achieve CO₂ neutrality at all Stoelzle production plants by 2050. We look forward to partnering with GPI to shine a light on this important goal."

SSRC manufactures specialised, engineered precast refractory shapes and un-shaped monolithic refractory products, key components for the glass manufacturing industry.

"We were invited to be guests of the Glass Packaging Institute for their Fall meeting in Atlanta and after attending this meeting and speaking with multiple attendees and GPI representatives, we decided to join this important organisation supporting glass packaging manufacturers," explained Bob Hunter, Director of Sales and Marketing at SSRC.

GPI President Scott DeFife said he was "thrilled" to welcome Stoelzle and SSRC to the association: "Stoelzle and GPI will focus on bolstering the spirits packaging industry and promoting glass produced at their new Pennsylvania plant. SSRC and GPI will focus on improvements for necessary machinery and equipment used inside glass manufacturing plants. I look forward to working and collaborating with both new member teams on behalf of the North American glass container industry."

www.gpi.org ●

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AMETEK Land releases container glass quality guide

Manufacturer of monitors and analysers for industrial non-contact temperature measurement AMETEK Land has released a guide to help container glass manufacturers achieve the most consistent product quality.

The company's new application note identifies key locations where accurate and reliable temperature measurements are critical for production process for container glass and specifies the best measurement solutions that can be applied for temperature, gas analysis, opacity monitoring and combustion efficiency. It also outlines the benefits of these measurements for efficiency, quality, damage prevention, and environmental compliance.

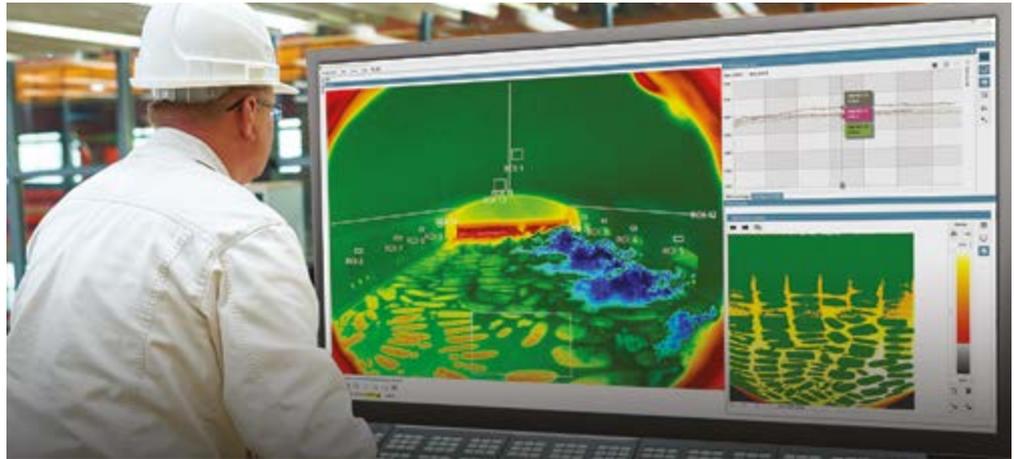
Based around infrared technology, the devices deliver non-contact measurements and include fixed, fibre-optic, and portable thermometers.

Among the solutions detailed are the SPOT range of fully featured, high-performance pyrometers – available in a range of operating wavelengths, temperature ranges and process requirements – and the LWIR-640 long-wavelength thermal imager, which provides a full temperature measurement range of 0–1,000°C in two ranges with a choice of different optics and fields of view.

Along with the pyrometers is the NIR-B-2K-Glass borescope thermal imaging camera, specifically developed to return precise temperature measurements in glass furnace applications. Finally, the Cyclops C100L handheld portable pyrometer is also featured, which is designed to provide accurate, point-and-measure temperature readings between 600–3,000°C.

“Our specifically designed instruments provide accurate results at key locations throughout the process, meeting the highest standards of quality and reliability,” said Philippe Kerbois, Global Industry Manager – Glass at AMETEK Land. “This application note will support glass manufacturers in finding the right solutions to suit their own application,” he added.

www.ametek-land.com



AMETEK Land's new application note identifies key locations where accurate and reliable temperature measurements are critical.

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O-I Glass leader receives national Women in Manufacturing Award



Monica Pacheco.

Monica Pacheco, a Global Glass Science Engineer at O-I's World Headquarters in Ohio, USA, received a 2022 Science,

Technology, Engineering and Production (STEP) Ahead Award on 28 April in Washington, D.C.

Ms Pacheco is among 130 women being recognised nationally by The Manufacturing Institute; the award celebrates and honours women who have achieved significant impact in the manufacturing industry.

"I am honoured to receive this award and represent all the talented, high performing women at O-I," said Ms Pacheco. "I hope this award demonstrates to young women around the world what's possible, within the fields of engineering, technical and manufacturing, when you respect all people, have passion for the process, understand the importance of teamwork, and constantly strive to perform high quality work."

Ms Pacheco's career began with an internship with O-I 12 years ago. She then went on to become lab technician followed by batch and furnace manager at O-I's plant in Soacha, Colombia and then, glass scientist for Latin America. Today, as a global glass science engineer, Ms Pacheco leads a global team and is responsible for

establishing and standardising best manufacturing practices globally. She also formulates the glass recipe and provides technical support for Industria Vidriera de Coahuila, in Mexico, a 50/50 joint venture between O-I Glass and Constellation Brands and the largest glass factory in the world.

o-i.com ●

GIMAV elects new board officers for flat glass



Nancy Mammaro.

Having received approval for a new contribution resolution and completion of its roster of board officers, GIMAV, the Italian Association of manufacturers and suppliers of machinery, equipment and special products for glass processing, has elected Nancy Mammaro Vice-President and Nicola Lattuada Deputy Vice-President responsible for flat glass.



Nicola Lattuada.

CEO of Mappi International Srl, Nancy Mammaro has been a Board Member and, since 2016, Vice-President of GIMAV, focusing her efforts on ensuring that Italy's glass industry continues to grow and excel around the globe.

Nicola Lattuada is a Partner at Adelio Lattuada Srl and President of Lattuada North America Inc. He has been a GIMAV Board Member since 2016 and Vice-President since 2018. Among the most active board participants during both terms in office, since late 2020, due to his

knowledge of the membership base, Mr Lattuada participated in the implementation of GIMAV's reforms plan introduced by President Michele Gusti.

www.gimav.it/en/ ●

Massimo Antonini remembered



Massimo Antonini.

On 27 February 2022 President of Antonini srl Massimo Antonini passed away. In the 70s Mr Antonini transformed the small family business founded by his parents into a leading company for the construction of annealing lehrs for hollow glass. Dedicated to the business,

Mr Antonini followed his intuition about products and developed Antonini srl over the years, personally taking care of construction, installation, production processes and relationships with numerous customers. He leaves a thriving company, known and appreciated all over the world.

www.antoninisrl.com ●

Former Ramsey Products CEO passes away

Following a four-year battle with amyotrophic lateral sclerosis, on 5 February 2022 William (Bill) C. Hall passed away peacefully, aged 65.

As the leader of a reputed silent chain company, Mr Hall was well known for his significant contributions to the power transmission and conveying industry. He joined Ramsey Products Corporation as a senior mechanical engineer in 1983 and became President and CEO of the company eight years later. In 2019, he turned CEO operations over to Mark Taylor but remained Chairman of the Board of the company. Under Mr Hall's long-standing leadership, Ramsey Products flourished into an international company and gained eight patents due to its engineering innovation. Mr Hall was on the Board of Directors of The Employers Association in Charlotte, North Carolina, and he served as President of the former American Chain Association.

Ramsey Products Corporation emphasised that Mr Hall was revered by all who knew him, both personally and professionally.

www.ramseychain.com ●

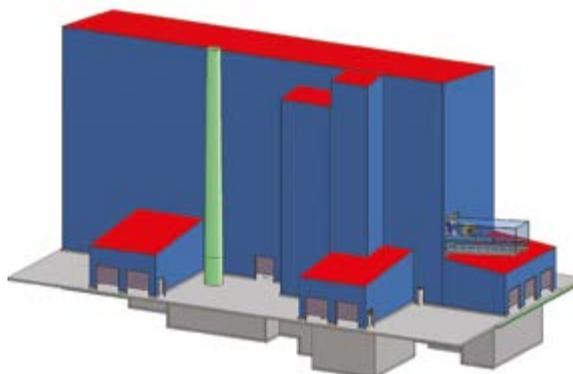
ZIPPE batch plant with extensive silo system for Schott India

Schott India has commissioned a new batch plant from ZIPPE for its Jambusar glass tubing production centre. The batch plant will supply several furnaces on site and commissioning is due in 2023.

A special feature of this new plant is the large silo system, consisting of raw material and cullet silos. In the technically highly complex dosing and weighing system, raw materials are weighed precisely by several scales according to each formula. A high-performance mixing plant then ensures optimal batch distribution.

The scope of supply also includes equipment for the batch transport systems from the batch house to the furnaces with ZIPPE conveyor technology. Scope of delivery includes the basic engineering, project management, detailed engineering of the building installation, delivery of the process equipment as well as supervision, commissioning support and detailed training of the operating personnel. Schott is providing the silo plant and buildings as well as installation works locally.

www.zippe.de ●



Schott India has commissioned a batch plant from ZIPPE.

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On the Spot... Vitaliano Torno

In an exclusive interview, *Glass Worldwide* spoke to Vitaliano Torno, O-I Glass' President of Business Operations, about the strategic priorities of the world's largest glass container manufacturer. In line with the strategic vision of the company, leveraging O-I's global scale and capabilities, and driving collaboration and knowledge-sharing, he is responsible for delivering business performance across the company's global operations.

GW: Having invested significantly in Europe in recent times to strengthen O-I capabilities and market leadership, what is the current status of that initiative?

We made a number of investments into our plants to upgrade them with the latest technology, increase capacity, and further improve the sustainability of our operations. Investments into the Gironcourt plant in 2020 but also more recently Sevilla and Nove Sedlo are testament to that. And just recently, we announced the

plan to invest more than €60 million into the plants in Puy-Guillaume and Vayres in France.

In Puy-Guillaume, the plant, which is also celebrating its 120th anniversary this year, will increase its production capacity, its flexibility and its energy efficiency. The project includes the complete renewal of one of the two furnaces and of one of the attached production lines with new industrial equipment.

In Vayres, the site will be equipped with the new GOAT (Gas Oxy ▶



Recycling content is an important component to sustainability for O-I.

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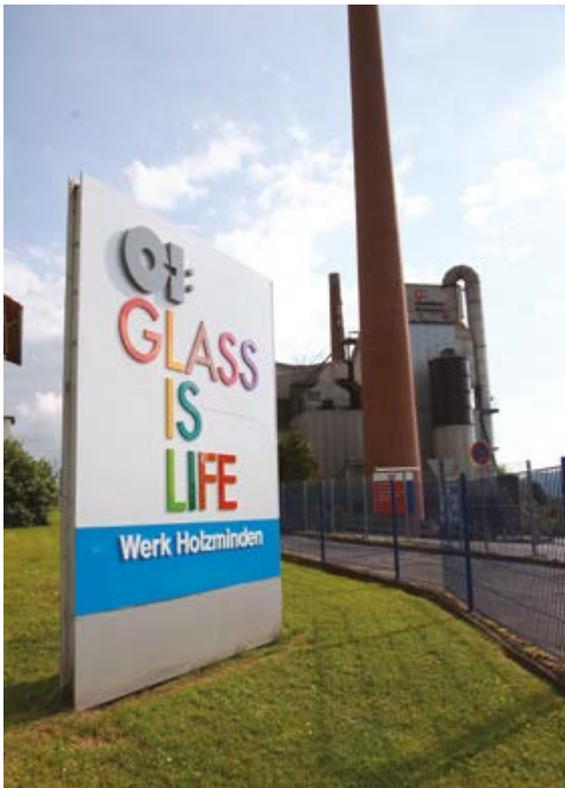
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A full-scale generation 1 line of O-I's MAGMA glass manufacturing technology is located at its Holzminden plant in Germany.



O-I is focused on creating efficiencies in the melting and refining processes through gas-oxy furnaces, reuse of furnace waste heat and more efficient electrically powered equipment.

Advanced Technology), which uses oxygen to reduce our CO₂ emissions by 20% and our NO_x emissions by 60%. The new GOAT furnace will also be equipped with a system recovering energy from the furnace to heat raw materials. By investing in new, more efficient and less carbon-intensive production units, we are positioning the glassmaking profession well into the future.

GW: What are the solutions for addressing aging workforces and recruitment challenges in the glass industry?

First, we are doing more and more to promote the

sustainability of glass. In the current environment, working in a sustainable industry is highly attractive. In addition, a few years back O-I defined its employer value proposition: what does it mean to work for O-I, and what are we offering to employees around the world? We are actively using this concept at job fairs and in the talent acquisition process, for example. Beyond that, we are significantly increasing our efforts in the areas of Diversity, Equity and Inclusion. O-I is an equal-opportunity employer without any bias. We are also constantly adapting our benefits to ensure they remain attractive [to the] changing preferences of our employees. And

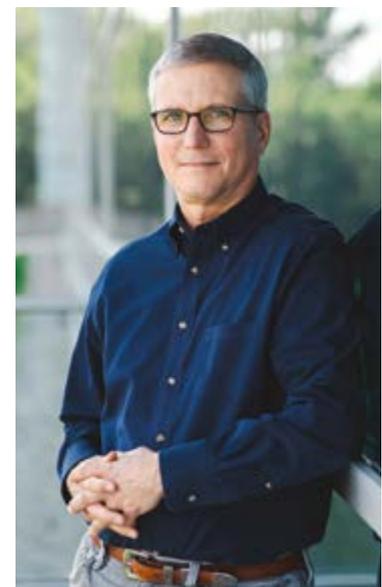
lastly, we are increasingly focusing on core strategic work internally, while leveraging third party experts and automation where possible and appropriate. This elevates many of the job profiles we are looking for, and in fact can make it easier to recruit.

GW: Moving forward, how would you summarise the investment strategy across your production operations?

We are closely monitoring consumer trends as well as supply and demand. If there are new and additional business opportunities to add extra capacity due to increasing demand for glass, for example, we are ready to ▶



Following significant upgrades at Gironcourt in France, O-I plans to invest more than €60m into the Puy-Guillaume and Vayres plants.



Randy Burns' role as Chief Sustainability and Corporate Affairs Officer was created by O-I to elevate sustainability throughout the organisation.



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look at that. We have ambitious goals and are working hard to pursue them, but it can also be a challenging time to invest at the moment – it's not just a matter of investing capital, it's also a matter of availability of equipment, for example.

GW: Are your partnerships and alliances with technology suppliers such as Bucher Emhart Glass, SORG and Tiama assisting with overcoming those present investment challenges?

It's an advantage of working very closely together with highly experienced suppliers that operate globally. They are not only experts with their technology, but they also know their supply chain and deliveries well enough to find solutions in times of a shortage of vessels, for example. We have had to manage the pandemic and that came with insights and learnings on so many levels.

GW: Having recently achieved external recognition, where does O-I's sustainability strategy sit in the plan?

For O-I, sustainability is a journey not a destination. We are continuously examining our global footprint for areas of potential improvement. And this includes our approach to sustainability itself. In 2020, O-I refreshed [its] sustainability strategy to better represent our ambitions. This included the appointment of Randy Burns as our first Chief Sustainability Officer. [see *Glass Worldwide* January/February 2021, p.S8]



Working closely with experienced suppliers that operate globally provides advantages to O-I.

Through the appointment of a CSO, we have built a global network across our company footprint to unify and coordinate our sustainability vision—to be the most innovative, sustainable, and chosen supplier of brand-building packaging solutions.

We are focused on creating efficiencies in our melting and refining processes through gas-oxy furnaces, innovative reuse of furnace waste heat, and more efficient electrically powered equipment. We are committed to increasing recycled content – developing closed loop networks to keep recycled glass in the manufacturing stream and out of landfills. But, at the same time, we are working to transform the future of glassmaking through our Modular Advanced Glass Manufacturing Asset (MAGMA) which will revolutionise the container glass manufacturing process.

So, while these recognitions are demonstrating that our sustainable vision has made tangible progress, our journey is one of innovation and transformation that will continuously

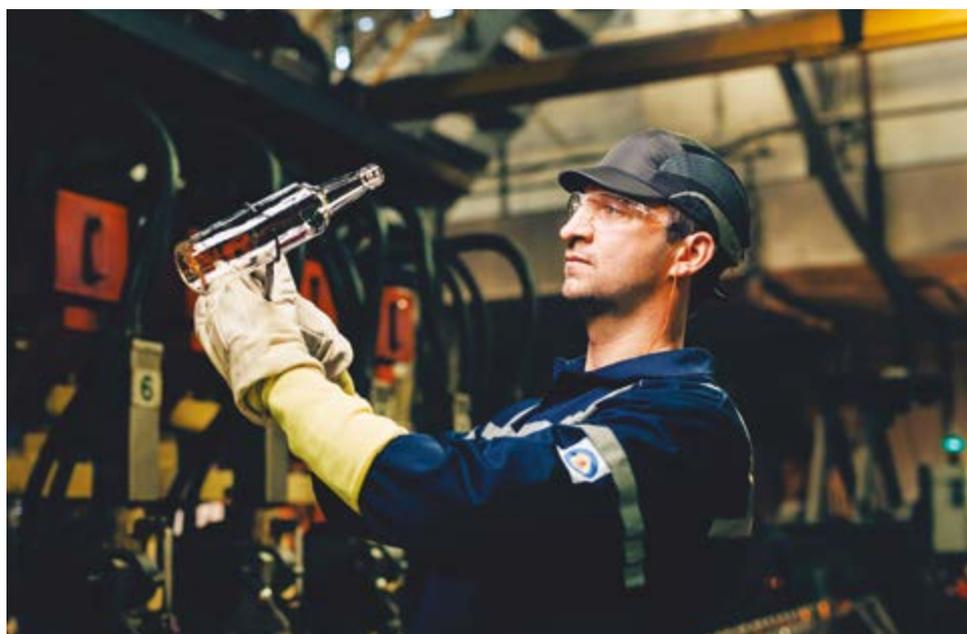
balance our products and operations with the needs of society and the planet.

GW: Ahead of MAGMA or other initiatives revolutionising the glass melting process, what are O-I's current preferred furnace technologies?

We are currently building a number of oxy-fuel furnaces. While not the final glass melting solution, they are a highly pragmatic and sustainable solution for what we need to act upon today before we start bringing our MAGMA technology on stream.

GW: What was the reason for the recent sales of the Cristar and Le Parfait tableware businesses as part of O-I's Ongoing Portfolio Optimisation Programme?

These transactions are examples of O-I's strategy to focus on our core business of manufacturing and selling glass containers, and create value for all our stakeholders. We see significant and attractive expansion opportunities based on, for example, O-I's revolutionary MAGMA innovation, and we will use the proceeds from these sales to fund the expansion. Cristar and Le Parfait were successful and profitable businesses... but in the end they are tableware and not our core container glass businesses. ●



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Borosil Renewables' Bharuch facility in Gujarat is currently the focus of significant investment.

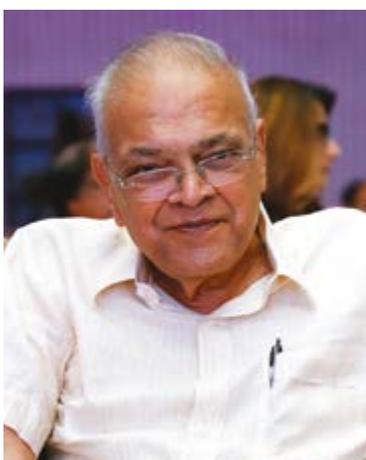


On the Spot... Shreevar Kheruka

Managing Director Shreevar Kheruka outlines Borosil's expansion plans to cater for increased demand across its diverse solar glass, consumer productions and life sciences divisions in an exclusive interview with *Glass Worldwide*, preferred international journal of the All India Glass Manufacturers' Federation (AIGMF).

GW: Following the sad passing last December of Borosil's Executive Chairman Mr B L Kheruka, what legacy did he leave behind within the company and the wider glass industry?

"Leave every place you visit in a better condition than it was when you entered." This seemingly simple learning played a large part in all aspects of my grandfather's existence. As he departed this life on 12 December 2021, he leaves behind a family that has strived



Mr B L Kheruka, Borosil's Executive Chairman, passed away last December.

to create a positive impact through all its members and two companies that have added tremendous value to all their stakeholders. He also leaves behind a shining path of values such as integrity, discipline, hard work and giving back, for all of us to follow. Finally, he leaves behind his love and passion in all of us.

GW: What is the progress of the new brownfield solar glass plant being constructed at Borosil Renewables' Bharuch facility in Gujarat?

The construction of the third furnace is in full swing and it is expected to get commissioned by July 2022. Our project team, the equipment suppliers, and associates working on project construction have done a commendable job to stay on the project schedule despite supply chain disruptions and various restrictions being faced in view of the ongoing Covid-19 pandemic. We hope there are no further challenges to the schedule!

GW: Following the doubling of Borosil Renewables' capacity in 2016 and a further successful upgrade and expansion project in 2019, what is the motivation for the latest significant increase?

We more than doubled the capacity to 450tpd in 2019 from the earlier 180tpd in view of the increasing demand for solar glass in India and abroad. Due to a very positive outlook from governments across the world, the demand for solar power is increasing substantially. Moreover, the political and regulatory support for the creation of a robust domestic supply chain has created a conducive environment for domestic players like us. We firmly believe that domestic solar manufacturing industries in geographies like India, Europe, the Americas,

Turkey, MENA, etc. are on the cusp of significant growth, and demand for solar glass in these geographies is expected to increase substantially. Since we have been catering to these markets and have long-term relationships with the customers, we were motivated to expand our capacity.

GW: What are the highlights of this investment?

This is a 550tpd integrated (from raw materials to tempered coated solar glass) solar glass manufacturing capacity being built with state-of-the-art technology from the best-in-class equipment suppliers. We have added several types of equipment in this expansion that will be compatible with changes that are expected to take in the solar industry in near future in terms of sizes, thicknesses, coatings, etc. This is a brownfield expansion and the available land, utilities and permits are already available. The team of professionals, contractors and equipment suppliers are largely the same that worked on our last expansion in 2019, and hence we are confident that we shall be able to complete the project within the estimated costs and timelines. ▶



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Solar glass production at the Borosil Renewables factory.

GW: Is it still your policy to adopt state-of-the-art technology from renowned international suppliers? Which partners were selected for the latest expansion?

We have been using state-of-the-art technology since the inception of our factory in 1994 when we successfully used the Pittsburgh process. We are now going for a 550tpd furnace and the design for the same has been sourced from a leading supplier of large furnaces. This furnace design uses a cross-fired technology for charging the fuel for glass melting and is expected to be very efficient and user-friendly. Moreover, such furnaces are expected to have a longer running life before they become due for a rebuild. The other equipment used for glass manufacturing and processing is also from very reputed global suppliers.

GW: And you were also recognised last year for the commercialisation of indigenous technology with an award from the Department of Science and Technology at the Government of India?

Last year, the Department of Science and Technology, Government of India honoured us with the National Award for 2021 for the development and commercialisation of indigenous technology. This is a very prestigious award and we are very proud of our team for this achievement. Innovation and continuous improvement in the areas of products and processes are the values ingrained in the DNA of the Borosil group and these are the main reasons for our survival and success as well as growth.

In Borosil Renewables Ltd. we have successfully been able to commercially develop the world's first

antimony-free solar glass. We are also the first company to develop the commercial capability to fully temper solar glass in 2mm thickness. Other recent product developments include the high efficiency 'Shakti' solar glass and 'Selene' Anti-glare solar glass.

This award is great recognition from the government of India and is a testimony to our efforts in developing new technologies and products. It is important to note the previous awardees for this recognition are very reputed industry names such as Reliance Industries, Larson and Toubro, Nuclear Power Corporation, etc. and it is our honour to join this prestigious league.

GW: What are the current and future prospects for the solar market in India and following the brownfield expansion, how well equipped will Borosil be to meet this sector's needs?

The solar market is one of the fastest-growing markets across the world in terms of solar installations as well as manufacturing activity. With a very strong political will and regulatory support for domestic manufacturing, the solar module and component manufacturing in India is expected to grow manifold in near future. The installed manufacturing base of around 15GW per year of solar module capacity is expected to cross 50GW per year within the next three years. Borosil Renewables is very well placed to meet this demand as we have a strong relationship with the customers, a high-quality product, the global certifications for our glass, and our customers' modules certified with our glass. Being a domestic supplier, we are able to offer certain unique benefits to our customers such as shorter delivery time, flexibility in terms of changes in glass sizes, ease of doing business, etc. With the upcoming expansion and the next set of expansions in the near future, we are very well equipped to meet the future demand.

GW: What is the strategy for future investment at Borosil Renewables?

We expect to complete the ongoing expansion by July 2022, taking the installed capacity to 1000tpd. We have obtained enabling approvals from our board for the installation of our 4th and 5th furnace at the same location with 550tpd, which are expected to get commissioned by Q4 of CY2023 and Q4 and CY2024, taking the installed manufacturing capacities to 2,100tpd which should be able to cater to solar module requirement of ~12GW per annum. ▶



Examples of calibrated laboratory glassware.



Performing a bending test on 2mm solar glass.



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GW: How is the company structured to best serve the different sectors?

The board of Borosil Ltd. has approved the restructuring of the business of the Company into two separate listed entities by a composite scheme of arrangement. As you are aware, Borosil Ltd. operates two distinct businesses viz. consumer products and scientific products. The consumer business comprises glassware, non-glassware and Opalware product ranges for usage in the kitchen and for serveware, while the scientific business is made up of laboratory glassware, laboratory instrumentation and primary pharmaceutical packaging. Both the businesses have been functioning as separate profit centres with separate business heads and largely independent teams. Each is responsible for delivering on their own profit & loss and this has been the case for quite a few years now. Going forward, each of these businesses has distinct capital and operating requirements. The growth path and organic and inorganic growth potential is different, which entails different capital-raising requirements. Consequently, the scientific business will be demerged from the Borosil Ltd business. Pursuant to this demerger, Borosil Ltd will house the consumer products division of the company and the demerged scientific division will be housed in a separate company that is proposed to be named as Borosil Scientific Ltd. This company too will be listed on the National Stock Exchange as well as the Bombay Stock Exchange upon completion of this scheme. We expect that this scheme will further create value for all stakeholders of our company.

GW: How is Borosil Ltd, the household and laboratory glassware production business, performing?

Borosil Ltd houses our consumer products, scientific & industrial products, and pharmaceutical packaging businesses. Consolidated revenues for this business YTD Q3 2022 saw a very healthy growth



Borosil's Classic Delite ware.

www.glassworldwide.co.uk



of 54% compared to YTD Q3 2021. The EBITDA [earnings before interest, taxes, depreciation and amortisation] of the business grew to \$16.61 million in YTD Q3 2022 from \$8.88 million in YTD Q3 2021. These represent a strong operating result even with the harsh second wave of Covid that hit India very hard between April – June 2021.

Our consumer division (including glassware and non-glassware products) has seen a good bounce back in sales across all our key product lines. In fact, in each of our main categories, the sales during the nine-month period ended December 2021 exceed the sales for the entire 12 months of FY21.

Net sales of Scientific and Industrial products during the nine-month period ended December '21 registered a growth of 35.5% over the same period last year. We have embarked upon a strategy to add new avenues of growth to supplement its domestic lab glassware by foraying into the export markets for lab glassware and introducing a range of lab instrumentation in India. Both these initiatives are beginning to contribute towards the healthier top-line growth of the scientific business.

Borosil's vials and ampoules brand of pharma packaging products, Klasspack registered a sales growth of 61.7% over a nine-month period of the previous financial year.

GW: How would you describe prevailing market conditions in the sectors served by this business?

Despite a few variants of Covid emerging and there being a substantial rise in the number of cases, the impact has not been as severe as earlier waves, partly on account of the vaccination coverage. After a decline of maybe 8% in FY21, GDP growth for the country is estimated at 11% during this financial year. This bodes well for a recovery in demand.

Our consumer business has significant tailwinds for a few reasons. It is obvious that the larger theme of people upgrading their lifestyles from steel and melamine has continued towards the more contemporary glass.

Secondly, with Covid lots of get-togethers have been at home over going to restaurants and that has definitely led to people improving their lifestyles at home. Thirdly, in general, people are increasingly aware of the environmental and health impact of many plastics and are therefore looking for substitutes. Glass is becoming an increasingly preferred alternative here. Finally, we have clearly seen a reduction in imports from China and that is due to high levels of freight. So, owing to all these factors, we certainly see domestic demand has become stronger.

The growth in the scientific and industrial products business was despite schools and colleges still remaining broadly closed and even government institutes having limited funding. However, on the flip side, pharmaceutical companies have been growing substantially and our presence in this segment has boosted our revenues from all three of our product categories viz. lab glassware, lab instrumentation as well as pharmaceutical ▶



Ashok Jain of Borosil Renewables with the AIGMF's prestigious 2021 Balkrishna Gupta Award for Exports.




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In recognition of his achievements, the late Mr B L Kheruka was the 2019 recipient of the AIGMF's C K Somany Award for Innovation and Technology.

packaging. There has also been a jump in our export sales of laboratory products owing to our world-standard manufacturing capabilities and I am happy to say that the number of countries we export to has increased exponentially.

GW: What have been the highlights of investment into Borosil Ltd's manufacturing facilities since we last spoke in 2019?

We have already announced expansion projects for the consumer and scientific business during the first two quarters. Firstly, the project towards

capacity expansion for Opalware production in Jaipur would take the capacity of our plant from 42tpd to 84tpd. Secondly, we are starting up the production of pressed borosilicate ware in India with an initial capacity of 25tpd, also at our Jaipur plant. We expect production of Opalware from the expanded capacity to commence sometime in the Q3 of CY22 and production for borosilicate glass press products to commence in Q2 of CY23. Finally, we have also announced an upstream project for the manufacture of glass tubing (due to uncertainty in the global supply chain as well as increased cost) with a capacity of 24tpd in Bharuch, which is likely to be commissioned by Q3 of CY23. The expansion of our production capacity for vials (close to double the existing capacity) and ampoules has also started and all orders to this extent have already been placed.

GW: In general across all Borosil's operations, is investing in digital platforms still a priority to enhance manufacturing operations?

We have identified the potential of digital platforms and data for the businesses of Borosil Ltd and Borosil Renewables Ltd. We have either implemented or are in the process of implementing various digital solutions in the area of automation of the manufacturing process, improvement of the quality assurance process, the relevant CRM solutions and data analysis to make informed [investments]. We still have some ways to go to entirely achieve Industry 4.0; however, our team is committed to the same and we have been taking various steps in this direction.

GW: With Borosil having been recognised externally for its efforts in recent times, what importance is the company placing on sustainability?

The sustainability aspect has been at the very core of operations for Borosil. To give a few examples, the energy consumption of our solar glass manufacturing process is about 1100kCal/kg compared to ~1600kCal/kg that global leaders in solar glass are able to maintain as per our estimate. In addition, according to a life cycle assessment analysis carried out by a very reputed French institute, the carbon footprint of our operations is 22% lower compared to the default score of the glass industry. Moreover, other steps such as developing a toxin-free solar glass and employing reusable packing help make us more environmentally friendly.

As we all know, people are the key to any business. Our efforts on sustainability go beyond products and operations and we also focus on the well-being of all our stakeholders. We have been actively working on various initiatives in the area of water conservation, improvement of health outcomes for low-income citizens, female education, sports, etc. With the help of a very reputed organisation, we have been able to contribute towards a manifold increase to the income of farmers in the severe drought-affected Beed district of Maharashtra. Further, our employee policy that we announced during the Covid-19 pandemic to support the families of any deceased Borosil employees was considered an industry benchmark and was subsequently adopted by several leading Indian corporates.

To take these credentials to a next level, we are working on the development of the ESG [environmental, social and governance] roadmap and have identified critical areas where our teams would be working on to achieve the global benchmarks on various parameters of ESG.

GW: Following Mr B L Kheruka being awarded the prestigious C K Somany Award in 2019, what did it mean to Borosil to be the recipient last year of the AIGMF's sister award, the Balkrishna Gupta Award for Exports?

We are truly thankful to AIGMF for honouring Borosil Renewables with the prestigious Balakrishna Gupta award for Exports. It is pertinent to note that when we started the business of manufacturing solar glass, it was primarily from the view of catering to the export market. Back in 2010, the Indian solar manufacturing industry was in its nascency. Even today, we export nearly 20–25% of our products to customers spread across various geographies such as Western Europe, the Americas, Russia, Turkey, MENA countries, etc. The sale in export markets helps keep us updated on various areas like emerging technology trends, quality requirements and also provides us with a risk diversification. We have been consistently meeting the requirements of our customers worldwide and have a long-standing relationship with them. Solar module manufacturing across the globe is expected to increase as the need of local supply chains is being felt in most of the geographies. With our existing presence in these geographies, exports are expected to grow significantly in the near future. ●



Shreevar Kheruka addresses staff at the Borosil glassworks.

Further information:

Borosil Ltd, Mumbai, India
tel: +91 22 6740 6300
email: borosil@borosil.com
web: www.borosil.com

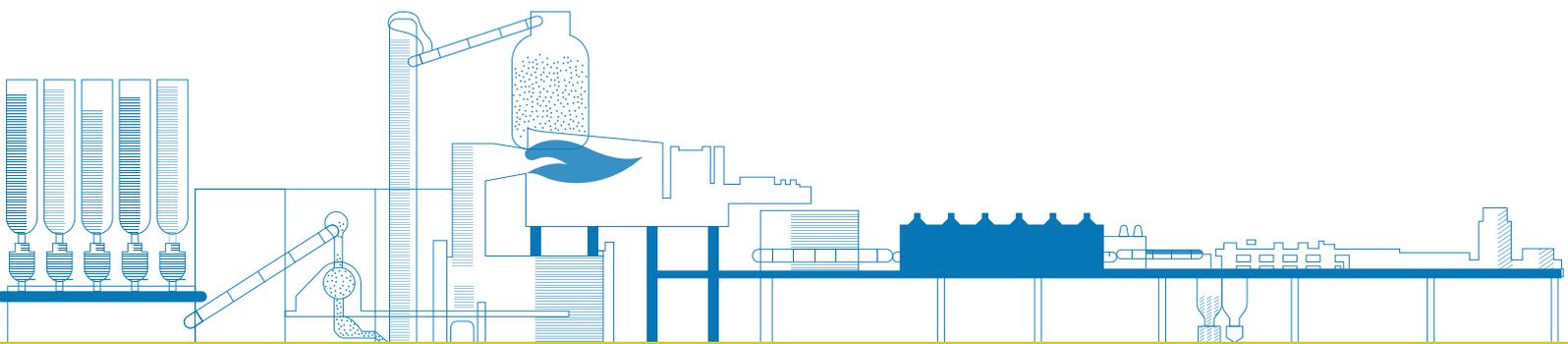
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New furnace brings speciality glass opportunities

Investment in a 154tpd clear glass furnace and five production lines at AGI glaspac's Bhongir manufacturing facility will enable the company to export to countries such as the USA, Australia and to Europe, as well as India.

Glass Worldwide, preferred international journal of the All India Manufacturers' Federation (AIGMF), spoke exclusively to Rajesh Khosla, AGI's President & CEO about the company's entry into the speciality glass sector.



Rajesh Khosla, President & CEO of AGI glaspac.

AGI glaspac's recent INR 400 crore (\$52.2 million) investment at its Bhongir facility will provide substantial opportunities for the Indian glass manufacturer. Not only will it expand the company's capacity to produce speciality clear glass but it will also enhance its opportunities to produce glass for export, according to the company's President and CEO Rajesh Khosla.

"AGI glaspac's entry in the new segment of manufacturing speciality glass is a strategic decision. It will allow us to cater to the much-expected rise in the global demand after the pandemic subsidies," he explained.

The facility has been set up in line with the company's 'Make in India' and 'Aatmanirbhar Bharat' (self-reliant India) vision. It will help reduce dependency on imports, as well as promote sustainability by encouraging various industries to opt for glass products over plastic. The company foresees top line growth of not less than 15–18% by 2022–23.

Furnace

AGI glaspac's Bhongir facility operates alongside the company's 600tpd¹ glass plant in Hyderabad. The company has



The new set-up means the Bhongir plant can produce 154tpd of premium flint and other different colours.

served its clients in the liquor, wine, food, chemicals and pharma industries worldwide with commercial and Type-1 glass for more than 40 years.

The Bhongir furnace has a capacity of 154tpd, or the equivalent of 2 million (20 lakh) containers and bottles per day. From its five manufacturing lines spread across 15 acres, the facility will make high end glass bottles, vials and containers to cater to the requirements of sectors such as cosmetics and perfumery, pharmaceuticals, premium spirits, food and beverages as well as water bottles and candle jars. Construction of the unit has meant the company can not only focus on the domestic market, but also export to countries such as the USA, Australia and to Europe.

Pandemic

Like the rest of the world, AGI glaspac had to grapple with the problems caused by Covid-19, particularly as the impact of the pandemic coincided with the construction of the Bhongir facility. Mr Khosla says the impact of the pandemic caused many businesses to struggle with new ways of life and to grasp what it would mean for their operations. It was an issue particularly pertinent to construction projects and capital expenditure programmes due to their many components.

"There were delays, loss of efficiencies and cost impacts because of Covid-19 and related regulatory responses, and there was little to no precedent to help companies

understand what the potential future impacts of Covid-19 on the capital project and construction programmes may be, or when restrictions may end," he explains. "Even if project planning, design, and management did not stop altogether, work was likely to be more costly and to take more time."

The support of the local Telangana state government was instrumental in the success of the project. It not only provided state relief, but was also one of the first states to allow industries to continue their production from May 2020 onwards, even while restrictions continued elsewhere in the country.

Currently AGI has invested approximately INR16 billion (US \$208.8 million) in its facilities in Telangana and is keen to invest further, driven by the ecosystem enabled by the state government. One disappointing impact of the pandemic was that the company has had to put its plans for a 700 crore (\$91.3 million) expansion in the east of India on hold.



Approximately INR16 billion has been invested by AGI into its facilities in Telangana.

Bhongir facility

According to AGI, the commissioning of its new furnace has seen the Bhongir campus emerge as one of the largest, single location glass facilities in the world. The glassworks will now have a combined capacity to process 1,154 metric tonnes of glass per day and produce about 7 million (70 lakh) bottles and containers per day.

“We are looking at the new facility adding revenues of Rs 250–300 crore

(\$32.6million) and targeting capturing a 10–15% share of the speciality glass segment in India,” says Mr Khosla.

Growth opportunities

AGI is confident that its flint glass furnace will open opportunities and enable the company to reach new customers in a post-pandemic business environment. The pandemic has resulted in geopolitical disengagement with certain countries and will leave the



AGI glaspac's glass plant in Hyderabad has a capacity of 600tpd.

glass industry with a huge void and a shortfall of suppliers or importers in the future, predicts Mr Khosla.

“We believe that it is a huge opportunity for Indian manufacturers and start-ups from various industries to increase exports and reduce imports,” he expounds. “It is a golden opportunity to raise the bar in the international markets for ‘Made-in-India’ products.”

AGI already has plans to invest in both greenfield and brownfield expansion in future years.

Another potential growth opportunity is via acquisition of other Indian glassmakers. Mr Khosla does not rule out any such acquisitions, providing they give value to AGI’s customers.

“Definitely, it makes a lot of synergy for [our] existing glassmaking business because it gives us an ample opportunity to grow but at the same time we are also evaluating various other opportunities, so that we can further enhance the sales.” ▶

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AGI exports to the US, Australia and a few markets in Europe.

Rajesh Khosla believes adopting the latest technology from renowned suppliers is critical to the company's success.

Skilled workforce

The entry into the speciality glass segment means the company will engage more than 4,600 people, including direct and indirect employees. The total strength of the team is 14,700, which should grow to 19,300 by the end 2022.

It is testament to the perseverance of AGI glaspac staff that, despite the challenges posed by the pandemic during the construction period, the furnace was fired on time, on 24 January.

“Developing and sustaining a skilled technical workforce is a high-priority goal for AGI,” states Mr Khosla. “We are making substantial investments in achieving a broad range of education and training goals.”

In a talent-based economy the workforce itself is arguably the most important tangible asset of most organisations, he states. Yet despite its importance, it is often not carefully planned, measured, or optimised, which creates challenges



AGI glaspac been designing and manufacturing glass bottles and jars for over 49 years.

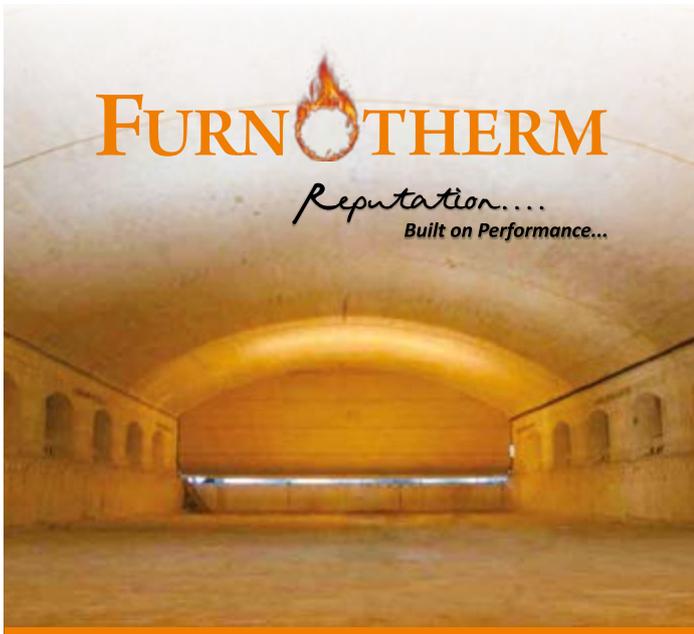
in terms of a gap between intent and execution. Consistent objectives regarding the outputs of workforce planning, and a consistent process of conducting workforce planning and predictive modelling can bridge this gap, states Mr Khosla. Such is the company's commitment to its staff, it has modified its workforce development practices to include options that potentially accommodate the diverse needs of its employees.

Supplier support

While communications with staff are a key component of the company, relationships with technology suppliers are also essential to the success of the company. In the past AGI has partnered with companies including Agr International, Bucher Emhart Glass, Dukhiram, EMS Group (Zecchetti), Furnotherm, Heye International, HORN Glass Industries, IRIS Inspection machines, Lubitech, Pennekamp, Shamvik, Sheppee International, Sonicam, SORG, Strutz International and ZIPPE.

Mr Khosla is quick to recognise the contribution these companies have made to AGI glaspac's growth.

“Suppliers are critical to the success of any company. They drive new growth within your industry and ensure you are able to achieve revenue and profit goals. They are at ▶



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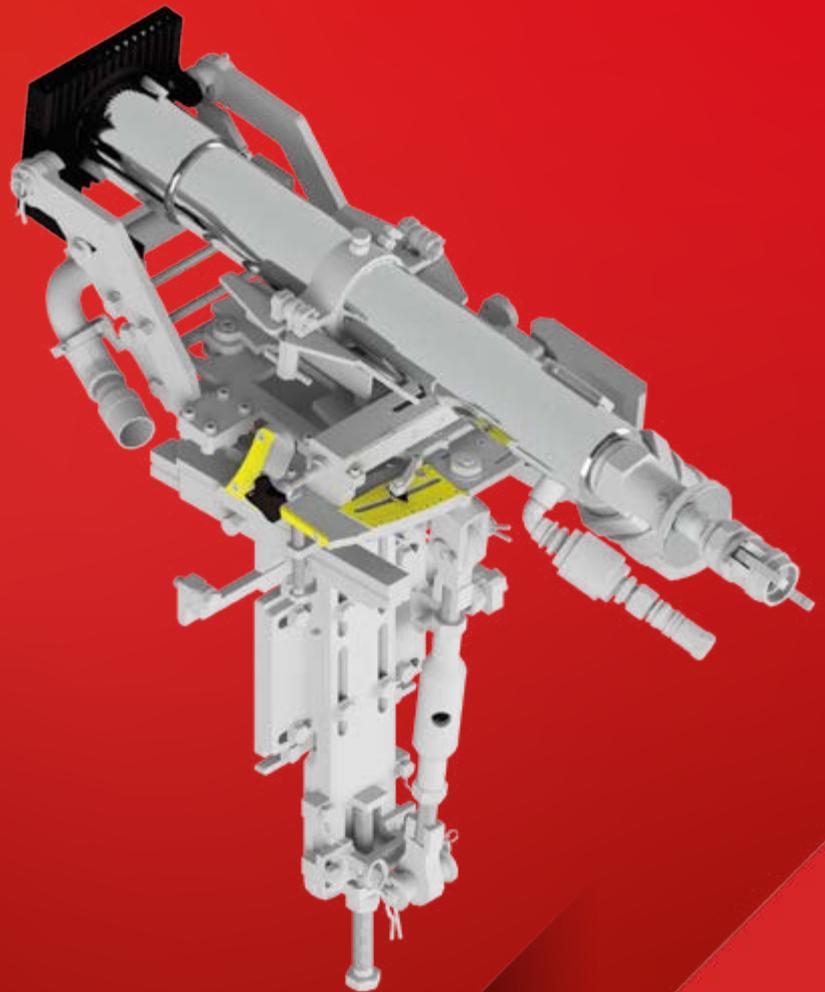
With Hyderabad and Bhongir facilities combined, AGI melts 1600 tonnes of glass per day.

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Developing and sustaining a skilled technical workforce is a high-priority goal for AGI.



AGI manufactures high-quality glass containers for sectors including food, pharmaceuticals, soft drinks, spirits, beer and wine.

the heart of any organisation's processes and activities.

"However, you might not consider how important it is to effectively manage your relationships with them," he stresses. "In the past, procurement was simply the department that bought goods and services. Nothing more, nothing less.

"But now, procurement should be considered a part of your overall business strategy. To get the best value for your money, you should be taking a strategic approach to efficiently manage your suppliers. Doing so will have myriad beneficial effects."

During these unprecedented times, the AIGMF was pivotal in keeping its members updated about the latest market dynamics, notes Mr Khosla. "The best part was peer learning that we get through the platform, which enabled [...] better decision making."

As the world emerges from the pandemic and restrictions begin to ease, Mr Khosla is looking forward to meeting equipment suppliers and other

members of the glass industry again at glasspex INDIA and the parallel 13th International Conference of the AIGMF in Mumbai in September next year. ●

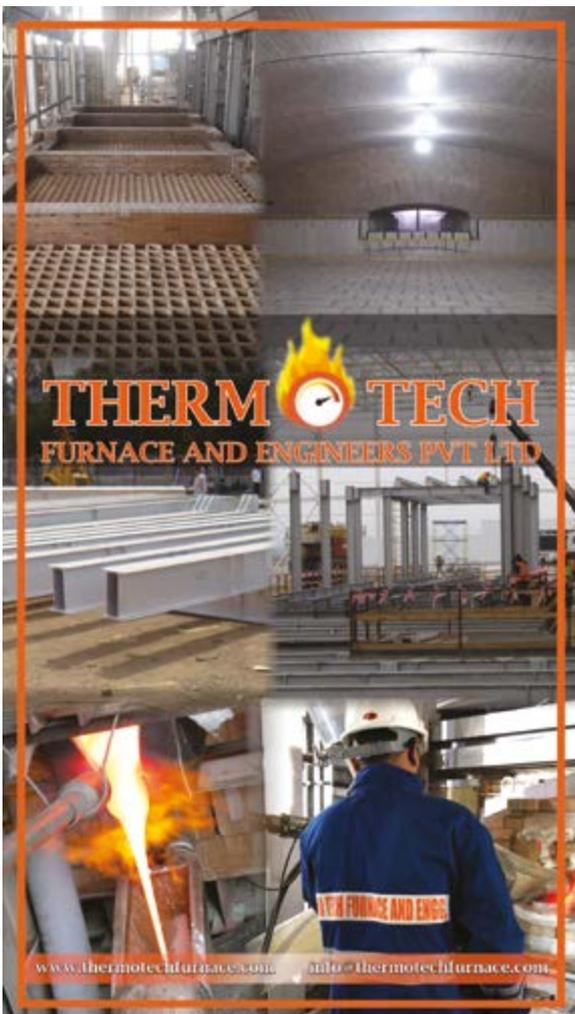
1 Source: AGI glaspac website



AGI glaspac has a stringent eco-friendly policy in place as well as a policy to always maintain ethical and transparent business practices.

Further information:

AGI glaspac, Hyderabad, India
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Rajesh Khosla is confident that glasspex INDIA 2023 and the parallel 13th International Conference of the AIGMF will be a grand success. As preferred partners, AIGMF and Glass Worldwide share an exhibition area.

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Şişecam's headquarters in Istanbul, Turkey.

Promoting the strategic role of glass

At the opening ceremony for the International Year of Glass 2022 held in Geneva, Şişecam's Chairman Prof. Dr. Ahmet Kirman emphasised the strategic role of glass for a sustainable future.



Şişecam Chairman Prof. Dr. Ahmet Kirman.

In a world where the importance of sustainability is increasingly recognised and embraced, the strategic role of glass for a healthy future becomes ever more prominent. This remarkable material has been – and continues to be – one of humanity's greatest solution partners. The year 2022 was declared the 'International Year of Glass' by the United Nations (UN) and a wide range of awareness-raising activities are taking place around the world. The opening ceremony for the International Year of Glass was held at the United Nations Office in Geneva, Switzerland, from 9–11 February (see previous issue, page 18).

Glass manufacturer Şişecam was one of the main sponsors of the

event held by the International Glass Commission (ICG) and attended by leading representatives from the global glass industry. The opening ceremony featured a closing speech by Şişecam Chairman Prof. Dr. Ahmet Kirman. In addition, Şişecam Glass Technologies Director İlçay Sökmen delivered a presentation on innovative products developed by the company's scientists, explaining how these have added value to many industries, from health care to agriculture.

Supporting modern human history

In his speech Prof. Dr. Kirman pointed out that glass has added value to the development of civilisations and human life from past to present. Glass also promises to be one of the most strategic materials of the future with its sustainability-oriented features. He elaborated: "... Şişecam was founded 86 years ago, in 1935, with the vision and directive of Mustafa Kemal Atatürk – the founder of the Turkish Republic. As one of the most specific initiatives of a young republic's industrial-based development drive, Şişecam has sustained its value-creating growth over many years. It has transformed into a strong corporate enterprise with a global reach. Today, our operations have expanded to 14 countries. On one hand, we take great pride in the values we create and embody. On the other, we also feel the weight of our evolving and deepening responsibilities for future generations."

The history of glass dates back 5,000 years, observed Prof. Dr. Kirman. Glass production is considered one of the most important developments and main supporters of modern human history, he continued: "The perception of glass has evolved immensely over the last two centuries with groundbreaking innovations. Progress in glass technology has helped meet the basic needs of modern society in critical areas – including architecture, transportation, medicine, energy, communication, agriculture, and imaging technologies. There is no doubt that glass, which is already indispensable in its traditional use, will be the main

component of many different and new applications in the future thanks to its unique transparency, formability, hardness, low cost, widespread availability and sustainability features."

Unlimited development

Prof. Dr. Kirman indicated that the world has entered a new era with the Covid-19 pandemic that started in late 2019, noting that: "A material like glass that is 100% and infinitely recyclable is one of humanity's greatest assets. On this occasion, we should remember that glass has helped humanity face challenges in every arena with innovative products and technologies. A recent example is the V-Block antimicrobial coating technology developed by Şişecam during the pandemic period. The endless potential of glass for development attests to the important position it will surely occupy in the future. As key stakeholders of the glass industry, we are responsible for extending the incomparable contributions of glass to every field it can enter and expanding its area of benefit."

Fighting climate change

Prof. Dr. Kirman emphasised that Şişecam is aware of its responsibilities as the only global company operating in all core areas of glass manufacturing in the world. "One cannot ignore the alarms sounding from nature in many ►



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V-Block Technology was Developed by Şişecam's Science, Technology and Design Centre.

different parts of the world today.” He also said that the world can only achieve 8.6% of circularity at present. Glass is the material with the greatest promise due to its circularity. Prof. Dr. Kirman also stated, “Targeting recovery in every area where glass is used is a crucial opportunity for our planet in the fight against climate change. Şişecam’s 2030 sustainability strategy ‘CareforNext’ responds to the evolving challenges and needs of societies

and our planet and is based on the UN’s Sustainable Development Goals. Şişecam carries the glass legacy forward, by focusing on ‘Protect the Planet,’ ‘Empower Societies,’ and ‘Transform Life’ pillars. As part of the company’s ‘Transform Life’ strategic objective,

Şişecam plans to maintain and expand its sustainable solutions to meet the changing needs of our planet and our societies. Further developing our existing products with research studies based on life cycle analysis is a central part of our sustainability goals. Thanks to its unique structure and value-added qualities, glass contains a huge diversity of uses and richness that directly serve the United Nations’ Sustainable Development Goals. With these goals in mind, Şişecam is carrying out many initiatives. We are developing solutions for energy glass, supplying glass fibre for wind turbines, and promoting the transition to low-e glass. In short, Şişecam is taking action in many areas. We are actively supporting intensive R&D studies on advanced furnace control technologies, recycling of glass, electricity generation from renewable resources to power our facilities, and innovative furnace technologies. Şişecam is also continuing its science-based target setting studies to limit global warming to 1.5 degrees.” ▶



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Prof. Dr. Ahmet Kirman was a speaker at the International Year of Glass opening ceremony in Geneva in February.

Taking responsibility

Prof. Dr. Kirman stated that Şişecam is boldly taking responsibility to protect, empower and transform its ecosystem: “This understanding and sense of responsibility lies at the heart of Şişecam’s intensive efforts to declare 2022 the International Year of Glass”, he explained. “As an active member of ICG [International Commission on Glass] – the most prestigious institution of glass science in the world – Şişecam has supported the goal of United Nations International Year of Glass 2022 from the very beginning. We have maintained steady support for this important designation with all our stakeholders. Şişecam plans to work on further boosting the global focus on glass throughout the year. We are proud to take a pioneering role in the development of



Şişecam’s V-Block Coating Technology was initially applied on Paşabahçe glassware products.

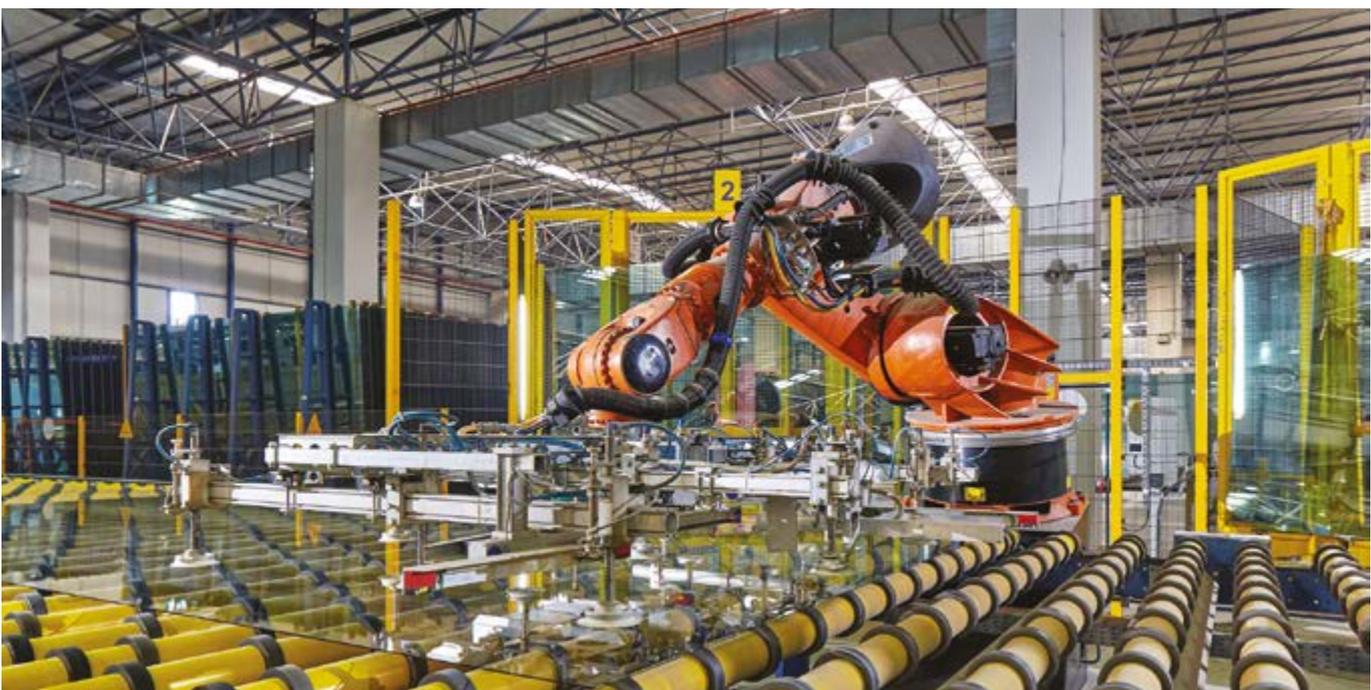
glass, a singularly unique material. Glass responds to the world’s economic development needs without any drawbacks. In addition, glass is one of the most valuable materials of humanity, from the ancient past to the modern-day present. We see glass not only as a line of business but as a service to humanity and economic development. Şişecam has the well-deserved reputation of a global leader operating in the glass industry. Our sector provides high employment and plays a critical role in the development of many other industries.

“I would like to take this occasion to thank, on behalf of all of us, every stakeholder contributing to the development and transformation of glass,” he added. “This includes all those who work near the hot furnaces, engineers who design furnaces, academics who devise research

projects to further develop glass, and associations that stress the importance of glass. The history of humanity is inherently shaped by the tools that human beings use most frequently. As a result, the time is right to raise awareness on the major role of glass in the development of the human mind, language and culture. Şişecam remains committed to taking the lead in adding value to humanity with our industry and improving human lives. We must leave a world as sustainable as glass to future generations. Şişecam will always do what is necessary to ensure a sustainable tomorrow,” he concluded. ●

Further information:

Şişecam, Istanbul, Turkey
tel: +90 850 206 5050
email: sise@sisecam.com
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SGD Pharma's Saint-Quentin-Lamotte plant.



On the Spot... Christophe Nicoli

Last October global manufacturer of primary glass packaging for the pharmaceutical industry SGD Pharma was acquired by European private equity firm PAI Partners (PAI). SGD Pharma CEO Christophe Nicoli spoke exclusively to *Glass Worldwide* about his ambition to accelerate the company's growth trajectory through organic and external initiatives, mobilising PAI's resources and expertise in the packaging and healthcare industries.

GW: Since PAI acquired SGD Pharma from China Jianyin Investment Ltd (JIC) last year, what impact has the change in ownership had on the business?

The transition to PAI Partners is an exciting time for SGD Pharma. PAI is a French-based private equity firm, choosing to invest in SGD Pharma having watched the leadership team's skilful navigation of global markets and opportunities, leveraging a growing and resilient pharma market. This investment builds on the considerable management support in SGD Pharma's industrial and strategic plans provided by JIC since 2016.

SGD Pharma is currently market leader in moulded glass for pharmaceutical packaging, and

the support of PAI is enabling the leadership to focus on new areas of growth, investment and innovation. We expect the new strategic plan to be implemented from 2022 and will deliver on our existing global strengths.

The change in ownership gives SGD Pharma a new opportunity, particularly given the turbulent two years the world has experienced, and our executive team is now considering acquisitions and partnerships to enable SGD Pharma to expand its market share further.

GW: What are the main benefits of the new set-up and how have your customers responded?

Our business works predominantly in regulated markets, so a lot of ▶



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our focus is on maintaining and continuously improving quality and services for our customers. We see the new ownership as an opportunity for further developments – as do our customers. To this end, we have focused efforts on improving customer experience by segmenting our product propositions more specifically to their needs; this enables us to improve their supply chain, making it easier for customers to access products that meet their bespoke needs.

We hope to expand our customer base, making a strong start in 2021 with the addition of our Ensiemo range [SGD Pharma’s glass dropper bottle solution with an option for a child-resistant closure and tamper-evident seal] developed especially for the cannabidiol (CBD) market. We expect to be able to expand our products into more markets, and also to add new performance to our existing product ranges. There are several new launches planned for 2022 as a result, that should be announced at CPhI 2022.

GW: Following significant investment into SGD Pharma’s operations in recent years, will this level of backing continue under PAI?

With PAI’s resources and expertise in the packaging and healthcare industries, we are well positioned to accelerate the growth trajectory, through organic and external initiatives. We will continue to strengthen our fundamental principles under PAI’s ownership, to develop the quality of our factories and customer relationships through an expanded portfolio of products and services.



The Saint-Quentin-Lamotte plant is a centre of excellence for Type I Glass.

GW: What are the highlights of recent upgrades to your different manufacturing facilities?

Since the construction of the Saint-Quentin-Lamotte (SQLM) site in France in 2015 we have continued to invest significantly in our plants in France. We rebuilt furnace two, an electrical furnace, in 2018, increasing the capacity for Type I moulded glass vials by 10% on top of the previous furnace’s 300 million vials per year.

In addition, last year we injected €31 million into renovating the Sucy-en-Brie site, which included the complete rebuild and upgrade of furnace two, the modification of the building itself, full revamping of the ISO 8 clean rooms, next generation IS machines, and the installation of the most advanced technologies available for automatic inspection. Collectively, SQLM and Sucy produce 4 million moulded glass vials per day, so maintaining and upgrading the plants is crucial to our business and to meeting customers’ expectations.

In India we have recently upgraded one of the furnaces in our Vemula plant, which produces both moulded and tubular Type I glass vials for parenteral applications. India

has been a huge source of growth for SGD Pharma, with our local market share in moulded and tubular vials growing from 10% to 40%.

GW: How important is adopting the latest manufacturing technology to achieving the company’s goals?

SGD Pharma strives to be the best in the industry, in all aspects, including vial inspectability, dimensions, quality and chemical characteristics. Manufacturing excellence helps us to continue to service customers and keep their supply chains in place, to enable them to bring drugs to market. This is a huge responsibility, and also means that our role is contributing to global health and addresses several of the United Nations Sustainable Development Goals by 2030.

GW: What resources is SGD Pharma devoting to R&D initiatives?

Innovation is a group matter and Carole Grassi Mirchich, as Chief Innovation and Development Officer, who has joined the Executive Committee, leads the endeavour. For the last five years, SGD Pharma has regularly increased the dedicated resources for innovation, not only for R&D, but related marketing, quality, and engineering projects.

This means that innovation is at the heart of what we do, lead[ing] from the top. As such, we use all resources from the executive team – marketing, production, quality and sales – to focus on tracking trends and identifying opportunities, to spearhead ▶



Sterinity by SGD Pharma is a solution for sterile empty vials.



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our ability to invest in R&D. This is a highly important part of our proposition for customers and the market.

We keep our finger on the pulse of the patient, so to speak: market insight and trends in the pharma market help us to assimilate what is most important to our direct customers, and to innovate products and services to meet those needs. We have some very exciting initiatives underway that will come to fruition in 2022 and beyond.

We have an innovation roadmap in place that is both short and long-term in its vision, and takes into account enhancing our existing products and services, as well as expanding into newer areas.

GW: Will the new ownership assist with SGD Pharma differentiating itself from other suppliers of glass packaging?

Of course. Differentiation has always been at the heart of SGD Pharma, from our focus on sustainability and innovation through to manufacturing excellence. SGD Pharma is focused on bringing moulded glass to the masses, and reversing negative perceptions of this material in markets dominated by tubular glass (which we also manufacture, in our plant in India). Having a foot in both markets enables us to see what others cannot, and bring the best of both worlds to customers worldwide. Additionally, we also have the advantage of being able to supply to fill capacity gaps globally, as we have ex-stock in most of our moulded lines. This means we often



The Sucy-en-Brie plant is dedicated to oral applications (syrups, droppers, tablets) and parenterals (SVP & LVP).

have vials available 12 months ahead of suppliers whose supply chains were severely impacted by Covid-19 vaccine demand.

As a high-quality supplier, we recognise that customers need more than just packaging. We differ from other packaging manufacturers in the services we provide, which augment our glass vials and other containers. A good example of this is the recent enhancement of our Type I moulded glass portfolio, providing three market-driven product and service offerings. This has seen a great response from customers, enabling us to identify the challenges that they experience with

expectations of product performance. With our AXpert, AXecure, and AXess categories, we are now able to match product, service, quality and delivery expectations far more accurately. We are striving towards zero defects, and the ability to match product and customer needs better helps us to do this.

We have a strength in pharma and in moulded glass that means that SGD Pharma is able to partner, rather than just supply. The vials we manufacture in pharma, biopharma and veterinary applications become part of our customers' ability to succeed in their own markets and sales.

We have peripheral interests in some of our geographies and plants: for example, our China plant also manufactures a range of cosmetic and beauty packaging that adheres to our global sustainability goals, and helps SGD Pharma to support wider industries with green glass packaging.

The recent introduction of Ensiemo for CBD (including ▶



The Ensiemo range was developed especially for the cannabidiol (CBD) market.



Since the construction of the Saint-Quentin-Lamotte site in 2015, SGD Pharma has continued to invest significantly in its plants in France.

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beauty and nutraceuticals applications) also brings us closer to some other markets and enables our innovations in regulated, approved, compliant glass for pharma packaging to be adopted in even more industries.

GW: What did it mean to be awarded a ‘platinum’ sustainability rating by EcoVadis last year?

It was incredibly important to us, as it validated the considerable efforts being made by the whole company to reinforce our corporate social responsibility initiatives. It also differentiated us, not only within the glass industry, but also in other global manufacturing industries, since this level of recognition is only given to the top 1% of companies evaluated. This is massively important for our customers’ procurement and supply chain goals; by operating at this level SGD Pharma helps our customers to excel in sustainability too.

Sustainability in healthcare and pharmaceutical packaging is a top priority for drug manufacturers and consumers now, and we feel that our Platinum EcoVadis rating emphasises SGD Pharma’s dedication to a more environmentally friendly future. We have seen just how important the role of glass is in society as a sustainable material through the International Year of Glass 2022, which we have proudly sponsored. Our new CSR report will be published this year, spotlighting the latest advances across the company in our endless quest to lead from the front in sustainability.

GW: Are you particularly pleased with any recent product launches or innovations that are in the pipeline?

I think I speak for the entire team when I highlight our most recent extension to the Sterinity platform – the 100ml moulded glass vials in Stevenato Group’s EZ-fill Tray packaging system. We go to great lengths to listen to our customers and understand their needs, and it was clear that the pharma and biotech markets were in need of larger size pre-sterilised vials. This is the first time that a global pharmaceutical packaging manufacturer has offered this solution, so we are proud to fill that gap in the market.

We also have many exciting projects in store for 2022, in particular focusing on our added value services that distinguish SGD Pharma as a provider of high-quality glass packaging.

GW: Considering your position as a leader in the manufacture of primary pharmaceutical glass packaging, how important a contribution has SGD Pharma made to the global battle against the Covid-19 pandemic?

SGD Pharma is renowned not only for the quality of its glass packaging, but for its large global capacity. Companies know they can rely on us to provide solutions in times of disruption. When the pandemic hit, we immediately made available vast stocks of our moulded and tubular Type I glass vials and, like other packaging suppliers, allocated a proportion of our production solely to meet the needs of the vaccine manufacturers.

Not only this, but thanks to the hard work of our employees to minimise disruptions (I take this opportunity to reiterate my gratitude and admiration to all of them), our customers still received the packaging they needed to deliver life-saving therapeutics to patients.



The Sterinity platform has recently been extended.

GW: To summarise, what are the main opportunities and challenges facing SGD Pharma moving forward?

It goes without saying that a world that opens up post-pandemic will enable SGD Pharma and our customers to meet again, and exchange ideas together. Supply of pharmaceutical packaging is a long-term relationship: our customers do not easily choose to change product or suppliers. So the relationships and trust and continuity are vital to both sides.

We saw a number of opportunities emerging from the Covid-19 pandemic: an increase in demand for tubular vials put constraints on the industry supply chain, and being able to manufacture both tubular and moulded glass vials and sustain our customers with vials to meet their timeframes has put SGD Pharma in a unique position that no other vial manufacturer has been in.

There are huge opportunities for us to bring even more innovation to the industry, which in turn means our customers can depend on the vials from SGD Pharma to meet both their current and future needs, and to remove any challenges they encounter with their existing supply chains.

Our growing portfolio of vials for fill/finish is adding to the global market capacity, and puts SGD Pharma in a position of dependability for our customers. We aim to reverse their experiences of bottlenecks and quality issues encountered with other vials in the market in recent months and years.

Regarding challenges, rising manufacturing costs and shipping costs have impacted everybody, not just SGD Pharma. ●

EZ-fill is a registered trademark of Stevenato Group



SGD Pharma was well placed to bring knowledge of compliance in pharmaceutical packaging to the dynamic CBD market with the Ensiemo range.

Further information:

SGD Pharma, Puteaux Cedex, France
 tel: +33 14090 3600
 email: marketing@sgdgroup.com
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The French connection

The EPower SCR controller which forms the heart of Eurotherm by Schneider Electric's glass heating and melting power solutions is designed and developed at the French operation's headquarters in Lyon. Christian Megret, Eurotherm's Glass Business Development Manager for France spoke exclusively to *Glass Worldwide* about supporting multiple glass business sectors and responding to the industry's transition to electrification.



Christian Megret is Eurotherm's Glass Business Development Manager – France.

Fully integrated into Eurotherm by Schneider Electric, the French operation of the process automation and power control solutions specialist has been active in France's glass industry for decades, and the Lyon base is the centre of excellence and R&D for the power group. In his role as Eurotherm's Glass Business Development Manager and Key Account Manager for glass customers in France, Christian Megret primarily looks after the company's interests in France and Belgium, also working closely with a global team on cross-border projects, for example in Italy, Germany and the UK.

"It's an international effort with the global team working in countries

with business managers like myself," explains Mr Megret. "In France I then co-ordinate our effort with our local territory sale representatives. In all, many people are involved to support our clients and opportunities."

Communication is key, he stresses. "Our glass market vertical is driven by my colleagues Mikael Le Guern, Global Business Development Manager and Torsten Hannappel, Global Key Account Manager. Together we have regular check-ins with the other Eurotherm offices to discuss projects and share information about the market and solutions. Often, when French glass companies have projects in other countries in Europe or overseas, we collaborate with the local Eurotherm office to better serve the customer."

Trust is the key to a good customer relationship, underlines Mr Megret. "As a team, our mindset is dedicated towards maintaining the trusted advisor status that our customers depend on. It takes time and effort, but we are strongly committed to our customers."

"I have had multiple hats throughout my career at Eurotherm and I have always been involved with glass customers in one way or another," he reflects. "My involvement has grown over the years with our particular focus on glass as a key market for us; it is a particularly

interesting industry and one with new excitement as it goes through this transformation to electrification."

Complete package

Eurotherm France has over 40 years of experience delivering DCS [distributed control system – in which autonomous controllers are distributed throughout the system] process control systems. Expertise accrued by Mr Megret's team in Lyon covers myriad aspects of the glass making and forming processes, from complete hot end process control systems to increasingly larger electrical boosting and melting systems for electric and hybrid furnaces, and extends across multiple industry sectors: float, fibre, container, pharma and other speciality glass.

Being part of a large organisation enables the French operation to provide glass customers with end-to-end one-stop-shop solutions combining power and control in a complete package, including model predictive control (MPC) for best results, in accordance with Eurotherm's 'from grid to glass' strategy.

"Essentially, we can offer a comprehensive integrated solution for a glass plant, from substations, MV [medium voltage] transformers, switchgears and UPS [uninterruptible power supply], to the Eurotherm electric boost systems, ▶



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including if needed: cables, cable tray installation and commissioning; as well as the furnace DCS control system and cloud based platforms and tools,” says Mr Megret.

Solutions and services

The business’ portfolio centres around two classes of products: the Eurotherm T2750 PAC controllers for furnace process control coupled with an AVEVA system platform-based SCADA [supervisory control and data acquisition] system, and – from the thyristor controller range designed and developed at Lyon – its EPower SCR power controller for heating and boosting applications.

“We usually package those products into turnkey systems that we engineer, manufacture, deliver and commission,” explains Mr Megret. “We also offer services as part of a sales level agreement to support the full life cycle of the system.

“Today, full process and power control system solutions represent most of our business,” he continues. “From hot end process control systems, roof and lehr heating systems to large electric boost systems for container glass furnaces, the range of system solutions is expanding. The market trend is particularly toward larger electrical heating or boosting systems on glass furnaces.”

While the bulk of the company’s business comes from supporting container and flat glass companies, Eurotherm has also had success combining its DCS process control and thyristor-based electrical power control solution for France’s pharmaceutical glass manufacturers. “It is a very interesting sector and we have been proud to help this industry to meet its vaccine packaging demands in these unusual times,” comments Mr Megret.

Another speciality glass sector now benefitting from Eurotherm’s expertise is crystal glass, which has “a long tradition of excellence in France and is part of the French heritage,” he notes – undaunted. “It is a different type of glass with smaller furnaces that require precise control. As this sector is also working towards electrification we are happy to support them in this journey.”

Electrification

Europe is leading the world in the electrification of the glass industry, believes Mr Megret, while France, with its “relatively favourable electricity availability situation compared to other countries,” is well positioned to adapt



A network of Eurotherm water-cooled power supply boxes offers redundant power capability.

to market changes arising from a significant increase in electrification.

“A lot of activities regarding decarbonisation and electrification are happening in Europe to implement the Paris Accord and various commitments that companies have made to reduce CO₂ emissions,” he comments. “France is again at the forefront of this transition with some high-profile customers, and projects are in progress.”

The current market trend is toward larger electrical boosting and melting systems on glass furnaces to meet decarbonisation objectives, he observes, and Eurotherm is responding accordingly with innovative solutions to help its customers. “These efforts are particularly visible with the power box solution that we first developed for container glass furnaces but which we are now expanding and installing on fibre and float glass furnaces. These power supply boxes can be installed in a network topology, offering flexibility for power redundancy and up-sizing of power systems.”

The company collaborates closely with furnace OEMs to optimise the design of its solutions, particularly in the field of large electrical boosting. “Our experience and expertise in our field combined with know-how from OEMs is essential to provide the right solutions in this fast paced electrification transition,” confirms Mr Megret.

Conscious that the hollow glass sector was the first to adopt electrification “because the size of the furnaces made it easier to transition

to electrical energy,” Mr Megret has noticed “a push from actors in the flat glass sector to catch up and get serious about reducing emissions. We expect our activities will continue to grow and we have plans in place to invest accordingly to support the market,” he explains.

Interestingly, Eurotherm does not divide its priorities between the French flat and hollow glass sectors: “We consider both those sectors of key importance,” he states.

Decarbonisation

Accelerating pressure to reduce CO₂ emissions and meet environmental targets has spurred the glass industry in France and the rest of Europe to adapt and survive. “This industry used to be conservative but now to meet sustainability goals the speed of innovation has picked up dramatically,” reports Mr Megret.

Decarbonisation is now the main issue that Eurotherm – and the glass industry – needs to address. “We believe this is also a great opportunity for us as we believe we can address the challenge through electrification and also digitalisation with both our power control and DCS control solutions,” he asserts.

Traditionally, Eurotherm’s business in France was mainly products: temperature controllers, data recorders and power controllers. “This of course remains a significant part of our business but the main change in our glass industry offerings has been to drive the business through selling complete systems. Decarbonisation through electrification and digitalisation, including cloud-based solutions for data management and analytics, is increasing this trend and represents significant opportunities for us to help our customers,” explains Mr Megret. “I think we can say the future of glass is exciting and we are well positioned to serve this market and our customers for many years to come,” he concludes. ●

Further information:

Eurotherm Automation SAS, Dardilly, France
tel: +33 478 66 45 00
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Russian glass industry shaken by conflict

The invasion of Ukraine has put glass factories in Russia in a state of unprecedented uncertainty as Western sanctions promise to wreak havoc on the country's economy, reports a *Glass Worldwide* contributor.

Russia had for years been touted as a lucrative destination for establishing glass production facilities thanks to the growing domestic market, low taxation, a cheap but skilled labour force, and strong trade ties with some major foreign markets. However, the invasion of Ukraine and tough Western sanctions killed that balance sheet overnight. Russia now faces a massive exodus of foreign businesses with (at time of writing) more than 300 Western companies publicly announcing their decision to pull out of the country driven by reputational risks, and a gloomy economic outlook. The Russian economy is braced for a deep recession, with GDP projected to slump by as much as 18% in 2022, taking a heavy toll on domestic consumption and business activity, and effectively returning Russia to a state of the nationwide economic depression of the early post-Soviet era.

However, so far no foreign glass company has declared plans to sever ties with the Russian market. Koch Industries, which runs two Guardian glass plants in Russia, said it planned to continue business in the country. To some extent, the decision could have been taken in the background



The Russian economy is braced for a deep recession. Pictured: Irbit glass plant.

of the Russian government's threat to nationalise assets of all foreign companies leaving the country.

"While Guardian's business in Russia is a very small part of Koch, we will not walk away from our employees there or hand over these manufacturing facilities to the Russian government so it can operate and

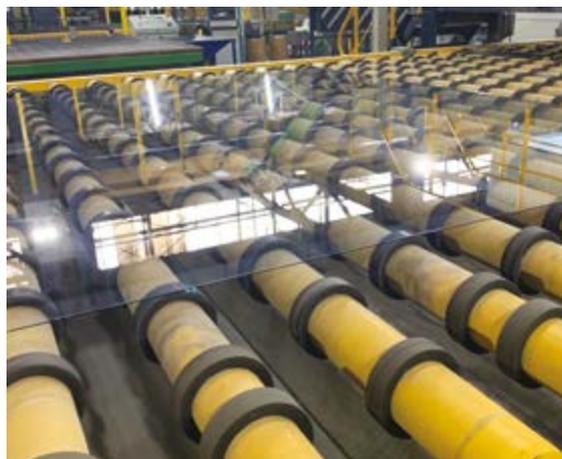
benefit from them," said Dave Robertson, President of Koch Industries, in a statement posted on the company's website on 16 March.

Mr Robertson added that the company was complying with all applicable sanctions, laws and regulations governing its relationships and transactions within all countries where it operates.

Russian authorities have promised not only to confiscate assets of foreign companies that have decided to stop business in the country but also to press criminal charges against their top managers. Against this background, some Western companies are still reportedly carefully weighing their plans in Russia.



Russian hollow glass production faces an uncertain future.



Slumping demand is the biggest problem for Russian float glass.

Float glass fallout

However, things are not going to be the same for the Russian glass plants in the foreseeable. In particular, there are chances that some Russian float glass plants will have to stop operating.

Over the past few years, Russian float glass production stood at around 250 million m² per year, according to estimates from the Russian union of glass producers Soyuzsteklo. By 2030, this figure was projected to reach 500 million m² on the back of expanding export supplies. Russian glass plants exported float glass to European Union, the Middle East, Africa and Asia.

In the May/June 2020 issue of *Glass Worldwide* (page 78) Victor Osipov, President of Steklosoyuz stated that exports would continue to represent an important factor for growth in the Russian float glass sector. In the same article it was speculated that like other industries with a strong foreign capital presence, float glass production appeared to be vulnerable to Western sanctions – particularly facilities owned by Japan, since its companies controlled 40% of float glass production in Russia.

Steklosoyuz declined to provide any comments regarding how Western sanctions imposed over the Russian invasion of Ukraine could impact Russian float glass production. However, there are reasons to believe that the consequences will be tough.

In a statement posted on its website on 16 March, Steklosoyuz claimed the organisation had started considering helping its members with partial relocation of the business to countries not joining Western sanctions against Russia.

According to the statement, “This measure is designed

to support the export of production technologies, including parts, with further assembling and establishing all production processes in the countries that didn’t back Western sanctions.” Regarding relocating the business: “Currently, such option in the first place exists in UAE, Vietnam, India, and Armenia”.

Steklosoyuz called on its members to provide feedback on whether they would really make this decision, and if so, under what conditions.

Dwindling demand - foreign and domestic

The proposed relocation seems a necessary step since the demand for float glass of Russian origin is projected to dwindle. In 2020, Russian float glass export was estimated to be close to 50 million m², most of which landed on European markets. Now, Russian goods experience ostracism globally, with foreign customers refraining from buying anything Russian: from vodka to oil. Besides, Western sanctions have banned international transactions for 70% of the Russian banking sector, and anti-crisis measures embarked

on by the government to prevent the national currency from a freefall have made sending money in and out of the country extremely troublesome.

However, there are looming fears over the prospects of the demand on the domestic market too. Russian Central Bank has raised the key interest rate to 20% to fight inflation, making mortgage loans unaffordable for the population. The price of real estate is projected to drop by 25–30% in 2022, Russian newspaper *Izvestia* reported, citing market participants.

“It is clear that the demand for float glass is set to slump – the only question is how deep this fall will be,” commented a source in the Russian float glass company who wished not to be named.

“We don’t know what share of export we are going to lose, and the same goes for the domestic market. All in all, the moderate expectations envisage our [Russian float glass plants] sales to collapse by around 100 million m² per year. I don’t have another word to describe this, but a catastrophe,” the source said, adding that this would drive some glass companies to shut down float glass ▶



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plants in Russia not out of political, but of economic sense.

The source indicated that all eyes now are on the Russian authorities, as market participants expect them to support business and facilitate access to new foreign markets, including China.

Customers deserting hollow glass

Hollow and automotive glass producers have also been hit by the current crisis, as key customers are pulling out from Russia.

In 2020, Russian hollow glass production totalled 13.8 billion units, up from 12.7 billion units in 2019, and 11.5 billion units in 2018, the Russian consultancy Unipack estimated. The Covid-19 pandemic is believed to be the main factor hampering the demand.

“Preliminary data suggests that Russian plants scaled down production in 2021, compared to the previous year, but in order not to suspend production, at the beginning of the year manufacturers had to cut prices,” Unipack said.

The new crisis is likely to be more complex for the Russian hollow glass plants. On the one hand, demand is predicted to plummet as large beverage producers cease operation in the country. Coca-Cola and PepsiCo – two of the world’s biggest beverage producers – have joined a long queue of companies that decided to suspend business in Russia. The same decision has been taken by a group of beer producers, including Carlsberg and Heineken.

On the other hand, the Russian population’s declining purchasing power is seen as an even bigger threat to domestic demand, as in order to



Float glass sales could collapse by around 100 million m² per year.

save money customers would opt for a cheaper package, and beverage producers will also likely switch to plastic.

Still, [some] foreign investors have so far refrained from shutting down production in Russia. In a statement from 10 March, the Governor of the Vologda region Oleg Kuvshinnikov said that the Russian branch of Siseecam had decided to continue its operation in Russia. Mr Kuvshinnikov added that the production capacities were fully loaded, and “there were no issues with the operation”.

The Russian economy is now experiencing a domino effect from Western sanctions: supply chains are becoming disrupted as some companies pulling out from the Russian market bring problems to their partners who continue to operate, said Eldar Murtazin, Senior Analyst for the Russian consultancy Mobile Research Group.

Domino effect in automotive sector

The domino effect is seen with a naked eye in the automotive segment, where the sanctions crippled what once was a very promising market. Key automakers, including Renault, VW and Mercedes-Benz have paused finished vehicle production in Russia.

Over the past decade, Russian authorities encouraged foreign components suppliers to localise their production in the country, promising tax breaks and state aid. For instance, Fuyao Glass Rus has established a production plant in Kaluga Oblast with a designed performance of 5.5 million units of automotive glass per year. In Russia, Fuyao Glass Rus sold glass to major carmakers, including Volkswagen, Volvo, Nissan, Hyundai, Renault, Peugeot and Ford. The company also exported nearly half of all production, primarily to Spain, Belgium, France and Italy.

Several automotive glass production facilities have been established in Russia under a so-called industrial assembly programme, and special investment contracts. Now, all [of these] production facilities have nothing left to do in Russia.

A source in the Russian automotive glass industry commented that the automotive industry in the country has been killed by sanctions, since no plant – even the Russian carmaker Avtovaz – can work without foreign components. The source added that it is clear that the current sanctions have been introduced for “years if not decades”, no matter the results of the Ukraine war, so virtually nobody in the industry really hopes or expects things will go back to the way they were. ●



Some hollow glass plants may cease operation.

About the author:

The reporter has requested anonymity for this article

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The Orda Glass Complex was slated to reach full designed production performance this April.

Kazakhstan adds float glass production capacities

With the new Orda Glass Complex recently launched in Kyzylorda, Kazakhstan promises to drastically change the landscape on the float glass market of Central Asia, and possibly even beyond this corner of the world, reports Vladislav Vorotnikov.

Owned by China Glass Holdings with the technology designed and supplied by Stewart Engineers, Orda Glass Complex is the third float glass plant in Central Asia – perceived by some as a rather poor region comprised of Kazakhstan, Uzbekistan, Tajikistan, Turkmenistan and Kyrgyzstan. Historically, Central Asia was a net importer of float and hollow glass, primarily from Russia. However, things are rapidly changing thanks to an inflow of investments in the glass industry in the past few years.

A new competitor

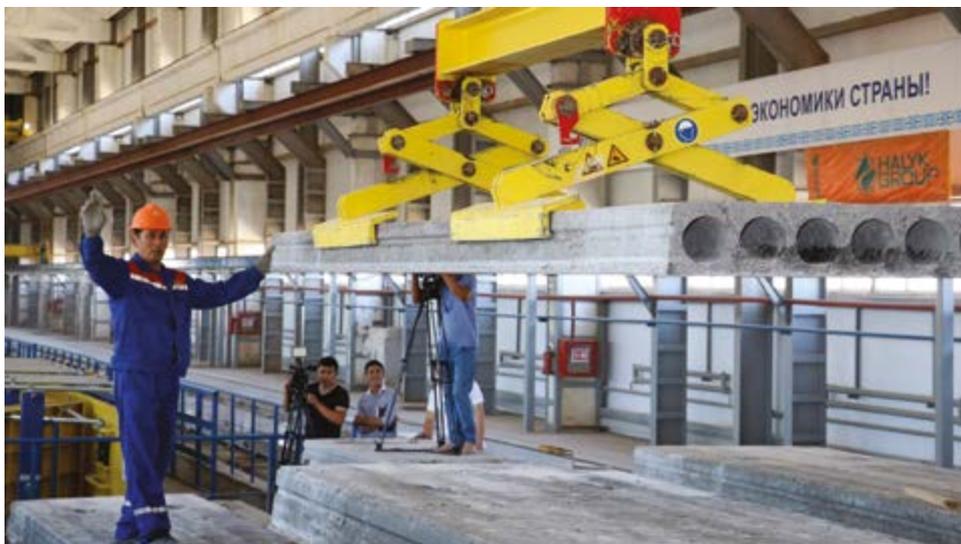
With a designed production performance of 600 tonnes of glass per day, Orda Glass Complex is the biggest industrial glass factory launched in Central Asia. The second-largest glass producer is Türkmen aýna önümleri or Turkmen glass products, which opened in the town of Ovadandep, 25km north of Ashgabat, Turkmenistan. With the investment cost estimated at \$375 million the plant has a designed production performance close to 250tpd – not only float glass, but also hollow glass

and pharmaceutical glass containers.

The Turkmen and Kazakh plants have a similar business model, with the main focus on exports. Türkmen aýna önümleri has been selling glass not only on the domestic market, but also to Uzbekistan, Kazakhstan and Tajikistan. The company also reported that export contracts were signed with

customers in Afghanistan, but no information regarding the share of export supplies in this direction is available yet.

The third factory is InterGlass, operated by German Steinert Industries GmbH. It was established on the site of an old Soviet factory launched in 1972, which nearly stopped operation in the 1990s. InterGlass went through a profound modernisation in the 2000s and has been rolling with the punches ever since. In 2008, the plant temporarily stopped operating and re-opened only in 2012. In 2016,



Kazakhstan was historically a glass importer.



the factory nearly went bankrupt over a large debt accumulated to Gazprom-Kyrgyzstan over gas supplies but managed to bounce back.

Like other glass factories in Central Asia, InterGlass is largely focused on export. During Soviet times the factory supplied nearly 95% of manufactured glass to other Soviet republics. Currently, one of the primary objectives of the plant is to supply float glass to the countries of the Central Asian region and cities of Siberia, and broaden the glass market entering the markets of other Asian countries, according to a company statement.

Independently, none of the Central Asia glass markets are large enough to justify building a glass factory. However, the region offers investors encouraging export opportunities, thanks to the countries' close ties with each other, as well as the large nearby markets of Russia and China. Export prospects are also supported by several free trade zone agreements, including within the Eurasia Economic Space.

In addition, the region is rich in natural resources and offers one of the cheapest labour force costs in the world.

A road of a thousand miles

There have been several attempts to build the first Kazakh glass plant. In 2005, the construction of a glass plant began near Aktobe, and in 2011–2012 – near Pavlodar, but neither project was completed, due to different reasons.

In Pavlodar, InturServicePulse intended to build a float glass plant for \$145 million, with a capacity of 140,000 tonnes per year. The company achieved an agreement on establishing electrical communications, water supply networks, and even building a 4.2km long railway line from Kalkaman station to the plant to improve logistics. InturServicePulse's plan envisaged a payback of five to six years, but the company failed to find investors.

Central Asia is traditionally considered a region with relatively high risks for foreign investors due to frequent political turbulence and weak public property protection. The unrest sparked in Kazakhstan is only one example of problems foreign investors may face in that part of the world.

In Central Asia, foreign investors sometimes lose their assets when relationships with local governments deteriorate. The most recent example is a standoff between Canadian mining company Centerra and the Kirgizstan government. In May 2021, the government expropriated the mine, alleging that Centerra was running it in a detrimental way for both the environment and nearby communities.

The Orda Glass Complex construction did not proceed smoothly either. Initially, the construction of the plant was planned to be completed in the fourth quarter of 2019. However, in April 2019, Kazakh officials reported that construction was delayed due to a conflict between Chinese investors and the technology supplier. The Kazakh government's department of industrial and innovative development issued a statement saying that the American company Stewart Engineers, without any explanation, refused to further participate in the project, thereby putting the main founder of the project – at that time, the Chinese company King Charm Development – in "a difficult position". Some local experts suggested that the project was on the brink of being abandoned.

Nevertheless, a few months later the US company decided to return to the Kyzylorda glass factory project, stressing that Orda Glass had to fulfil its obligations under the contract. Despite the delay in payments, in March 2019, American investors supplied some important equipment, including air ducts, to the construction site in Kyzylorda.

Having the new plant finally constructed is a big achievement for the Kazakh economy. Beibut Atamkulov, the Kazakh Industry Minister estimated that the new plant promises to meet the domestic demand in float glass by 98%. ▶



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The new Kazakhstan plant will change the shape of the glass market in the region. Photo credit: Sputnik.



Glass companies in Central Asia has been rolling with the punches.

The Orda Glass Complex is also likely to become the basis of a new cluster of companies. By 2025, Kazakhstan plans to build and launch two new facilities for the production of soda ash, to fully meet the domestic demand.

Gulshara Abdykalikova, governor of the Kyzylorda region commented that 90% of raw materials for the plant, including soda ash, are planned to be of Kazakh origin.

In 2018, Kazakhstan purchased float glass for 12.9 billion tenge (\$25 million), research conducted by the government showed. On average, the domestic demand for float glass was believed to grow by 12% per year.

Export is a cornerstone

The Orda Glass Complex is set to export at least 30% of its float glass, focusing on Central Asia, China and Siberia, the company said.

"This project will increase our export potential. Glass is a commodity that enjoys a growing demand in many areas of everyday life. The domestically-produced glass will significantly reduce the cost of services and goods in the construction of residential and commercial real estate, the automotive industry, the production of furniture and interior items," commented Marat Yessenov, Regional Manager of the Kazakhstan state-owned enterprise Kazakh Invest.

As explained by Yerzhan

Sagynbaev, Chairman of the Board of Orda Glass, Kazakhstan used to import glass at an average price of \$300 to \$350 per metric tonne.

"Our glass will cost \$200 to \$250 per tonne," he stated. [This is] "a significant difference, while good quality is also guaranteed. The facility utilises modern production technologies from the leading countries of the world – the USA, Italy, Belgium, Finland, China."

The company has already signed its first export contracts with customers outside of Central Asia – in India and Afghanistan, he added.

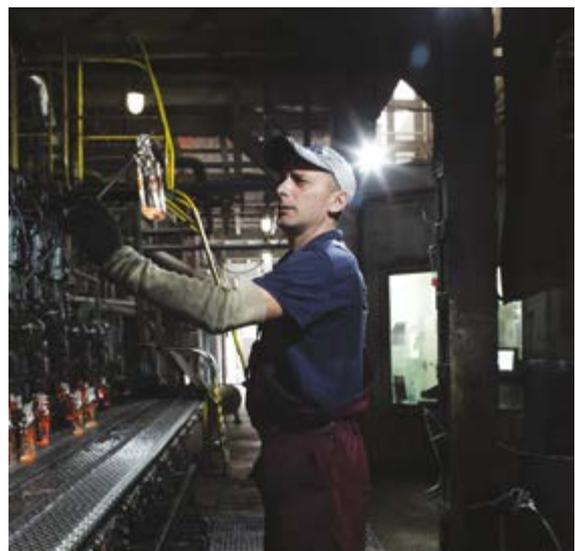
The new facility, which is reportedly slated to reach full designed production performance in April 2022, promises to change the trade flows in Central Asia. In previous years, Kazakhstan imported float glass primarily from Russia, with some supplies also coming from China and Kyrgyzstan. The new plant is likely to turn the tables.

Kuandyk Bishimbaev, former Chairman of the Board of the Baiterek Holding, said that in addition to Central Asia, where Orda Glass Complex was expected to become the largest glass supplier, the company planned to gain a foothold in the Russian Siberia.

"There are no glass plants in [the] Siberian part of Russia," said Mr Bishimbaev, adding that negotiations with local wholesale customers took place for a few years before the launch of the factory.

The Orda Glass Complex could bring more problems to the crisis-ridden Russian float glass industry. Most plants in Russia are concentrated in European Russia, and the Kazakh factory promises to pull in customers in Siberia, offering more attractive prices, stemming from low production and logistics costs. The Russian float glass market is expected to face oversupply in 2022, especially if the newest Western sanctions bar the way for the Russian products to foreign markets.

In this context, losing the Kazakh market and having a powerful competitor in Siberia is definitely not what the Russian float glass plants wish to see these days. ●



There are now three glass plants in Central Asia.

About the author:
Vladislav Vorotnikov is an independent international journalist

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Chilean container production specialist

Cristalerías Toro SpA is a major glass producer in Chile. The family-owned business sells glass products throughout the Americas, from Canada to Argentina. The company is a leader in sustainability, generating all of its energy needs through renewable sources. Richard McDonough reports.

“Cristalerías Toro is a family-owned company which started its operations 70 years ago,” explained Mr Francisco Ruiz Morandé, Chief Executive Officer of Cristalerías Toro SpA. “It was founded by Guillermo Toro González (1924–2018) and two of his sons worked in the company until 2020; nowadays they act through the board of directors where their three sisters are represented as well.”

The glass container operations are located in Santiago, Chile, in two different facilities within a distance of 10km. The firm was founded in 1952, and has grown through the years. Mr Ruiz explained that the company is vertically integrated for the supply of sand and calcium carbonate for all of its needs.

“Cristalerías Toro owns Minera Toro, where it gets the supply of sand and sodium carbonate; Plasvi, a company that gives painting, frosting, decorating and sleeve glass services for glass containers; and Cristoro Maipú, the logistics and distribution centre.”

Beyond the resources needed to produce glass, this business also controls the supplies needed for its energy needs.

“Cristalerías Toro was one of the pioneers when installing a wind farm back in 2008 in order to supply green



The Parque Eólico Lebu – the wind farm at Lebu – provides energy to the glass operations at Cristalerías Toro in Chile. Photo provided courtesy of Cristalerías Toro.

electricity to its operations,” Mr Ruiz stated. “Today, 100% of its electricity comes from renewable sources.”

The firm works with a number of the major suppliers of equipment and services in the glass industry. “Our main equipment suppliers are Horn, Emhart, Tiama, and All Glass, among others,” stated Mr Ruiz.

Mr Ruiz joined Cristalerías Toro in 2019. He was previously General

Manager with Quimetal Industrial, an agrochemical company with production in Chile and sales worldwide, from 2012 to 2019. Mr Ruiz worked at Molibdenos y Metales from 2000 to 2011; this firm describes itself as “a Chilean company with ▶



As part of quality control procedures at Cristalerías Toro, a worker takes statistical samples of bottles in order to complement the work of the inspection machines. Photo provided courtesy of Cristalerías Toro.



Bottles being manufactured at the Cristalerías Toro plant in Maipú, Chile. Photo provided courtesy of Cristalerías Toro.



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Bottles coming out of the annealing process at the Cristalerías Toro plant in Maipú, Chile. Photo provided courtesy of Cristalerías Toro.

the largest molybdenum and rhenium processing capacity in the world.”

Markets

“Cristalerías Toro mainly produces glass containers for the food, beverage and pharmaceutical industries,” said Mr Ruiz. “In our facilities, we have UV and TP decoration, frosting, sleeve glass and painting processes.” Within the food industry, glass containers are manufactured for wines, spirits, beers, soft drinks, waters, juices, and oils.

“In our customer portfolio, we have big and well-known customers as well as small businesses and entrepreneurs,” said Mr Ruiz. “We have always given special attention to supporting small businesses and helping them to put their products in the market.”

“Our business is focused in the Americas, serving customers from Canada to Argentina with a grand variety of products and flexibility,” said Mr Ruiz.

He indicated that the business “provides jobs to 600 people and to 800 if we consider all of our subsidiaries. With our three furnaces and nine production lines, we are able to meet our customers’ requests with high quality products.”

Activities during Covid-19 pandemic

“During the Covid-19 pandemic, we have seen a big change in consumer behaviour,” said Mr Ruiz. “Habits have moved to more personal or home consumption, hence increasing the demand for all types of personal containers. Glass has not been an exception.”

“In 2021, in the middle of the

Covid-19 pandemic, we were able to start a brand new furnace with state-of-the-art technology,” Mr Ruiz continued. “We are very proud to have achieved the start-up of the furnace with only a few weeks of delay from the original date and without the onsite support from many of our suppliers. We are very proud of our people, working with substantial team spirit.”

The firm officially started the heating of its new furnace in Maipú at 3:30pm on 9 February 2021. According to a news statement issued at the time, “This entire start-up process has been and will be supported by technicians from the different suppliers who come from Germany, the United States, Colombia, and México. For us, it has been a tremendous challenge to meet the dates we set, since the travel restrictions imposed by the pandemic have demanded our maximum capacity to be able to coordinate the different specialties and have everything ready to start the operation of the oven. The new furnace has a capacity of 300 tonnes per day, uses electricity from 100% renewable sources, and will produce bottles with more than 60% recycled glass.

“During 2021 we have seen many factors affecting our cost structure,” Mr Ruiz explained. “Undoubtedly, the increase in energy prices and availability of natural gas have been issues that we have had to deal with during the past year. Another issue is the delay seen in the supply chain, not only for raw materials but also for spare parts and electronics. The sea freight rates have soared to levels that I have never seen before, and it has been very difficult

to get spaces in the vessels to ship our products. Together with what has been explained, we have faced high inflation rates due to the financial aid given by many governments (Pandemic aid) and fluctuating currency exchange rates.”

Recycling

“As a company, we really believe that glass is the most eco-friendly material for producing containers due to the infinitely many times that it can be recycled,” stated Mr Ruiz. “A big part of our efforts focuses on collecting and using recycled glass in our products.

“Since its beginning, Cristalerías Toro has focused on the use of recycled glass in its products,” Mr Ruiz continued. “It has a special part of the company dedicated to bringing in recycled glass and a lot of efforts and resources are dedicated to increase the amount of this raw material. On average, we use more than 60% of recycled glass in our containers, but we are able to use up to 90% of recycled glass in green coloured glass. Cristalerías Toro has the most modern glass recycling plant in Latin America with a capacity to process all the recycled glass that it needs for its operations.”

Projections for the future

“We foresee a strong demand for this year, but with a cost structure that has been increasing substantially during the last 12 months, we will be obliged to focus on cost reduction measures,” Mr Ruiz said. “To look further to what is going to happen in the future is very difficult at this time, but as a company we will continue on executing our projects to reduce emissions, use cleaner energy, and reduce our carbon footprint.

“Our main concern for this year is the way we are going to deal with Covid-19, especially getting our products to our customers and supplies from our vendors,” explained Mr Ruiz. “We will also keep a close look at what is going on with the political situation affecting the gas supply from Russia to Europe.” ●

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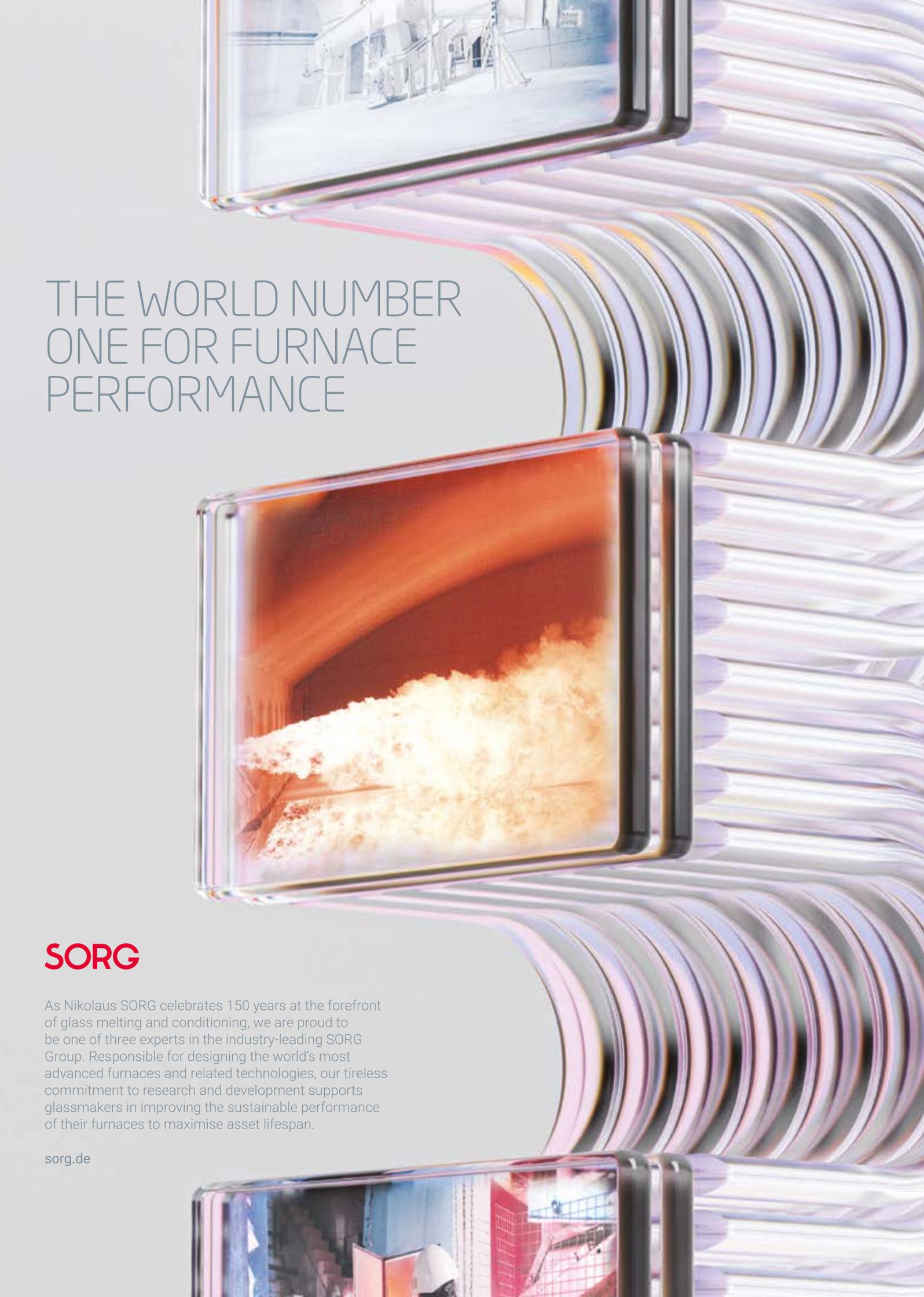
A worker at Cristalerías Toro checking that no stones, porcelanate, china, or other “big” impurities go into the recycling plant in Maipú, Chile. Photo provided courtesy of Cristalerías Toro.

About the author:

Richard McDonough is a civic journalist based in the USA. He writes on a variety of topics in the glass industry.

Further information:

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Verallia has a glass manufacturing plant in Mendoza, Argentina. Photo provided courtesy of Verallia.

Verallia in Latin America

Verallia has five glass manufacturing plants in Latin America. Amongst products manufactured here are glass bottles and jars for a variety of industries. Operations in Argentina, Brazil and Chile represent approximately 10% of Verallia's global sales. Richard McDonough reports.

Verallia Latin America includes operations in Argentina, Brazil, and Chile. Whilst the brand 'Verallia' is relatively young in age – it was created in 2010 – the company's heritage goes back generations in South America. Compagnie de Saint-Gobain operated hollow glass production operations from 1918 until 1972, according to Verallia, when the bottles and jars business segment was transferred to Saint-Gobain Emballage; this became the holding company of Saint-Gobain Group's glass packaging production operations.

"Verallia became an independent group in 2015," stated Mr Quintin Testa, General Manager for Verallia Latin America and a Member of the Verallia's Executive Committee. "In October of 2019, Verallia became a

listed company on Euronext in Paris."

Overall, the company reported that it is the third largest producer of glass containers for food and beverages globally. The Latin American operations of Verallia represented 11.38% of worldwide sales of Verallia in 2021. This compared to sales from Verallia's Latin American operations in 2020 that represented 9.35% of global sales by the company. Revenue was €304.2 million for the Latin American operations of Verallia in 2021 according to the 2021 Annual Report issued by the company on 16 February 2022. That amount compared to €237 million in revenue for the Latin American operations of the firm in 2020. The annual report stated that these changes resulted from "an increase in sales prices in Latin America and a good product mix over the year at Group level also contributed to the growth in revenue."

Mr Testa indicated that the Latin American operations of Verallia sold 655,000 tonnes of glass products in 2020 as compared to 618,000 tonnes of glass products in 2019. Production increased again in 2021.

"In Latin America, the Group reaped the benefits of having increased capacity in 2020," the 2021 Annual

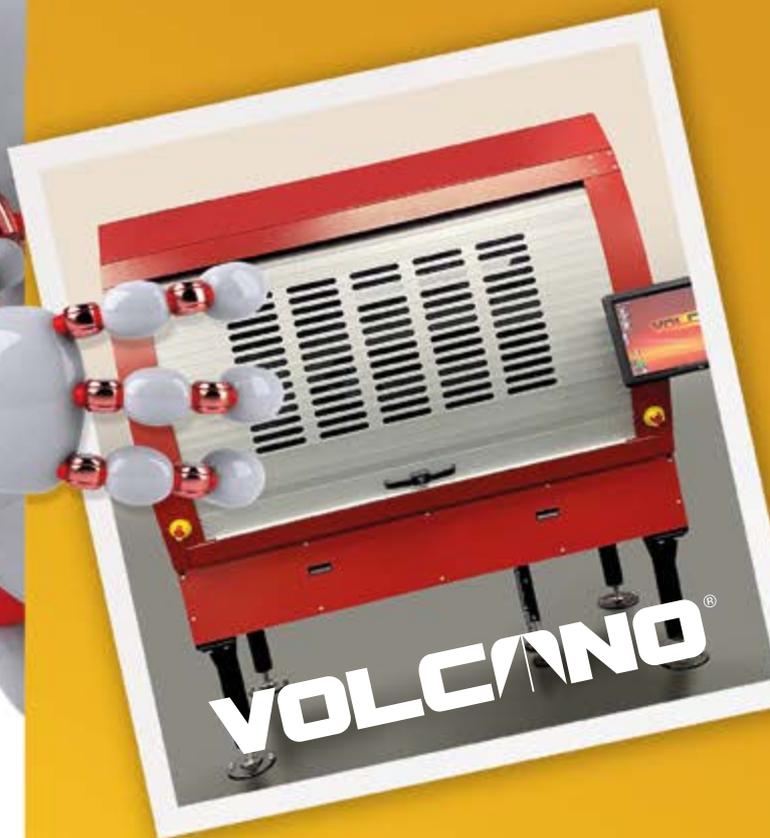
Report noted. "Revenue shows a strong reported increase of 28.3% and 39.3% organic growth. Annual revenue grew in all product categories except food jars. In addition, previous increases in selling prices in the region – particularly in Argentina in response to local hyperinflation – also contributed to the strong growth in revenue. Sales volumes, on the other hand, fell slightly in Argentina in the second half of the year, impacted by a fire [at the glass manufacturing plant in Mendoza] in the third quarter which temporarily disrupted customer supply over the six-month period."

Currency exchange rates impacted some of the results in Latin America.

"The impact of exchange rates was -1.3% in 2021 (-€33 million), primarily concentrated in the first ►



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half of the year,” detailed the results in the 2021 Annual Report. “It was in large part linked to the depreciation of the Argentine peso and the Brazilian real and, to a lesser extent, the Russian rouble. In the fourth quarter, the impact of exchange rates was positive at +2.2% (+€13 million). At constant exchange rates and scope, revenue grew +6.8% over the year (and +5.0% excluding Argentina), with an acceleration in the fourth quarter leading to organic growth of +10.2% (and +9.4% excluding Argentina). After a volatile 2020, which formed an extremely variable basis for comparison from one quarter to another, Group sales volumes in 2021 recorded growth, returning to their 2019 pre-Covid level.”

Mr Testa has been General Manager for Verallia Latin America and a member of the Verallia’s Executive Committee since 2018. He began his professional life as General Manager of Quality at Nissan Motors in México in 1989. Ten years later, in 1999, Mr Testa joined Nematik in México within Operations. In 2002, he joined Valeo where he held the positions of Vice President of Quality and Project Management for the Group, and from 2015 onwards, assumed the position of Vice President of Powertrain Transmission for the Group. Mr Testa graduated as a Mechanical Engineer from Monterrey Tech, México, and holds a Master’s degree in Quality and Productivity.



The entrance to the Verallia glass manufacturing plant in Mendoza, Argentina. Photo provided courtesy of Verallia.

Argentina

“The history of Verallia Argentina begins in 1947, when a traditional family from Mendoza founded the Cristalería Rayen Cura,” stated Mr Testa. “In 1998, it was acquired by the Packaging division of the Saint-Gobain Group. As of that year, a series of investments were made that enabled the growth of the company and the incorporation of state-of-the-art technology.”

Expansion continued at this plant in the 21st century. In 2000, the company inaugurated its Furnace 2, and in 2012, Furnace 3 became operational. In 2021 a new production line was inaugurated in Furnace 3.

Mr Testa indicated that “today, Verallia Argentina is a leading company in the region due to the quality of its products and services.”

Verallia Argentina is headquartered in Ciudad de Mendoza in the province of the same name. Approximately 420 employees work at the glass manufacturing plant here. Verallia Argentina produces 500 million glass bottles and jars per year. Glass is produced in three colours: green, dead-leaf, and flint.

Brazil

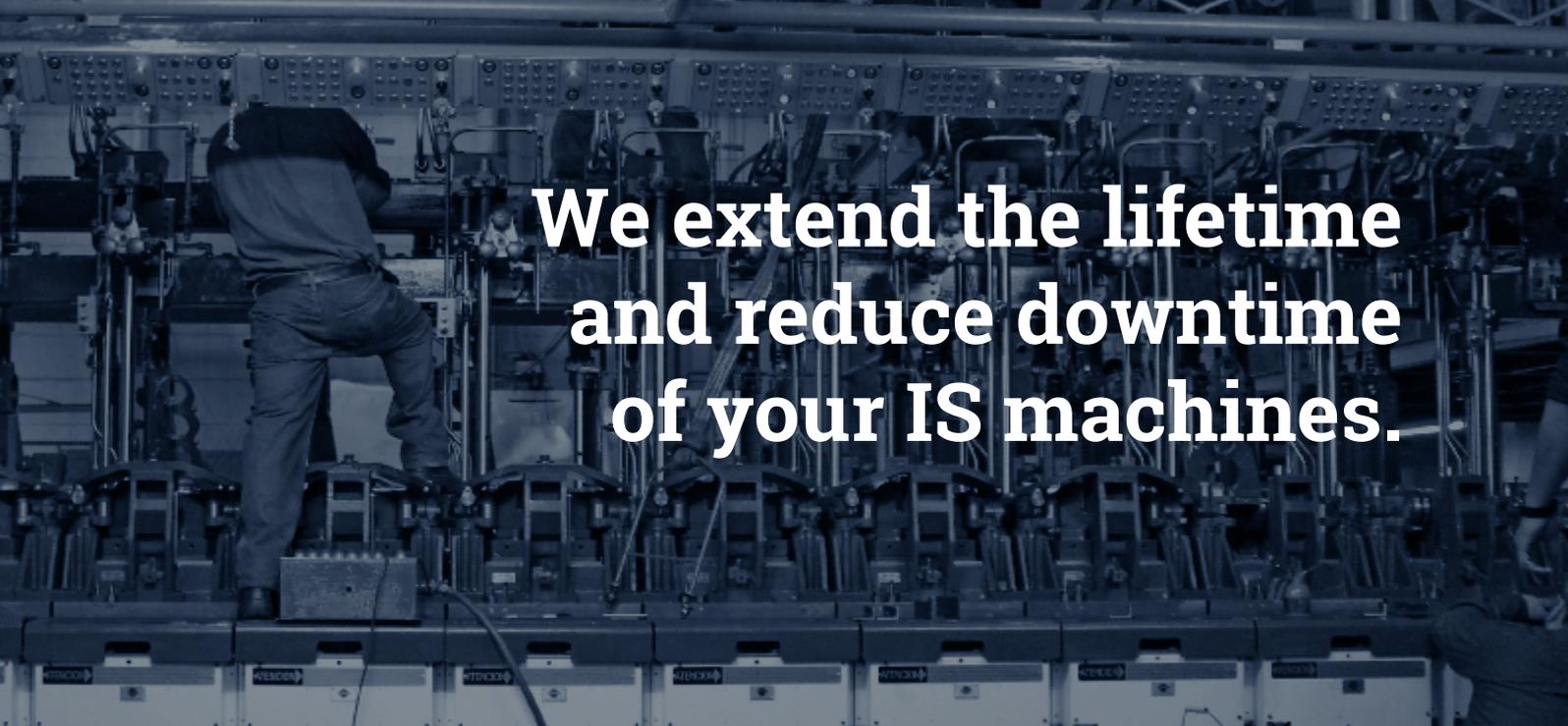
“Verallia’s first factory in Brazil was opened in the Água Branca district of São Paulo,” explained Mr Testa. “In 1810, glass began to become more present in Brazil and it was in that same year that the first glass factory appeared, along with the arrival in the country of the Portuguese Royal Family. In 1892, Councilor Antônio da Silva Prado and Dr. Elias Fausto Pacheco Jordão began the exploitation of peat with a primitive kiln in lands that covered approximately 33 thousand m² from Água Branca to Freguesia do Ó, in the Tietê floodplain, where they had discovered deposits of sand with the ideal colour and quality for the manufacture of white glass. And so, in 1896, the Companhia Vidraria Santa Marina was born in São Paulo, which would later become associated with the Saint-Gobain Group and which gave rise to what is now Verallia.”

“Not every company reaches 125 years,” Mr Testa continued. “The main goal is our solid commitment to society, the environment, investors, our internal public and all stakeholders.”

Verallia is in the process of a number of expansion projects in Brazil, ▶

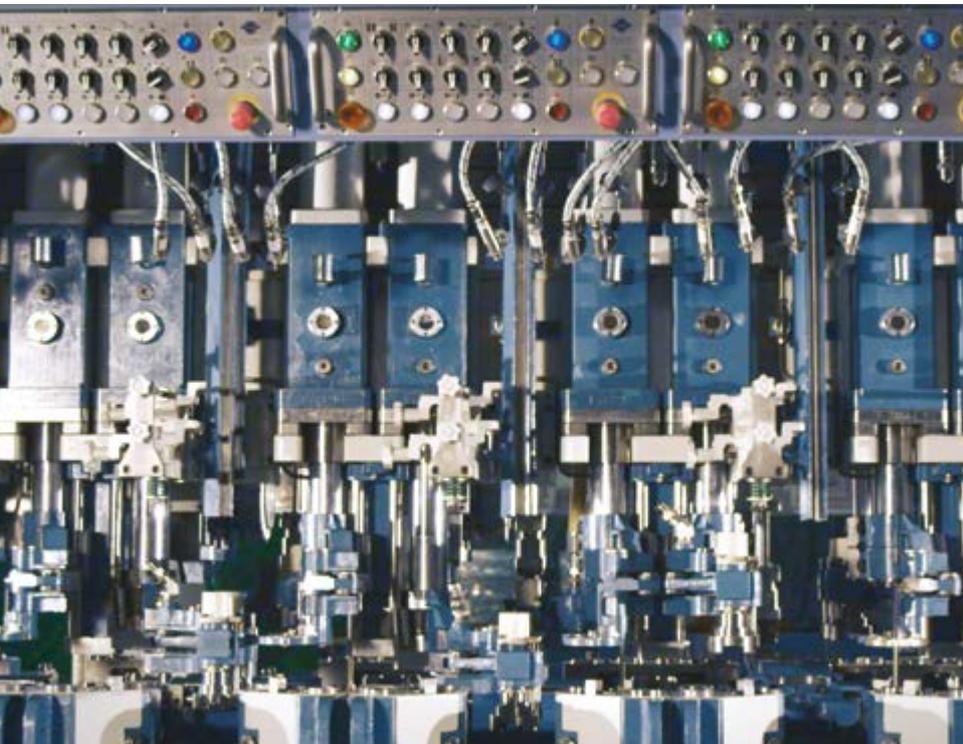


Verallia has a glass manufacturing plant in Campo Bom, in the State of Rio Grande do Sul in Brazil. Photo provided courtesy of Verallia.



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The Latin American operations of Verallia includes a glass manufacturing plant in Jacutinga in the State of Minas Gerais, Brazil. Photo provided courtesy of Verallia.

including two new furnaces. A new furnace is scheduled to start operations at the plant in Jacutinga in the State of Minas Gerais by the end of 2022. The second furnace is being installed at the plant in Campo Bom in the State of Rio Grande do Sul; it is anticipated that this furnace will become fully active in the fourth quarter of 2023. A third Brazilian plant is located in Porto Ferreira in the State of São Paulo.

“We have advanced significantly in Brazil,” said Mr Testa. “By adding the two ongoing large investments, Verallia Brazil’s production will gain more than 730 million glass packaging units per year, more than doubling the installed production capacity in Brazil by 2023. In addition to increasing production, it will also bring an increase in the number of employees and more revenue for the cities and surroundings.”

The glass packaging portfolio in Brazil, according to Verallia, serves the food and beverage industries through the production of 197 different types of glass containers, 169 of which are bottles and 28 jars. On average, Mr Testa indicated that 15 new products are launched annually in Brazil.

Verallia Brazil is headquartered in São Paulo in the

province of the same name. About 700 employees work at the three glass manufacturing plants in this country. Verallia Brazil produces 900 million glass bottles and jars per year. Glass is produced in four colours, including flint, green, emerald green and amber.

Chile

“Saint-Gobain bought BO Glass from a Chilean investor group in 2007, before it began manufacturing bottles (in May of that year),” explained Mr Testa. “With an attractive business proposition and with the technical support of the international Group that is now Verallia, the Chile operation became an alternative for quality and service for the wineries, in a country that had only two local suppliers (before Verallia).”

“We’ve achieved a solid presence

in most of the top 20 wineries in Chile, which buy over 80% of all wine bottles,” Mr Testa continued. “Over the past few years, we’ve significantly diversified our product portfolio to serve the greater value-added segments and smaller wineries. Verallia Chile is currently the third largest manufacturer with a flagship position for the winemaking industry, which accounts for approximately two-thirds of the total glass volume produced in Chile.”

Verallia Chile is headquartered in Rosario in Cachapoal Province. Approximately 195 employees work at the glass manufacturing plant in this country. Verallia Chile produces 330 million glass bottles and jars per year. Glass is produced in four colours, including green, dead-leaf, antique green and flint. ▶



Bottles are amongst the products manufactured by Verallia in Chile. Photo provided courtesy of Verallia.

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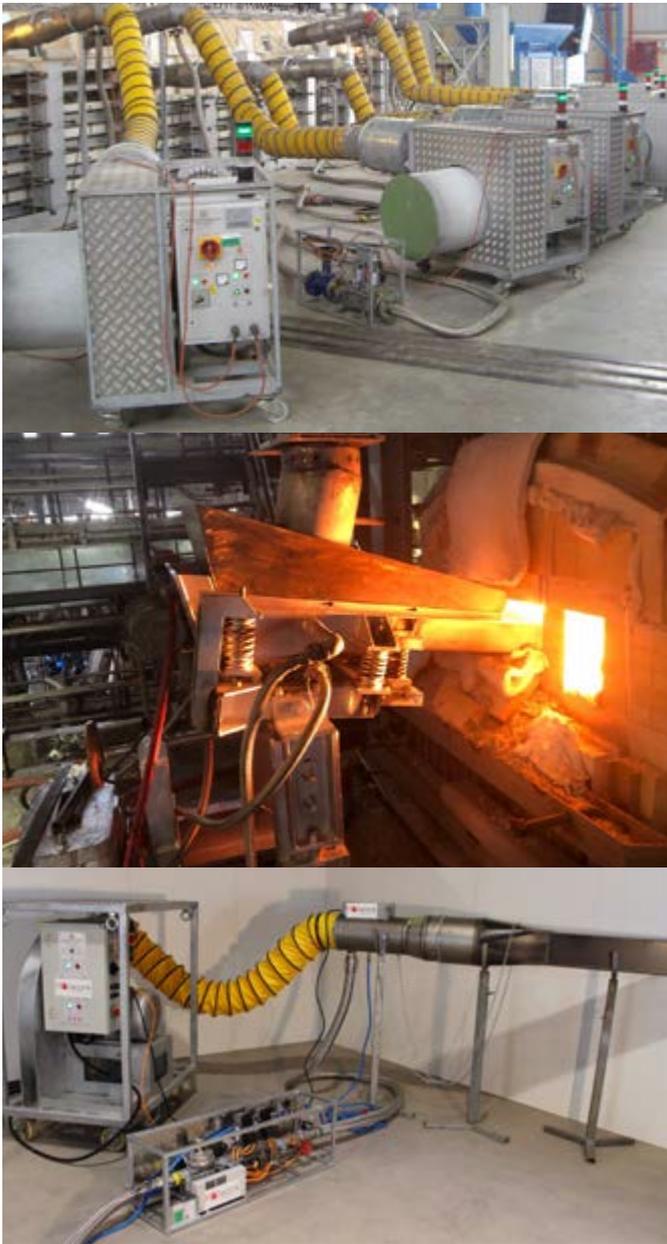
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Markets

“In Latin America, our business is mostly still focused on wine and beer,” stated Mr Testa. “Wine market growth in Argentina and Chile is driven by sustained export growth, with local consumption holding up well despite a difficult macro environment. In Brazil, beer and wine are the largest contributors to market growth. Beer is the largest end-market following the one way and localisation trends, and the wine market is driven by the rapid increase in Brazilian consumption.”

Mr Testa indicated that the glass bottles and jars produced in the manufacturing plants of Verallia in South America are sold to clients based in South America: “Verallia’s ‘Glo-Cal’ business model is built on the strength of its international network combined with proximity relationships maintained with its customers locally. The Group offers a diversified product offering including a range of both standard products and specialised products that are designed in collaboration with the Group’s customers and tailored to their specific needs.”

As an example of how glass bottles are designed for specific market segments, consider Verallia’s production of glass containers for still wines. Mr Testa noted that “in order to meet market demands, the Group offers a wide range of bottles offering various shapes and sizes adapted to the different regional markets, in order to address two powerful market trends: the growing appeal of premium products and the development of rosé wine, for which differentiation is mainly based on the packaging used.”

Covid-19 pandemic

“The glass packaging market has been undergoing a major transformation since 2019,” said Mr Testa. “At the beginning of the pandemic, there was a retraction, but immediately the trend of increasing demand returned with even more intensity. It is undeniable that the pandemic accelerated the process, and with it, demand grew substantially in the second half of 2020 and continues to rise significantly in Latin America.

“The glass market is generally resilient and stable and we have good short-term visibility of our customers’ consumption trends and expect demand to grow by more than 2% in Europe and even more dynamically in Latin America,” Mr Testa continued. “Nevertheless, in 2021, we had to face a significant inflation of energy costs in particular. In order to limit the impact of this inflation, we have covered 85% of our electricity needs.”

Recycling and sustainability

“The circular economy is at the heart of Verallia strategy and we are convinced that glass is one of the most sustainable materials,” explained Mr Testa. “To this end, we start from the purpose of Reimagine glass for a sustainable future, working with all our stakeholders in the following three areas: help increase glass collection by supporting, raising awareness and mobilising the various players involved in this collection to integrate more and more recycled glass into our productions; work on optimising the integration of external cullet by continuing to invest in our dedicated cullet treatment centres, but also in the work of all our cullet specialists so that quality and quantity improve every year, worldwide, taking into account all local characteristics and differences; and finally, make reuse a win-win solution for the planet and the glass packaging we believe in. The goal is to perpetuate local loops offering the reuse of glass packaging whenever it is feasible, and it makes sense.”

Mr Testa indicated that as part of the sustainability efforts of Verallia, “we have identified three macro pillars: significantly reducing CO₂ emissions, increase the circularity of glass packaging and provide employees a safe and inclusive workplace. With these three goals, we contribute to six of the 17 goals of the United Nations. We believe that to put this into practice, we need to start from the inside out. Employees are not more than a reflection of society.

Therefore, we work internally on environmental education. From the moment employees enter the factory, recycling, all purposes and actions on the subject are addressed.

“To achieve our purpose of Reimagining Glass for a Sustainable Future in Brazil, we have several projects,” Mr Testa continued. “We have just launched the Vidro Vira Vidro project, which consists of the initial installation of 200 containers for recycling glass. This brings one more collection option, in addition to the existing ones – such as, for example, selective collection, which is still underdeveloped in Brazil. After the initial phase, our goal is to install thousands of containers in different regions of Brazil.”

Verallia Argentina has a glass recycling programme called “Vidrio una Acción Transparente.” Mr Testa stated that “this programme consists of putting containers in specific location; then the glass containers are collected and purchased by Verallia.” He explained that an equivalent amount of money is then donated to the Notti Foundation, which uses these funds to aid in the construction of a hydrotherapy centre for the rehabilitation of children. “The aim of this action is to promote the importance of recycling glass.”

In Chile, Mr Testa indicated that Verallia has a partnership with CVGreen and municipality of Rengo to develop a recycling culture in the community through an educational program with KIKLOS to promote the sustainability of the glass. He explained that these efforts focus on area schools (with more than 9,000 students) and a network of recycling bins at area parks that are near the participating schools. The firm also supports a green approach from tree planting at municipal parks so as to create a strong bond amongst education for sustainability, glass recycling, and nature preservation.

Projections for the future

Mr Testa explained that the priorities for Verallia Latin America during 2022 include keeping safety levels, health standards, quality controls and industrial performances at the “best in class levels” as well as meeting the deadlines on the company’s strategic growth projects, including the Jacutinga expansion and Campo Bom expansion in Brazil.

“Despite a volatile and challenging environment, Verallia Latin America is achieving excellent results on all business criteria,” Mr Testa stated. “We need to keep our focus on the realisation of the growth, keeping our commercial spread positive and implementing our productivity action plans in a timely fashion. The potential external factors we closely pay attention to include macroeconomic environmental aspects (GPD, inflation, FX); glass costs; logistics costs; and the impact of the Covid-19 Pandemic.”

In the 2021 Annual Report of Verallia, the company noted in its 2022 Outlook that “Provided that the situation linked to the Covid-19 Pandemic does stabilise, that the inflation in costs and the geopolitical context do not deteriorate further, Verallia is expecting a sharp growth in its annual revenue. In the current environment of accelerating inflation since the second half of 2021, Verallia anticipates a significant increase in its production costs in 2022, of which energy is a major factor.” ●

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About the author:

Richard McDonough is a civic journalist based in the USA. He writes on a variety of topics in the glass industry.

Further information:

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China's flat glass industry

Professor Peng Shou reports on developments taking place in China to promote the transformation of the country's flat glass industry from extensive growth to high-quality growth, and from high energy consumption and high pollution to green and low-carbon manufacture.

Supporting the growth of strategic and pillar industries, glass has an important role in the development of national economy. As early as 1922, China began to develop its modern glass industry and the Qinhuangdao Yaohua Glass Factory was established. Then in 1981, when the Luoyang float glass process was successfully developed, the Chinese glass industry entered into the era of large-scale industry.

As of 2021, the production capacity of China's glass industry ranks first in the world, and the country's annual output of flat glass exceeds 1 billion (1.02 billion) weight boxes. The world glass industry pattern is being reshaped by China, and will gradually enter the 'China era'.

Breakthroughs in recent years

After decades of dedicated efforts, Chinese glass practitioners have conquered a series of key core technologies for glass preparation, and have completed a comprehensive improvement in the scale of the glass industry, product types and technical content. The Chinese glass industry has made a huge leap from following and running to leading.

In terms of production capacity, by the end of 2021, there were 299 float glass production lines in the country, 264 of which are in production, with a daily melting capacity of 174,825 tons – accounting for more than 60% of the world's float glass production. High-quality production lines account for about 40% of Chinese float glass, and 231 photovoltaic rolled glass production lines are running, with a daily melting volume of 41,260 tons.

In terms of varieties, breakthroughs have been made in ultra-thin touch glass, flexible glass, medicinal glass, TFT-LCD glass, high-aluminium cover glass, etc. Meanwhile, performance of ultra-white photovoltaic glass, power generation glass, smart glass, photovoltaic photothermal glass, radiation protection, anti-ultraviolet glass and agricultural facility glass has been continuously improved. The thickness of float glass with full coverage changing from 0.12mm to 25mm has also been achieved.

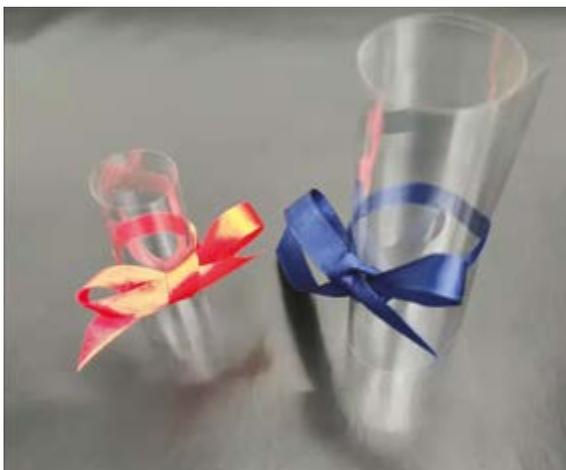


Figure 1: 0.12mm ultra-thin touch glass.



Photovoltaic glass produced by CNBM(YIXING) New Energy Resources Co., Ltd.

In recent years, the demand for deep processing glass in new energy vehicles, green buildings and other industries has been being raised with the rapid development of green energy. The cumulative output of tempered, laminated and insulating glass has reached 619.979 million m², 131.501 million m² and 159.137 million m², respectively (as of 2021).

In terms of glass processing technology, [China] independently developed the integrated technology of thinning, strengthening, cutting and forming processing in order to adapt to the trend of thinning and flexibility in the information display industry, which can produce ultra-thin flexible glass with a thickness of 30µm in mainstream specifications. This glass can be bent 400,000 times continuously without damage, with the bending radius of less than 1mm, guaranteeing the safety of China's information display industry chain from the source.

At the same time, with the continuous improvement of China's glass industry technology and equipment level and the guidance of the national 'One Road One Belt' [foreign policy and economic strategy to expand China's global economic reach and influence], the output of China's glass industry has spread to most parts of the world. Since 2019, new glass projects in China have

successively entered Asia, Africa and Europe (e.g. Egypt, Bangladesh, Algeria, Saudi Arabia, Turkey, South Korea, India, Ukraine, etc). However, we must also be soberly aware that the glass industry will gradually transform from extensive growth to high-quality growth as the peak carbon dioxide emissions, carbon neutrality goals and the proposal of China's new development concept are established.

Photovoltaic glass

Previous photovoltaic module production in China was based on importation and the market was mainly dominated by foreign enterprises such as Saint-Gobain, Pilkington, ACG and NSG. However, China has been actively pursuing independent production of photovoltaic glass core process technology since 2002 and completed sets of equipment with rapid development in the photovoltaic industry.

In December 2006, the first 250tpd photovoltaic glass production line in China with independent core technology was established. By 2011, China had become the world's largest producer of photovoltaic glass, accounting for about half of the global production share. In 2016, the photovoltaic glass industry in China achieved localisation [domestic production]. Foreign companies had withdrawn from China's photovoltaic ▶



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8.5th generation TFT-LCD ultra-thin float glass substrate production line thin-film building-integrated photovoltaic (BIPV) application demonstration project.

glass market, while Chinese photovoltaic glass firms had begun to build factories overseas and were expanding their production. In 2017, China constructed the world's largest photovoltaic glass production line (1,000tpd) and achieved stable mass production of the world's thinnest photovoltaic glass (1.5mm).

By the end of 2021, China's daily output of photovoltaic glass was about 57,200 tons, accounting for more than 90% of the global market. Largescale enterprises include Xinyi Group, Flat Group and CNBM. The goal of 'carbon neutrality' and 'carbon peak' has opened up a broader market for China's photovoltaic industry, which has stimulated the development of the photovoltaic glass industry. In the future, photovoltaic glass production capacity will be ushered in a major expansion.

Information display glass

With the rapid development of information technologies such as 5G, Internet plus and artificial intelligence, the demand for human-computer interaction has been gradually increased. At the same time, the requirements of glass substrates for electronic information display are also increasing. Information display glass mainly comprises ultra-thin electronic glass, TFT-LCD glass and super-strong cover glass. At present, China has been at the forefront of the world in ultra-thin glass, with product thicknesses ranging from 0.55mm to 0.03mm. CNBM claims to be the only enterprise in the world that can independently develop 30µm flexible glass – from original sheet to post-processing. A 30µm foldable glass developed by the General Research Institute of Glass New Materials established by CNBM has been bent

400,000 times without damage, with a bending radius less than 1.5mm.

The current development trend for information display is large-screen and multi-screen. In the future, the market demand for high-generation G8.5 [liquid crystal] substrate glass and above will be increased. In 2019, the first G8.5 TFT-LCD glass substrate product was officially rolled off the production line in China, creating a precedent for the localisation of G8.5 TFT-LCD float glass substrates. China has been the third country to master the production technology of high-generation TFT-LCD glass substrates, following the USA and Japan.

In terms of super-strong cover glass, China has also made a series of breakthroughs, which have been at the forefront of the world in the development of related industries since the country's first high-alumina glass production line was built in 2014.

Architectural and traffic glass

With the implementation of the national dual-carbon strategy, China's construction and modern transportation industries reflect the development trend for energy saving, safety, light weight and compounding. In the field of construction, building-integrated photovoltaic (BIPV) technology combines photovoltaic power generation glass with buildings, which not only meets the basic needs of buildings, but also generates electricity, further reducing the building's energy consumption. Thus, it is expected to become the mainstream technology for future building development. Moreover, the trend for insulated glass, vacuum glass and coated low-emissivity glass to reduce energy consumption is also becoming more and more obvious. New technologies such as dimmable and light-converting glass also offer a new direction for the development of building energy conservation.

In the field of automotive glass, the application of dimmable glass has developed rapidly in recent years. Its main technical paths are PDLC [polymer dispersed liquid crystal], EC [electrochromic] and SPD [suspended particle glass]. Established earliest, PDLC technology is the most advanced and mature with a relative low cost. Most domestic dimmable glass production companies use this scheme. EC offers low haze, low energy consumption, good heat insulation effect, continuous dimming while the cost of EC is in the middle. It is represented by ZEEKR 001 and AIONSPPLUS. SPD is mainly used in Mercedes-Benz' luxury cars due to its high power consumption and high cost. Upstream companies that can provide PDLC, EC, and

SPD dimming films include Guoan Qiwei, Zhonghe Technology, Guangyi Technology (NIO and BYD participated in the investment) and Hitachi Chemical. Midstream manufacturers that can provide automotive dimmable glass include Yutian Guanjia, Jingyi Technology, Webasto, Fuyao Glass, Asahi Glass, Nippon Sheet Glass and Saint-Gobain. Among them, Fuyao Glass is in a leading position with comprehensive glass products (PDLC, thermochromic, EC) and faster mass production progress.

Glass processing

Deep processing of glass includes coating, laminating, heat-treating, polishing, thinning and other process technologies, involving many fields of industries. For example, low-E glass, hollow (vacuum) glass, intelligent light control glass for building energy savings, and electrode glass for solar cells are based on deep processing technologies. In addition, some glass products emerging on the market often integrate a variety of deep processing technologies, exemplified in the flexible/foldable glass used in the display field.

Based on extensive accumulated technical experience in thinning, strengthening, cutting and forming processing, Triumph Science & Technology Co. has independently developed high-strength flexible glass formulations and produced an ultra-thin flexible glass with a thickness of 30~70µm. The product can be continuously bent 400,000 times without damage, and the bending radius is less than 1.5mm. The main performance indicators and parameters are at the leading level in the industry. It is the only UTG [ultra-thin glass] industry chain covering 'high-strength glass, extreme thinning and high-precision post-processing' in China.

Following years of continuous investment in science and technology, China's glass deep-processing industry has made great progress, and a series of star glass products have emerged. However, whereas the deep processing industry in developed countries is relatively mature and balanced with over 80% of glass being deep processed, this figure is only 40% in China. For low-E insulating glass, the utilisation rate in developed countries is as high as 80%, while in China it is only 12%. Therefore, leading by science and technology to drive the development of glass deep processing ▶

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is very important to accomplish 'big to strong' in China's glass industry and enhance its international competitiveness.

Production technology

In recent years the production technology of China's flat glass industry has undergone rapid innovation. Breakthroughs have been made in core technologies such as raw material mining, flotation, digital recipe library construction, online optimisation of production lines and new localised equipment. The R&D and mass production of new glass materials have been achieved, including ultra-white photovoltaic module glass, 30µm ultra-thin glass, flexible glass and transparent conductive glass.



Xing ke Low-E deep processing production line.

Raw material purification: The acquisition and purification of glass raw materials are important to guarantee the preparation of high-quality glass. In view of the fact that the iron content in quartz sand is too high in China's raw material ore veins, pioneering research of ppm-level quartz sand short-range flotation process has been developed. The use of a cationic plus non-ionic mixed flotation collector to combat the convergence of impurity ions such as K+, Na+, Ca₂₊, Mg₂₊ ions on the surface of natural minerals results in the technological innovation of an element-selective flotation process.

With the promotion and application of glass materials in the fields of electronics and semiconductors, purity requirements for raw glass materials have been gradually increased. Based on the rapid development of precision instruments in China, a distributed digital closed-loop control system has been introduced into the raw material system. The static batching accuracy

can reach 1/2000, which effectively improves the batching accuracy and reduces the presence of unwanted material.

Melting technology: The research and development of new glass materials is inseparable from the innovation of melting technology. In recent years, China has successively developed new glass melting technologies, such as large-scale glass melting furnaces, segmented melting, flying melting, advanced combustion, electric boosting, bottom bubbling, thermal gradient composite insulation, etc., which effectively reduces the heat consumption of molten glass and improve its melting quality. Nowadays, oxygen-enriched combustion technology has been adopted by China's flat glass production. At the same time, all-electric melting and the introduction of environmentally friendly alternative fuels are also developed vigorously. High-efficiency and low-

emission production of new glass materials is expected, along with reducing production losses and environmental pollution of glass materials, and promoting the rapid development of new glass materials. Table 1 shows the melting improvement methods available.

At present, the heat consumption of a 1200tpd float line in head enterprises has been reduced to 1350kcal/kg molten glass below, and the heat consumption of 600tpd float line has been reduced to 1450kcal/kg molten glass below. This provides a feasible reference for achieving low-carbon and energy-saving production in traditional high-energy-consuming industries.

Ultra-thin forming technology: As information display products continue to become more lightweight and portable, thin and flexible glass has become the favourite of the future electronic display field. Through the breakthrough improvement of China's float process technology, the float forming, thinning, strengthening, cutting and post-processing integrated technologies and complete sets of equipment have been developed, and the world's thinnest glass (0.12mm thickness and over 3m slab width) was successfully produced. Figure 1 is an example of 0.12mm ultra-thin touch glass.

This technology breaks the monopoly of foreign countries and guarantees the security of China's information display industry chain from the source, and also puts the country's information display glass materials in a leading position.

Energy saving

Reduction of carbon dioxide emissions and achieving carbon neutrality is an important part of actively participating in global climate governance and building a community with a shared future for mankind. It is also an inherent requirement for achieving high-quality economic and social development. The development process of the glass industry should fully implement the new development concept which contains, establishing a clean, low-carbon, efficient and safe, modern energy production and consumption system, actively seeking a more sustainable, inclusive, and resilient economic growth mode, as well as achieving a balance between man and nature – co-ordinated development.

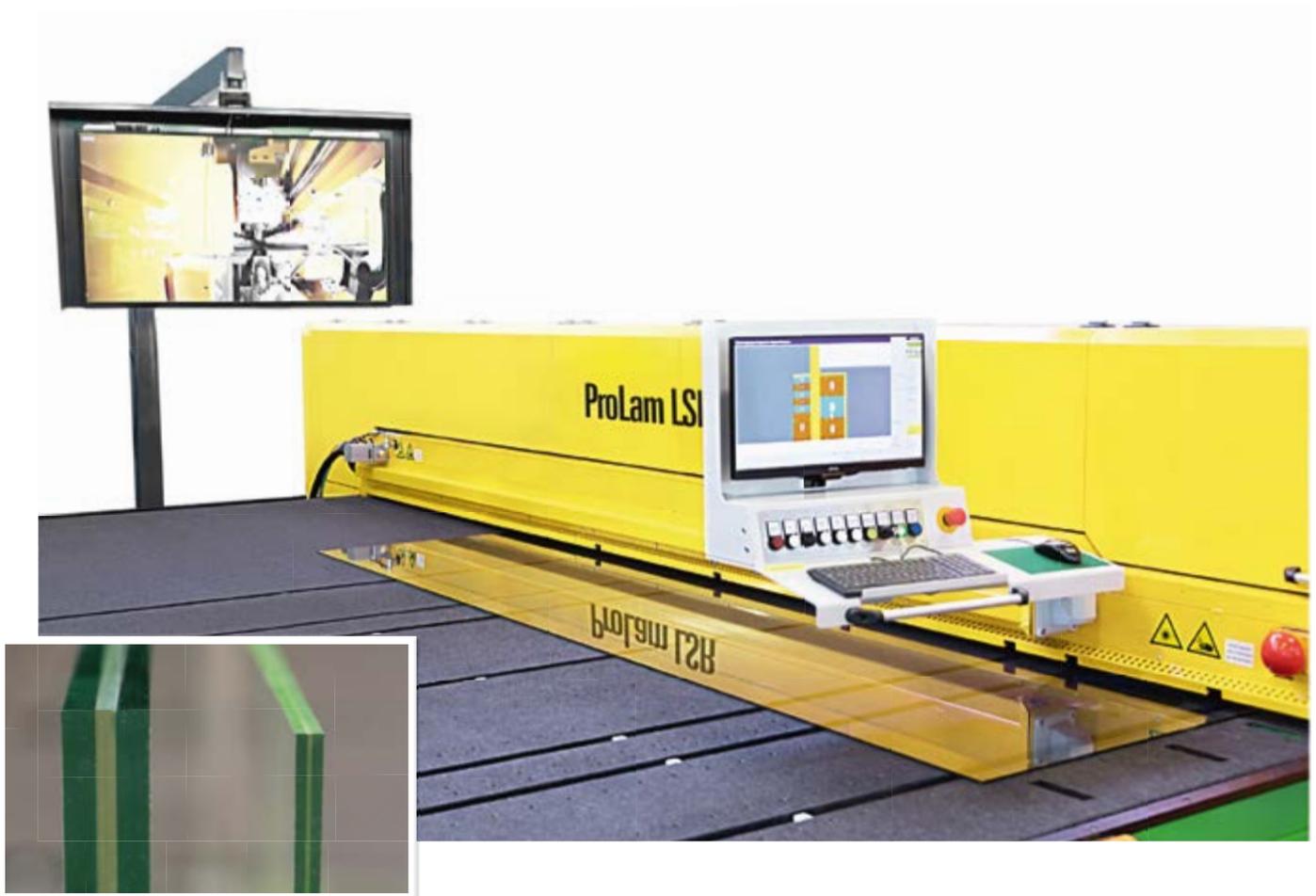
The carbon dioxide emissions of China's flat glass industry account for about 4.2% of the carbon dioxide emissions and 0.3% of the country's domestic carbon dioxide emissions for the national building materials industry.▶

| No. | Modified stage | Main technical content | Popularity (%) |
|-----|-------------------|--|----------------|
| 1 | Burning | oxygen-enriched combustion | 100 |
| 2 | | 0# Pure oxygen combustion supporting technology of spray gun | 10 |
| 3 | | oxygen-fuel combustion | 7 |
| 4 | | Energy saving combustion spray gun | 100 |
| 5 | | Atomising medium heating | 100 |
| 6 | Furnace Structure | Stepped pool bottom and dam retaining technology | 100 |
| 7 | | Segmented melting technique | 100 |
| 8 | | Double neck tandem technology | 100 |
| 9 | | Full thermal insulation technology | 100 |
| 10 | | Thermal insulation coating technology | 10 |
| 11 | | Large-scale melting furnace | |
| 12 | | Regenerator energy saving technology | 100 |
| 13 | Melting procedure | Bubbling technology | 30 |
| 14 | | Auxiliary electrofusion technology | 10 |
| 15 | Melting equipment | Selection of energy-saving equipment | 100 |
| 16 | | Automatic control system | 100 |
| 17 | | Furnace waste heat power generation technology | 100 |
| 18 | | Hot air utilisation technology of annealing kiln | 5 |

Table 1: Melting improvement methods.

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| No. | Time of Release | Name | Main relevant content |
|-----|-----------------|---|--|
| 1 | 2019 | Implementation of Opinions of the Ministry of Industry and Information Technology on Promoting the Quality Improvement of Manufacturing Products and Services | Accelerate the transformation and upgrading of traditional industries such as steel, cement, electrolytic aluminium, and flat glass, promote clean and efficient production processes, implement green and intelligent transformation, and encourage the development and application of full-process quality online monitoring, diagnosis, and optimisation systems. |
| 2 | 2021 | Guiding Opinions on Strengthening the Eco-environmental Sources of High Energy Consumption and High Emission Construction Projects | Accelerate the decision-making and deployment of promoting green and low-carbon development, curb the blind development of high-energy-consuming and high-emission projects, and promote green transformation and high-quality development. |
| 3 | 2021 | Measures for the Implementation of Capacity Replacement in the Cement and Glass Industry | Further promote the supply-side structural reform, strictly control the construction of high-energy-consuming and high-emission projects, and further consolidate the achievements in reducing overcapacity in the cement and glass industries. |
| 4 | 2021 | Action Plan for Carbon Dioxide Peaking Before 2030 | Strengthen oversight on production capacity replacement, move faster to eliminate low efficiency production capacity, strictly prohibit new cement clinker and flat glass production capacity, and guide the building materials industry in transitioning to become lighter, more intensive, and more product-oriented. |
| 5 | 2021 | Strict energy efficiency constraints in key industries of metallurgy and building materials to promote energy conservation and carbon reduction action plan (2021–2025) | To curb the blind development of high-energy-consuming and high-emission projects, it is required that the proportion of production capacity with energy efficiency reaching the benchmark level in the flat glass industry exceeds 30%, by 2025. |
| 6 | 2021 | Energy efficiency benchmark level and benchmark level in key fields of high energy-consuming industries (2021 Edition) | Taking kilograms of standard coal/weight box as the index unit, the benchmark level for flat glass production capacity greater than 800t/day is 8, the benchmark level is 12, and the benchmark level for flat glass production capacity greater than or equal to 500t/day and less than or equal to 800t/day is |
| 7 | 2021 | The 14th five-year plan for the development of raw materials industry | It is required to promote the high-end industrial supply, and focus on promoting the melting and forming technology of special glass. It is proposed to accelerate the greening of industrial development, study and promote the implementation of ultra-low emissions in key industries such as glass and cement. |
| 8 | 2021 | Industrial structure adjustment guidance catalogue (2019 version) (Revised version) | Encourage the development and application of new energy industries such as solar generator thermal systems and solar photovoltaic power generation system integration technologies. |
| 9 | 2021 | Comprehensive Work Plan for Energy Conservation and Emission Reduction in 14th Five-Year Plan | Promote energy-saving renovation and in-depth pollution treatment in the architectural material industry, promote energy-saving renovation of existing buildings, and the integrated construction of building photovoltaics, and improve policy mechanisms for energy conservation and emission reduction. |
| 10 | 2021 | Catalogue of the first batch of application demonstration guidance for key new materials (2021 edition) | Carry out the first trial of insurance compensation for the use of key new materials, such as new display glass, ultra-thin flexible glass, and high-performance lithium-aluminium-silicon glass, and accelerate the development and application of new materials. |
| 11 | 2021 | Smart Photovoltaic Industry Innovation and Development Action Plan (2021–2025) | Promote the in-depth integration of the photovoltaic industry and the new generation of information technology, accelerate the realisation of intelligent manufacturing, intelligent application, intelligent operation and maintenance, and intelligent scheduling, comprehensively improve the development quality and efficiency of China's photovoltaic industry, to achieve carbon peaking in 2030 and carbon neutrality in 2060. |
| 12 | 2022 | Implementation Guidelines for Energy Conservation and Carbon Reduction Transformation and Upgrading in Key Areas of High Energy-consuming Industries (2022 Edition) | From the adjustment of industrial structure, product structure, energy structure and improvement of energy utilisation efficiency and other aspects, the transformation and upgrading path of cement, flat glass and building and sanitary ceramics industries has been clarified; strengthen advanced technology research and speed up the popularisation and popularisation of mature technology. |

Table 2: Industrial policy of the Chinese glass industry.

At present, energy conservation and emission reduction in the Chinese glass industry are mainly achieved by improving energy utilisation, strengthening the application of advanced energy-saving technologies, and adjusting the structure of energy consumption. Energy-saving and consumption-reducing technologies such as large-scale melting furnaces, all-oxygen combustion, new furnace insulation, furnace automation and precise control have been rapidly promoted and popularised.

A breakthrough has been made and successfully applied to many domestic production lines. New energy-saving and emission-reduction technologies such as waste heat power generation, flue gas treatment and high-efficiency energy-saving melting furnaces contribute to the green development of the glass industry. At the

same time, the glass industry has achieved significant carbon reduction with continuous breakthroughs in new technologies such as alternative fuels, electric boosting, green electricity oxygen production, rooftop photovoltaics, BIPV [building-integrated photovoltaics] power stations, thermochemical regeneration, carbon dioxide capture and purification and application, low-temperature waste heat and low-carbon formulations. The road to zero-carbon development has a bright future.

Policy support

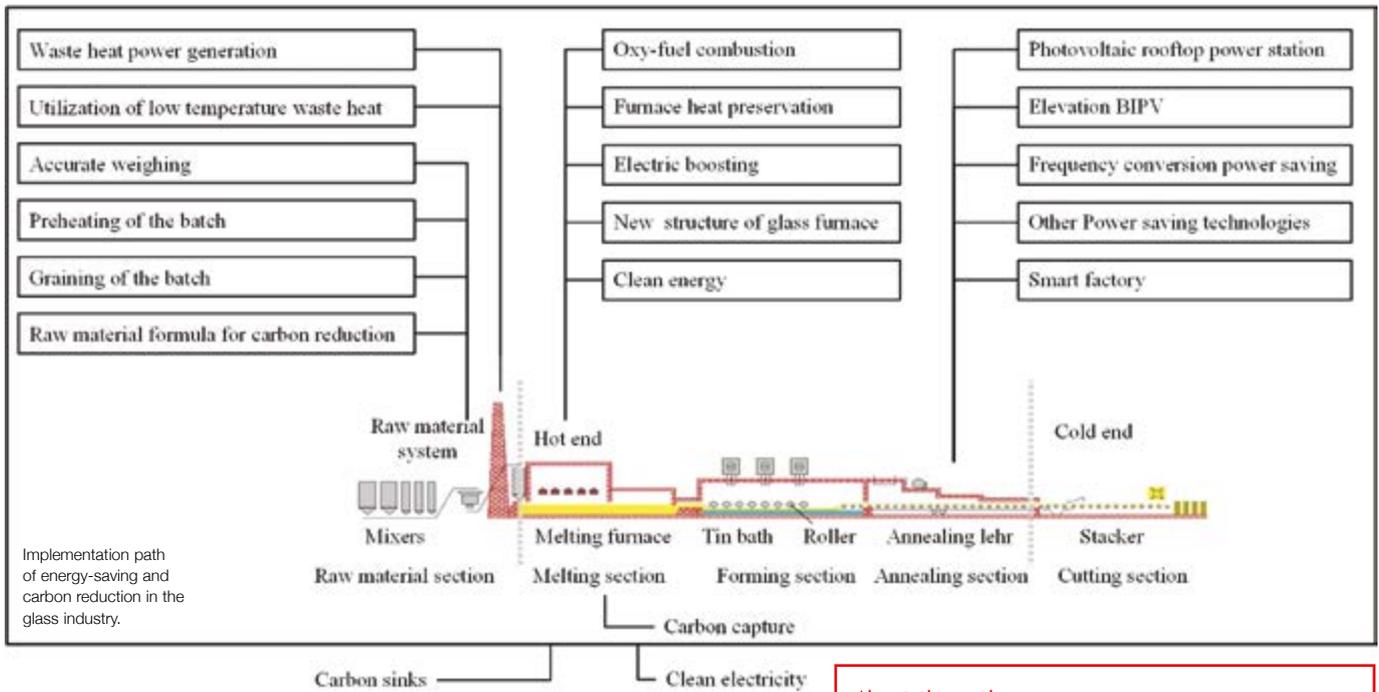
In order to promote the transformation of China's flat glass industry from extensive growth with high-quality growth, and change from high energy consumption and high pollution to 'green' and low-carbon, the Chinese government has issued a series of policies and measures to guide the healthy development of China's flat glass industry. Relevant policies clarify the transformation and upgrading of China's flat glass industry in terms of industrial structure, product types, energy utilisation and other aspects. The promotion of advanced technology research and the popularisation of mature processes have also been emphasised.

Development prospects

As China continually promotes the reform of its supply side structure, in addition to implementing the replacement of production capacity, eliminating backwards flat glass production capacity, constantly promoting the technological progress of the industry, and implementing intelligent manufacturing and green manufacturing, the industry concentration of China's glass production enterprises will gradually increase.

Continued development of the country's flat glass industry will comprise the following characteristics:

- **Innovation drive:** innovation leads growth and promotes high-quality development of enterprises through scientific and technological innovation.
- **Collaborative innovation:** interdisciplinary and cross industry co-operative research and development will become the main form of innovative glass development in the flat glass industry.
- **Transformation and upgrading:** production enterprises with low scientific and technological content and low product added value will gradually face industrial transformation and upgrading.
- **Green manufacturing:** save energy, reduce carbon and improve resource utilisation. China's flat glass industry will accelerate its development towards low-carbon and green environmental protection.



Conclusion

After decades of rapid development, China's glass industry has entered a stage of high-quality development. Green manufacturing, interdisciplinary and cross-industry collaborative innovation

will become the main direction of R&D. With technological breakthroughs in relevant fields and the effective pull of emerging industries, China's flat glass industry has great prospects. ●

About the author:

Professor Peng Shou is Chairman of Triumph Science & Technology Group Co Ltd and President of Bengbu Design & Research Institute for Glass Industry

Further information:

tel: +86 2152916280
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Japanese packaging materials review

The accompanying statistical data has been sourced from the Japan Glass Bottle Association for *Glass Worldwide's* 2022 Focus on Japan

feature. As well as identifying shipment volumes by packaging material type, a comprehensive breakdown of glass container shipment volumes is provided, including detailed analyses of sales by market sector, usage and colour.

The Japan Glass Bottle Association (JGBA) has six member companies and seven associate members that collectively cover some 98% of glass container production in Japan. *Glass Worldwide* is the JGBA's preferred journal. ●

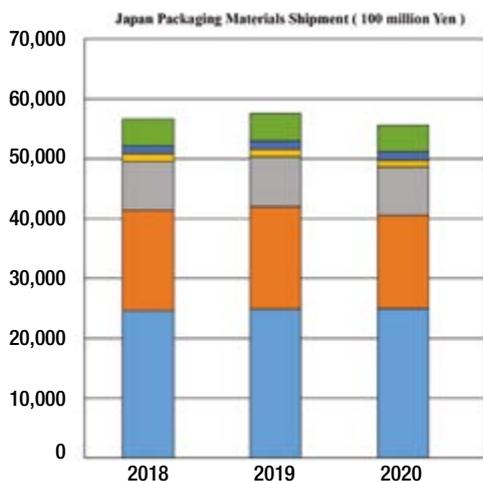


JGBA dignitaries with *Glass Worldwide's* Dave Fordham in 2020.



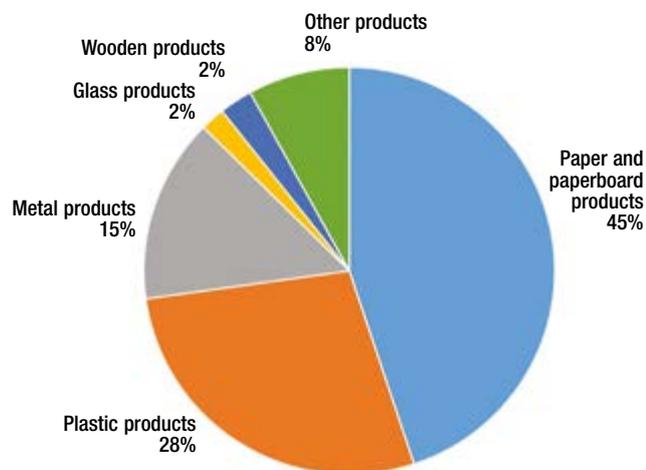
Further information:
web: www.glassbottle.org

SHIPMENT VALUE ALL MATERIALS



- Paper and paperboard products
- Plastic products
- Metal products
- Glass products
- Wooden products
- Other materials

| Japan Packaging Shipment value (100 million Yen) | | | |
|--|---------------|---------------|---------------|
| | 2018 | 2019 | 2020 |
| Paper & Paperboard products | 24,610 | 24,908 | 24,969 |
| Plastic products | 16,784 | 17,119 | 15,519 |
| Metal products | 8,179 | 8,328 | 8,138 |
| Glass products | 1,195 | 1,164 | 1,076 |
| Wooden products | 1,361 | 1,461 | 1,454 |
| Other materials | 4,471 | 4,529 | 4,459 |
| Total | 56,600 | 57,509 | 55,615 |



2020 Japan packaging materials shipment (value %)

Source: Japan Packaging Institute

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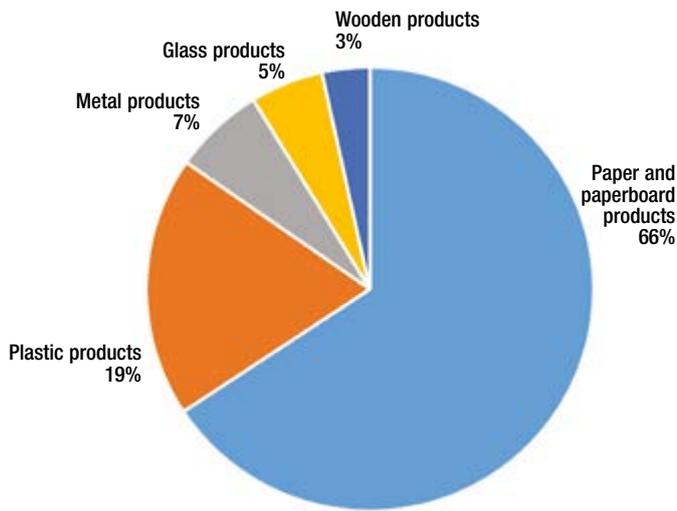


Your Dreams, Our Challenge

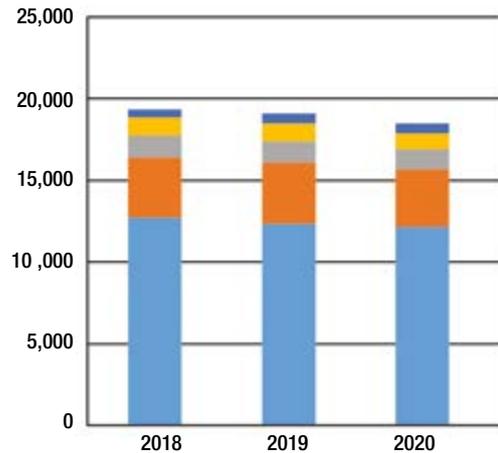
SHIPMENT VOLUME ALL MATERIAL

| Japan Packaging Shipment value | | | |
|--------------------------------|--------|--------|--------|
| | 2018 | 2019 | 2020 |
| Paper & Paperboard products | 12,695 | 12,346 | 12,154 |
| Plastic products | 3,709 | 3,745 | 3,513 |
| Metal products | 1,322 | 1,304 | 1,219 |
| Glass products | 1,135 | 1,069 | 977 |
| Wooden products | 514 | 610 | 639 |
| Other materials | na | na | na |
| Total | 19,375 | 19,074 | 18,502 |

Japan packaging materials shipment volume (1000 ton)



2020 Japan packaging materials shipment (ton %)



Japan packaging materials shipment (10,000 ton)



Source: Japan Packaging Institute

GLASS BOTTLE IMPORT

| Japan Packaging Shipment value (Billion Yen) | | | | | |
|---|------|------|------|------|------|
| | 2016 | 2017 | 2018 | 2019 | 2020 |
| Wine | 155 | 161 | 152 | 166 | 149 |
| Whisky & Brandy | 20 | 29 | 36 | 41 | 38 |
| Hard Cider | 5 | 5 | 5 | 5 | 4 |
| Synthetics Sake & Pajju | 2 | 1 | 0 | 0 | 0 |
| Other Distilled Liquor | 30 | 29 | 28 | 27 | 23 |
| Other Spirits | 43 | 42 | 41 | 40 | 32 |

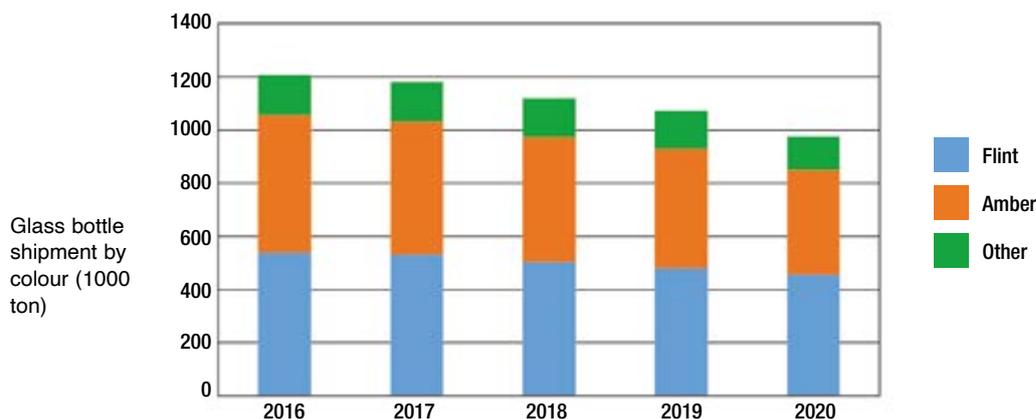
Imported bottles containing alcoholic beverages (Estimate, 1000 ton)

Source: Glass Bottle 3R Promotion Association

GLASS BOTTLE SHIPMENT COLOUR

| | 2016 | 2017 | 2018 | 2019 | 2020 |
|-------|------|------|------|------|------|
| Flint | 538 | 530 | 503 | 478 | 456 |
| Amber | 518 | 502 | 469 | 451 | 395 |
| Other | 150 | 150 | 148 | 144 | 124 |

Glass container shipment volume (1000 ton)



Source: Glass Bottle 3R Promotion Association



The Universe of **Glass**

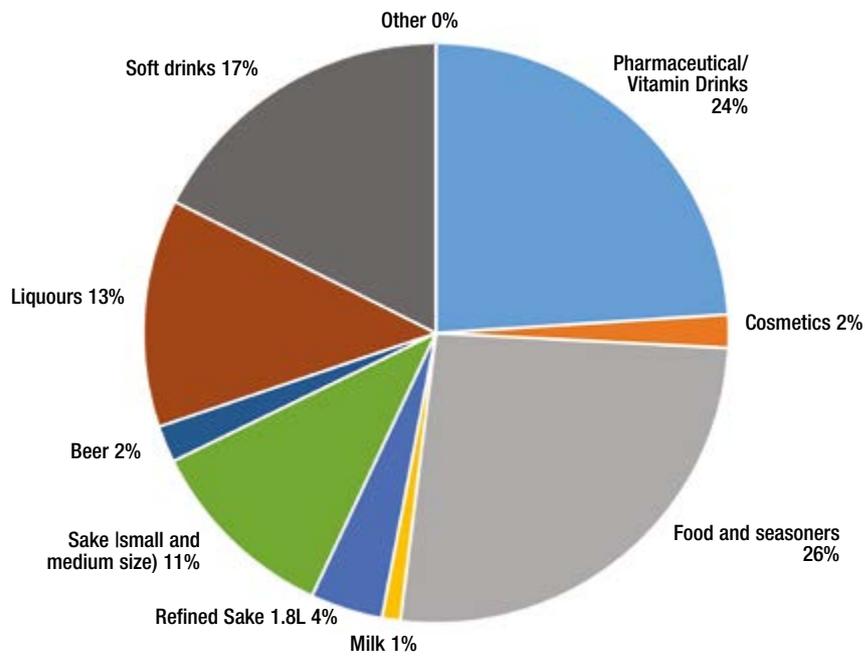
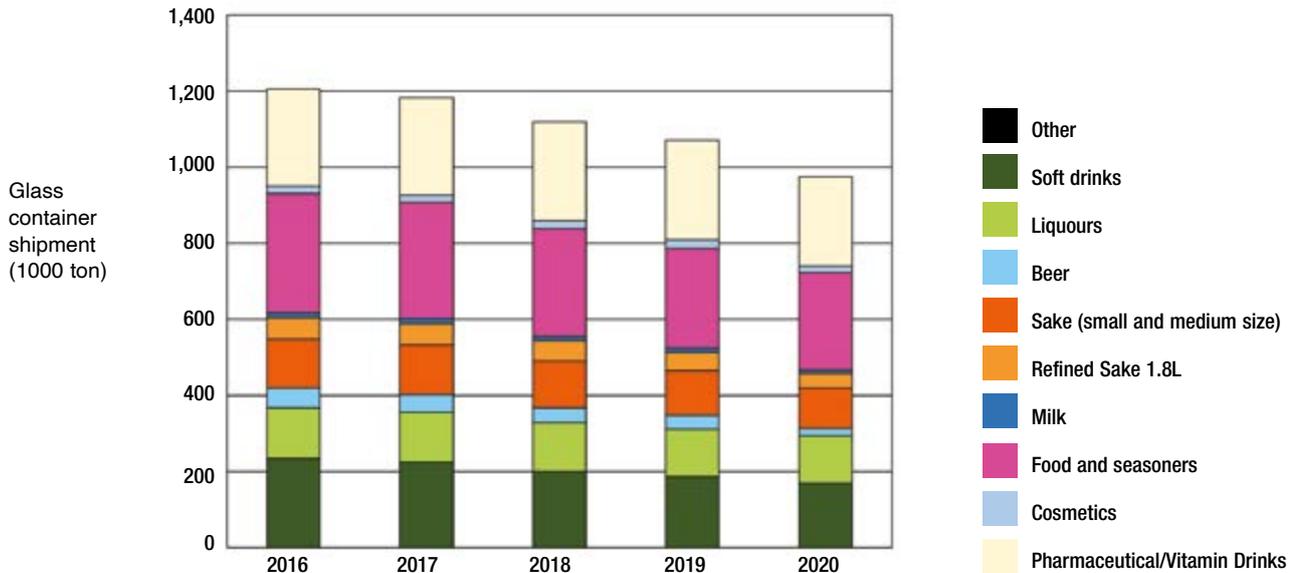
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GLASS BOTTLE SHIPMENT GLASS-3R

| Glass Container Shipment volume (1000 ton) | | | | | |
|--|---------------|---------------|---------------|---------------|--------------|
| | 2016 | 2017 | 2018 | 2019 | 2020 |
| Pharmaceutical/Vitamin Drinks | 257 | 256 | 260 | 261 | 234 |
| Cosmetics | 19 | 19 | 21 | 23 | 18 |
| Food and Seasoners | 313 | 306 | 282 | 263 | 255 |
| Milk | 13 | 13 | 12 | 11 | 10 |
| Refined Sake 1.8L | 57 | 56 | 53 | 47 | 39 |
| Sake (Small and Medium size) | 128 | 131 | 123 | 119 | 105 |
| Beer | 51 | 47 | 39 | 35 | 20 |
| Liquours | 133 | 131 | 130 | 126 | 124 |
| Soft Drinks | 236 | 225 | 200 | 187 | 171 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Total | 1207.0 | 1184.0 | 1120.0 | 1072.0 | 976.0 |

Glass container shipment volume (1000 ton)



Source: Glass Bottle 3R Promotion Association

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Talking about gender bias

British Glass' Communications Manager Victoria Adams reflects on past behaviours in the glass industry and considers ways to acknowledge and challenge bias in the workplace.



Victoria Adams, Communications Manager at British Glass.

It is no secret that the glass industry is male dominated, and largely white male at that but this has improved in recent years and has been recognised by our members. Many are looking at ways to improve gender balances, diversity and inclusion within their businesses and at British Glass, we are exploring ways to support this, but this isn't something that is going to be instantaneous.

Personal experiences

On International Women's Day (8 March 2022), I took the opportunity to talk to the women in our business and it was heart-warming to hear some hadn't even thought about bias in our workplace, and others noting how much this has improved over the years. Our business (British Glass and Glass Technology Services) has a fairly even split between men and women (54/46%) and we have a good representation in technical and management positions – something that is not representative in the wider industry. While this is positive, we did acknowledge we could improve this further – we have no female



Glass Technology Services and British Glass has a fairly even split between men and women.

representation at director level and very little representation at board level.

Whilst our business is generally balanced and perceived positively, speaking to my colleagues highlighted some past events when we felt we'd experienced gender bias. Some of these were quite shocking – and relatively recent – such as someone asking to speak “to a man” or only addressing male colleagues at external meetings or events (I'd like to add, they were only disadvantaging themselves by missing the opportunity of speaking to some of our world-leading experts). We work with organisations across the globe and experiences certainly differ from place to place; thankfully in the UK we felt we'd experienced this less although there are still occurrences.

Calling out bias

My own experiences generally revolve around being spoken over, not heard or my opinion being belittled. I don't think this is just as a woman because I have also seen my younger male colleagues experience this as well. We are fortunate in our business that we are encouraged to share our ideas, opinions, and voices, and this should give confidence and empower woman and younger staff, but this doesn't extend out externally and maybe we should look at ways to challenge or call out bias?

I know my takeaway from this thought exercise will be to acknowledge and challenge bias when I recognise it and

looking into education for how we can support each other. 2022 is also the UN's International Year of Glass and during this year British Glass will look to raise the profile of the glass industry with young people as we aim to improve diversity and representation and attract those who can hopefully become our future leaders. There are so many different opportunities in the industry and I have enjoyed speaking to different people about their experiences in the glass industry. I also hope this year we can highlight the many inspirational women in it! ●

About the author:

Victoria Adams is Communications Manager at British Glass

Further information:

British Glass Manufacturers' Confederation, Sheffield, UK
tel: +44 114 290 1850
email: v.adams@britglass.co.uk
web: www.britglass.org.uk



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Joint venture promotes fully automatic glass forming

Bottero and Tiama have pooled their know-how in process automation and AI to create GlassFORM.ai, an independent company developing solutions for data-driven process automation.



Marco Tecchio, CEO of Bottero Group.



Benoit Burin Des Roziers, CEO of Tiama.

Provider of glass packaging inspection and quality control solutions Tiama and manufacturer of processing machinery Bottero have been co-operating for several years. Based in Rovereto, Trento, Italy, their joint venture marries Bottero's process knowledge with Tiama's sensor expertise to offer a fully functional, open protocol digital platform designed to help glassmakers improve their productivity.

Today's glass market is increasingly driven by the need for higher production efficiency, reduced environmental impact and increased overall safety for operators. Acquiring/building know-how is becoming a challenge: the industry is losing experienced personnel while new technologies require the development of specific competencies. Bottero and Tiama believe that automation built on data processing is the key to answer to such emerging needs.

In this new, highly demanding context, GlassFORM.ai aims to:

- Provide solutions to automatically manage the forming process

according to the production targets.

- Contain environmental impacts through energy saving, light-weighting and resource optimisation.
- Reduce exposure of operators to machine adjustments via automatic controls
- Compensate the loss in process know-how leveraging on the deployment of Artificial Intelligence technologies.

Universal application

Strong connections with Trentino Sviluppo (the agency of Provincia Autonoma di Trento promoting a sustainable development in Trentino area) and the Centre for Digital Industry of FBK (Fondazione Bruno Kessler – a research institute active in the fields of scientific, technological and human sciences) in the framework of the 'Manifattura Project' [to transform a historic tobacco facility in Italy into an innovation hub for green building, renewable energy and environmental technology], are a plus for establishing stable relationships with local industries

and research centres, with the aim of identifying common R&D projects and joint development activities.

All GlassFORM.ai solutions are designed and developed to be universally applied, open to all IS machines and sensors in the market. The starting point of the GlassFORM.ai development portfolio will be based on products and solutions already available, where edge technologies (i.e. big data and machine learning) have been successfully implemented, exploiting the results achieved in other industrial segments. Examples of the first solutions to be available are the automatic management of gob forming operations and the integration of cold/hot end data to optimally drive process stability and accuracy.

Demand for automation

"According to our discussions with all our customers, the automatization of the glass containers process is becoming a key priority to meet all the current challenges," said Benoit Burin Des Roziers, CEO of Tiama. "Creating an independent co-enterprise with Bottero to provide universal and plug&play solutions appeared to us obvious long time ago. Tiama is now very happy to transform long discussions in reality with GlassFORM.ai. This industry trend is obvious in many segments and Tiama feels extremely committed to contribute to deliver very competitive solutions to all its Customers. Our Glass Containers segment cannot be competitive without such solutions, and we want to contribute strongly."

Bottero and GlassFORM.ai CEO Marco Tecchio responded: "Automation is today of paramount importance in the glass processing industry and Bottero products have always been ahead with innovative solutions leveraging machine learning and artificial intelligence. This joint venture with Tiama is our next strategic step in order to fully automatise the glass forming process. Thanks to Tiama's leadership in the inspection and quality control systems and our in-depth knowledge in IS machine and forming process, GlassFORM.ai will be a leading player in our industry, committed to deliver the best solutions for our customers." ●

Further information:

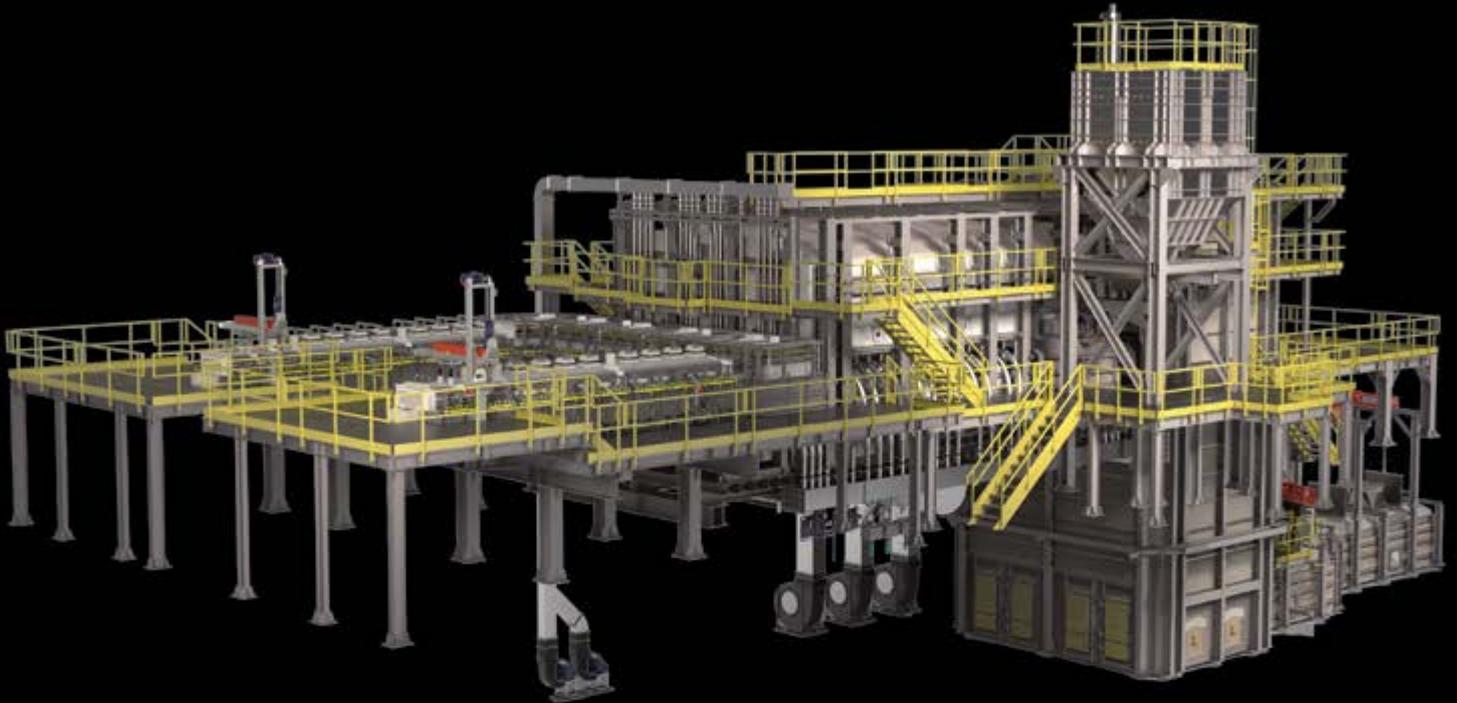
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Making vacuum process visible

René Kius explains how futronic's new advanced vacuum process control can detect manufacturing problems before they occur.



Florian Pawlowski, Product Manager at futronic.

Last summer automation specialist futronic launched its VCS (Vacuum Control System) reject system to enable the detection of manufacturing problems occurring during the vacuum process. The company has now introduced a more advanced version: VPC (Vacuum Process Control System), which makes processes visible in the vacuum cycles and records pressure



The VPC can optionally be integrated into IS machines or retrofitted to existing equipment and is also available in a standalone version. Photo courtesy of futronic/Marco Mehl.

curves and errors precisely. The wear condition of filters, valves and blow moulds, for example, can be represented in this way so that the

VPC detects manufacturing problems at an early stage before they have a chance to occur. The system can optionally be integrated into the FMT24S IS machine control system or retrofitted to existing equipment and will also be available in a standalone version.

Quality has to be controlled, and the manufacturing processes in container glass production are no exception. The principle is invariably the same: sensors identify faulty containers automatically and reliably, and those containers are then accurately removed by the reject unit. futronic's VCS works this way too: sensors measure the vacuum that is applied to each job and compare the value with a setpoint which is individually defined for each section. If a discrepancy is determined, the inferior article is ejected from the conveyor belt. The VCS can thus make a significant contribution to improving the quality of both the products themselves and the manufacturing process.



futronic's VPC makes the entire vacuum process visible based on the data supplied by the sensors – practically in real time.

| | Station01 | Station02 | Station03 | Station04 | Station05 | Station06 | Station07 | Station08 | Station09 | Station10 | Station11 | Station12 | Station13 | Station14 | Station15 | Station16 | Station17 | Station18 |
|-------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| t1: Reaktionszeit[ms] | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| t2: Vakuumaufbau[ms] | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| t3: min. Zeit [ms] | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 | 800 |
| p1: Druck[mbar] | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 | -50 |
| p2: min. Vakuum [mbar] | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 | -200 |
| p3MAX: MAX.Vakuum[mbar] | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 | -400 |

Parameters such as the response time of the vacuum valve, the increase or decrease in pressure, the maximum values and the duration of the vacuum cycles are also monitored.

Quality-sensitive

But wouldn't it be even better to detect errors before they have a chance to occur? "Of course that has to be the goal," says Florian Pawlowski, Product Manager at futronic. It is the reason why Mr Pawlowski and his colleagues have held many discussions with machine operators, production managers and technicians ever since the VCS first appeared on the market. Their verdict: the majority of manufacturing processes and sequences in an IS machine are measured in even the most inaccessible corners, and monitored and controlled from the furnace to the lehr. However, the vacuum process in the blow mould has so far taken place largely in the dark. "Our conversations showed that the vacuum process is very quality-sensitive", explains Mr Pawlowski. Both the testing machines and the VCS can do no more than react by rejecting faulty products. Even so, it's not unknown for quality assurance to overlook manufacturing problems such as so-called 'bird swing' [a glass thread extending across the inside of a container], especially where very small bottles are concerned. "Bird swing has extremely sharp edges and you can easily get hurt," he cautions. In addition to this, it could break off, so that glass chips land on the pallet or maybe fall into other containers. In order to clear the problem, the machine generally has to be stopped and the packed pallets re-sorted at considerable expense.

Development partners

Specialists at futronic set about further developing the VCS – hoping to close one of the last remaining quality monitoring gaps in container glass production. Important input was received from technicians at Heye International, manufacturer of production equipment and for many years an important business and development partner of the Tettngang firm as well as the licensor for this technical process. Other longstanding futronic customers also collaborated on the project.

Proactive maintenance

"The idea was to bring light into the darkness, in other words to make the entire vacuum process visible," states Mr Pawlowski. To do that requires sensors that supply key data separately for each section. The pressure or the vacuum in the blow moulds are particularly relevant parameters, for instance. The increase or decrease in pressure, the maximum values and the duration of the vacuum cycles are also measured, as are the response times of the vacuum valves. All data is displayed on the operator terminal and the complete vacuum process is represented in this way – practically in real time. "Machine operators can keep a constant eye on the functionality and wear condition of the valves, the filters and the blow mould itself in this way", adds Mr Pawlowski. "They can react quickly and correct any malfunctions before they result in defects, without having to interrupt production."

Seamless integration

The VPC option from futronic is due to become available in April for all IS machines equipped with futronic's FMT24S machine control system. It can furthermore be retrofitted to any existing equipment featuring an FMT24S control system. The VPC will be implemented as a seamless add-on for the FMT24S's OT software. futronic can also supply the VPC in a standalone version with a separate interface for integration into the control infrastructure of other manufacturers. ●

About the author:

René Kius works in Corporate Communications for futronic

Further information:

futronic GmbH., Tettngang, Germany
tel: +49 171 1915263
email: rene.kius@kius-kommunikation.de
web: www.futronic.de



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Data-driven furnace audit

Modern technology has expanded the capabilities of furnace audits. Yakup Bayram explains the difference between traditional audits and data-driven assessments using PaneraTech's Refractory Health Index.

Once a furnace is constructed, manufacturers use regularly scheduled inspections to monitor the condition of the refractory structure over its campaign life. Furnace audits are essential to identify issues early and prioritise maintenance expenditures. If the assessment is accurate, it helps the manufacturer to address potential problems before they become larger structural issues, extending the total life of the furnace.

A traditional furnace audit usually consists of a visual examination of the structure, thermographic inspection, and endoscopy. While these audits supply valuable information, they fall short of a comprehensive evaluation. The human eye and temperature assessment supply limited information and do not give a data-driven assessment of how the refractory is responding to furnace operations. Because there is no real assessment of how the current conditions are affecting the refractory wear, there is no opportunity to improve these conditions and optimise the campaign life.

More comprehensive report

PaneraTech is disrupting the traditional audit and introducing a more comprehensive report with a new service called SmartAudit. This advanced audit combines the latest technologies in

furnace refractory inspection with highly experienced auditors in furnace refractory inspection to produce a data-driven refractory assessment. A SmartAudit includes traditional examinations such as visual inspection, endoscopy and thermography; however, it also incorporates SmartMelter radar and data from hundreds of radar inspections. The addition of radar to the audit means that manufacturers can make data-driven decisions about furnace operation, maintenance, and repair on an annual basis.

The SmartAudit radar component includes two measurements on each side of the furnace (eight total) to understand the general refractory condition of the metal line as well as up to 10 insulation measurements that can be completed on any sidewall or bottom insulation areas that are of a customer concern.

Refractory Health Index

A key component of SmartAudit is the SmartMelter Refractory Health Index, which measures how well a glass contact refractory is performing given its furnace age, operation and campaign history. This index leverages the SmartMelter database of over one million measurements at over 200 glass plants, along with operational data to determine what the expected current wear should

be. PaneraTech can make appropriate recommendations for the furnace in the final audit report based on this data.

SmartAudit follows guidelines outlined in FM Global Insurance Property Loss Prevention Data Sheets. These data sheets are based on the research FM Global conducts to support their customers' loss prevention efforts and are used as a risk management standard by multiple industries. Data sheet 7-26 outlines recommendations for glass manufacturing.

The data sheet directs glass manufacturers to implement an asset integrity program and provides a list of "maintenance, operating, and remaining life assessment activities" to be included "at minimum" in this program (Section 2.5.13). Among this list, FM Global asks glass manufacturers to "consider employing emerging technologies to help assess refractory health." The data sheet continues by noting that "Radar-based technologies have been employed successfully for several years to monitor for thinning and/or glass penetration." Finally, it recommends that manufacturers consider these technologies when planning to rebuild: If utilised, modify refractory support (steel) during the following rebuild to allow for a complete examination of furnace refractory." (Section 2.5.13 D).

Experienced auditors

SmartAudit is not only about advanced technology; it also includes a standard of expertise for the auditor. PaneraTech has a strict list of qualifications for those who perform audits. Auditors must have at least 10 years of experience in the glass industry plus inspection experience as a third party or at the plant or corporate level, including visual inspection, thermography, and SmartMelter radar. The auditor is required to have experience with both cold and hot audits and extensive knowledge of furnace operations. They must have familiarity in all types of glass melting furnace designs and refractory applications as well as furnace start-up and shut down experience. Finally, an auditor for PaneraTech must have experience in refractory maintenance and scope definition.

PaneraTech's staff includes multiple furnace experts. The team has 58 years combined experience in furnace design, maintenance, and operations, and this experience is brought into both the customer support during the audit and the compilation of the report.

SmartAudit is a new traditional audit that adds the latest technology and knowledge from the SmartMelter database. This improves the quality of data given in the audit report and empowers manufacturers to make smarter decisions. ●

SmartMelter and SmartAudit are registered trademarks of PaneraTech, Inc.

| Audit Contents | Traditional Audit | SmartAudit* |
|---|-------------------|----------------|
| audit content follows guidelines outlined in FM Global Insurance Property Loss Prevention Data Sheet 7.26 | | ✓ |
| SmartMelter Refractory Health Index | | ✓ |
| performed by industry experts | ✓ | ✓ |
| visual inspection of furnace, regenerators, and distributor | ✓ | ✓ |
| thermal inspection of glass contact areas and melter/regenerator crowns | ? | ✓ ¹ |
| internal endoscope photography | ? | ✓ ² |
| assessment of glass breakout containment area | ? | ✓ |
| safety and housekeeping assessments | ? | ✓ |
| current inspection, maintenance, and emergency procedure assessments | ? | ✓ |

A comparison of standard audits with SmartAudit.

About the author:

Yakup Bayram is President and CEO, PaneraTech

Further information:

PaneraTech, Inc., Virginia, USA
tel: +1 703 719 9666
email: kelly@paneratech.com
web: www.paneratech.com



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Applied Vision engineers machine vision systems for the worldwide food and beverage container industry to help manufacturers achieve 100% automatic inspection at line speeds.

Optimal inline inspection of multiple defects

Manufacturers should not have to compromise when inspecting sidewall and dimensional defects. Brian Ensinger explains how Applied Vision's sidewall inspection system uses advanced software and processing algorithms to help manufacturers achieve 100% automatic inspection at line speeds.

An inspection approach for glass containers can be as unique as the containers themselves, with the difficulty being to optimise the inspection for multiple defect types. As lighting and optical geometries are tuned for a target defect, it may become harder to identify

other types of imperfections present in the same container. This is the limitation of standard lighting and monochromatic imaging techniques that effectively require users to strike a balance between primary and secondary defect detections, or in many cases, to invest more time in machine set-up as jobs and detections change.

Colour provides critical information

Applied Vision's Volcano Sidewall (SW) inspection system helps plants to achieve their goals for greater accuracy, speed and reliability in sidewall and dimensional defect detection. The use of colour illumination provides manufacturing facilities with a customisable solution when faced with process-induced defects and the ever-growing complexity of containers. The Volcano imaging stations

are fully programmable in terms of intensity, colour selection and pattern geometry. The system can perform a wide range of inspections including opaque defects such as inclusions, transparent defects like blisters, bubbles and tears, as well as dimensional defects including lean, filler lean, height, diameter and thread inspection. The system also employs dedicated cameras utilising circular cross-polarising filters for detection of internal stresses.

Volcano SW incorporates high-quality, programmable light-emitting



Using the full colour spectrum to emphasise defects, Applied Vision's container sidewall inspection improves detection identification, accuracy and repeatability.



The Volcano Sidewall inspection system.

diodes (LEDs) as a light source, multiple independent arrays of high-resolution colour cameras, and fully calibrated imaging geometries to inspect glass containers. Using advanced software and processing algorithms, a single image can be utilised to perform virtually any type of detection.

False reject rates are reduced by machines that recognise a glass container on the narrow edge of tolerance as good packaging that should not be recycled. It is now possible to automatically detect acceptable variation limits that only a human inspector could once perceive.

Inspection accuracy and efficiency

The Volcano SW is a self-learning solution built to inspect the most complex glass containers at line speeds. Time, money and material can be saved when machines tolerate a level of variation not exceeding tight thresholds for dimension, colour and pattern inspection regardless of heavy embossing, colour or container thickness.

It is the combination of capable hardware and software architecture that unlocks operational benefits for container manufacturers. Inspection accuracy and efficiency are improved by Volcano SW technologies that alleviate the burden of plant engineers and machine operators. Capabilities include:

- A bottle geometry tool that learns, locates and registers the sidewall in the captured image automatically. The benefit is that established inspection sequences are saved and recalled quickly. A library of algorithms is used to inspect for defects in these processed images.
- Sentinel software that highlights regions of the captured colour image that deviate from the established statistical model for a glass container. This tool looks for candidate defects, learns what is normal, and comes to understand what is abnormal by training on a large number of containers.
- A 'blob classifier' algorithm that helps plant personnel to see what types of defects are being produced and how often. Defects are identified, categorised and graded based on user-applied criteria that can be adjusted without taking the machine offline.

Contactless inspection

As a 'no-touch, no-turn' solution for plants striving for a contactless inspection, Volcano SW eliminates handling of containers that can lead to breakage and limits production speeds. Machines that provide a high degree of imaging precision and defect classification accuracy without the need to reorient containers can save manufacturers both floor space and maintenance costs since there are fewer moving parts to manage.

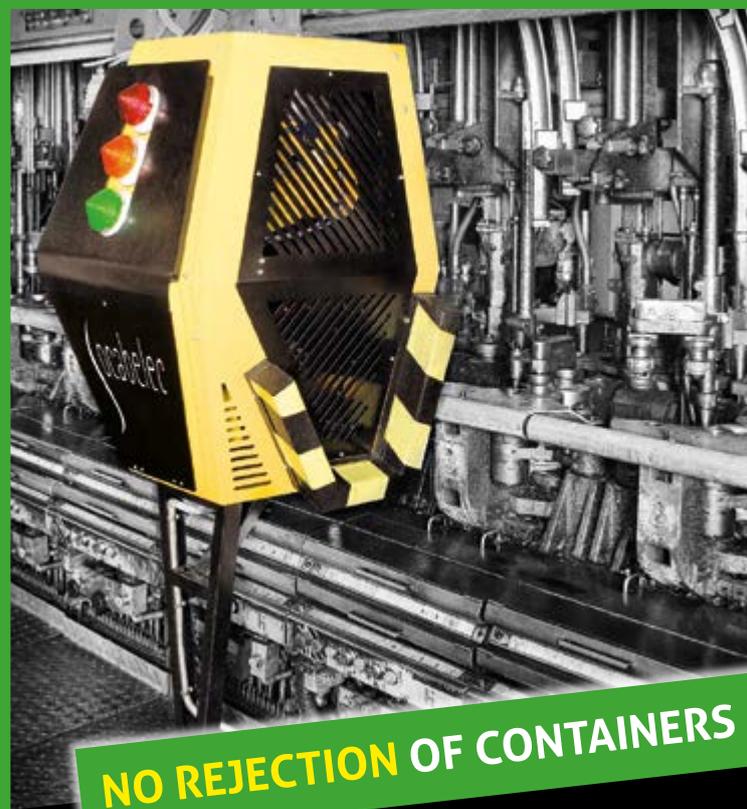
Today's machine vision systems can perceive obscure anomalies between glass containers – subtle imperfections that the human eye can masterfully distinguish but machines once struggled to conceptualise. Supported by self-training algorithms and expanding AI capabilities, these systems can better decide between acceptable and unacceptable variations, further reducing the number of false positives. Throughput is also improved by machines that can perform multiple optimised detections in a fraction of the time once required. Making it all possible are multispectral illumination solutions that use colour to help container manufacturers operate on schedule and within budget. ●

About the author:

Brian Ensinger is Product Line Manager, Glass Inspection at Applied Vision

Further information:

Applied Vision Corporation, Ohio, USA
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Hydrogen blends for glass melting

Ashwin Vinod, Michael J. Gallagher and Junxiao Wu from Air Products discuss the use of advanced combustion technology to enable a transition from natural gas to H₂ blended gas in glass furnaces as a step towards decarbonisation.

Climate change, and the threat it poses to the environment and population, has moved decarbonisation into the focus of many players in the glass industry.^{1,2} One approach that has gained notable consideration in this regard is transitioning from natural gas to hydrogen (H₂) as the primary fuel for melting in glass furnaces. This approach, however, has its challenges. The combustion characteristics of methane (CH₄), the primary constituent in natural gas, and H₂ are substantially different (see Table 1.)

Essentially, H₂ is a significantly more reactive fuel, which when incorporated into existing burner systems, could yield shorter flames due to rapid combustion kinetics. Shorter flames, in turn, may have two major implications, (1) altered heat release profiles with the bulk of the reaction occurring closer to the burner risking breast wall overheating, and (2) increased nitrogen oxide (NO_x) generation due to higher flame temperatures. Additionally, the absence of carbon in the fuel noticeably lowers the flame luminosity and thereby further affects the radiative heat transfer efficiency to the glass melt.

In view of the key differences between the two fuel types, a complete transition to H₂ would necessitate modifications to burner designs to ensure optimal fuel and oxygen velocities, and maximum operational flexibility and efficiency. Adopting natural gas-H₂ blended fuels in existing burner systems is an important first step to kickstarting decarbonisation efforts, and glass manufacturers stand to gain practical experience and understanding of the implications of H₂ combustion on glass melting efficiency and the furnace itself. This article discusses the combustion performance and functionality of the Air Products Cleanfire HR_x burner in efficiently handling a natural gas-H₂ blend that incorporates 30% H₂ by volume. Operational parameters such as flame length, luminosity, NO_x, breast wall temperatures and melting efficiencies are discussed via results obtained from laboratory tests and computational modelling.

Cleanfire HR_x Burner

Air Products has a three-decade-long history of producing innovative combustion technologies to meet the evolving needs of the glass manufacturing industry. The Cleanfire HR_x

burner is a flat flame oxy-fuel burner designed for the glass industry. The state-of-the-art burner incorporates key features such as extreme oxygen ▶

| Property | Natural Gas/Methane (CH ₄) | H ₂ | Relevance |
|---|--|----------------|--|
| Heating Value (Btu/scf) | 900–1100 | 325 | Fuel flow rate, nozzle flow velocity |
| Ignition Energy in Air (mJ) | .29 | .02 | Ignition in the event of a leak |
| Wobbe Index (kcal/Nm ³) | 11,597 | 9714 | Flow controls, piping sizes |
| Required Oxygen (lb O ₂ /MMBtu fuel) | 164 | 128 | Oxygen flow rate, blower/oxygen plant size |
| Flammability Range (mol%) | 5–15 (Air) | 4–75 (Air) | Adjustability of combustion conditions |
| | 5–61 (Oxy) | 4–94 (Oxy) | |
| Laminar Flame Speed (cm/s) | 35 (Air) | 270 (Air) | Reaction rates/flame stability |
| | 330 (Oxy) | 890 (Oxy) | |
| Flame Temperature (deg C) | 1875 (Air) | 2045 (Air) | Radiation heat transfer, NO _x |
| | 2780 (Oxy) | 2805 (Oxy) | |

Table 1: Key properties pertaining to combustion of natural gas and H₂.

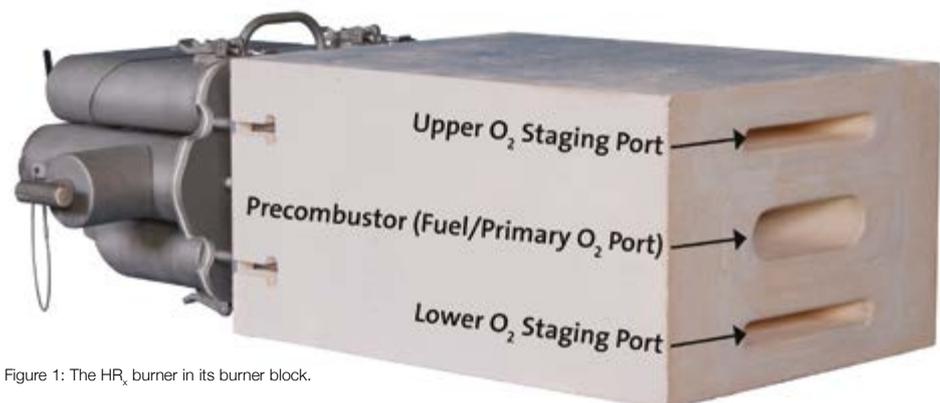


Figure 1: The HR_x burner in its burner block.

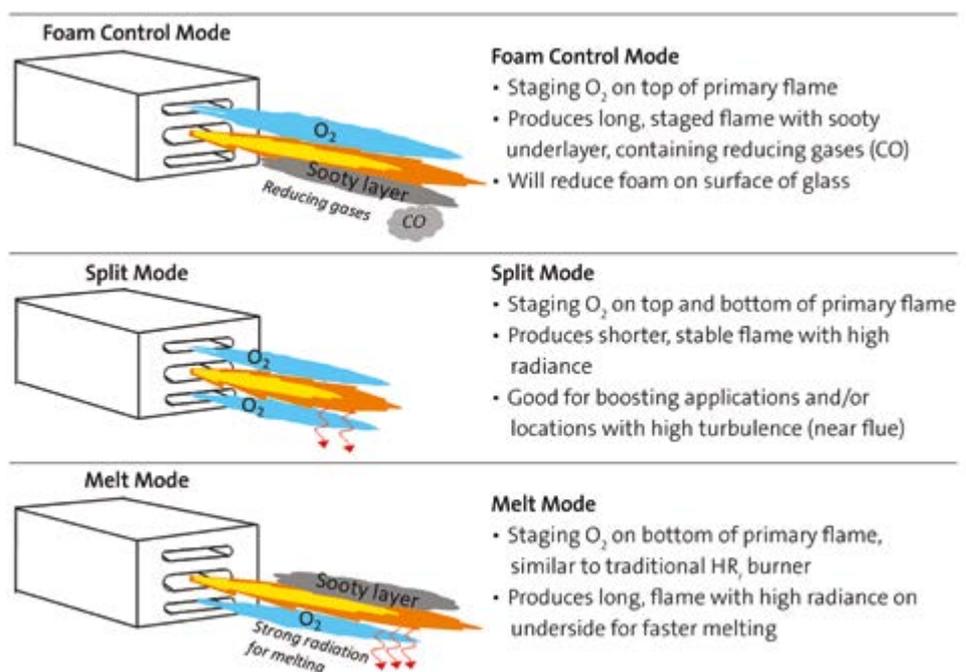


Figure 2: Staging modes of the HR_x burner.



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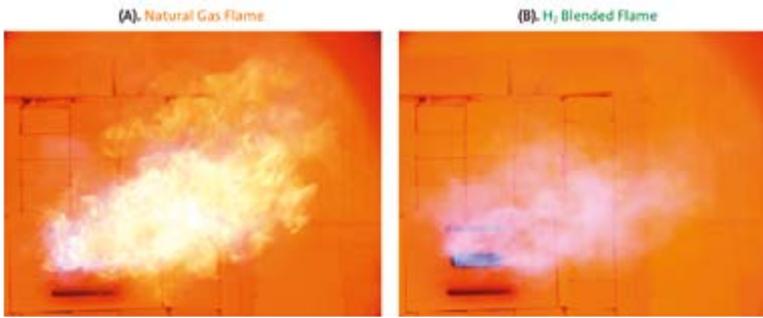


Figure 3: Images of (A). natural gas flame and (B). H₂ blended gas flame produced by the HR_x burner.

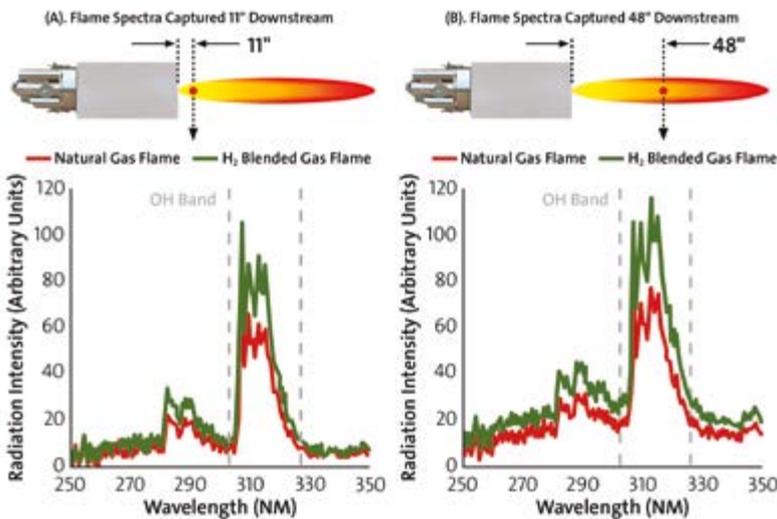


Figure 4: Flame spectra captured at downstream distances of (A) 11 inches and (B) 48 inches from the burner block, with 25% staging O₂.

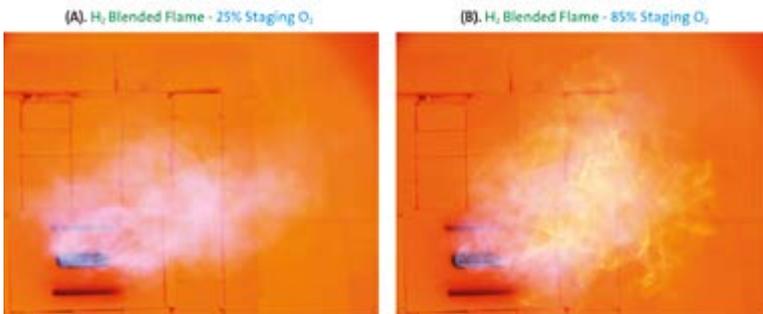


Figure 5: Images of the H₂ blended gas flame produced by the HR_x burner with (A) 25% staging O₂ and (B) 85% staging O₂.

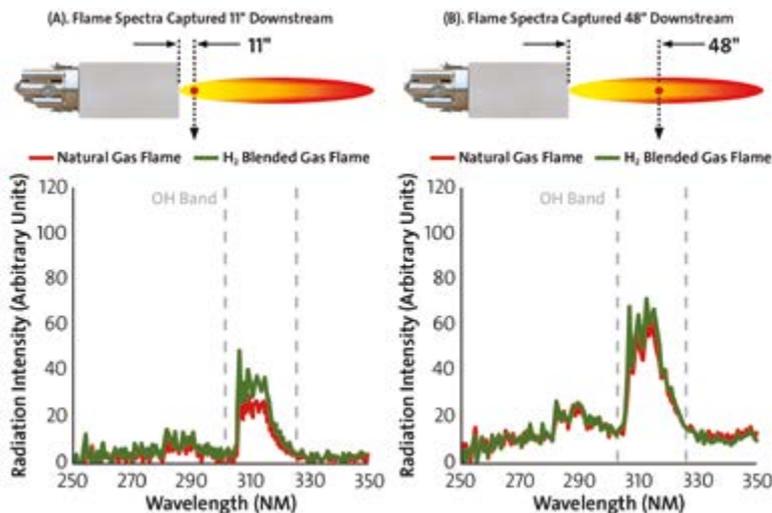


Figure 6: Flame spectra captured at downstream distances of (A) 11 inches and (B) 48 inches from the burner block, with 85% staging O₂.

(O₂) staging up to 95%, low NO_x emissions, foam reduction mode to destabilise surface foam,³ and optional sensors for remote performance monitoring.⁴ Figure 1 shows the HR_x burner in its burner block. The burner block includes three ports: a central precombustor port for initiating the combustion reaction via a stable and rooted flame, and upper and lower ports for staging O₂.

The HR_x burner can be operated in any of the three distinct O₂ staging modes, each having its own operational benefits depending on the location of the burner within a glass furnace. Figure 2 depicts the various staging modes of the HR_x burner and their respective functionalities. In Split Mode, the staging O₂ is evenly split between the upper and lower staging ports resulting in a high momentum flame ideally suited for the more turbulent locations within a furnace. In Melt Mode, all of the staging O₂ is directed to the lower staging port located below the flame. In this state, the flame develops a bright bottom surface due to the reaction between the fuel and staged O₂, resulting in increased radiation directed towards the molten glass below, thereby speeding the melting process. In Foam Control Mode, the entire volume of staging O₂ is directed to the upper staging port located above the flame. As a result, the flame develops a sooty bottom layer composed of reducing gases such as carbon monoxide (CO), in concentrations of several percent, that effectively destabilise surface foam and thereby minimise inefficiencies in the melting process.

The HR_x burner is also equipped with an O₂ staging control valve that essentially controls the split of combustion O₂ into primary O₂ and staging O₂. When 100% open, about 75% of the combustion O₂ flows through the primary port, speeding up the mixing of O₂ and gas, thereby producing a high momentum flame. This setting also significantly lowers the O₂ backpressure and enhances cooling of the burner tip due to the volume flow of O₂ around it. Conversely, when the O₂ staging valve is completely closed, only 5% of the O₂ flows through the primary port and the remaining 95% is directed to the staging ports. High levels of O₂ staging delay the mixing between the fuel and O₂ thereby lengthening the flame. This delay, in turn yields two benefits; firstly, it impedes NO_x production due to the lower flame temperature of the long flame, and secondly, it augments flame luminosity due to the burning of soot formed by fuel pyrolysis.

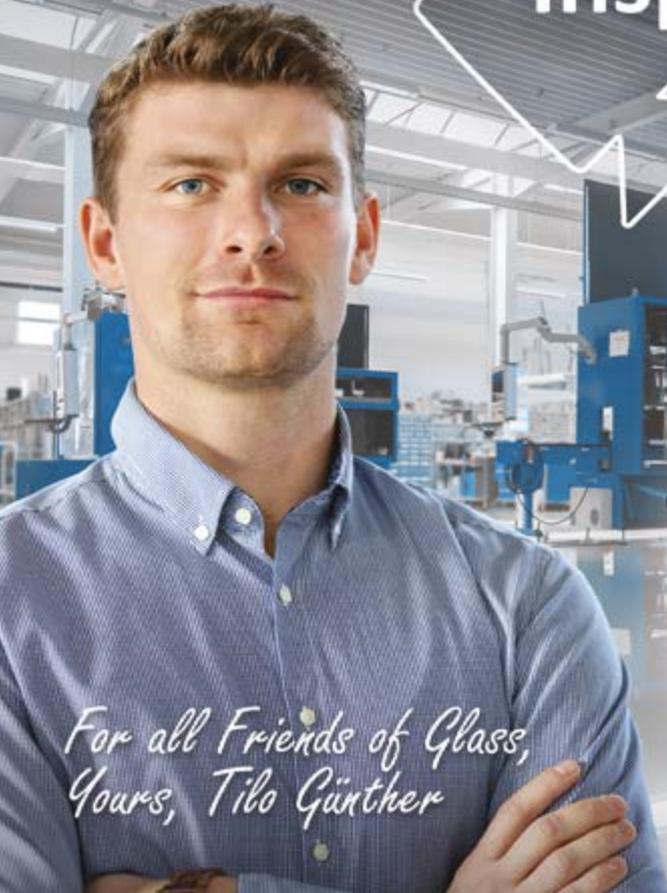
Performance with H₂-blended natural gas

The performance of the HR_x burner with a fuel blend that constitutes (by volume) 70% natural gas and 30% H₂ was evaluated thoroughly in the test furnace at the Air Products Research and Development (R&D) facility in Allentown, Pennsylvania, USA. Burner level operational parameters relevant to H₂ combustion, such as flame length, luminosity, ▶

| | Flame Length Changes by... | Breast Wall Temperature Changes by... | NO _x Produced Changes by... |
|--|----------------------------|---------------------------------------|--|
| On transitioning from natural gas to 30 vol% H ₂ blended gas... (at 25% staged O ₂) | -7% | +19 °C | +6 % |
| On staging the H ₂ blended flame from 25% to 85% staged O ₂ ... | +30 % | -36 °C | -12 % |

Figure 7: Effect of fuel transition and O₂ staging on flame length, breast wall temperature and NO_x.

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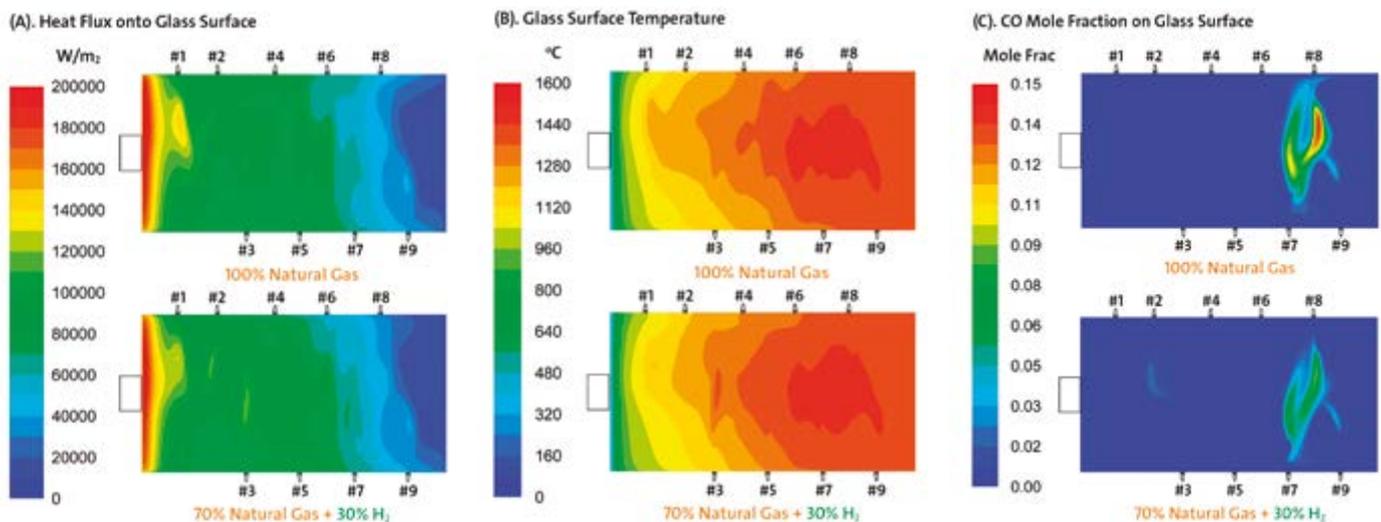


Figure 8. Effect of transitioning from natural gas to H_2 blended gas on (A). Heat flux onto glass surface, (B). Glass surface temperature, and (C). CO mole fraction on glass surface

breast wall temperatures and NO_x were benchmarked against the burner's performance with 100% natural gas as the fuel. Figure 3 shows images of the flames (at 25% staging O_2) with (a) 100% natural gas (hereafter simply referred to as 'natural gas') and (b) 70% natural gas – 30% H_2 (hereafter referred to as ' H_2 blended gas'). The images clearly depict the reduced flame luminosity and length resulting from the presence of H_2 in the fuel.

The reactivity effect of the two fuels was further examined using flame spectroscopy. Figure 4 depicts the flame spectra (in the UV range) captured at downstream distances of 11 inches and 48 inches from the hot face of the burner block. The hydroxyl radical spectral emission peaks (OH bands) are visible in the spectra and are indicative of the presence/strength of the flame front. The OH bands provide a better sense of the rate of progression of the combustion reaction with the two fuels. The spectra of the H_2 blended gas flame exhibits stronger OH peaks at the two probed locations, clearly signalling the higher reactivity of the H_2 blended fuel. The higher concentration of radicals due to the presence of H_2 facilitates faster breakup of the first C-H bond,⁵ thereby accelerating the reaction and consequent heat release closer to the burner block via a shorter flame.

The previously described oxygen staging feature of the HR_x burner was tested for its ability to delay the reaction with the H_2 blended gas. Figure 5 shows the photographs of the H_2 blended gas flame with (a) 25% staging O_2 (b) 85% staging O_2 . The longer, more luminous staged flame depicted in the figure demonstrates the

effectiveness of the HR_x burner's O_2 staging control. Delayed introduction of O_2 into the flame permits more abundant nucleation and growth of soot particles, which are responsible for the bright yellow appearance of the flame. Once again, the UV range flame spectra is utilised to better assess the downstream progression of the combustion reaction (see Figure 6.). The OH band intensities seen in the spectra of Figure 6 further confirm that the enhanced oxygen staging feature of the HR_x burner effectively counters the higher reactivity of the H_2 blended fuel while still providing control of the flame length and luminosity to a level comparable to that of the natural gas flame.

The specific impact on flame length, breast wall temperatures and NO_x , of transitioning from natural gas to H_2 blended gas (at 25% O_2 staging) and staging the H_2 blended flame (25% to 85%) was also evaluated and is summarised in Figure 7. As is evident from the data presented, H_2 blended flames without oxygen staging are shorter and hotter, which leads to increased NO_x and breast wall temperatures. But when the oxygen staging feature of the HR_x burner is employed, the results show that it is possible to neutralise these challenging effects, thereby reducing NO_x and breast wall temperatures and maintaining control of flame length and luminosity. Such results firmly endorse the HR_x burner's readiness to handle hydrogen blends in its current form with very few required modifications.

Impact on furnace performance/operation

To better forecast the operational effects of transitioning from natural

| Burner Port # | % Furnace Power | Staging % | Staging Mode |
|---------------|-----------------|-----------|--------------|
| 1 | 9% | 25% | Split |
| 2 | 10% | 50% | Melt |
| 3 | 11% | 75% | Melt |
| 4 | 11% | 75% | Melt |
| 5 | 14% | 75% | Melt |
| 6 | 13% | 75% | Melt |
| 7 | 13% | 75% | Foam |
| 8 | 12% | 75% | Foam |
| 9 | 6% | 50% | Foam |

Table 2: HR_x burner settings utilised in the glass furnace simulations.

gas to H_2 blended gas in a glass melting furnace, a commercial scale furnace equipped with HR_x burners was modelled in ANSYS Fluent, and CFD [computational fluid dynamics] simulations were performed using both natural gas and H_2 blended natural gas as the energy source. The burners were configured to operate primarily with high O_2 staging to maximise flame length and heat transfer within the simulation. Additionally, a combination of Split/Melt/Foam mode operation was incorporated to ensure maximum melting efficiency (see Table 2 for details of burner configurations). Figure 8 illustrates the impact of H_2 blended fuel compared to natural gas fuel on the following parameters: (a) heat flux into the glass surface, (b) temperature on the glass surface, and (c) CO mole fraction on the glass surface.

The contours of simulation results shown in Figure 8 positively suggest that the impact of transitioning from natural gas to 30% H_2 blended gas is likely to be minimal from a furnace standpoint. The heat flux into the glass surface, and glass surface temperatures were observed to be very similar in the two test cases, suggesting comparable melt mode efficiency of the HR_x burner with the two fuel types. The higher CO mole fraction on the glass surface seen down tank is a reflection of the foam mode setting of burners #7, #8 and #9. While a difference in CO concentrations is evident between the two test cases, the CO surface concentrations with the H_2 blended gas (~8%) and natural gas (~14%) are of the same order of magnitude. Such high CO concentrations in close proximity to the glass surface has been proven to be sufficient to destabilise the secondary foam layer, thus eliminating the negative effects of surface foam on glass melting efficiency and the refractory life.⁶ This observation shows that the HR_x burner's Foam Control Mode can still be very effective despite the reduced carbon content in the fuel.

Summary

The Air Products Cleanfire HR_x burner is a widely deployed, high-performance oxy-fuel burner in the glass industry. The burner and furnace level performance presented and discussed in this article demonstrates that the HR_x burner is well equipped to handle combustion of natural gas-H₂ blends, offering its users an immediate path to reducing their carbon footprint without causing higher breast wall temperatures, elevated NO_x emissions, or glass melting inefficiencies. The state-of-the-art capabilities of the HR_x burner enable the flexibility to handle the key differences in chemical kinetics of H₂ blends, without compromising the widely appreciated operational efficiency and functionalities of the burner. The burner technology continues to evolve and the next generation under development will be tuned to maximise performance with higher H₂ blends (50–100%).

We are confident that the HR_x burner platform will remain a leading technology as the glass industry navigates towards zero carbon emissions via increasing H₂ adoption. The HR_x system is slated for a commercial trial with H₂ blends ranging from 0–100% in the latter half of 2022. As a global leader in H₂ production, Air Products is well-positioned to deliver step-by-step support beyond the supply of molecules. This includes critical safety analysis and state-of-the-art combustion technologies, as well as consulting services for laboratory testing, burner assessment, combustion and process modelling. Kickstarting the H₂ transition with smaller volumes, gaining the operational experience with H₂, and thereby optimising the tools, technologies, and procedures to adopt 100% H₂ fuel safely, efficiently and economically could very well be the most promising path towards decarbonising the glass industry. ●

Cleanfire is a registered trademark of Air Products

- 1 O-I Receives Approval for Science-Based Emissions Reduction Targets. <https://www.o-i.com/news/contributing-to-a-healthier-world/>
- 2 SAINT-GOBAIN NET-ZERO CARBON BY 2050, 9/24/2019. <https://www.saint-gobain.com/en/news/saint-gobain-net-zero-carbon-2050>
- 3 M. D'Agostini, W. Horan, "Optimisation of Energy Efficiency, Glass Quality, and NO_x Emissions in Oxy-Fuel Glass Furnaces Through Advanced Oxygen Staging"; 79th Conference on Glass Problems (GPC), 2018.
- 4 Hendershot, Reed. "First smart burner for the glass industry." Glass Worldwide, March/April 2016.
- 5 Di Iorio, S., Sementa, P., & Vaglieco, B. M. (2014). Experimental investigation on the combustion process in a spark ignition optically accessible engine fuelled with methane/hydrogen blends. International journal of hydrogen energy, 39(18), 9809-9823.
- 6 Laimbock, P. R. "Foaming of glass melts.", Ph.D. Dissertation, Technical University of Eindhoven, (1998). ISBN 90-386-0518-8.

About the authors:

Ashwin Vinod, Ph.D. is a Senior Research Engineer, Combustion Technology – Glass; Michael J. Gallagher, Ph.D. is Lead Engineer, Combustion Technology – Glass; and Junxiao Wu, Ph.D. is an Engineering Associate – Computational Technology at Air Products & Chemicals

Further information:

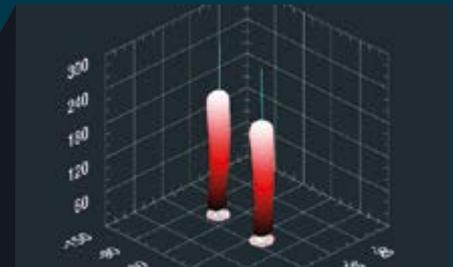
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Glass melting of the future

Erik Muijsenberg from Glass Service a.s. considers current and future methods of glass melting that align with worldwide targets for carbon reduction and increased sustainability.

Glass plays an important role in our society. Its usage in housing, transportation, communication, food storage, etc. is crucial to enjoying a high quality of life. Adopted by all United Nations Member States in 2015, the 2030 Agenda for Sustainable Development outlines 17 Sustainable Development Goals (SDGs) for all countries to achieve. Goal 11: 'Make cities and human settlements inclusive, safe, resilient and sustainable' promotes the role of glass recycling.

Sustainable glass recycling

To produce glass, we need raw materials and energy. We can reduce our reliance on these materials through increased recycling. Indeed, a significant advantage of glass is that it can be endlessly recycled without loss in quality or purity, although glass waste needs to be purified, cleaned and colour-separated before use.

Using more cullet for melting offers considerable savings in raw materials costs and energy usage, and CO₂ emissions are also lower. Clean cullet needs to be reheated and homogenised but melting reaction energy is not required and every 10% cullet addition reduces the energy consumption of glass melting by 2–3%. To melt soda lime glass from raw materials requires about 2.6MJ/kg of energy. As pure cullet, this is reduced to 1.9MJ/kg. More importantly, re-melting cullet avoids CO₂ emissions from soda ash (Na₂CO₃) and lime (CaCO₃) in the batch. Every metric ton of waste glass recycling saves about 315kg of CO₂ that would be released manufacturing a new glass product.³ The most common, efficient, end-fired, container glass furnaces, melting with an average of 50% cullet, consume about 3.5MJ/kg.

Responsible glass production and climate action

UN Goals 12: 'Ensure sustainable consumption and production patterns' and 13: 'Take urgent action to combat climate change and its impacts' encourage responsible glass production aligned with climate action ▶

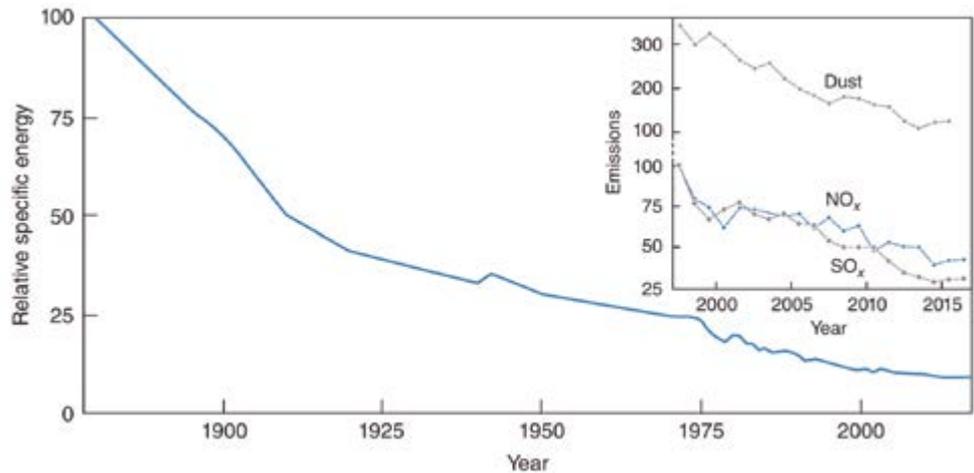


Figure 1. Energy efficiency gains over 150 years and NO_x, SO_x and dust emissions for the last quarter century. Source: <http://www.agc-glass.eu/sustainability/environmental-achievements/air>

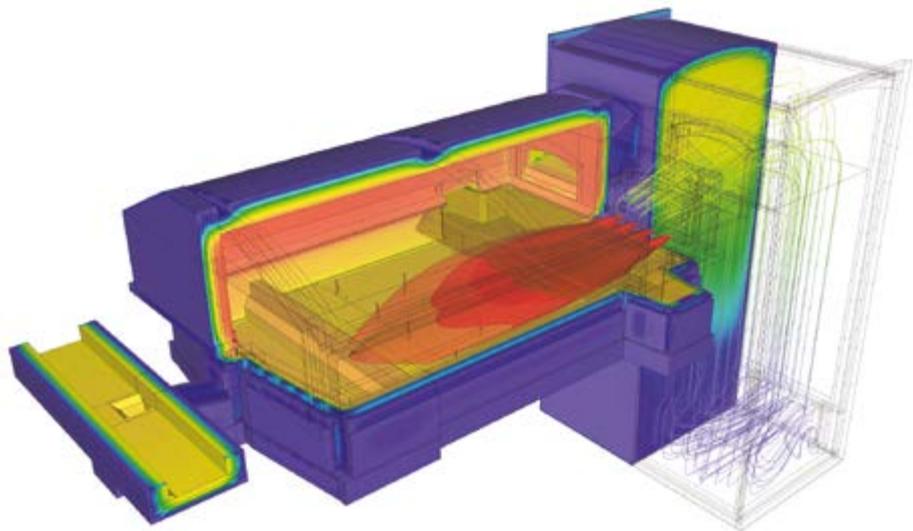


Figure 2. A 350tpd container glass melter. Image courtesy of Glass Service a.s. (www.gsl.cz)

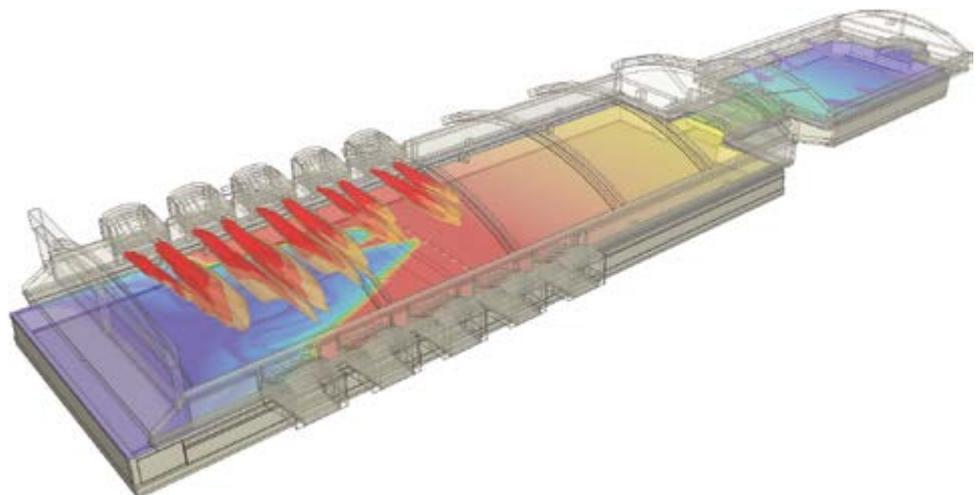
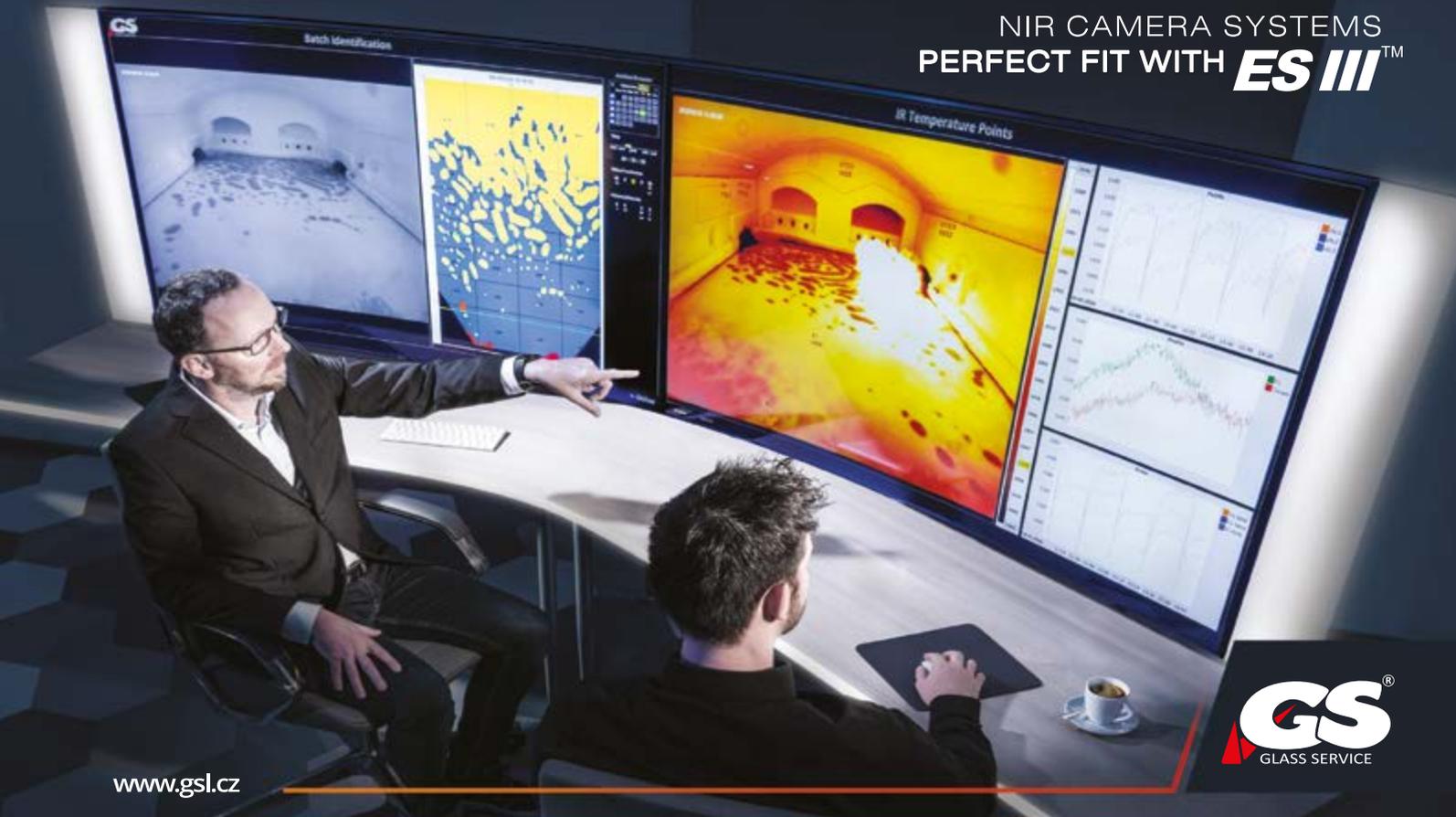


Figure 3. A cross-fired regenerative 600tpd float glass melting furnace. Image courtesy of Glass Service a.s. (www.gsl.cz)



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- Glass catch-tray & canisters for easy cleaning



Pressure Tester

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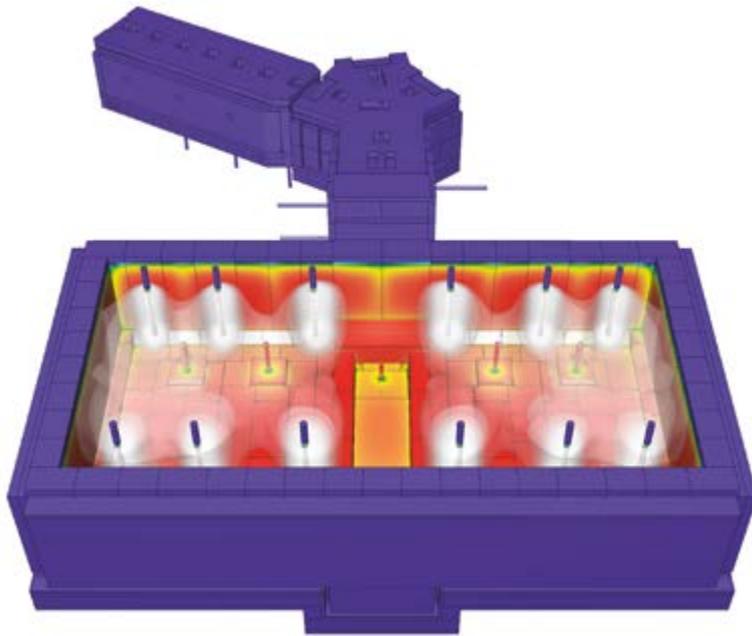


Figure 4: A 80tpd cold top rectangular all-electric melter using top, side and bottom molybdenum electrodes. Image courtesy of IWG Wagenbauer and Glass Service.

to protect the environment.

Melting glass requires considerable energy to reach the high temperatures required (>1500°C). Glass production used to take place in ‘glass houses’ with local resources: sand and wood ash as raw materials and wood from the forest for energy. Old glass houses can still be found in forested areas. As much as 150–200kg of wood was typically required to melt one kg of glass.⁴ Assuming wood burning generates about 19MJ/kg, this equates to >2850MJ for one kg of glass. Today’s figure of 3.5MJ/kg (see

above) is astonishingly 800 times more efficient.

Over the last century, the main energy source has shifted to fossil fuels such as oil and natural gas. Modern glass melting uses about 1% of all industrial energy,⁵ much less than for example steel production. Nevertheless, it is energy-intensive and massive improvements have been made over the years. Asahi Glass Company has plotted these downward trends, and the reduction in pollutants such as NO_x, SO_x and dust emissions for flat glass production (See Figure 1).

Figure 1 also shows that since the year 2000, the relative specific energy line has flattened, suggesting little improvement in recent furnace designs for flat glass. Furnace efficiency increased because new refractories allowed higher combustion and crown temperatures, and increased melting temperatures. Furnaces became larger, producing more glass per m² of heat loss surface. Some flat glass furnaces now produce a remarkable 1,200–1,500tpd, while container glass furnaces can melt 800tpd. But furnace size is limited by the maximum crown span (width), the size of equipment, flame length and other factors. Larger regenerators have increased heat regeneration from 50% to 70%, close to the theoretical maximum of 75%. This maximum arises from the difference in heat flow in the waste gas (greater mass and specific heat) than the air being preheated.

Container glass melting

Figure 2 shows the design of the most common U flame (end-fired) container glass melting furnace, producing about 350–380tpd. Cold air enters the base of the regenerator at the right and is preheated to 1,200–1,300°C, before leaving at the top and entering the combustion chamber. Gas (or oil) is injected into the hot air at the base of the port. This example has four injectors. The iso-temperature surfaces indicate the flame shape that develops. The hot gases radiate heat to the glass melt surface, the furnace walls and the crown – the latter two re-radiating energy to the glass. The waste gases then circulate around the furnace and exit via the left exhaust port, entering the opposite regenerator, and preheating it until the process is reversed after 20–30 minutes. Raw materials enter the melting basin from two sides. First, the batch under the flames is melted. Some designs have a barrier wall (0.8m high) on the bottom of the furnace to bring the glass from a typical depth of about 1.3m to the melt surface to aid the removal of small bubbles – the so-called fining process. The glass then dives down into the sunken throat to be delivered into the distributor which connects to the forehearth that takes the glass to the forming machines. The small rods protruding from the bottom of the glass basin are molybdenum electrodes ▶

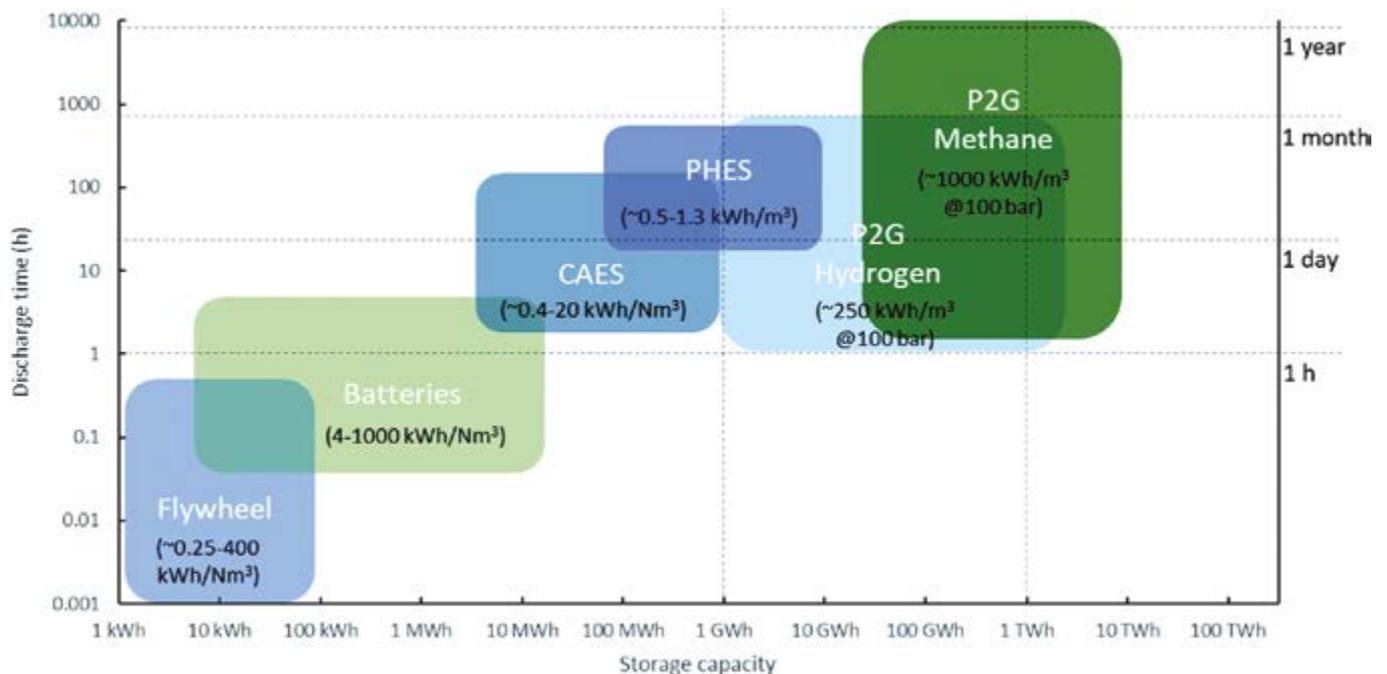


Figure 5: Chart showing the capacity and discharge times for different storage technologies. Source: RMIT.

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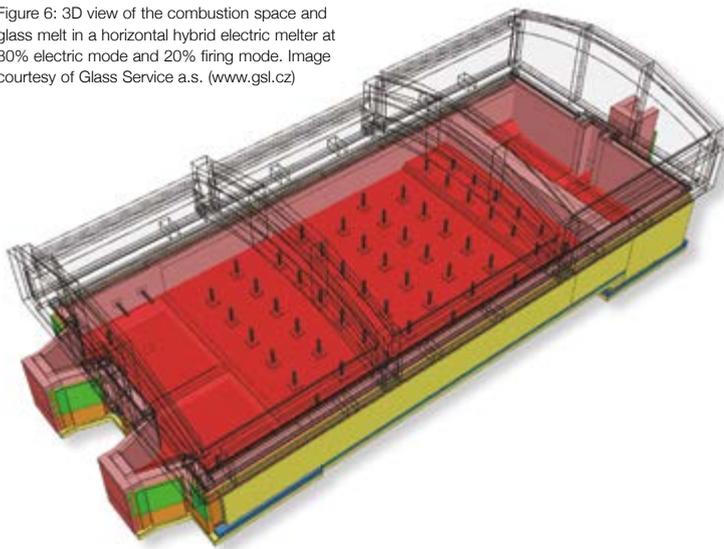


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Figure 6: 3D view of the combustion space and glass melt in a horizontal hybrid electric melter at 80% electric mode and 20% firing mode. Image courtesy of Glass Service a.s. (www.gsl.cz)



that assist in melting the glass by electrical Joule heating, often called electric boosting. This type of melter is typically about 15m long by 6m wide.

Float glass production

The second most common glass melter is the cross-fired regenerative float glass furnace. Flat glass is formed after leaving the melter by floating the melt on a molten tin bath. This glass is mainly used for window glass or automotive windshields; solar panels and LCD products can also be produced. The furnaces can be 35–40m long and 10–12m wide. The most typical pull rate is 600–800tpd, but some furnaces produce 1,200 or even 1,500tpd. These cross-fired

regenerative furnaces alternate firing from opposite sides. They have five to nine burner ports on each side and the preheated air comes from brick regenerators on each side. Injectors introduce gas into preheated air to create flames crossing the glass melt surface, the hot waste gases exiting to the opposite regenerators. This process is reversed about every 30 minutes.

Figure 3 shows a 600tpd float furnace with five ports with two gas injectors on each side. Raw materials are introduced by batch chargers. After melting, the glass is cooled in the working end and leaves by the canal onto the molten tin, where it spreads out to form a flat sheet.

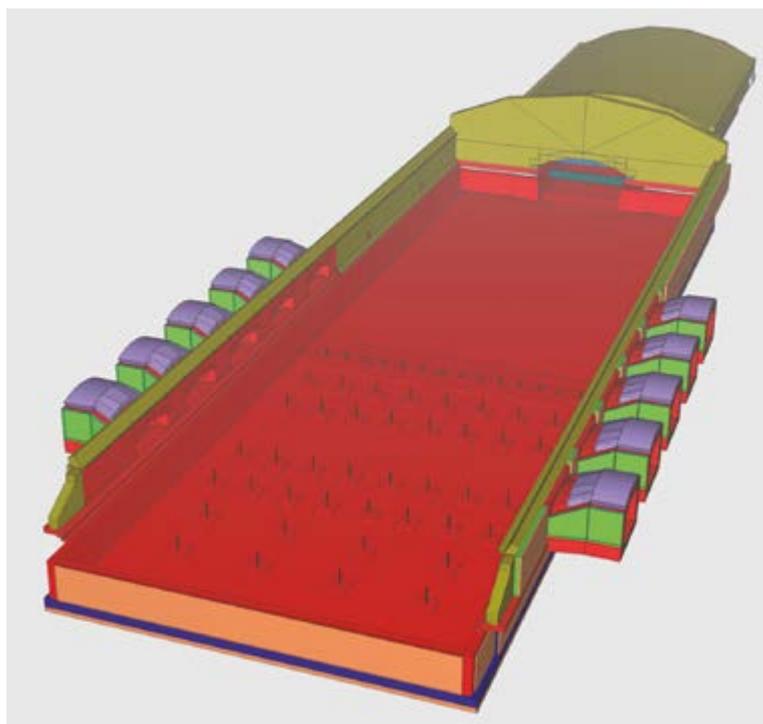


Figure 7: Float furnace with 6MW super boosting, going hybrid.

Other furnace designs

Other technologies include the recuperative and the oxy-gas furnace. Oxy-gas furnaces use pure oxygen, extracted from air and may seem more energy-efficient than the best regenerative furnaces. A correct analysis though requires the energy and cost of separating the oxygen be considered and usually favours a regenerative furnace. However, oxy-gas furnaces can bring other benefits: NOx reductions and a smaller footprint. Recently, two industrial gas suppliers reduced their energy consumption by preheating the fuel and oxygen.

Linde (Praxair) developed its OptiMelt technology to save 20% more energy by preheating the natural gas with waste gas from the oxymelter to create a syngas ($\text{CO} + \text{H}_2$) formed by cracking CH_4 with CO_2 in the waste gas.⁸ An interesting side benefit is that CO tends to reduce foam on the glass surface, increasing heat transfer and lowering seed counts.

Air Liquide designed HeatOx technology with heat exchanging recuperators using furnace waste heat to preheat the natural gas and oxygen indirectly to 400–500°C, giving 9–10% additional energy savings.^{7–9} Should this technology be installed in a conventional regenerative float furnace converted to oxy-gas firing, a total of 20–25% energy savings could potentially be achieved. A side effect would be a major NOx reduction.

Finally, an oxy-gas furnace can burn hydrogen more easily than an air-fired furnace. Burning hydrogen with air gives higher flame temperatures, typically equating to higher NOx emissions. Oxy-gas furnaces may therefore be more attractive when hydrogen is affordable.

Electric melting options

The first continuous regenerative glass melting furnace was invented by Charles William Siemens of Westminster England between 1872 and 1880 and modern regenerative furnaces have changed little since then.

However, continuous all-electric melting (AEM) is almost as old as gas-fired regenerative melting. The first electric furnace was built in 1905 following French Sauvageon's design and was for window production. Even then the specific energy consumption was only 0.73kWh/kg. Many designs have been implemented since but recently electric melting has fallen in popularity due to its high cost compared to widely available fossil fuels.

Global warming and pressure on carbon footprints, has rekindled interest in full or partial (hybrid) electric melting. Alternative energy sources for electricity have helped to lower costs and production is essentially CO_2 -free; for example in Germany, 40% of electricity is generated using renewable resources such as wind, solar, hydro and bio. The question for the future is not if more electricity will be used for glass melting but what will be the balance between fully electric and hybrid furnaces (substituting bio fuel for fossil fuel).

Glass is important in generating green renewable energy, or 'green electricity.' Most wind turbine blades are composed of reinforced glass fibre. And most solar panels use large quantities of flat glass. In the future, photovoltaics will probably be widely integrated into windows. These applications mean that glass is not only a consumer of renewable energy but also has an important role in generating it.

For larger furnaces with higher pull rates, the higher volumes and lower wall losses make recuperators or regenerators sensible. Gas-fired furnaces can be cheaper than the efficient electric melter. This was historically so in ▶

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most countries because electricity was generated from fossil fuels, and typically 2.5 to 3x more costly per kWh than the fuel alone.

Even small electric furnaces are 70–85% thermally efficient. While a fuel-fired furnace without a recuperator at a low pull is only 10% efficient, adding a regenerator increases efficiency to 45%, and an oxy-gas-fired furnace can achieve 50% efficiency.

Most common all-electric melters produced 10–30tpd, sometimes up to 80tpd. They were round or hexagonal to avoid heat losses via the furnace walls and to allow more easily-distributed batch charging and electric connections. Figure 4 shows a larger rectangular 80tpd melter. These cold top electric melters used the batch cover as a heat insulating blanket, conserving heat inside the melt. They were called vertical melters, as the glass melts on the surface near the batch, refines at lower levels and flows out via a bottom throat into a working end/distributor. To maintain batch coverage and hence an insulating blanket, the cullet content was usually below 50%. Electric melters were mostly used for high quality clear glasses and crystal (lead) glasses, as the redox (colour) control is best managed with this process.

During the 1970 global oil crisis, some glass producers, especially in the USA converted their regenerative furnaces to all electric melters. They retained the infrastructure and horizontal configuration because other shapes were difficult to incorporate into their existing space; sidewall losses are less important at higher pull rates.

| Renewable source | Electricity | Hydrogen electric | Hydrogen combustion |
|---|-------------|-------------------|---------------------|
| Renewable source | 100% | 100% | 100% |
| Electrolyzer | | 70% | 70% |
| Compressor | | 92% | 92% |
| Transportation | 92% | 98% | 98% |
| Transformer/fuel cell | 95% | 52% | |
| Heat losses effect (electrode holders, fluegas) | 90% | 90% | 45% |
| Total | 79% | 30% | 28% |

Table 1: Comparison of electric melting efficiency versus hydrogen.

Future of carbon-free melting

Currently, 95% of all glass melting uses fossil fuels, mostly natural gas or heavy oil, but industries are now strongly encouraged to follow the 2015 Paris Climate Agreement guidelines and are seeking to minimise CO₂ emissions. Many but not all countries are enforcing rules, with penalties for carbon emissions and benefits for reductions. Either way, the glass industry knows its consumers expect low-carbon or carbon-free production and are working to achieve this while remaining competitive amongst themselves and with other packaging materials.

Four key technologies for carbon reduction exist, in addition to those already discussed. They are:

1. Cold top all electric vertical melting (AEM)
2. Hydrogen combustion (replacing natural gas in regenerative or oxy-gas furnaces)
3. Horizontal hot top electric melting (H2EM) also referred to as hybrid melting
4. Horizontal hot top hydrogen electric melting (H3EM)

The question is: What is the best solution – not just now – but for 2030? 2050? After 2050?

Hydrogen

Currently, truly green hydrogen produced by electrolysis using renewable electric energy is the first choice, but there is simply not enough available. Even with low electric pricing, hydrogen at €6/kg is too costly to compete with natural gas. In most regions it would be uneconomic without state subsidy.

Additionally, more research on hydrogen combustion is needed, specifically the effect on the molten glass and refractories of water concentrations approaching 100% in the combustion atmosphere. Certainly concentrations near 50% in the combustion atmosphere of oxy-gas furnaces

have created problems. Using electricity to break water into H₂ and O₂ by electrolysis is expensive and is only now reaching 70% efficiency levels. However, expectations are that investment costs should decline while efficiency continues to increase, so that as more renewable electricity becomes available, hydrogen will become affordable.

But why consider hydrogen? If electricity is used directly, the furnace melting efficiency is much higher than via the hydrogen route. An advantage of hydrogen is the possibility of storage for long periods, allowing long-distance transportation and creation of a buffer against supply hiccoughs. Storing electricity for similar times is not efficient. Unused batteries slowly lose power while storing sufficient energy would require huge batteries. Different storage options are shown in Figure 5; some, such as hydro power have been created but are not universally applicable – mountains and water reservoirs, as in Norway or Austria being necessary. Energy storage today is facilitated by methane which can be stored for millennia in caves with appropriate geology.¹⁰

FlammaTec (part of GS Group) developed the first hydrogen burner for glass melting in 2018.¹³

All-electric melting

Electric melting has been a proven technology for over a century so why not convert all furnaces to all-electric melting? Mainly, because electricity typically costs three times that of natural gas/kWh. While electric melters are twice as thermally efficiency, they are more expensive to operate. Another obstacle remains: most electric melters are producing less than 80tpd. Only a handful in the entire world melt more than 100tpd; and only two have produced 200tpd – both were stopped due to production issues. All-electric melters greater than 200tpd have diameters so large that maintaining a well distributed insulating batch blanket across the melt surface is difficult despite being a key requirement ▶



Figure 8: This article is based on a paper presented by Erik Muijsenberg at the International Year of Glass Opening Ceremony in Geneva on 11 February and is adapted from the publication in chapter seven of the IYOG book 'Welcome to the Age of Glass'.



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for keeping the furnace operational. Should the batch cover disappear, the furnace loses heat from the top, the glass cools, melt quality and pull rate fall and production deteriorates. There is also currently limited long-term experience at that size for producing reduced-colour glasses or melting with high cullet levels.

Hybrid melting

Hybrid melting entered the glass dictionary in 2017, being mentioned by companies such as Glass Service, FIC, BDF Industries, Fives, Teco, Horn and SORG. Previously discussion was limited, although hybrid melting simply means more than one heat source and has a long history. It is analogous to hybrid cars that have an engine for the main power source and battery-driven electric motors that can move the car short distances and add extra power during acceleration. Electric boosting in glass production was often for 15–30% of the total energy input. Combustion is also used in hybrid melters (H2EM) but 50% or more energy comes from electric heating. The thermal efficiency of the electricity is 85–90%, while combustion is about 50%.

A smaller all-electric furnace (<4tpd/m²) has the following advantages:

- No emissions (NO_x, SO_x) or particulate dust, so no filter or cleaning costs for waste gas
- No chimney stack (and therefore fewer complaints from neighbours)
- Lower investment: no crown, regenerator or flue gas channels
- No regenerators to clean
- Lower raw materials costs, because volatilisation reduced
- Lower repair costs and shorter repair times
- Efficiency is less impacted by furnace size and capacity

Common disadvantages are:

- Less pull rate flexibility
- Shorter furnace lifetime (eight years for smaller furnaces 50–80tpd)
- Limited experience of operators

- Dependent on electrical power stability
- Proven melting only up to 55% cullet
- Limited experience with producing reduced-colour container glass (hybrid melting helps)

Hybrid melting removes some disadvantages; only two remain:

- Shorter furnace lifetime (10–12 years)
- Less experience of operators (behaves more like a standard furnace)

Glass Service and FIC in co-operation with BDF Industries developed the first hybrid furnace in 2017. A flexible design independent of energy source, melting at times with 80% fossil fuel/H₂ and 20% electric boost (at 3MJ/kg), or conversely 80% boost and 20% combustion (at 2.5MJ/kg) should reduce the risks of adopting a new technology. Figure 6 shows the concept design of such a horizontal hybrid electric melter for container glass.

A hybrid electric melting and oxy-gas furnace such as this can break the magic energy barrier undercutting a specific energy consumption of 3GJ/ton of glass (with 70–80% cullet).

Table 1 shows that using electric energy directly in the glass melt is much more efficient than hydrogen, whether by combustion or via the fuel cell. Direct efficiency is estimated to be 79%, whereas hydrogen reduces efficiency below 30%.

For float glass production it will become possible to use more electric heating or super boosting. A design made by FIC UK to make some first steps into this direction is shown in Figure 7 with a 6MW bottom melter boosting installed in a conventional regenerative float furnace. To make the complete transition it may be more interesting to combine this with oxy combustion and then at some point replace the natural gas with more hydrogen and waste heat recovery. But the efficiency route using electricity directly will always be higher.

Conclusions and outlook

With the acceptance of Industry 4.0 automation, the required 55% reduction of carbon emissions should be possible before 2030 through:

- Improved glass recycling (in both amount and quality)
- Greater use of low-cost green electricity, in hybrid or all electric furnaces
- Use of hydrogen for combustion or electricity generation. Generating hydrogen using green electricity will become important post-2030. The 2050 goal of an 80% CO₂ reduction will require large amounts of green electricity and a functioning hydrogen economy to replace fossil fuels for glass production and transportation to and from the factory.

Industry 4.0 automation will continue its forward progression. A dark [robotic system] glass factory may be difficult to imagine by 2030, but not by 2050 when the light from hot gobs falling from the forehearth spout will be all that illuminates the factory hall. ●

- 1 <https://www.cambridge.org/core/journals/contemporary-european-history/article/glass-recycling-container-in-the-netherlands-symbol-in-times-of-scarcity-and-abundance-19391978/D4119AC7A38C4D29486557CCACF3D4FC>
- 2 <https://www.gpi.org/a-circular-future-for-glass>
- 3 <https://publications.jrc.ec.europa.eu/repository/handle/JRC68281>
- 4 https://en.wikipedia.org/wiki/Forest_glass
- 5 <https://www.eia.gov/todayinenergy/detail.php?id=12631>
- 6 <https://www.lifeoptimelt.com/>
- 7 https://www.oxyfuel-heatrecovery.com/sites/oxyfuel-heatrecovery/files/2017/03/28/oxygen-natural_gas-preheating-for-oxy-float-glass-air-liquide.pdf
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- 11 <https://patentimages.storage.googleapis.com/99/83/53/27b1751a9d6aed/US972779.pdf>
- 12 <https://www.neuman-esser.de/en/company/media/blog/hydrogen-storage-in-salt-caverns/> <https://insideevs.com/news/493578/volkswagen-300-gigawatt-batteries-achieve-ev-goal/>
- 13 <https://www.flammatec.com/services-products/burners/gaseous-fuels/hydrogen-carbon-free/>

About the author:

Erik Muijsenberg is Vice President of Glass Service a.s.

Further information:

Glass Service, a.s., Vsetin, Czech Republic
tel: +420 571 498 511
email: info@gsl.cz
web: www.gsl.cz

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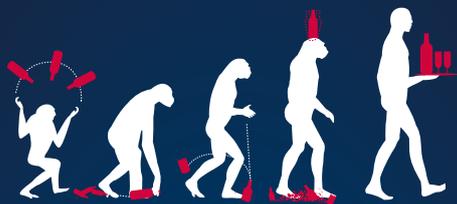
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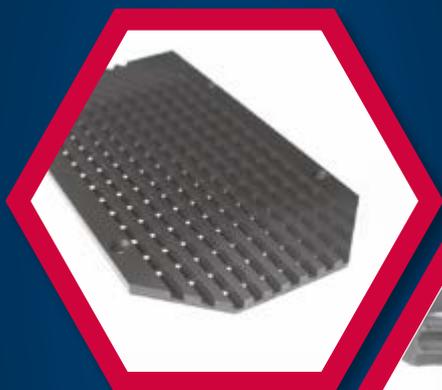
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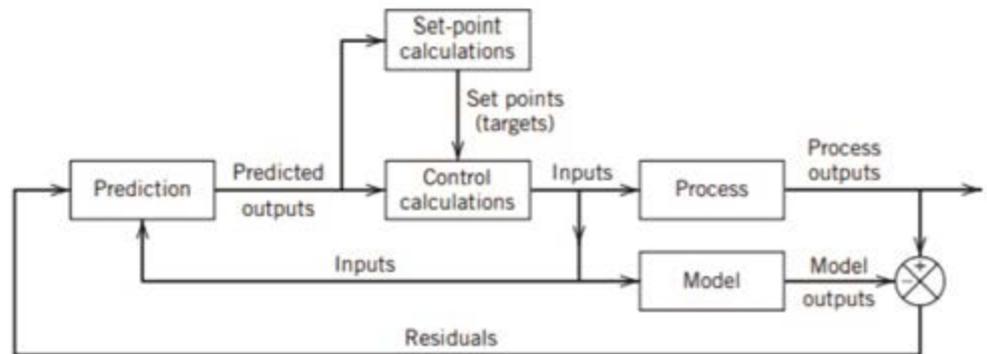
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Finessing a furnace with rMPC

Continuing a topic introduced in *Glass Worldwide's* January/February 2022 buyers guide (pp70–71), René Meuleman from CelSian explains how creating an accurate digital copy of a customer's furnace helps to build a reliable model predictive control system before the melting facility is even operational.



René Meuleman.



Block diagram for model predictive control. Image source: Seborg et al. (2011) "Process Dynamics and Control".

Making the decision for a furnace control system can have a big impact on your daily production. To build a traditional model predictive

control (MPC) system, the actual running furnace or forehearth is disturbed, leading to undesired process variations and resulting in production losses. Conversely, limiting these losses by making small disturbances results in unreliable control model data.

By using a digital copy of your furnace to generate a control system, there is no impact on your daily production. This method, using a digital copy of the furnace, is called rMPC [the 'r' stands for 'rigorous']. CelSian's glass furnace modelling software tool GTM-X generates a digital copy that produces reliable, rapid and 'rigorous' results. With this, the company has the ability to perform step responses in-house and build a reliable model predictive furnace control system even before the furnace is operational.

How does it work?

The process starts with the client sending over furnace and/or forehearth design drawings together with furnace data. CelSian uses an online portal that provides guidelines for easy exchange of information and furnace drawings. Information and design drawings provided will be used to build a digital representation of the furnace and/or forehearth. Once complete, this exercise forms the foundation of GTM-X and many of CelSian's services such as finding design flaws, predicting refractory wear and of course designing an rMPC. GTM-X is more or less a Swiss Army Knife capable of serving many purposes; for example, if there is a glass defect problem that needs to be investigated and resolved and the furnace in question is in our database, CelSian can react quickly, focusing on the specific problem to find the root cause and provide guidelines to overcome the problem in the minimum amount of time.

Let's go back to rMPC

It is important to understand that if CelSian is involved in checking furnace design during the design stage, most of the work has been already done. Developing an rMPC for the furnace in question will 'only' require the final steps: running step responses on the GTM-X model and afterwards, designing the controller. Furthermore, rMPC control will be already operational before the new furnace is fired up – saving a lot of time, operational headaches and money.

How does it interact with traditional process control?

Once in operation, rMPC requires real time process control data such as MVs (manipulated variables) and DVs (disturbance





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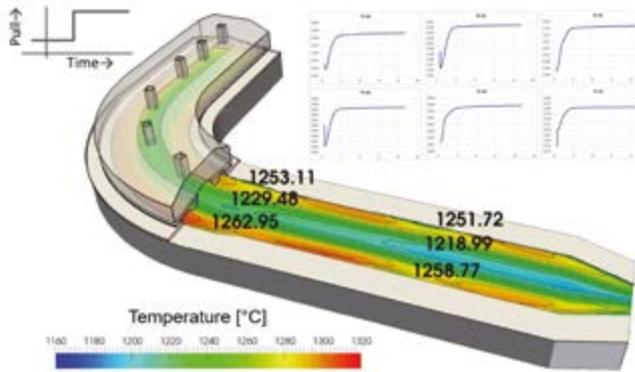
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The rMPC process starts with the client sending over furnace and/or forehearth design drawings together with furnace data.

variables) to perform mathematical calculations and, as a result provides refined CV (control variable) setpoints for the traditional PID [proportional integral derivative] controllers running in the process control system. Traditionally, Windows PCs or server systems are used to run the model predictive controller communicating with the process control system via OPC (open platform communications) connections to exchange data. This method remains the same regardless of the type and source of data.¹

In principle that all works fine but handing over important process control task to a MS Windows environment is perhaps questionable because it is unlikely that a specific Windows version and the hardware on which it is running will 'outlive' a modern process control system and the furnace it is monitoring. It is even less likely that it will be as stable and reliable as the process control system due to the inevitable interruptions from hard- and software updates required by a stand-alone Windows platform.

Today, many process control and DCS [digital signal control] suppliers provide embedded advanced control functionality. They are anticipating that customers require MPC to run their processes safely, reliable and efficiently. These modern process control processors will be able to run complex computations alongside traditional tasks. With this in mind, CelSian has been investigating embedding rMPC into the most common process control/DCS systems. One of these has already proved successful.

Conclusion

Rigorous Model Predictive Control (rMPC) is a well-established technology that supports the glass manufacturing process to become more stable and efficient. Rigorous MPC no longer requires time-consuming on-site furnace disturbances, and provides a reliable advanced control system from the start-up of the furnace. Embedding rMPC into the process control hardware layer will provide the same stable operation as is expected from process control. Integration into HMI (human machine interface) will enable the same look and feel of a traditional process control system. Some process control systems already support this technology by offering a stable embedded rMPC controller. ●

1 https://en.wikipedia.org/wiki/Open_Platform_Communications

About the author:

René Meuleman is Business Development Director at CelSian

Further information:

CelSian Glass & Solar BV, Eindhoven, The Netherlands
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Preventing vial breakage from lensing failure

A common type of tubing vial breakage observed during the over-sealing operation consists of the intact bottom being separated from the remainder of the vial. Dave Machak, Wenke Hu and Gary Smay from American Glass Research discuss an investigation into problems caused when the bottom contour of the vial is not formed properly during production.

When a tubing vial fails under the action of a vertical force during the over-sealing operation, the bottom of the vial usually is separated as a single piece of glass from the remainder of the vial. This failure mode is referred to as 'lensing' because the shape of the bottom piece of glass

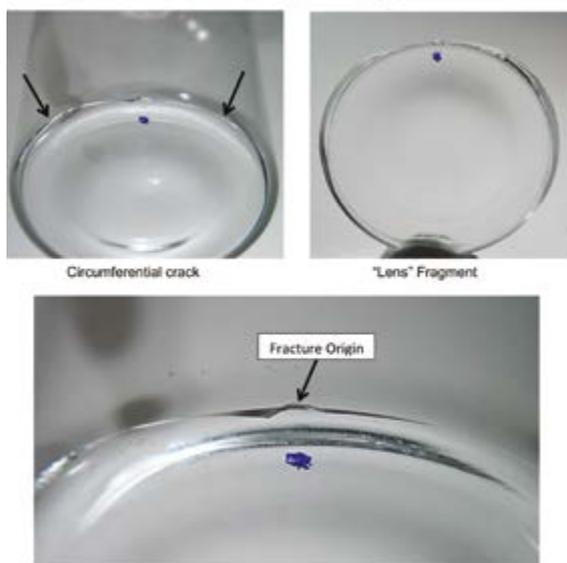


Figure 1: Typical example of lensing failure (blue dot marks the point of origin).

resembles an eyeglass lens (see Figure 1). Examination of numerous vials that had broken from the over-sealing force in the trade have shown that the fracture origin is located on the outside glass surface nearly always at the lower most heel region (Figure 1).

Detailed fracture analyses have indicated that lensing failures are caused by an unusually high magnitude of tensile stress that has been correlated to a condition in which the bottom region of the vial extends below the normal horizontal plane of the bearing surface. This causes a shift of the vertical over-sealing forces from the bearing surface to a smaller diameter circumference in the bottom of the vial. Even though this correlation has been empirically found by laboratory tests, the precise role of the bottom contour in the creation of excessive tensile stresses has not been quantified.

This study utilised FEA [finite element analysis] models to determine the distribution and magnitude of stresses that are developed in tubing vials during the over-sealing operation for various bottom contours. Results of the FEA study were used to evaluate the conclusions drawn from empirical laboratory tests.

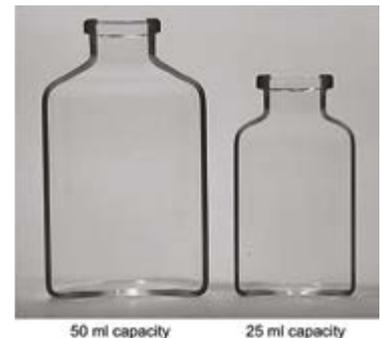


Figure 2: Profile of tubing vials.

Experimental procedure

Shown in Figure 2 are profiles of two vials (50ml and 25ml capacity) that were used in this study. Glass thickness distributions and key bottle parameters were measured and the results are summarised in Table I. The physical profiles, glass thickness data and physical dimensions were used to create the FEA computer models. The analyses involved the application of a vertically aligned force to the top of the vials while they were supported on a flat, solid plate and positioned on their normal bearing surface diameter and two smaller diameters that were reduced by 20% and 40%, respectively as shown in Figure 3. These latter two models ▶

| | 50 ml | 25 ml |
|-------------------------------|-------|-------|
| Bearing Surface Diameter (mm) | 34.2 | 26.2 |
| Sidewall Diameter (mm) | 42.4 | 31.5 |
| Push-up (mm) | 1.0 | 1.0 |
| Heel Contact Height (mm) | 4.1 | 4.1 |
| Overall Height (mm) | 73.1 | 58.2 |
| Glass Thickness (mm) * | | |
| SC | 1.5 | 1.1 |
| SW | 1.5 | 1.1 |
| HC | 1.5 | 1.1 |
| LMH | 1.5 | 1.1 |
| BS | 1.6 | 1.6 |
| BTM | 1.8 | 1.4 |
| Weight (g) | 35.0 | 16.3 |
| * SC: shoulder contact | | |
| SW: sidewall | | |
| HC: heel contact | | |
| LMH: lower most heel | | |
| BS: bearing surface | | |
| BTM: bottom | | |

Table I: Vial dimensions.

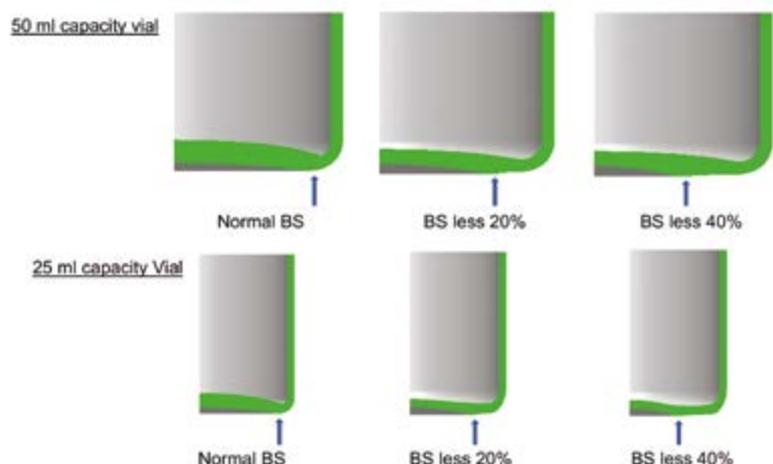


Figure 3: Location of load bearing points.



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Figure 4: Comparison of general stress patterns. Stress generally increases in the following progression: Blue < green < yellow < orange < red.

represented simulations in which the bottom contour of the vials had been mis-formed during the manufacturing process.

The FEA output is given in terms of a stress index which is defined as the magnitude of stress (MPa) per unit of applied vertical force (kgf). Stress indices at the heel contact point, the lower most heel region and the bearing surface were compared for the various vial sizes and load point diameters.

Discussion of results

Shown in Figure 4 are the overall FEA stress distribution patterns for the 50ml and 25ml vials while resting on their normal bearing surface diameters. Tensile stresses were observed only around the circumference of the vials at both the shoulder contact and heel contact zones which is expected for cylindrically shaped containers subjected to vertical forces. For this study, the focus is on the heel area of the vials and Figure 5 shows

the distribution of stresses at the heel contact, lower most heel and bearing surface regions for the two vial sizes and three bearing surface configurations (these models are a quarter symmetry view of the entire circumference of the vials). For all of the FEA models in Figures 4 and 5, the generalised tensile stress indices increase in the order: blue < green < yellow < orange < red.

The numerical values of the stress indices are summarised in Table II. The stress indices were greater for the smaller capacity vial which agrees with the basic principle that stresses from the application of a vertical force to a cylindrical shaped object will be greater when the overall diameter is smaller. Also, the stress indices for the shoulder and shoulder contact regions were not affected by changes in the bottom load point of the vials. This was expected since the diameter and shoulder configuration of the vials remained constant throughout the analyses.

The data also show that the stress indices for the heel contact, lower most heel and bearing surface regions all increased as the bearing surface diameter decreased. This is attributed to a bending action that is produced radially in the bearing surface/heel region as the load point is shifted inward from the normal bearing surface location. It is also important to note that the lower most heel region (shaded yellow in Table II) is the highest stressed region in the bottom portion of the vials both for the normal bearing surface diameter and for progressively smaller load point diameters.

Glass objects fail when the tensile stress exceeds the glass surface strength at any specific

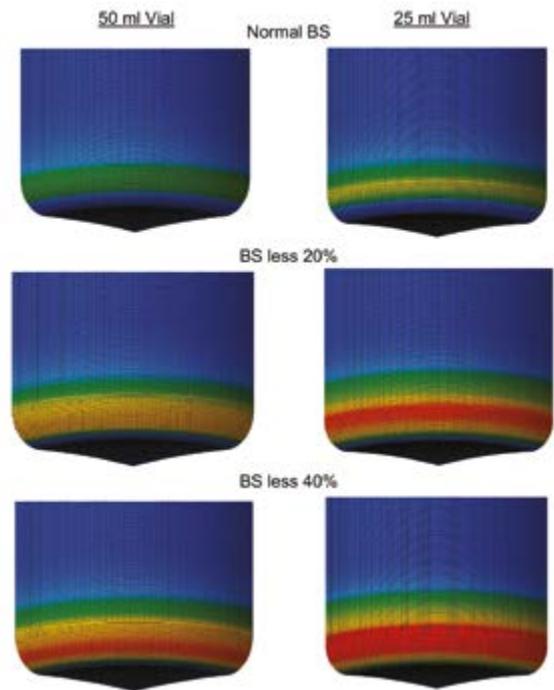


Figure 5: Comparison of stress. Stress generally increases in the following progression: Blue < green < yellow < orange < red.

location. If the glass surface strength in the heel contact, lower most heel and bearing surface regions is universally the same, fractures will occur exclusively at the lower most heel region since it exhibits the highest stress index. This analytical result is consistent with the empirical evidence obtained from laboratory experimentation of vials that had experienced lensing failures in the trade.

Further examination of the data in Table II for the 50ml vial shows that the stresses at the lower most heel region increased by 1.8x when the bearing surface diameter was decreased by 20% and increased by 2.3x when the bearing surface diameter was decreased by 40%. The increase in the stress indices for the 25ml vial was even greater (2.2x for a 20% reduction in the bearing surface diameter and 3.4x for a 40% reduction).

Conclusions

Usually, a tubing vial with a properly formed bottom contour does not lead to problems during the over-sealing operation. However, data from the current FEA study shows that when the load point in the over-sealing operation is shifted from the normal bearing surface diameter to smaller diameters, the stress magnitude at the lower most heel region increases dramatically. This increased tensile stress magnitude is typically responsible for lensing failure of tubing vials. It is anticipated that similar trends would be observed for other sizes of tubing vials although the numerical values of the stress indices may vary. ●

50 ml capacity

| bearing surface diameter (mm) | Stress Index (Mpa/kg) * | | | | |
|-------------------------------|-------------------------|-------|-------|-------|-------|
| | SLDR | SC | HC | LMH | BS |
| 34.16 | 0.293 | 0.202 | 0.179 | 0.217 | |
| 27.33 | 0.293 | 0.202 | 0.287 | 0.385 | 0.195 |
| 20.50 | 0.293 | 0.202 | 0.353 | 0.496 | 0.350 |

25 ml capacity

| bearing surface diameter (mm) | Stress Index (Mpa/kg) * | | | | |
|-------------------------------|-------------------------|-------|-------|-------|-------|
| | SLDR | SC | HC | LMH | BS |
| 26.16 | 0.415 | 0.307 | 0.187 | 0.234 | |
| 20.93 | 0.415 | 0.307 | 0.369 | 0.520 | 0.204 |
| 15.70 | 0.415 | 0.307 | 0.520 | 0.784 | 0.527 |

| | |
|----------------------|--|
| * SLDR: shoulder | |
| SC: shoulder contact | |
| HC: heel contact | |
| LMH: lower most heel | |
| BS: bearing surface | |

Table II: Stress indices for vertical loading of pharmaceutical vials.

About the authors:

Dave Machak is Manager, Pharmaceutical Services and Wenke Hu and Gary Smay are Senior Scientists at American Glass Research

Further information:

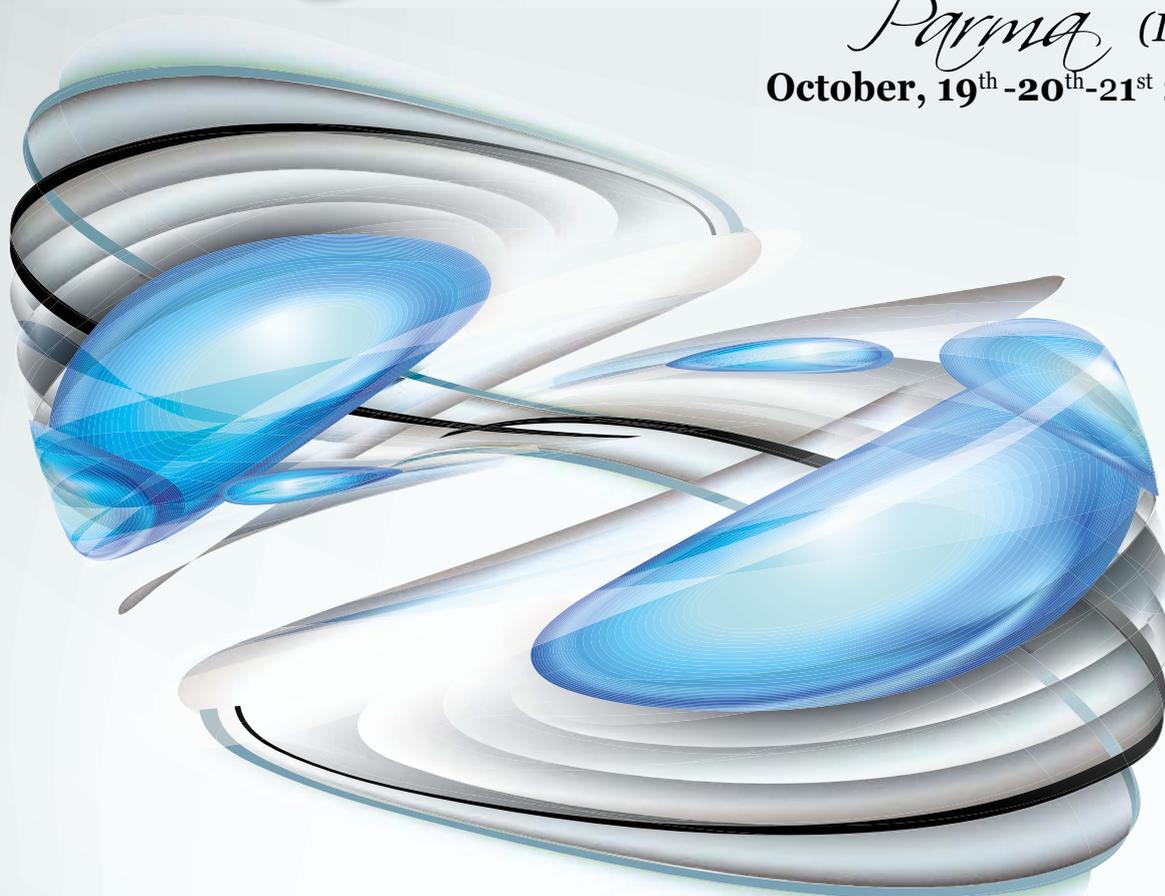
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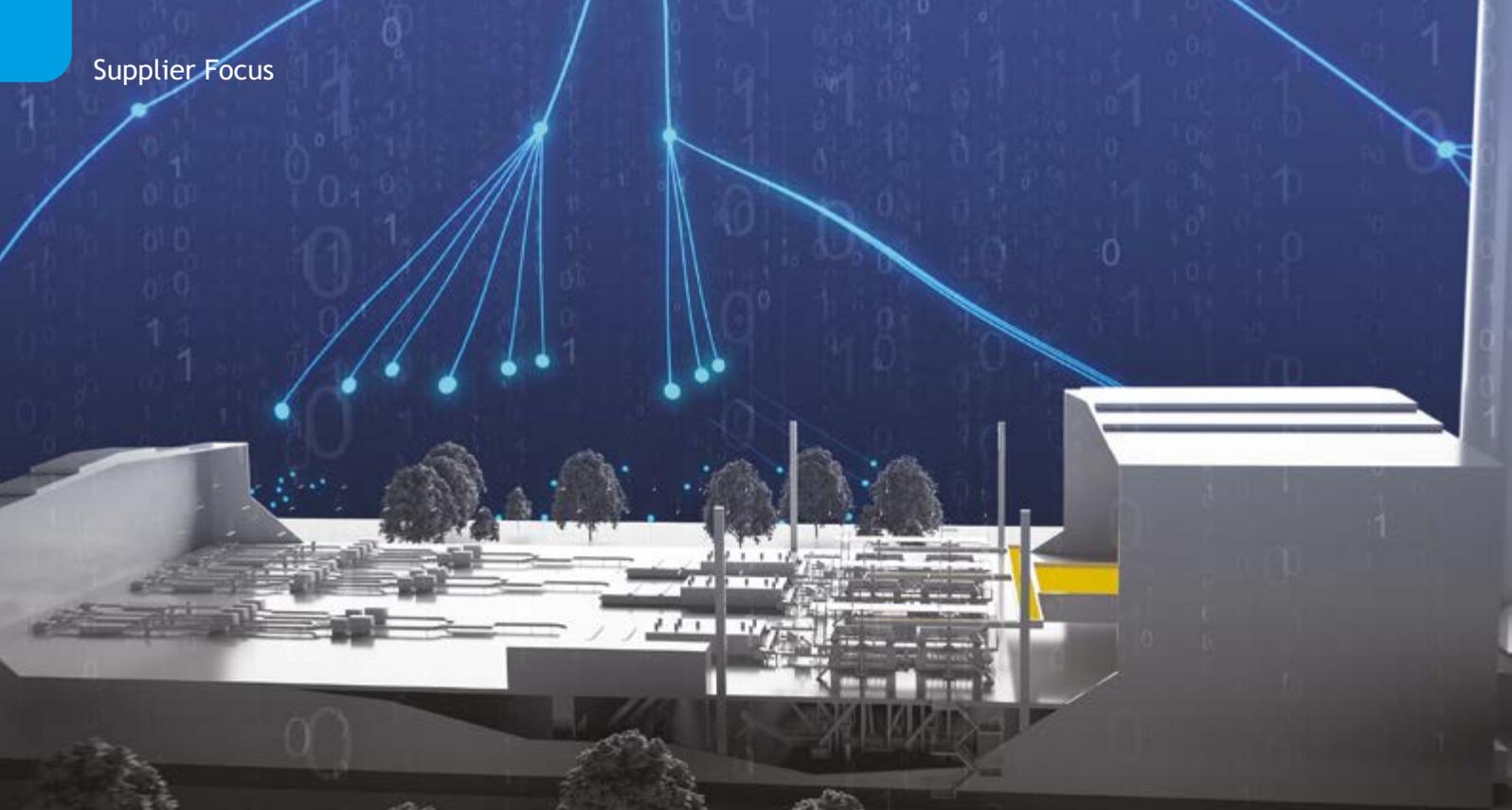
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Heye is dedicated to developing solutions for the smart glass plants of the future.

Developing digital systems for modern manufacturers

Pioneering hot end smart forming solutions and cold end smart inspections, Heye International supports glass plants with an eye on the future. Development Engineer Dr. Michael Kellner talks digitisation, emissions and the potential for artificial intelligence.



Dr. Michael Kellner, Development Engineer at Heye International.

Dr. Michael Kellner was born in Jena, east-central Germany, and came into contact with glass as a student through an internship at Schott Glas, having studied building materials and process engineering with a focus on glass in Weimar. As early as 1986, he was involved with the first image processing cameras and their use for inspecting glass.

“The theory was there, but the technology was not yet powerful enough for the glass industry,” he says. During his doctorate on automation and image processing technology in glass production, Michael Kellner began working at Schott Glas. After the doctorate, he started as a trainee at the former company Heye-Glas, a very innovative, medium-sized enterprise. Initially, he was the link between production and development for introducing automation solutions in glass production. In 1992, he was responsible for testing the first image processing applications based on image processors at Heye, and shortly afterwards he began to develop PC-based image processing solutions. “Experts at the time thought that image processing could never work with a PC,” says Kellner. “What a mistake.” The process engineer with a doctorate left the company in 2000, but returned to Heye in 2006 as Head of Development. Since 2019, he has been responsible for the development of Heye’s digital systems.

Digitisation and Industry 4.0 are currently major topics. How long have you been dealing with them?

Dr. Michael Kellner: Digitisation is not a new field at Heye. At the beginning of the 1990s, we introduced a PC-parameterisable, electronic timing system for controlling the IS-machines and the hot end reject system, including the evaluation of pushing glass containers from the dead plate onto the machine conveyor by means of pushers. The complete hot end process was converted to servo technology, i.e. from gob forming to ware handling. This

was a huge step into the future, as the motion sequences were now matched and followed by the feedback generators according to the given motion curves. Shortly afterwards, the first servo motors were also used in the IS-machine to make critical process sequences reproducible and to avoid container defects. An important component in light glass production is certainly the introduction of the Heye Process Control, which digitally records and visualises the pressing process by recording the plunger positions.

In 1998, Heye worked on a hot end gob camera for recording the cut of gobs. But the resolution of the cameras and the performance of the PCs was not sufficient. Nevertheless, the experiences gained were extremely important in order to build up the skills for the following years. When the first grabber cards were available, the new Terra computers were bought and a camera-based mould number reader and a camera-based sealing surface tester were developed.

What is the state of affairs at Heye International?

We have converted complete machine platforms because the market has tended towards triple- and quadruple-gob operation. Consequently, we made all the hot end equipment 'fit for the future'. Today, we offer the complete technology platform for all applications. We are on the right track. The further development of sensors and actuators has created new opportunities. Since the introduction of industry 4.0, we are raising the bar higher and higher. For example, the new IS-machine, namely the 'Heye SpeedLine' we have developed. The SpeedLine IS-machine is the first machine that is fully bus-capable.

The next development goal was to create areas in the IS-machine where sensors, actuators, the necessary cables and the processor technology could be installed safely and reliably. Safe and reliable means, in this context, protection against heat, oils, oil vapours, water, water vapour, dirt and glass. We have succeeded very well with the SpeedLine because we have conceived the design differently. The cable routing was designed first and it was tested – where the sensors must be mounted and how we can technically protect them to ensure long-term stability. Operating sensors without failure in a 1,000°C hot environment is not easy. Thanks to the bus system, all systems in the machine are networked together and a large number of sensors can be managed. This naturally brings with it new possibilities and products, for example the intelligent lubrication interval control – the 'Heye Multi-Circuit Central Lubrication' – which significantly saves oil and increases the lifetime of the components. Also the inline measurement of pressures and temperatures of the equipment should only be mentioned here.

With this machine, we have taken a giant step into digitisation. There is now a 'Communication Tower' that combines all network components, computers and servers in one cabinet. The components are interconnected and communicate with each other. SpeedLine is a platform technology in which components such as robots or measuring and control systems can be integrated very easily. Via the Communication Tower there is also a gateway to the outside, i.e. to the customer. The Application Programmable Interface 'Heye SmartLink' provides the customer with the data of the manufacturing process for individual data analysis.

Do you do everything yourselves at Heye? For example, programming?

Most of the software is developed by us, especially in the key technical areas. The hollow glass industry is a relatively small and very special market segment. It is difficult to explain the processes to external companies. There are a few components that we buy, such as sensors, for example. However, the suppliers then work for the glass industry in the long term and are therefore aware of the requirements.

The reduction of CO₂ emissions is a field that will accompany us more than ever in the coming years. What contribution can the container glass industry make?

It is probably the most topical issue at the moment: CO₂ footprint or decarbonisation. If you look at the side of energy consumption and leave the compensation models aside, then it is essentially about the sensible use of energy and the avoidance of energy waste.

For us as a machine manufacturer, two different directions are relevant when it comes to emissions. On the one hand, it is a matter of minimising losses, which means producing as much as 100% of the glass bottles possibly without defects. Then you don't have to throw away glass bottles, don't waste the energy needed to make them and have a better CO₂ footprint.

On the other hand, the focus is on equipment availability. It is best to operate the machine 24/7 and produce glass bottles without any defects. This also includes minimised job change times.

To avoid emissions, it is important that errors are found and ▶

●
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●
PERFORMANCES

●
ENERGY SAVING

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LONG LASTING



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eliminated as soon as possible. This is why it is so important to reduce the gap between cold end information gathering and hot end information processing. To increase efficiency, we use the 'PlantPilot' information system, which records the efficiency situation and messages deviations to those points where corrections need to be made. This results in a significant improvement in equipment availability and an increase in yield by reducing transport and quality losses.

Efficiency increase and CO₂ reduction are therefore closely related.

Then, ideally, the measurements would have to take place at the hot end?

Exactly! This is not easy, however, because many of these measurements are contacting measurements. And when I contact a hot bottle with a measuring tool, it deforms and becomes unusable. We still do not have a solution to how it might work to turn a hot bottle and, for example, to measure the wall thickness. That is not realistic at the moment.

Today, we want to measure the parameters of the forming process directly and keep them constant within narrow limits. We use infrared cameras at the hot end to identify deviations in the process more quickly and, above all, not to exceed or fall below the limits and to take countermeasures



Smartline² cold end inspection machine.

immediately. This technology is called a 'hot end closed loop'. Ideally, non-contact sensors control and regulate the process.

Which control loops do you mean?

Different sensors are also used at different locations for the different process sections. They are then used to influence parameters of the gob, the parison or the bottle.

If you start with the gob forming, you use a gob camera to adjust and control the gob shape and gob weight. Also, the gob temperatures can be measured to influence the spout temperature in the feeder. On the blank side, the gob delivery into the blank mould can be detected and adjusted. The tool temperatures on the blank side (blank mould, neck ring and plunger) can also be measured and controlled. Infrared cameras on the machine conveyor are already

frequently used today to measure wall thickness distribution and detect global errors. Optical cameras are planned on the machine conveyor for measuring and controlling the container geometry and for detecting glass defects.

And at the cold end?

The manufacturing process is completed when the glass container passes the annealing lehr. The cold end does not deal with controlling the process. However, what should be mentioned is to check automatically whether the inspection machines are set correctly by using sample containers. However, downstream processes, such as printing or surface treatments for increasing the strength, can also be measured and controlled.

What role does the weight and shape of the glass bottle play?

In the 1990s, a price war broke out for disposable packaging. In order to save on raw material, energy and transport costs and also to reduce the charges to the dual system for disposable bulk items, projects have been launched to reduce the weight of glass containers – to produce with thinner wall thickness. Heye has a great advantage with its experience from H1-2 technology and was able to transfer this to IS-machine technology. A relic of these times is the famous Paderborner beer bottle. It was shown that the shape has an immense influence on the weight of the container while maintaining its strength. Today, a compromise is sought between an individual bottle shape, volume and weight with sufficient strength. If we want to become more ecological, then we will have to compromise on the individual



Heye SpeedLine IS machine.

bottle shape in favour of the container weight.

Many machine components and HI products, which were already developed for light glass technology at the time, are now standard in industry. Starting with process control, through axial cooling and hot end transport – all of these components can be used with know-how for the production of lightweight containers.

Lightweight glass production seems to be a big challenge.

The characteristic of simple light glass is that it breaks very quickly. You can fix this problem with thermal or chemical post-processing, but it will increase unit costs. It is unlikely that anyone would pay a deposit of several euros for a Gorilla Glass milk bottle. For the future, a technology must be developed that is based on the current hollow glass production and is efficient. Anyone who manages to increase and maintain the glass surface strength in the production of lightweight glass will be at the forefront in the future.

Where do you see further emission savings potential?

I see the big emission savings in the glass industry globally in the recycling of cullet from the market (waste glass collection and processing), because for glass bottle production from cullet, much less energy is needed than for a production from raw materials. Energy savings through heat recovery from the forming processes and in the annealing lehr have further potential. The ecological approach follows the economic approach: if you save energy, you also save money. This is a strong incentive. The biggest cost factor in glass production is energy.

Heye machines are in use worldwide. Remote access and remote maintenance are becoming more and more important. What do you need to take into account?

For remote access via the internet, it is essential to consider security. Cyber criminals are lurking everywhere, and so companies are sealing themselves off more and more. This means that service providers cannot get into the company networks to connect to the machine and provide support from there without considerable effort. Solutions must be found in consultation with the IT departments of the customers.

How do you assess the potential of artificial intelligence for the glass industry?

AI is currently high on the agenda. I am now in the third wave: The first was in the 1980s, the second in the 1990s and the third is rolling now. You can certainly do a lot with artificial intelligence. But, you have to keep the boundaries in mind: artificial intelligence is determined on the basis of learned information from the past. In order to learn a corresponding neural network, a large number of good and bad example objects are needed – we talk about 500 to 5,000 [examples of] information. Gaining and learning these examples is a huge effort. And when new objects appear, the neural network cannot begin with them. There are AI applications; the decision is already working very well. In the glass industry, on the other hand, this only works for simple applications, such as reading mould numbers in the seven-segment code. Glass defects, on the other hand, become more difficult because they always look different. If new information is added that the trained system does not know, AI will not get any further. There are basically no two exactly the same checks. Perhaps a combination of imaging processes and neural networks can help, but that is still a dream for the future. ●

Further information:

Heye International GmbH, Obernkirchen, Germany
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Rapid deployment force for glass production

As float glass production plants must run reliably around the clock, Grenzebach provides its customers worldwide with seamless service to make this possible.

In hardly any other industry does the motto 'time is money' hit the mark as much as in glass production. Plants run around the clock 365 days a year. This demands absolute reliability because every hour of downtime costs a huge amount of money. Maximum availability is therefore an important expectation for any plant operator.

For this reason, it is essential to have a partner on hand who can restore availability immediately and smoothly in the event of a malfunction or plant shutdown. Grenzebach, headquartered in Hammlar, Bavaria, has built up an internal service infrastructure to solve problems of any kind as quickly and effectively as possible. Customers are offered a service partnership over the plant's entire lifecycle – with everything you could possibly expect from it. These are, first and foremost, constant availability thanks to a hotline and professional support from specialised technicians.

24/7 readiness

The Grenzebach service team is available around the clock, seven days a week for customers worldwide.



The cutting technology at German firm f | glass has been in operation since 2009. Service teams from f | glass and Grenzebach jointly take care of maintenance. Source: Grenzebach.

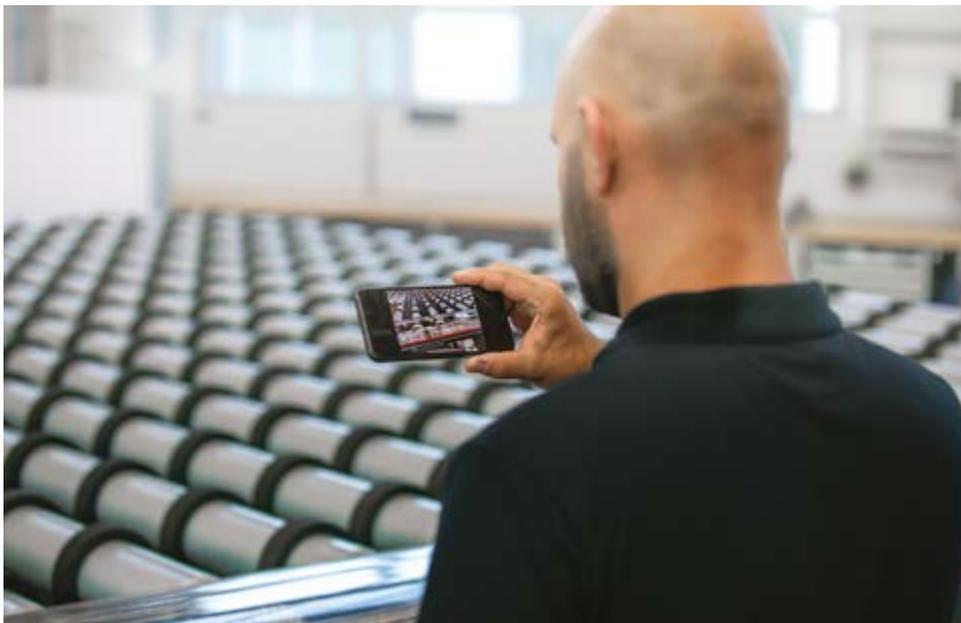
If there is a malfunction or any other challenge, everything is immediately set in motion so that the plant is up and running again as soon as possible.

The fact that this comprehensive service promise is kept is shown by statements from customers who have

experienced Grenzebach's service in action and have nothing but high praise for it. In 2021, for example, Saint-Gobain Stolberg were surprised by a flood and needed immediate help from Grenzebach:

"In 2021, we had an immense flood in Germany," says Dr. Christoph Schmitz, Plant Manager at Saint-Gobain Glass Deutschland GmbH in Stolberg (Rhineland). "The water was 50cm deep in our control cabinets. We were forced to shut down our production. The Grenzebach service team was on-site very quickly to assess the damage and took action immediately afterward: motors were replaced and other spare parts delivered. After the repair, the plant was back in operation in only five weeks."

Erwin Schwertberger, Service Manager at Grenzebach, who looks after this customer, recalls: "It was a pretty disastrous situation for Saint-Gobain, but our people did everything they could to restore production capability in the shortest possible time. I'm proud of the team." ▶



Service from Grenzebach helps customers to enable smooth 24/7 operation of their production plants. Source: Grenzebach.

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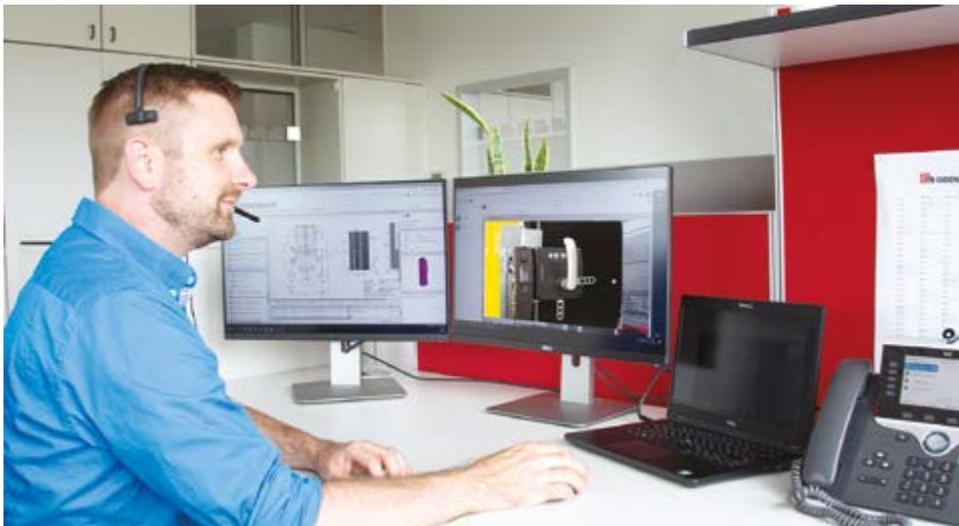
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The Grenzebach service team can be reached quickly and reliably from any part of the world with the phone hotline. Since the technicians have remote access to each plant, problems can often be solved directly and immediately. Source: Grenzebach.

Dedicated service

Each customer has a Personal Service Manager – an experienced expert at their side to provide long-term individual advice. In this way, glass producers are protected against breakdowns and prepared for changing market requirements or necessary modernisations due to discontinuations.

The Grenzebach service team can be reached quickly and reliably from any part of the world with the phone hotline. Since the technicians have remote access to each plant, problems can often be solved directly and immediately. The current guaranteed standard response times for Grenzebach service contract customers are one hour until the technician calls back and a maximum of two hours until he or she remotely

accesses the plant. In the vast majority of cases, the process is even faster.

Depending on the type and severity of the problem, a three-level process is applied:

- 1st level: The service technician solves the problem on the first call via remote access. Around 90 percent of service tickets can be successfully handled at this level.
- 2nd level: If, contrary to expectations, level 1 support does not resolve the issue, Grenzebach Engineering intervenes with additional expertise and, if necessary, the deployment of specialists on-site.
- 3rd level: If the engineering department is unable to resolve the issue, the customer receives support from Grenzebach's development department.

Spare parts and digital support

Much depends on a smoothly functioning spare parts supply. Grenzebach takes care of this with smart warehousing with lean, system-supported processes that enable high spare parts availability and short delivery times in most areas of the world. Due to a new 'Fast-

Lane,' critical spare parts can now be delivered to any location in just a few days.

The service customer portal my.grenzebach.com will provide customers with a digital hub for service in the future. On this central platform, users can find an overview of their glass production plants, exchange information, make inquiries and obtain quotes. They can post service tickets, upload images, and view current status and a history of service tickets. Also included is a digital spare parts catalogue and a 'document repository' for instructions, documentation and video tutorials. Grenzebach offers video tutorials that illustrate the design and operation of the systems and components for various technical topics, such as changing conveyor gearboxes or graphite blocks in a tin bath.

"Everything can be improved"

Florian Nagler, Vice President, Sales Business Unit Glass at Grenzebach Maschinenbau GmbH summarises the situation: "My colleagues and I see accompanying our customers as journey partners throughout the entire service life of a plant as a sporting challenge. And we want to do that better and better, even though the production lines already have very high availability. Everything can be improved, so we take every available opportunity for technological progress to help our customers even more effectively."

The Grenzebach service offer is reportedly very well received by the company's clients. Currently, most of these customers in the glass industry have opted for the service contract with the 24/7 hotline.

Jens Schmidt, Process Engineer, Cutting Line at AGC f | glass GmbH in Osterweddingen, Saxony-Anhalt, also has high praise for the Grenzebach service: "High plant availability is extremely important to us, which is why we [decided on] a service contract with regular maintenance on the cutting technology and stacking technology – including a 24/7 hotline and training for our personnel. The result has been a very high availability since the plant was commissioned in August 2009." ●



Flooding at Saint-Gobain in Stolberg in 2021: four team members from Grenzebach were on-site to put the cold end of the float glass plant back into operation. Source: Grenzebach.

Further information:
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High-speed ware handling

Roy Clarkson shares the development process of Sheppee's 10th generation lehr loader and explains how the high-speed Speedliner[®] could be a particular asset to glass container manufacturers in the post-Covid era.

Ware Handling has never been a more critical factor in the success of a high-speed glass container production line. Manufacturing containers at production speeds of more than seven hundred bottles per minute is not so uncommon today, but the real trick is handling them and loading them in to the lehr without loss.

Sheppee has been at the forefront of ware handling evolution for over 80 years and the 10th generation Sheppee lehr loader, the Speedliner[®] has opened the door to a new level of high-speed ware handling.

Design evolution

The Speedliner[®] builds on the strengths and successes of its predecessor the Tri-Flex[®], which in turn was an evolution of the original Tri-Flex Lehr Loader. The development of each machine has been the result of the Sheppee design team thinking ahead and setting new goals for the Speedliner[®] to achieve.

The initial brief for the design team was to review the software of the previous Tri-Flex Lehr Loader and to look at a more efficient motion for the push bar. Following various studies, it was clear that there were inefficiencies in the previous cycle motion, where 60% is the push phase and 40% is the return phase. The new focus was to minimise the return phase and increase the push phase. The software team analysed the mathematics and was able to deliver the most efficient return profile for the push bar.

During trials under glass, it was clear that the software was a resounding success and even at excessive production speed, the push bar had an unexpectedly long idle time due to the superlative motion control that had been achieved. Following consultations with container manufacturing partners, it was made clear that this idle



Four-point Lift Frame for additional support and reduced vibration of the Air Less Pushbar.

time could be put to good use. Base defects can be caused by friction between the base of the container and the lehr mattress as the container is pushed in to the lehr. Sheppee implemented its unique-patent applied for Lehr Tracking software, which links the Speedliner[®] to the speed of the Lehr mattress. As the pushbar collects the containers and pushes them on to the lehr, it tracks the lehr speed and ensures the containers do

not move faster than the lehr mattress itself, ensuring no friction whatsoever and eliminates base defects at this point.

Speedliner[®] specifications

Designed specifically for high-speed container production lines where it is imperative that there is minimal loss of production – either in numbers of containers or machine downtime – the new loader is capable of meeting



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T: +91 11 2331 6507 E: info@aigmf.com

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Sheppee's Speedliner® complete with machinery directive-compliant guarding.

72m/min cross conveyor speeds and has the ability to cycle at 27 loads per minute, if required. All of this is coupled with Industry 4.0 compatibility.

The mechanics of the Speedliner® are the most robust of any Sheppee lehr loader. Previous models have been based on using lift cams, whereas the Speedliner® is equipped with a captive lift frame through a rack and pinion, which allows for a faster and more controlled return of the push bar to its lowered position. The new machine is fitted with zero backlash gearboxes to minimise any vibration transmitted through the frame and to the push bar, ensuring the most delicate motion even at high-speed handling.

On the widest of lehrs, where traditionally the longest pushbars can vibrate excessively at the extremities and deflection can occur along the length, the Speedliner® is furnished with a frame that secures the pushbar in four places, not two, specifically to eradicate these problems. The company's ALP (Air Less Pushbar) is suitable for this mounting arrangement as it is manufactured to be straight and engineered to remain straight under the heat from the containers and the lehr entrance, so being secured at four separate points causes no problems.

Optimising productivity

For many years, Sheppee's lehr loaders have harnessed dial-in technology, allowing Sheppee technicians to react quickly to issues with the machines in the field but we strive for a proactive future and not a reactive one. The ability to gather and monitor correct and relevant data in a real time environment opens countless opportunities for Sheppee to maximise the uptime of the machines it supplies and therefore the productivity of its customers. Having the correct data to hand combined with the right experience means Sheppee can now see problems with the lehr loader before they become a serious issue, informing the customer and providing a preventative solution with the correct and necessary preparation in mind and on time.

Whilst everyone embraces the concept of preventative maintenance programs, it is easy to overlook certain aspects due to production demands especially in the glass industry and the high-pressure non-stop environment. Having remote monitoring from Sheppee, a number of important factors can be realised:

- Production downtime is decreased
- Better conservation of equipment and increased life

expectancy thereby eliminating premature replacement of machinery and equipment

- Reduced overtime costs and more economical use of maintenance workers due to working on a scheduled basis instead of a crash basis to repair breakdowns
 - Timely, routine repairs instead of time-consuming large-scale repairs
- Monitoring and recording running data allows Sheppee to determine when critical components will require attention. Each machine will run at different cycle rates and Sheppee can measure when components need changing based on the cycles completed rather than the number of years running, ensuring that components do not fail due to a miscalculated maintenance programme.

Furthermore, even as we enter the post Covid-19 era, glass container manufacturers are still conscious of the implications that future restrictions and possible lockdowns could have on their workforce and maintaining its capacity at any one time. The issue of external suppliers not being allowed into production facilities to perform essential tasks remains a concern. Having a remote monitoring facility constantly watching the running status of the lehr loader combined with remote support provides a critical advantage to the glass manufacturer. ●

About the author:

Roy Clarkson is Regional Sales Director at Sheppee

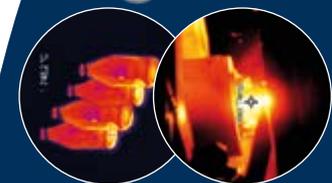
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Fully customisable sweepout assembly

Wesley Weaver details the capabilities of Dura Temp's fourth-generation sweepout assembly, which can be made in single, double, triple, and quadruple gob configurations.

Since 1983, Dura Temp Corporation has been providing innovative and successful customised ware handling solutions for the glass industry's everyday issues. The company's clients across the globe specialise in offering a wide variety of containers produced in varying conditions, which is challenging for classic ware handling parts and assemblies.

New design

Dura Temp's Generation IV Vortex Sweepout Assembly is designed to improve handling and user experience on servo pusher systems that may incorporate vertical pocket air. The

universal backplate allows for flexibility and reduces storeroom inventory.

The Vortex' sweepout assembly can be disassembled from the front, and all contact material and nozzles can be replaced. The one-bolt mounting allows for easy removal of the entire assembly from the machine. This allows for quicker replacement and less downtime on machines using Vortex assemblies.

The overall design of the Vortex Sweepout Assembly allows for it to be lightweight and simplistic, while still maintaining strength to withstand the harsh conditions of glass factories. The sweepout assembly can be made in single, double, triple, and quadruple

gob configurations. Each configuration can be made for left, right, or convertible left/right hand operations. Steel reinforced fingers over-moulded with Dura Temp's proprietary silicone composite material helps to prevent thermal checks. High strength steel brackets resist bending even in the roughest conditions. When using the Vortex Sweepout Assembly, containers are likely to see less denting and checks due to the large contact pads that protect the glass from damage.

Customisation options

Since Dura Temp Corporation often has customers that manufacture containers that are non-round, the Vortex Sweepout Assembly can be customised for container shape and size. The assembly can also be customised when it comes to the contact material. In addition to its silicone moulded material, Dura Temp offers stainless steel braid and carbon-fibre-carbon contact materials based on clients' preferences or operating conditions. Owing to the assembly's robust design, there is a significantly increased wear life, ranging from six months to one year. Vortex Sweepout Assemblies are fully customisable from their mounting types to the contact pad locations. This enables the assembly to adapt to some of the most challenging containers.

Client feedback

The Generation IV Vortex Sweepout Assembly has been installed and is currently in operation at glass manufacturers worldwide. Users of the VSOA have remarked on "flask handling improvement; handles all containers smoothly, and success with all shapes and sizes" to express their experiences using the assembly. Dura Temp's engineering team can customise each Vortex Sweepout Assembly to achieve the correct combination of adaptability and rigidity necessary for any job. Current users have reportedly commented on the ability of the Dura Temp VSOA to handle new machine start-ups with ease (start-ups typically plague standard sweepouts with broken contact materials). Customers have also seen notable improvements versus their original equipment, noting increased material wear life and overall structural life.

Vortex Sweepout Assemblies are currently used in the production of bottles for wine, beer and spirits. ●



Double gob Vortex Sweepout Assembly.



Triple gob Vortex Sweepout Assembly with stainless steel braid.



Quadruple gob Vortex Sweepout Assembly.

About the author:

Wesley Weaver is Vice President of Sales and Business Development

Further information:

Dura Temp Corporation, Holland, Ohio, USA
tel: +1 419 866 4348
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Cold end ware handling and reject devices

Pete Cooper explains how Pro-Sight has augmented its range of ware handling and reject devices for container production with the enhancement of its dual synchronised star wheel separator and the introduction of a multi-finger bottle reject.

Due to ever increasing production speeds, and with ware handling being a crucial part of reliable inspection and line control, separator and reject device requirements are expanding, driving the need for more sophisticated systems to reliably control the containers without compromising stability. It is also becoming more common for reject devices to be needed not only to remove defective containers from production lines but to also divert containers into automatic sampling inspection machines, such as Pro-Sight's new online machines for pressure testing, vertical load testing or automatic sample dimensional gauging.

All Pro-Sight devices are available as standalone units or as options to complement the company's range of inspection machines. They can also all be retrofitted to existing production lines and are designed to minimise installation and job change time.



Star Wheel Discs.

Dual Synchronised Star Wheel Separator

The Pro-Sight Star Wheel Separator is a popular product in its own right, being deployed with the company's inspection machines or as a standalone component throughout container manufacturing plants, as well in filling and bottling halls.

Pro-Sight has recently upgraded its Dual Synchronised version of the Star Wheel Separator to further increase the stability of containers during spacing at high speed, where the two opposing star wheels operate in unison. Dual wheels provide the

advantage of two contact points controlling the container, which prevents the ware turning during spacing, making this a preferred device for non-round containers. To compensate for changes in line speed, the device comes with a line encoder which allows the system to automatically adjust the speed of the Dual Star Wheels making this very much a 'fit and forget' component. Alternatively, the system can take in an analogue signal from an inspection machine or line control PLC to automatically adjust its speed, and there is a manual override speed ▶



Dual Synchronised Star Wheel.



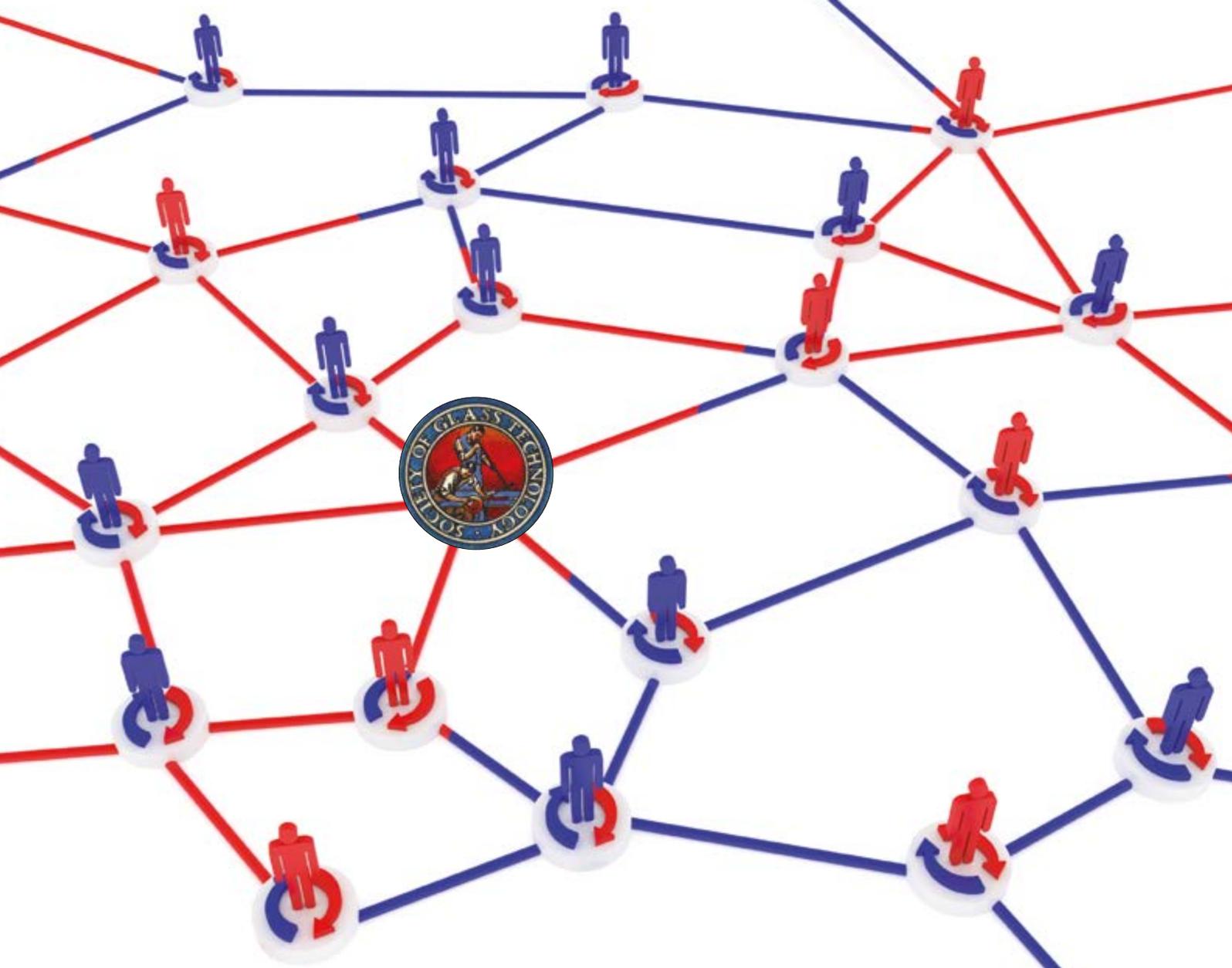
Reject Station - Kicker type.



Servo Orientator.



The new Pro-Sight Multi-Finger Reject.



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control on the panel. This system uses the 7–14 finger configurable Pro-Sight Star Wheels, making it compatible with a wide range of ware diameters. Each Star Wheel is controlled by an independent motor resulting in no wear parts, as opposed to some belt-driven alternatives.

Due to the innovative, reversible design of the Pro-Sight Star Wheel Discs, changing the handing of all Pro-Sight Star Wheels from left-hand to right-hand (or vice-versa) is a sub 30 second task, with no change parts required and no need to remove any fingers from the wheel.

Pro-Sight also offers optional line control sensors to be mounted before and after the separator, or existing sensors can be connected into the system. Likewise, the Star Wheels can be provided without a control panel, for direct control from existing hardware.

Multi-Finger Reject

A new development from Pro-Sight; the Multi-Finger Reject employs up to 12 individually actuated fingers that operate in a cascading action to reject or divert containers from the line. This innovative method is perfectly suited for either high-speed lines where containers are moving quickly with very little space between them or when a bottle needs to be removed whilst remaining upright, for instances such as diverting into automatic sampling inspection machines. These requirements for high-speed and/or maintaining bottle stability during rejection would make rejecting

a single bottle difficult with a traditional blow-off or kicker type device, but the Pro-Sight Multi-Finger Reject is able to pick out single bottles at high speed without disrupting the leading or trailing bottles, and whilst maintain excellent bottle stability.

Bottles are moved laterally across the conveyor in a single smooth action with each finger moving the bottle further off the line. This removes the container in a long, smooth motion rather than the traditional ‘rapid impact’ method and as such provides much higher stability. This smooth action vastly reduces the risk of containers falling when being removed from the line. The fingers are actuated by a series of small bore pneumatic cylinders which operate over a pivot point, resulting in only a very short stroke and therefore extremely low air consumption. Individual fingers can be enabled or disabled to suit different ware sizes and conveyor widths. As a floor-standing unit, the Multi-Finger Reject can easily be installed on any production line with minimal adjustments to guide rails.

The Pro-Sight-supplied PLC Control Panel manages the offset timing for the actuation of the first finger and the subsequent fingers from just the usual single reject pulse from the inspection machine or mould number reader (also available from Pro-Sight). A supplied line encoder enables the system to automatically adjust its timing to accommodate changes in the conveyor speed.

Optional Reject Conveyor

An optional partner for the Multi-Finger Reject is the Pro-Sight Reject Conveyor. This conveyor can be used to collect rejected bottles and either divert them into a sampling inspection machine (such as the Pro-Sight Online Pressure Tester or Online Automatic Dimensional Gauging Machine) or hold them for an operator to manually inspect. The stainless-steel conveyor comes in varying lengths to suit customer requirements, and has a specially designed cross-over point to maximise bottle stability.

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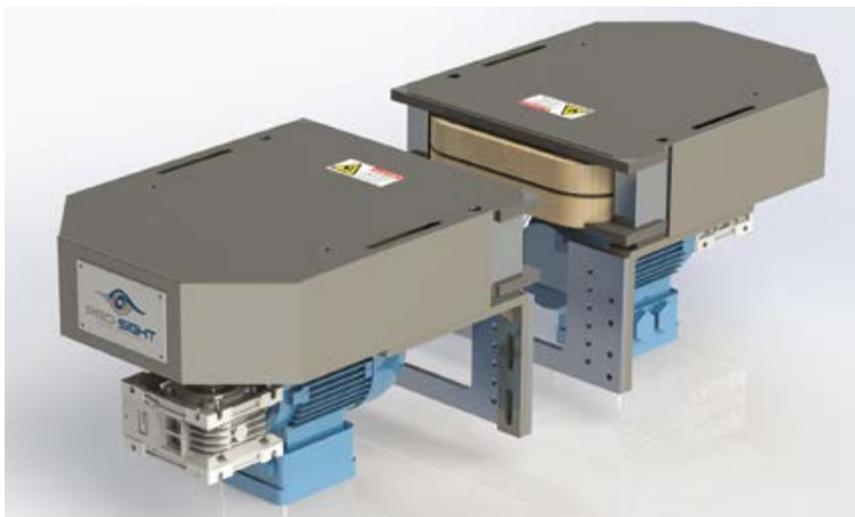
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Quad Belt Separator.

Build-back control is included with the system to detect when the Reject Conveyor has reached its maximum capacity. If the sensors detect build-back, a pneumatic gate will open at the end of the conveyor to allow bottles to proceed from the conveyor into a collector.

Additional ware handling devices

Standard Star Wheel Separator:-

- A simple and cost-effective way to space containers
- Left-hand and right-hand configurable without removing the fingers
- Multi-finger configurations

Servo 360 Orientator:-

- An on-line machine to orientate containers prior to inspection or palletising
- High speed with high accuracy
- Can accommodate small or large, heavy bottles

Dual and Quad Belt Separators:-

- Pliable gripper belts to space or bunch containers.
- Available in dual or quad belts for straight sided and tapered bottles

Scroll Separator:-

- A compact-design suitable for positively indexing containers
- Left-hand or right-hand configurable

Reject Devices:-

- Blow-off type
- Kicker type
- Multi-Finger Reject (6, 8 and 12-Finger Configurations)

Pro-Sight's full range of equipment will be shown at glasstec this September. ●

About the author:

Pete Cooper is an Engineer at Pro-Sight

Further information:

Pro-Sight Vision, Hoyland, UK
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The evolution of ware handling

Francesco Baldin outlines how Revimac upgraded its Ensemble ware handling system to handle increased speed of production, whilst maintaining the highest reliability and stability of container transfer, conveying and stacking.

In 2021 manufacturer of hollow glass forming machinery and allied ancillary equipment Revimac introduced its 'Ensemble' high performance ware handling line (see *Glass Worldwide* July/August 2021 p.108).

The company has now developed the Ensemble Evo, the evolution of Ensemble system, designed to handle an increased speed of production whilst maintaining the highest reliability and stability of containers. The Ensemble Evo is comprised of the XHS900 ware transfer, the RC900 cross conveyor and the RSS100 lehr loader (stacker).

Ware transfer

Revimac's XHS900 High Performance Ware Transfer is an integrated transfer system capable of transferring articles from primary conveyor to cross conveyor at a very high production speed, variable according to container dimensions.

The new design is based on a triple belt conveyor drive with a short auxiliary belt that keeps containers in firm and steady contact with fingers during transfer. This is possible due to the new engineering of the XHS900's main elements: the auxiliary belt system, the wheel adjustments, the transfer plate and the adjustable conveyor head,

which ensures the correct transfer of the articles.

Another improvement has been made in the adjustments by means of a hinged tilting head mounted on cross conveyor, so that its height can be set equal to the annealing lehr, independently of transfer height.

Finally, new safety standards, quality of regulations and greater ease of use maintenance make the integrated transfer system reliable for high performance lines.

Cross conveyor

The RC900 cross conveyor has been developed to be installed without a cooling system for increased flexibility, permitting it be adapted to any layout without additional installation devices.

Thermal distortion due to the annealing lehr heat radiation is mechanically compensated for. The cross conveyor's structure – depending on the length – is made of modular, individually supported beams which can be adjusted independently in planarity and height. All adjustments are made with plumbing screws positioned on the upper beam supports on the cross-conveyor cold side. The adapting plates can also be adjusted on all axes in order to fix a perfect planarity with the lehr belt.

The design of the floor supports positioned on the structure offers easy height adjustment.

The RC900's modularity means that spare parts stock can be reduced to a bare minimum, and the conveyor is designed for ample access for easy maintenance, reducing downtimes and costs.

Lehr loader

The Ensemble Evo system's three-axis RSS100 servo lehr loader (stacker), is reportedly becoming a real staple for production handling operations.

Beside its proven strong mechanical structure – which, without any wearing parts, gives the RSS100 an exceptionally long life, new software based on artificial intelligence has been developed in for increased ease of operation and to minimise the operator's intervention in each phase, especially at start-up and during job change.

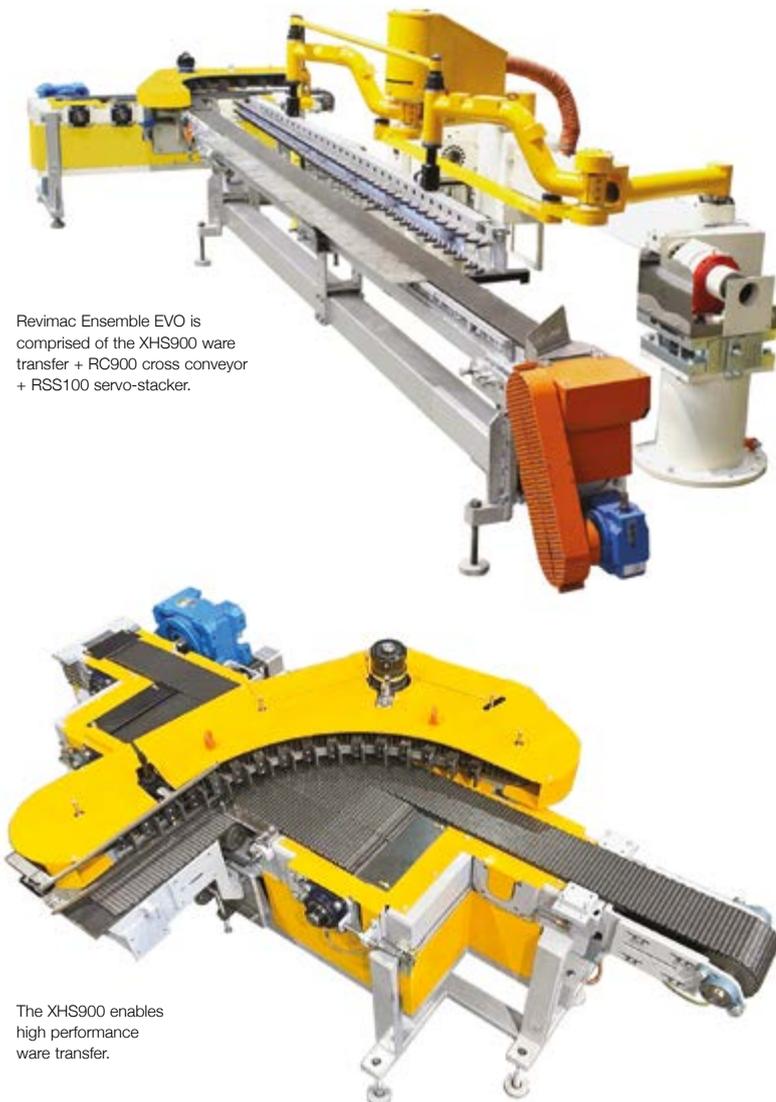
With its self-learning algorithm, this new software release enables the stacker to automatically manage the loading profile with few inputs and to phase the loading curve by detecting the speed of IS machine. In each stacker cycle, the RSS100 software acquires all the necessary parameters to adjust itself for a perfect and stable push of the containers on the lehr belt, even when there is a speed variation and without the operator's intervention. ●

About the author:

Francesco Baldin is Key Account Manager at Revimac

Further information:

Revimac S.r.l., Vicenza, Italy
tel: +39 0444 493494
email: revimac@revimac.com
web: www.revimac.com



Revimac Ensemble EVO is comprised of the XHS900 ware transfer + RC900 cross conveyor + RSS100 servo-stacker.

The XHS900 enables high performance ware transfer.

Improved conveyor chains for high speed handling

Industrial equipment manufacturer Pennine offers a range of handling solutions to meet glass manufacturers' requirements. Will Law explores the capabilities of the company's latest conveyor chains.



Figure 1: Pennine's Swiftlink Chains are easily connected to enable a continuous running surface.



Figure 2: The laser-welded ends of the 2-Pin chain mean no pinheads can protrude.

Over the last 20 years, Pennine Industrial has been at the forefront of both the design and the development that has helped to improve conveyor chains used in the handling of hot glass containers.

Pennine claims to be the only company that can currently offer both laser-welded two-pin chains and a complete range of head protection products to suit the different types of single pin conveyor chains. One example is the development of its Swiftlink chains (US patent 10358293 & EU Patent 334897) to help provide customers with an easy and quick chain-joining experience, optimised by a continuous side running surface to help with the transfer of small containers.

By using a connecting pin with a single-threaded end, the chain can be quickly taken apart and reconnected using the locking nut and driver that are supplied with all Swiftlink chains. This connecting system is available on all styles, guides and assembly types using Swiftlink or the original range of thick head protectors; DTHPL/DTCHPL/DTSHPL.

High speed handling

For higher speed applications on glass container lines moving in excess of 60m/min, Pennine has developed its laser-welded Calibre 2-Pin chain. The longer of the two pins is laser-welded to the end links to ensure no pin-head can protrude from the chain – meaning pin-head wear is no longer an issue.

During operation the internal pins roll against each other to create a bearing effect; this action considerably reduces the wear on the surface of the pin, and in turn, reduces overall chain elongation and provides an extended chain life when compared with the single pin chains, especially on higher speed production lines over 400 bottles per minute.

Thick-bottom glass products

The high-speed production of large, high quality, thick-bottomed glass articles such as sparkling wine and premium liquor bottles can create challenges for today's glass bottle manufacturers. To overcome some of these problems, Pennine now produces a range of Premium Calibre 2-Pin chain in Stainless-Steel.

Benefits provided by the Stainless-Steel material:

1. Lower thermal conductivity – which results in the heat being drawn from the glass container at a slower rate, helping to prevent bottom checking.
2. Lower diffusivity – which means the chain holds more heat, therefore the difference in temperature between the metallic and ceramic surfaces is reduced, helping to prevent checking on glass containers.

These two important properties coupled together mean that the chain gets hotter, stays hotter longer, and draws less heat from the glass, meaning the bottom of the glass cools slower

and the chance of thermal checking is reduced.

Over the last two years international travel has been difficult but now it is becoming easier and glass container plants are starting to allow visitors. Pennine's team of sales engineers backed by its network of global agents and partners are once again starting to travel and support customers with their technical challenges. ●

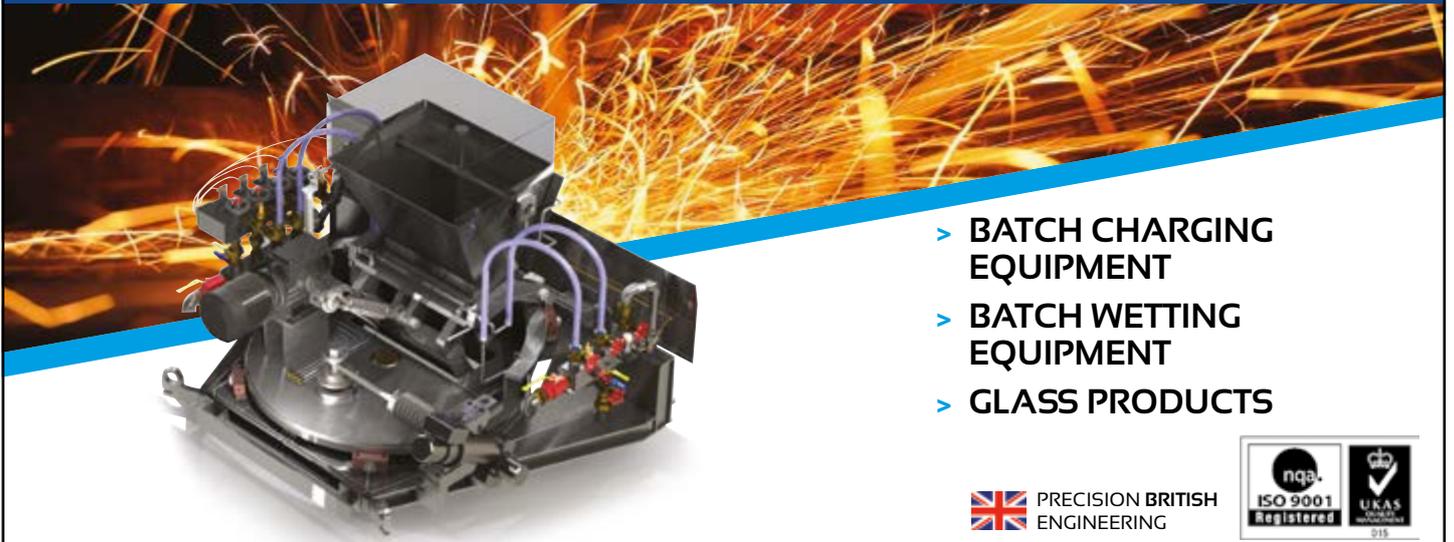


Figure 3: Diagram showing the internal bearing created by the Calibre 2-Pin chain.

About the author:
Will Law is a Technical Sales Engineer at Pennine

Further information:
Pennine Industrial Equipment Ltd., Huddersfield, UK
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Safe and ergonomic stacking

Mark Ziegler introduces Sklostroj's new stacker, designed for high speed handling and ease of use, particularly for glassware production lines requiring many job changes.

Accurate ware handling plays an important role in reaching high pack-to-melt rates. In response to this, Sklostroj's ZO230 stacker combines precision at high speeds with a unique safety feature for frequent job changes. According to the engineering company, which specialises in the production of equipment and machinery for hot end container glass lines, customer feedback for the newly designed stacker is "very positive" and a "major European glass company" has recently standardised its ware handling by using the solution from Sklostroj.

"The reason for this was an ideal combination of technical performance with a competitive product price," explains Lenka Drahonovska, Sales Manager at Sklostroj. "The Siemens-based control system with standard components makes it easy to integrate the stacker into the existing control infrastructure." In addition, "no connection the central lubrication or the water cooling-cycle is necessary."

Ease of operation

Ergonomic design and safety are key machinery requirements nowadays. The upper part of the ZO230 stacker, called the 'shift box' is movable and can be changed into a service position just by pressing a button on the control panel. This makes it easy to exchange or adjust the pushbar, or to access the annealing Lehr. Rails on the floor are not necessary; the lower part is permanently mounted on the floor. Operators are said to be enthusiastic about the ergonomics of the stacker, particularly for lines with many job changes.

From the software side, the control panel has been designed to be easy to understand. Set-up only requires the product body diameter, height, number of products on the pushbar, pitch among products and number of gobbs per cut to be entered (in case of stand-alone installation).

To protect the stacker's

mechanisms from being damaged, a unique safety crank has been implemented. "This system triggers when the pushbar encounters a strong resistance," says Jan Koren, Head of R&D.

The stacker is suitable for a wide article portfolio. An additional fourth servo-axis for a counter-holder is available as option for tall and unstable glassware.

Remote service and diagnostics is guaranteed by VPN.

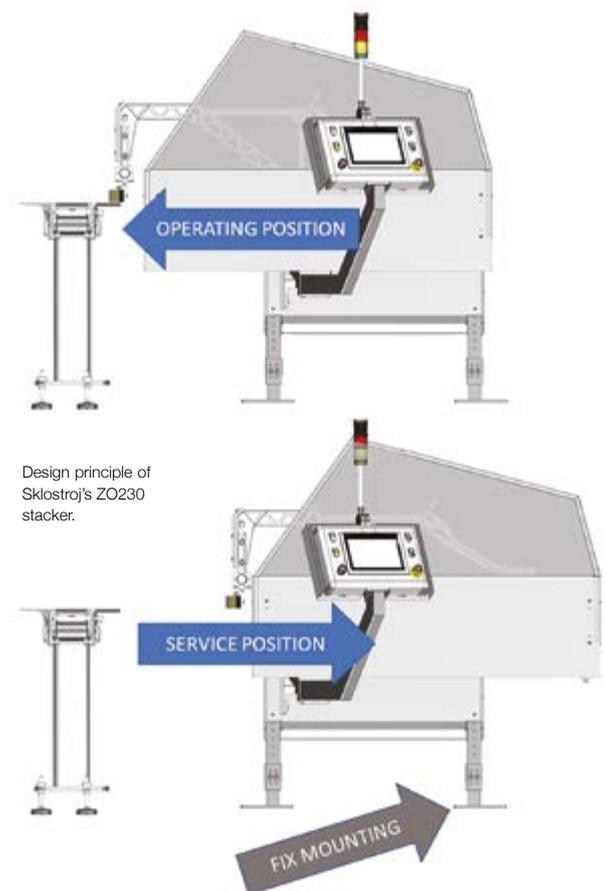
According to operators, the ZO230 stacker is "mechanically robust" and achieves a high level of accuracy and repeatability. ●

About the author:

Mark Ziegler is Global Business Development and Marketing Manager at Sklostroj

Further information:

Sklostroj Turnov CZ, s.r.o.,
Přepeře, Czech Republic
tel: +420 481 350 200
email: LDrahonovska@sklostroj.cz
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Design principle of Sklostroj's ZO230 stacker.



The ZO230 stacker is suitable for a wide portfolio of glass articles.

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A tailored solution for glass transfer

Renato Trotta shares Famor Engineering's approach to automated step-by-step glass handling, from the annealing lehr through to stacking.

Based in Italy, Famor Engineering has been supplying machinery for the glass industry since 1977. The company's design and engineering portfolio includes mechanical design and fabrication drawings of supplied components and standard products as well as spare part replacements for most competitors' machinery.

Handling robots & conveyors

In smaller glass factories production is often transferred manually to the annealing lehr, as fully automatic production is not possible in many cases due to the small batch sizes. This problem can now be solved with a system that is based on a conventional robot.

Using a mechanical gripper, the robot picks up the articles arriving on a conveyor belt, then lifts them from the conveyor belt, and in the corresponding position transfers them to another machine or on the belt of annealing lehr. The running conveyor belt ensures that usual traffic in the glassworks is not disturbed. Glass is quickly and efficiently transferred from the glassmaker's workplace to the lehr, thereby reducing the risk of cracks. The overall system is controlled from an electronic master control unit, offering ease of operation for the machine operator. This control unit also provides the corresponding commands for the robot's control unit. The robot itself is protected against the heat radiating from the lehr occurring when the articles are transferred.

Take-out unit

The take-out device is used within the automatic process system two or three times.

The first device is usually for

unloading the forming machines, the second is for loading the rim flame polishing machine or burn-off machine, and the third is for taking the article from the article holders and placing it on the transport conveyor.

The first take-out is placed between the press and the fire polishing machine. A similar device is located between the fire polishing machine and the conveyor for the transport system, or in case of blow tableware production, it is located between the burn-off and the conveyor.

Operating principle

The take-out mechanism system is carried out with a high-speed take-out unit. This unit consists of two separate mechanics for vertical and horizontal movement, also installed in some cases on a central rotary axis, without horizontal movement.

The take-out arms are shifted by 180° with reference to the central axis, so that one take-out is located above the position for unloading and the second is above the position for dropping off. The up/down movement of the two arms is controlled by a servo axis and can be individually adjusted. In combination with the separate adjustable turn movement, two superimposing movements are used for the take-out cycle. After picking up the article at the press (or fire polishing) machine, the turning movement over 180° is started (carried out via ON-OFF control) so that it is in position to reach the 'unload' position.

Conveyors

It goes without saying that 'hard-earned' experience in the field is an asset when developing new solutions and building up the knowledge to be able to match



Transport line.

the best solutions with customers' needs, such as:

- Type and mix of glass articles to be handled
- Line speed
- Available space
- Previous specific experiences of glass work
- Future requirements

A durable, flat and exceptionally smooth conveying surface is necessary for rapid, synchronised transport of fragile products. Lack of lubrication and drastic temperature changes from the hot-end can compromise production performance. In addition, specific options may need to be installed to reach quality requirements, for example: muffle, burners, transfer plates in special materials to ensure that there are no cracks in glass items.

Stackers

Stackers and more generally the lines' formation phases are perhaps the most important annealing operations. This is the first area where glass articles of whichever shape must be prepared in a decisive and precise way to achieve the 'infinite' loading annealing lehr that glass factories are expected to create. It is for this reason that Famor proposes a wide and advanced range of options in terms of speed, number of feeding lanes, equipment dedicated to special shaped glass articles.

The ultimate goal is to have the best solution tailored to the specific needs of each client, hence Famor offers pusher stackers for low, medium and high speeds.

The units can operate in the various basic modes:

- sweep-off
- step-by-step sweep-off
- step-by-step pick-and-place with row approach
- step-by-step pick-and-place with row approach and article spacing

All devices necessary for handling any type of glass article in a step-by-step operation are covered. ●



Conveyor with muffle.

About the author:

Renato Trotta is Sales Director at Famor Engineering

Further information:

Famor Engineering Srl., Rivalta di Torino, Italy
tel: +39 348 3650 872
email: r.trotta@famoren.com
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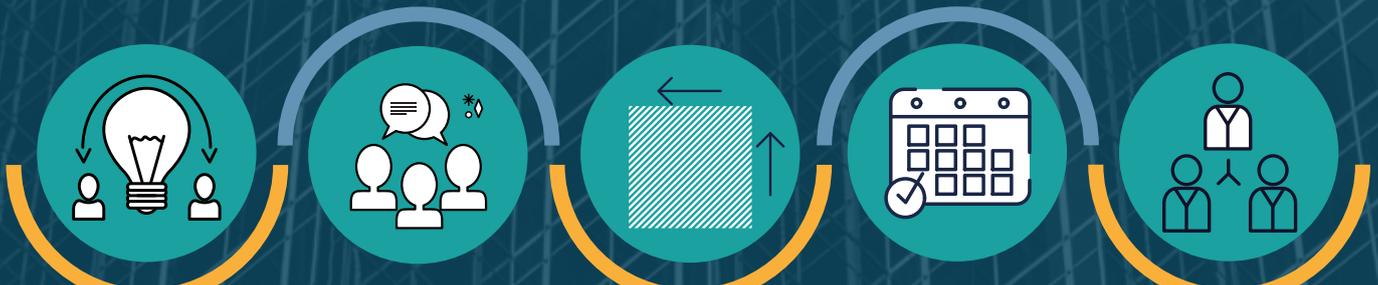
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Dr. Thomas Jüngling, Managing Director of the DGG.

A meeting place for scientists, technologists, engineers, artists, as well as glass industry members and suppliers, ICG 2022 is hosted by the Deutsche Glastechnische Gesellschaft e.V. (German Society of Glass Technology; DGG), which is holding its 95th annual meeting from 3–8 July in Berlin.

The 2022 congress' call for paper was successful, with more than 600 abstract submissions from over 30 countries, promising a get-together packed with experts from around the world. "The feedback has been very positive; everyone is looking forward to the congress, after the pandemic abstinence," confirmed Dr. Thomas Jüngling, Managing Director of the DGG. "That is why the ICG 2022 will take place only 'in presence', no hybrid option. Our focus is to provide a high-quality congress, offering many networking possibilities."

As the DGG also wants to offer a platform for the next generation of glass scientists, students can purchase tickets at a subsidised price.

Programme

ICG 2022 provides plenary sessions and 45 technical sessions grouped in eight symposia and includes the



More than 900 people from 45 countries attended the previous ICG congress in Boston 2019. (Photo: ACerS)

13th International Congress on Advances in Fusion and Processing of Glass (AFPG2022). This year's congress chair, Professor Dr. Joachim Deubener, Clausthal University of Technology and programme chair, Professor Dr. Lothar Wondraczek, University of Jena, have compiled 485 lecture and 120 poster contributions for the ICG 2022.

The lectures will be delivered throughout the congress:

- Symposium I: Chemistry and the Structure of Glasses
- Symposium II: Glass Physics, Properties and Characterisation
- Symposium III: Computational Glass Science
- Symposium IV: Sustainable Glass Production
- Symposium V: Glass Forming, Post-Processing and Quality Control
- Symposium VI: Recycling and Raw Materials
- Symposium VII: Emerging Glass Applications and Application-related Challenges
- Symposium VIII: Culture, Heritage and Education

A preliminary programme and schedule are available on the congress website. The conference language is English.

In addition to the lectures and poster hall, an exhibition of suppliers from the glass industry will be staged.

A variety of social events have been arranged for attendees, including: an opening ceremony when awards from Otto Schott Research, the ICG and DGG will be

presented; a welcome reception celebrating SORG's 150th anniversary; excursions; and a banquet to mark the DGG's 100th anniversary.

ICG 2022 and the DGG annual meeting will be held at the Marriott Hotel Berlin Central District from 3–8 July 2022. ●

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ICG 2022 is being staged in Germany to commemorate the 100th anniversary of the Deutsche Glastechnische Gesellschaft (DGG).

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Forthcoming events



MAY 2022

11–12 May: Glassman Latin America (Monterrey, Mexico)

JUNE 2022

6–9 June: Mir Stekla 2022 (Moscow, Russia)

8–9 June: Furnace Solutions Conference (St Helens, UK)

29 June – 2 July: Glass South America (Sao Paulo, Brazil)

JULY 2022

3–8 July: ICG 2022 – 26th International Congress on Glass / DGG Conference (Berlin, Germany)

10–15 July: 16th International Conference on the Physics of Non-Crystalline Solids (Canterbury, UK)

SEPTEMBER 2022

20–23 September: glasstec 2022 (Düsseldorf, Germany)

OCTOBER 2022

18–20 October: GlassBuild America 2022 (Las Vegas, USA)

19–21 October: XXIV ATIV Conference (Parma, Italy)

26–28 October: Glasstech Asia 2022 (Marina Bay Sands, Singapore)

31 October – 3 November: 83rd Conference on Glass Problems (Columbus, Ohio, USA)

DECEMBER 2022

8–9 December: International Year of Glass official closing ceremony (Tokyo, Japan)

FEBRUARY 2023

17–18 February: Glassman Asia (Seoul, South Korea)

APRIL 2023

25–26 April: GlassPrint 2023 (Düsseldorf, Germany)

MAY 2023

4–10 May 2023: interpack 2023 (Düsseldorf, Germany)

JUNE 2023

21–22 June: 16th International Seminar on Furnace Design – Operation and Process Simulation (Velke Karlovice, Czech Republic)

SEPTEMBER 2023

5–8 September: Vitrum 2023 (Milan, Italy)

14–16 September: glasspex INDIA (Mumbai, India)

OCTOBER 2023

31 October – 2 November: GlassBuild America 2023 (Atlanta, USA)

For up-to-date listings of exhibitions, conferences, webinars and seminars around the glassmaking world, visit www.glassworldwide.co.uk

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Glass industry gathers at House of Lords

In recognition of the United Nations' International Year of Glass 2022, The Worshipful Company of Glass Sellers of London staged an industry gathering together with Glass Futures and British Glass at the House of Lords in London in March. Official journal of Glass Sellers and preferred journal of Glass Futures, *Glass Worldwide* was in attendance.

The event was well-attended by members of the international glass manufacturing community who enjoyed a champagne reception and lunch, courtesy of the Lord Prior of Brampton, David Prior, in support of the Glass Sellers' Charity Fund.

Past Master of Glass Sellers Richard Katz, Glass Futures CEO, and fellow liveryman Dave Dalton, British Glass CEO and Glass Futures board member, provided updates on Glass Futures' significant strides in connecting the glass industry and academia to create the Global Centre of Excellence in glass in St Helens, comprising R&D, innovation, training and up-skilling. For a report on the centre's breaking-ground event in January, see the March/April issue of *Glass Worldwide*.

Advocating introducing glass to early education, Past Master Leigh Baildham, Glass Sellers' Chairman of Charity Fund Trustees, described how the Company's Glass in Society project provides grants to primary schools to encourage interest in STEM subjects, with participation from more than 15,000 children to date.

Other speakers included Lee Rowley MP and Parliamentary Under Secretary of State in BEIS and Minister for Industry, and the Lord Karan Bilimoria CBE, DL, FCA, President of

the Confederation of British Industry (CBI) and Chairman of Cobra Beer.

The House of Lords reception was preceded, the previous evening, by a grand Glass Sellers Court & Livery Dinner at the historic Cutlers' Hall in London. With a glass manufacturing association of over 57 years, Stuart Hakes became the latest industry personality to join the company as a Freeman and was welcomed by Barbara Beadman, Master, and a wide spectrum of glass dignitaries in attendance. A renowned expert in electric boosting and melting technology, Mr Hakes has managed glass production sites in the UK, New Zealand and Papua New Guinea as well as running mould manufacturing subsidiaries in Australia and China. Since 1999, he has been Chief Executive at FIC (UK) Ltd and is the current President of the Society of Glass Technology. ●

Further information:
Worshipful Company of Glass Sellers of London
web: www.glass-sellers.co.uk

Glass Futures
web: www.glass-futures.org

British Glass Manufacturers' Confederation
web: www.britglass.org.uk



Stuart Hakes became a Freeman of the Worshipful Company of Glass Sellers of London at the Cutlers Hall on 22 March. L-R: Frazer Campbell (*Glass Worldwide*), Stuart Hakes (FIC / SGT), Barbara Beadman (Master), Brian McMillan (Glass Futures Chairman) and Professor Alicia Durán (Chair of IYOG2022).



Glass Worldwide's Frazer Campbell with Ernesto Cattaneo of Stara Glass, designer of the Glass Futures' 30tpd experimental R&D furnace.



Aston Fuller, General Manager of Glass Futures (left) with Tony Allen, Director of BEIS.



L-R: Kieran Leonard (Encirc), Lord David Prior (Lord Prior of Brampton), Dave Dalton (British Glass), Sheldon Davis (Guardian Glass), Richard Katz (Glass Futures) and Adrian Curry (Encirc).



L-R: Allen Norris (British Glass), Matthew Demmon (British Glass / MKD32), Paul McLavin (O-I) and Andrew Pea (Special Shapes Refractory Co).

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Leave no bottle behind

President of the Glass Packaging Institute Scott DeFife provides an update on the GPI's efforts to increase glass recycling and recycled content rates for domestic glass containers in America.



Scott DeFife, GPI President.

A year ago, the Glass Packaging Institute (GPI) and its manufacturing member companies issued a Roadmap to boost glass recycling rates for North American-made glass to 50% and higher over the course of a decade. Much progress has been made since the release of this strategy, and while work remains, there are signs of progress that the tide is changing.

In that Roadmap, GPI examined existing glass recycling infrastructure with an eye towards increasing glass recycling and recycled content rates for domestic glass containers, which have



In 2021, GPI issued a Roadmap to boost glass recycling rates for North American made glass.

averaged in the low 30th percentile for the past decade. Recycled glass cullet is a key input to produce new bottles and jars, and increasing its use has many environmental and sustainability benefits.

In addition, consumer packaged goods companies are focused on more sustainable packaging options

and asking all material groups to increase their recycled content levels. GPI manufacturing companies prioritised this issue and identified a set of solutions to address gaps in the domestic glass recovery system to lead to higher recovery rates and boost recycled content averages to 50% by the end of the next decade. The plan focuses on seven key levers for meeting industry goals, tailored to the needs of a particular region.

Capturing more glass

Recycling and waste management policy, a key lever, was very active in 2021 and Q1 2022. Recycled content availability was impacted in 2021 due to Covid pandemic precautions. The strongest sources of quality recycled glass in the US come from beverage container deposit states, where many of the return and redemption options for consumers were shuttered in response to the pandemic.

The market is still recovering from that setback, but the infrastructure is in place to allow those states to rebound. In fact, there was movement in several of the US container deposit states in 2021 to expand their redemption programmes, and Connecticut enacted expansion, which is one of the key drivers of fundamental change. Additionally, Oregon and Maine passed Extended Producer Responsibility (EPR) laws designed to reform and expand their recycling and waste diversion systems. This legislation will further increase the volumes of glass available to recycling into new containers. As several additional states consider container deposit expansion and EPR on the West Coast, Mid-Atlantic and New England, these regions are poised to increase their already strong positions.

But the 10-year strategy did not rely on major policy



Recycled content availability was impacted in 2021 due to Covid pandemic precautions.

changes alone, and in regions that are slower or reluctant to adopt container deposit system or EPR regulations, the strategy is to leverage incremental tons from the other levers. Leaving no bottle behind focuses on collection and diversion from landfill. In recent years, concerted efforts by some in the waste management industry to restrict glass recycling access and to move that material to the waste stream and landfill have complicated industry efforts to increase the use of recycled cullet.

Capturing more glass means increasing access, improving the quality of collection streams, expanding commercial (on-premises) recycling, and implementing new regulatory initiatives to keep glass out of landfills.

Commercial collection

GPI and its members took steps to bring these suggestions to life in 2021, seeding pilot bar and restaurant glass collection programmes in the Chicago, Illinois area, as well as in Arizona. The Chicago area pilot programme generated a fair amount of enthusiasm and has been brought back this

spring, with the goal of making it permanent and expanding the number of establishments served. This commercial account collection model is highly replicable for cities wishing to implement similar programmes, and there was increased interest in the model throughout the Great Lakes states.

GPI also promoted other transformative collection systems, which captured best practices from communities that either maintained or reverted to dual-stream kerbside glass recycling, along with those that expanded community collection programmes.

Expanding and improving secondary glass processing was another significant area of concentration, with new processing capacity coming online and initial investments in new facilities being made.

Glass cleaning

Another focus area is private sector and government grants for material recovery facility (MRF) glass cleaning equipment investments to improve existing streams that enhance the economics

of kerbside single-stream glass and create additional yields. High level talks took place in several states with glass manufacturing facilities aimed at incentivising new glass cleaning facilities and looking to expand processing facilities.

GPI led educational and awareness building seminars on the basics of sorting and processing glass in the existing recycling system and worked on partnerships needed with state and local governments, supply chain partners, consumers and others. The association engaged with stakeholders in a dozen states to get those partnerships rolling in 2021.

Given the increased attention on circular economies and environmental sustainability and food and beverage brand goals to increase recyclability and recycled content, GPI worked closely on policy areas critical to maintaining glass' high standing among consumer and policymakers. The association will continue its efforts to expand workplans to implement these initiatives, in co-ordination with allies in the North American glass supply chain.

If you have any questions about our projects or how your company can engage, please reach out to GPI ●

About the author:

Scott DeFife is President of the GPI.

Further information:

Glass Packaging Institute
Arlington, Virginia, USA
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Let's get the Fit for 55 package right

Europe is now at a critical junction in shaping its energy transition, only accelerated due to the tragic events unfolding in Ukraine. Glass For Europe calls on the EU flat glass industry to face today's energy crisis to support the transition towards climate neutrality.



Thirty years since the adoption of the first global agreement on tackling climate change, Europe's transition to a

sustainable, a low-carbon, circular economy is now a reality.

A reality that, we, the EU flat glass industry, believe in. Sustainability policies are central to both our sector and our investors.

Our industry is proudly on track when it comes to sustainability. Our R&D efforts mean we're already providing the endlessly recyclable materials essential to renovate buildings, support the green mobility transition, and help increase Europe's share of renewable solar energy.

At the same time, there's no hiding from the fact that glass production is an energy-intensive process with resulting CO₂ emissions. That's why we've worked tirelessly to reduce our CO₂ emissions by an impressive 43% per tonne of flat glass since 1990.

Despite facing higher regulatory and energy costs than our global competitors, the EU flat glass industry has been fighting hard to maintain its competitive edge.

Europe's flat glass industry is leading in the sustainability race today. But what about tomorrow?

EU demand for flat glass will increase exponentially as Europe retrofits its buildings over the coming decades and progressively invests in solar energy.

Glass is "the hidden gem in a carbon-neutral future" according to the leading scientific journal, *Nature*. Not to mention that the United Nations has designated 2022 as the International Year of Glass. Clearly, the EU flat glass sector has a key role to play tomorrow too. Yet our industry's ability to deliver this future value hinges on the EU's current decisions on key legislation to help mitigate the impact of soaring energy costs and energy insecurity, boost carbon-avoiding products, and drive investments in low-carbon manufacturing.

Our industry has laid out a clear, ambitious vision for 2050. We aim to slash further CO₂ emissions from our manufacturing, as well as develop and roll out our novel manufacturing techniques. And we'll achieve this while delivering the several billion euros of industrial investments needed to meet Europe's significantly higher future need of building glass with flat glass 'made in Europe'.

What support is needed?

In the very short term, authorities must guarantee the uninterrupted supply of energy to our industry, whose continuous production process cannot be stopped without serious and lasting damage to industrial assets.

Energy costs also need to be contained, via urgently revising State-aid guidelines on the EU Emission Trading System (ETS) to compensate the flat glass sector's indirect costs.

In short, we must do what it takes to keep Europe's industry afloat, but we equally need to stay focused on the EU's long-term objectives.

As a crucial part of our sector's 2050 vision, we've developed a rapidly actionable, virtuous decarbonisation cycle. This cycle starts by mainstreaming the carbon-avoiding products that we already have available. Market forces alone don't ensure their uptake at a scale in line with EU climate objectives, especially in terms of building renovation.

We urge the European Parliament and Council to ensure that the Energy Efficiency Directive (EED) and Energy Performance of Building Directive (EPBD) help shape markets as powerful tools in delivering on climate neutrality, by:

- Supporting the European Commission's proposal in the EED for a revised upward energy efficiency target for 2030. Energy efficiency is indispensable for Europe to protect itself from high energy prices, energy dependence and the geopolitical insecurity we sadly witness these days.
 - Ensuring the EPBD triggers the currently lacking energy-efficient renovation of buildings. Slashing buildings' energy consumption is the primary instrument to ensure cost-effective and long-lasting CO₂ emission reductions. For instance, the Directive should set the objective of phasing-out single glazing and inefficient double glazing.
- Our second and third steps in the virtuous decarbonisation cycle deal with industrial competitiveness and attracting industrial investment. Transitioning to a carbon neutral economy can be a 'green growth engine' for enabling sectors like flat glass. But we must get the Fit for 55 package right.

We urge the European Parliament and Council to design adequate competitiveness mitigation tools so hard-to-substitute, transition-enabling products like EU flat glass remain affordable to consumers and industrial investment is unlocked by:

- Ensuring that new sectors like flat glass manufacturing are not hastily introduced into the Carbon Border Adjustment Mechanism. Because of its complex value-chain, possible impacts need to be carefully assessed prior to any inclusion to avoid loopholes, risks of circumvention and the destabilisation of the entire eco-system.
- Recognising the EU Emission Trading System provisions

are the flat glass industry's only and indispensable line of defence against the risk of carbon leakage. Free allocation should remain based on realistic CO₂ benchmarks without conditionality or penalty disconnected from technical or economic realities, be it audit, transformation plans or a Cross Sectoral Correction Factor. We all aim at attracting investment in low carbon manufacturing in Europe. We must avoid collateral damage on sustainability leaders like the EU flat glass sector.

- Reintroducing the exemption for mineralogical processes industries in the Energy Taxation Directive. This will help both mitigate the impacts of soaring energy costs on our industry, and ensure EU-made flat glass products remain affordable to final consumers.

We've all come a long way since that first landmark global agreement to tackle climate change back in 1992. We're working towards deep reductions in energy demand for key sectors such as building and transport, with our remaining energy consumed becoming progressively carbon neutral.

The EU flat glass industry is a key enabler in this radical transformation, a sustainability leader that continues to actively tackle its own industrial challenge.

We urge European policymakers to help us trigger the EU flat glass Industry's virtuous cycle of decarbonisation – we're ready to play our part. With the right framework, just as we have done for the last 30 years, we are convinced that our industry will deliver. ●

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