glass WORLDWIDE

March/
April 2020

Exclusive interviews: AGI, Borosil, Shandong Jingyao Glass & Sisecam + market reports & technology. Latest news & issue highlights at glassworldwide.co.uk

Welcome

Welcome to the latest issue of *Glass Worldwide*, featuring an extensive selection of specially written articles, geared to the interests of flat, hollow and specialty glass producers and processors around the globe. Among this issue's 'exclusives' is an extensive interview with Sisecam Group Vice Chairman and CEO, Professor Dr Ahmet Kirman, who speaks about the group's current financial performance, its latest investment initiatives across a diversified range of glass types produced in 14 different countries and the organisation's expectations for the future. Supporting this interview are separate analyses of Sisecam's flat and container glass activities in Turkey, highlighting in particular its activities in Yenisehir, close to Bursa. Sisecam is focused on a sustainable value creation growth strategy, with organic and inorganic growth supported by investments in new capacities, value creating acquisitions, maximum capacity utilisation and the development of value added products.

Readers will also discover an exclusive interview with Tang Yong, the entrepreneurial Chairman of Shandong Jingyao Glass Group Co Ltd. One of China's leading beer bottle producers, Shandong Jingyao Glass has invested strongly in the high speed production of lightweight bottles, purchasing some of the industry's most advanced manufacturing technologies to keep pace with fast-growing demand and the growing need for optimal quality levels. Now, the management team is looking to reinforce its position as China's market leader for NNPB production technology. This article introduces *Glass Worldwide*'s annual Focus China feature, which also includes an assessment of the ongoing trade dispute with the USA and its impact on the local glass industry's performance/prospects. Another specially commissioned report discusses the growth of China's pharmaceutical industry and the opportunities created for an increasingly successful group of local glassmakers.

Separately, the Indian glass industry comes under the microscope. In an exclusive interview, Shreevar Kheruka, Managing Director at family-owned Borosil Ltd, reviews the company's return to profitability in recent times and its latest plans for future success. Separately, Rajesh K Khosla, President and CEO of AGI glaspac, is On the Spot, discussing the next part of an ambitious investment programme that will see the company's glass container production capacity double.

Colin Robinson

Graham Lovell

A series of specially commissioned Technology articles complements an extensive Buyers Guide, devoted to recent advances in process control and inspection, while this year's ESMA glass decoration supplement includes no fewer than 10 contributions from member companies.

I should like to take this opportunity to welcome Colin Robinson as *Glass Worldwide's* Senior Sales and Marketing Manager. Graham Lovell is retiring from his day to day account management role but remains an important member of the team on a part-time basis. Colin, an experienced publisher and longstanding friend of the team, looks forward to making contact with advertisers and readers alike in the coming months.

We hope you enjoy reading your latest issue of *Glass Worldwide*. In addition, readers are invited to visit our website (www.glassworldwide.co.uk) for the latest glass industry news and access to selected feature articles. We look forward to receiving your feedback, together with any recommendations for future editorial coverage.

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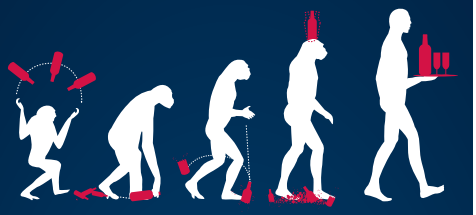
Hot glass handling is evolving



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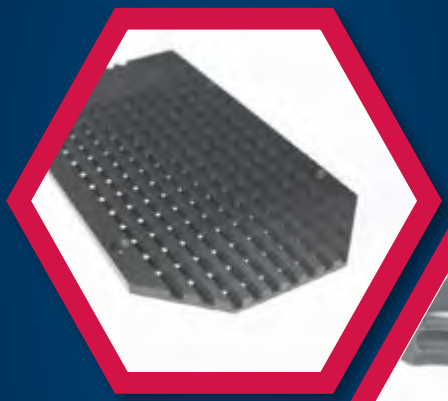

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News For the latest news, visit the Hot Topics section at www.glassworldwide.co.uk

Cradle to cradle certification awarded in Europe

Guardian Glass Europe has attained Bronze level Cradle to Cradle certification for float, coated and laminated glass products manufactured at eight of its European plants. The standard is a globally-recognised methodology used to constantly evaluate the sustainable attributes of products and a tool for the glass industry's response to the circular economy challenge.

The standard evaluates products across five categories of human and environmental health and encourages continuous improvement over time by awarding certification on the basis of ascending levels of achievement and requiring certification renewal every two years.

Each certification level represents increasingly rigorous achievement across five critical performance categories:

- Material health – optimising the chemistry of the materials used in the design of products/ buildings to minimise impact to human health and the environment.
- Material re-utilisation – design to eliminate the concept of 'waste' with intentional constituent cycles to retain the full value of the constituent.
- Renewable energy and carbon management – a future powered by renewable energy, where manufacturers positively impact energy supply, ecosystem balance and keep carbon in soil and vegetation.
- Water stewardship – treat water as a precious resource by encouraging effective management and use strategies.
- Social fairness – responsible business operations and ethics for all stakeholders, including the supply chain and the environment.

"This is a great achievement by Guardian Glass" Guus Boekhoudt, Vice President of Guardian Glass in Europe confirmed. "Over the past 12 months, eight of our European production plants and around 60 employees across more than 15 capabilities have been involved in the C2C certification process. Attaining bronze level certification validates Guardian's ongoing commitment and investment as a global leader in the responsible manufacturing of sustainable glass products."

www.guardian-glass.com ●

AI project to accelerate flat glass development

AGC Glass Europe is collaborating with Citrine Informatics to use artificial intelligence to accelerate the development of next generation glass. Citrine Informatics is a technology platform that harnesses the power of AI to bring materials to market faster and capture materials-enabled product value.

There is currently high global demand for optimising optical and mechanical properties for strong scratch and abrasion-resistant glass in the automotive and communication industries. The purpose of the collaboration is to look for innovative solutions to meet this ever-higher glass performance demand faster.

AGC is providing experimental data to build proprietary AI models using the Citrine platform and is iteratively testing the newly suggested materials. The models are improved by Citrine through this sequential learning process, which targets the identification of the best process conditions to reach high performance glass materials.

"The future of materials development depends on speed" said Marc Van Den Neste, CTO of the Building & Industrial Glass Company from AGC. "Developing these high performance materials faster will require managing and using data more effectively, which includes consolidating data into a single consistent searchable format, as well as structuring, storing and using materials data to harness the power of AI. Artificial intelligence is expected to dramatically change how the scientists design experiments or value data, leading to breakthrough results."

www.agc.com ●

Solar glass float furnace restarted in Vietnam

NSG Group recently restarted a float furnace in Vietnam to produce TCO (transparent conductive oxide) coated glass for solar panels. The previously dormant furnace was upgraded as part of a plan announced in May 2018 to expand production capacity of TCO glass to support the growing solar market.

The furnace is one of two lines at NSG Vietnam Glass Industries Ltd, located near Ho Chi Minh City. TCO glass production at VGI has been positioned to support a long-term supply agreement with First Solar, the world's leading provider of comprehensive photovoltaic solar systems.

www.nsg.com ●

Schott increases sales and plans record investments

In fiscal year 2018/19, Schott AG increased sales by 5.1% to approximately EUR 2.2 billion. The operating result (EBIT), which now stands at EUR 275 million, also improved slightly. Consolidated net profit for the year amounted to EUR 206 million. The group's precision materials, optical industries and home appliances businesses all contributed positively. Business with special glass tubing for pharmaceutical packaging produced particularly dynamic results. Elsewhere, a difficult situation in the automotive industry impacted the electronic packaging division's performance.

Investments in property, plant and equipment amounted to EUR 257 million, an increase of 38% over the previous 12 months. More than half of this amount went to sites in German-speaking countries. Among other projects, the expansion of the Glass-Ceramic Competence Centre in Mainz was completed to meet strong demand for ZERODUR glass-ceramic. The expansion of production capacity of an existing plant in India and the construction of a new plant in China accounted for the largest foreign investments.

This year, Schott plans to invest EUR 320 million, the highest amount in the company's history. An important focus will be on capacity expansions in the pharmaceutical packaging business in China and India. In Germany, the group plans to invest in its pharmaceutical packaging business in Müllheim, among other sites, as well as in its manufacturing capacities for specialty glass in Mainz and Jena.

www.schott.com ●

Schott is one of the world's leading suppliers of pharmaceutical packaging, producing more than 11 billion pharmaceutical packaging units annually. Image: Schott.

Solar glass specialist expands batching capacity

Indian solar glass producer Gujarat Borosil Ltd recently selected EME to engineer a capacity increase for its existing, non-EME batch plant, from 180 to 460 tonnes/day for the batch and cullet supply of two furnaces in Bharuch.

Phase one involved an exchange of the existing dosing equipment and mixer during full operation load of the 180 tonnes/day furnace. Part of the engineering, completed in a second phase, involved the design and installation of a batch transport system for the new 230 tonnes/day furnace.

At the end of 2019, the 180 tonnes furnace was replaced by a 230 tonnes installation, the upgraded batch plant reaching its full operating load of 460 tonnes/day. The parameters of cycle times, batch homogeneity and capacity of the batch plant surpassed calculated performance figures and the customer's expectations.

www.eme.de ●

Production expansion project in Brazil

One of Brazil's leading glass container producers, Vidroporto has confirmed plans to expand manufacturing capacity in Brazil and has contracted the Fives industrial engineering group to undertake an important part of the project. The glassmaker intends to increase production to 370 tons/day at its Indústria Videira do Nordeste (IVN) site in Sergipe, Estância, north east Brazil. The project includes design, equipment and engineering services from Fives to upgrade the furnace's electric boosting capacity, while also incorporating an additional high speed production line.

Fives will supply transformers and equipment for the e-boosting system and a complete Prium BH-F 400 Series T-Tandem forehearth system to distribute thermally conditioned molten glass efficiently to the tandem 8-section IS machines on the new line. According to Edson Rossi, President Director at Vidroporto, this ambitious project represents the glassmaker's first installation of a triple gob IS machine with 16 sections. In addition, a swabbing robot will be installed.

www.fivesgroup.com ●

Prium BH-F 400 Series T-Tandem forehearth system.

Printing inks acquisition focuses on growth

INX International, North America's third largest manufacturer of printing inks, recently signed an agreement to acquire Germany's RUCO Druckfarben, A M Ramp & Co GmbH. The agreement is part of the future strategy of the long-established German company and it secures the succession of the current owners, the Menke family. The transaction is expected to be completed by the end of the first half of 2020. "We are very pleased that with INX we have found a partner who shares our values and wants to lead the RUCO Druckfarben brand into the future" said Heinz Walter Menke, owner and Managing Director of RUCO Druckfarben.

INX has built up a strong market presence over recent decades, especially in southern Europe and was looking to better serve customers in central and eastern Europe. "RUCO's excellent market position and the expertise of its employees as well as the opportunity to build up additional capacities at the Eppstein site convinced us" Peter Lockley, President of INX Europe added.

In the area of flexible packaging, both companies want to jointly expand their capacities and thus better meet increasing demand. "In addition, the knowhow of our employees in screen and pad printing optimally complements the portfolio of INX, which is not yet active in these areas" Heinz Walter Menke explained.

"By investing in the Eppstein site and advancing the portfolio, we want to expand RUCO Druckfarben's leading position as a supplier to the toy, pharmaceutical and packaging industries under the ownership of INX" Mr Lockley confirmed.

www.ruco-druckfarben.de ●

Centre of excellence for type II pharma glass production

Gerresheimer has reinforced its leading position in the manufacture of pharmaceutical containers made from type II glass by introducing innovative furnace technology, expanding its cleanroom and introducing automation and digitalisation to its testing and packing lines in Essen, Germany. Two hardening and tempering methods allow extremely small injection bottles to be produced, as well as typical infusion bottles with larger volumes. Guaranteeing the quality and hydrolytic resistance of the type II glass is the top priority.

"Our customers want safe, flawless products from us" commented Silvio Carriço, Senior Product Manager for Pharma, Food and Beverages, "so we need to make sure that we have the best possible production processes, even before hardening and tempering the inside of the type II glass, by monitoring the situation constantly and intervening where required."

After overhauling and upgrading its clear glass furnace in Essen, two new production lines have been opened that link directly to the recently expanded cleanroom. The site is focused on further increasing its capacity and expertise, supplemented by sizable investments in state-of-the-art self-learning testing lines etc.

www.gerresheimer.com ●

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Sophisticated wine bottle designs introduced

Ardagh Group, Glass - North America has unveiled six sophisticated glass wine bottle designs. An expansion of the company's extensive portfolio, the latest designs include three texture options, one 375ml Claret style bottle with a Stelvin finish, one 375ml Claret style bottle with a cork finish and one 375ml Burgundy style bottle with a Stelvin finish.

To further engage today's inquisitive consumer, Ardagh has developed three textures that can be applied to a variety of bottles. The REMO, CUADRAS and VINA designs deliver an emotional connection to the consumer using special shapes and textures, thus establishing a more interactive consumer experience. For wineries looking for single serve options, the three 375ml bottles provide the ability for consumers to mix-and-match varietals and sample products without committing to a multi-serve format.

www.ardaghgroup.com ●

Forehearths reconstruction project in USA

USA-based glass packaging manufacturer, Anchor Glass Container Corp has selected Fives to undertake its latest forehearth system reconstruction project in Lawrenceburg, Indiana. The project includes design, engineering and key equipment supply, as well as supervision of the installation and commissioning for a complete Prium BH-F forehearth system.

Fives previously worked with Anchor in 2018, designing and supplying Prium foreheath technology for the glassmaker's Elmira factory in New York.

www.fivesgroup.com ●

Cognac market presence reinforced

Stoelzle Glass Group has recently opened a sales office in Cognac, France to strengthen the company's partnerships with current and future customers in the local market. By maintaining a local presence and a dedicated Cognac sales team, the company can offer better visibility, faster answers and improved customer service.

Prestige glass spirits bottles and decanters are produced at Stoelzle Glass Group factories in the UK and Poland. In addition, a prestige standards range of bottles is available for immediate delivery and can be decorated to represent the company's brand.

"Stoelzle Glass Group believes the French market is growing and is confident (of providing) a better service with its new Cognac office" says Andrea Gherzi, Global Sales Director. "By having a local presence and a dedicated team, we think we have the perfect offering to new and existing customers between our bespoke services and global glass manufacturing footprint capacity."

www.stoelzle.com ●

Stoelzle Glass Group's dedicated Cognac sales team.

Maximising strengths in process air technology

Germany's LWN Lufttechnik GmbH has announced a series of operational changes in recent months. Reiner Giesbert and Wieland Wittig, who have been the sole owners of the Willsdruff, Germany-based business since 2012, have overseen essential restructuring of the company and repositioned it for future business growth in service of the hollow and flat glass sectors.

Since October 2019, joint Managing Directors of LWN Lufttechnik have been Reiner Giesbert and Aleksander Pinda. Mr Pinda has been working for the company as a Construction Manager for many years. At the same time, to satisfy growing demands on production and quality, the company's operation management team has been strengthened, with Jörg Günther assuming production management responsibility at Wilsdruff.

Separately, in an effort to react more quickly to customer requirements, the sales team has been strengthened. Michael Nisius, who has worked in the glass industry since 1980, has recently joined the team.

LWN Lufttechnik has also expanded its product portfolio into areas that complement the company's strengths in process air technology. The piping of compressed air, water and vacuum, as well as complete electrical wiring projects, are successfully undertaken on behalf of glass industry customers, covering everything from planning to the complete assembly.

www.lwn-lufttechnik.de ●

The LWN Lufttechnik senior management team.

The recently expanded sales team comprises Johann Keyserlingk, Frank Lohbach, Wieland Wittig and glass industry veteran Michael Nisius.

Conveyor and palletiser supply solutions

Founded in 1992, Vetromeccanica is headquartered close to Parma, at the heart of the Italian packaging industry. Initially, the business concentrated on the maintenance and overhaul of cold end lines and palletisers, before turning to the production of conveyors and latterly, to the manufacture of palletisers as well. Today, Vetromeccanica operates a production site of 16,000m^2 under cover and an outdoor production area of 23,000m^2.

From the outset, it has been the company's passion to deliver customised solutions, tailored to the needs of customers. Now, this passion guides the Vetromeccanica R&D Department in its design and blueprinting of cold end solutions, both conveyor lines and palletisers, featuring important innovations in terms of efficiency, maintenance and speed. The development team has benefited from the addition of several leading industry personalities in recent times, bringing considerable knowhow and professional experience to the role.

Vetromeccanica is a major player in more than 70 different countries thanks to its attention to detail and capability to offer a 360° service, alongside the efforts of a skilled customer care team. Mechanical-electrical engineering, production, assembly and after sales service functions are all maintained in-house, helping the company to deliver reliable support to hollow glass industry customers worldwide.

It is acknowledged that companies are only as good as their people and their competence, passion and knowhow to run the necessary equipment. Many trusted customer relationships have been established, as Vetromeccanica continues to reinforce its position as an important supplier of conveyor lines and palletisers.

www.vetromeccanica.it ●

Batch plant commissioned in Angola

EME has successfully commissioned a batch plant for the greenfield glass container plant of Embalvidro in Angola. Located in Luanda, the factory will primarily produce beer bottles in amber and emerald green colours. The batch plant is designed for a capacity of 180 tonnes/day. A tower concept with a small footprint was selected to reduce building costs significantly. Additionally, a high number of batch cycles is achieved because no gathering belt is needed; another positive effect is the reduction of dust producing sources, thus minimising the plant's overall dust emissions.

www.eme.de ●

Computer-to-screen system installation success

In December 2019, leading German flat glass processor Joh Sprinz GmbH installed the latest XXL JetScreen! LT 55/32 computer-to-screen system from Switzerland's Lüscher Technologies AG. This further reinforces a working relationship between the two organisations dating back two decades.

Joh Sprinz GmbH processes approximately 110 tons of raw glass every day to manufacture shower enclosures, glass doors, exterior facades and other high quality special glass products.

Joh Sprinz GmbH has installed the latest XXL JetScreen! LT 55/32 computer-to-screen system from Switzerland's Lüscher Technologies AG.

It was in 2000 that the company took the decision to invest in computer-to-screen, which at that time was still based on ink jet technology using hotmelt. Last spring, the contract was signed for a JetScreen! LT 55/32, with a maximum frame format of 5500mm x 3200mm.

In mid-December 2019, the JetScreen! LT, weighing 7.5 tons, was installed at the Gruenkraut plant. Due to its size and sturdy construction, three trucks were required to deliver the components. The system was assembled on-site under challenging circumstances, as the system had to be installed on the first floor. After three days of intense team work, the equipment was successfully put into operation.

Hubert Hofer, Screen Printing Production Manager, is not only expecting savings in consumables but also a considerable improvement to the quality of screen printing stencils. Compared to the old system, which operated with 635 dpi, the new system works with resolutions of up to 2540 dpi.

www.luescher.com ●

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Helping clients meet increasingly challenging product specifications

Increasingly tight dimensional tolerances, dosage control and line rejection targets have led to a surge in demand for dimensional verification of glass packaging and components by leading experts in glass, Glass Technology Services. The UK-based laboratories continue to expand their capabilities and capacity through strategic investments in staff and equipment to meet growing demands.

Extending their dimensional measurement capabilities across a range of glass products and specialist components, a vision measuring system has been commissioned and installed. This extends the comprehensive range of dimensional measurements and specification checks already provided to clients across pharmaceuticals, components, food and drinks, photonics and glass manufacturing sectors.

The vision measuring system allows GTS to provide more accurate dimensional measurements in a fraction of the time it currently takes for manual and profile-projection techniques, as well as allowing automated measurement of large sample batches. Measurements are non-contact, repeatable and allow accurate measurement and evaluation of complex three-dimensional components, closures, drug delivery systems as well as traditionally challenging measurements such as sink, bulge, surface flatness and to highlight accurate internal profiling and wall thickness for flexible and pressure-sensitive items such as component assemblies and flexible stopper materials.

www.glass-ts.com ●

Dimensional verification of glass packaging and components.

Optical inspection analysis software

Since its creation 25 years ago, Dr Günther Inspections GbR (formerly Optische Prüfsysteme Dr Günther) has expanded steadily, developing standard and customer-specific camera inspection machines for glass containers, tableware etc that can inspect various shapes for different defects. These individual concepts, such as inspections for black glass, eyeglass lenses and cosmetic containers, have been developed in close co-operation with customers. The experiences gained from developing special solutions are incorporated into the company's standard inspection machines.

The latest development is a concept called OPG-O, which has been conceived to meet growing demand for data analysis options. On a clear operator interface, the user can see the ratio between good and defective parts in real-time.

The specially developed error classification enables the user to see the reason for the ejection immediately. Furthermore, it is possible to integrate external production machines into the data acquisition system. Machine changeover times are also taken into account. A buffer system that continues to collect data in the event of a connection termination, as well as interfaces for spreadsheet programmes, are standard functions. Customer-specific changes can be made at any time.

www.optical-inspections.com ●

Furnace management innovations discussed

At a specially organised seminar in Bangkok, Thailand recently, Fosbel summarised innovations in furnace construction, ceramic welding repair technology and the hot casting repair of furnace bottoms. In what is expected to become an annual event, the day-long seminar consisted of presentations, group meetings and visual demonstrations, followed by a Q&A session. The event attracted 30 delegates, representing 11 different glassmaking companies.

Bob Chambers, Managing Director of Fosbel's Americas region, presented FLAME (Furnace Life Asset Management and Evaluation) as the web-based platform for facilitating the management of repair actions in the short-, medium- and long-term. The event also included a presentation from Fred Aker, Vice President of Sales and Marketing at PaneraTech, on SmartMelter technology, which enables a radar-based, non-invasive health measurement of refractory thickness. Since the beginning of this year, Fosbel has been recognised as a certified SmartMelter partner with PaneraTech, strengthening an already well-established portfolio of furnace inspection innovations.

www.fosbel.com ●

Eric Tatgenhorst (centre), Fosbel Operations Manager South East Asia, with Bob Chambers (second from right), Fosbel Managing Director and Fred Aker (far right), VP of Sales and Marketing at PaneraTech, pictured with seminar delegates.

Attendees represented 11 glass production companies.

Single source pneumatic energy

Vacuum centralisation means generating pneumatic energy with a single source, instead of several split rooms. This was the solution preferred by a leading hollow glass manufacturer in Mexico, who decided to design its latest glass plant correctly from the outset.

The customer selected two Pneumofore UV100 vacuum pumps, equipped with PLC and HMI. These machines have been successfully commissioned in recent weeks to the customer's full satisfaction. The variable speed operation of these large pumps allows users to adapt the vacuum demand coming from production quickly and precisely.

Once the vacuum level is set, in this instance at 350 mbar(a), the rotation speed of the machines changes according to the number of lines in operation. Furthermore, the vacuum flow requirements can alter in the case of a job change.

The capacity range extends from 1.900m³/h up to 12.800m³/h. Moreover, the indications provided by Pneumofore during the construction phase were observed fully by the engineers on site, resulting in generous accessibility during rare maintenance tasks, scheduled only twice each year.

www.pneumofore.com ●

Pneumofore UV100 vacuum pump, equipped with PLC and HMI.

Defects training success

Glass Service and CQ Masso partnered with Sisecam last November to organise a glass defects and refractory training day for attendees at the Sisecam International Glass Conference in Istanbul. The expert training session was delivered by Martina Jezikova, Filip Janos and Jerome Canaguier, focusing on the analysis and possible sources of glass defects, as well as refractory defects and quality control.

According to Glass Service, the room was packed with 50 motivated delegates, who wanted to learn more about where glass defects may come from.

www.gsl.cz ●

Fifty delegates attended the glass defects and refractory training day in Istanbul last November.

People & posts

Do you have a company appointment to tell the world about? Email us at news@glassworldwide.co.uk

GPI strengthens leadership team

The Glass Packaging Institute (GPI) has selected Bertrand Paulet, President and CEO of Ardagh Group, Glass – North America, as Chairman of its Board of Trustees. His term as Chairman began this January.

"On behalf of our member companies and suppliers throughout the glass industry, I am pleased to congratulate and welcome our incoming Chairman, Bertrand Paulet" said Scott DeFife, President of the Glass Packaging Institute. "Mr Paulet brings to GPI vast experience in the packaging and container industries and his leadership will be extremely valuable to our members as we create and implement legislation and marketing strategies that protect and enhance glass packaging in North America."

"It is an honour to be selected as Chairman of the GPI and I look forward to working with our members to efficiently align our resources and add value to our mutual businesses" said Bertrand Paulet. "These efforts will include implementation of GPI's energetic new programmes to promote the growth of glass packaging in North America and increase the use of recycled glass in bottle and jar production. Together, we will leverage our collective capabilities to advance glass recycling and effectively position glass as a preferred packaging option for sustainability and the circular economy."

Along with Mr Paulet's elevation to Chairman of GPI's Board of Trustees, Temeca Mitchell of Rocky Mountain Bottle Co and Nigel Dart of Gallo Glass Co have both assumed trustee roles. Ms Mitchell and Mr Dart join Miguel Alvarez, President, Americas - Owens-Illinois, as Executive Committee members of the GPI Board.

www.gpi.org ●

Financial management change at Anchor Glass

USA-based Anchor Glass Container Corp has announced that Chief Financial Officer Steve Jackson has left the company to join another organisation. Don Leclair, Anchor Glass Board Member, will assume the role as Interim Chief Financial Officer until a permanent successor to Mr Jackson is named. Mr Leclair will also remain a Director on the Anchor Glass Board.

Headquartered in Tampa, Anchor Glass is a leading North American manufacturer of premium glass packaging products. The company employs approximately 1700 people and operates six manufacturing facilities located in Florida, Georgia, Indiana, Minnesota, New York and Oklahoma.

www.anchorglass.com ●

Inspection solutions sales appointment

Armando Brusamolino.

IRIS Inspection machines has expanded its international sales team, appointing Armando Brusamolino as Area Sales Manager. Mr Brusamolino brings extensive experience and expertise in export businesses, having successfully developed sales opportunities for leading suppliers of environmental, laboratory and pharmaceutical control and analysis technologies in the B2B arena for more than two decades.

Born and raised in Italy, he speaks fluent English, French, German, Portuguese and Spanish, as well as Italian and has previously enjoyed expatriate experience in Argentina, China and the UK. Most recently, he was Export Manager at SERES Environnement, a specialist electronics manufacturer in Aix-en-Provence.

In his new role at IRIS, Armando Brusamolino will be responsible for the development of international sales opportunities, participating in and managing training and demonstrations, as well as developing and maintaining important business relationships with hollow glass customers throughout the world.

www.iris-im.com ●

Materials engineering expertise

Chris Weirman.

Wall Colmonoy has appointed Chris Weirman as Technical Director for its European headquarters in Wales. Having joined the business in 2019, Mr Weirman brings over 25 years' experience in chemistry, materials science and manufacturing, with a strong background in product and technology research and development.

He will head the technical function at Wall Colmonoy Ltd (UK), as the company looks to the latest technologies to drive its growth objectives. He will lead a high performance technical team who support customers with material selection, innovative alloy development and practical experience of key manufacturing processes.

www.wallcolmonoy.co.uk ●

US recycler leadership role

Christopher Dods.

North America's largest glass recycler, Strategic Materials Inc has named Christopher Dods as Chairman of the Board, Chief Executive Officer and President. Mr Dods has significant executive leadership experience in the environmental and industrial services industries, with a proven ability to drive sustainable and profitable growth in the sector.

Prior to joining Strategic Materials, he served as CEO of Clean Earth, one of the largest specialty waste companies in the USA. He also served as President, Environmental Services Division at Philips Services Corp and earlier in his career, he was a Senior Vice President at Aramark Corp.

www.strategicmaterials.com ●

Extended inspection equipment management team

Tilo Günther, Linda Günther and Friedrich Günther, directors of Dr Günther Inspections GbR.

Optische Prüfsysteme Dr Günther of Meeranne, Germany recently changed its name to Dr Günther Inspections GbR, following changes to the company's ownership structure. The previous owner, Dr Friedrich Günther, remains the majority shareholder but is joined by his children, Linda and Tilo Günther as partners in the business.

Tilo Günther is a graduate engineer in electrical engineering. Since 2014, he has been working as a Project Manager for the company, proving his competence in various projects. He is now responsible for development and production.

Linda Günther completed her studies in business administration, before gaining experience within another business and then moving to Optical Inspections Dr Günther last September. She is now responsible for materials and business management.

www.optical-inspections.com ●

Sisecam Group has been adopting digital transformation not only as the digitalisation of production facilities but also to increase the digital capabilities of business units in terms of the supply chain, finance and human resources etc.

Sustainable growth strategy set to shape the future

Sisecam Group Vice Chairman and CEO, Professor Dr Ahmet Kirman spoke exclusively to John Wallis about the group's current financial performance, its latest investment initiatives across the diversified range of glass types produced and the organisation's plans/ expectations for the future.

Under the leadership of Professor Dr Ahmet Kirman, Sisecam continued its sustainable and value creating growth via another strong financial performance in 2019, with consolitated revenues exceeding $3.2 billion.

The Sisecam Group is a financially strong global player in flat glass, glass tableware, glass packaging and glassfibre, as well as soda ash and chrome compounds. With 43 specialist production sites in total, the group undertakes production activities in 14 countries with a workforce of 22,000 people and sells its products to more than 150 countries. Sixteen plants are located in Turkey and 27 abroad, including interests in Germany, Italy, Bulgaria, Romania, Slovakia, Hungary, Bosnia-Herzegovina, the Russian Federation, Georgia, Ukraine, Egypt and India.

A flexible and proactive management approach is pursued, typified by constantly improved competencies, effective cost management, as well as prudent risk management practices against existing fluctuations and tough competitive conditions in the markets in which the group operates. "We are proud to see the positive effects of this strategy in our financial results and in the shareholder value created" Dr Ahmet Kirman explains.

Last year, Sisecam continued its sustainable and value creating growth via another strong financial performance. In 2019, consolitated revenues exceeded TRY 18 billion ($3.2 billion), representing a 16% increase compared to the previous year. International sales, involving both the total amount of exports from Turkey and sales from overseas production, represented 63% of the total. Almost five million tons of glass and 2.4 million tons of soda ash were produced in the same period.

Moreover, in 2019, total investment expenditure increased by 11% to $510 million. Consolidated EBITDA volume reached $860 million, representing a 27% margin. "We conduct our operations with a sense of responsibility of being the only global player active in all core business areas of the glass industry" Dr Kirman confirms. ▸

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"In terms of production capacity, our group ranked among the top three in (household) glassware, top five in flat glass and glass packaging, top six in synthetic soda production and first in chromium chemicals worldwide. Sisecam is among the world's most distinguished glass manufacturers, due to its degree of specialisation and the considerable competitive advantage of its operations."

Thirteen float lines and 10 automotive glass facilities are currently operated by Sisecam across Europe, Russia and India.

Sustainable growth strategy

Sisecam is focused on a sustainable value creating growth strategy, with organic and inorganic growth supported by investments in new capacities, value creating acquisitions, maximum capacity utilisation and value added products. A strong focus maintained on customer needs and technological developments has continued to add value.

As a global manufacturer, with operations in various countries and a wide range of products, Sisecam is constantly mindful of the different market drivers for every business sector and the opportunities that can emerge. In the household glassware sector, for example, where the global market is effectively saturated, the addition of new capacities in existing markets is considered unrealistic, Instead, Dr Kirman contends that growth via acquisition in potential markets is a more realistic goal, as was the case for Sisecam in Egypt. "Alternatively, in the flat glass business, we will look for opportunities in areas with high demand growth to invest, such as the case of our investments in Italy" he adds.

Investment priorities are focused on projects that create value and increase capacity. And although these major investments are associated primarily with extra production, it is anticipated that digitalisation and R&D investments will also play a significant role. In its flat glass business, for example, Italy and India have been the focus of attention. Sisecam is now the leading flat glass producer in Europe and the recent integration of its Manfredonia facility in southern Italy is expected to boost this position further. In addition, it is planned to increase production capacity in Ankara, Turkey via a new furnace investment.

Modernisation of the group's household glassware production facility in Egypt has been another important project, with this operation expected to play a significant role in Middle East and North American markets in the future.

Sisecam's investment priorities are focused on projects that create value and increase capacity.

In the glass packaging arena, furnace investments have been finalised in Turkey and cold repair plans are part of the current programme. The latest projects are focused on Turkey and Russia, where Sisecam is the market leader.

In addition, Dr Kirman confirms plans to diversify the revenue stream and enter new markets. "We continue to explore possible opportunities to grow in each business area via organic and inorganic investments. Moreover, strategic investments are planned in new businesses that offer growth potential in global markets, tracking start-ups that integrate innovation alongside agile entrepreneurship capabilities. Evaluating potential strategic partnerships with start-ups that have glass-related solutions or the capability to contribute value added services or technologies for our group could be part of our growth strategies."

Flat glass

For the year 2019, the Flat Glass Division's revenues increased by 13%, while its share of the group's consolidated sales reached 36% compared to 2018. The group continues to perform strongly across its flat glass markets despite short-term challenges resulting from a slowdown across the globe, while strengthening its position in both architectural and automotive glass.

In 2010, the Flat Glass Division included seven float lines and two automotive glass production facilities ▸

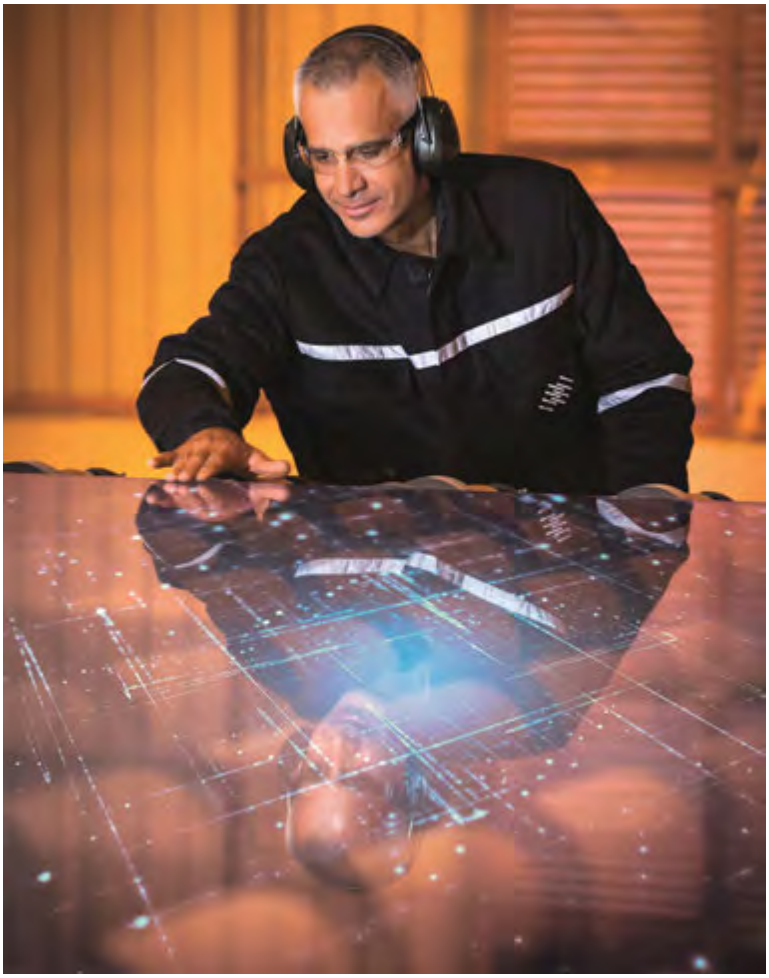
in Turkey and Bulgaria. A decade later, however, production capacity has almost tripled, with 13 float lines and 10 automotive glass facilities operated across Europe, Russia and India. "In a global flat glass market, we expect to continue our rapid growth, with an increasing focus on value added products and product innovation" says Dr Ahmet Kirman.

In recent years, Sisecam Group has increased its flat glass production capacity in Europe by inorganic growth in Italy. At the end of 2016, the group acquired Italian float glass producer Sangalli's facility in the north of Italy. Today, this facility has a nominal capacity of 220,000 tons/year and is an important supplier to major industries. Following this acquisition, Sisecam has emerged as Europe's largest flat glass manufacturer in terms of production capacity.

"As an industrial group, Sisecam creates economic value in all geographies where it operates" Dr Kirman reports. "We also realise investments in capacity increases and the modernisation of existing production facilities with a continuous investment approach. Within this scope, we have initiated an investment of Industry 4.0 and digital transformation at the Porto Nogaro plant, which has an annual production capacity of 220,000 tons. We plan to invest €6 million in generating electricity from flue gas. In this way, we will take an important step for the facility in terms of energy efficiency."

Following the acquisition of Sangalli's Manfredonia plant in southern Italy in 2018, Sisecam Group has further reinforced its leadership position. "The second facility in Italy is an important opportunity to contribute to sales, expansion and competitiveness by increasing the product range" says Ahmet Kirman. "This investment will also enable us to realise the strategy of developing the value added product portfolio demanded by the global market."

Together with additional investments, more than €55 million has been spent at Manfredonia, including the acquisition value and working capital. Not only has the furnace been rebuilt with an advanced design but coating and lamination lines have been added.



The Sisecam Group continues to perform strongly across its flat glass markets despite short-term challenges resulting from a slowdown across the globe, while strengthening its position in both architectural and automotive glass.

Elsewhere in Europe, Sisecam is one of the largest foreign investors in Bulgaria with its float, automotive and household appliance glass facilities. This regional presence is soon to be expanded via the completion of a new windscreen production line. In addition, the automotive glass facility in Romania is soon to expand its operations by supplying new car models including electric vehicles from some well known producers.

Secondary operations, consisting of glass encapsulation and parts assembly applied on automotive glasses, are performed at six dedicated facilities located in Slovakia, Hungary, Turkey and Germany. While the Slovakia and Hungary plants focus on the mass production of encapsulated glass for various brands, the facility in Germany carries out niche production for premium vehicle brands.

Moreover, Sisecam's latest furnace investment in Ankara will ensure that growing demand from the Turkish market can be accommodated fully. Some $127 million will be invested in a new 220,000 tons/year furnace, increasing annual production capacity from the site to 520,000 tons. "The investment will increase our flat glass production capacity in Turkey to 1.9 million tons and contribute to our product diversity in the flat glass sector" Dr Kirman explains.

Glass packaging

The Glass Packaging Division also performed well last year, especially in Russia and Turkey, increasing total sales by 31% in 2019. Today, this division accounts for 24% of Sisecam's consolidated sales revenue. Its footprint as the leading regional producer has been strengthened via a series of capacity increase and modernisation projects, especially in Turkey.

Glass packaging is manufactured in different colours and sizes for the food, beverage, spirits, pharmaceutical and cosmetics sectors. An annual production capacity of 2.6 million tons makes it the largest glass packaging manufacturer in Turkey and one of the world's leading producers, with other operations in Russia, Georgia and Ukraine. The only producer in Turkey capable of supplying the pharmaceutical sector in accordance with ISO Class 8 specifications, the company relies on supply chain excellence, lean production and high levels of automation, as well as data-driven production.

Manufacturing capacity in Turkey has been increased substantially in 2019 following another $18.2 million investment. Last August, Sisecam commissioned its latest furnace in Mersin, featuring an annual production capacity of 80,000 tons. In the last three years, the company has increased its annual glass packaging capacity in Turkey by 30% to 1.3 million tons. Today, 12 furnaces are operated at three Turkish glass packaging facilities in Bursa, Eskisehir and Mersin.

Household glassware

Further important advances were made by the Glassware Division in 2019. Last year, revenues increased by 22% and its share of the group's consolidated sales revenue reached 17% compared to 2018. Accounting for 9% of the global market, the Sisecam Glassware Division's international sales constitute 65% of its total business.

Production is undertaken at facilities in Kırklareli, Eskisehir and Denizli in Turkey, as well as in Bulgaria, Russia and recently in Egypt.

Since finalising the acquisition process in the final quarter of 2017, production started in Egypt at the ▸

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In the last three years, Sisecam has increased its annual glass packaging capacity in Turkey by 30% to 1.3 million tons.

end of 2018. This acquisition has strengthened the Glassware Division's growth strategy in the Middle East and Africa. And thanks to Egypt's special trade agreement with the USA, it provides an important opportunity to access the North American market thanks to customs and tax benefits.

In order to convey accumulated expertise and experience as quickly as possible to the 500-strong workforce, skilled Sisecam technicians were assigned to work at the production facility in Egypt. "Additionally, Egyptian employees were trained at our other facilities to achieve the targeted production performance" Dr Kirman explains. "We also provided the production processes with continuous technological developments along with our in-house developed machines and equipment, imported from Turkey. In a short period, we have gained the ability to make Sisecam level quality products at high production efficiency."

Automated and hand-made soda lime, heat-resistant and crystal glassware is made across the six Glassware Division production sites, with sales undertaken to 140 different countries. "Our global design brand Nude has been performing very successfully in the premium segment, since its launch in 2014" Ahmet Kirman confirms. "We have recently launched Nude's 'Stem Zero' collection with 'Ion Shielding' technology thanks to our R&D success by building on its sustainable technologies. This innovative and elegant collection increases product impact resistance and flexibility. It is the world's toughest, yet finest, lead-free crystal glass, designed to enhance the experience of different wines."

Chemicals

The Chemicals Division has also performed well. In 2019, revenues increased by 17%. Today, Sisecam Group is among the world's top six synthetic producers with a total annual soda ash production capacity of 2.4 million tons provided by production facilities in Turkey, Bulgaria and Bosnia and Herzegovina.

Plans are now underway to expand the group's production operations to the USA. Last June, an equal production partnership contract was signed with Ciner Group (a global leader in natural soda production) for natural soda production in the USA. A similar production partnership structure has been in place in Bulgaria for many years with Solvay, the world's largest synthetic soda manufacturer.

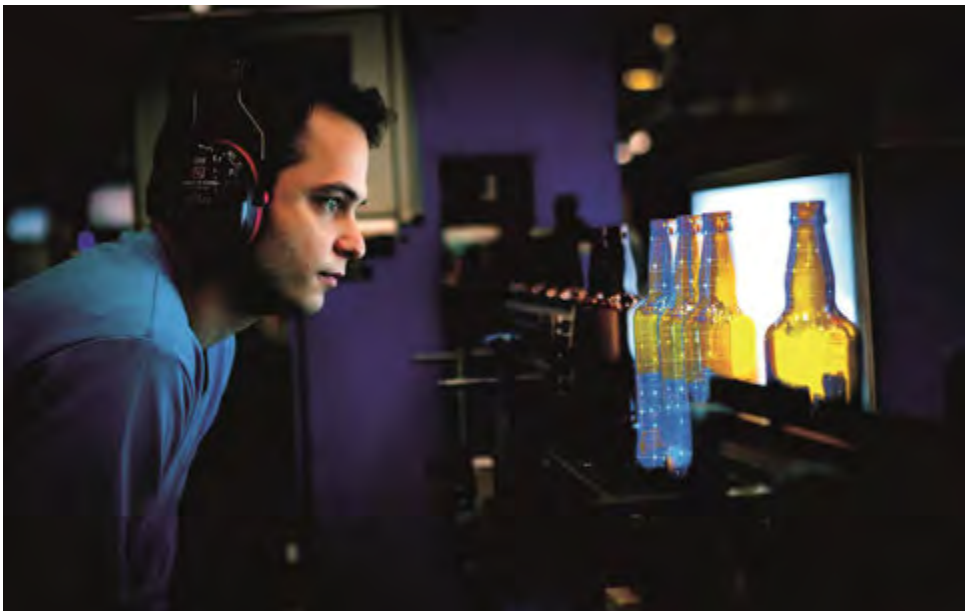
The Green River, Wyoming investment will offer the possibility for natural soda production by employing low cost solution mining. Moreover, the investment will boost Sisecam's global market share by strengthening its position in Asia and Europe. "We expect to start operations in 2024, following acquisition of the necessary operating permits and licenses" Dr Kirman confirms. "We are planning to finance this investment, which has an annual natural soda ash production capacity of 2.5 million tons besides 200,000 tons of sodium bicarbonate production capacity, with a long-term project financing loan by 80% and the balance with an equity capital to be invested equally. The capital expenditure is estimated at $2 billion for this greenfield investment."

When this investment is put into effect in 2024, Sisecam Group will be among the top five global players in soda ash. This will be an important step towards its goal to become one of the top three global glass manufacturers.

Corporate sustainability strategy

While striving to be among the leading global companies in each of its core business activities, the Sisecam Group also takes seriously the social, environmental and economic pillars of sustainability to bring an equitable, viable and bearable future for future generations. A supporter of the United Nations Sustainable Development Goals, the group has initiated an integrated corporate sustainability strategy called 'Care for Next'.

"In line with our sustainability approach, we have been promoting and applying the conscious use of natural resources, energy efficiency and renewable sources in our operations" Ahmet Kirman explains. "Because we operate in energy-intensive industries, the efficient use of energy, ensuring continuous energy supply in the most effective manner, the constant review of energy-related risks and opportunities and ▸



An annual production capacity of 2.6 million tons makes Sisecam the largest glass packaging manufacturer in Turkey and one of the world's leading producers, with other operations in Russia, Georgia and Ukraine.

Household glassware production is undertaken at facilities in Kirklareli, Eskisehir and Denizli in Turkey, as well as in Bulgaria, Russia and recently in Egypt.

the management of operations in this regard are of great significance to our group."

Manufacturing operations are managed on the basis of international energy management standards, with energy efficiency projects and solutions implemented to ensure continuous energy consumption reduction. According to Dr Kirman, a total of 815,285 GJ of energy was saved by means of the energy efficiency projects carried out in 2018. "Moreover, thanks to the efforts undertaken in the same period, 15 MW of electricity generation capacity was established with the application of waste heat recovery systems and 1% of total annual energy consumption was saved."

As part of its renewable energy approach, in 2017 a 6.2 MW solar power panel plant was installed on the roof at Sisecam's flat glass production facility in Mersin. In addition, 330 solar panels with a total installed power of 87 kW have been installed on the roof of the Sisecam Science, Technology and Design Centre. Elsewhere, Sisecam-branded energy efficient flat glass products are helping to reduce energy costs in Turkey by 40-65% compared to conventional insulating glass units.

"We also believe that efficient waste management is the basis of cyclical economics" Dr Kirman explains. "Recycling, which is an important part of the waste management approach, reduces the amount of waste and raw materials efficiency is ensured by reusing the recovered products in production processes."

The objective of Sisecam's integrated waste management approach is to develop projects to realise the 'zero waste' goal. For this purpose, active studies are being carried out to promote the culture of recycling through global awareness studies. In 2018, all recyclable wastes were reintroduced to production again and non-recyclable wastes were sent to facilities with required certificates and permits for final disposal. In this period, Sisecam collected 54% of its packaging waste from the market and recovered it. Approximately 16,500 tons of paper, cardboard, plastic and wood was recycled.

On the glass recycling front, the group continues to promote the transition to a recycling society in Turkey by generating social behavioural change through its 'Glass and Glass Again' project. The key elements of this project are raising public awareness for separate collection of glass packaging waste at its source, improving the infrastructure for collecting glass packaging waste, modernising recycling facilities and increasing capacities.

Digital transformation

Sisecam Group has been adopting digital transformation not only as the digitalisation of production facilities but also to increase the digital capabilities of business units in terms of supply chain, finance and human resources etc. "This holistic approach is key to integrate business processes with innovative technologies" Ahmet Kirman confirms.

The group's 'Root and Wings' digital transformation project has been proceeding across both manufacturing companies and central functions. Its aim is to empower the infrastructure in order to hasten digital transformation and enhance business processes. Every business function is involved, where interpreting data in business processes by advanced analytics applications is predicted to enhance operational excellence.

Many other projects are also being implemented including a transition to 'cloud' systems in information technologies, robotic process automation to increase efficiency in business processes and developing data architecture and cyber security technologies to support digital transformation.

Separately, increasing overall equipment efficiency and integrating RFID technologies in the warehouses at Sisecam production facilities have been an important area of attention. The Research and Technological Development Department has been conducting data analytics applications by using sensor readings from furnaces and managing temperatures automatically with smart algorithms, to enhance energy efficiency.

"The digitalisation process includes not only processes but also the solutions and products offered to the market" Dr Kirman confirms. "Thus, we are working hard to improve our R&D competencies and to offer products that primarily satisfy customer expectations at a much faster pace."

According to the road map defined by its digital transformation strategy, Sisecam Group plans to invest in 'business intelligence' to create a better understanding of market and group organisational structuring globally. "We are implementing transformation projects in our business units that will support the digitalisation of processes, enabling data-driven business decisions and improving efficiency."

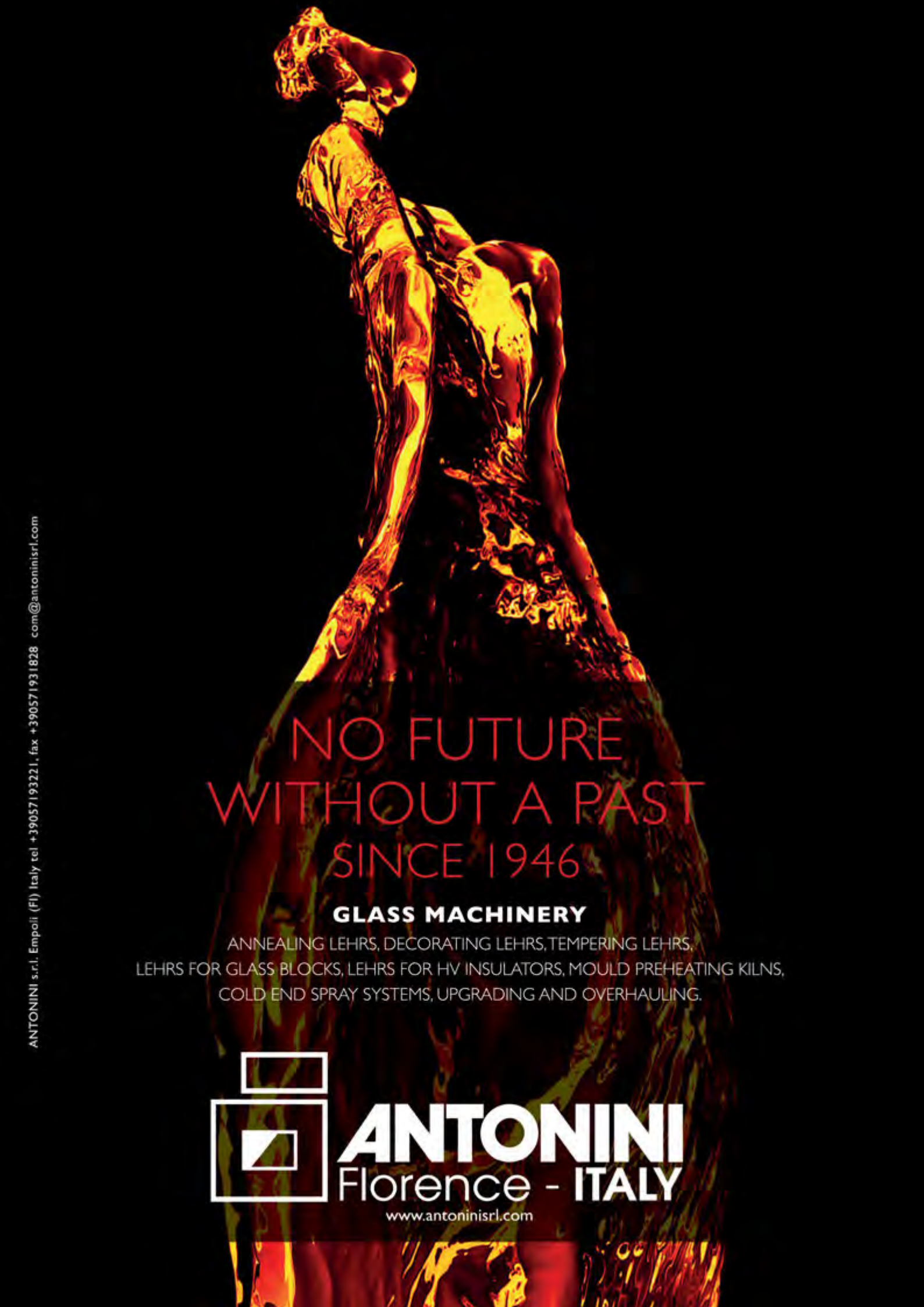
These transformation projects are handled in collaboration with the subject matter experts and solution partners. "Capitalising on robotic process automation, artificial intelligence and cloud technologies will support Sisecam to achieve its goals in globalisation, operational excellence and customer orientation" Dr Kirman explains. "Thus, technology suppliers offering high quality services and goods on time are crucial both for the glass industry and Sisecam Group itself."

Ambitious goals

With ambitions to become one of the world's top three manufacturers in its core business areas, Sisecam Group continues to expand its production capacity with investments that maintain a leading and competitive position in global markets. "In the last five years, these investments have continued diligently and the average ratio of capital expenditure and revenues has reached a level of 13.5%" Dr Ahmet Kirman confirms.

Annual glass production has increased by 25%, reaching the five million tons level in line with the group's capital expenditures, thanks both to organic and inorganic growth. In this period, eight production facilities have been added - four flat glass production facilities (one in Turkey, one in the Russian Federation and two in Italy), two automotive glass production facilities (one each in the Russian Federation and Romania), a glassware production facility in Egypt and a glassfibre plant in Turkey. According to Dr Kirman, by combining its extensive experience with an ambitious vision, Sisecam is growing as a people-oriented and environment-friendly global company that creates wealth and shapes the future, its products and services, adding value to its stakeholders. ●

Further information:
Sisecam Group, Istanbul, Turkey
web: www.sisecam.com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Yenisehir is one of three high productivity glass container production sites operated by Sisecam in Turkey.

Optimised operational practices in glass packaging manufacture

Yenisehir is one of three advanced glass container production plants operated in Turkey by the Sisecam Group. John Wallis visited the site and discovered some of the priorities for the world's fifth largest glass packaging manufacturer.

In the last three years, the Sisecam Group has increased annual glass packaging production capacity in Turkey by 30% to 1.3 million tons. The group's Glass Packaging Division operates three high productivity facilities and 12 furnaces in Yenisehir, Eskisehir and Mersin and is the leading supplier of bottles and jars to a growing domestic market.

A variety of colours and sizes are manufactured for the food, beverage, spirits, pharmaceutical and cosmetic sectors, in sizes from 6cc to 15,000cc. The organisation's advanced design centre has won in excess of 70 awards in the past 12 years, including 17 global awards. It is the only glass packaging producer in Turkey with the ability to supply the pharmaceutical sector in accordance with ISO Class 8 specifications and relies throughout its plants on supply chain excellence, lean production and increasing levels of automation, as well as data-driven production to maintain its market leading position.

Alongside its Turkish factories, the Sisecam Glass Packaging Division also operates highly successful plants in Russia, Georgia and Ukraine, raising annual production capacity to 2.6 million tonnes and making Sisecam the world's fifth largest manufacturer, with 24 furnaces in total.

According to Sisecam Group Vice Chairman and CEO Professor Dr Ahmet Kirman, the Glass Packaging Division is responding to growing demand for premium and value-added products, greater health awareness and reduced sugar/sugar-free products in both local and global markets. Dr Kirman also emphasises an increased focus on recycling, with the notion of sustainability expected to be one of the main growth drivers in the glass packaging market.

"Uncertainties in the markets have made the glass industry grasp the importance of sustainability and efficiency even more" he suggests.

"In the light of Industry 4.0 applications, the glass packaging industry especially will optimise its business and operational processes to ensure sustainable growth with value creation. Glass packaging producers like Sisecam Group have been working hard to integrate automation and digitalisation technologies to its holistic processes and to achieve continuous growth." In particular, Dr Kirman expect to see increased digitalisation initiatives that relate to such subjects as preventative maintenance and quality.

High productivity facility

Established in 2005, the Yenisehir glass container plant near Bursa occupies an area of 240,000m^2 and employs 647 people. This advanced facility operates four furnaces, 17 production lines and 234 sections to make up to 530,000 tons/year of green, amber and flint glass packaging.

The high productivity forming equipment installed includes 8+8-section triple gob IS machines, 10-section doubles and triples, ▸

Product traceability represents an important advance at the Yenisehir site.

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Data – the deciding factor

Sisecam has invested heavily in automated quality control and process monitoring solutions to minimise machine-related defects.

The advanced Yenisehir factory operates four furnaces, 17 production lines and 234 sections to make up to 530,000 tons/year of green, amber and flint glass packaging.

10+10-section triples, as well as a high proportion of 12-section IS machines in quadruple, triple and double gob configurations. The majority of IS machines have been sourced from Emhart Glass, including seven AIS and three NIS designs, together with Bottero and Heye International equipment. Swabbing robots are currently employed in three of the four production shops, with the remaining machines scheduled for conversion in the future.

The company has invested heavily in automated quality control and process monitoring solutions to minimise machine-related defects, including the widespread installation of XPAR Vision hot end infrared cameras. At the cold end, the latest Tiama equipment has been sourced to identify visual, dimensional and stress defects in the body, finish and base, as well as cracks, ovality, line over and thin wall defects etc. And all production information and quality records from the hot and cold ends is available to factory personnel via a Vertech' production supervision system.

Product traceability is another important advance at the site, with tracking provided via pallet labels and all production information available through barcode numbers. Similarly, when it comes to finished goods and warehouse loading, packaging of the pallets is controlled once again before loading, with improperly loaded pallets rejected and sent for re-packaging. In addition, truck beds are controlled before transportation and improper trucks are not loaded.

The high productivity forming equipment installed at Yenisehir includes 8+8-section triple gob IS machines, 10-section doubles and triples, 10+10-section triples, as well as a high proportion of 12-section IS machines in quadruple, triple and double gob configurations.

Recycling focus

According to Turkey's Ministry of Environment and Urbanisation, only one of every 10 glass containers purchased is currently recycled in Turkey. The government is looking to improve this record and the recycling habits of its citizens by introducing a deposit return scheme in 2021.

The Sisecam Group continues to promote the transition to a recycling society by generating social behavioural change through its 'Glass and Glass Again' project, which has been in place since 2011. The key elements of this project involve raising public awareness for separate collection of glass packaging waste at source, improving the infrastructure for collecting glass packaging waste, modernising recycling facilities and increasing capacities.

Since the start of the project, recycling-related training has been provided to more than 250,000 primary school students, 20,000 glass recycling banks have been donated and more than 1.2 million tons of glass packaging waste has been recycled. The project has been awarded with a prestigious Sustainability Business Award 2019 in the 'Social Impact' category.

The group's glass recycling efforts also led to an award from the European Bank for Reconstruction and Development (EBRD) in 2018. Sisecam Group won the Silver Prize in the Environmental and Social Innovation category for its contributions to glass recycling, in issues such as resource efficiency, glass recycling and energy efficiency and glass recycling capital.

Further information:
Sisecam Group, Istanbul, Turkey
web: www.sisecam.com

Sisecam's Yenisehir flat glass plant near Bursa occupies an area of 327,816m^2 and is sited close to the group's glass container factory.

Strong investment commitment for flat glass production

In 2010, the Sisecam Group's Flat Glass Division featured seven float lines and two automotive glass production facilities in Turkey and Bulgaria. A decade later, production capacity has almost tripled, involving 13 float lines and 10 automotive glass facilities across Europe, Russia and India. John Wallis visited the Yenisehir float and coating plant in Turkey to gain an understanding of the division's capabilities and some of its priorities.

Sisecam Group reports a strong performance in the architectural and automotive flat glass sectors, despite prevailing short-term market slowdown challenges internationally. The group operates 13 float lines with a manufacturing capacity of 2.8 million tons, eight automotive and encapsulated glass facilities, five laminated glass lines, four coating lines, one home appliance glass line, five mirror silvering lines and one specialist solar glass line. The combined workforce of these specialist operations in 10 different countries now exceeds 6000 people.

In Turkey, the group has seven float lines, with plants in Ankara, Kirklareli, Mersin and Yenisehir. Investment priorities are focused on projects that create value and increase capacity. This includes a planned $127 million expenditure to build a 220,000 tons/year furnace at the Ankara site, raising the company's annual flat glass production capacity in the country to 1.9 million tons.

Sisecam is now Europe's leading flat glass producer and the recent integration of its Manfredonia facility in southern Italy reinforces this position significantly, a project that involves float glass production, as well as laminating and coating lines. There are now two float lines in Italy, two in Bulgaria and ▸

Sisecam is now Europe's leading flat glass producer.

Two float lines are operated at Yenisehir.

When producing 4mm glass, both float lines are designed to pull 750 tons/day of clear or ultra-clear glass. Their thickness range is 2-15mm.

one each in Russia, India and Egypt, the latter being a joint venture in association with Saint-Gobain Glass. Separately, the organisation operates automotive glass encapsulation and parts assembly facilities in Slovakia, Hungary, Turkey and Germany, as well as specialist automotive facilities in Bulgaria and Romania.

According to Ahmet Kirman, Vice Chairman and CEO, Sisecam creates economic value in all geographies where it operates. "We also realise investments in capacity increases and the modernisation of existing production facilities with a continuous investment approach. In the global flat glass market, we expect to continue our rapid growth, with an increasing focus on value added products and product innovation."

Producing different grades of low-E, solar control low-E, temperable low-E and temperable solar control low-E materials, the coating equipment delivers glass in a thickness range from 1.6mm to 19mm.

Diversified production capabilities

The Yenisehir flat glass plant near Bursa occupies an area of 327,816m^2 and is sited close to the group's glass container factory. The first of two float lines started production in mid-2007, with the second line becoming operational six months later. Coating and laminating lines were commissioned in mid-2007 and late 2008 respectively, a second coater also having been brought on stream in October 2018.

Collectively these projects, combined with the installation of a waste heat regeneration system in 2011, represent an investment of €296.6 million, with

Today, Sisecam operates 13 float lines with a manufacturing capacity of 2.8 million tons.

Some 3.5 million m² of 3+3mm – 12mm+12mm laminated glass is made at the Yenisehir site.

another €90 million allocated for planned investments at the site.

When producing 4mm glass, both float lines are designed to pull 750 tons/day of clear or ultra-clear glass. Their thickness range is 2-15mm. Both lines are 500m from one end to the other and their chimneys are 130m tall.

Producing different grades of low-E, solar control low-E, temperable low-E and temperable solar control low-E materials, the coating equipment delivers glass in a thickness range from 1.6mm to 19mm. The original coater No 1 and the more recently installed coater No 2 provide throughput capacities of 6000 and 8000m²/year respectively.

Some 3.5 million m² of 3+3mm – 12mm+12mm laminated glass is also made at the Yenisehir site, where substantial progress has been made in the recycling of heat and water in recent times. The factory's dedicated steam turbine facility produces 30,000MWh/year to provide significant natural gas savings for batch mixer heating, as well as for plant and warehouse heating duties. In addition, 140,00 tons/year of water from the factory's washing machines is recycled to the cooling towers, further reinforcing the group's professional approach to energy management and the delivery of effective energy efficiency projects. ●

Further information:
Sisecam Group, Istanbul, Turkey
web: www.sisecam.com

The Shandong Jingyao Glass plant currently features four melting furnaces and 16 high speed production lines, with a combined nominal capacity of 1000 tons/day. As this artist's impression shows, the site is big enough to house a fifth production shop.

Lightweighting investments benefit beer bottles specialist

One of China's leading beer bottle producers, Shandong Jingyao Glass Group Co Ltd continues to invest strongly in the high speed production of lightweight bottles. Tang Yong, Chairman, spoke exclusively to *Glass Worldwide* about his company's latest development and investment highlights.

China's iconic Tsingtao beer has gained popularity throughout the world, its bottles' easily recognisable logo displaying an image of Zhan Qiao, a famous pier on Qingdao's southern shore in Shandong Province. Local glassmaker, Shandong Jingyao Glass Group Co Ltd is an established supplier of glass packaging to Tsingtao Brewing Co Ltd and has been the subject of significant investment in recent times to keep pace with growing demand.

As well as supplying Tsingtao, the specialist bottle maker has emerged as an important supplier to such global brands as AB InBev, Carlsberg, Heineken and Snow Beer. Production is primarily in 207ml, 250ml, 296ml, 330ml, 355ml and 640ml lightweight bottle sizes in emerald green, clear and amber glass compositions. ▸

The site is responsible for an annual production capacity of 1.4 billion bottles (360,000 tons).

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Since taking over as Chairman, Tang Yong has led the glassmaker's differentiation development strategy, following a path where no other Chinese beer bottle producer has achieved similar success to date.

Although the vast majority of output is sold in China, a small amount of export work is undertaken to Vietnam and other neighbouring countries.

According to Tang Yong, Chairman, Shandong Jingyao Glass now ranks ninth among the world's leading beer bottle manufacturers. Located at Linyi City in Shandong Province, the specialist glassmaker has successfully implemented a development strategy for the mass production of lightweight bottles to satisfy growing demand in the local market, while also developing the high end beer bottle sector and further enhancing the company's position within the industry.

Glass industry veteran

As well as being Chairman of Shandong Jingyao Glass, Tang Yong is also Vice Chairman of the China National Glass Association for the Glass Industry. An industry veteran with over 28 years' experience, he joined Jingyao's predecessor business in Linyi City, Pingshang Glass Factory, in 1991. Pingshang Glass was subsequently restructured into Shandong Jingyao Glass in 2005.

Tang Yong moved into product sales in 1998, initially as Supply and Marketing Company Office Director, before serving as Supply and Marketing Company Deputy General Manager and then as General Manager. He was named President of the company in 2005, prior to taking over as Chairman in 2010. Working at the helm of the company, his main responsibilities relate to strategic development, personnel selection, raising funds and making investment decisions. "My father, Tang Shunfu was the inspiration for my career in the glass industry" Tang Yong explains. "He led Shandong Jingyao Glass through some tough times along the road to development and in so doing, he strengthened my resolve to work in the glass industry, as well as my faith in the industry. He has been the guiding light in my career."

Since taking over as Chairman, Tang Yong has led the glassmaker's differentiation development strategy, following a path where no other Chinese beer bottle producer has achieved similar success to date. "So far, more than €80 million has been invested, most of it on the installation of modern, high speed production facilities associated with making lightweight bottles and pollution treatment equipment, where NO_x and CO_2 removal is necessary" he says, acknowledging that this project still represents one of the most rewarding aspects of his job to date. "There is still a long way to go compared to the world's most advanced glass bottle manufacturers in Europe and the USA, however, with the need for continuous innovation and achieving the most advanced global standards representing my greatest future challenges."

Other key members of the Shandong Jingyao Glass management team include Bo Wencai, Qiu Xugang and Yu Guoming. Of these, Bo Wencai has been involved in bottle manufacture since 1985 and has a wealth of production and management experience, while Qiu Xugang has been associated with the industry since 1991, initiating the company's lightweighting development and manufacturing initiative in 2012. "The lightweight bottle production team he led worked around the clock at the production site, abandoning the traditional blow-blow production ▸

Shandong Jingyao Glass now ranks ninth among the world's leading beer bottle manufacturers.

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process and achieving breakthroughs with narrow neck press and blow technology to successfully produce lightweight bottles" Tang Yong confirms.

The third significant member of the management team, Yu Guoming holds a Master's degree in materials science from the Shandong Institute of Light Industry. Since graduating, he has worked for three decades at Jingyao in glass formulation and other areas of process management. A series of patents have been obtained through his research into lightweight glass material formulation.

The Shandong Jingyao Glass plant provides employment for 590 people in Linyi City.

Advanced production technology

The Shandong Jingyao Glass plant, which provides employment for 590 people in Linyi City, features four melting furnaces and 16 high speed production lines, with a combined nominal capacity of 1000 tons/day. Currently operating at maximum capacity to keep pace with fast growing customer demand, the site is responsible for an annual production capacity of 1.4 billion bottles (360,000 tons).

Some of the world's most advanced glass container production technology is operated at the site, including Heye International NNPB process IS machines, as well as several Sanjin-Emhart IS machines that can be converted to NNPB operation as required. The high speed 10-section Heye International IS machines are successfully operating with advanced cold end inspection equipment from Lyon-based IRIS Inspection machines. This includes Evolution 12 machines to perform sidewall and sidewall stress inspection, as well as IRIS Evolution 5 machines for base, base stress and finish inspection. Other automated inspection technology operated at the site has been sourced from Shandong Sanjin Glass Machinery and Beijing Daheng Image Vision, as well as from Heye International in Germany.

HORN forehearth technology is widely employed throughout the factory, as well as forehearths and annealing lehrs from Shandong Sanjin Glass Machinery. The four melting furnaces were designed by China Light Industry International Engineering, while the factory's batching equipment was purchased from local suppliers Qingdao Haisheng Automatic Engineering and Auto-System Technology Development.

Cold end handling and palletising equipment has been sourced from Italy's Emmeti (EMS Group) and from Weifang Sanjian Glass Machinery.

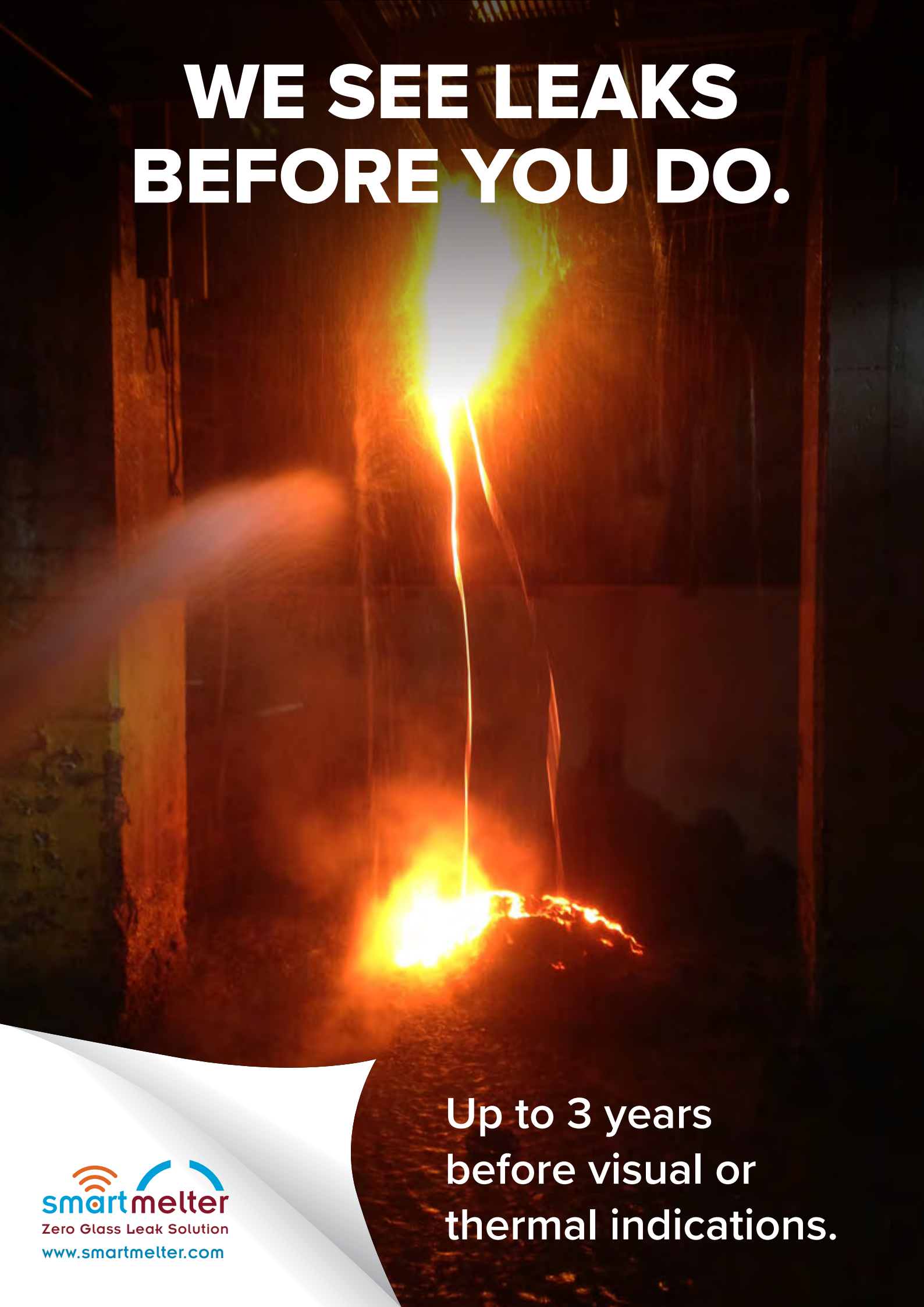
As part of the company's ongoing investment strategy, Shandong Jingyao Glass has acquired the Chinese glass container industry's first automatic swabbing robots, as well as press duration control (PDC) systems and the PlantPilot information technology solution from Heye International. A technical assistance agreement has also been signed with Heye to improve and optimise NNPB technology at the site, as the glass plant management team looks to reinforce its position as China's market leader for the technology.

Shandong Jingyao Glass has been on a steep learning curve in recent years, as the company continues to grow stronger in line with the expanding needs of the local economy. Plans are in place to invest in the production of lightweight packaging for mineral water and other beverages but the production of beer bottles will continue to represent a focal point for the factory's activities.

Tang Yong confirms that a national standard for beer bottles is soon to be issued. As a result, he anticipates even higher demand for lightweight beer bottles in China and the potential for supply shortages. All of which represents the latest major business opportunity for Shandong Jingyao Glass! ●

The Shandong Jingyao Glass factory is currently operating at maximum capacity to keep pace with fast growing customer demand.

Further information:
Shandong Jingyao Glass Group Co Ltd, Linyi City, Shandong Province, China
web: www.sdjingyao.com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Global trade war recovery goals

The Chinese glass industry could benefit from additional growth impetus this year, due to the major progress achieved between China and the USA during the latest round of trade talks. As Eugene Gerden explains, trade wars have negatively impacted the glass trade of both countries and led to significant losses for Chinese glassmakers.

The US tariffs, which were imposed last year on the $360 billion Chinese imports, also affected Chinese glass exports to the USA, making at least part of these supplies unprofitable for many producers. Closure of the US market to Chinese glass had a negative effect on entire Chinese glass exports, taking into account the status of the country as the world's largest glass exporter, valued at almost $10 billion in 2018.

While results for 2019 are still to be announced, analysts from the Chinese Ministry of Commerce expect an overall decline of Chinese glass exports of 20%-25% last year, compared to 2018.

From its side, China has struck back in the trade war by imposing duties on about $135 billion of US goods. This also affected US glass and glassware imports to the country but did not have a major impact on US suppliers, however.

In the meantime, due to the closure of the US market, many Chinese producers have already accelerated their efforts for re-orientation towards other markets, while the list of possible options includes primarily the markets of such emerging nations as India and Russia, as well as the CIS states. In recent years demand for glass in these countries has significantly increased, which, according to analysts, may provide additional opportunities for growth to Chinese glass exporters.

At the same time, analysts have warned that expansion into these markets will not provide an opportunity for producers to compensate at least 50% of their losses, associated with the closure of the US market, as the planned volume of supplies will be significantly lower than those to the USA. As for Russia, while local demand for glass has significantly increased in recent years, the export potential of its market for Chinese glassmakers will still be lower than those of the USA.

In the meantime, the ongoing decline of glass exports has already posed a threat for the implementation of strategic projects and Chinese government plans. For example, in accordance with the 'Made in China 2025' Strategic Plan, which was approved by the Chinese Government in 2015, China should become one of the world's largest exporters of high-tech glass products by 2025.

Closure of the US market to Chinese glass has a negative effect on total exports.

Steady high-tech growth

In general, China's exports of high-tech goods (including glass) increased steadily after reform policies began in 1978. However, due to the current trade wars, there is a high possibility that further growth may be complicated.

This is despite the fact that in recent years, the quality of glass produced in China has significantly improved, which allowed many of the country's leading producers to strengthen their position in western markets, including those of the USA.

The success achieved by Chinese producers in high-tech glass products is also reflected by major industry exhibitions that have been dominated by glassmakers from China. One of such expo was Guangzhou Glasstec Expo 2019, an important annual event in the global glass industry, where a number of leading Chinese glassmakers presented their latest developments. China Glass Holdings Ltd, for example, showcased its innovative products in the field of energy conservation, environmental protection and energy innovation, including Online Sun-E and Sun-R series reflective glass, ultra white UV-resistant glass and high transmittance glass.

At the same time, products shown by Shanghai SYP Glass Group included a broad range of innovative products, with a focus on low-E coated glass, automotive glass and energy saving insulating glass for buildings, ink jet printed glass, hyperbolic curved and tempered glass, as well as high end tri-silver low-E coated products.

In addition to production, in recent years progress has also been achieved in the development of glass processing equipment, including cutting tools and abrasives, as well as other glass manufacturing technologies and equipment. The latter came mainly due to the successful adoption of western glassmaking technologies. Further sharing of experience and the adoption of western technologies may be significantly complicated by the decision of the Trump administration to create a set of narrow rules to limit the export of sophisticated technologies to China. Reportedly, this may significantly delay the commissioning of large-scale glassmaking facilities in China in the coming years.

China's glassmakers suggest, however, that the ongoing trade wars ▸

Analysts from the Chinese Ministry of Commerce expected a 20%-25% fall of Chinese glass exports for 2019.

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with the USA will not stifle the industry's growth momentum. According to recent statements released during Guangzhou Glasstec Expo 2019, the production of high-tech glass will continue to expand, while architectural decorative glass, electric glass, home glass furniture, automotive glass, electronic glass and solar glass all continue to represent growth opportunities.

In addition, the volume of production for energy saving, safety and new energy glass, including touch screens of high aluminium cover glass, ultra white float glass and ultra white rolled glass will also continue to grow. At the same time, driven by new real estate projects and energy saving renovation of buildings, the building glass sector is expected to remain stable over the coming five to seven years. Finally, demand for glass used in aerospace is also expected to increase.

Expansion opportunities via acquisition

In the meantime, amidst the existing threat of potential technology shortages, many Chinese glassmakers are considering opportunities to expand their co-operation with existing western partners, often via acquisitions or mergers. The sphere of interest of Chinese glass companies includes EU glass producers that have significant experience of operating in global glass markets and operate valuable technologies. Potentially, these organisations could be of interest to Chinese producers.

A recent example of this approach was the acquisition of Italian glass equipment manufacturer Olivotto Glass Technologies SpA by China Glass Holdings in 2018. Olivotto is a leader in engineering, manufacture, installation and commissioning of hollow glass forming plants, systems and machines and is an all-round technological partner. Analysts expect similar deals to be signed this year.

Industry analysts also believe that the Chinese glass industry will continue efforts to overcome problems of excess production capacity. These problems have not yet been resolved effectively, leading to downward pressure on the Chinese glass industry, in an atmosphere of ever rising prices of raw materials, fuel costs and tighter environmental protection policies.

According to the predictions of analysts at the Chinese Ministry of Commerce, to help counter the trade war's impact, China is likely to continue to encourage its companies to establish operations abroad. In the meantime, most global glass majors also believe in the huge potential of the Chinese glass market.

As Jonas Spitra, who responsible for Corporate Communication at SCHOTT explained recently, the Chinese pharmaceutical market is one of the largest and fastest developing markets. "Within China's innovation roadmap, the pharmaceutical sector plays a very important role" he confirmed. "The shift towards innovation is clearly visible. Leading Chinese pharma companies have turned from generics to new drug development and newly founded local biotech companies have started addressing unmet medical needs. The main driver for this is certainly the 'Healthy China 2030' initiative, which will continue to push the market."

According to Mr Spitra, the company serves the local pharmaceutical market with high quality ampoules, vials and cartridges made from premium glass tubing at the company's two production sites in Jinyun, Zhejiang Province and Suzhou, Jiangsu Province. Strong demand for high quality glass tubing for the pharmaceutical industry has also prompted SCHOTT to build a state-of-the-art tubing plant in Jinyun County, Zhejiang Province. This plant will enable the group to participate in the advancement of the Chinese pharmaceutical packaging industry. ●

About the author:
Eugene Gerden is a freelance correspondent

China's pharmaceutical glass industry overview

For most industries during the last two decades, it is hard to escape the feeling that all roads lead to China. The country's steady rise as a global factory and its huge population has seen it transform into one of the world's foremost drivers of both production and demand for a number of products. As China continues its economic transition from a heavy manufacturing focus towards a more service-based model, its pharmaceutical industry is witnessing huge investments, driving glass container industry growth. Sunder Singh presents an overview of the country's pharmaceutical glass industry and its major players.

Involving about 45 small, mid- and large-scale producers, China's pharmaceutical glass industry has posted very strong numbers, much like the country's overall glass container industry. New investments, capacity expansions and modernisation exercises by existing producers have intensified during recent years due to increasing volumes and ever-increasing quality standards for pharmaceutical packaging.

Pharmaceutical glass packaging has a 21% share (based on value) of the overall Chinese pharmaceutical packaging market, which was estimated at RMB 106.8 billion ($16.02 billion) in 2018. The $3.36 billion pharmaceutical glass market is divided among vials, bottles, cartridges and syringes and ampoules in the proportion (value terms) of 34%, 27%, 9% and 30% respectively.

China has reached a major turning point in recent years with a shift from 'quantity' to 'quality'. Of the approximately 87 billion glass ampoules and vials used worldwide (45 billion glass ampoules and 42 billion vials), half are used in China. The quality required in Chinese pharmaceuticals has been different compared to Europe, the USA and Japan. Against this backdrop, in August 2017 the Chinese government announced the introduction of a conformity evaluation test system that requires companies to test generic drugs using tests equivalent to those used for original drugs. As a result, there is a growing demand for high quality products within China.

Considering that the Chinese pharmaceutical industry is expected to grow steadily in the coming years, pharmaceutical glass production is expected to register steady growth for a number of years to come. The pharmaceutical segment is the only instance where the glass container industry has not lost much share to alternative forms of packaging.

The country has been increasingly tightening its regulatory framework to support patient safety standards. Hence, demand for high quality drug packaging products is steadily increasing. As container glass is considered one of the safest modes of pharmaceutical packaging, Chinese pharmaceutical producers are expected to gain a further share in overall pharmaceutical packaging markets in the future.

Globally, more than 80% of glass vials and ampoules are made from neutral type I borosilicate glass tubing, which is the key component for manufacturing tubular glass components. Leading multi-national pharmaceutical glass producers such as Schott, Nipro and Gerresheimer are predominantly leading the parenteral packaging market,

Of the 87 billion glass ampoules and vials used worldwide, half are used in China.

China's pharmaceutical industry is witnessing huge investments, driving glass container industry growth.

owing to their large integrated production facilities and glass tubing abilities to supply to conversion lines, giving them control of over 60% of the overall parenteral packaging market.

In addition to these producers, however, a number of domestic pharma glass producers have started to produce type I borosilicate glass tubing. Companies including Linuo Glass Group, Shandong Honhai, Four Star and Jinan GT are among the industry's leading borosilicate glass producers, who have established state-of-the-art, high end glass tubing production facilities in recent years.

In order to cater to export markets, all major glass tubing producers have set up their production facilities around the coastal provinces of Shandong and Jiangsu. Proximity to coastal regions facilitates cheaper and efficient in-land logistics and also facilitates in sourcing cheaper freight charges for overseas shipments.

Emerging opportunities

China is the world's second largest market for pharmaceuticals and the fastest emerging market in the global pharmaceuticals industry. A burgeoning middle class and rapidly ageing population presents vast opportunities for pharma glass producers.

The country has become the world's second largest economy in a matter of decades under a strict one child policy (in place between 1979 and 2015), contributing to a rapidly ageing society with rising medical needs, which has necessitated huge spending on pharmaceutical products. China has a sizeable elderly population that is increasing. The population aged 65 years and older will increase from 90.6 million people in 2017 to 143 million in 2027, almost a 60% increase. Compare that to the USA, where population ages 65 and older will only reach 48.9 million in 2027.

According to health care information company IQVIA, China was the world's second largest national pharmaceutical market in 2018, worth $137 billion. It was also the biggest emerging market for pharmaceuticals, although IQVIA forecasts that growth has slowed from a 19% CAGR in 2008-2013 to an 8% CAGR in 2013-2018 and is expected to continue to decline to 3-6% through to 2023. Relatively low healthcare spending as a portion of GDP in China (around 6% in China, compared to a range between 10% and 17% in the USA, Europe and Japan) suggests that the market has a long way to go. For comparison, the world's largest health care consumer, the US pharmaceutical industry was $466.6 billion in 2017 and Japan was at $84.8 billion in the same year.

Made in China 2025

Pharmaceutical glass producers in China are expected to reap rich dividends from Beijing's 'Made in China 2025' industry plan. The Chinese government has identified the pharmaceutical sector as one of the focus sectors under this initiative.

Made in China 2025 (MIC 2025) is a national strategy, announced by China's State Council in May 2015, to comprehensively upgrade, consolidate and balance China's manufacturing industry, turning it into a global manufacturing power that is able to influence global standards, supply chains and drive global innovation. It has very specific objectives to 2025 and also in the longer term with general objectives onwards to 2049 (the 100th anniversary of the founding of the People's Republic of China).

Major producers

Comprising some 45 pharmaceutical glass producers, the Chinese pharmaceutical glass manufacturing industry, which was highly disorganised until the first decade of this century is gradually concentrating towards an organised sector. A number of domestic producers have invested heavily in operations in recent years to expand the scale and quality of products. Leading foreign pharmaceutical producers have also invested significantly in the last 10 years in the country's pharma glass sector. ▸

Shandong Pharmaceutical Glass

Shandong Pharmaceutical Glass is among the largest pharmaceutical glass producers in China. Established in 1970 as Shandong Pharmaceutical Glass Factory, the company changed its name to Shandong Pharmaceutical Glass Company in 1993, when it shifted operations to Zibo City.

The company's products include moulded glass pharmaceutical bottles, ampoules, amber bottles, butyl rubber stoppers and aluminium caps. Its product range covers nine major series of 500 products with differing specifications, which include moulded glass vials and bottles that conform to USP types I, II and III with an annual installed capacity of about 10 billion pieces. Currently, the company is undergoing an extensive modernisation exercise with an outlay of Yuan 698 million.

Over the years, the company has established a number of subsidiaries, which are engaged in the production of pharmaceutical glass. Prominent among these are Baotou Kangrui Pharmaceutical Glass Packaging Products Co Ltd in Inner Mongolia, which was established in 2002 and the acquisition of Sichuan Mianzhu Chengxin Medicinal Glass Co Ltd, which was carried out in 2014.

Although the company had not declared 2018 results at the time of writing, with an operating income of RMB 1150 million ($172.5 million) in 2017, Shandong Pharmaceutical Glass registered an increase of 18.43% in operating income over the prior year's figures. Domestic sales accounted for about 68.5% of total revenues, while exports accounted for the remaining 31.5% of revenues.

Cangzhou Four Star Glass Co

State-owned Four Stars Glass Co is among the leading producers of borosilicate tubes, vials and ampoules in China. Located at Cangzhou, Hebei Province, the company, which has an installed capacity of 100,000 pharmaceutical glass tubing, has emerged as a leading supplier to downstream converters in this category.

The company also has an installed capacity to produce 1.2 billion pieces of vials and ampoules on an annual basis. Producing pharmaceutical glass since 1988 from its production facility located at the Industrial Development Zone of Jidong suburb of Chengdu City,

Company	Installed capacity	Location
Anhui Huaxin Pharmaceutical Glass Products Co	600 million pieces of bottles and vials/year	Chuzhou City, Anhui Province
Cangzhou Four Star Glass Co	100,000 tonnes/year of neutral borosilicate glass tubes and 1.2 billion pieces of vials and ampoules	Zhifangtou Industrial Park, Cangzhou county
Cangzhou Xingchen Glass Co	1.6 billion pieces of bottles and vials	Cangzhou City, Hebei Province
Chengdu Jingu Pharma Pack Co	Mentioned in profile	Chengdu, Sichuan Province
Chongqing Zhengchuan Pharmaceutical Co Ltd	Seven billion pieces of glass vials and ampoules/year	Beibei district, Chongqing
Dezhou Jingfeng Glass	180,000 tonnes/year of glass bottles and vials	Shandong
Dezhou Jinghua Pharmaceutical Glass Co Shandong	2.8 billion moulded schering bottles in 5-100ml sizes	Dezhou Economic Development Zone,
Famacy Glass Co Ltd	Mentioned in the profile	Jiangsu and Sichuan Provinces
Hongguang Pharmaceutical Glass Co	NA	Ruicheng, Shanxi Province
Jiangsu Chaohua Glassworks Co Ltd	40,000 tonnes/year of vials and ampoules	Danyang, Jiangsu
Jiangsu Jiajia Pharmaceutical Glass Co	32,000 tonnes/year of vials and ampoules	Jiangsu
Jiangsu Huayue Pharmaceutical Glass Co	500 million vials/year	Fangxianzhen, Jiangsu
Jiangsu Tian Ning Glass Technology Co	700 million vials and ampoules	Danyang, Jiangsu
Jinan C-Flying Industrial Group	12,000 tonnes/year of pharmaceutical neutral glass tube and 800 million pieces of tubular vials, moulded glass vials and ampoules	Jinan, Shandong
Jinan GT Industrial Co (GT Glass)	36,000 tonnes/year of pharmaceutical glass tubes in clear and coloured glass	Jinan, Shandong
Jotop Glass	500 million pieces of moulded glass bottles and vials	Jinan, Shandong
Ningbo Zhengli Pharmaceutical Packaging Co Ltd	600 million pieces of vials range from 1ml to 30ml, prefilled syringes and cartridgess	Ningbo City, Zhejiang Province
Nipro Corp	-	Henan, Jilin and Sichuan Provinces
Ompi Pharmaceutical Packaging Technology (China) Co	300 million pieces of vials and ampoules	Zhenjiagang
Puyang Lumeng Glass Co Ltd	25,000 tonnes/year of glass tubing, three billion pieces of vial and ampoules	Jinan, Shandong
Qingdao Yutai Pharmaceutical Packaging Co	800 million pieces of vials, ampoules and bottles	Jiazhou City, Qingdao
Schott China	2.4 billion pieces of vials and ampoules	Suzhou and Jinyun
SGD Pharma	1.2 million type II and III flint moulded glass vials daily	Zhnajiang City, Guangdong
Shandong Linuo Technical Glass	Mentioned in profile	Jinan, Shandong
Shandong Pharmaceutical Glass Co	Mentioned in profile	Zibo City, Shandong
Shandong Hon Hai Industrial Glass Co	100,000 tonnes of borosilicate glass tubes, plus one billion pieces of vials and ampoules	Jinan, Shandong
Shanxi Hongjin Medical Glass Co	800 million pieces of vials and ampoules	Yuncheng, Shanxi
Triumph Junheng Hebei Pharmaceutical Glass Co	30,000 tonnes/year of neutral glass tubes	Henden City, Hebei
Wuhu Changjiang Glass Produce Co Ltd	Two billion pieces of moulded bottles, vials and ampoules	Wuhu, Anhui
Zibo Rongdian Glass Co Ltd	600 million pieces of pharma bottles and vials/year	Yiyuan, Shandong

Leading pharmaceutical glass producers in China.

Chengdu Jingu Pharma Pack Co operates five furnaces (three for clear glass tubes, one for low boron and silicon amber glass tubes and one for infusion bottles) to produce 43,000 tonnes/year of clear glass tubes, 7000 tonnes of amber glass tubes, 150 million glass infusion bottles, four billion ampoules, three billion glass vials and three billion bottles for controlled oral liquids.

The company is equipped with a state-of-the-art production facility from Italian company, OCMI.

Chongqing Zhengchuan Pharmaceutical Packaging Co

Chongqing Zhengchuan Pharmaceutical Packaging Co Ltd specialises in the production of medicinal glass vials and caps for glass injection vials and oral liquid vials.

The factory has an installed capacity of more than seven billion glass vials and 1.5 billion bottle caps per year. In 2017, the company was listed on the Chinese Stock Exchange.

Jiangsu Famacy Glass Co

Established in 1988, Famacy Glass has emerged as one of the leading pharmaceutical glass producers in China. The company operates from three production bases located at Changzhou City in Jiangsu Province, Chengdu City and Yaan City, Sichuan Province.

Famacy Glass operates a total of five furnaces and 218 production lines to produce nearly two billion glass vials, 3.5 billion ampoules, one billion moulded glass bottles and 100 million cartridges per year. The company also has an installed capacity to produce 40,000 tonnes per annum of pharmaceutical glass tubing (including 6000 tons per annum of amber glass tubing).

Dezhou Jingfeng Glass

Dezhou Jingfeng Glass, a group company of Jinghua Group, is among the leading producers of pharmaceutical glass in China. The company has an installed capacity of 180,000 tonnes/year of pharma glass via 27 production lines. Sister concerns are leading float and glass block producers in the country.

Linuo Technical Glass

A subsidiary of Linuo Group, Linuo Technical Glass was established in 1994 to produce pharmaceutical glass packaging for domestic customers. Over the years, the company has emerged as a leading producer, with an installed capacity of 130,000 tonnes of borosilicate glass (3.3) tubes and rods, 30,000 tonnes of pharmaceutical glass tubes and 2.6 billion ampoules and vials.

Schott China

Germany's Schott operates three state-of-the-art pharma glass production facilities in China. Schott entered the Chinese pharma glass market in 2008 by establishing a manufacturing facility at Suzhou, Jiangsu Province. The company's Suzhou plant produces glass vials and ampoules with an annual capacity of more than 100 million ▸

vials and ampoules.

In 2012, Scott entered into a joint venture with existing pharma glass producer Xinkang Pharmaceutical Packaging Co Ltd to expand its pharmaceutical glass production in the country. In October 2017, Schott commenced commercial production from its greenfield plant with an installed capacity to produce two billion pieces of high quality pharmaceutical packaging per year. The plant is managed by the joint venture Schott Xinkang business.

"The plant highlights Schott's philosophy of keeping production sites close to the customers and markets" Schott management commented. "It is located at the Schott Xinkang headquarters in Jinyun, Zhejiang and produces high quality ampoules, vials and cartridges made of premium glass tubing for the domestic pharma industry."

Last August, Schott held a groundbreaking ceremony for its greenfield pharmaceutical glass tubing plant in Jinyun, Zhejiang. The company is investing €60 million in the first phase to install a yearly capacity of up to 20,000 tons and production is scheduled to start by the end of 2020.

The plant will manufacture FIOLAX glass tubing, which is a 5.0 middle borosilicate glass. The new production site will support the move away from the low borosilicate glass (7.0 glass type) to the higher quality middle borosilicate glass (5.0 glass type), which is already well established globally. Production will be based on Schott's perfeXion process, with 100% quality control of each individual tube and in accordance with the worldwide quality criteria of Schott Tubing.

"The new plant will supply the Chinese domestic pharmaceutical packaging market to aid its development. We believe that healthy people make for a thriving society" said Dr Patrick Markschläger, Executive VP of Schott Business Unit Tubing at the time of the groundbreaking ceremony.

Gerresheimer Shuangfeng Pharmaceutical Glass

Gerresheimer's Shuangfeng facility produces vials, ampoules, cartridges and other specialty products made from clear and amber glass types I, II and III for pharma companies in Asia, the USA and Europe.

The group's Chinese operations comprise three tubular glass converting facilities in Danyang and Zhenjiang, Jiangsu Province. Gerresheimer had acquired the business of existing pharma glass producer Shuangfeng Pharmaceutical Glass in 2006. The Danyang I facility, which was built in 1986, is some 220km away from Shanghai and produces pharmaceutical vials. The second glass production facility at Danyang (Danyang II) commenced operations in 2009 to produce high quality pharmaceutical vials and cartridges for injection systems. Gerresheimer's third glass production facility at Zhenjiang started production in 2002. In total, these three manufacturing facilities are equipped with 150 production lines.

Ompi Pharmaceutical Packing Technology (China) Co

Italian pharma glass major, Ompi initiated glass container production in China in 2014 at Zhangjiagang (near Shanghai). Set up for an investment of €27 million, the company's production facility comprises five production lines with an installed capacity of 300 million ampoules and vials. Zhangjiagang's geographical location offers the company easy access to key pharmaceutical hubs in eastern China; just half an hour's drive to Suzhou for example, one hour to Wuxi and two hours to Shanghai.

As part of the Pharmaceutical Systems division of Stevanato Group, Ompi offers the widest range of glass primary packaging from the traditional, such as vials and ampoules, to high value added products such as syringes and cartridges for auto injectors and pen injectors.

In 2017, Gerresheimer signed an agreement with Ompi to provide standardised solutions for the pharmaceutical packaging industry. As part of the deal, Gerresheimer will use the Ompi EZ-fill packaging technology to develop its Gx ready-to-fills (RTF) vials, which can be washed and sterilised in trays or in nests and tubs.

Nipro

Japanese pharma glass producer Nipro operates four manufacturing facilities in China. Puyang City Changda Glass Co Ltd (Puyang City, Henan Province), Anyang Nipro Changda Pharmaceutical Packaging Co Ltd (Anyang City, Henan Province), Jilin Nipro Jiaheng Pharmaceutical Packaging Co Ltd (Changling county, Jilin Province) and Chengdu Pingyuan Nipro Pharmaceutical Packaging Co Ltd (Chengdu City, Sichuan Province) produce glass tubing, vials and ampoules for local consumption.

With worldwide glass manufacturing and converting facilities located in China, Europe (France, Germany, Belgium), the USA (Millville, Chase City, Westport), India, Indonesia, Japan and Russia, Nipro Glass is a vertically integrated global supplier of pharmaceutical tubular glass packaging. The company's product range extends from tubing, ampoules and cartridges to sterile syringes and vials.

China Glass Holding acquires Olivotto Glass Technologies

China Glass Holding, one of the leaders in float glass production, acquired a 100% stake in Italian glass equipment manufacturer Olivotto Glass Technologies SpA for a consideration of €21.45 million in October 2018.

Olivotto produces equipment mainly used in the production of neutral medicinal glass and household glass. The company is among a selected few global leaders in glass tube drawing technology and a supplier of pharmaceutical neutral glass products manufacturing equipment.

On the occasion of the acquisition, China Glass Holding said in a press release: "The acquisition will be of great significance to neutral glass manufacturers in China, given that the pharmaceutical industry is a key industry in the world and China is expected to play a major role in it in coming years."

SGD Pharma

SGD Pharma is a global leader in glass pharmaceutical packaging and Chinese state-fund China Jianyin Investment Ltd became a stakeholder in the business in 2015. SGD Pharma operates a pharmaceutical glass production facility at Zhanjiang and globally, the company produces over eight million vials and bottles per day at its five manufacturing plants in Europe and Asia.

The Zhanjiang plant has an installed capacity of 1.2 million Type II and III flint moulded glass vials per day for the parenteral market and healthcare beauty products. Spread over an area of 85,000m^2, the Zhanjian plant has one furnace, six production lines and an ISO 8 clean room of 2000m^2.

In 2018, SGD Pharma invested $8 million at the Zhanjiang plant, including rebuilding of the furnace and installation of new automation and production equipment. The energy supply for the furnace was modified, as the new furnace is natural liquid gas-based compared to the previous fuel-based technology. This change brought the furnace into compliance with China's new environmental regulations.

According to SGD Pharma, the investment has enabled the obtainment of a more precise refinement in production that improves the quality of the glass, with an increase of 11% in production.

For a full profile of the SGD Pharma Zhanjiang plant, see the May/June 2019 issue of *Glass Worldwide* (issue 83). ●

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Customer focus drives positive results for Indian glassmaker

A hot topic of conversation at last October's glasspex INDIA 2019 exhibition in Mumbai involved the positive performance of Borosil Glassworks and the diversified company's latest pro-active investments. Shreevar Kheruka, Managing Director, exclusively explained his influential role in the family-owned glassmaking organisation's return to success to *Glass Worldwide,* preferred international AIGMF journal.

Shreevar Kheruka took over as Managing Director of Borosil in 2011.

Today, Pradeep Kheruka concentrates on the Borosil Renewables solar business.

Borosil Ltd is the market leader in India for laboratory glassware and microwavable kitchenware. The parent company, Borosil Glass Works Ltd was established in 1962 in collaboration with Corning Glass Works. This business became a wholly-owned Indian enterprise in 1988, managed and directed by members of the Kheruka family from headquarters in Mumbai. Sister company Borosil Renewables Ltd specialises in the manufacture of high performance solar glass. Other production specialties include lighting, extra clear patterned glass and pharmaceutical glassware. In 2016, Borosil completed its acquisition of Hopewell Tableware (manufacturer of tempered opal glass tableware) and Klasspack, a producer of glass ampoules and tubular glass vials. Both businesses have now been successfully integrated within the Borosil Group.

In the 2000s, however, the business has encountered severe financial difficulties, before ultimately returning to its current position of stability and profitability. Labour problems, challenging bank lending rates and escalating fuel costs all combined to impact the company's performance, at a time when cheap imports started to flood the local market. In addition, it became necessary to source some products from outside India to satisfy customer requirements. "It was a very difficult situation" Shreevar Kheruka confirms "but I was blessed to be placed in a position to be able to address such huge challenges."

Over the years, the company has operated four different manufacturing sites in India but its two main production sites are at Bharuch in Gujarat and at Jaipur in Rajasthan.

Family glassmaking dynasty

Shreevar Kheruka was six years old when his grandfather, Mr B L Kheruka, who already owned a glass manufacturing business in Kolkata, took the decision to acquire Borosil from Corning in 1988. "Where I grew up in the Marwari or Gujarati community of north west India, the area is famous for its entrepreneurial families, where it is normal to hear business discussions at the dinner table. Even though I might not have been aware of it on a career level, subconsciously the knowledge and experience keeps going in and as children, we would visit the glass plant in Kolkata every weekend. So when our family took over Borosil and relocated to Mumbai, I was fully aware of the company."

Following the completion of his studies in India, Shreevar Kheruka completed a dual finance and international relations degree at The Wharton School of the University of Pennsylvania in the USA. He then worked for two years at Monitor Consultants (now Monitor Deloitte) in Boston, before returning to Mumbai in 2006 to join the management team at Borosil.

It was always envisaged that Shreevar Kheruka would follow in the footsteps of his father and grandfather and work in the family glassmaking business. During four years at university in the USA, he was exposed to different types ▸

Mr B L Kheruka is still Executive Chairman at Borosil.

The Borosil Renewables factory at Bharuch, Gujarat.

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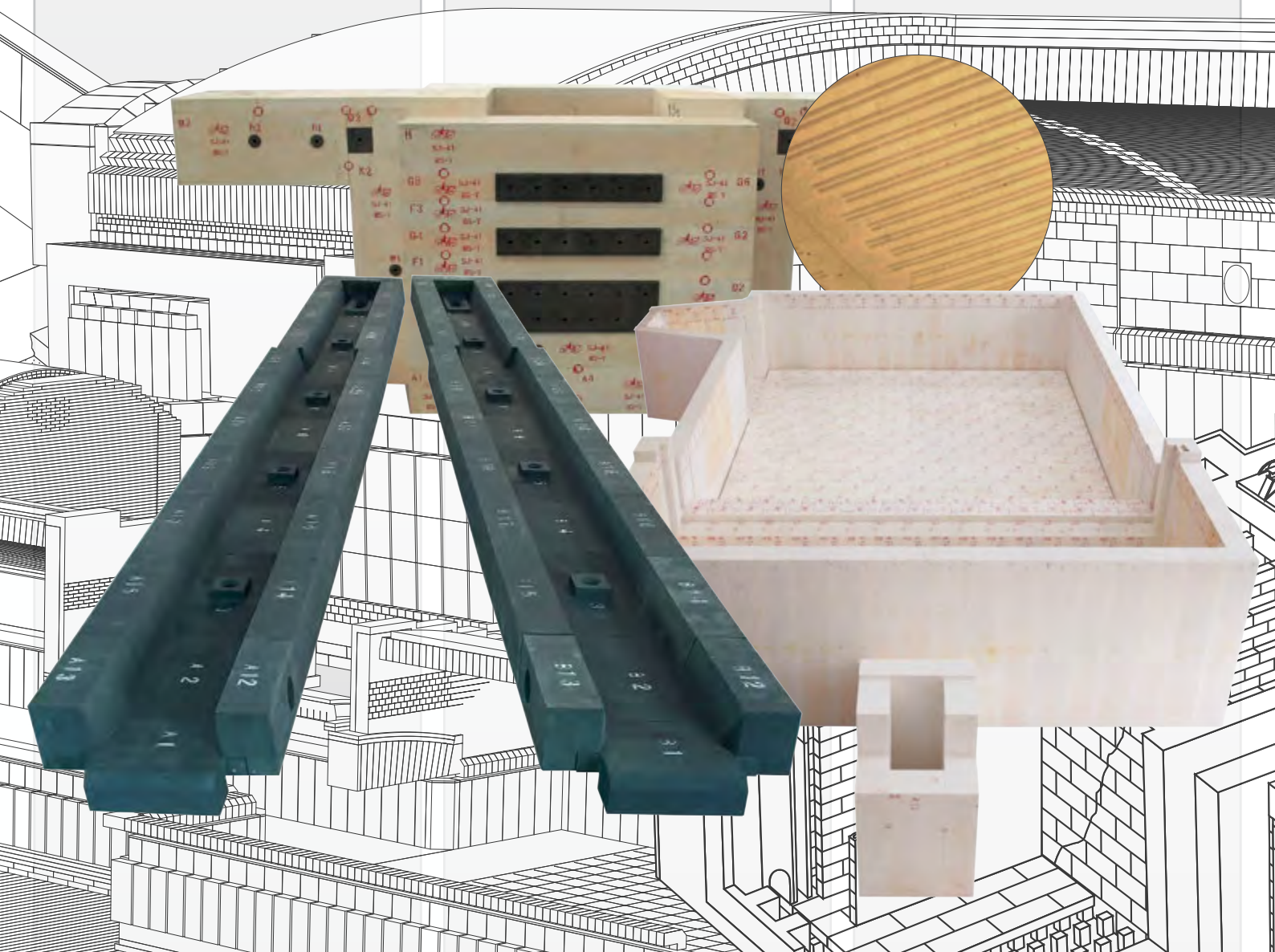

of communication and education, in a very international environment, before experiencing how corporate America works during his time in Boston. "Studying at a prestigious university and having worked for a successful company gave me a lot of credibility when I came back to India to work at Borosil, rather than being viewed as someone who was entitled and the son of the owner!"

He joined as Assistant Vice President, at a time when the business was in the midst of a substantial crisis, suddenly going from being profitable to making losses. As explained above, the Mumbai operation was bleeding money heavily and represented a tough initiation for the latest member of the Kheruka dynasty. "The challenges that affected the business so significantly all arose within a short space of time, so we were caught unawares." It was necessary to address product costings and Shreevar Kheruka visited numerous glass factories around the world, learning many best practices that helped in the formulation of a new business model. "There were lots of moving parts but by 2010, I think we had managed to deal with the bigger problems and ever since, the company has been on a very good wicket."

Close-knit family benefits

While the company's patriarch, Mr B L Kheruka (Executive Chairman) concentrated on developing valuable architectural business opportunities and his son Pradeep (Vice Chairman) was heavily involved in intensive labour and legal issues, grandson Shreevar was tasked with the day-to-day running of the Borosil Glass Works consumer and scientific division. This involved sourcing, operations, setting up a new plant in Gujarat and connecting with customers.

The reallocation of responsibilities worked well, to the point where Shreevar Kheruka was made Managing Director in 2011. Today, he has full responsibility for the consumer and scientific division, while his father Pradeep is responsible for the solar business. "I would never say that my grandfather has retired because he has a very high level work ethic and I don't know what he'd do with himself! But as Chairman of the Board, he is now in a more advisory role rather than operations" Shreevar explains. "Obviously, we are a very close-knit family and any key decisions are taken with 100% consensus between the three of us. Overall, the co-operation between us could not be better and the communication and level of understanding is very strong."

In recognition of his six decades' long career in the glass industry and his valuable contribution in the areas of technology, manufacturing, innovation, services and education, last year Mr B L Kheruka was announced as a worthy winner of the AIGMF's C K Somany Award for Innovation and Technology. This award was supported by *Glass Worldwide*. "Always thinking beyond himself, he has continually been trying to improve the prospects of not just Borosil but the glass industry in general" his grandson commented. "He was delighted to receive this award because it means so much to receive recognition from his peers."

All three generations of the Kheruka family share the same work ethic and approach to the delivery of appropriate value systems, respecting customers and suppliers alike, offering high quality products and observing the simple yet important tenet of promising only what can be delivered and delivering what is promised. "There is no culture of making a quick buck and there is a high degree of alignment."▸

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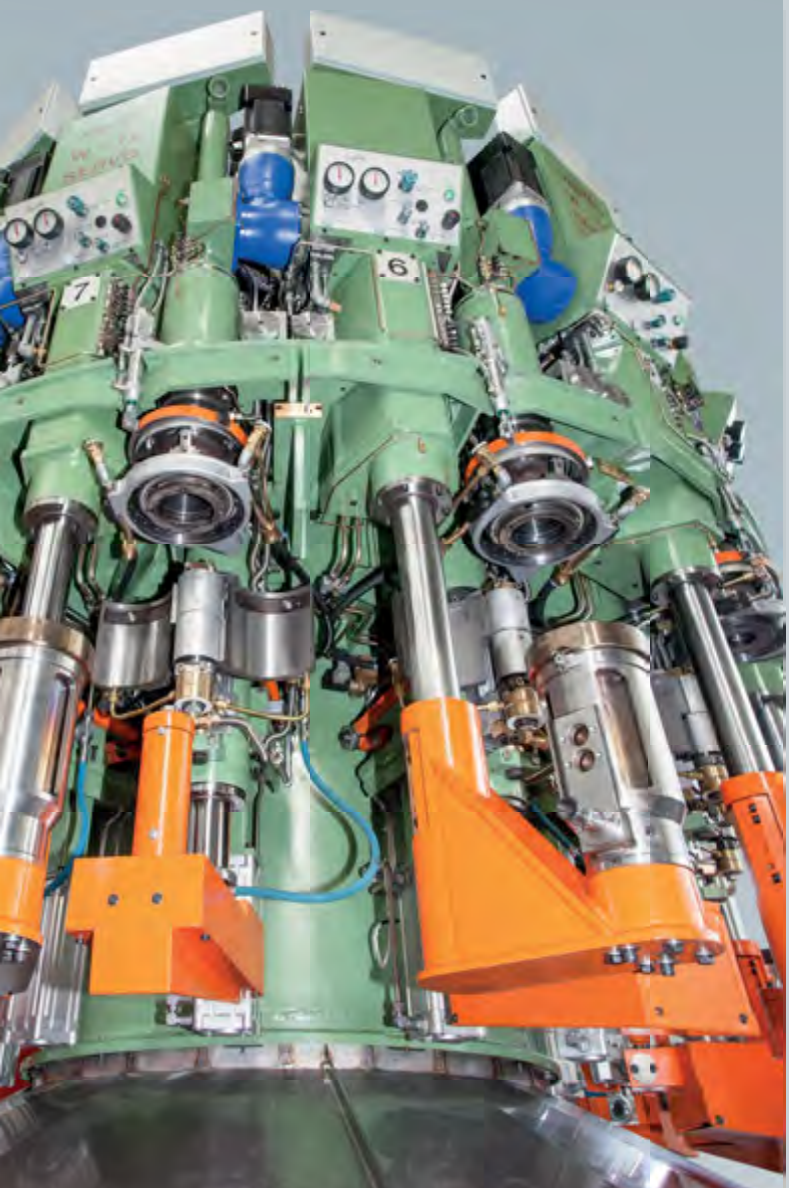

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Shreevar Kheruka addresses staff at the Borosil glassworks.

Importantly, Shreevar Kheruka has pioneered the introduction of a different approach to employee involvement in the creation of a shared company vision and the adoption of a more 'bottom up' rather than 'top down' decision-making process. "The way the company operates has changed dramatically in the last 10 years" he confirms. "The world is changing… we have to be more flexible and move with the times to meet expectations and recruit and keep the best people. It is our responsibility to continue to evolve with the times."

Staff training and development is an important aspect of the management style adopted by Borosil and a strong performance management process has been devised, where the company's vision and deliverables are created and regularly assessed. Shreevar Kheruka is strongly committed to this approach, personally devoting in excess of 30% of his time to HR and organisational development related to people. "It's time well spent" he contends. "It's simply not always possible for us to make the best decisions from top down; the market is evolving rapidly and new product ideas need to come from our people on the ground, who are talking to customers every day. What we need to do in terms of investing in the plant should come from the people at the plant, rather than head office as it often was in the past. Our employees need to feel part of the organisation for the company to continue to move in the right direction."

Sales and product development practices are consistent across the company, observing a customer-centric focus. This embraces the concept of teams setting goals together in a room and people buying into those goals for the medium and short term. "The openness of discussion that we have across our teams, the transparency of data sharing is absolute across the company" Shreevar Kheruka confirms. ▸

Solar glass production at the Borosil Renewables factory.

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Glass is **our Passion**

Including contract workers, the group currently employs 2500 people, 1500 of whom work for the consumer and scientific division and 1000 for the solar division. These numbers reflect the lower labour costs in India compared to many other parts of the world, where automated production practices are increasingly more cost-competitive.

Investing in the future

Like every forward-looking glassmaker around the world, Borosil is investing strongly in digital technology to optimise production efficiencies. While all equipment is already linked to the internet and data is gathered from every operation, however, the company recognises that opportunities exist to use this data in a more meaningful way. For example, Shreevar Kheruka believes that the level of autonomous or predictive maintenance algorithms adopted can be increased to reduce downtimes. A pilot project has been budgeted for 2020 to illustrate the benefits that could be realised.

Separately, a pilot on-line production monitoring project was initiated last year to show the yields of operating machines. Although further analysis of the data generated has still to be undertaken, this project is considered a step in the right direction.

Leading suppliers of production and processing technologies are playing an equally important role in the company's recent resurgence. "Working with the correct supplier for machinery and technology can make all the difference between being a low performance company and a high performance company" says the Borosil Managing Director. "We are not in the business of saving money in terms of using the cheapest equipment. We invest in the best equipment to make the best quality glass, with the highest efficiency, so we always prefer to buy the best machinery and technology available for a specific purpose and that is the case for all Borosil business units."

Last October's glasspex INDIA 2019 exhibition in Mumbai was recognised as a valuable opportunity to meet international suppliers in one place and is prioritised for attendance, along with glasstec in Germany. "A lot of discussion is undertaken in a short period of time and many things can be resolved in terms of cross checks and functionality, because we select suppliers on a project by project basis" says Shreevar Kheruka. "The 13th International Conference of the All India Glass Manufacturers' Federation that was staged alongside glasspex INDIA with the support of *Glass Worldwide* was also a great opportunity to see and hear from international suppliers. We don't have tie-ups with individual suppliers but if their previous work with us has been successful and we are well connected with them, we will strongly consider them again, of course."

Performing a bending test on 2mm solar glass.

Strongly performing acquisitions

Since their acquisition in 2016, Hopewell Tableware (manufacturer of tempered opal glass tableware) and Klasspack (manufacturer of glass ampoules and tubular glass vials) have been successfully integrated within the group. And according to Shreevar Kheruka, both companies have grown substantially in the intervening period.

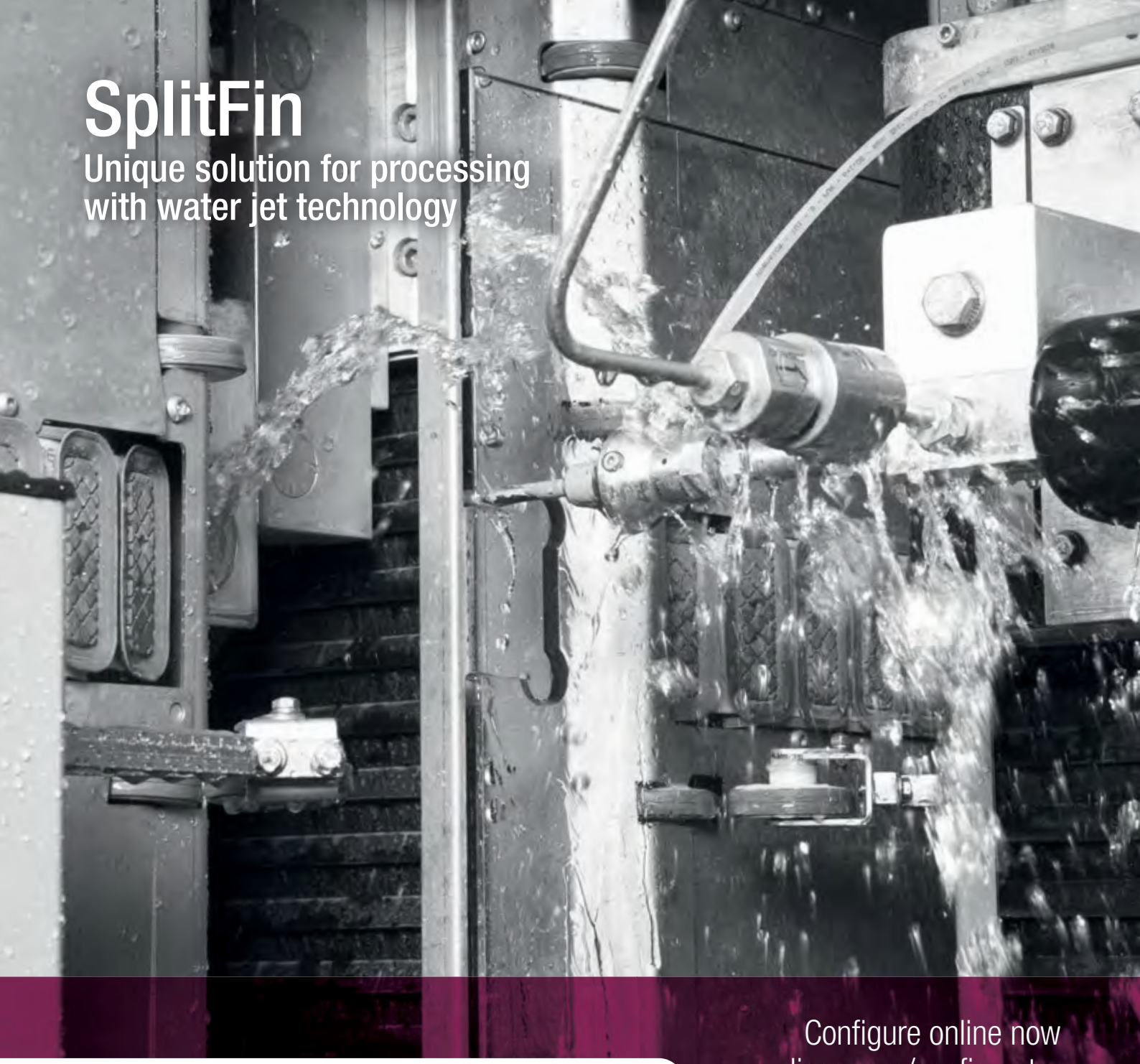
By 2019, Hopewell's revenue had tripled and continues to increase. European melting and forming technology has been introduced, while the product portfolio has been upgraded via investments in new shapes and moulds. In addition, sales and marketing functions have been integrated within Borosil, as the brand continues to successfully benchmark its opal products against leading European manufacturers.

Since Borosil acquired an approximately 80% interest in the pharmaceutical packaging producer Klasspack in 2016, sales have increased from approximately $4 million to some $8.5 million in 2019. Investments have been made in the latest forming lines, camera inspection systems and clean room technologies to satisfy the demanding requirements of the pharmaceutical sector. ▸

Borosil's Vision glasses range.

Examples of calibrated laboratory glassware.

Mr B L Kheruka was announced winner of the AIGMF's C K Somany Award for Innovation and Technology in 2019.



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Having now stabilised the business as a whole and witnessed the benefits of its latest acquisitions, Borosil is constantly on the lookout for further possible acquisitions that are considered 'a good fit' with the existing portfolio. "Acquisitions can be a risk from a cultural and disruption perspective, so the reward has to be commensurate" says Shreevar Kheruka. "We have a fantastic franchise here in India in terms our brand name, distribution strengths and the teams that have been built up and go out to see customers… and we should be looking to push as many quality products as possible through that pipeline. We have a good vehicle for acquisitions and if we find something interesting then we will review it; our progress in the last decade and the position of the company now means we are able to do that."

Borosil's Classic Delite ware.

Solar glass investments

In 2019, approximately $37 million was invested to double solar glass production at the Bharuch manufacturing site in Gujarat. The original 180 tonnes/day line has been repaired and its capacity has been increased to 210 tonnes/day, while a second line of the same size has been added.

This significant production capacity expansion was undertaken in an effort to keep up with fast expanding local demand for solar glasses but another doubling of capacity could soon be on the cards. Sufficient space at the site exists to increase manufacturing capacity to some 840 tonnes/day and another fast track investment is currently the subject of evaluation.

"Our solar company is extremely innovative in terms of cost cutting and achieving higher efficiencies" Mr Kheruka explains. "The team is strong and the very high levels of efficiency achieved allow us to be competitive with Chinese suppliers. The quality of glass and our energy consumption per tonne is world beating, as are other areas of the business."

Focus on customer value

While acknowledging that the glass industry has been boosted by the prevailing anti-plastic sentiment throughout the world, Shreevar Kheruka warns that greater innovation is necessary if the industry is to solve the challenges of reducing weight and increasing strength at a viable cost. "There is a huge growth opportunity in the field of glass but increased innovation and technology are key" he stresses. "At Borosil, we are constantly trying to find new ways to deliver this value to the customer."

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On the Spot… Rajesh K Khosla

Announcing plans to enhance production capacity by 100% during the next phases of an ambitious investment programme, Rajesh Khosla, President and CEO of AGI glaspac, spoke exclusively to *Glass Worldwide* about the company's growth, current market trends and the performance of glass versus competitive packaging in India.

GW: What are the prevailing market conditions for the hollow sector in India and what are your forecasts for the next 12 months?
There is a temporary slowdown in the general market, owing to the local political conditions and muted consumer sentiments. The hollow sector, too, is not insulated and is going through a brief period of calmness. The Indian government is taking the necessary steps to drive up the investment, boost liquidity, restore consumer confidence and bring back the bullishness in the economy. We foresee good growth in the alcoholic beverage and pharmaceutical segments in the coming year and estimate 9% to 10% growth in the container glass market in India.

Both AGI glasspac plants have started using natural gas in their furnaces.

GW: Are any markets performing better than others and if so, what is the driving force?
Yes. The alcoholic beverages segment is performing better than other segments such as food and soft drinks. The liquor and wine segment benefitted from an extended winter this year and contributed positively to glass bottle sales. On the other hand, the crop yield this year has been low, as most of it was damaged due to heavy rainfalls in some parts of the country, while also affecting demand for jars in the food segment.

GW: How is legislation from the Indian government influencing the performance of glass versus competitive packaging such as plastic?
The initiative by the government to phase out single use plastics has been commended, in general, by the public. But the impact of the same on glass sales is yet to be realised. For alcoholic beverages, which is our major user segment, glass is already a preferred packaging material and is being used extensively. In the food and soft drinks segment, which is a high potential market for packaging materials, the switch from plastic to alternate packaging materials is happening at a slow pace. Similarly, pharmaceutical companies are yet to make up their mind on glass replacing plastics. In the long-term, I expect that most segments will follow the consumer preference of sustainable packaging, thus benefitting the hollow sector.

Future plant investments will see manufacturing capacity increased by 100%.

GW: How have other political climates such as the China-USA trade war affected prospects for the Indian glass sector?
In the age of globalisation, no country or market is insulated from the global political climate and India is no exception to that. The US adventure in Iran affects global crude supplies and has an impact on the profitability of glass in India. The China-USA trade war is also expected to affect the Indian industry but its impact on glass would be a fraction of that, as the glass business is very cost-sensitive and freight becomes a major cost element when transporting over long distances.

GW: How would you summarise the performance of AGI since our interview last year?
The past year has been a very positive and promising one. We have launched new designs, resolved bottlenecks that were limiting our capacity and improved operational indicators. Looking forward, we have plans to invest in greenfield and brownfield expansion and double our capacity. ▸

GW: What are the significant movements in Indian consumer trends and how well positioned is AGI to adapt accordingly moving forward?
Indian consumer taste is evolving. The demography is shifting towards the young. They are educated, have higher disposable income and are striving for a lifestyle that is on par with international standards. They are sensitive to the environment and prefer a sustainable product. AGI, with its in-house design team and R&D capability, is well equipped and abreast of evolving trends and preferences; and would be first among equals in meeting customer expectations.


A series of greenfield and brownfield investment projects are planned.

GW: Have you been particularly pleased with any recent product innovations launched by AGI?
Yes, we had a good year. The new design launches were well received and appreciated by our customers. The drive towards reducing bottle weight has been a mutually beneficial initiative and is bringing good returns to us and to customers. This year, we have launched two special types of bottles:

- Hollow decoration bottle, where the design is clearly visible but cannot be felt when the container is emptied.
- Anti-depression (negative ion) bottle: The most important benefit of AGI's negative ions is that they clear the air of airborne allergens such as pollen, mould spores, bacteria and viruses. Negative ions perform this function by attaching themselves to positively charged particles in large numbers and negatively charging those particles.

GW: Are any further product launches already planned for this year?
Yes, we have a few product launches planned this year and some of them are already in the pipeline. Our thrust is towards strengthening the in-house design and R&D capability, so you will be seeing more innovations from us in the future.▸

AIGMF/*Glass Worldwide* co-operation

Glass Worldwide is the preferred international journal of the All India Glass Manufacturers' Federation (AIGMF), in association with *Kanch*, providing the Indian sub-continent with the best possible forum for the exchange of news and views between glass manufacturers and their suppliers. *Glass Worldwide* shares the AIGMF's goals of promoting the Indian glass sector to a domestic and global audience, as well as informing Indian glass professionals of all developments from other regions. Rajesh Khosla, a member of the AIGMF executive committee, lists the main benefits of this exclusive co-operation:

- To encourage, promote and develop the manufacture of glass articles of all kinds and to safeguard and protect the interests of the glass industry and glassware business in India.
- To form a common link among glass manufacturers in India and thus develop a spirit of mutual help and co-operation with one another.
- To promote study and research in glass technology.
- To consider all matters relating to the manufacture and marketing of glass articles in India and the question of exports and imports.
- To devise ways and means for securing necessary supply of raw materials required for the manufacture of glass articles at comparatively lower prices and thus to reduce the cost of production and increase the national wealth.
- To collect necessary information and data and propagate it for the benefit of the glass industry and trade in India.
- To make representations whenever necessary to the Union Government or any unit of the Union of India for the removal of difficulties that might hamper the trade of glass articles or for the granting of special facilities for the glass industry.
- To organise a united front on behalf of all glass manufacturers and thus strive to gain all those advantages that may not be possible through individual efforts.

GW: Is the company taking any specific measures to control energy, raw materials and other production costs?
The company is very particular about its cost of production and believes that each cost should be accounted for and nothing should go to waste. We are entering into long-term contracts with our suppliers so that they have visibility and we get the best price and guaranteed sustained supply. An energy audit of the plants is being carried out to identify and plug the energy leakages. Now, both of our plants have started using natural gas in the furnaces and are substituting for a part of the alternate less green fuel in our energy mix. To harness the advances in technology, the company has plans to invest 130 Crs in the technology upgrade.

GW: How successful have investments in production facilities proved to be in recent times?
We have generated favourable returns on investments. As mentioned earlier, we have plans for further technology upgrades and investment in building new capacities.

GW: What is your strategy for further investments in AGI's manufacturing plants?
As stated earlier, we are enhancing our production capacity by 100%. The investment is planned in two phases and will be spread over a number of years.

GW: Will there be any further increases in capacity and are any specific investment projects already underway or planned for the coming months?
The additional capacity will be added through both greenfield projects and brownfield expansions. The major addition will be from new facilities planned in two phases. Phase one will add 400 tonnes/day and phase two will add 350 tonnes/day capacity.

The Anti-depression (negative ion) bottle development

AGI glasspac's Hollow decoration bottle innovation.

GW: Are you investing in digital platforms to assist the production capabilities?
Yes, we are working on automation, IoT, Industry 4.0, smart manufacturing and digitalisation fronts. It will standardise processes, minimise errors on account of human inefficiency and equip us with a lot of process data that can be analysed for further improvements. Our intention is to extend digitisation to our customers and suppliers as well.

GW: How important are your suppliers of production technology and machinery in reaching the company's goals?
We believe in maintaining a sustainable business relationship with our suppliers. They are very important and are an integral part of our business strategy.

GW: How useful was glasspex INDIA 2019 in Mumbai last September for meeting your international suppliers and what was achieved?
Glasspex INDIA 2019 was fantastic for AGI glaspac. Our stand attracted many visitors and suppliers from more than 10 countries and from companies involved in glass production, processing and finishing technology, measurement and control engineering, tools, replacement, auxiliary, equipment fittings, contracting, consulting, engineering, research and teaching, trade literature, trade associations and many more. We have built many strong relationships with our suppliers and discussed their contributions to AGI glaspac.

GW: And what did the parallel 13th International Conference of the AIGMF add to proceedings?
This was a high profile content-driven conference that highlighted key issues and developments by industry experts. I compliment the complete AIGMF team and Dave Fordham of *Glass Worldwide* for his exceptional moderation. ●

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see pages 98-99

"Tell me and I forget, teach me and I may remember, involve me and I will learn." Benjamin Franklin

Sheppee training centre

In addition to a guided tour of the Port of Duqm, the AIGMF delegation made visits to the Indian Embassy in Muscat and the Majan Glass factory.

AIGMF delegates explore opportunities in Oman

A delegation from the All India Glass Manufacturers' Federation (AIGMF) accepted an invitation from the Port of Duqm in the Sultanate of Oman recently to explore opportunities provided by the new seaport for Indian glass manufacturers. The Port of Duqm is the gateway to the planned special economic zone at Duqm (SEZAD), which spans over 2000 square kilometres and is the largest integrated free zone development in the region. Mohammed Ali Ghazi reports.

Last year's AIGMF tour was preceded by Port of Duqm representatives attending an AIGMF executive committee meeting in Hyderabad, where opportunities for glass manufacturers in Duqm were raised. The delegation to Oman was led by Raj Kumar Mittal, AIGMF President, along with representatives from the container and solar glass sectors. The delegation also made a courtesy visit to the Indian Embassy in Muscat and met Ambassador Munu Mahawar, who was briefed about the prospect of AIGMF members setting up glass manufacturing units in Duqm.

Free zone incentives

Potentially, glassmakers may be attracted by the free zone incentives that Duqm offers, including 30 years of corporate tax exemptions, no customs duties, free repatriation of profits and 100% foreign ownership.

Delegates took the hour-long flight from Muscat to Duqm, which lies in central Oman. Their visit started with a guided tour of the SEZAD area, which includes several different areas, including an industrial zone, a residential zone and a tourist zone, all served by a recently built international airport and the seaport, which is operated by Port of Duqm Co SAOC. SEZAD also includes a series of mining areas, where prospects for several industrial minerals such as limestone, dolomite, silica sand/quartz, salt, shale and clay are being explored and mined, close to

AIGMF dignitaries with representatives from the Port of Duqm.

the special economic zone.

The glassmakers also visited Port of Duqm's industrial land, which is being developed and marketed by a subsidiary company called DILC (Duqm Industrial Land Co). This industrial land is described as being ideally suited for glass manufacture. It is situated close to the seaport and is connected by an excellent network of roads, making logistics very convenient. Proximity to the port makes it easy to import raw materials via the port's dry bulk and break bulk terminals, as well as exporting products via the proposed 1.7 million TEU/annum container terminal. The industrial land is also close to locally available raw material sources such as a dolomite and limestone quarries, as well as silica sand prospects. The DILC land is connected with essential utilities including electricity, natural gas, water and waste handling services.

A guided tour of the Port of Duqm and its various cargo terminals was followed by a detailed discussion about glass industry prospects in Duqm, including opportunities for the soda ash industry. Delegates were informed that there is an excellent prospect for a salt works near Duqm, which is expected to lead to downstream developments including soda ash manufacture.

Soda ash project

The Port of Duqm is actively working on bringing a soda ash plant to the site, which could potentially serve adjacent glass manufacturing units. Port representatives also attended the World Soda Ash Conference 2019 in Cannes, France, where meetings with several prominent industry players were arranged. Officials are now hopeful of announcing a soda ash project in the near future.

Majan Glass visit

AIGMF delegates also visited local glass packaging specialist, the Majan Glass factory, where Asit Chawla, CEO, organised a guided tour of the manufacturing facilities. There are currently two manufacturers of container glass in Oman, with opportunities for several more. Pragati Glass and Majan Glass operate plants in Sohar and Nizwa respectively, cities that are in the north of Oman. There are currently no float glass manufacturers in Oman and it was suggested that tremendous opportunities exist for float as well as safety glass production. ●

The Port of Duqm is situated on the south eastern seaboard of the Sultanate of Oman.

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Reputation built on performance

Furnotherm Glass Projects India is a leading glass melting furnace construction company, based in Maharashtra, India. As Jogendra Singh explains, the company provides complete turnkey construction services from draining/demolition to commissioning, including construction.

Jogendra Singh.

Furnotherm maintains an extensive base of professional manpower and equipment to construct many furnaces simultaneously worldwide. Recently, for example, projects have been executed for Schott Glass T65, Piramal Glass Ceylon, Piramal Glass India, Vitrum Glass India and Sirdaryo Glass, Uzbekistan. Current projects include Schott Glass T66, Piramal Glass 145 tonnes/day, Frigo Glass, Nigeria and Sunrise Glass India, all of which have been conducted simultaneously.

Furnotherm is constantly working on the development of innovative and modern techniques for installation work and has also developed in-house workshop facilities for the fabrication of steel and glass plant equipment.

Industry recognition

The company was created by Jogendra Singh, who has been associated within the glass industry for the last 20 years and has constructed many glass melting furnaces in India and abroad. Recognised for executing projects with utmost customer satisfaction, Mr Singh is highly experienced in the field of glass melting furnace construction on a semi-turnkey basis.

Furnotherm is the only furnace builder in India to cover the maximum range of furnace construction activities, extending from draining to heat-up and involving demolition, rebuild, steel work, refractory installation, utility, electrical and instrumentation.

Activities

Furnotherm's knowhow is in the areas related to furnace construction, which means the company can offer a comprehensive service in all fields according to client specifications.

The expertise of its specialist departments guarantees the best possible solution in the following areas:

- Demolition and waste management.
- Steel structure fabrication and installation.
- Controlled furnace cool down.
- Hot drilling and electrode insertion.
- Refractory and steel materials logistic management.
- Total refractory installation.
- Industrial chimney construction and refractory lining.
- Cold and hot repairs.
- Hot sealing and insulation.
- Furnace heat-up/cullet filling.
- Pre-manufacturing and installation of ductwork for metal-line cooling ducting for combustion air and the installation of electrical blowers.
- Electrical and instrumentation cable laying and installation of electrical equipment.

Furnotherm's goal is to provide overall service and good value for money to glass industry customers, from project conception to completion and commissioning. Utilising experience that has been gained from two decades of global activity, the company's personnel understand that attention to detail and quality as well as dedicated services are critical to the company's success.

With complete confidence in the skills of employees and their knowledge, the company's search for the latest and best installation techniques has enabled Furnotherm to become a leading furnace construction company, with the implementation of safe working practices and ensuring good industrial relations. Adopting high performance specifications monitoring ensures excellence and quality assurance.

These attributes enable Furnotherm to create a competitive advantage by providing high efficiency to execute solutions with superior quality, low cost and outstanding customer satisfaction. ●

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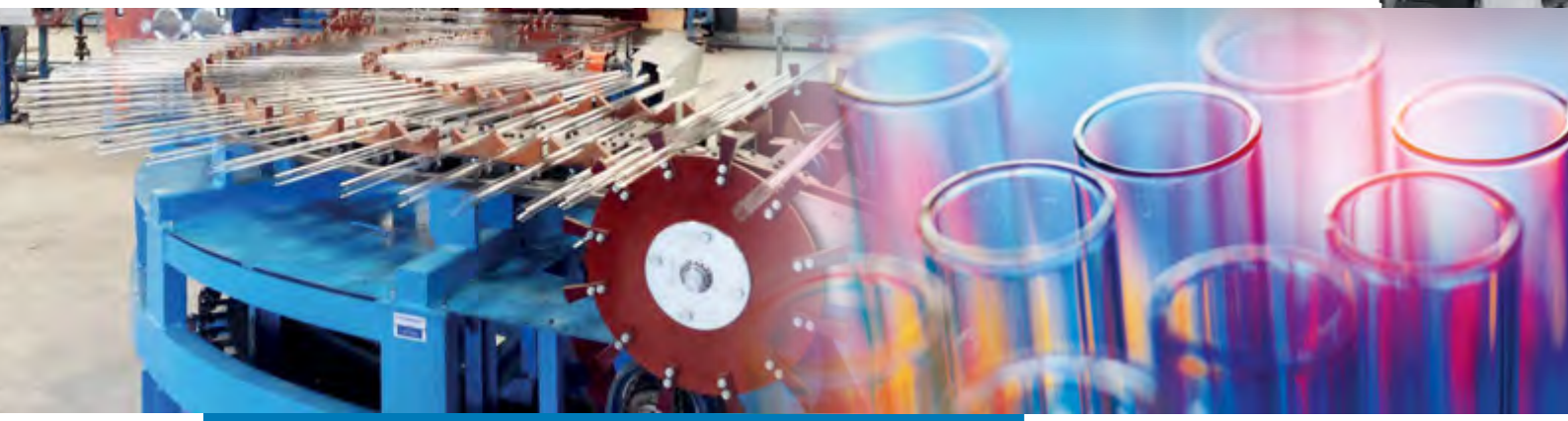
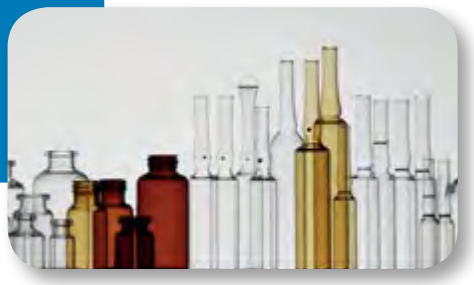


LEADER IN TUBING LINES FOR PHARMACEUTICAL PACKAGING



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The decarbonisation fuel challenge

What challenges and opportunities do the main fuel options present to the glass industry in terms of energy supply, cost and decarbonisation potential? Gary Cafe reports.

Since the Paris Agreement made at COP21 in December 2015, commitments have been made to avoid the worst impacts of climate change by limiting global warming to 1.5°C above pre-industrial levels. But what does it mean for the glass industry, which has historically been mostly reliant on carbon emitting fossil fuels for the melting process? Will container glass customers move towards paper, bio-plastics or aluminium? What about flat glass and tableware? Is there a low carbon glass melting process that can secure its usage in decarbonised economies?

Considering the decarbonisation trajectory defined by the Paris agreement, the Intergovernmental Panel on Climate Change (IPCC) stated that in order to limit global warming to 1.5°C, the world must be carbon neutral by around 2050. Global emissions projections in figure 1 show that with current efforts, global warming is likely to reach 1.5°C between 2030 and 2050[1]. Owens-Illinois, NSG and Saint-Gobain have all made public commitments towards this goal by engaging with the Science Based Targets initiative, which demands an individual trajectory towards carbon neutrality in line with the global goal. This suggests that the biggest players in the glass industry are committed to completely decarbonising their melting processes – likely eliminating fossil fuels altogether.

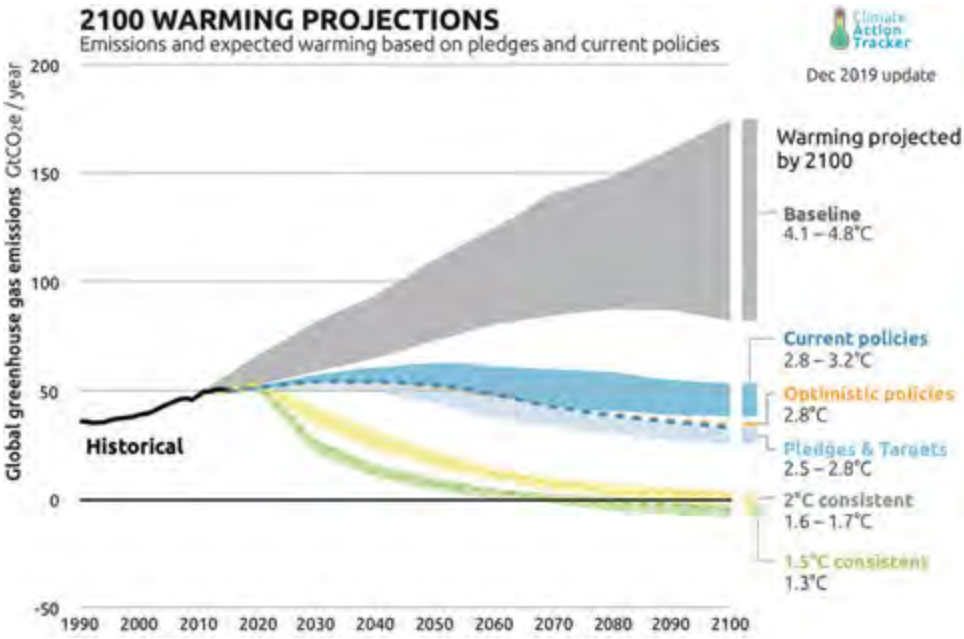

Figure 1: Emissions and expected warming based on pledges and current policies.

What are the options today?

There are potentially many fuel options and methods from a sustainable energy standpoint but this article will focus on the four most potential sources today: Natural gas – the business as usual case; hydrogen – perceived as similar to natural gas but a big step, as it lacks established infrastructure and technology; hybrid electric with natural gas or hydrogen – another big step as also technically unestablished; all-electric[2] – redesigning and scaling up a 100+ year old technology to meet the needs of today's industry.

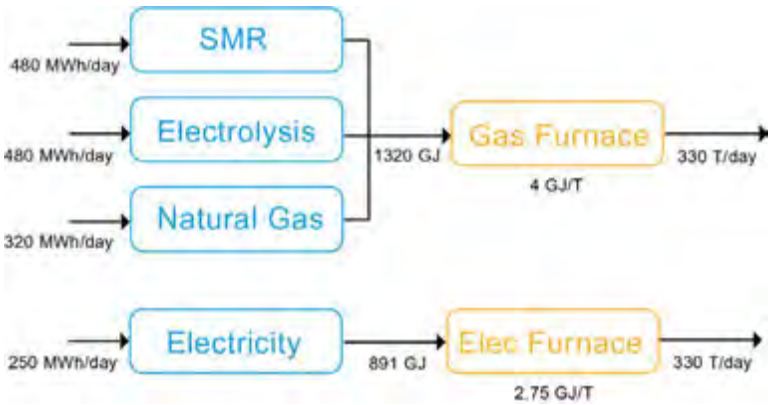

Figure 2: An approximate calculation of energy required for the same tonne of container glass. SMR needs 30% more than natural gas and electrolysis consumes double the power of an electric furnace.

Why think differently?

Historically, energy cost was relegated to a single line or two in the business case presented to management for a new furnace. The same business case devoted 200 lines or more to the capex breakdown. It can be surmised that with only one fuel to choose from, it made no sense to model this out further, as competitors were exposed to the same future market conditions.

Now there are multiple different variables in the equation; natural gas, power, carbon and renewable electricity. Each of these has different fundamentals and is independently impacted by sovereign risk that varies between countries.

Consider now that tweaking that energy cost figure by just 10% can make a bigger $/tonne difference than a 50% change in capex. Said another way, one could work incredibly hard to reduce the capex of a natural gas furnace design only to have those savings completely wiped out by a 10% gas price increase, compared to a competitor who chose an all-electric furnace driven by fixed price renewable electricity. Complex and hard to quantify in just one line of a spreadsheet, right?

Can the options be carbon-neutral?

Start with the three most challenging fuel sources to decarbonise: Natural gas, hybrid electric/natural gas and steam methane reforming (SMR) originated hydrogen. All of these need a breakthrough in Carbon Capture and Storage or Usage technologies (CCS/CCU). Many attempts have been made to get CCS/CCU pilot projects off the ground in this space, yet only a handful managed to get government subsidy and even fewer have shown potential for commercial application.

Hydrogen from electrolysis can indeed be carbon ▸

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neutral when powered by renewable energy but according to approximate calculations, hydrogen from electrolysis consumes nearly twice the energy to melt glass than using the electricity directly (see figure 2). Despite this, a scenario could also be envisaged whereby the extra energy and technology cost of a hybrid approach versus all-electric could be worth it due to technical advantages – or at least worth considering. Breakthroughs in technology such as new electrode surfaces made from lower cost abundant metals and electrolysis improvements that reduce energy efficiency by nearly 50% may help if they are proved commercially viable.

An all-electric furnace can certainly be powered by renewable electricity from many grids across the world and therefore can be considered carbon neutral. Especially if matching a new 200 GWh of annual demand with 200 GWh from a new renewable energy installation on the grid – even though the grid is far from carbon neutral today.

What are the supply risks?

Can the energy be delivered in a safe and reliable form, like everyone has come to expect from natural gas? In fact, will natural gas still be available? Not just physically but will the world allow it? More than 60 countries have or are already considering putting carbon neutrality into law. Recently, the EU presented the European Green Deal, aiming to be the first climate neutral continent by 2050. The Commission wants to leave no stone unturned and plans to review every EU law and regulation in order to align them with the new climate goals. This will start with the Renewable Energy Directive and the Energy Efficiency Directive but also the Emissions Trading Directive. Most likely fossil fuel will soon become economically punitive in the EU, which represents 22% of the global economy.

This would result in huge demand for green hydrogen, a massive ramp up from the approximately 4% it occupies today. Also, the International Energy Agency's report on the future of hydrogen shows current government policy support for industry a long way down the queue. This supply/demand crunch makes green hydrogen solutions appear challenging at best.

The other option is all-electric. Even though electricity grids are well established, due to increased electrification demands from industry, households and electric vehicles, significant investment is required to ensure that power can be delivered and demand balanced with supply. The International Renewable Energy Agency (IRENA) report on Global Energy Transformation estimates $18 trillion would need to be invested in the power grid and energy flexibility before 2050. The growth in renewables, however, is significant, with investment over $2.5 trillion per annum and this presents opportunities.

Quantifying risks and finding opportunities

With all these varying fundamentals at play, it is crucial that senior managers of glass manufacturing companies are well informed and understand where the risks and opportunities lie. Solid 10+ year outlooks related to carbon, gas and power from professional organisations are key to building potential scenarios. Multiple scenarios coupled with rigorous sensitivity analysis show what can happen and therefore, what the most realistic outcomes might be. Only then can management teams move with confidence into this brave new world.

One lever to reduce these market risks is using renewable energy, as it has essentially zero marginal production cost and no fuel costs, so can therefore decouple itself financially from the energy market. Renewable electricity from technologies like wind and solar are also dropping in cost and rising in corporate implementation. Australia, the USA and increasingly, Europe (see figure 3) [3] are hotbeds for so-called corporate Power Purchasing Agreements (PPAs), because commercial and industrial buyers are seeing them as lower cost and lower risk alternatives to the wholesale market outlook. It is not just the business to consumer (B2C) or telecommunications sectors who want to green their image either. BlueScope Steel, Ball Corp and Cummins are just a few examples of industrial players taking advantage of the opportunities.

Conclusion

Unfortunately, it is not easy to predict the future but steps can be taken to understand the possibilities. Take the time to look ahead and get a good understanding of future energy costs and availability to build solid scenarios for the management team using credible, 10 year energy market outlooks. Consider supply risks when choosing the energy source by finding out where investments are being made in relevant technologies and infrastructure.

It is important to research this in advance, otherwise the fact that a chosen energy supply is technically unavailable may be discovered too late down the line in a project. And last but not least, look at de-risking and greening the portfolio with renewable energy. More information about these subjects will be presented in a free Webinar at the end of April, which readers can sign up for by contacting the author. ●

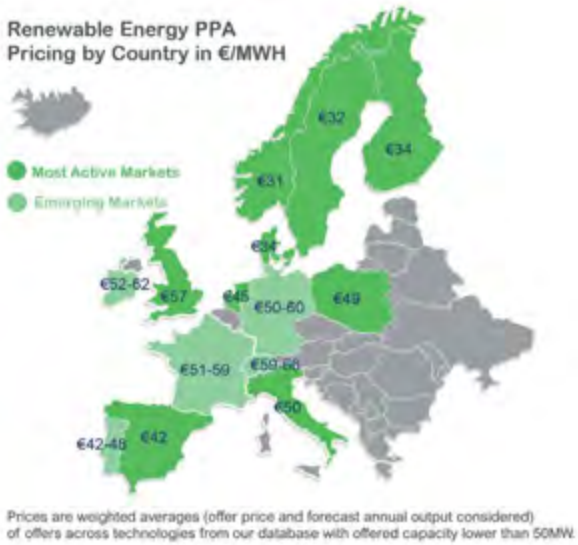

Figure 3: Europe is seeing significant growth in PPAs thanks to strong supply opportunities. Especially in Spain, Poland and the Nordics but others are fast catching up.

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All-electric melting prospects for glass container production

Lars Biennek discusses the opportunities and limitations of all-electric melting furnaces for glass container production, as the industry searches for CO_2-free melting solutions.

Currently, the world is under pressure to limit global warming. Whether climate change is due to human interference or not is an outdated discussion. Society has to change its way of life and the way to produce goods. The boom in the glass industry shows that glass meets consumer needs for a sustainable packaging material, much in contrast to plastic. The entire industry is forced to produce goods more efficiently and with less CO_2 emission.

As a leading supplier of innovative glass melting furnaces and complete production lines, HORN is continuously developing and suppling eco-friendly solutions for the glass industry. An economic motivator for glass producers worldwide is the increase of CO_2 allowances. The shortage of fossil fuels in the near future and stricter industrial emission directives for NO_x and SO_x emissions should also be mentioned.

The use of electrical power seems to be a solution for the dramatic reduction of CO_2 emissions, at least on glass factory sites. When electrical power is produced by wind, solar, water or other regenerative energy sources, CO_2 emissions can be reduced generally. Furthermore, nuclear power is still making a significant contribution to reducing CO_2 emissions.

Energy producers and energy suppliers share a responsibility to deliver electrical power that is environmentally-friendly and is available 24/7. As a reputable German engineering company, HORN assumes full responsibility. The evidence lies in the intensive efforts of the R&D Department in the development of large all-electric furnaces, hybrid furnaces and the further improvement of the efficiency and reduction of emissions of conventional furnaces. For example, every year the company supplies 15-20 large electric boosting systems for container and float glass furnaces, with an upwards trend in number of installations and size of installed electric power.

Future trends

Future trends for the glass container sector are still unclear. Increasingly, fossil fuel-based furnaces are boosted electrically. Oxy fuel furnaces have been developed and partially introduced but this does not seem to be the solution. In addition, hybrid furnaces are under development throughout the world.

An end-fired furnace with electric boosting is already a hybrid furnace, because two heating technologies are combined, hence it is a so-called electrically boosted furnace. The understanding of the hybrid furnace nowadays is rather the technological solution, where the electric heating of the furnaces dominates and is only supported by natural gas heating. If in this type of furnace the natural gas heating is stopped completely, it would end up in an all-electric furnace based on hot top technology. But what about the all-electric furnace based on cold top technology (AEF)? Is there a chance for this solution in the future?

The all-electric furnace based on cold top technology has been successfully applied for many decades. Its use has been driven either by non-existing gas pipelines, too high fossil fuel prices or by emission issues, especially in connection with the production of technical glass, where the volatilisation of boron, chlorine and fluorine volatiles occur, partially connected with glass defects. The typical melting capacity for specialty glass is < 30 tonnes/day; for container glass it is <80 tonnes/day; and for fibre glass, it is < 200 tonnes/day, of course with exceptions in each case for higher and lower melting capacities. The largest all-electric furnace in operation worldwide is located in Western Europe, with an impressive total melting capacity of 400 tonnes/day for fibre glass.

Figure 1a: Overview of the top electrode.

The all-electric melting process following the cold top technology route is basically a vertical melting process. A batch layer uniformly covers the entire glass bath. The batch is continuously introduced into the furnace at the top side of the batch layer. The subsequent melting process takes place from the top side of the batch layer until the bottom of the furnace. At the end, the melt leaves the furnace through its ▸

Lars Biennek (second from left), with AFGM dignitaries at the 43rd AFGM Glass Conference in Cebu.

ASEAN FEDERATION OF GLASS MANUFACTURERS

This article is based on a paper presented at the 43rd ASEAN Glass Conference in Cebu, Philippines, in October 2019 **www.aseanglass.org**

Glass Worldwide is the official journal of AFGM

Figure 1b: All-electric furnace with top electrodes.

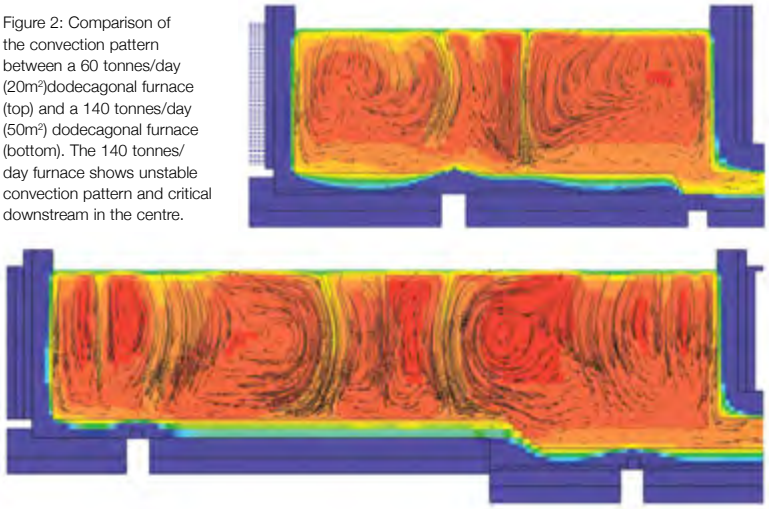

Figure 2: Comparison of the convection pattern between a 60 tonnes/day (20m²)dodecagonal furnace (top) and a 140 tonnes/day (50m²) dodecagonal furnace (bottom). The 140 tonnes/day furnace shows unstable convection pattern and critical downstream in the centre.

throat, which is also located at the bottom side.

A very important basic requirement is to produce and maintain a uniform and thermal insulating batch layer at the top of the glass bath. Only a sufficient thermal insulation makes it possible to keep the melting and the refining temperature above the level needed. In this way, the temperature of the superstructure can be kept at a temperature of 100-180°C, which is necessary for safe operation of the batch charger. The batch layer thickness increases proportionally to the melting capacity and vice versa. This technological connection also leads to the limits of this melting process.

Batch layer condition

The condition of the batch layer depends on the area-specific melting capacity and can be described as follows: The lower the melting capacity, the lower the batch layer thickness. This means the lower the batch layer thickness, the lower the thermal insulation. At a certain level, the minimum necessary temperature in the melt cannot be maintained due to excess thermal losses through the batch layer.

A further increase of the electric heating power will melt down the batch layer even faster and will not compensate the thermal losses, as some might expect. A further drop of the temperature is an unavoidable result of the power increase. On the other side, the higher the melting capacity, the thicker the batch layer. This means fewer thermal losses. The thermal insulation of the batch is increasing but at the same time, its permeability for gases is decreasing. Now, at a certain point, gases from the batch reactions cannot penetrate the batch layer fast enough. The melt below the batch layer can no longer exhaust. An accumulation of gases between the batch layer and the melt is the consequence. As a result, heat transfer from the melt to the batch, which keeps the melting process running, is no longer ensured.

Ultimately, the area-specific melting rate will drop dramatically and the batch layer needs to come back to the target condition at a lower melting capacity. Raw materials selection (including cullet) has a significant influence on the melting speed and the permeability for gases as well. It is now understandable why the flexibility of the melting capacity (70%-100%), the share of cullet (30%-60%) and the selection of suitable raw materials are limited. These technological aspects define the disadvantages of the cold top electric furnace.

Cullet

Cullet usage in the glass melting process is a popular way for saving raw materials and for reducing energy consumption. Unfortunately, there is always a potential risk of metallic contaminations in recycled cullet, especially post-consumer recycled glass introduced in the furnace.

Three-phase convection (metallic melt – glass melt – refractory) is the driving process for pitting corrosion, which in the worst case leads to a complete uncontrolled furnace drain. If bottom electrodes are applied, either the pitting corrosion is intensified due to the higher bottom temperature level or a direct interaction of the metallic melt with the electrode occurs. Both processes are increasing the risk of an uncontrolled furnace leakage. On the other hand, side electrodes could solve the interaction issue but a typical high load of the electrodes in electric furnaces connected with the driven intensive convection of the melt will increase the corrosion of the sidewall significantly. A short furnace lifetime would be the result.

Electrode placement

The use of top electrodes seems to be the way out. Top electrodes (as shown in figure 1a) are characterised by a vertical molybdenum electrode, which is connected to a horizontal water-cooled connector. This, in turn, is attached to a swing-in device.

The vertical molybdenum electrode penetrates the batch layer, which has a typical thickness of 25cm-3cm. The upper part of the electrode remaining in the batch layer is internally water-cooled. In this way, oxidation of the molybdenum is suppressed and the batch layer above the hot spot of the electrode is locally and thermally stabilised.

The above-mentioned interaction with metallic contaminations from recycled cullet can be excluded. Sidewall corrosion is moderate and an easy exchange of worn electrodes are the main advantages of top electrodes. A HORN all-electric furnace using top electrodes can be seen in figure 1b.

CFD modelling

During the development of larger all-electric furnaces, a variety of electrode positions were tested in CFD models and evaluated. The most compromising results were gathered with the application of top electrodes. These results will be described and evaluated below. ▸

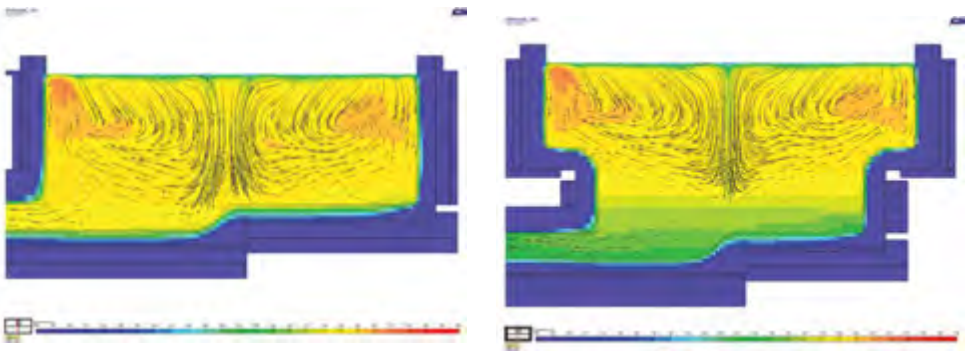

Figure 3: Comparison of the convection pattern between a 140 tonnes/day (20m²) rectangular furnace (left) and a 140 tonnes/day (20m²) rectangular furnace with a shelf (right).

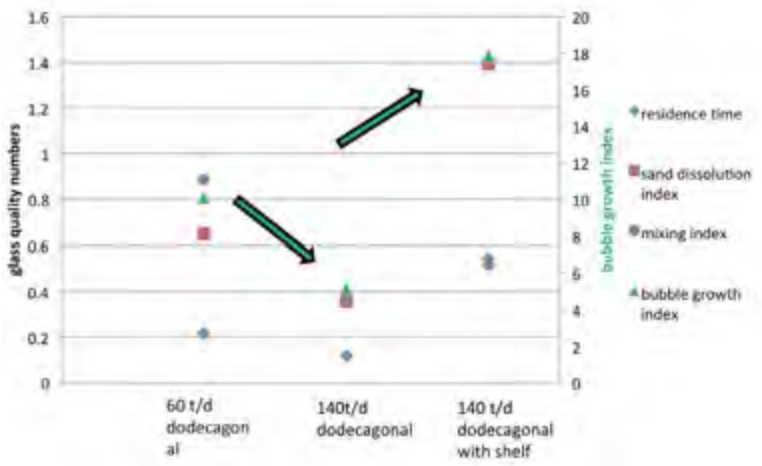

Figure 4: Glass quality indicators for dodecagonal furnaces with a melting capacity of 60 tonnes/day (20m²) and dodecagonal furnaces with a melting capacity of 140 tonnes/day (20m², with a shelf and without a shelf).

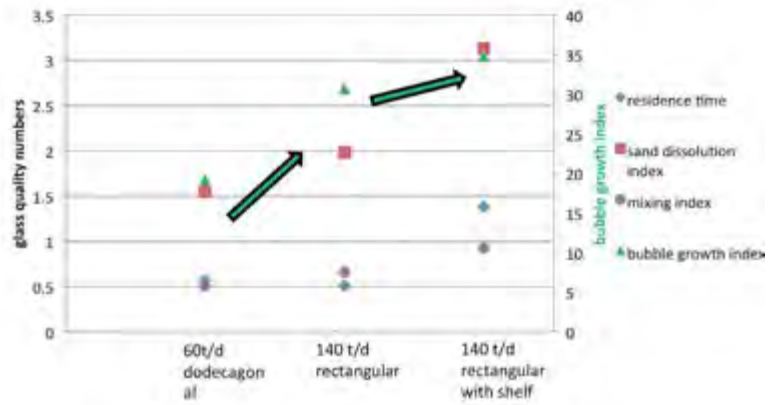

Figure 5: Glass quality indicators for a dodecagonal furnace with a melting capacity of 60 tonnes/day (20m²) and rectangular furnaces with a melting capacity of 140 tonnes/day (50m², with shelf and without shelf).

The basis for the evaluation of different cases based on CFD modelling is an existing dodecagonal furnace for super flint glass with a melting area of 20m² and a melting capacity of 60 tonnes/day, heated by means of top electrodes. The glass quality reached is <10 seeds/100g. The modelling work compares two main furnace designs to investigate their suitability for the production of extra flint glass with a melting capacity of 140 tonnes/day. The evaluation for green and amber glass has to be investigated and evaluated separately, because their thermal transparency is different and this would influence convection in the furnace significantly.

The first sequence of modelling cases follows the dodecagonal furnace shape. The second sequence follows the rectangular shape. In the case of the dodecagonal furnace, the electrode distance will increase by increasing the melting surface.

In comparison to the dodecagonal shape, the rectangular furnace bears the chance to keep the distance of the top electrodes constant, independently of the melting surface (of course only in certain limits is this technologically reasonable). The same distance of the top electrodes avoids a lack of energy between the electrodes for keeping the same good conditions for the melting processes.

Both furnaces are heated by 24 top electrodes in total. The electric heating circuits of the rectangular furnace are separated into three heating zones (left, centre and right). Each heating zone is heated by means of 4x2 top electrodes in a Scott connection. The dodecagonal furnace is heated by means of the top electrodes in three-phase connection. Each phase uses 2x4 top electrodes. Both furnace types have a melting area of 50m². The rectangular furnace is 10m wide and 5m deep. The dodecagonal furnace has a diameter of 7.9m. The total required electric power is about 6000 kW for 30% cullet for a new furnace.

For comparison and evaluation of the results of the modelling cases, the following typical indicators are used:

- Minimum residence time.
- Sand dissolution index.
- Mixing index.
- Bubble growth index.

The comparison of the convection pattern of a 60 tonnes/day dodecagonal furnace and a 140 tonnes/day dodecagonal furnace is shown in figure 2. The convection in the centre of the 60 tonnes/day furnace is moderate. Due to the increased distance of the electrodes at the 140 tonnes/day furnace, the lack of energy in the centre drives a very intensive downstream convection.

The glass quality indicators in figure 4 show a drop of all numbers. A significant decrease of glass quality is to be expected. Only the additional implementation of a shelf can partially compensate the weakness of this design (convection pattern is not shown here, see glass quality indicators in figure 4). It becomes obvious that the shape of the dodecagonal furnace in general will not be the proper design for larger melting capacities.

The convection pattern of a rectangular furnace without shelf, compared to a rectangular furnace with a shelf is shown in figure 3. Both types of furnaces show even better convection flow compared to the proven dodecagonal 60 tonnes/day furnace. The shelf additionally generates a well-defined conditioning zone, which lowers the entrance temperatures into the throat. This means both lower throat corrosion and lower entrance temperatures at the distributor entrance.

The glass quality indicators shown in figure 5 are increasing significantly, especially with the implementation of a shelf. The comparison of the glass quality numbers of the 140 tonnes/day rectangular furnace with the 140 tonnes/day dodecagonal furnace confirms very clearly the advantage of the rectangular furnace with top electrodes for larger melting capacities.

With its rectangular design and a capacity of 140 tonnes/day (figure 6), the HORN all-electric furnace is an excellent solution for melting flint and super flint glass. Thanks to the use of top electrodes, it is the most reasonable and safest solution for melting container glass with respect to glass quality, stability of the melting process, safe operation (metallic contamination) and furnace lifetime. The limited flexibility of the melting capacity, as well as the limited share of cullet, are the typical main disadvantages of all-electric furnaces based on cold top technology. This type of furnace gives customers the opportunity to reduce CO_2 emissions radically. Unfortunately, the necessary uninterrupted supply of CO_2-free electrical energy at an economically accessible level is still not available in most countries. ●

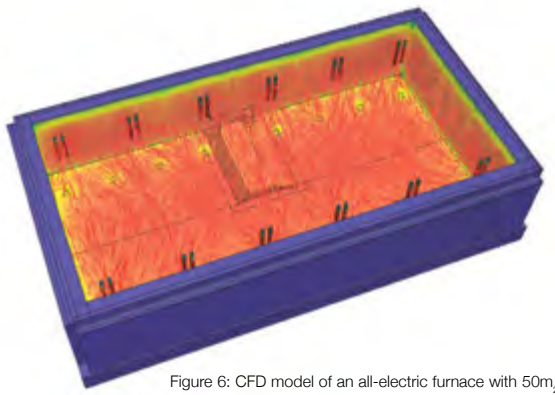

Figure 6: CFD model of an all-electric furnace with 50m$_2$ and a melting capacity of 140 tonnes/day for high quality super flint glass, showing the convection pattern for the melt below the batch layer.

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Chemical attack of borosilicate glass containers examination

Borosilicate glass is generally considered the reference packaging material for parenteral pharmaceutical preparations due to its high chemical durability. Nevertheless, it can have some usage limits, mainly with basic pH solutions. Some drugs formulations can contain components or excipients with a known ability to corrode glass silica network mainly if they are dissolved in an alkaline medium. A flaking issue may become visible only after a long storage time and has forced a number of drug product recalls in recent years. By analysing the extracted silicon from the glass surface after different surface attack conditions, Alberto Biavati and Giorgia Severi point out the synergy between basic pH and the presence of complexing agents on the rate of glass chemical attack.

A short summary of glass surface chemical interaction and attack in function of the pH is shown in table I. Table 2 shows the factors that influence glass surface durability. The complexing agent role in enhancing glass surface corrosion together with unfavourable high pH has been known for a long time. One or more complexing agents can be involved in cations complexation to reach the most stable configuration. Moreover, their dissociation constants pKa that is a function of pH, plays a decisive role to let the functional negative charged groups able to interact with cations.

Considering that silicon binds strongly with oxygen to form silicates anions, only the complexes formed by the other glass components are relevant to affect glass surface attack. Among the glass network formers, aluminium and boron must also be considered, due to their propensity to bind with organic complexing agents after the hydrolysis of the (Al, B) – O – Si bonds.

Complexing agents dimension, type of co-ordination, steric hindrance, structural mobility and solubility, together with the ion nature (charge and dimension) characterise glass surface attack enhancement at constant ionic strength and pH.

During the ion exchange step at acid pH, the amount of

Acid pH : Quick available ions exchange, negligible attack to silica network.

GLASS–SiONa + H_3O^+ = GLASS–SiOH + Na^+ + H_2O

Neutral pH : Ion exchange equilibrium, surface glass network hydration.

GLASS–SiONa + H_2O = GLASS–SiOH + Na^+ + OH^-

Alkaline pH : Silica network slow dissolution rate with a silica hydrated layer development.

GLASS–Si–O–Si–OH + OH^- = GLASS-Si–O^- + –Si–$(OH)_2$

Table 1: Summary of glass surface chemical interaction and attack in function of the pH.

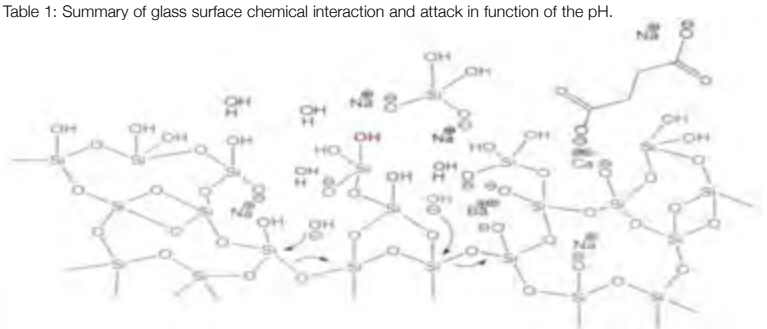

Figure 1: Hydroxylic OH- attack to silica network with opening of the cavities occupied by network modifiers elements (Ca, Ba, Na) and contemporary first step of complexation by succinic acid.

- pH
- Some complexing agent solutions.
- Some concentrated salt solutions.
- Time and temperature.
- Surface/volume ratio.
- Surface treatments (alkali depletion).
- Under filling.
- Glass container forming technology and temperature.
- Synergies of the above.

Table 2: Main factors that influence glass surface chemical durability.

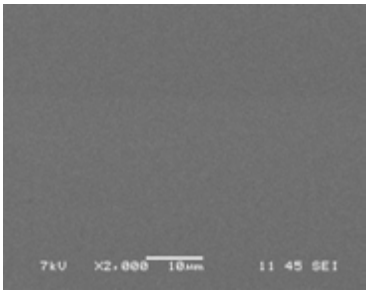

Figure 2: SEM image of slight uniform roughness on inner glass surface of a moulded glass container after autoclaving at 121°C for one hour with 1% citrate solution at pH 9.

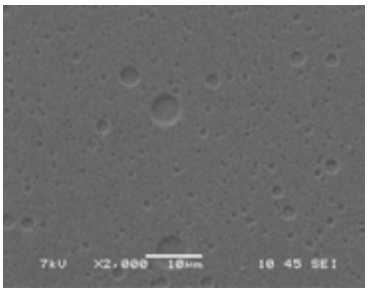

Figure 3: SEM image of inner surface pitting near the bottom of a tubing glass container after autoclaving at 121°C for one hour with 1% citrate solution at pH 9.

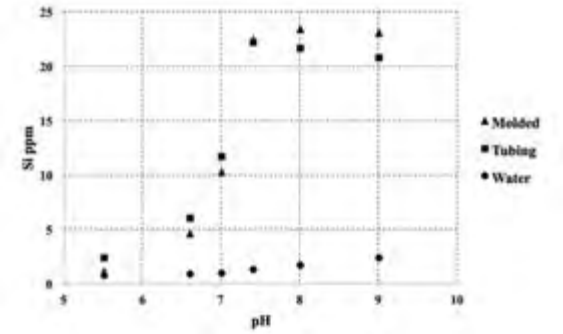

Figure 4: Si release after autoclaving at 121°C for one hour with 1% citrate solution at pH 9: Comparison between 20ml moulded and tubing borosilicate glass containers.

ATIV Associazione Tecnici Italiani del Vetro

This article is based on a paper presented at the XXXIII ATIV Conference in Parma, Italy in November 2018.
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	Moulded	Tube
SiO_2 %	71	74.5
Al_2O_3	5.5	6
Na_2O	7.5	7
K_2O	1.5	0.5
CaO	1	0.5
BaO	2	0.5
B_2O_3	11.5	11
Linear expansion	~ 61 x 10-7 °K-1	~ 52 x 10-7 ° K-1

Table 3: Indicative flint borosilicate glass compositions.

the released glass components, mainly alkali, generally depends to the glass chemical durability (glass composition). Nevertheless, glass physical or thermal treatments such as annealing, tube converting temperatures and surface alkali depletion can strongly affect glass chemical durability.

When pH increases to ~ 7, OH- ions concentration increases more and more and a slow silica network attack develops. In the presence of complexing agents like citrates, able to form very stable complexes, silica network attack is already promoted at lower pH ~ 6.4 but generally, complexing agents do not affect glass chemical durability at acid pH.

Whenever the glass network is subjected to relevant chemical attack at high pH, the ratio in solution between network modifiers (alkali, alkali-earth elements, etc) and network formers (alumina and boron) with silicon, is similar to that present in the glass bulk.

During OH- ions attack at basic pH, thicker and thicker hydrated layers develop on the glass surface that continue to envelop in some way the network modifiers during the progressive disruption of the glass silica network (nucleophilic SN_2 type on Si-O-Si bonds). The lower structural density of these hydrated layers is interested by diffusion and transport phenomena, letting the complexing agents present in the water solution compete with silicates, OH- and water solvation, to bind the cations released by glass network (figure 1).

Moulded glass containers have the advantage of a chemically homogeneous inner surface, substantially unaffected by container forming, even if moulded glass chemical durability is often a little lower than that of tubing glass, due to its higher alkali content. The chemical durability of tubing glass containers is affected by converting temperatures in the bottom and shoulder areas (figures 2 and 3). So in comparison with moulded borosilicate glass, tube glass containers often show a higher release up to neutral pH but a lower release at basic pH (figure 4).

Glass surface chemical attack is a very slow reaction that requires months or years to develop 'visible' effects at room temperature. So accelerated testing methods like autoclaving for one hour at 121°C can be the best choice to enhance glass corrosion. This test simulates approximately five years of contact between glass and an aqueous solution at room temperature.

Testing conditions were performed with 0.024M complexing agent solutions, in the 5.8 – 10 pH range, on 20ml type I moulded glass containers, by autoclaving for one hour at 121°C. The extracted silicon was analysed by ICP atomic emission spectrometry. Silicon release in pure water is plotted for comparison in figure 4.

Complexing agent examples

Among the experienced complexing agent series, three of them are shown here as significant examples:

(a) table 4 and figure 5: Dicarboxylic acids with four carbon atoms, with and without one double bond: succinic, maleic and fumaric acid

The complexing activity comparison of the above acids clearly shows that the molecular structure can prevail on a lower pKa2, as demonstrated by the comparison between the cis and trans double bond configuration of maleic and fumaric acids. Probably at least two molecules of fumaric acid are necessary for complexation of a divalent ion. The same ▸

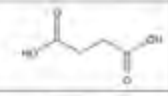
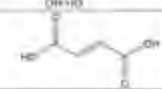
	pKa1	pKa2
Succinic acid 	4.20	5.60
Maleic acid 	1.80	6.10
Fumaric acid 	3.10	4.40

Table 4: Molecular structures and dissociation constants of maleic, succinic and fumaric acid.

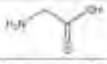
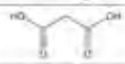
	pKa1	pKa2	pKa3
Acetic acid 	4.76	/	/
Glycine 	2.35	9.78	/
Malonic acid 	1.85	4.70	/

Table 5: Molecular structures and dissociation constants of acetic acid, glycine and malonic acid.

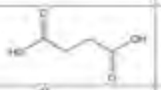
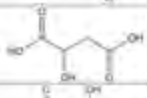
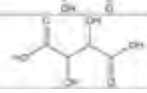
	pKa1	pKa2
Succinic acid 	4.20	5.60
Malic acid 	3.40	5.10
Tartaric acid 	3.00	4.30

Table 6: Molecular structures and dissociation constants of succinic, tartaric and malic acid.

consideration is also valid in the comparison between the 'rigid' but more favourable molecular structure of maleic acid and the 'mobile' molecular structure around the C-C single bonds of the succinic acid, whose chemical attack at pH > 7.4 is intermediate between the other two acids.

Succinic acid intermediate behaviour can be explained considering that its two oxydrilic groups are more distant from each other than in maleic acid, regardless of any possible molecule arrangement, so probably less available for complexation.

(b) table 5 and figure 6: Acetic acid with the replacement of a hydrogen atom by the functional groups NH_2 (glycine) and COOH (malonic acid)

Malonic and acetic acids show a progressive increase of the chemical attack on glass, with an expected advantage for the malonic, due to the two carboxylic groups.

Glycine complexing activity increases quickly from pH 9 considering the highest pKa2 corresponding to the deprotonation of ammonium group:

$$-NH_3^+ = -NH_2 + H^+$$

The complexing activity of glycine becomes relevant only when the NH_3+ steric hindrance of the positive charged group is removed, followed by the NH_2 electron pair availability for complexation.

It is interesting to note that silicon release at pH up to almost nine is lower than that obtained with pure water. Glycine behaviour can be interpreted as a quite stable adsorption of proteins on glass surface able to delay OH- attack up to the deprotonation of the ammonium group. This is in agreement, for example, with proteins strong binding to silica surfaces, used in some pharmaceutical preparation to prevent a decrease of the active principle concentration due to adsorption phenomena on glass. On the contrary, the progressively silicon release increasing with pH observed with dicarboxylic acids suggests that a possible adsorption on glass surface, if any, is not strong enough to prevent OH- attack.

(c) table 4 and figure 7: Dicarboxylic acids with up to two OH groups on the linear alkylic chain of four carbon atoms: Succinic acid, tartaric acid and malic acid

Regardless tartaric acid higher deprotonation (lowest pKa values), its complexing activity is the lowest in almost all the pH range, probably due to the steric hindrance of OH groups, considering that the highest silicon extraction was obtained by succinic acid without OH groups on the alkylic chain.

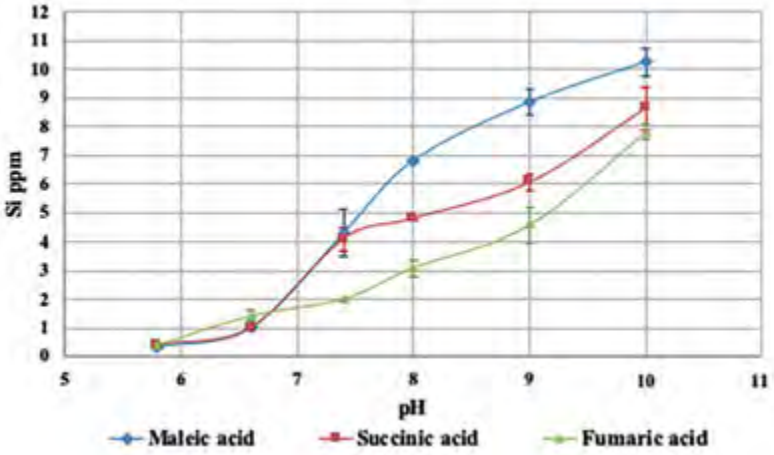


Figure 5: Comparison plot of the extracted silicon by 0.024 M maleic, succinic and fumaric acid.

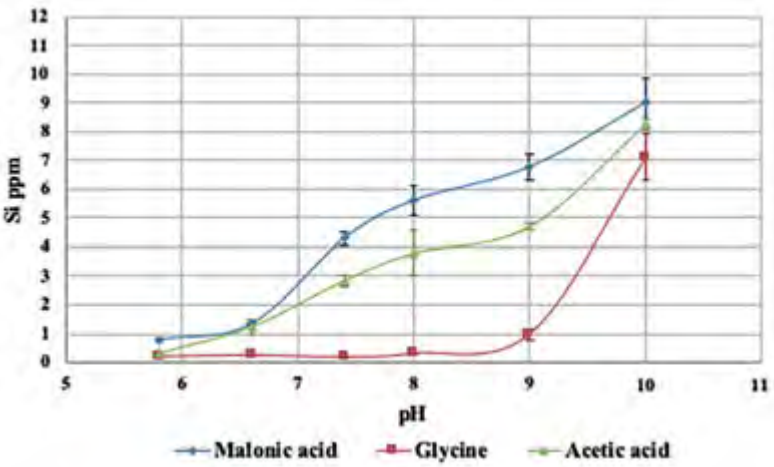


Figure 6: Comparison plot of the extracted silicon by 0.024 M glycine, acetic and malonic acid.

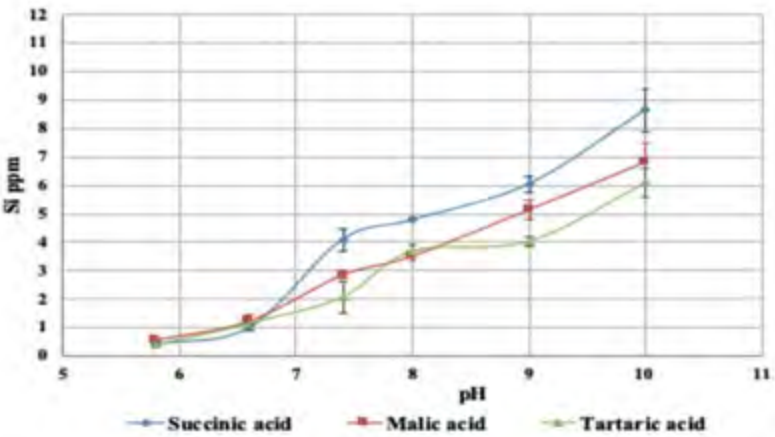


Figure 7: Comparison plot of the extracted silicon by 0.024 M succinic, tartaric and malic acid.

Conclusions

Glass surface chemical attack by the homologue series of complexing agents at the constant concentration of 0.024M, in the 5.8 – 10 pH range, was performed in small volume 20ml type I moulded glass containers. The test was performed by autoclaving according to the European Pharmacopoeia for one hour at 121°C.

At acid pH glass surface chemical attack is not or poorly influenced by complexing agents but often ion exchange (alkali surface depletion) is even prevented in comparison with pure water, due to adsorption phenomena as experienced in the case of amino acids. The same adsorption phenomena seem not to occur with carboxylic acids without aminic groups, due to the upward trend of glass attack with pH. When pH increases up to neutrality and over, the role of OH- becomes more and more effective in glass network disruption and in this context, the synergy with complexing agents becomes relevant to speed up glass surface attack.

The examined series of carboxylic and dicarboxylic acids showed that even if acid dissociation constant pKa plays a decisive role to let the functional negative charged groups able to interact with cations, complexing agent molecular structure and the presence of functional groups can be the main driving factor for glass ions extraction and complexation in function of pH. ●

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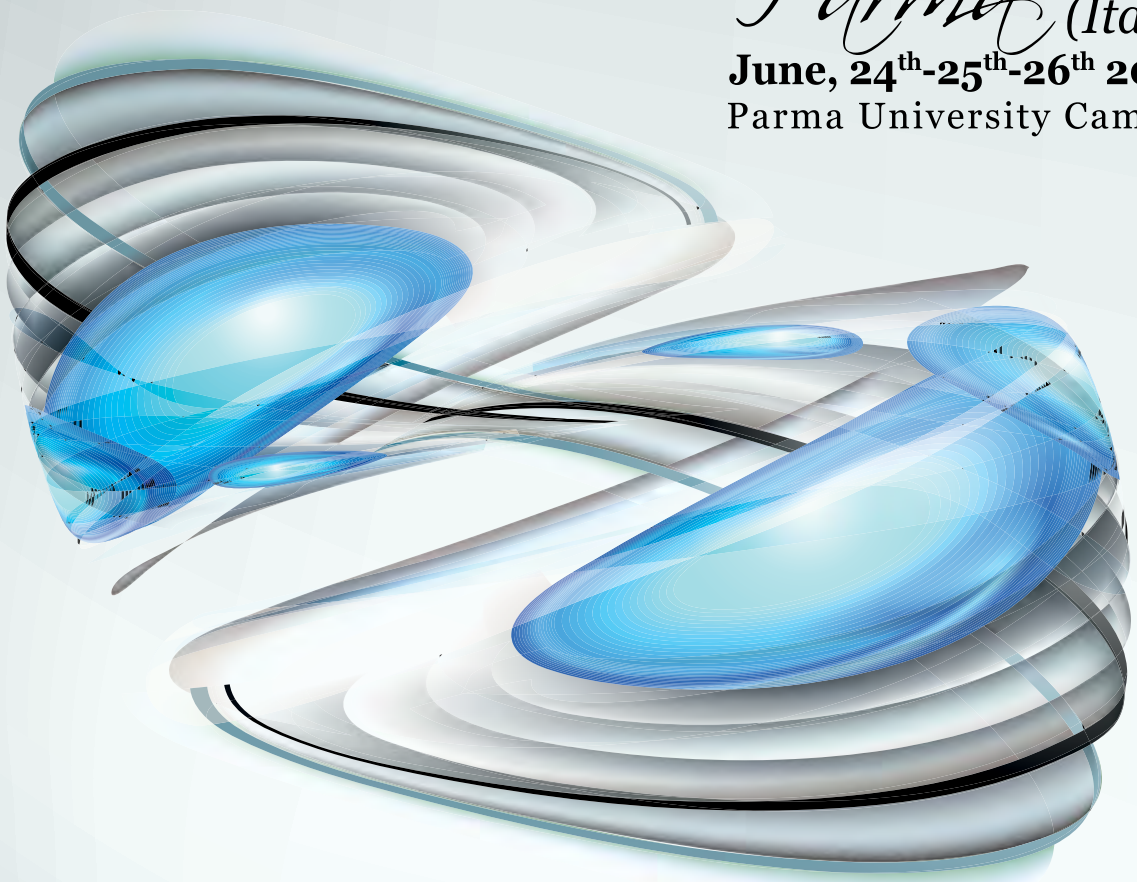

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Building a market for innovation

For glass fabricators contemplating investment in a new technology, a well-planned roadmap that extends far beyond the actual installation is essential for success. Adding an innovative technology is more than making room on the production floor for a new machine. Nor is it simply a matter of delivering the same product or service, only faster or better. According to Phil Maitland and Shirley Segev, it is about taking strategic actions, adding new expertise and capabilities, building a market and creating demand, while reaching new customers.

For early adopters, the journey can be challenging and this is particularly true for digital printing technology, which can require some fundamental business adjustments compared to screen printing. As such, it is not one that any glass processor should navigate alone. Rather, the technology supplier should be willing and able to assist throughout the journey, fully committed as a partner for mutual success.

While every company defines partnership differently, Ferro thinks there are five key criteria that help differentiate genuine collaborators and partners from mere suppliers. While the focus of this article is on digital printing, the same principles apply to any new technology introduction.

Look for great innovation and proven technology

Most importantly, start with the technology itself. Look for a truly innovative solution that answers a clear need for the business. This could be to satisfy an immediate customer demand – for example, adopting digital printing to introduce design and/or functional innovation, production and/or service flexibility - or to position the company for future growth. Consider if the solution is easy to use and fast and simple to maintain. An easy onboarding process will reduce the time and effort for your team to become proficient with the new technology and overall ease-of-use and maintenance will empower them to work productively.

The VEra digital glass printer for appliance glass is powered by ULTRA-FIX technology, based on a Dip-Tech patent and supported by the recently developed Ferro ULTRA-FIX inks.

Next, explore other crucial elements about the company itself. For example, does it have proven experience and success stories, preferably in your target markets, both vertical and geographic? Does it continue to innovate? Not only with its ability to introduce new solutions but also to upgrade legacy solutions - for example to support new ink formulations, higher resolution, or other advanced capabilities made available with newer systems - so that new equipment does not soon become outdated.

Deep understanding and knowledge

To help customers succeed with a new technology, your partner must understand your business, as well as your market. This begins in the purchase process, as they work with you to pinpoint the exact solution from within their portfolio that best suits your business needs. Then, once installed, it is important that your partner is able to help you market your new technology, together with its capabilities.

So, for example, if you are making a first time purchase of a digital glass printing machine, not only will you want to introduce this option to existing customers, you will also want to attract new clients in new markets. A true partner will help you position your new offering with existing clients and also work with you to better define your wider market.

Your technology partner should be familiar with your target market, their varied options and the type of information potential clients may need to influence their decision to work with you.

Talk with successful users

More than likely, you are not the company's first customer. Even a leading-edge technology will have existing users you can query. It is strongly recommended that you request testimonials about working with the company and its technology, as well as challenging the resulting improvements to overall business and work flow.

Ideally, ask for a live meeting and/or demonstration at a busy customer's site. Seeing the technology in action in a real glass fabrication environment will likely trigger more questions as you learn and watch. It is understood that not everyone will invite in a competitor but Ferro has found that many of

the companies partnered for advanced glass solutions are happy to showcase their capabilities to others in their industry. For example, WOON-TECH, a Massachusetts, USA -based glass fabricator, explains the benefits this way: "We're willing and able to teach prospective users - even competitors - about our digital glass printing division, creating new awareness of the technology and its merits. As we see it, our identity as a Dip-Tech partner, not just a user, creates exposure in positive and productive ways. This includes opportunities for networking and discussions that drive us to up our own printing game."

Demand end-to-end support

No more 'buy and goodbye'! A partner must aim to be around for the long haul and provide end-to-end support. In addition to providing stellar technical support and on-site training, your technology partner should be ready and able to assist you in building a team of skilled personnel to work with and maintain the new technology.

Installation should be merely the beginning of a collaborative relationship, throughout which your partner is easy to reach and continually delivers 360 degree support. For example, Dip-Tech provides customers with technical support, spare parts, design and graphics support, marketing support and ready-to-use sales tools such as brochures, videos and presentations. Likewise, your partner should 'stand by you' in joint marketing events, offering its experts for seminars, conferences etc, helping you to raise your profile and expand your market reach within its wide network.

Look for local support

Most companies will offer some form of support but for a new technology installation, local presence is a huge advantage. Working with a partner that has a local team of personnel who speak your language can make a significant difference.

Additionally, wherever you are in the world - the Americas, Europe, MENA, or Asia – it would be preferable to partner with an organisation which has a local parent or subsidiary company, rather than only third party representation in your area. A local in-house team will be trained and dedicated to deliver the company's values and will have the global reach, market knowledge and expertise that you will need along the journey.

Ferro believes that success with a new technology depends on collaboration. And finding the right partner is as important as identifying the right equipment or product. A true partner will help you to navigate new markets, garner expertise and sell your services better.

Beyond narrowing your learning curve, this saves time, money and human resources every step of the way. In other words, when adopting a new technology, do not face the challenges ahead alone, partner with the experts who have a proven track-record. ●

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Digital heat transfer decoration

By mixing the advantages of a heat transfer process with high end digital printing technology, Kammann Spezialmaschinen & Steuerungstechnik has created different ways for smaller volume and personalised glass decoration. Michael Kammann explains.

From the digital printing of heat transfer decals to heat transfer machines or even contract decoration services, depending on each customer's needs, there is a perfect solution. Focusing on quality and sustainability, the process does not use any VOCs or UV-curing monomers, which makes it safe to use. In addition, the DIGITRAN brand was invented to combine all services connected to heat transfer decoration and make them easily accessible.

It all starts with the digital printing of heat transfer decals, for which customers send their artwork to KSM. These are inspected and optimised in the company's prepress department to ensure that the colours printed match expectations. After the files have been approved, the images are printed on a special carrier material using a CMYK plus white printing technology.

After the actual printing, the transfers are optimised for the final application, which can be anything from perfume to beer, wine or spirits bottles. Likewise, drinkware or home decoration items can be decorated, as well as other materials including plastics, ceramics and metals.

The last step in the printing process is the slitting and rewinding of the freshly printed heat transfer decals to create compact rolls that can be easily shipped around the world for the application.

Printed gin bottle.

The whole process from receiving printer ready artwork to sending out rolls of digitally printed heat transfer decals takes less than five days. By this speed and fast turnaround times, quick sampling and prototyping is possible.

Heat transfer application

Once the transfers arrive at the customer, it comes to the application process using heat transfer equipment. KSM offers a range of semi and fully automatic heat transfer machines. Heat transfer machines are comparable to hot stamping equipment. However, there is a difference as a heat transfer machine registers and applies a finished print compared to stamping out only a part of a foil. In contrast to other printing technologies, these heat transfer machines stand out because of their flexibility and short set up times, as well as stable process conditions and low investment costs. Depending on the machines used, products and shapes from flat to cylindrical or even tapered drinking glasses can be decorated.

During the application process, the machine will register and position the print over the product to be decorated. Once the print is positioned, a heated transfer roller or plate coated with a rubber material will press the print against the product. Due to the heat and pressure applied, the print is activated and bonds with it. After this, the carrier material will be automatically peeled off. This way, only the actual print will adhere to the product, making this indirect printing technology result in a direct print decoration. Following this decoration process, other additional decoration technologies can be used with DIGITRAN heat transfer decals ranging from hot foil stamping to coatings or other printing technologies.

Larger perfume bottle (rectangular) printed.

Small perfume bottle (square) with chameleon 4C+W print.

For special applications, other functionalities can be added to the DIGITRAN heat transfer machines. If not already included, these can be anything from optical or mechanical product registration to pre-treatment devices.

Contract decoration

The third service offered besides digital printing heat transfers and heat transfer machines is contract decoration. To make this possible, KSM and other companies using the DIGITRAN technology offer to decorate in-house. By providing this service, customers get the chance to test digital heat transfer technology and introduce it to the market prior to investing in equipment. And for those who like to outsource the decoration process, options like warehousing and on-demand decorations are available.

With DIGITRAN technology and its full service concept, KSM wants to open the market of high quality, photo-realistic printing to anyone, at any quantity, from start-ups to special editions or personalised and specialty products. ●

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ESMA GLASS DECORATION

2020-21 guide to advanced glass decoration

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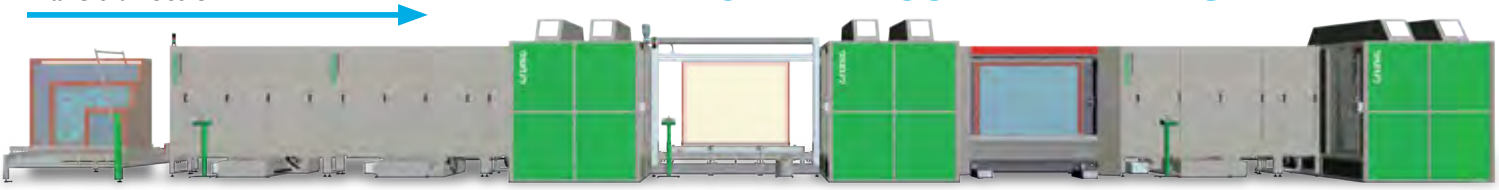

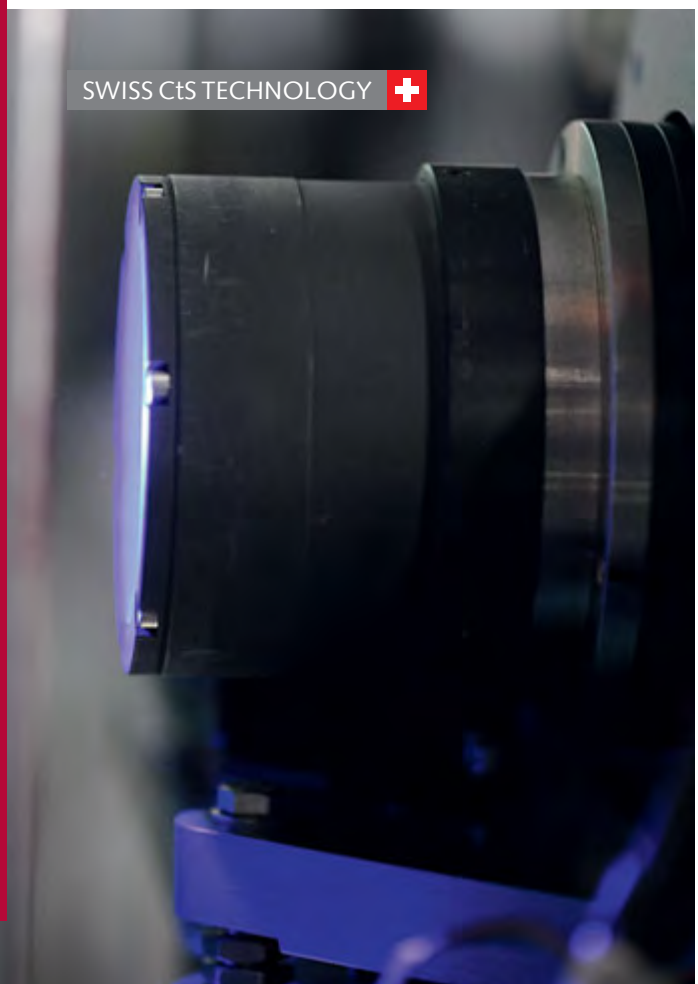

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Digital 360º metallisation possibilities

Proving that digital printing and metallisation fit together, Jochen Grabert discusses the Digital inLINE FOILING (DiF) process.

It was in 2014 that ISIMAT successfully introduced the inLINE FOILING process for the metallisation of glass containers. For designers, this process opened up the possibility for creating glass decoration with multi-colour, high sheen metallised images, while also strengthening the company's competitive edge.

The process needs three printing stations inside an ISIMAT decoration machine and works in the following manner:

- Screen printing a UV curable adhesive.
- Bringing the metallised layer of the foil into contact with the adhesive and curing the adhesive.
- Screen printing a clear or tinted varnish over the metallised image.

This solution offers many options for customers, as they are now able to create different metallisations with only one foil, simply by using various coloured varnishes. Another important benefit is the fact that this can be achieved within a single machine pass and without additional handling. This is also beneficial from a sustainability perspective. The combination of different print technologies inside only one printing machine reduces energy consumption compared to the use of various specialist machines, eg one each for the pretreatment and metallisation of the product.

The process works without heat and with low pressure, which also makes it usable for thin walled containers. Without these heat and high pressure parameters, the handling of this process is much easier than with similar systems. However, this system has a limitation, namely 360° metallisation is impossible due to the process itself.

Example of a metallised rum bottle with inLINE FOILING.

360º metallised Tequila bottle with DiF.

Digital advance

Now ISIMAT is going one step further and making the process digital, in order to eliminate this limitation. For the first time, 360° metallisation can be applied to glass containers. This is made possible through the use of a digital printing head inside the foiling unit, in contrast to the traditional inLINE FOILING process, where it was previously necessary to apply the adhesive directly onto the glass via screen printing. Now, however, the adhesive is digitally transferred onto the foil itself.

This has two additional benefits compared to traditional methods:

- The saving of one printing station inside the printing machine.
- Enables designers to create artwork with 360° metallisation.

This improvement also means that ISIMAT was able to transfer metallisation into the digital age. All advantages that digital printing offers are useable, including variable data, individual batch sizes and more. Users can combine it with analogue printing technologies like screen printing, as well as digital printing techniques. This means customers are offered a hybrid solution, tailored to individual requirements.

Importantly, this system uses UV-based inks and hence, ISIMAT can provide all options that would give the customer's products a distinctive look. The large colour gamut achievable with UV inks enables accurate colour matching to the customer's designs. Images printed with UV inks have clean edges and outstanding surface quality. Images can be printed with a higher resolution than is possible with thermoplastic inks.

However, UV inks also have their limitations. It is impossible, for example, to screen print shiny metallised images with UV inks. But brand owners favour metallised images because they enhance their products' shelf appeal. Instead, decorators can use hot stamping: A hot stamped image on a glass bottle is shiny and comparable to a metallised image that is screen printed with precious metal ink. Nevertheless, hot stamping is not able to offer a wrap angle of 360°. It is precisely at this point that the DiF process shows tremendous potential. It is a game changer in the market, with the potential to change the industry in several ways. ●

inLINE FOILING is a registered trademark of LEONHARD KURZ Stiftung & Co KG.

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CristalChile invests in high print quality and efficiency

The leading producer of glass containers in Chile, CristalChile is now working with the full range of Gallus Screeny and Heidelberger Druckmaschinen AG equipment, in order to integrate direct printing of bottles with high print quality and efficiency. CristalChile increased its decoration department with this substantial investment, which included the complete Screeny C-Line system, as well as prepress equipment from Gallus Screeny and Heidelberg. Rosina Obermayer reports.

This equipment was installed in November 2019 and is now running successfully within the manufacturing chain. It is the first Gallus Screeny C-Line system and also the first Screeny 400Eco. In combination with the screen printing equipment, CristalChile also invested in a Heidelberg Phoenix 800 CtS for the first time, a UV LED direct image setter for preparing the pre-coated meshes.

The glassmaker invested in a full range of equipment for direct printing of bottles. Besides a Screen C-Line system, the investment package includes a Screeny Tactile mesh, a Screeny fast tension frame and the first Screeny 400Eco development unit.

Key reasons for this broad investment include the high quality of the screen meshes and reproducibility, leading to a consistently high print quality of products. Now, the large glass bottle producer and direct printer is working with three Kammann machine systems, with a total of 14 screen printing units. In April 2020, two further Kammann production lines will be installed.

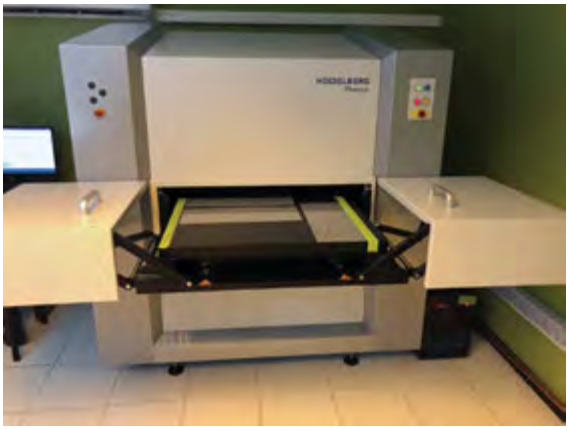
Left to right: Alex Riquelme, Graphic Processes Specialist, CristalChile; Cristhian Llanos, Head of Graphic Processes, CristalChile; Nathalie Tschepe, Head of Print Solutions, Bracker SpA; Elvis Villalobos, Process Engineer, CristalChile; David Cuevas, Operations Manager, CristalChile; Christian Bracker, General Manager, Bracker SpA; Juan Pablo Aros, Pre Digital Printing Laboratory Operator, CristalChile; and Gonzalo Carrasco, Graphic Designer, CristalChile. Image courtesy of Bracker SpA.

Left to right: Juan Pablo Aros, Pre Digital Printing Laboratory Operator, CristalChile; Elvis Villalobos, Process Engineer, CristalChile; and Gonzalo Carrasco, Graphic Designer, CristalChile. Image courtesy of Bracker SpA.

Reproducibility and print quality

The printing plate C-Line convinces with its superior, reproducible quality. The system solution, including the Gallus frame system, is suitable for UV, solvent and one and two-component ink systems. The ideal application is direct printing on hollow objects. CristalChile is using a UV ink system, as well as a thermo plastic ink system.

"In total, we are more than just happy with the equipment of Gallus Screeny and Heidelberger



The Gallus system solution for efficient and high quality screen printing. Image courtesy of Gallus.

The prepress department with the Screeny and Heidelberg equipment, which was installed at CristalChile in November 2019. Image courtesy of Bracker SpA.

Druckmaschinen" confirms David Cuevas, COO at CristalChile. "We are now able to trust on the print quality consistently and in combination with the reproducibility. This was one of the main reasons for this investment because our customers are often brand owners."

The Gallus Screeny C-Line screen printing plates enable a fast production time of just six minutes per print-ready screen printing plate. This is leading to a time saving of 60 minutes compared to conventional screen manufacturing.

Less production stops - higher productivity

David Cuevas continues: "Due to the quality of the C-Line screen mesh, the production stops are lower and thus, the production line is now already working more efficiently." Due to the quality of the meshes leading to fewer stops, overall productivity at CristalChile has increased since the installation in November 2019.

Successful co-operation

CristalChile is producing and printing glass bottles for the beverage and spirits market and is the leading producer of glass bottles in Chile. With more than 2500 employees, the company is still growing.

Bracker SpA, a specialist for the South American market, enabled this trustworthy co-operation. Christian Bracker and his team were able to support this entire installation successfully, so that the first bottle was printed in time. "We would like to say a huge thank you to Nathalie Tschepe, Head of the Decoration Business Unit at Bracker SpA" comments Matthias Rosenfelder, Head of New Business Screen Printing at Gallus. "Only with her help could this project with CristalChile become such a huge success."

The spring-mounted plate loading process prevents distortion in the screen printing plate during the squeegee process, which increases the size of print runs. Compared to conventional screen manufacturing, the Gallus Screeny C-Line offers cost benefits and quality improvements when decorating hollow items.

In addition to the Gallus C-Line system, the installed equipment at the Chilean glass bottle producer included the Gallus Screeny fast tension frames for increased overall efficiency during the screen printing process.

In-house prepress production

CristalChile invested not only in the screen printing equipment itself but also in the prepress production lines, in order to expose the screen printing plates in-house. Thus, the exposure, development and washing out of screen printing plates can be undertaken in-house on demand.

In addition, the automatic developer unit Screeny400Eco and the Heidelberg Phoenix 800 CtS (computer to screen) also enable a high degree of automation within the prepress department.

"The co-operation with Gallus Screeny was incredibly trustworthy" comments Elvis Villalobos, project leader at CristalChile, when summarising the project. "The whole project was going well, from the very beginning with the question of what we need to the very end, the first produced screen and the first printed glass bottle. I would imagine that further equipment by Gallus and Heidelberg will follow." ●

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The changing market of inkjet coating and decorating glass

Inkjet decoration of glass has become an accepted and well established manufacturing process. Used in both flat and container glass, inkjet is opening opportunities for manufacturers and allowing printers to increase their capability offering to customers. Custom short run printing is often seen as the key opportunity but inkjet is also changing production processes for many industries from home appliances to automotive glass. Part of this acceptance is that inkjet simplifies the production process, removes the need for masking or screens and reduces both set up costs and time, as Debbie Thorp and Neil Cook explain.

Debbie Thorp.

Neil Cook.

The flat glass architectural and interior decor markets have seen the benefits that inkjet can provide, delivering dazzling graphics for buildings and home interiors for many years – and growth continues. The last 18 months have seen several high production systems from Keraglass, Rollmac, Tecglass and Dip-Tech introduced to the market. Higher productivity is available via more print heads in XY scanning mode and more significantly with the latest single pass printers.

Pioneer opportunities

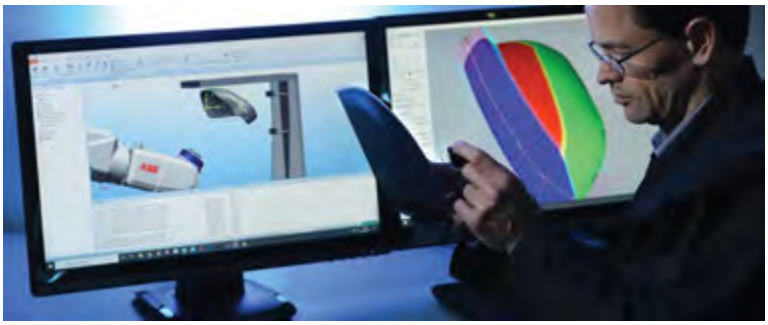
Beyond the decoration in flat glass, inkjet printing is now part of the functional use of the product. Systems are targeting opportunities in home appliance control panels and in automotive applications. The home appliance market is dominated by large companies producing similar products under different brand names. Due to this scenario, several components (especially control panels and doors) are the same item with different graphics. Inkjet printing, in conjunction with innovations in ink formulations and processes, is enabling cost-effective, shorter runs and greater brand differentiation; features that were previously financially prohibitive in small volumes. Dip-Tech working with Ferro ink technology has been a pioneer in this area.

The same is also seen in the automotive and special transportation glass sectors for printing the black frit around the edges of windscreens. The black print areas allow the screens and windows to be bonded into the frames, providing a clean finish. With the wide range of transportation glass formats and applications, inkjet is offering manufacturers the flexibility to allow them to meet the industry's just-in-time manufacturing models, without the need to make and store stock.

These systems need to have smart technology within them to correct registration issues as panels of glass are fed into the system. Camera systems are typically employed to identify the orientation of the windscreen as they travel down a conveyor and through the inkjet printer. This image is processed and the print design is rotated to ensure that the border is applied correctly. The combination of software and camera systems can be utilised further by being able to recognise a piece of glass from a known catalogue of templates and then print the correct template. This means that all the glass for a single vehicle could be printed in one job without any additional set up, or a single printer could be positioned to accept glass from several production lines. Dip-Tech, Tecglass and Thieme all have their own rotation correction or dynamic registration technologies. GIS also offers a number of image correction tools to ensure that OEMs have the capability to handle the variances in rotation to ensure accurate registration.

Hollow glass possibilities

In the hollow glass sector, cylinders (as in simple bottles) present little issue for inkjet printing. Once the handling and rotation of the bottle has been managed, the printing is



GIS Print Path Designer Tool.

Black frit is commonly seen on automotive and transportation glass.

effectively the same as printing a flat image. However, the physical characteristics of the printhead still create factors to take into consideration. There are three key issues; printhead symmetry, distance between printhead nozzle rows and the number of printhead nozzle rows.

Symmetrical orientation of the glass cylinder under the printhead is important. If a printhead has two rows of nozzles, the object should be orientated so that the rows are symmetrical either side of the centre line of the cylinder. The narrower the distance between the nozzle rows, the better. And although more rows of nozzles in large printheads may increase productivity, the wider the printhead, the harder it is to print onto glass objects with a small circumference.

An additional factor to consider with hollow glass decoration is when the sides of the bottle or glass are not parallel, such as the conical shape, which is common in drinkware. Printing onto conical objects adds greater complexity and challenges for inkjet. Cut a cone down its length, lay it flat and the user has what looks like a section of an old vinyl record. Image compensation is required to wrap the image around the cone and the system also has to contend with resolution changes as the conical shape rotates under the printhead at different speeds. The image screening is more complex and the increase in drop density in the image must be compensated. Without correction, these errors can result in unacceptable image quality. Special software (such as the GIS Curved Surface Map Generator) is required to correct printhead nozzle alignment errors, provide density correction, ensure no dot gain issues and ensure there are no screening artefacts.

Future prospects

So, what does the future look like for inkjet in the glass industry? In container glass, low end systems have flourished but the industry is finally seeing more adoption at production volumes and this is expected to continue. A recent important announcement was made by AB InBev with its Tattoo Alpha Plant in Belgium.

In flat glass, further advances can be expected in ink chemistry and software, enabling more functional printing in industrial sectors. So, more penetration is expected in the automotive and home appliance markets. As the amount of glass used increases in private and public transportation vehicles, along with the subsequent amount of black frit associated with autonomous vehicles, there may be challenges in managing the process of forming the printed glass into the desired shape.

The increased black frit areas can cause intense heat in these areas, causing the glass to warp. It is possible that this could lead to manufacturers looking beyond printing onto flat glass and to printing the black frit after the glass has been shaped and formed. This would require sophisticated handling of the windscreen and inkjet printheads – probably using robotics - and advances in software such as the GIS Print Path Designer to manage the complex print path of the printheads over the curved surface, whether convex or concave.

The glass industry has enormous advantages and strengths in both industrial and consumer packaging applications. This article has not even touched on the use of printed glass in mobile phones, display screens and solar, all of which also offer opportunities for inkjet technology. It is clear that the future for inkjet printing in glass markets remains strong, with greater opportunities to come. ●

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More than screen printing squeegees alone

Sandrine Ritoit discusses Fimor's specialisation in the manufacture of screen printing squeeges and a series of complementary product developments.

In over 40 years, Fimor has become a specialist in the manufacture of technical polyurethane parts for various industries. The customised formulations developed are thermoset compounds with exceptional chemical and mechanical resistance properties.

One of Fimor's main markets has long been squeegees for most screen printing applications, including glass and the company is now recognised as an international leader with its serilor brand. However, over the last decade, significant investments have been made to develop other activities in parallel with the production of squeegees in order to ensure long-term growth in several industrial markets, mainly in sectors with large volumes of polyurethane elastomers. Protective parts for glass handling, intended for the flat glass industry and manufacturers of pvc and aluminium sidings/frames, represent one of the company's areas of diversification.

This range of polyurethane profiles is marketed under the serilor Protec brand. These moulded profiles prevent the chipping of painted or fragile parts by protecting them from shocks and from rubbing against metal surfaces. Most glass manufacturers are familiar with the inconvenience of foam protectors that tear and are shredded in workshops, or with the black marks left on products by rubber protectors. Non-elastomeric thermoplastic profiles, once fixed in place, no longer recover their shape and can also scratch parts. All these issues are eliminated with polyurethane.

Properties

Among the key features of serilor Protec polyurethane profiles are the following:

- High chemical resistance (lubricants, solvents, synthetic oils etc).
- High mechanical resistance (abrasion, wear and tear).
- Flexibility and elastic properties depending on hardness.
- Excellent compression set resistance.
- Good ageing in severe environments.
- Anti-slip properties.
- Easy to clean and maintain.
- Odourless and non-marking.
- Bonds to most materials.
- Colour coding possible.

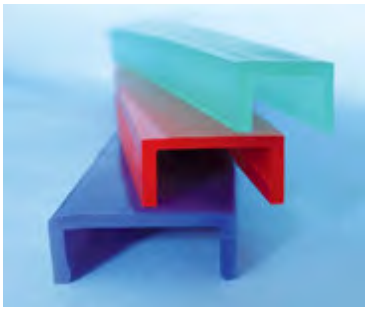
Fimor offers a full range of profiles that can be adapted to work benches and storage trolleys, enabling manufacturers to save on maintenance costs, while guaranteeing their production and reducing reject rates.

serilor Protec profiles are available in five standard dimensions and three standard hardnesses, depending on the desired effect (sliding or adherent), or custom-designed.

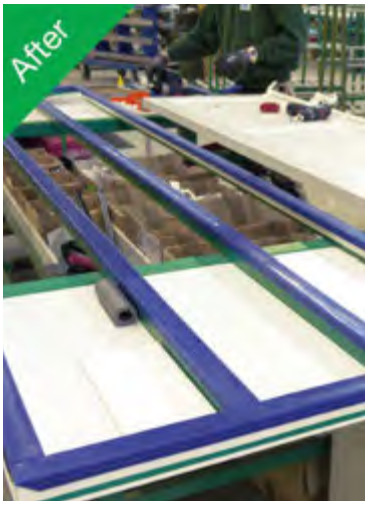
Professional testimonial

"In search of an efficient solution to replace the foam, which was tearing and was not resistant to shocks with joinery, we decided to equip our workbenches and profiles storage trolleys with serilor polyurethane" David Desnoes, Maintenance Manager at FPEE Industries explains. "This allowed us to save on maintenance costs, while guaranteeing the quality of our joinery. We have already installed more than 6km of PU profiles and are now benefiting from a consequent reduction in the number of damaged structures, which means shortened times and therefore, satisfied customers." ●

Half moon profile.



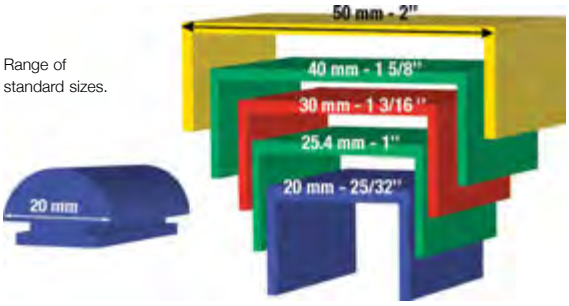
Square profile.



Before/after the installation of profiles.

Relationship between hardness and required effect.

Range of standard sizes.



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High-tech from Swiss countryside to the global market

The homes of Grünig and SignTronic are no fancy big city manufacturing sites but medium-sized production and company offices in small villages near Niesen mountain (Grünig) in the western part and the Säntis (SignTronic) in the eastern part of Switzerland. Focused on suitable production premises to cover the needs of its internal departments, as well as to highly educated and professional employees, both companies sign also for modesty in their appearance, says Andreas Ferndriger. Many customers are astonished to find the production of such high-tech products in small villages. International companies supplying clients in more than 40 countries around the world with high-tech products are – normally – not to be found up in this countryside.

Grünig and SignTronic are dedicated to the screen manufacture and preparation processes in the screen printing industry. Their core competences are based on Swiss professionalism and quality. 'Made in Switzerland' is not employed simply as an empty phrase but as a commitment that is implemented wholeheartedly by the organisations and workforces.

Screen making is one of the elementary factors in the screen printing process, as this is the crucial point that determines printing quality, printing output and – essentially – costs. Under the slogan 'ONE VISION - the perfect screen', Grünig and SignTronic offer solutions that can be summarised by the term 'technology and automation'.

The Grünig-Interscreen site in Schwarzenburg.

CtS direct exposure technology

SignTronic has offered CtS direct exposure technology for almost 20 years. This advanced technology eliminates various screen preparation processes and based on the artwork data, exposes the screens directly and without any deterioration of quality, without film, montage, vacuum frame etc. This results in considerably improved printing quality with smooth transitions/continuous tones, sharp details and lines up to photo-realistic prints that look digital but have actually been achieved by screen printing, substantially lower screen costs, due to shorter set-up times and increased flexibility.

With an extensive third and fourth generation product range, SignTronic offers HR technology with a resolution up to 3040 dpi. For decal applications, an option is provided for photorealistic prints and the finest half tones. For textile applications – mainly direct, transfer and sublimation printers – the modular STM-TEX and STM-D-Series are the optimal solutions. In the industrial sector with its wide field of applications, screen printing demonstrates its full potential and strengths. This is regardless of whether the articles to be printed are glass, porcelain, labels etc. For these highest standards, model STM-1010HRC is recommended by SignTronic.

SignTronic recently moved to purpose-designed premises in Rüthi.

Automating the screen making procedure

Grünig offers equipment and machines for automating the screen making procedure. The product range covers stretching, gluing, coating, drying, washing, developing, preparation and water treatment. Automation is setting standards in the field of almost operator-less screen preparation involving various processes.

In the coating sector, a growing number of customers are standardising their screen sizes, which considerably facilitates the implementation of in-line coating processes. The same is true where the use of coating emulsion is concerned. The shorter the list of required parameters to be taken into account, the simpler automation will be.

When talking about print quality, the most important part to achieve is increased mesh stretching precision and fastening. When working with smaller screens, often larger quantities in top quality and within the shortest possible time are needed. Grünig offers the G-STRETCH 275 UV BOND LED solution that sets benchmarks in the combination of stretching and gluing processes.

Last but not least to be mentioned in screen making is the washing process. Whether single compact plug and wash machines (handling small XS up to extremely large XXL formats) or fully in-line automation solutions are required, Grünig offers tailored quotes to match customer requirements. The G-WASH 170XM series p e is a modular installation concept for

all washing processes, providing automatic degreasing, washing, decoating and developing of printing screens of any size.

Strategic partnership

Both companies' engineers work systematically towards the objective of combining technology and automation in state-of-the-art in-line solutions for screen making. This LAB concept, whose key factor consists of positioning screen manufacture as an essential link between the artwork/RIP and printing departments is well accepted in the market.

Sizes and quantity of such worldwide projects are increasing and proof of the growing need for this combination in all important market segments, such as industrial, textile and graphic. The STM-TEX-Pro-10 IN-LINE solution is a typical example of the perfect screen project.

Although both headquarters are maintained in Schwarzenburg and Rüthi (SignTronic recently moved to a bigger site, also located in the Rhine valley, a short distance from its former home in Widnau) and despite the close working relationship that exists between these two companies, they remain legally independent entities. Marcel Grünig is the CEO of Grünig-Interscreen AG and Andreas Ferndriger is the CEO of SignTronic and Marketing Director for both companies. Since 2019, André Kreuter has been Sales Director at Grünig-Interscreen.

Marcel Grünig and Andreas Ferndriger strongly believe in highly qualified, motivated and flexible staff members as the basis for their companies' success. ●

STM-TEX is an example of the Grünig/SignTronic one vision.

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Ink design considerations for smart phones

A touch screen or cover glass is the display that allows users to interact with their fingers. The most commonly used displays are for smart phones. According to Caroline Bonnafoux and Olivier Cocagne, designing an ink for smart phone applications requires a skilled process.

When it comes to designing inks for smart phone applications, the requirements are very high and very specific. Apart from these specifications, ink designers have to follow smart phone design changes, as cover glass devices evolve from flat (2D) to curved (3D) shapes. In addition, images once bordered by a narrow frame can now flow seamlessly down the sides, creating a striking visual experience.

- 2D: Flat glass surface and straight edges.
- 2.5D: Slight curvature at the edge of the glass display, also known as a contoured edge.
- 3D: Larger curved glass, representing the shape of things to come.

Cover glass is used for the front and back of smart phones and Encres DUBUIT has developed special inks for these applications. Inks need to be halogen-free and compatible with the glue, as well as the whole technology of the device. These requirements have a serious impact on the sourcing of raw material (pigment without chlorine and bromine, total needs to be under 900 ppm). The limited raw material used adds difficulties to reach these requirements. The back side is fully printed, each brand and each series having their own specific colours.

Shape changes also have a serious impact on the printing method and the material used for cover glass. The printing methods employed have moved from direct screen printing on glass (2D and 2.5D) to indirect printing by spraying (on PET film laminated on the cover glass) for the back side and from screen printing to pad printing for the front side. Each shape has an impact on the printing process.

- 2D, 2.5D tempered glass: Screen printing (front side) PL black/tablet white, yellowing resistant; screen printing decoration on full back side cover glass (PL black/tablet white, yellowing resistant).
- 3D bent glass: For the front side, direct decoration on curved glass is performed by pad printing (E-pad) or screen printing (HCP black and white on PET). For the back side, decorated film is done in screen printing (HCP black or white) or by spray directly on glass (SPR).

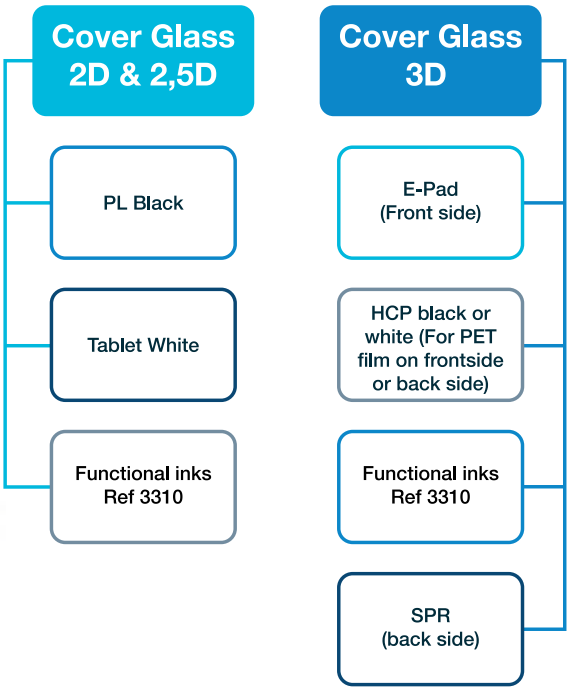
2D/2.5D cover glass process

First, the 2D and 2.5D cover glass use ultrasonic cleaning, going through several baths to be cleaned and then dried. To achieve opacity, it is necessary to apply two or three layers of the PL black ink and then apply the 3310 to get the right optical density. The PL black ink has high optical density and strong chemical resistance. This ink is non-conductive to ensure the tactile function of the screen. It can be used for all layers and can resist temperatures up to 180°C.

The tablet white ink needs more layers, up to four to reach the correct opacity. Then, 3310 functional ink is applied to achieve the correct optical density. The tablet white has good resistance to high temperatures (180°C) and superior screen stability. It has a smooth surface and is yellowing resistant. A primer and the tape or the optical clear adhesive are added to stick the whole screen of the smart phone.

The last layer is functional, with the 3310 ink. It is used to ensure better cohesion with the adhesives used for assembly of the cover glass and the frame of the smart

Examples of application: Front side, back side and camera.



The Encres DUBUIT ink range for smart phones.

phone. Its main feature is the high surface tension of the film after drying.

3D cover glass process

Back and front sides are very different from the 2D/2.5D, printing on PET film for the back side that can be metallised. The front side is printed by spray instead of screen printing. Processes for front and back sides in 3D cover glass are slightly different. Front panels are mainly printed by pad printing and the back side is sprayed.

Front side direct printing on glass

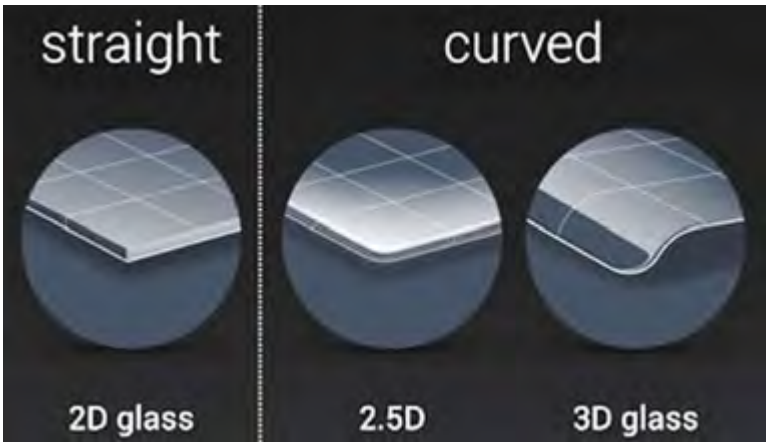
As per the 2D/2.5D cover glass, first the glass is cleaned by use of an ultrasonic bath. The E-Pad series developed by Encres DUBUIT is a two components ink. Several layers are applied directly on the curved glass (two/three layers) and then the sensor is laminated with the UV glue.

When printing on PET, the screen printing process can be used for the front side on the PET film. Several layers of ink need to be applied to gain the opacity required. Encres DUBUIT has developed the HCP ink in black and white. The black is very intense and offers excellent opacity on transparent substrates. After complete curing, the ink exhibits excellent hardness and good resistance to abrasion and chemicals.

For the back side, direct printing is performed on the glass. The SPR series is a two component epoxy ink, designed specifically for 3D cover glass. The ink can be black (specific colour according to the brand and the smart phone, or white and resists temperatures up to 150°C.

When printing on PET, the process for the back side is the same as that for the front side.

The smart phone industry is very innovative, where smart phone manufacturers and glassmakers are working together to offer the latest features to final consumers. As an ink manufacturer, Encres DUBUIT must follow these trends and adapt its chemistry to the latest specifications and process printing. So far screen printing, pad printing and spray are the main printing processes used. This application method can also be extended to tablets and watches. ●



Different types of cover glass.

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Computer-to-screen expertise for the glass industry

CST GmbH is a family business with local roots and a global presence. Michael Mogge highlights the German company's knowhow in the manufacture of high quality computer-to-screen machinery.

In the early 1990s, when computer-to-screen was spraying a mask with ink or wax onto screens, CST delivered hundreds of inkjet and waxjet imaging units throughout the world. Since the introduction of the DLE (Digital Light Engraver) in 2004, more than 1200 machines have been installed in different market fields, including in glass printing in small and large formats.

DLE is a direct to screen system, which cuts out all consumables like film, chemistry, ink, wax, spraying heads and lamps. The customer's files are transferred direct to the coated screen, without any consumables. The results are sharp lines and dots in highest quality and with resolutions between 720 and 5080 dpi. Fine lines down to 30 µm thicknesses on small sizes are possible.

Today, the customer can choose between different technologies and light sources to image screens. Besides CO_2 laser and YAG laser systems, they can select between high energy multiple wave light UV LED light sources or blue laser light. The machine bed can be customised to individual application need and sizes.

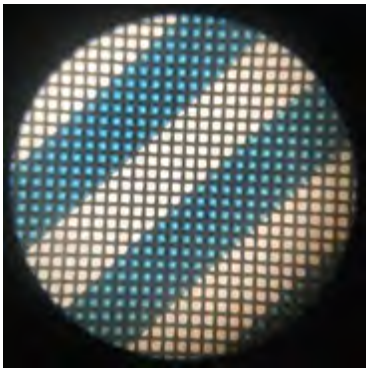
In addition, existing machines from other suppliers can be upgraded. CST machine design flexibility allows for custom-specific imaging systems in different screen printing applications that optimise production, competitiveness and profitability.

All installed and future CST machines with their industry leading open architecture can be upgraded to the latest UV LED light sources, blue laser or any future imaging technology.

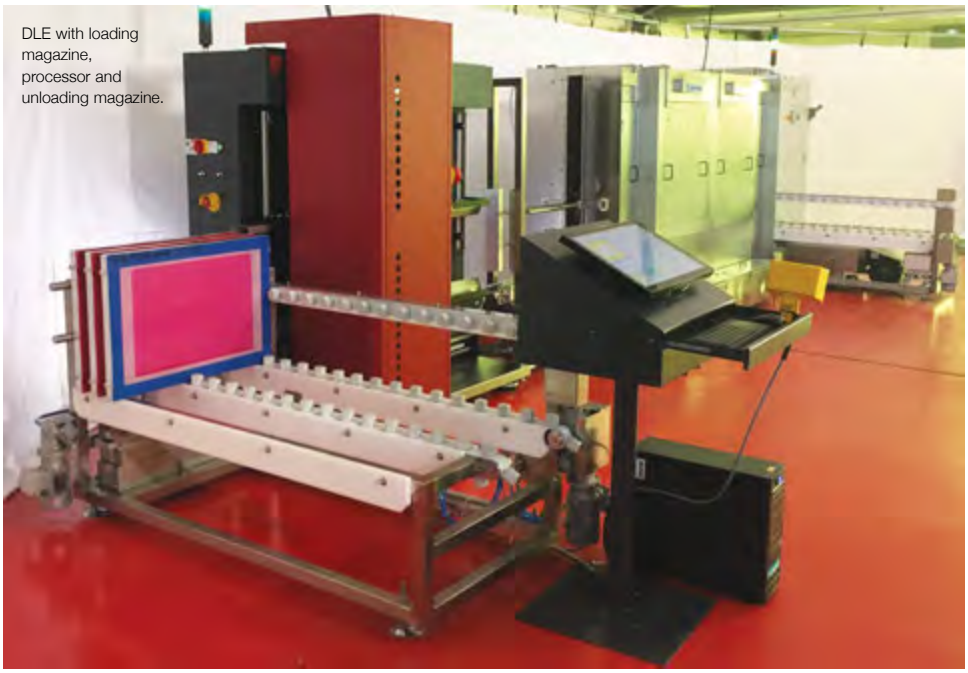
CST provides the glass industry with stencils in large and small formats.

Horizontal DLE as well as vertical DLE are available in all sizes. The vertical DLE can be further automated with loading and unloading magazines and processors to develop the exposed screens inline.

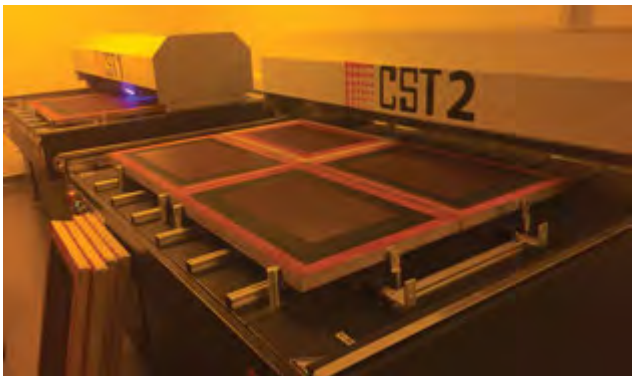
All DLE are equipped with a CCD module to service them



Microscope image.

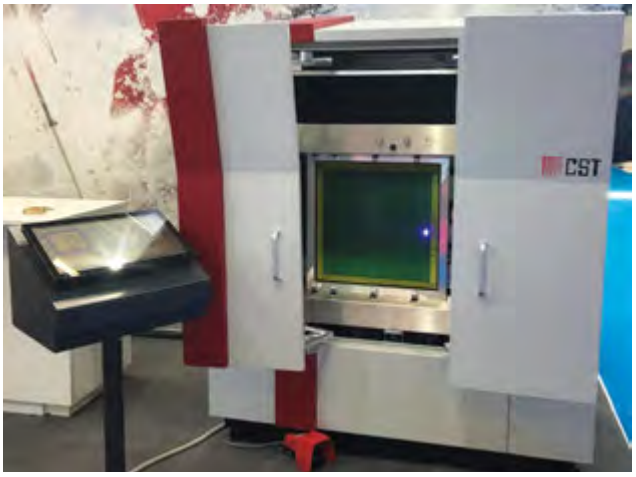


DLE with loading magazine, processor and unloading magazine.

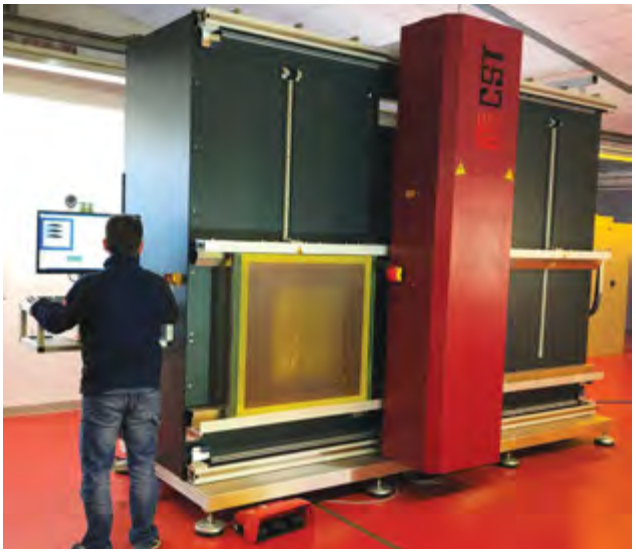


Multi-exposure for small stencils.

straight via the web with remote access. The machines are designed and produced in Krefeld, where the majority of the company's service engineers are based. CST also manufactures engravers for flexo, pad printing and embossing as well as 2D and 3D scanners. ●



Vertical exposure for small sizes.



Standalone or automated equipment can be built.

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Growth maintained by decoration equipment specialist

Continuous strong growth in all markets in recent years has made it necessary for Koenig & Bauer Kammann to relocate to larger premises with more space and customised facilities, as Axel Bohlmeier explains.

The Koenig & Bauer Kammann factory in Bad Oeynhausen, Germany provides a production area measuring 6000m^2 and 3000m^2 office space on a 27,000m^2 plot of land, with sufficient space for future expansion. The building features a state-of-the-art infrastructure, including:

- 65% more storage space for parts and components.
- Automated high rack warehouse.
- Computerised, immediate 'on demand' delivery and short distances from the warehouse to the assembly line.
- Assembly space to build 12 machines simultaneously.
- 10 new work stations for engineering and administration.

This facility is designed to meet the precise needs of customers to build fully automatic screen and digital printing machines for the glass industry. The relocation was completed last December and all business units are now operating from the new building, which is just 3km from the previous location.

Koenig & Bauer Kammann relocated to larger premises in December 2019. All business units now operate from this building.

Demo and development centre

With several permanently installed machines, the company's demo and development centre provides the perfect showroom to present various machine models and the latest machine features. It also allows Kammann to print samples, to test new screen and digital inks and to further develop digital printing with an in-house team of process engineers.

Machine innovation

Coinciding with the inauguration of the enlarged premises was the presentation of Kammann's latest machine development, which targets the beer and soft drinks market. Designed for the highest speeds and best possible productivity, the HS300 equipment offers speeds of up to 300 ppm and up to eight printing stations for thermoplastic inks, more than 50% more output than competitive machines. The first delivery was scheduled for February 2020 and a double speed machine for 600 ppm is scheduled to be ready by the end of 2021.

Besides speed and productivity, the HS300 offers several innovative features, including:

- Contactless camera pre-orientation to the bottle seam. This allows glass manufacturers to reduce the thickness of the base and reduce bottle weight.
- Freely selectable use of each printing station; each printing station can be used to print either on the body or on the neck. Any combination is possible.
- Print image inspection system to identify misprints or colour variations.

Digital printing

In the past 24 months, digital printing on glass has also contributed to a significant expansion of the Kammann business. Growing demand for machines with the capability to print high resolution images with up to 720 dpi using the half tone process has resulted in more than 20 machine sales. This machine type has become

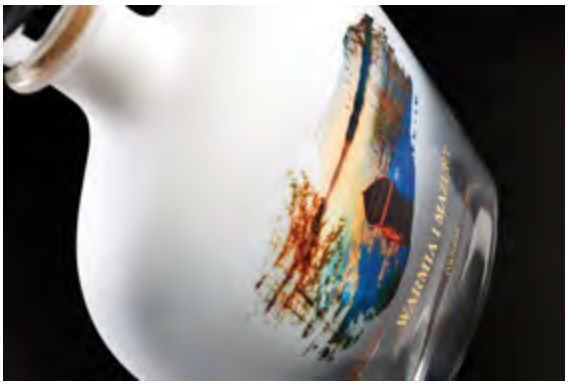
Customers on every continent rely on the quality of the Kammann brand.

The purpose–designed building features the latest state-of-the-art infrastructure.

The HS300 equipment range is designed for high speeds and productivity.

Koenig&Bauer Kammann is a supplier of flexible, precise and efficient decoration machines.

the industry standard for printing high quality beverage bottles (spirits), drinkware and cosmetic containers with the digital process. High resolution print images, the realisation of small order quantities and individualisation are now possible with this technology.



The company's success is based on technical, innovative product development, flexibility and customised precision solutions,

Another interesting feature of digital printing is the possibility to imitate embossed glass by printing multiple passes of clear digital ink, thus achieving any thickness required. The results are astonishing and have drawn considerable attention from industry experts. For small runs or exclusive designs, this process eliminates the need to create special moulds.

Process combinations

Digital printing also offers possibilities in combination with other processes, such as foil transfer. The recent K-show in Düsseldorf witnessed the introduction of a process that offers the possibility to use a digital primer in combination with a foil transfer unit. This allows users to change foiled images without changing screens.

Standard range

Some 50% of Kammann's sales worldwide is still obtained from the best selling K15 screen printing machine, which offers unrivaled features for printing on all kinds of glassware. This extends from printing on simple round bottles with thermoplastic inks up to nine colour screen printing on difficult shapes with UV or LED curing inks.

Another recently developed feature is LED Pinning, which allows the printing of a 360% wrap around the article. This is only possible if the beginning of the print image is touch dry (overprintable). ●

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Printing on glass – A goal without a plan is just a wish…

There is hardly a task in digital printing that has such a wide spread in solutions and technologies than printing onto glass. From wine bottles to windscreens, from vials to 500+ kg laminated safety glasses, there is a wide field of different requirements in terms of machinery and digital colour coating technologies, as Christian Gächter explains.

Christian Gächter.

Solvent glass inks with inorganic pigments are used for printing onto float glass for architectural and automotive applications. While the process is widely accepted and proven, it is still very time-consuming, as it is necessary to fuse the inks onto the glass at temperatures of approximately 650°C-750°C. Not to speak of the energy involved. The result is a coloured glass layer fused on glass, providing a durable and stressable surface.

A downside to the system is that - due to the printing process and the pigments involved - the gamut as well as the resolution and the detail definition are remarkably lower compared to other inks. Alternatives with UV inks, as well as the latest development of Austrian-based TIGER Coatings GmbH & Co KG, TIGITAL Powder has proved its capability to substitute the VOC-based fluids in a number of applications.

UV inks are on the way to establish themselves in furniture construction, exhibition stand design, interior applications like kitchen and wet rooms, as many requirements (eg resistance to hot/cold conditions, moist and wet conditions) are met in a very acceptable way. Patented solutions for the exterior are also available with both organic and inorganic pigments, widening the range of UV printers, without the need of six digit investments for pre- and post-treatment.

Even within the range of UV inks, there are vast differences between outdoor inks (allowing images to stay stable for many years on facades) and heavy duty inks, allowing them to withstand physical and chemical challenges like cleaning detergents.

Whenever high resolution and brilliance, as well as ease-of-use are key to succeeding in a print job, UV inks are a good choice. In terms of adhesion and physical/chemical resistance, they are weaker than solvent glass inks. As UV inks are easier to run and UV systems are easier to maintain (eg no need to flush the lines, remarkably less setup costs, wider application range), they are often not only technically but also economically the better choice.

In between the technical properties of these liquids is the TIGITAL Powder, which has the same properties as a 'normal' powder coating, meaning excellent adhesion on rigid substrates and little to no migration of harmful compounds. It also offers high resolving and brilliant image quality. A print service provider 'just' needs to take care of the transfer process and curing of the material. The print service is provided by Tiger Coatings. This allows it to implement that process into industries that are not ready to invest in digital printing, either in terms of machinery or in terms of personnel.

Last but not least, the most important part involves the primers. In order to achieve the required adhesion between the glass and the colour layer, a chemical agent is needed to assure longevity and performance in all circumstances. Knowledge of the priming process and the necessary pretreatment is at least as important as the choice of the right ink.

As virtually every glass is individual in its composition and many variables influence the final print quality, it is necessary to evaluate upfront for every application and every business case the correct production setup. It is still the tricky part to identify not only the quality requirements but also the feasibility of the print/production solution in daily life. Soon, one ends up with an expensive machine that runs infrequently, causing enormous daily running costs with little to no turnover. TIGITAL runs all alternatives in the portfolio to print on glass and is independent in terms of machinery and technology, helping customers to set up a plan that matches their individual needs. ●

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Sputter coating of architectural glass

Michael Gross discusses the application of sputter coatings on decorative and functional architectural glass.

A family-owned German business based near Heidelberg, Kissel + Wolf GmbH supplies chemical products worldwide for screen and textile printing: Industrial, flock and special adhesives; cleaning agents; as well as resists and coatings.

Using a resist, a glass surface can be masked with a design, either partially or full-faced, prior to further finishing, processing or transportation, protecting it from external influences. Applications such as etching, sandblasting or sputtering are the focal point of this product range.

Figure 1: Selective sputter coating on architectural glass.

Magnetron sputter coating

Magnetron sputter coating, also called physical vapour deposition, is the removal of metal or metal oxide atoms in a vacuum chamber by energetic ion bombardment, to coat a substrate with the sputtered metal particles. This coating is common for heat reflection at architectural glass – well known as mirrored glass on skyscraper facades in financial centres.

The same application method is used for selective sputter coating of architectural glass. Only that for the selective sputter coating, the metallic deposition is applied partially and not over the entire surface. Figure 1 shows an example of selective sputter coating on architectural glass. The glass facade with the floral design is at a shopping centre in Leicester, UK. The sputtered pattern should give the building an interesting appearance and protect the interior from the sun.

Bird-friendly glass

To reduce the death rate of birds, so-called bird-friendly glass has been developed (figure 2). This type of glass uses the spider web effect. Unlike humans, birds are able to detect light in the ultraviolet wavelength range. This circumstance protects spider webs from being destroyed by birds. The spider web reflects the UV light. Birds recognise the spider web as visible obstacles and avoid them. UV light-reflecting structures that have been applied to the glass by means of a selective sputter coating remain invisible to humans. Only the bird's eye sees a contrasting pattern and is thereby warned of the obstacle.

The areas that should not to be coated are masked with a resist. The masking can be performed either by inkjet or screen printing. For glass sizes of less than 6mm and larger numbers of glass panes with the same design, masking by means of screen printing is recommended. For larger glass formats or individual designs, the masking is preferably applied with inkjet. After the sputter coating process, the resist and the metallic coating above can be removed with a special cleaning chemical either manually or in an automatic washing unit.

Requirements for inkjet capable resists:

- Special selection of raw materials.
- Good mechanical resistance during transport.
- Good resistance to aqueous cleaning processes.
- Good stability at high vacuum.
- Easy removal. ●

Figure 2: Bird-friendly glass.

About the author:
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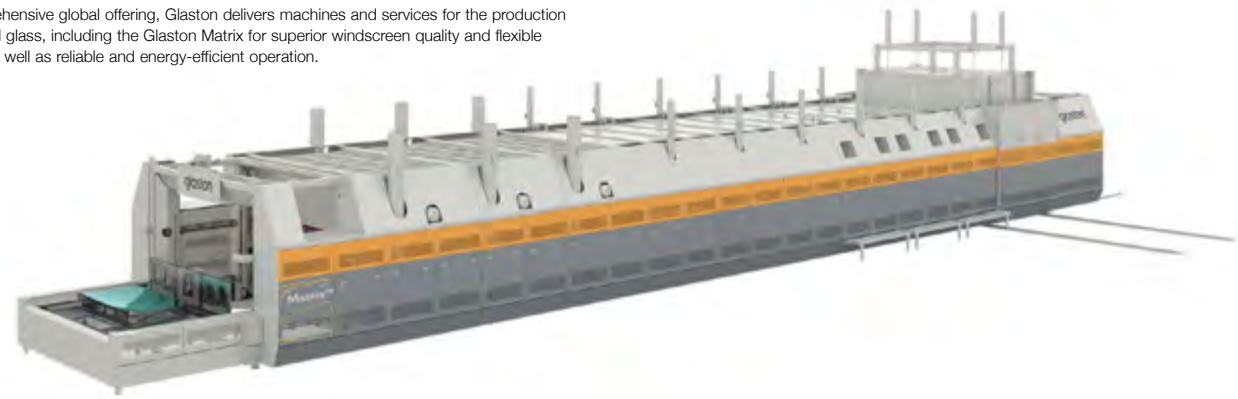
With a comprehensive global offering, Glaston delivers machines and services for the production of heat treated glass, including the Glaston Matrix for superior windscreen quality and flexible production, as well as reliable and energy-efficient operation.



Leading glass processing technology company anniversary

The origins of Finnish glass processing technology specialist Glaston date back to 1870, having evolved from a traditional forest industry company. For 150 years, quality, the development of the latest technologies and internationalisation have been evident throughout the organisation.

Glaston's roots go back to the company Hammarén & Comp, founded in 1870. Operations focused on forestry and paper and the successful Kyröskoski Works was established. Ever since the days of its founders, the company has continuously developed its operations and in order to respond to changing circumstances in both domestic and foreign markets, has seized business opportunities beyond the country's borders. In addition, utilisation of the latest technologies to secure efficient, high quality operations has been an enduring characteristic. The company has exported products since 1907. In 1909, Hammarén & Comp became a limited company and in 1941, its name was changed to O/y Kyro A/b.

A major realignment of Kyro's business took place in the 1980s, when the company's management decided in 1981 to diversify its operations. With the acquisition of Tamglass Oy, operations expanded beyond the traditional forest industry into glass processing.

Tamglass, which specialised in the manufacture of laminated and tempered safety glass and particularly the sale of tempering machines and technologies, rapidly developed into a leading manufacturer of tempering machines.

From the middle of the 1980s, acquisitions were focused on glass processing technology and the company began to specialise increasingly on flat tempering technology and its development. From 1990 to 2000, Kyro saw a transformation in which the company evolved from a forest industry company into a modern and international technology group. In 2007, Glaston Corp, specialising in glass processing technologies, was born. In 2019, the company took the next big development step with its acquisition of the Swiss-German company Bystronic glass, with the ambition to further strengthen its position in the glass processing value chain.

Co-operation and innovation

The company's goal has always been to play the role of a reliable and responsible partner. Since its founding, Glaston has been actively involved in the industry's development. An example of this approach is the Glass Performance Days (GPD) conference, the objective of which is to gather and share the latest information among the industry's operators.

Glaston is known to be the front-runner in glass processing technologies and was among the first players in the industry to seize the opportunities presented by the digital age.

At the forefront of its product development has been digital and IoT-based solutions and services that enable the optimisation of machine performance and the transition to fully automatic glass processing. Sensor, processing, interface and cloud service technologies have been developed that make the products better, more efficient and more reliable. For customers, this means ease of use and higher efficiency.

Digitalisation is also evident in the modernisation and upgrade products offered, which enable customers to monitor production in real-time and to digitalise their operations with their present machine stock. Glaston wants to continue to be in the forefront of development and innovation. Today, glass processed on its machines is delivered to the architectural, automotive, solar energy and appliance industries. With approximately 800 employees, Glaston operate in 11 countries around the world in production, services and sales.

B'VARIO, one of the system solutions by Bystronic glass for insulating glass.

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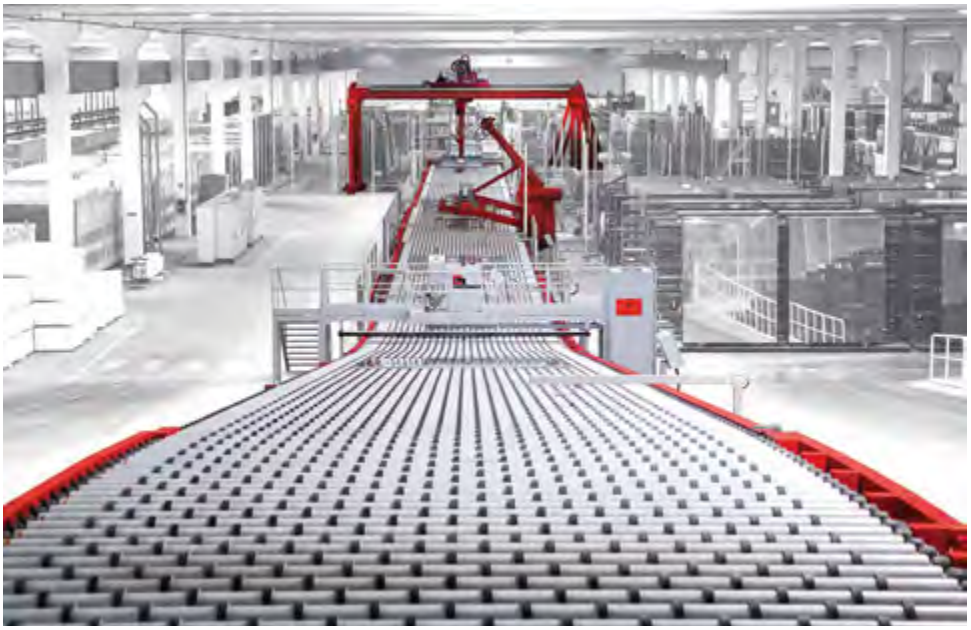
Integrated solutions for the flat glass industry

Grenzebach, a market leader for cold end equipment in float glass production lines, recently completed its acquisition of CNUD EFCO GFT, a leading provider of solutions for annealing lehrs, tin baths and accessories, as the following contribution explains.

Two leading providers for flat glass production technology have united their strengths, following the Grenzebach Group's acquisition of CNUD EFCO GFT, the float and container glass business unit of the BMT Group. "In the past, we frequently built our cold end following the tin bath and annealing lehr from CNUD and one could clearly tell that both companies stand for high-tech and quality", says Egbert Wenninger, Senior Vice President Business Unit Glass at Grenzebach.



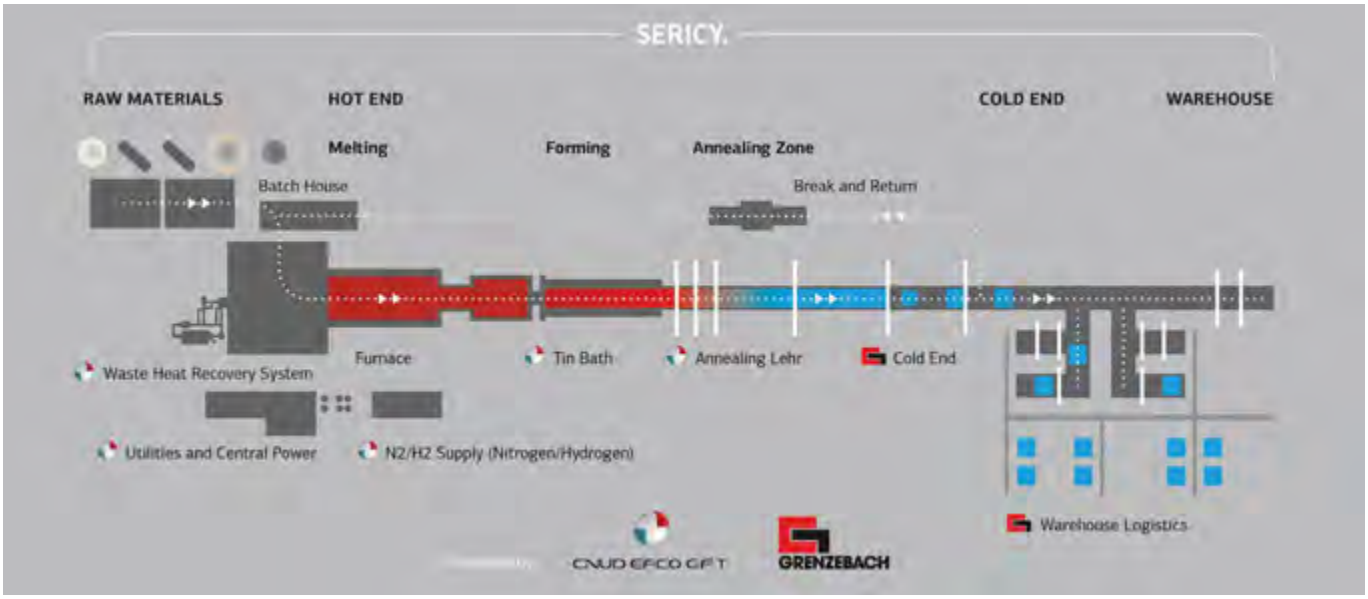
To date, over 300 cold end systems for flat glass production lines have been delivered worldwide by Grenzebach. Customers profit from decades of experience. Image courtesy of Grenzebach.

Integrated solutions

Worldwide, there are over 300 flat glass production lines with Grenzebach cold end equipment. CNUD EFCO GFT offered solutions for annealing lehrs, tin baths and accessory machinery, enjoyed a positive reputation and a leading position within the market and contributed to the installation of 300 production lines. CNUD EFCO GFT has several international locations in Belgium, Germany, Romania and China and going forward, will also profit from the Grenzebach locations in China and the USA. "Together with integrated solutions, we are a unique partner for our customers worldwide" says Dennis Schattauer, CEO of GFT GmbH. "The daily exchange within the Grenzebach Group with automation and digitalisation experts is readily available to us" he adds. "This will push our team even more." With a common strategy, glass production technology will be further optimised and automated."

Higher quality, more sustainability

One-cast solutions for increasingly complex float glass production lines, joint technological improvements and the latest developments, the ▸



Via the acquisition of CNUD EFCO GFT, Grenzebach is now able to offer the complete equipment from the tin bath to the annealing lehr and cold end and to the transport of the final product to the warehouse. This extension delivers numerous advantages to the customer, down to the digital processing of thermal process knowledge for process analyses. Image courtesy of Grenzebach.

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Experts from Grenzebach and CNUD EFCO GFT have joined forces and expertise to work on improved heat recycling systems for flat glass equipment. Image courtesy of CNUD EFCO GFT.

creation of additional values with innovation for the digital glass industry and a focus on energy efficiency: The close co-operation between Grenzebach and CNUD EFCO GFT will bring advantages to customers for product quality, economic efficiency and sustainability.

Integrated control system and inspection technology can be realised with knowknow collected from several decades. CNUD EFCO GFT has extensive experience in the thermal processes of glass lines, upstream from the cold end, where the quality of the glass ribbon and therefore the customer's profit is decided.

Data record of the complete production line

These empirical values and the process knowledge from CNUD EFCO GFT are combined with data resulting from Grenzebach's inspection solutions. With SERICY, the digitisation platform developed by Grenzebach, future data can be collected on the complete float glass production line and be available for optimisations at the glass manufacturers, up to detailed recommendations for equipment operators, as well as solid indications for the quality manager. For example, sheet thickness is measured at the beginning of the annealing lehr, in order to be able to react early on should production neglect the admissible thickness tolerance range.

In a second example, at the cold end, Grenzebach measures the glass ribbon tension profile, ie the tensions within the glass along a measuring line across the glass ribbon, which is created during the cool down process. With Grenzebach's IIoT platform SERICY, it is possible to adapt the annealing lehr settings directly to achieve the optimum tension curve. With this integrated approach, significant improvements can be realised. "In the future, we are able to detect, analyse and achieve all relevant production parameters of a campaign or even a single sheet along the complete line for subsequent follow-up" says Egbert Wenninger.

Consistent control system, optimised usability

For the tin bath and the annealing lehr in the forming area, as well as for the cold end, a consistent control system with less interfaces and improved usability will be possible. These examples show the increased potential of co-operation in terms of digitalisation. The digitisation of flat glass production lines is one of the innovative drivers within the glass industry.

All from one source

From the tin bath to the annealing lehr and the cold end, plus the transport of final products to the warehouse, Grenzebach is now able to offer the complete equipment. Synergies derived from design, common development and planning from the integrated production lines allow for the smooth realisation of projects, with a clearly reduced, co-ordination effort for glass manufacturers.

Energy efficiency improvements

Reduction of the energy consumption and the output of emissions, such as CO_2, are fundamental challenges for the glass industry to achieve climate targets and to receive future operating permits. The experts from Grenzebach and CNUD EFCO GFT work together to build improved heat recycling systems for flat glass equipment.

"The improvement of energy efficiency of flat glass production technology is an important item on our joint agenda" says Dennis Schattauer. "Last but not least, we are able to prove that it is possible to significantly reduce energy consumption and CO_2 emissions with digital means."

Grenzebach is a leading automation solution provider for the global glass, building material and intralogistics market. In addition, the company constantly develops application areas like friction stir welding, the automation of industrial additive manufacturing or digitalisation. The digitisation platform SERICY allows customers to develop their own future-proof digital knowhow.

Grenzebach ranks among the global technology leaders in its markets. The global manufacturing footprint with production sites in Germany, the USA and China, as well as additional worldwide locations, ensure customer support on-site. More than 3000 installed plants in more than 55 countries testify quality and reliability. Since its creation 60 years ago, the company has been owned by the founding family. With an export ratio of more than 90%, Grenzebach is a global player.

CNUD EFCO has been building annealing lehrs and tin baths roofs for the float glass industry since 1957. High quality technical solutions are offered in terms of engineering and equipment. The company enables its clients to successfully introduce new products and applications and to develop a higher profile in an ever-increasingly competitive global glass market.

CNUD EFCO works for all leading glass manufacturers around the world. The goal is to offer reliable equipment and to guarantee a continuous efficient process. The company's success is based on a strategy of innovation. Its ambition is to be a beacon of knowledge its customers can always rely on. ●

CNUD EFCO GFT annealing lehrs stand for high tech and highest quality. Image courtesy of CNUD EFCO GFT.

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Global service maintained by furnace heat-up specialist

Towards the end of 2019, Hotwork International completed its latest warehousing investment in the Philippines. This is one of a network of offices operated by the group throughout the world to support the international glass, ferrous and non-ferrous metals, power generation and other industries with their furnace heat-up, drain and combustion requirements. Benjamin Koester, CEO discusses the history and present day activities of this specialist family-owned business.

Benjamin Koester, CEO of Hotwork International.

It was seven years ago that Benjamin Koester purchased Hotwork International from his father, Joerg Koester, subsequently developing the business rapidly into a global organisation. "In 2013, we had our head office in Switzerland and an office in the Philippines but today, the business has developed into a global company with nine facilities across the world" Benjamin Koester confirms. In that time, the workforce has also expanded 10-fold to some 300 people.

The Hotwork name enjoys a rich tradition, originating in the UK in 1962, when combustion engineer Trevor Ward founded Hotwork Ltd and developed heat-up burners that enabled glass container furnaces to be heated properly in just a few days rather than in weeks by applying hot spot heating methods. Importantly, the development helped Pilkington Brothers to commission its first float furnaces.

Family ownership maintained

Hotwork Germany (a subsidiary of Hotwork Ltd) was purchased by Joerg Koester in 1986, before the company evolved into Hotwork Koester and then Hotwork International in 2000. The headquarters were moved to Switzerland in 2004, before a new building was completed at Egnach in 2014.

"This is the company that developed heat-up as we know it today, as well as developing an innovative combustion system" Benjamin Koester explains. "The majority of burners used in container and float glass are somehow related to and/or adapted from our combustion developments in the 1990s."

The Koester family name is well known in the glass industry, especially in Germany. "Many customers and associates I meet have known me since I was a child… I saw my first glass furnace at four years of age and have grown up with the glass industry ever since."

Under the management of Benjamin Koester, Hotwork International has achieved significant growth in a relatively short timeframe. "To realise the opportunity to create such an ambitious expansion plan, you need correct partners and people in the right place working with you" he suggests. "It's a complete team effort and everyone has played a major role in the company's development and its focus on quality and service."

Mr Koester is quick to acknowledge the benefits of initiating his company's ambitious expansion plan in 2013 from an already well prepared platform, however. "We had a very well known and respected name and a customer reference list that was evidence of high levels of capability. My father already had global ambitions for the business but there was a different management structure in place that could not facilitate fast expansion. We reorganised with responsible directors in all the regions to take care of their markets, with my role as CEO to provide guidance and technical assistance from the Swiss headquarters. This was a very different approach to previous times and led to very fast growth."

Celebrating 20 years in Cebu

Hotwork International Asia-Pacific celebrated its 20th anniversary and inaugurated a purpose-designed warehouse in Cebu last October. The company has been active in the Philippines since 1999 and has been the subject of investments amounting to some €2 million in recent years to maximise growing regional market potential. Today, the Asian market as a whole represents some 30% of the projects undertaken by Hotwork International.

Thirty of the 80-strong workforce in Cebu are dedicated to the needs of the Asian glass industry, although a separate office in Shanghai has been responsible for Chinese customers since opening in 2015. The Philippines facility has almost tripled in size since 2019, involving major expansions of office space, warehousing and equipment. This operation delivers European maintenance and equipment certification standards, providing a convenient hub to deploy equipment ▸

Inauguration of the Hotwork International Asia Pacific warehouse and office in Cebu.

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throughout the region, as far afield as Australia and New Zealand, while also supporting standalone operations in such important markets as Japan.

A specialist training programme has been in place since the Philippines operation was created 20 years ago. This has allowed senior engineers to be correctly trained, providing the ability to transfer knowhow and safety expertise to all employees and technicians. In addition, employees are regularly brought to head office in Switzerland to gain further expertise and knowhow.

"We are in Cebu for the long-term and this is why we have invested so much in building a new warehouse, setting up all the equipment and specifically training locals for the work that was previously performed only by European personnel" Benjamin Koester explains. "So even though expertise is always available from Switzerland, the Asian operation is now fully independent from European supervision and all jobs are completed under local supervision, with local labour."

Services and technology development

While the Philippines facility is dedicated specifically to service, Hotwork International's next manufacturing hub is in Shanghai, developing combustion technology, electric boosting and bubbling. This set up enables easy access to and regular communication with customers.

Services (heat-up and furnace drains) are the company's top seller, followed by combustion technology and electric boosting. According to the company, 29 complete electric boosting projects have been delivered to customers in Asia (including China) in the last three years. This includes projects for the float, hollow and fibre sectors.

Having created the company's China operation in 2003, a successful joint venture was formed with a Hong Kong holding company in 2015. This enterprise has increased turnover by more than 70% in the last three years. A shift of emphasis from low cost to high quality is now evident among local customers, illustrating a desire for an improved level of assistance and quality in equipment and services.

In addition to the Egnach - Switzerland, Cebu – the Philippines and Shanghai - China facilities, Hotwork International maintains offices in Hong Kong, Mexico, India, Indonesia, South Korea, Japan and New Caledonia. Although glass is not relevant to all locations, the industry remains a key priority and accounts for the majority of work undertaken.

When the Mexico office became operational in 2015, for example, the company was able to quickly develop significant local and regional business (except the USA and Canada) by investing in dedicated warehousing, equipment and the extensive training of personnel. "The operation is doing well and business is growing" Benjamin Koester explains.

Opened in 2016, the Indonesian operation has also been the subject of equipment investment, with over 20 heat-up sets in stock. "We are capable of performing on any type of furnace and business is going well in challenging market conditions" Mr Koester confirms.

India is another challenging environment, in part because of the historic price culture. "We are on standby there" says Benjamin Koester "and when the market is ready for our quality and progresses in the same way as China towards quality rather than only looking at the cost, we are

Furnace heat up burner set, equipped with the latest safety features.

ready to go. In the meantime, we have the option of our very well experienced and trained Indian manpower to deploy on other projects worldwide."

The Japanese market is handled in association with AGC Ceramics, with whom an excellent relationship is maintained. "We are working together very closely, co-operating in terms of combustion, electric boosting and services. AGCC is a very good partner and we have successfully completed many projects together."

Significant investments are also anticipated in South America and other parts of the APAC region in the near future.

Technology development emphasis

According to Benjamin Koester, Hotwork International is constantly pursuing opportunities to further develop the technologies offered to the world's glassmakers. Having worked previously on the flameless oxidation system, for example, the company is currently investing in oxygen and natural gas preheating as a heat recovery system on oxy-fired furnaces.

Other initiatives are currently introducing nano technology to help reduce emissions. "We are constantly investing in our technology and working on R&D" Mr Koester confirms. "A key factor is to thinking outside the box. I don't favour working on existing furnace designs because they can be stretched to their limit already… everybody knows it but it needs addressing, so we like to look outside the box for solutions, including investigating existing options in other industries. I really like to work on such projects" he concludes. ●

A Hotwork International team meeting at the head office in Switzerland.

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Training and skills development priority

Roy Clarkson considers how effective employee training can help to maximise uptime at glass container manufacturing operations.

Sheppee recognises that the single greatest asset to any organisation is its employees. Quite simply, people are the assets that make things happen and are the driving force to success. A company can have the most advanced technology and the best facilities available but without the correct people with the necessary skills making all of it work, all the technology in the world is wasted.

As the adage states, "time is money" and as the glass container market continues to expand at this unprecedented rate, the necessity for production uptime has never been more critical. The glass industry simply does not have enough hours in the day to manufacture the glass required to fulfil the market's demands and consequently, the manufacturer cannot afford to lose any of those seemingly too few hours that are available.

It is essential, therefore, that the optimum performance from every production line is achieved and that efficiencies are as close to 100% as possible. While it is recognised that a key to this is the correct equipment and technology being in place, it is of equally paramount importance that the people that have been made the custodians of this equipment have the soundest knowledge and deepest of understanding to ensure it delivers maximum efficiency, through correct set up and the ability to respond quickly in the event of breakdown, while minimising any unnecessary downtime.

A full range of Sheppee equipment is in place at the company's ware handling test area.

Under the current pressures of today's production environment and the total focus on production uptime, it is fair to suggest that the rule of thumb "If it isn't broke, don't fix it" generally applies. This means that it is not until a critical breakdown occurs, resulting in the stop of an entire production line, that the technicians and operatives will have the opportunity to refamiliarise themselves with the technology. This can lead to extended and avoidable down time.

Dedicated training focus

Over a decade ago, Sheppee invested in a dedicated training centre, providing customers with tailor-made training programmes. Each programme is designed around the customer, the specific type of glass production and the equipment already installed, or the equipment planned for installation.

The programme is both hands-on and theoretical. At the training centre, the company has a fully equipped

Sheppee's latest lehr loader.

Working ware handling line.

ware handling test area, where examples of all Sheppee equipment are installed on a cold production line. This provides the perfect opportunity for technicians and operatives to work on live equipment without the fear of consequence, as there would be under normal production conditions. During the hands-on training, attendees will be faced with a multitude of breakdown possibilities and Sheppee technicians will provide the best possible training and mentoring to ensure that all attendees leave with the confidence and understanding to ensure that they have the ability to respond quickly and efficiently should the opportunity arise.

As well as practical development, the training centre also provides a quiet and peaceful classroom environment, giving attendees the perfect setting to reflect and receive in-depth training on all aspects of ware handling technology and set up.

Shared experience

One of the most successful initiatives in recent years has been for the company's customers sending a collective of technicians and operatives from various manufacturing facilities together to the training centre. This is often a great chance for technicians and operatives to come together and share their different experiences and varied knowledge. Not only is this a great bonding opportunity but it represents an ideal moment to ensure that the attendees receive the same amount and high standard of training.

As with all training and education, unless what has been learnt is used on a regular basis, over time, things will become vague or uncertainty can take hold. Therefore, it is essential that training is not just a one-off. Increasingly, customers are taking the initiative to use the facility on a regular basis for refresher training. The refresher training programme is intended to follow up, refresh and extend the knowledge and skills acquired during the initial training session. Furthermore, the programme will work to build and maintain a better onboard knowledge base.

Once training has been completed, each attendee will take an exam and will receive certification and given feedback. Use of the training centre is free-of-charge to existing customers, the only cost to the customer involving the travel, accommodation and subsistence while in York.

Sheppee encourages its customers to take full advantage of the training and development programme available. It is designed to provide the highest level of set up and fault finding knowledge and gives glass manufacturers peace of mind that their best assets are equipped with the correct skills and knowledge to ensure maximum production efficiencies are achieved and unnecessary downtime is avoided.

Sheppee strongly believes that working partnerships with customers is key and for the industry to continue to grow and develop, the correct skills should be in place. ●

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Gob measurement innovation to optimise production

The latest technology available from Bucher Emhart Glass allows glass container manufacturers to measure every gob, opening up possibilities for optimising production and closed loop control. Florian Boucher reports.

For years, glass container manufacturers have been searching for a practical way to analyse the shape and fall of gobs as they drop from the feeder into the scoops. The solution was easy to imagine: A camera mounted just below the shear that would capture an image of the falling gob. However, the technical limitations of photographic technology meant this was easier said than done. It was possible to photograph one gob - or a few - but that was little help in optimising production. There simply was not enough high quality data to draw any meaningful conclusion on what was happening inside the machine.

Line-scan cameras are useful but they do not reveal everything about the direction and orientation of the drop. Matrix cameras were superior in theory but for a long time, they could only handle smaller gob sizes or a relatively narrow field of view.

GobRadar measures the gob immediately after the shear cut.

System description

Now, Bucher Emhart Glass has found the answer. Its GobRadar system uses high speed matrix cameras to scan up to four gobs simultaneously as they fall into the scoops. GobRadar can capture every gob, despite the very limited time window available and can even scan gobs that are larger than its own field of view by taking multiple pictures of the falling gob.

Two separate cameras are used, so the equipment can achieve full 3D stereo vision. This allows full 3D modeling and 'all-round' vision to detect bending on the far side of the camera that would otherwise be missed.

Ideally, the cameras are set at 90º to each other. However, the system can operate within 70º to 110º and a range of inter-camera distances, allowing it to adapt to whatever space is available on the feeder platform.

The cameras are mounted in a protective housing that is specially designed to withstand the harsh environment of the feeder area. The housing itself is water-cooled and the lens is regularly flushed with air to keep it free of dirt. This design means the cameras need virtually no maintenance.

Accurate measurement and instant analysis

Based on the images captured, GobRadar can analyse a host of physical properties, including length, diameter, radius, overall shape and mass, allowing freak gobs to be detected on the fly. It also picks up the angle, position and trajectory of each gob and even its temperature. This reduces the workload on operators, as the time between manual weightings can be extended drastically.

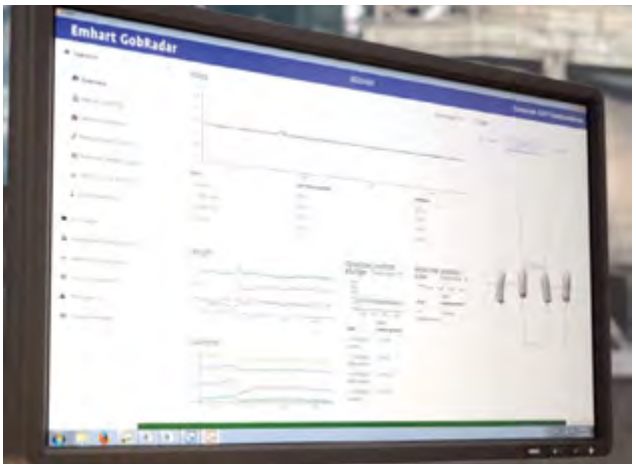
Geometry data is continuously collected, analysed and displayed on the easy-to-use interface, which can be viewed on a dedicated workstation in the IS control room or remotely via a mobile device. A dedicated touchscreen is recommended and is available as an option.

Clear, colour-coded graphs show trends, variations and deviations, while 3D reconstructions and multiple sectional views give the operator an intuitive 'snapshot' of the gobs being produced. Users can even define their own 'gadgets' within the interface, featuring the metrics in which they are most interested.

Gob shapes can be stored for reference and compared with current production. This is particularly helpful during job changes, in order to reproduce the 'best shape from last time'.

GobRadar correlates its data to each individual section of the IS machine. It even highlights the adjustments that need to be made in order to correct anomalies. Malfunctions and warnings are all recorded and displayed on a clear timeline for reference.

The high speed maxtrix cameras can still monitor partially obscured gobs.



Results are displayed continuously on the monitor.

Closed loop and look ahead control

With GobRadar, operators can stabilise the shape and length of gobs to compensate for the shifting viscosity of the molten glass. Flow conditions at the spout and outlet mean that gobs can vary within a multiple gob zone – even on the same cut. However, if tube and plunger needles can be controlled individually, results from the industry show that the gobs can be adjusted to hit a very narrow target range of weights (0.25% typically ±0.5g), ultimately saving glass. Additional drive solutions for the tube and plunger needles are available.

With closed loop weight control, the weight of the gob can be automatically controlled on the fly, in real time. In theory, it could even be possible to create a 'look ahead' system that delivers the perfect gob to each section of an IS machine, rather than relying on the delivery system to alter gobs within each section.

A quick win with rapid payback

GobRadar offers traceability and quality assurance from the beginning of the production line, at the cut of the gobs. It delivers an instant process improvement with rapid payback at minimal maintenance.

The equipment can be installed on any production line, from single to quadruple gob, as well as on multi-gob machines where it significantly reduces job change times. It works with press and blow and narrow neck press and blow, as well as blow and blow, where PPC weight control cannot be applied. The BEG innovations currently in development, such as SmartFeeder, will work seamlessly in combination with GobRadar.

Over 30 systems are already in production around the world, at multi-weight production lines operated by industry leaders including SGD, Vetropack, Verallia, Ardagh and Wiegand. The sensor system includes two cameras, mounting brackets, connection boxes for electricity, water and air, plus a control cabinet, touch screen and scale.

"We're delighted to introduce GobRadar to our customers" says Martin Jetter, President of Bucher Emhart Glass. "It's another important link in the chain of closed loop control, which we ultimately aim to extend to every stage of the production line End to End development strategy. However, no matter how manufacturers choose to use it, GobRadar will deliver quality improvements from day one, with almost no extra work or maintenance. We expect it to be very popular indeed." ●

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Camera check detection

Check detection is one of the most important quality inspections in glass container production. The HiSHIELD Ranger 2 system has been developed to fulfill customers' quality expectations and is available throughout the world, as Peter Witthus explains.

Developed by Heye International, the Ranger 2 check detection system consists of one camera, collecting five images simultaneously via five lenses and fibre optic image guides, the illumination unit and the control unit with the software for image processing, including the 'container ok' or 'container not ok' decision. Based on the budget and glass plant needs, users can start with one system and add any number of parallel systems whenever they are wanted. A typical and recommended configuration would be four parallel systems, each dedicated to and optimised for one of the following types of checks:

- Horizontal.
- Shoulder.
- Vertical.
- Bottom.

Each system runs independently and does not need to be synchronised with the others. So there is no influence or need to compromise between systems. This allows the individual optimisation of all settings (illumination etc) for the respective type of check. If one system is unavailable or not adjusted optimally, the others are still fully operational.

The HiSHIELD Ranger 2 camera check detection system.

Intelligent cloud masking - self-learning systems

Every container produced must be regarded as an individual object and any check detection concept has to respect this. For this reason, each Ranger 2 system uses Heye's Intelligent Cloud Masking (ICM) system. Bearing in mind that each article is distinctive, the Ranger 2 system is designed to investigate each one independently. Accordingly, it is unnecessary to teach the detection system but each container serves as a time saving reference for itself. Moreover, the inspection zones are dynamic in nature. Therefore, the Ranger 2 equipment is able to detect different variations of checks, as well as to recognise variations of them during production.

Apart from advanced camera and non-contact solutions, smart data is the key. The Heye PlantPilot system collects and aggregates production data in the plant. Borders between hot end and cold end will disappear, with information shared on the spot. Tracking and tracing as well as the possibility of creating user-specific analysis are additional components, allowing continuous improvement processes to increase productivity.

Self-learning systems are one of the cornerstones of Industry 4.0. Ranger 2 camera check detection is the best solution in the market. Heye's clear and innovative product strategy, integrating latest camera solutions, remains unchanged. ●

The Ranger 2 system uses Heye's Intelligent Cloud Masking (ICM) system.

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Quality inspection of glass tableware

Paolo Panza discusses the challenges of automatic inspection technology for drinking glassware and the development of solutions that match the demanding requirements of manufacturers and customers.

The quality analysis of geometric and cosmetic faults in drinking glass production is increasingly important to guarantee homogeneous quality control, reduce labour costs and improve reliability for the benefit of customers. The automatic inspection of glass tableware represents a major inspection challenge, resulting from the diversity of products, as well as the wide range of faults found on the surface or inside a glass. A wide range of geometric and cosmetic flaws have to be recognised and classified both automatically and continuously to the same level as those identified by specialist quality personnel.

Compared to widely used inspection systems in glass container production, the inspection complexity and accuracy demanded in drinking glass production is much higher (see table 1), so a special solutions for this application has been devised by IPROTec GmbH.

Combined inspection and sorting task

In drinking glass production, there is a high rate of faulty items, making inspection and sorting an essential task to provide consistent quality. Due to the high number of specific error classes (up to 60) and high production rates, manual inspection will never be reliable.

With an automatic inspection system, it is possible to increase reliability of testing and achieve a certifiable quality level. Additionally, capturing and statistical analysis of glass data can be used as feedback to optimise the production process. Manual testing methods usually identify only one flaw in an item while automatic inspection delivers an overview of all flaws that appear, aiding producers to react and improve ware quality by improved machine production parameters.

Complementary to cold end inspection, testing before the annealing lehr at the hot end allows fast and direct process intervention. For such a setup, glass tracing will enable even a correlation of faults to specific stations of a press or blow machine.

Improved product quality

To achieve stable quality levels without outliers, reduce personnel costs and improve production quality, the introduction of automatic quality inspection systems is highly recommended. Unlike in drinking glass production, the use of automatic inspection systems has been widely used by glass container producers for many years. Many attempts have been made to adapt these systems to drinking glass production. Due to different boundary conditions, ▸

Drinking glass	Container glass
Low throughput	High throughput
High variability of products	Low variability of products
Low product cycle time	High product cycle time
Custom-specific differing quality levels and test criteria	Comparable test criteria
High variability and subtle fault characteristics faults	Low variability of stronger shaped
High priority to cosmetic faults	Low priority to cosmetic faults
Complex geometric and optical structure of stemware, with the need to inspect all parts of a glass	Usually much simpler geometric and optically conditions

Table 1: Comparison between table glassware and glass container inspection requirements.

Figure 1: Linear inspection machine.

Machine type	No of cameras	Typical articles typology	Working area	Inspection accuracy grade	Machine performances (defect classes)	Detectable flaws
Linear	13-16	Tumblers and stemware	Cold end	****	****	Geometry Body flaws Base plate
Linear on conveyor (cold end)	4-6	Tumblers and one-piece stemware	Cold end	***	**	Geometry Body flaws
Linear on conveyor (hot end)	2-4	Tumblers and stemware	Hot end	***	**	Geometry Body flaws
Rotary	20	Two-piece stemware	Cold end	*****	*****	Geometry Body flaws Base plate

Table 2: IPROTec inspection machine options.

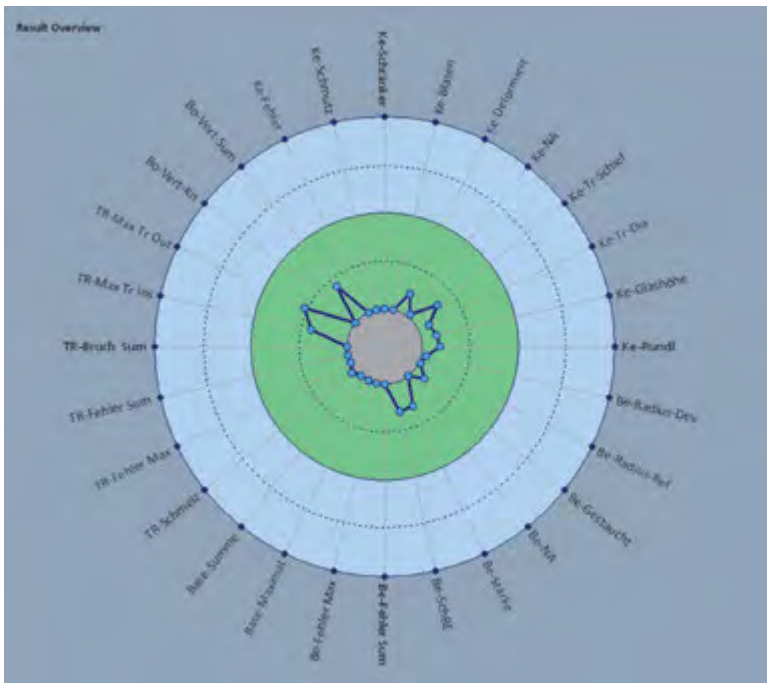

Figure 2: Defect diagram.

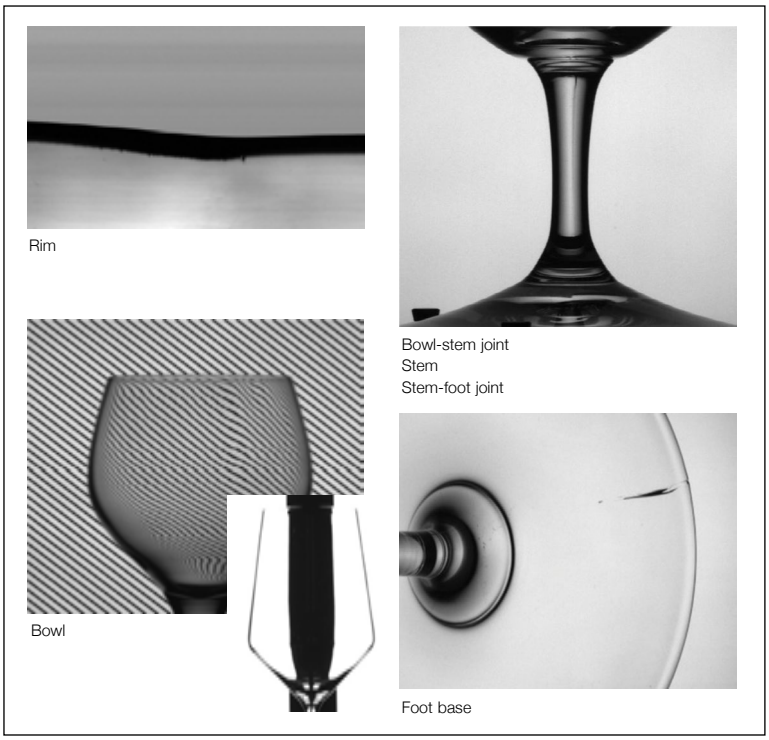

Figure 3: Defect detection areas.

however, it is impossible to achieve a comprehensive and accurate solution with these systems.

The set up of container inspection machines is normally performed by image processing specialists, since the equipment does not require frequent intervention due to the long production campaigns. In the case of tableware articles, the set up must be changed almost every day. New articles are often produced, so the system must also be simple for the machine operator to reprogramme. IPROTec has developed a simple interface to simplify this operation.

Detectable defect classes and areas

With the IPROTec machine (figure 1), it is possible to detect from a low to high number of defect classes with different accuracy grades and in different parts of the articles as follows (see figure 2):

- All kinds of shape deformations.
- Break-outs and cracks.
- Inclusions.
- Seams.
- Knots.
- Surface defects like cords and run marks.

The detection area could be in all regions of the glassware, as shown in figure 3.

Machine realisation

IPROTec started building the first generation of dedicated glass inspection systems in 1995 and has been able to gather 25 years of operational production experience at the Schott Zwiesel plant. Based on this experience, four types of inspection machines have been developed according to customer needs in terms of articles typology, defects to be detected and quality accuracy (see table 2). A possible camera configuration is shown in figures 4 and 5.

Inspection machine advantages

- *Accuracy and high number of defect typologies detection:* The machines realised enable the inspection of all typology of blow or press and blow drinking glasses and stemware.
- *Modular concept (cold end and hot end):* By use of a modular concept, the system can be customised according to the client's needs and adopted for use at the cold end or hot end.
- *Easy set up:* For the realisation of this inspection system, multiple innovative optical and algorithmic solutions have been developed, as well as a dedicated HMI (figure 6) to facilitate the operator's set up, as well data analysis.
- *High reliability:* The highest grade components (CPUs, cameras and sensors) are used to guarantee maximum reliability.
- *Low maintenance:* Direct image processing is used to avoid mirrors, so that maintenance and reliability are always guaranteed.
- *High stability:* The special algorithms used allow self-adjustment of the system to environmental changes (eg light and dust), as well as production fluctuations, without re-adjustment.
- *Experience-based development:* The machine, sensors, handling and image processing are based on 25 years of in-house experience and development to provide a ready-to-use machine for the tableware process. ●

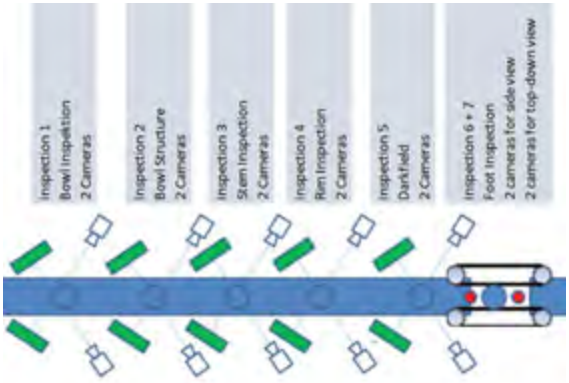

Figure 4: Cameras configuration.

Figure 5: Camera layout

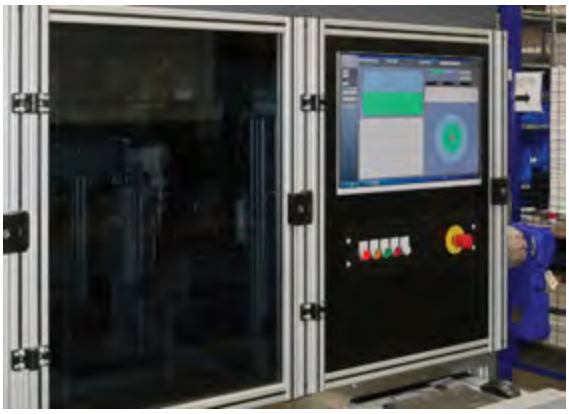

Figure 6: Machine HMI.

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Automatic capacity/volume measurement innovation

As glass container manufacturers implement the concepts of Industry 4.0 and embrace the Smart Factory, the latest instrument developed by Somex contributes to improved inspection technology, as Brian O Keeffe explains,

Liquidlink 4.0 is a platform designed to automate the tedious task of capacity/volume measurement in glass containers. While the tools to perform the task manually are inexpensive, the labour time required is considerable and results are not always reproducible from operator to operator. Volume/capacity measurement lends itself well to automation but this is only of interest if precision and repeatability is equal to or better than the manual method.

Automatic capacity/volume measurement also lends itself to integrate with other measurement systems to configure an effective, highly automated work cell, for example upstream automatic weight or dimensional measurement and/or downstream automatic pendulum impact or internal pressure test.

Liquidlink 4.0 is a standalone measuring instrument that includes a robot arm to load containers from the upstream conveyor. A precision actuator fills the container and after accurate measurement, the container is emptied and placed on the downstream conveyor.

The assembly is constructed from a sturdy 50mm section stainless steel frame, no 'black box' components are used in the assembly, all parts are standard 'off-the-shelf' and easily available from reputable suppliers. Remote technical support using a secure VPN access router is also standard.

The automation of volume/capacity measurement using Liquidlink 4.0 ticks many boxes:

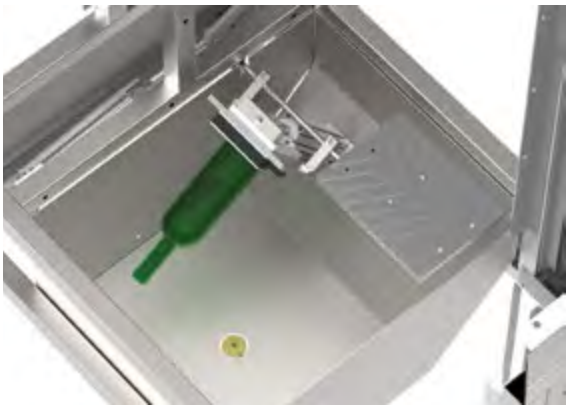
- Measurement accuracy and repeatability.
- Flexibility.
- Data handling and results.
- Environmental.
- Ease of programming.
- Calibration.

Measurement accuracy and repeatability

By combining an accurate fill height sensor with precision control of the filling cylinder, volume measurements within +/- 0.5ml are achievable for both fill level and brim full. This is achieved by using a linear actuator with repeatability of positional accuracy of +/- 0.02mm.

Flexibility

There are five measurement modes including fill level, brim full and fill by volume. By incorporating an Epson



100% water recycling.

Transfer by Epson robot.

robot for product handling, a wide range of bottles and jars (including non-round) can be measured without any tooling change. Changeover to a new product type merely requires selecting the correct test profile.

A variety of different product types can be tested in sequence. The flexibility of the robot also allows re-centering of the bottle after placing in the measurement position. Measurement of leaners is also possible by using the robot to hold the finish during the measurement cycle if required.

The Liquidlink 4.0 frame has been designed to incorporate additional measurement stations. Using the 'idle time' and flexibility of the robot, for example, a container's weight, dimensional measurement or other tests can be performed, thus increasing the functionality of the work cell.

Data handling and results

Liquidlink 4.0 interfaces directly with the customer's production control software. Results are available on the HMI and uploaded directly after each test is complete. Results include test profile name, mould number, temperature, volume at fill level and volume at brim. Automatic upload of results has an additional benefit; removing the operator from the process eliminates errors due to transcription and handwriting legibility.

Environmental

Water used is 100% recycled. After each measurement cycle, the water is emptied from the measured container and filtered prior to draining back to the reservoir. Aside from environmental benefit, recycling the water improves accuracy and repeatability measurements by maintaining water temperature homogeneity and reduced water aeration typically caused by introducing fresh water.

Ease of programming product type

The HMI is a simple-to-use intuitive interface. Creating a new test profile is easy, requiring just seven inputs:

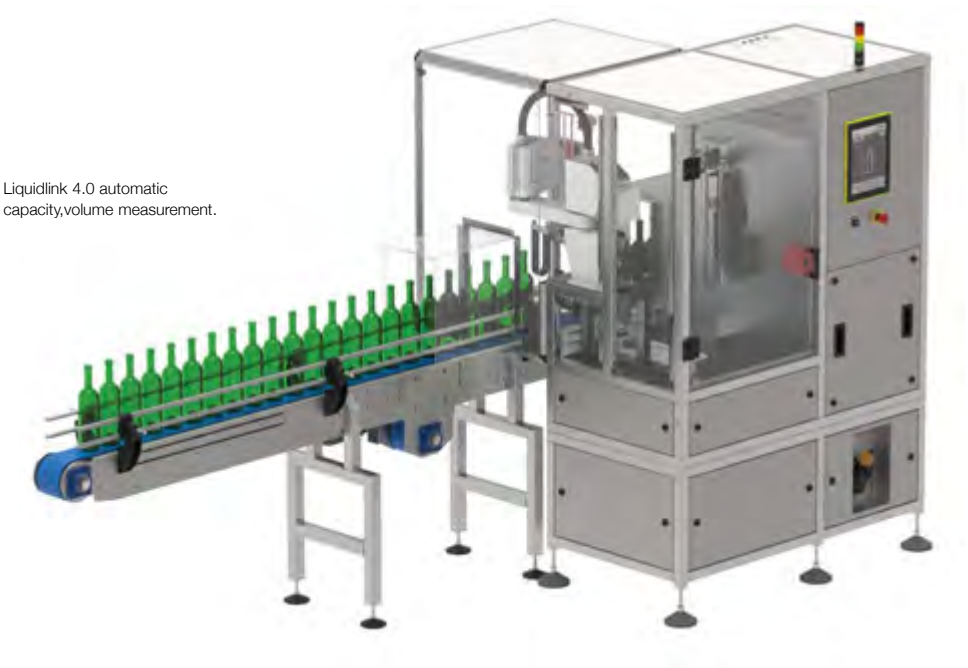
- Container height.
- Pick up height.
- Container diameter.
- Container volume.
- Fill height level.
- Select one of five measurement modes

The new test profile is then saved to machine memory. There is no limit to the number of test profiles that can be stored for easy recall.

Calibration

The Liquidlink 4.0 incorporates an easy-to-use calibration routine for both volume and sensor position. A linear two point volume calibration is performed using calibrated scales/balance. Functionality also includes a verification routine, which can be used on a periodic basis to confirm accuracy against an external calibrated reference. This is also a useful tool to demonstrate the precision of measurements to customers.

In summary, the Liquidlink 4.0 can be used to measure volume/capacity in a wide range of glass containers without the requirement to make mechanical changes. It significantly reduces non-value add tasks required by traditional measurement systems. The technology used introduces precision and repeatability and by removing the operator from the measurement process, in itself eliminates errors due to transcription and manual handling. ●



Liquidlink 4.0 automatic capacity,volume measurement.

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Innovative wire edge and overpress defect detection solution

Jean-Luc Logel discusses a solution that helps glass container manufacturers to eradicate critical wire edge and overpressed defects from their production lines.

Figure 1: Example of overpressed on the inner rim of the sealing surface (indicated in red).

Figure 2: Wire edge is located under the inner ring of the sealing surface (indicated in red).

Representation of an article without defects.

Overpressed and wire edge are widely acknowledged as critical defects in glass container production, each representing major health and safety risks. They are among the bottling industry's worst nightmares, as well as those of major beer, carbonated beverage and other brands, resulting in potential sealing problems and the possibility of finding glass particles within the packaging.

Overpressed is located on the inner rim of the sealing surface (figure 1). A fin of glass extending above the sealing surface, it can be continuous and form a perfect ring. Alternatively, it can follow the inner rim of the finish only partially. Overpressed can be perfectly horizontal, parallel to the sealing surface or it can bend on one side.

Like the overpressed, wire edge is also a fin of glass but it is located under the inner ring of the sealing surface (figure 2). It can also be continuous and form a perfect ring or it follows the inside of the finish only partially. As the wire edge defect does not extend above the finish, it is sometimes difficult to differentiate from the normal characteristics of the inner finish with traditional inspection solutions.

Futhermore, the press and blow process, in particular narrow neck press and blow, allows glassmakers to increase productivity by reducing weight, although this trend has pushed companies to secure overpressed and wire edge detection.

Both faults are process-related and their root causes are the same:

- Excessive gob weight.
- Wrong plunger dimensions.
- Wrong plunger mechanical adjustment or synchronisation.
- Dirt or glass particles disturbing the plunger stroke etc.

The solution

IRIS Inspection machines has developed a solution to detect both wire edge and overpress defects. This technology features a dedicated optical system and algorithms, together with an innovative software called NEO intelligence.

IRIS makes it possible to differentiate between overpressed/wire edge even on small and saleable ware. In comparison with existing solutions, the recently announced system is easier to set up and goes further. It allows glassmakers to reach an optimal set up with less compromise and in much quicker time. Therefore, the wire edge finish station is less dependent on human intervention. This finish station can be easily integrated within the Evolution 5 NEO machine. It is also available as a standalone Evolution 2 NEO machine.

In association with several glassmaking customers, the patent pending equipment has been fully validated on many products for a variety of global brands, including Heineken, Desperados, Budweiser, Coca-Cola, Fanta, Sprite, Pepsi, Bec's, Corona and Leffe. Irrespective of glass colour, the wire edge solution delivers the same inspection results on green, amber or challenging flint.

Industry 4.0-compliant innovations

IRIS Inspection machines has developed an innovative approach to defect identification. Earlier technologies relied heavily on the knowledge of operators, who would help machines to identify what is a defect and what is not. Evolution NEO marks a break with other inspection machines. This latest generation technology includes intelligent defect recognition. Thanks to intelligent machine learning, Evolution NEO can recognise a defect, while the operator decides on its size only. The equipment is able to detect, recognise and provide accurate information about the defect itself.

Inspection data created by the Evolution NEO is available not only on the machine itself but remotely for plant managers to monitor performance and initiate changes where necessary. In addition, defect images are available to hot end personnel, with the ability to share critical defect characteristics and defect images in real-time, alerting IS machine operators to instances of critical defect detection.

A series of web-based trend analysis tools can be accessed to provide graphical views of defects in real-time, to assist glassmakers to find the causes of defects, to simplify the adjustment of settings and to reduce false rejection rates. ●

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Glass container finish control and measurement

Graeme Reid discusses the latest developments from Pro-Sight Vision in quality control and the measurement of glass container finish dimensions.

At the last glasstec exhibition in 2018, UK-based cold end inspection supplier Pro-Sight Vision launched an off-line quality control inspection tool for the precise measurement of critical dimensions associated with the roll-on pilfer-proof (ROPP) finish. This machine was aimed specifically at measuring the 'tuck under' angle and radius values. These small but critical values need to be maintained within limits so that when a bottle with an ROPP finish is opened for the first time, the security retainer ring stays on the bottle neck and the screw cap comes away cleanly. Readers may have experienced an occasion when an ROPP cap will not separate from the retainer. This is a typical result of incorrect 'tuck under' values on an ROPP finish.

Although it was initially developed for high value spirits bottles, the ROPP closure is now used on a variety of wine, water and carbonated drinks bottles, as part of a wider industry move to prevent product tampering. This has resulted in a need for glass manufacturers to tighten up standards and procedures in order to achieve 100% performance of this type of glass container closure for the consumer's peace of mind.

Full finish capability

It is also becoming more important for glassmakers to have the ability to quantify, measure and record the critical dimensions of all types of container finish. To meet this demand, Pro-Sight Vision has further expanded the 'tuck under' machine into a larger, more capable unit, called the 'Full Finish Inspection Machine'. This machine is able to measure a much wider number of critical dimensions, angles and radiuses and is applicable to all types of glass container finish.

The latest Pro-Sight Full Finish Measurement System is of a similar construction to the existing tuck under machine, except with much larger lenses and enhanced software. The method of use remains the same, as an off-line sampling machine. It can be used at the cold end by the QC sampling operator, in the QC lab and also at the hot end by the IS machine operator on suitably cooled samples from the IS machine conveyor. The main mechanical difference is that to facilitate full QC checks of the finish, the container being sampled is gripped from the inside of the bore, in order to provide full 360 degree imaging of the exterior profile.

As before, the unit is supplied as a mobile, table-mounted system and includes a process control unit and a larger, high definition operator interface touch screen and an imaging drive unit. This drive unit features a stepper motor-driven rotation head, which is equipped with a three jaw chuck. The container

Full Finish Measurement System.

is mounted in the inverted position onto the chuck for maximum accuracy.

The latest version of the unit can be configured to measure the dimensions specified by the customer, for example:

- The E dimension - Diameter of the finish at the thread root.
- The T dimension - Diameter of the finish at the thread peak.
- The U dimension - The thread height over its entire helical length.
- The S dimension - The distance from the sealing surface to the start of the thread.
- The H dimension - The height from the sealing surface to the end point of the thread.
- The F dimension - The distance from the sealing surface to the 'tuck under'.
- The L dimension - The diameter of the finish at the 'tuck under'.
- The 'tuck under' angle.
- The 'tuck under' radius.
- The N dimension - The diameter of the ring at its mating point with the container neck.

In addition, any other dimensions, profiles or angles can be measured, as may be specified by the customer. The unit will inspect narrow or widemouth finishes and it can be used in single sample mode, or in batch sample mode, recording all the measurements by mould number and also by cavity position on the IS machine.

The touch screen interface provides a step-by-step procedure guide for the operator and is used to set job number and the IS machine section and cavity numbers. A prompt asks the operator to push the start button to commence the measurement cycle, during which the container is rotated through 360 degrees. As the container rotates, the system captures 120 images (one every three degrees) using its ultra-high definition imager and calibrated lenses. The operation takes less than 10 seconds, after which the results are displayed on the operator interface.

For each point being measured, the QC Manager can set password access protected upper and lower acceptable tolerances. If a measurement should be outside of these lmits, the system will raise an alert. This allows the QC operator or the IS machine operator to see at a glance definitive confirmation if a particular sample is within or outside the specified limits for all measurements being monitored. Immediate action can be taken to change any ring mould equipment that has become out-of-specification through being dirty or damaged.

The operator interface software has one very useful feature. After a sample from each cavity is measured and recorded, the operator can view the single sample or the entire sample batch on-screen and the upper and lower setpoint limits are used to display the result for each cavity as Green (within limits and no further action); Amber (close to limits and recommended neck ring change); or Red (above limits and urgent neck ring change required).

The job history of all sample measurements taken is saved by mould number and cavity location on the IS machine. This provides a useful tool to enable management to monitor the dimensions as they change. The data can be exported as a CSV file via a convenient USB connection, which is built into the machine. This also provides the glass manufacturer with another level of data acquisition and production information/history. ●

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Advances in the analysis of hot end coatings on glass containers

Gary Smay discusses the evolution of hot end coatings for glass containers and the equipment available to monitor their thickness levels.

Non-refillable beverage bottles were first produced in the late 1950s as a lightweight, single use alternative to heavier refillable bottles. Because the glass was relatively thin, it was necessary to protect the surface of the bottles from becoming damaged during filling and subsequent handling. This protection enabled the bottles to withstand the loads that are typically encountered in the trade [1, 2, 3].

The results of experimental studies indicated that the required surface protection could be achieved by cold end coatings but only when applied over hot end coatings. Thus, the presence of hot end coatings became an integral part of protecting the surface of non-refillable bottles from the creation of crescent crack damage due to bottle-to-bottle sliding contact. More recently, hot end coatings have been applied in conjunction with cold end coatings onto the surface of refillable bottles. The primary purpose of the dual coatings on refillable bottles is to delay the onset of visually objectionable scuffing, thus prolonging the service life of the bottles [10].

Application methods

Hot end coatings are most commonly applied from vapours of mono-butyl tin trichloride (MBTC), that are blown against the sidewall of hot glass containers as they are conveyed from the forming machine to the annealing lehr[4, 11]. The resultant coating (figure 1) consists of irregularly-shaped voids, randomly located within a thin film of tin oxide[4, 6]. After annealing, a cold end coating is deposited onto the surface of the containers most often from an atomised spray of a dilute aqueous suspension of slightly oxidised, low density polyethylene[5, 11].

The polyethylene coating (figure 2) consists of small discrete droplets of the dried polymer[9].

The force that is required to break through the combination of tin oxide and polyethylene coatings during bottle-to-bottle sliding contact is usually greater than 60kg. This is a substantial increase compared to the force that is typically required to cause damage for a polyethylene coating that is applied directly onto a glass surface in the absence of a hot end coating (less than 6kg). The surface energy of the glass also changes when these two coatings are present. Uncoated glass surfaces exhibit a relatively high coefficient of friction (COF) of 0.8. However, when coated with both tin oxide and polyethylene, the COF is dramatically reduced to values typically ranging from 0.1 to 0.25.

These improvements in the protection and lubricity of glass surfaces are due to the interaction between the polyethylene and tin oxide coatings. The interaction of polyethylene with glass surfaces without tin oxide is very weak. However, the presence of the hot end coating changes the nature of the glass surface from being chemically basic to one that is chemically acidic, dramatically increasing the strength of the interaction with the polyethylene coating[2, 7].

A minimum of 30 CTU of tin oxide is generally recommended to achieve high levels of protection and lubricity of glass container surfaces when over-coated with a suitable polyethylene coating. The thickness and spatial distribution of hot end coatings are normally measured by use of an AGR coating meter. Unfortunately, there is no analytical method to quantify these factors for a polyethylene coating. Therefore, the suitability of the cold end coating is typically evaluated by means of performance tests such as with an AGR tilt table. It is generally recommended that the maximum COF for non-refillable bottles is 0.27.

When bottles are treated with both hot end and cold end coatings, certain problems may occur if these coatings are not deposited correctly. Two such problems, label adhesion and closure rusting, will be briefly summarised in the following paragraphs.

Label adhesion problems are usually caused by excessive amounts of polyethylene on the glass surface[9]. The extent of the surface that is covered by the polyethylene coating can be monitored by a 'contact angle' technique [2, 9]. Data from this measurement are used to assure the surface coverage is sufficient to achieve the desired level of protection and lubricity, while avoiding excessive levels that can cause label adhesion problems.

Closure rusting is caused by water that becomes trapped under the closure skirt during application[8]. If this situation occurs, the extent and rate of rusting is exacerbated by the presence of excessive amounts of tin oxide coating. The ▸

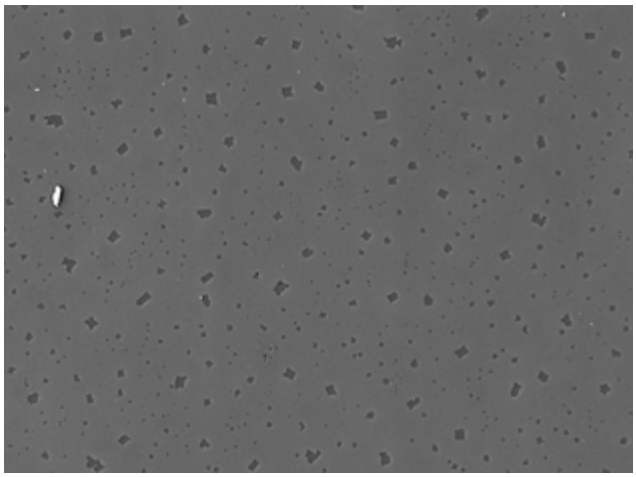

Figure 1: SEM view of a typical tin oxide coating (1000x).

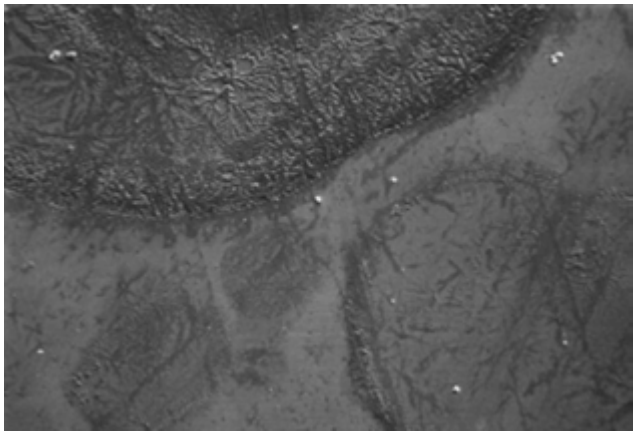

Figure 2: SEM view of a typical polyethylene coating (400x).

Figure 3: Combined Coating Measurement System (CCMS).

thickness of tin oxide in the finish region of bottles is usually monitored by an AGR coating meter; the maximum thickness that can be tolerated is 17 CTU [8].

Coating monitor innovation

In late 2018, AGR introduced the Combined Coating Measurement System (CCMS, see figure 3), for use in quantifying the thickness of hot end coating that is present on both the body and finish of glass containers. The CCMS is designed so that positioning of the measurement heads, container rotation and the capture of measurement data are performed without the need for operator intervention. This fully automated operation eliminates the potential for error that may be inadvertently introduced by the user.

A direct-drive rotary table facilitates measurement at up to 10 circumferential locations at each chosen vertical height. Motorised body and finish heads are automatically positioned, ensuring the most accurate and repeatable measurements possible. Independent tests of the CCMS at American Glass Research revealed that the accuracy and reproducibility of this coating meter is excellent (± 1 CTU). ●

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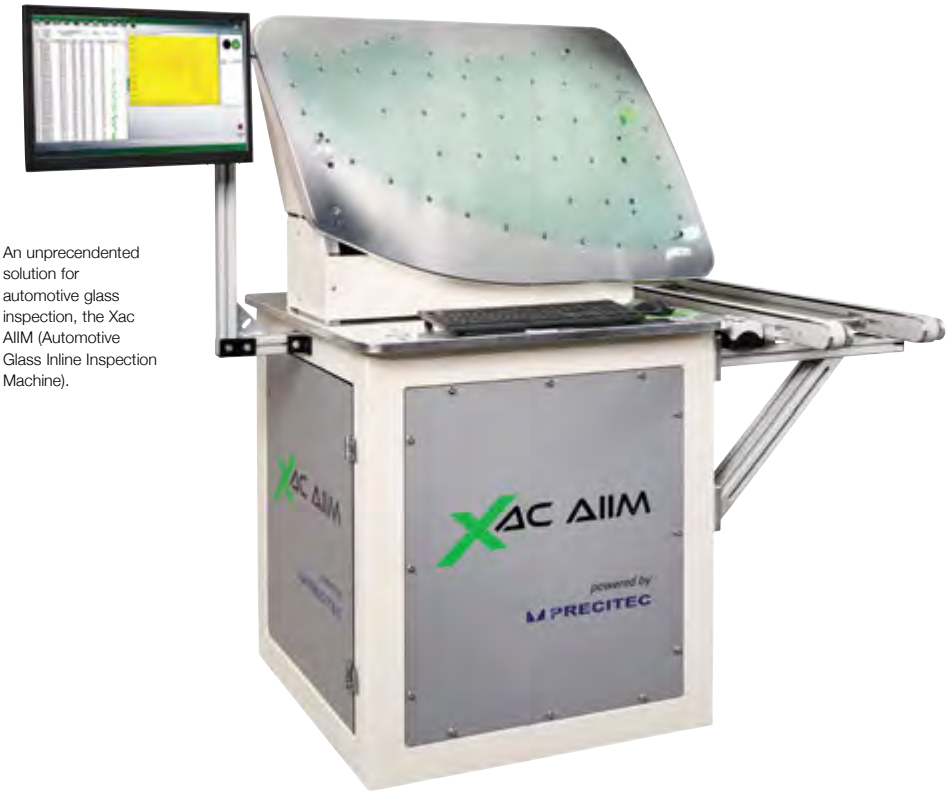
Automated inline inspection for automotive glass

An unprecedented solution for automotive glass inspection, the Xac AIIM (Automotive Glass Inline Inspection Machine) is the outcome of a collaboration between the specialist German machine builder Xactools and Precitec Optical Measuring, with its expertise in chromatic confocal sensor technology. According to Marvin Krebs, this novel type of contact-free measuring machine enables high speed inline inspection for windscreens, sidelites, backlites and sunroofs.



An unprecendented solution for automotive glass inspection, the Xac AIIM (Automotive Glass Inline Inspection Machine).

In recent years, the automotive glass industry has been confronted with numerous challenges. The quality demands on the shape and thickness of each piece of glass have increased as a result of higher safety standards. At the same time, the cycle times have to be as short as possible to increase the output from production lines.

Conventional measurement tools such as LVDT contact probe sensors cannot cope with these demands. These tactile probes are mounted in a template that can only be used for one model of automotive glass. In other words, a large number of templates and tactile probes are required to inspect different glass models.

Tactile probes have other disadvantages as well, including slow measuring speeds, non-negligible wear and tear of the probes that results in a large maintenance effort and a high probability of damage to the surface since the probes must touch the glass. Additionally, the thickness of the glass cannot be measured. These facts alone indicate that a measuring system based on tactile technology is an outdated, non-ideal fit for inline quality control of automotive glass.

The Xac AIIM in combination with Precitec Optical Measuring's 96-channel chromatic confocal sensor CHRocodile MPS96 instantaneously delivers shape topography and thickness measurements, thus easily outperforming tactile systems. With its highly flexible and non-contact measuring technology, this all-in solution allows for a 100% inspection of all automotive glass types and models, while significantly reducing cycle times and increasing output.

The additional integration of an interferometric sensor – the Precitec CHRocodile IT – enables analysis of other physical properties, such as measuring the thicknesses of all layers in laminated glasses, an important parameter in windscreen production, for example. Furthermore, any air gaps at the glass-PVB-glass interfaces or the wedge shape and waviness of the PVB foil can be determined. This is mandatory to fulfill the strict optical quality demands for windscreens, especially in the head-up display (HUD) area. This measurement capability brings added value to the manufacturer and increases the quality of each piece of automotive glass.

The CHRocodile MPS optical multipoint sensor offers up to 96 simultaneous distance and thickness measurments.

Measurements in just 0.5 milliseconds

Thanks to the contact-free measuring principle based on chromatic confocal technology and its scanning feature, the Xac AIIM is a highly flexible tool that instantly adapts to different glass types and models. This means there is no longer any need to change templates, which saves a lot of manpower, time and costs. ▸

The CHRocodile MPS96 offers 96 independent measuring channels (with the possibility of extension to 144), each equipped with very small 10mm measuring range optical probes (8mm diameter) and a measuring speed of up to 2000 measurements/ second per channel. Hence, the shape and thickness of a single piece of automotive glass can be measured in just 0.5 milliseconds.

The additional contact-free interferometric sensor from the CHRocodile IT series offers the possibility to resolve the multi-layer structures found, for example, in windscreens. Due to the high measuring speed of 70 kHz for the IT sensor, larger areas of interest eg in the projection region of HUD, can be scanned quickly as well.

Significant boost to output

A CAD file is produced for each measured glass and then immediately compared with a reference or 'golden piece'. If the deviation between the measured shape and/or thickness and the reference piece is too big, the glass is sorted out or reprocessed directly.

Thus, faulty parts can be sorted out at an early stage in the production process, which reduces production costs per piece and increases the yield and quality of the final product.

Turnkey solutions

The all-in solution comprising the Xac AIIM, the CHRocodile MPS96 and the interferometric sensor CHRocodile IT delivers precise measurements of thickness, topography and shape for all kinds of automotive glass.

With data acquisition rates of 2 kHz per channel for the CHRocodile MPS 96 and 70 kHz for CHRocodile IT, the desired measuring parameters can be acquired very quickly.

Furthermore, the machine can be easily adapted and integrated into any production line as a turnkey solution for automotive glass quality controls. After all, Precitec Optical Measuring enables automotive glass manufacturers to measure more precisely with light.

All in all, the combination of the Xac AIIM and Precitec's sensor technology takes automotive glass quality control to the next level, increasing output, reducing downtimes and improving the overall quality of the final product. ●

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Optimised use of moulds for higher productivity

In the competitive environment of manufacturing, glassmakers need to have great production outputs, while managing costs. Mould sets definitely correspond to high expenses, along with machinery and raw materials. In this context, moulds are worth investing in a system to improve their management and cost-effectiveness, says Anne-Sophie Lelièvre.

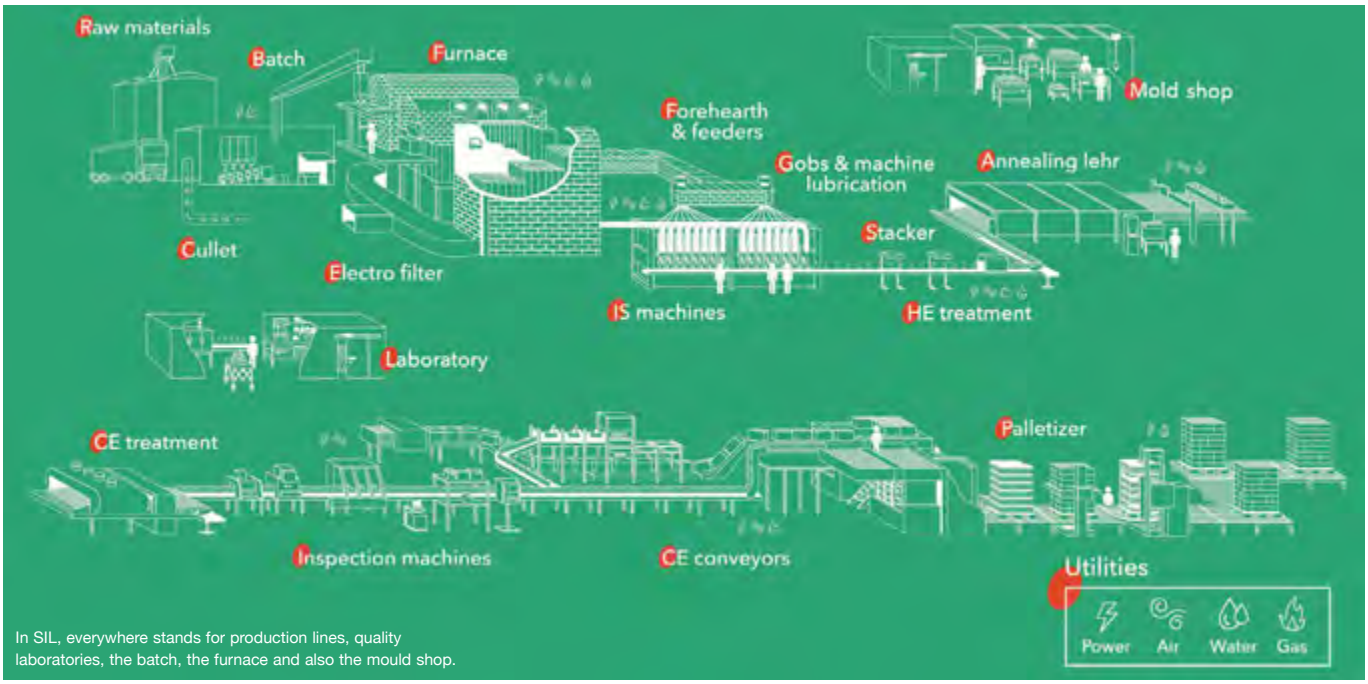
Vertech' provides glassmakers with a Manufacturing Execution System (MES) called SIL, supervising production everywhere in the glass plant, starting from the batch. In most cases, moulds and mould sets management are not included in glass supervision systems. However, a good mastering of moulds is essential from both a financial and technical point-of-view. Indeed, moulds represent high costs and their impact on articles produced is extremely strong, of course. What if one of the mounted moulds has a defect? What if there is no more available mould? Moulds cannot be forgotten in production supervision. They are a central element in the success of a glass manufacturing group.

Vertech' has already equipped many mould shops for a number of years and experience shows that tracking and analysing KPIs on moulds is very profitable in the short- and long-term.

Purchasing moulds

Obviously, choosing moulds is the starting point for good mould management. But this is not an easy task! Cost, potential, and quality: The perfect balance between these three parameters must be found. To make the best decision, analyses based on precise KPIs must be carried out. The

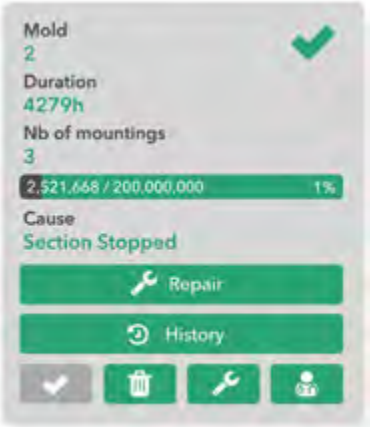
By consulting SIL, the operator will see at a glance how many moulds are available, how many are in repair or how many are scrapped.



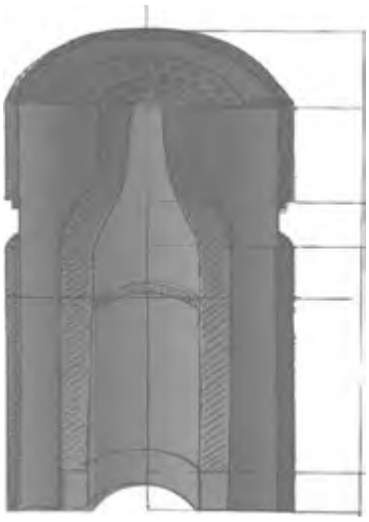
In SIL, everywhere stands for production lines, quality laboratories, the batch, the furnace and also the mould shop.

good news is that with SIL, all these KPIs are available!

With SIL, every single mould possesses its own ID card with the mould's detailed lifespan. The theoretical potential, the number of rotations, the number of gob cuts and the history of repairs are interesting elements to analyse before selecting a mould provider. SIL shows the theoretical potential versus the number of gob cuts and rotations for each mould. And sometimes, the difference between these figures is huge. Having this data available makes the choice much easier.



Each mould is tracked and possesses its own ID card with status and technical characteristics.



Thanks to dimensional controls on moulds, defects are anticipated.

Optimising mould sets

Good mould management does not come down to the choice while purchasing them. It is essential to make optimised use of them. SIL is not only able to track a mould set but also every single mould, thus granting full traceability.

It would be regrettable to have high quality moulds and not to make the best use of them. With SIL, the number of gob cuts and rotations for each mould is recorded in the system, thus enabling the consistent use of moulds within a set. Thanks to this system, the moulds of a specific set wear out at the same speed and the set can be scrapped whenever all moulds are out of use, not just a part of it.

Ensuring production

What is worse for glassmakers than having sections stopped because of a lack of moulds? Good choice by purchasing moulds and the optimised use of mould sets must be enhanced by a good management process for them. The full traceability made possible by SIL avoids such situations when no moulds are available to be mounted.

On top of traceability, SIL improves the work organisation of mould shop operators by means of dashboards and alarms. The tasks to be achieved are prioritised by the system, so that the operator directly knows on which moulds he needs to work first. He can also see if several moulds have been unmounted for the same reason.

Carrying out effective repairs

Traceability plays a major role when starting the repair. The lifespan of the mould, in particular the history of repairs, made available by SIL is of great help to undertake quick and appropriate actions. Communication between operators at different places in the plant is made easier, as an operator in the mould shop and an HE operator are able to communicate through the system. Thanks to all this, moulds are made available after repair within a shorter period.

Ensuring maintenance

With SIL, dimensional quality controls on moulds can also be managed. The mould shop manager configures a control by selecting moulds and threshold values, before the operator carries out the control. As the system directly communicates with measuring device in the mould shop, some time is saved and the number of errors is reduced.

Traceability and prioritisation are at the heart of mould management. Available and high quality moulds have a big impact on production and should not be neglected. In 2020, supervising production in the whole plant, including the mould shop, is an important necessity for glassmakers.●

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Beyond the visible: Industry 3.91

Neil Simpson discusses the benefits of in-furnace thermal imagers to gain an improved level of understanding of glass furnace operation.

AMETEK Land's five year development of an in-furnace Near Infrared Borescope (NIR-B) has taken the glass industry to another level of understanding of glass furnace operation. With over 324,000 continuously measured optical temperatures in over 50 end-fired and cross-fired regenerative furnaces, through case studies, it is possible to demonstrate the potential to use this data to further develop furnace controls to meet the needs of Industry 4.0 and optimisation of the furnace process. A picture, or in this case, a single thermal image, really is worth a thousand words and can convey complex and sometimes multiple ideas.

Current standard practice is for operators to take manual infrared pyrometer temperature measurements, often using AMETEK Land's Cyclops and the frequency is really company and site-specific but at least once per shift. Whenever anything goes wrong on a furnace, one of the first things that operators should do is take an optical temperature reading at a predetermined point and time. Depending on the reading, furnace operating parameters may be changed, or alternative areas investigated.

An in-furnace thermal imager, such as AMETEK Land Near Infrared Borescope (NIR-B Glass), can measure up to 324,000 Cyclops equivalent temperatures continuously, or with its latest model release now nearly three million. Based on the emissivity used and measured temperature, the thermal imaging software generates a pixel of image equivalent to that of the measured temperature. The data collected is significant and the resulting visual images are excellent.

Batch flow focus

Before reviewing the additional thermal capabilities of the NIR-B Glass, it is worth considering that it gives operators the same views as a conventional CCTV system. The primary purpose is looking at the batch pattern. Time-lapse recording can be used for reviewing batch flows as a conventional CCTV. Since the image is based on thermal data, it is possible to add areas and apply alarms if cold batch reaches a certain point(s). Whenever an alarm is triggered, the image is recorded for QA and troubleshooting purposes.

The batch flows are initially impacted by the charging method/control and flames. However, once in free space, the flow patterns are driven by the thermal flows/convection currents. The same way that heat flows from hot to cold, the thermal currents follow the same thermal vectors.

The most important initial benefit of the NIR-B Glass is the ability to obtain a furnace thermal profile every reversal when the flames go out (or continuously in oxy furnaces). To take a thermal profile manually using a portable infrared pyrometer varies between three to six hours. Optimisation of the thermal profile is critical to yield, throughput, energy and hence emissions. In both cross-fired and end-fired regenerative container furnace case studies, the primary objective is to optimise the thermal profile. Once the thermal profile is optimised, burner work can be performed to lower emissions. By utilising a specific thermal palette and adjusting the temperature bands, it is possible to identify which port and which flame is the most intense or hottest, therefore generating the most thermal NO_x.

The background to the end-fired case study was that an ageing furnace was struggling to achieve limits of NO_x ▸

Neil Simpson (second from left) at the 43rd ASEAN Glass Conference in Cebu, Philippines.

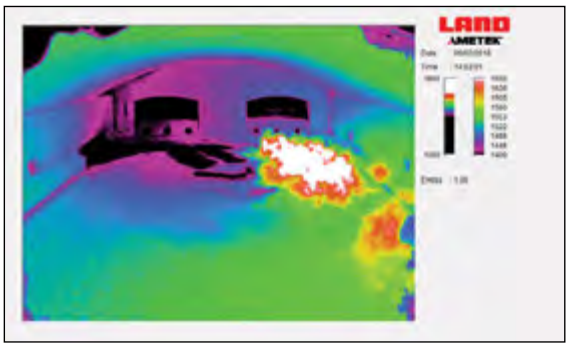

Figure 1: NO_x palette firing left to right, showing short intense flame.

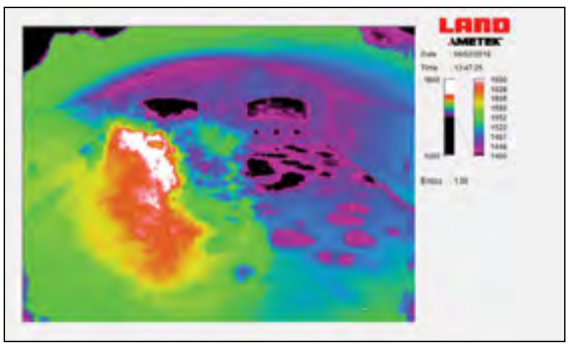

Figure 2: NO_x palette firing right to left, showing long and less intense flame.

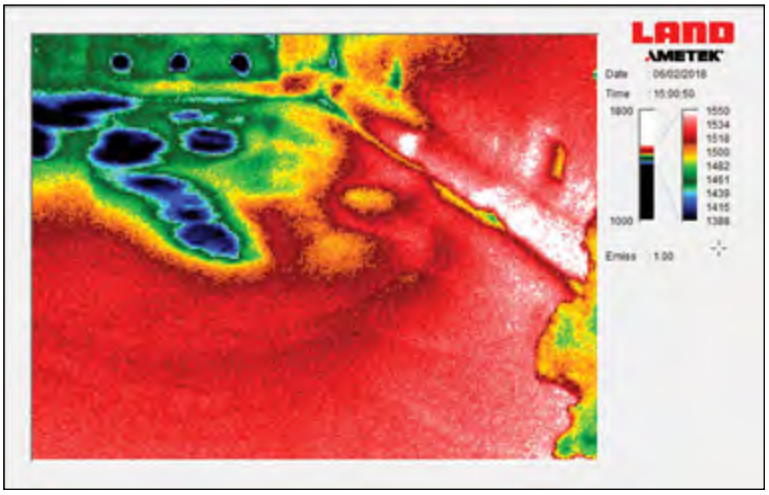

Figure 3: 3x zoom end firing left to right, showing the over-heating.

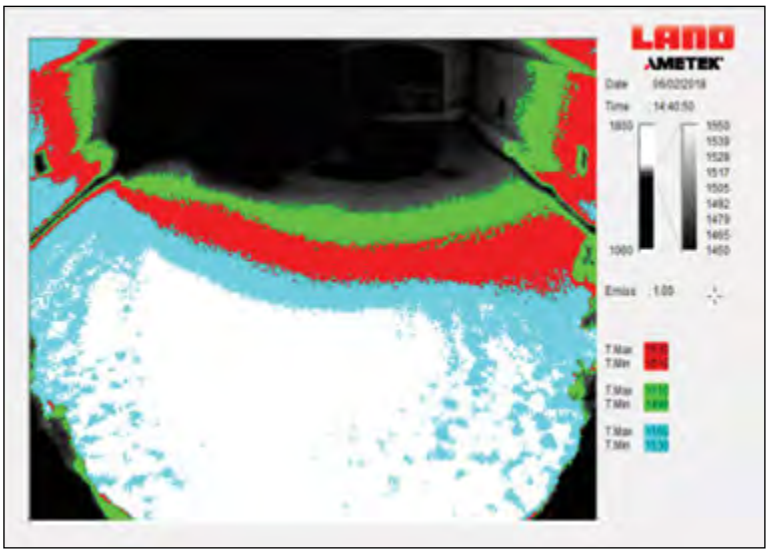

Figure 4: End firing right to left.

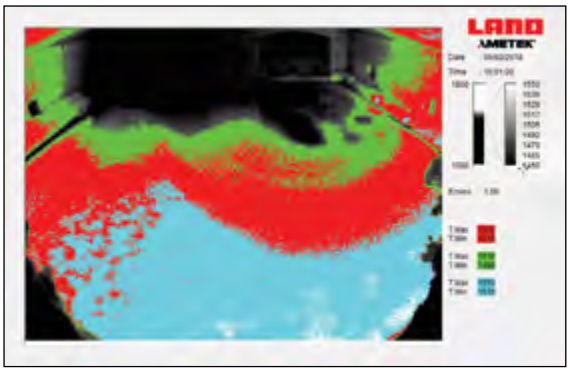

Figure 5: End firing from left to right.

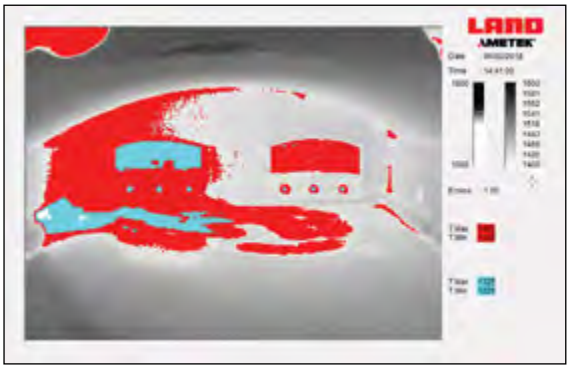

Figure 6: End right to left.

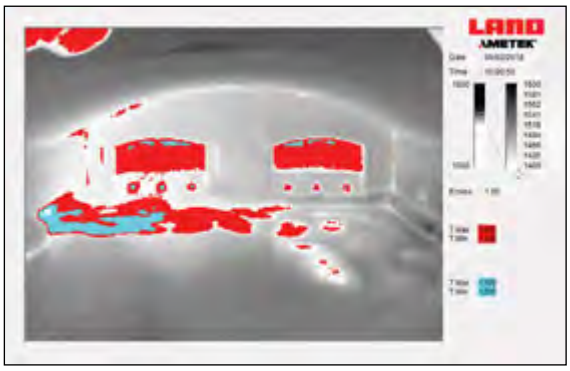

Figure 7: End left to right.

emissions. AMETEK Land was invited to propose different technical solutions, including new low NO_x burners and in-furnace staging techniques.

As part of the assessment process, a brief NIR-B analysis was suggested to see if there was anything that could be achieved in the short-term. In February 2018, the NIR-B was briefly installed in the existing conventional CCTV location. Simultaneously, regenerator target wall measurements of $\%O_2$, ppm CO, ppm NO and ppm NO_2 were taken using an AMETEK Land Lancom gas analyser.

The initial analysis unusually highlighted that the NO_x was lower on the side with the single doghouse. Using the 'NO_x Palette' confirmed that the flames were significantly hotter on the side with the NO_x, with corresponding overheating of refractory at the charging end of the furnace (figures 1-5).

The batch pattern at the end of firing was completely different from firing from one side to the other.

The Lancom confirmed that there were problems with calibration of the oxygen lambda probes and combustion airflow measurement. Re-alignment of the flow meter and reverting to ratio control brought the combustion closer to normal and gas was removed from the ports as a result.

Typically, it takes significantly longer to initially analyse the data than physically taking the measurements. By reviewing data at the flame-out furnace reversal, it became clear that there was a significant temperature difference between the exhaust port and target wall temperatures firing from one side to the other. By utilising the zoom and isotherm functions, it was possible to show after firing from left to right the target walls and temperatures were almost identical (figures 6 and 7).

Firing from right to left, the temperature difference was 100 degrees. Clearly, there was a regenerator issue that was a partial blockage.

A three hour NIR-B thermal survey identified four significant issues that were all interrelated. They had impacted the energy efficiency and resulting NO_x emissions. It was important to resolve the issues before trying new technology to lower the NO_x emissions. The glass manufacturer increased the firing cycle and cleared the regenerator blockage, had the oxygen probes and annubar flow meter serviced before hiring a NIR-B thermal imager for 30 days.

With the original combustion equipment operational, stable combustion with consistent excess oxygen was achieved. By making an adjustment to the burner angles, the thermal profile was optimised by the customer. Further adjustments to the burner impulse settings were able to lower the NO_x. Within 30 days, NO_x emissions were within limits and no additional abatement equipment was required. ●

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Decarbonising the UK glassmaking sector

Glass Futures has won a £7.1 million UK Government contract to investigate decarbonising the sector.

The UK Department for Business, Energy and Industrial Strategy (BEIS) has placed a £7.1 million Industrial Fuel Switching Procurement Contract with Glass Futures Ltd to provide in-depth investigations of sustainable alternative fuel sources and innovative scenarios to decarbonise the glass manufacturing process in line with 'net zero' targets.

"Reducing emissions from homes and industry is a key part of our work to eliminate our contribution to climate change by 2050" commented the Rt Hon Kwasi Kwarteng, Minister of State at BEIS. "This innovative project by Glass Futures is an exciting development and could make a significant impact on our net zero ambitions."

The UK Government has committed to reducing net carbon dioxide emissions to zero by 2050.

Richard Katz, Director of Glass Futures said: "While the UK glass sector has made progress by more than halving its emissions over the past 50 years and its products continue to greatly contribute to energy savings through energy-efficient window and glazing systems, insulation in the built environment, wind turbine blades and an array of high-tech communications devices, there remains an urgent need to accelerate our efforts towards delivering innovative technologies that will advance us towards the net zero goal."

There are significant differences in infrastructure across the UK glass sector in relation to furnace design, age and specific application. According to Glass Futures, no single low carbon fuel scenario will be the panacea for all 17 of the UK's largest glass production plants, which collectively account for the majority of domestic glass manufacturing output and their associated CO_2 emissions.

This study and subsequent report will highlight what can and what cannot be done on different production platforms in glass manufacturing and will influence the most suitable routes for industry and government to work across in delivering the range of options best suited to decarbonise a given site. The Glass Futures study, which is due to be completed in March 2021, will investigate and recommend the most cost-effective and environmentally efficient routes to decarbonise

With *Glass Worldwide* as preferred journal, Glass Futures Ltd is a not-for-profit company, limited by guarantee. It has been created as a core entity to allow the evolution of 'catapult-like' centres of excellence in glass comprising R&D, innovation, training and up-skilling. Central to the proposition is a demonstration-scale glassmaking facility of 30 tonnes/day capacity.

Supporters of Glass Futures include Guardian Glass, Owens-Illinois, University of Leeds, Siemens, Swarovski, The Worshipful Company of Glass Sellers of London, Tecoglas, Encirc, Sheffield Hallam University, The Society of Glass Technology, Pilkington UK, AMETEK Land, University of Cambridge, The British Glass Manufacturers' Confederation and Glass Technology Services, University of Liverpool and FIC (UK).

The Glass Futures Industry Conference in St Helens, Merseyside in July 2019 outlined plans to create two centres of glass excellence; hot glass at St Helens and cold end research at the University of Leeds.

The UK Government has committed to reducing net carbon dioxide emissions to zero by 2050.

Dave Dalton, Maria Chanmugam and Richard Katz (members of the Glass Futures advisory board) with Dave Fordham of *Glass Worldwide* (preferred journal of Glass Futures).

The Rt Hon Kwasi Kwarteng, Minister of State at the UK Department for Business, Energy and Industrial Strategy (BEIS).

Richard Katz, Director of Glass Futures.

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Flat glass in a climate-neutral Europe

Triggering a virtuous decarbonisation cycle to maximise contributions to the climate challenge, Glass for Europe recently released its 2050 vision on 'Flat glass in a climate-neutral Europe'. This comprehensive work highlights how the flat glass sector can maximise its contributions to Europe's decarbonisation goals but also identifies how a virtuous decarbonisation cycle can be triggered on the journey towards climate neutrality.

According to Glass for Europe, high performance flat glass will be needed in much greater quantities to move towards climate neutrality in Europe. In addition, the flat glass should be manufactured with minimal CO_2 as soon as possible. These facts are at the core of Glass for Europe's 2050 vision on 'Flat glass in a climate-neutral Europe'.

Europe's flat glass sector accepts its role to produce at a competitive price the materials essential for renovating and decarbonising Europe's buildings, for supporting the clean mobility transition and for increasing the share of solar energy in Europe. In the building sector alone, at least a two-fold increase in the building renovation rate is needed to meet Europe's objectives and demand for high efficiency glazing should grow subsequently.

"Because our products help avoid so much CO_2 throughout their lifetime, the flat glass industry is already today a net carbon avoidance activity" says Christian Quenett, Chairman of Glass for Europe and Head of Architectural Glass at NSG Group. "Our sector will play its part to meet the objective of a climate-neutral Europe" he continues. "We are aware of our responsibility to lower industrial emissions to the maximum extent possible and we are already actively researching new manufacturing solutions."

Glass for Europe's 2050 vision identifies the disruptive technological routes for a massive decarbonisation of the flat glass manufacturing process and presents their respective maximum CO_2 emission reduction potential. The need for technological breakthrough and energy infrastructure to guarantee the availability of feedstock are also recognised as important enablers for policies to become supportive of the industry's decarbonisation efforts.

"Flat glass is largely a non-substitutable material that is strategic for the massive decarbonisation of Europe" declared Bertrand Cazes, Secretary General of Glass for Europe. "It is therefore crucial that the operationalisation of the European Green Deal creates the right conditions for our sector to maximise its contributions to climate neutrality."

Glass for Europe suggests actions for the EU to trigger a virtuous cycle of decarbonisation that starts with mainstreaming carbon avoidance products in sectors offering the highest CO_2 emission reduction potential. In this regard, the announced building renovation wave will be pivotal if it offers certainty thanks to binding targets and effective measures. Going circular by removing the barriers hampering the recycling of glass waste, developing an ambitious industrial strategy, supporting R&D in clean technologies and products, creating the appropriate economic and infrastructure conditions to attract low carbon investments, are also essential elements of this virtuous decarbonisation cycle.

"Glass for Europe is eager to share this vision and engage in a constructive dialogue with European stakeholders that have the tremendous responsibility to put Europe on track to deliver climate neutrality" Mr Cazes concludes. ●

GLASS FOR EUROPE

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Steady production growth recorded in Europe

FEVE
The European Container Glass Federation

European production of glass packaging for food and beverages continues to grow, according to latest figures published by the European Container Glass Federation. The increase of 2.0% in tonnes and 1.9% in units (748 million units increase) recorded in the first half of 2019 corresponds to the best performance over the past four years.

glass WORLDWIDE
Preferred journal of FEVE

Between 2016 and 2019, half year production weight increased by 3.5% (373,000 tonnes) and units increased by 3.5%. The pace of growth is particularly heartening if reference is made to 2018, where an increase was still recorded but at a lower scale (1% growth).

The strong half year data for 2019 is particularly noteworthy given broader macro economic trends in the EU, according to consultancy Vivid Economics. "2019 was a challenging year for many major European economies. However, container glass' impressive production and sales figures are indicative of a healthy, robust and dynamic industry" says Paul Sammon, Industry Lead at Vivid Economics, which reports and analyses data for FEVE. "The increase in growth suggests the sector remains an attractive one for customers and investors and that container glass will be central to a sustainable, circular economy."

Today, sustainability is influencing consumer purchasing behaviour. According to a publicly available report by Nielsen, within the fast-moving consumer goods (FMCG) space, it is now common practice for shoppers to look for a product that is good for them but also for the environment. For example, 81% of surveyed global respondents believe that it was either 'extremely' or 'very' important for companies to implement sustainability programmes.

"Today, growth opportunities for brands stay into the ability to combine what is good for the environment with what is good for consumers" commented Michel Giannuzzi, President of FEVE. "This increased demand for glass reflects the increasing consumer quest for a healthy and sustainable lifestyle also when it comes to packaging choice."

Glass packaging is unquestionably the leading packaging material for many sectors like beer, still and sparkling wines, spirits and it is steadily recovering market share into food, water and soft drinks markets. ●

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web: www.feve.org

Where glass science, art and technology meet

ATIV
Associazione Tecnici Italiani del Vetro

At the start of 2020, ATIV (Association of Italian Glass Technicians) initiated its annual membership campaign, inviting current members to renew their membership and inviting further applicants to join the association.

glass WORLDWIDE
Official journal of ATIV

ATIV is a 35 year old non-profit organisation. With contributions from its members and the freely provided commitment of Board members, ATIV organises meeting and events. A strong membership is confirmation for the association that its efforts are useful to improve the technical and scientific knowledge of associates.

This year, with *Glass Worldwide* as official journal, the XXXIV International ATIV Congress will take place in Parma, Italy on 24-26 June at Parma Campus University, with the theme 'Where Glass Science, Art and Technology Meet Together'.

The main topics to be covered at this meeting include:

- Glass science
- Glass technology.

Alessandro Bandini, ATIV President.

ATIV spreads scientific knowledge in the glass sector to members and all operators in the sector.

- Machinery and equipment for the glass industry.
- Glass in architecture.
- Special glasses.
- Characteristics and measures.
- History of glass.
- Glass and research.
- Emissions and environment.

It would not be possible to organise the association's activities without the support of its members. It is for this reason that ATIV is fully committed to attracting new members for what is the only association for Italian glass technicians. In 2020, membership initiatives and benefits will include:

- Award for the best communication from a young researcher under the age of 30.
- Preferential rates for companies that subscribe more than four people at the XXXIV International ATIV Conference (15% discount).
- Complementary subscription to *Glass Worldwide* (exclusive official ATIV journal).

Applicants are invited to contact the association by email or by visiting the website. ATIV also welcomes suggestions for the development of initiatives that match the association's goals. ●

Further information:
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web: www.ativ.eu / www.ativ2020.it

GlassTrend seminars are targeted at relevant themes and are attended by engineering and R&D leaders from the international glass industry.

Innovative raw materials for sustainable glass production

The reduction of both energy consumption and CO_2 footprint while increasing production efficiency are key challenges for the glass industry. With *Glass Worldwide* as preferred journal, from 31 March to 2 April 2020, the GlassTrend spring seminar will focus on how innovative raw materials and processing technologies can help the glass industry progress towards a more sustainable manufacturing process.

The GlassTrend seminar 'Innovative raw materials and processing technologies for sustainable glass production' is hosted by Sibelco and takes place at 't Kristallijn, in Mol, Belgium, with transportation available from Brussels and Antwerp.

The GlassTrend seminar in Mol will examine innovative raw materials, recycling technologies and new processing of raw materials.

Knowledgeable glassmakers, raw materials producers and process engineers from all horizons are invited to provide insights to their latest innovations and to illustrate the positive impact of raw materials and processing technologies on glass production. Three main themes will be covered: Innovative raw materials, recycling technologies and new processing of raw materials.

Preceded by keynote presentations on each topic, sessions will cover raw materials, batching and recycling and proceedings include a welcome reception and gala dinner hosted by Sibelco.

Visits will be organised by Sibelco to its Mol facilities, with optional excursions to the High5 cullet treatment facility and the Maasmechelen low iron sand quarry.

The seminar is free-of-charge for two participants from each GlassTrend member, with additional attendees welcome if maximum numbers are no reached.

The GlassTrend organisation is a consortium of worldwide operating industries and institutes working in the field of glass and glass production. The association aims to co-ordinate research and development activities to improve the competitive strength of glass industries, its suppliers and customers. ●

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Forthcoming events

MARCH 2020

10-11 March: CelSian training course 'Introduction to raw materials and melting' (Eindhoven, the Netherlands)

12-13 March: CelSian Expert training 'Redox, fining and glass quality' (Eindhoven, the Netherlands)

17-18 March: CelSian training course 'Introduction to combustion and emissions' (Sheffield, UK)

23-26 March: ICCG13 (Braunschweig, Germany)

30 March: CelSian training course 'Introduction to glass defect diagnosis' (Eindhoven, the Netherlands)

31 March – 2 April: GlassTrend seminar on innovative raw materials and processing technologies for sustainable glass production (Mol, Belgium)

APRIL 2020

18-19 April: Deco '20 (Cleveland, USA)

MAY 2020

7-13 May: interpack 2020 (Düsseldorf, Germany)

13-14 May: Glassman Latin America (Monterrey, Mexico)

19-21 May: ArchGlass 2020 (Moscow, Russia)

JUNE 2020

1-5 June: CelSian Glass Technology Course (Toledo, USA)

3-4 June: Furnace Solutions Conference 15 and training day (Stoke-on-Trent, UK)

3-6 June: Glass South America (Sao Paulo, Brazil)

4 June: GPD South America 2020 (Sao Paulo, Brazil)

8-11 June: Mir Stekla 2020 (Moscow, Russia)

15-16 June: Glassman Asia (Seoul, South Korea)

15-19 June: Joint USTV/DGG annual meeting (Orléans, France)

17-19 June: Intersolar Europe (Munich, Germany)

24-26 June: ATIV International Conference (Parma, Italy)

SEPTEMBER 2020

2-4 September: Society of Glass Technology Annual Conference 'Challenges & Changes' (Cambridge, UK)

15-17 September: GlassBuild America 2020 (Las Vegas, USA)

20-24 September: ICG/ESG Annual Meeting (Krakow, Poland)

OCTOBER 2020

5-9 October: CelSian Glass Technology Course (Eindhoven, Netherlands)

20-23 October: glasstec 2020 (Düsseldorf, Germany)

26-29 October: 81st Conference on Glass Problems (Columbus, USA)

29-30 October: CelSian Expert training 'Redox, fining and glass quality' (Detroit, USA)

NOVEMBER 2020

10-11 November: CelSian training course 'Introduction to glass container forming' (Eindhoven, the Netherlands)

17-18 November: CelSian training course 'Introduction to flat glass forming' (Eindhoven, the Netherlands)

Deco '20

Deco '20 will be held on 18-19 April 2020 at the Westin Hotel Cleveland, Ohio in Cleveland, USA.

This year's event features two keynote speakers and 24 exhibitors. The first day of the programme includes eight speakers and a panel discussion on organic inks. Featured speaker is Jeff Lubash, President of Affiliated Services Group Ltd. His presentation will focus on operational excellence and implementation. He has been recognised in *Fortune, Industry Week* and *Directions* magazines.

With Decorating Production and Processes as the theme, presentations in the technical sessions will include:

- Advances in digital printing (Marabu).
- Compliant glass and ceramic ware – A journey through the global regulatory landscape (TUV Rheinland of North America).
- Crystal digital transfer technology offers new decorating options (ACTEGA North American Technologies).
- Introducing sustainability into the production process (Global Products Inc).
- Improving supply chains through operational excellence (Affiliated Services Group).
- Digital printing…An opportunity or a threat (Fermac).
- Navigating the tariff wars: Keeping up with the changes and their impact on your business (Maryland China).
- Digital printing: Achieving the look you want without compromising quality (Innovative Digital Systems).

Exhibitors at this year's event in Cleveland include:

- Applied Surface Technologies.
- Decal Solutions Unlimited.
- Fermac.
- Ferro Corp.
- Fusion Ceramics.
- Geib Refining Corp.
- Heidelberg USA Inc.
- Innovative Digital Systems.
- ISIMAT.
- Inkcups.
- Koenig & Bauer Kammann.
- Marabu North America.
- Marck & Associates.
- Maryland China.
- Photo USA.
- PPG.
- Preciosa.
- RUCO USA.
- Servo Pak.
- Strutz International.
- Sun Chemical.
- Tecno5 (an affiliate of Cerve).

The Society of Glass and Ceramic Decorated Products will hold its annual meeting on the second day, followed by the keynote address delivered by Lisa Ryan, President of Grategy. The topic of her presentation is 'Mastering the millennial mindset: How to attract and retain emerging leaders'. A legislative update will follow. Exhibits will be open from 12:00 until 18:00 on the second day. ●

Further information:
Society of Glass and Ceramic Decorated Products, Zanesville, Ohio, USA
tel: +1 740 588 9882
email: info@sgcd.org
web: www.sgcd.org

English language content continues on page 133.

预防断电，降低电费

来自电加热系统不受管理的电力需求高峰可能会增加断电的风险，特别是当这些系统在应急发电情况下运行。当多个加热区随机地产生电力需求时，供电系统会不可预测地形成过载，从而导致断路器或发电机组跳闸。在最糟糕的情况下，来自多个加热系统的不受管理的电力需求可能会使玻璃制造厂的主电力供应接近其极限运行，并可能面临整个工厂断电的风险。高峰电力需求还会影响电力供应商用来设定电价和计算电费的衡量标准，从而导致用电成本超出必要水平。雷内·穆尔曼（Rene Meuleman）和安布尔·沃特金（Amber Watkin）解释了如何在EPower Advanced SCR功率控制器中采用预测性负荷管理策略，以通过“负载共享”和“负载限制”技术最大限度地降低高峰电力需求。

René Meuleman.

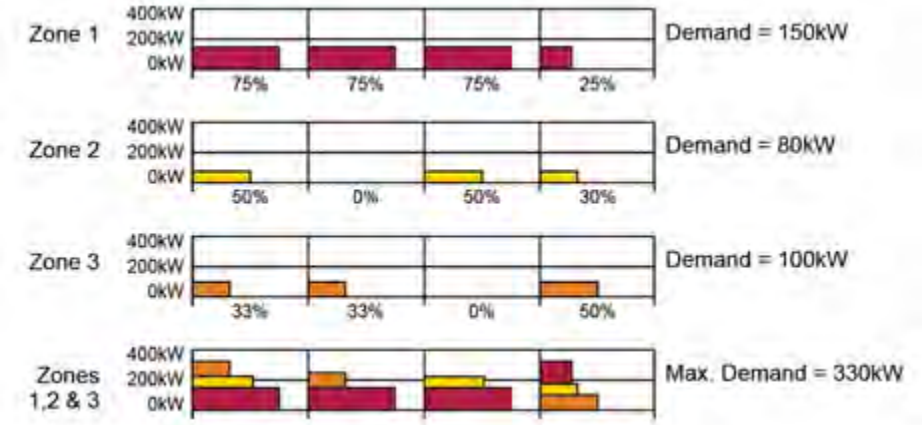

图1：不受管理的加热区可能会随机地同时全功率开启，从而导致出现电力需求峰值。

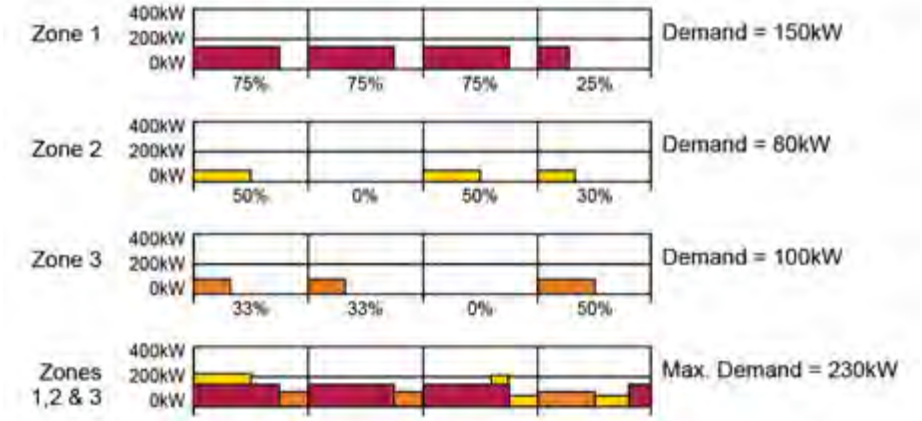

图2：英国欧陆公司的负载共享策略会通过在非定周期内的不同时间开启加热区电源来平衡电力需求。

玻璃厂可能会有许多大功率电气设备需要从干线电源供电。最大的问题就是电加热系统，例如电助熔、锡槽加热和退火窑。如果不加以管理，这些系统的电源会通过其控制装置随机打开。

当多个加热区同时接通多个电源时，可能会给电源带来巨大的电力峰值需求。这不仅会影响能源成本，而且在最坏的情况下，还会超出主电源或应急电源的最大容量，从而导致电力中断。

由于玻璃厂需要24/7不停地运转，因此非常不希望出现电力供应中断的情况。断电会导致温度、流程和排放控制系统无法正常工作，这可能会对企业带来极高的代价，包括生产损失、废品、环保排放罚款，以及对窑炉和其他昂贵设备可能造成温度相关的损坏。

由于采用高温流程生产，因此需要采取适当的紧急措施，以确保在意外断电期间维持安全状态，同时使系统恢复运行。通常，电加热系统都配有应急备用发电机（发电机组），但这些设备对电源的谐波失真很敏感，而且由于不受管理的电力需求会造成不稳定的瞬时峰值，从而很容易跳闸。当进行工艺改进，产品升级或提升生产能力时，任何额外的负载都可能超出单个变压器或干线电源的设计功率容量，此时，高峰电力需求尤其会成为一个问题。

频繁出现的不受控的峰值电力需求会在系统的大电流部件（如母线和变压器）中引起机械应力的波动，从而缩短使用寿命或增加维护成本。从系统效率的角度来看，功率损耗与系统需要提供的电流密切相关。在功率损耗计算中，电流总是被平方计算的。在这方面，在稳定的较低电流下使用一定量的电力比在波动电流下使用相同量电力更高效。

在一些地区，峰值电力需求还会影响到电力供应商用来计算协议电价和电费的衡量标准。公共事业公司需要确保自己有足够的能力，即使在高峰用电期也能可靠地为客户提供电力。为了进行规划并满足供电服务，要对用户的峰值用电需求进行评估，并在电费单上收取额外的费用。

根据地区的不同，这种“需量电费”可以有不同的计算方法。峰值用电需求读数可适用于整个计费周期的需量电费中，这不可避免地导致能源成本高于必要水平。通常，协议电价也会考虑到随机产生的峰值用电需求，而这再次不必要地增加了总用电成本。

即将实施的区域环境和能源效率目标将推动玻璃制造商减少其能源使用量和二氧化碳排放量。在未来大幅度提高能效方面，由于人们认为化石燃料炉已经达到其极限，因此，预计未来的发展方向将包括使用以电力为主和完全使用电力的窑炉。由于常见的化石燃料窑炉的使用周期为15至20年，因此玻璃厂还需要一两个窑炉来 ▸

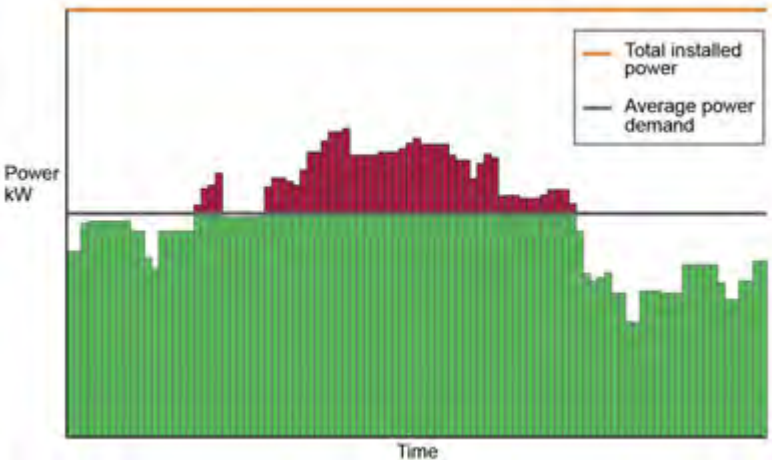

图3：如果没有预测性负荷管理策略，则电力需求量是随机的，从而导致在平均电力需求量周围出现峰值。

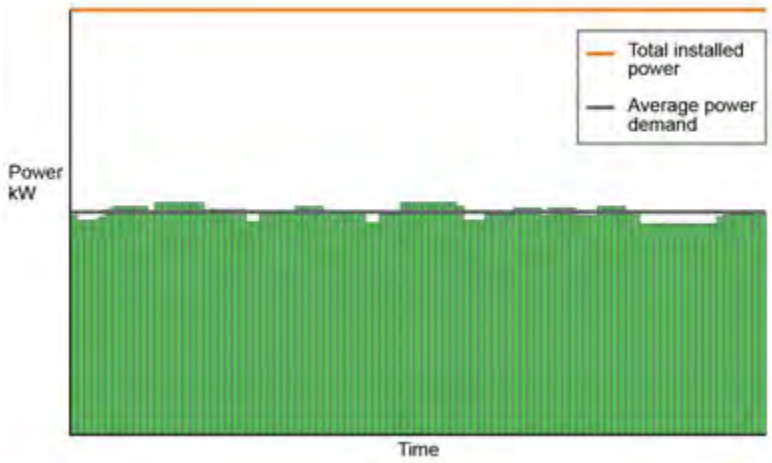

图4：如果采用预测性负荷管理策略，则电力需求量是共享的，从而将峰值需求量降至最低。

采用更高效能的技术才可满足其地方政府的目标，其中许多目标都是针对2050年。而作为这种转变的一部分，将需要采用高效的供电方法。

预测性负荷管理

英国欧陆公司（Eurotherm）与全球玻璃制造商合作开发解决方案。欧陆公司的EPowerSCR控制器提供了这一先进的（获得专利）控制功能，称为预测性负荷管理，可同时解决峰值用电需求和过载问题。首先，通过负载“共享”功能，可以管理许多负载的需求，从而降低功率峰值。这就有效地“平稳”了配电上的平均电力需求，同时很重要的是，可维持每个区域所需的电力。其次，通过“负载限制“功能，可以优化和限制系统的最大允许峰值电力需求。与EPowerAdvanced SCR控制器提供的过零触发（也称为全周期触发）方法结合使用，这些“负载共享”和“负载限制”功能可让玻璃厂有效地管理峰值功率，从而将其控制在他们供电能力或能源电价的范围内。

EPower控制器功率管理系统是基于一个控制模块，该控制模块可以在“类PLC”设计布局中控制多达四个晶闸管功率组。在生产现场，多达64个加热区可使用CAN总线网络同步在一起，并与可选用的现场总线（如以太网或PROFIBUS）隔离。例如，可在一个窑炉、多个窑炉，甚至整个工厂范围内来监控加热区，以在主供电网络上达到最有效的结果。预测性负荷管理功能会处理不同区域之间的差异，并在分配电力时考虑10kW区域与100kW区域会产生不同影响这一情况。适用范围包括玻璃热弯生产线、钢化炉和高压釜，以及完整的浮法玻璃锡槽、退火窑和复杂的多区域窑炉辅助设备。

为什么需要过零触发？

由于移相触发方法可提供平稳的功率控制，因此SCR控制器习惯于使用这一方法，但这也会引起很高的谐波失真和不良的功率因数（通常低于85%），而这对功率效率会产生负面影响。虽然人们知道过零触发方法会引起闪烁效应，而该效应会增加随机峰值功耗，但它可提供更干净的功率波形和最小的谐波噪声，并且具有很高的功率因数（通常高于95%）。

当功率因数低于95%时，许多公共事业公司会征收附加费。到今年年底，根据工厂设备安装规模不同，这意味将产生数千甚至数万美元的费用。由于随机峰值功耗可通过预测性负荷管理进行控制，因此在这种情况下，过零触发被认为是一种较好的控制方法。非常好的功率效率有助于降低电费和二氧化碳排放量。

负载共享策略

英国欧陆公司（Eurotherm）的负载共享策略在预测性负荷管理功能中发挥着重要作用，其在过零触发模式下通过管理多个EPowerSCR的触发来维持一个稳定的总体电力需求。该策略会为不同的负载来分配功率，以达到一个平衡的总功耗，从而最大限度地降低瞬态功率峰值。

每个加热区由一个EPowerSCR控制器来管理，该控制器被设定了输出功率、循环时间和最大功率（最大容量），这些数值可以以矩形方式来表示（见图1和2）。并非让这些矩形随机堆积而导致在给定的时间范围内形成高峰（如图1所示），而是电源负荷管理功能将这些矩形均匀地分布（如图2所示），从而保证在任何给定时刻总体电力需求都保持尽可能平稳。

重要的是要明白，输出功率并没有发生变化，而是被平衡和转移，以形成平稳的需求。通过智能负载共享功能，可基本消除闪烁效应和由此产生的随机峰值的问题，从而使总体功耗变得平稳。

负载限制策略

英国欧陆公司的负载限制功能是为电力需求可能超出加热系统设备或主电源容量的系统而设计的。仅当电力需求超过预设的最大容量时，该功能才可以设置为限制和转移这一功率。控制电力需求以维持在设定范围内，这有助于防止本地和工厂范围内的断路器过多地跳闸，同时降低造成设备损坏的高昂风险。

在电费较高的地区，负载限制功能还可用于将电力需求限定在某一电价阈值下。例如，如果总装机功率为2.5MW，但用户希望将输出功率限制在2MW的电费范围内，那么负载限制功能将在整个网络中消减功率，以使总电力需求维持在该限值之下。还可以通过现场总线通信网络（PROFIBUS、DeviceNet和以太网）进行调整，并可根据是否收取高峰期附加费来进行调整。

通过动态调整安装设备的最大阈值，玻璃厂可以控制最大用电费用，从而可以节省大笔资金。在某些地区，依合同规定，在接下来的最多11个月内，电费单中都将收取附加费。因此，一旦超出最大用电量，可能导致长达12个月的罚款。监控和管理用电量可以大大降低能源成本。预测性负荷管理功能允许用户自己设置优先级，从而可根据需要来转移功率。

结论

随着玻璃行业未来向更节能的方向发展，预计电加热技术的使用会增加，因此需要考虑采用最佳的控制方法，以提高成本效益，同时减少对环境的影响。EPowerSCR控制器所采用的智能预测性负荷管理策略可帮助玻璃厂将电力需求控制在其主电源容量的范围内。在现有安装设备中，允许添加额外的电加热设备，而不会带来未来断电的风险。同时可以满足对电价的限制，降低产生额外成本和罚款的风险，并且可重新协商电价以达到更好的结果。

使用具有过零触发功能的EPower控制器并结合预测性负荷管理功能，可提高功率因数，这还有助于提升系统的功率效率，降低电费和二氧化碳排放。英国欧陆公司的玻璃专业团队会基于预期投资回报率预先计算出能源节约量，以证明采用高效能技术是非常合理的。●

作者简介：

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网址： www.eurotherm.com/glass

惊人的发现 第21部分… 玻璃瓶罐吹吹工艺 中的涂油

在探索了提升成型工艺稳定性和减轻玻璃容器重量方面的不同方法后，在后续期刊中，Paul Schreuders 谈到了有关 XPAR Vision 在 BlankRobot 初模侧机器人研发上的惊人发现。在去年的玻璃科技展会引入 的 BlankRobot 初模侧机器人是玻璃成型上真正的革命，它能显著降低成型过程中的干扰量，因此为有效的成型过程自动化铺平了道路。本文主要关注涂油和 BlankRobot 自动涂油机器人本身。

根据第74期及后续介绍，绝大多数食品和饮料包装公司都在巴黎气候变化大会 （COP21）召开后认真承担起他们的社会责任，积极致力于降低他们的碳足迹。由于包装是碳足迹的重要组成部分，因此供应链协作对于能否降低碳足迹至关重要。众所周知，玻璃包装与金属、塑料及生物基包装处于同一竞争领域，对于玻璃包装而言，生存的关键是可回收性和降低重量（提高玻璃包装与包装内容的比例）。而降低重量要求进一步提升成型工艺的稳定性。

20年来，荷兰的 XPAR Vision 公司持续引领热端传感器发展用于提升玻璃容器成型性能。在近期的杜塞尔多夫玻璃科技盛会上，公司发布了本公司的 BlankRobot 自动涂油机器人设备。

顾名思义， BlankRobot 初模侧机器人不但专用于涂油，也可用于其他应用。在涂油方面，通过共同使用一种专用的润滑剂进行高度精确涂油，涂油频率降低到仅仅三小时一次，节省了足够时间来让机器人执行其他功能。

本文介绍了解涂油的各个方面知识的必要性以支持用户有效地使用涂油机器人。

Paul Schreuders, XPAR Vision 的 CEO 。

日常运作方面

之前的 XPAR Vision 文章‘惊人的发现…’（第 18 – 20 部分）提到了玻璃容器生产自动涂油方面的注意事项。XPAR Vision 的 BlankRobot 概念的根本，是为提升工艺稳定性而减少涂油对于工艺的干扰，这在第 18 部分有所描述。在第 19 部分概述了在专用涂油应用中使用正确润滑剂的关键因素。紧接着第 20 部分说明了由涂油机器人供应商提供知识和协助客户了解（机器人）和润滑剂配合使用的方式，对生产工艺进行优化。 XPAR Vision 目前已协助许多客户维持 BlankRobot 系统的日程运行。本文将讨论和回顾吹吹工艺中使用机器人涂油的相关事项。

涂油影响

本系列的最后一篇文章概述了哪些方面影响了自动涂油在玻璃瓶罐质量，效率，初模涂层和涂层持续时间方面的效率。根据 BlankRobot 系统持续运用于吹吹工艺的使用经验，了解到的结果确认这些影响因素为装料、料滴落入初模位置的一致性及初模的轮廓设计。

从绿料和白料玻璃瓶罐生产经验了解到，BlankRobots 进行自动涂油的吹瓶重量范围在 500 – 800 g 之间，生产速度为 130 – 200 瓶/分钟。

回顾各种影响， 涂油性能主要取决于初模轮廓。例如，一个窄锥形的初模设计需要在施加润滑剂层的厚度和施加润滑剂的型材区域之间达到微妙的平衡。同样的逻辑，较宽的初模设计则有不同的要求。

涂油参数不平衡会直接影响到落料印的产生，因为施涂的石墨层太薄或施加不持续导致摩擦力增强。实际上，难题是如何在施涂润滑剂层的厚度和涂油间隔上找到良好的平衡。 这为机器人技术提出了挑战，石墨及其向初模轮廓的颈部区域的施涂应精确确定。

XPAR Vision 的 BlankRobot 设计理念就在准确地处理涂油。不使用模具内涂油（如仅在初模开口开口内喷油）或乙炔裂解的涂油机器人不适用于吹吹工艺。

运行中的 BlankRobot。

结果

最终，数据将决定自动涂油性能。参照在不同客户处的吹吹工艺中 BlankRobots 的日常运作，XPAR Vision 达到了 2018年玻璃科技展会引入该设备概念时设置的期望值。总而言之，当时设置的期望目标是为了提供有效的自动涂油，结果延长了涂油间隔。

在成型过程中降低涂油涂油间隔会减少的涂油循环的干扰，能提升成型过程的稳定性和效率，使玻璃瓶罐质▸

量更好。此外，成型过程的稳定性能够对生产工艺进行改善，以更高速率生产出更轻的产品，同时满足客户的需要和要求。

相较于 其它竞争性涂油机器人或手动涂油的 20 – 30 分钟或更短的时间，使用BlankRobot 的自动涂油客户在吹吹工艺中的涂油间隔为 120 分钟。 这验证了 BlankRobot 概念；通过涂油减少热端损失而获得工艺稳定性及直接财务收益。

从质量角度，因落料印而导致在冷端的平均剔除率与人工涂油相等或更好，而玻璃分布（壁厚变化）明显改善。

初模涂层

除了对制瓶和成型过程的积极影响，评估对生产方式的影响也很重要。这里有一个重要因素就是可以提升（初模）模具套件有效使用时间。经验显示，至少初模使用的持续时间相等，这意味着对初模的寿命没有负面影响。

此外，出乎意料之外的是，使用中发现了 BlankRobot 自动涂油的积极的副作用。以往用手动涂油来给初模涂料以保持使用时间的客户，现在在吹吹工艺中只使用抛光的初模。涂料成本得到了节约，但或许更重要的是，不再需要使用有害物质涂料，从而不再损害模具车间工人的健康和安全，以及污染环境。

总结

使用 BlankRobot 进行日常运作的客户经验证实了该概念：当使用 BlankRobot 的专门应用技术以专用的方式使用 LubriGlass 的特殊润滑剂时， 在考虑积极副作用的情况下，可以达到甚至超过期望值。相较于手动涂油或其它类型机器人涂油间隔最高才到 30 分钟来说，BlankRobot自动涂油机器人涂油间隔可以提高到 120 分钟。

通过涂油减少的热端损失获得工艺稳定性，并直接降低瓶子重量，提高了生产效率，从而获得直接财务收益。

下一步

吹吹工艺的动作和压吹工艺及口部涂油的动作都不同。在后面的文章中，作者将讨论（小口）压吹生产及口部油经验的影响上。●

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冲头和冷却器专业生产商庆祝成立50周年

玻璃容器行业领先冲头和冷却器制造商 Hunprenco 公司在2019年庆祝成立50周年。英国公司创始人兼总裁Eddie Neesom，因其对北约克郡乡村经济-出口服务的贡献，近期被授予MBE（大英帝国最优秀勋章），他介绍了 Hunprenco 公司的起源和随后的国际成功。

GW: 您早期的工程职业生涯是如何开始的？

1947年离开学校后，我在布拉德福德的英国电器公司开始了为期5年的学徒生涯，事实证明这是一个良好的基础。接着我在皇家工程兵部队服役两年，然后回到了英国电气公司。我从公司的装备检查工作其，从事拆卸零件并检查的工作，随后便晋升为公司飞行器部的工艺工程师，这是一个了不起的工作。之后，我进入了钢铁行业，曾经为好几家先进的钢铁公司工作过。

GW: 您是如何进入玻璃行业的？

我当时还是钢铁行业的一名技术销售代表，但我的业余爱好是在废弃的马厩里进行机械加工和工程设计。一次与Rockware Glass （现为 Ardagh 集团旗下）代表偶然会面讨论到了公司在采购优质冲头方面面临着重大挑战。最开始时，他们希望我返修他们的冲头，因为现有冲头不符合他们的要求；这对他们来说已经是一个急迫的问题。虽然我那时的工程和机械加工的专业水准很高，但我对玻璃行业的了解十分有限...而且他们只给我48个小时来思考解决方案！

当时有模具制造公司供应冲头，但柱塞只是他们的产品组合的一部分，而非专业冲头制造商。那时，他们的做法也就是手工给冲头除去涂层并重新喷焊；这有点过时了，所以我们开始制作模板来完成并加工这些零件。我一直都是一个愿意谨慎冒险的人，我们在人员和机器上进行了大量的投资。这些并不是新技术，但确实真正需要一家专门的公司来将旧冲头重新加工成高标准冲头。我们可以立即为客户节省大量成本。

GW: 公司拓展以满足客户的需求的速度有多快？

1969年成立时，公司命名为 Hunmanby Precision Engineering Co，但那太拗口了，所以我把它简化为Hunprenco。随着人员逐渐增加，有两个玻璃行业的工程专家很快加入了我们的团队。

然而，寻找熟练的工程师以满足我们的标准一直是一个挑战。早期时候，我在常规机器而不是计算机机器上对他们进行内部培训。我白手起家，当订单开始源源不断时，我们必须快速发展。时至今日，我们成为玻璃瓶行业全世界最大的冲头和冷却器制造商。

在占地6200平方米的两个制造工厂中，有一支115名员工组成的团队，由熟练的机械师和冶金学家组成，他们对玻璃容器制造的生产方法有着丰富的知识。

GW：客户群增长有多快？

我们迅速建立了良好的声誉，以合理的价格提供优质冲头，赢得了Beatson Clark 等其他英国客户，然后业务开始增长。海外订单是当时很重要的下一步行动，带来了很多挑战和机遇。所有的机会都被评估，团队成员们开始拜访在我们在欧洲找到的潜在客户， 从 PLM （现也是Ardagh 集团旗下）拿到订单，接着关于我们解决方案的消息开始传播开来。但成功并不是一蹴而就的，我们曾多次重复拜访同一家工厂。一些客户是我们的长期服务对象，最初，我们就向他们展示了我们提供高质量的能力。随着客户开始了解我们并被我们的解决方案说服，业务也不断持续增长。

以前，通过航空寄任何东西风险都很大，我们所有的技术都是通过公路发送到欧洲。在很多方面，当时的交货期要求不像今天那么严格。如今有25%的业务来自欧洲，75%来自世界其他地方，客户仍然可以完全依赖 Hunprenco 及时提供优质产品。

GW：业务什么时候扩展到欧洲以外的？

成功的故事很多，我们向欧洲的扩展为向更多区域销售提供了平台。我们与一家日本公司取得了业务往来，然后进军澳大利亚和中东市场，继续以质量为基础进行销售，同时关注价格和交货期。

GW：随着产品组合和业务增长，您的工程方法有什么发展？

从最初到现在，我从未犹豫过投资新机器和技术；所有机会都被评估，如果对我们有优势，我们就进行相应投资。采用最新的方法和技术一直都是正确的做法，这些原则也是公司走到今天，以及能迈向未来的原因。

我们用最新科技引进了机械加工方法，使得流程比使用老机器更高效更快。 这包括了各种不同类型的喷涂材料，机械及切割工具，希望以更好的质量更高效的工作来保持竞争优势。生产中使用了许多最先进的工艺，包括检验、CNC 技术、 CNC 雕刻、研磨和抛光、CNC 微钻和型锻。

但即使在50年前，手动喷焊冲头仍能生产出高质量的产品。当1970 年代后期引入 轻量化瓶用模具（NNPB） 时，对那些涂层能更好地粘结到基础材料上的冲头的需求更大。随着此方向更深入地发展，在经过 O - I 试验后，我确信我们应该走机器人路线，并在进行了最初投资显示冲头没有气孔之后，Hunprenco 现在拥有了6个机器人。如今没有一个冲头需要手动喷涂，全部经 HVOF（高音速）喷涂，品质达到最高标准。

很多年前，珩磨机是根据我们具体要求进行内部设计的。时至今日，公司仍在使用一定数量这类设计的机器来确保达到最高标准的表面光洁度。这些精密的机器是Hunprenco特有的，有助于使我们独树一帜，成为行业领袖。

公司的主要活动现在集中在 NNPB ，PB，和 BB 作业的冲头和冷却器部门。我们还生产各种满足客户要求的精密机器部件。

GW：公司未来的投资方式是什么？

多年来，我们一直保持机敏，在正确的时间做正确的事...始终保持向前看，我们就是这样取得进步的。我们将继续进行明智的投资，但不局限于科技方面。 Hunprenco 近期投资了大量资金于企业资源计划 （ERP）系统 ，它将成为流程中的集成管理工具-收集，存储，管理和解析整个企业活动中的数据。这是一项重大投资，但在当今环境下，有必要更有效地管理业务方面。

GW：Hunprenco 如何投资于员工？

我们公司的座右铭是“你必须关怀他人”。这不仅仅适用于客户也适用于员工。 秘诀在于了解他人，以及为团队开发而投入是我们所有工作的核心。

科技发展如此迅速以至于在一定程度上，专有技术更少了...但你无法用其他东西轻易取代机械加工技能。秘诀在于有对的人和对的机器。 Hunprenco 为我们的员工和所拥有的技术感到十分自豪。

Eddie Neesom MBE 在废弃马厩中进行机械加工和工程设计的最初爱好，使得公司很快就能将一系列老柱塞翻新为高标准的柱塞，并且为玻璃行业的客户显著地降低了成本。

作为附近最大的雇主，我们目前雇用大约115名员工，其中包括熟练的机械师，冶金师和对玻璃容器制造生产方法有丰富知识的员工。

Hunprenco 是家族企业，在我87岁高龄之际，我仍然与我的妻子Marilyn一起，积极地投身到公司事务中。包括中美洲，南美洲以及亚洲的专家代理，团队的专业知识是首屈一指的，公司有能力继续前进。 但是，我们必须持续投资到下一代，因为他们代表了未来。 我们每隔几年成功地招聘学徒，尽管我认为国家政府和玻璃协会应该给予更大的激励。我对学徒制计划充满热情，为了玻璃行业的利益，我强烈鼓励行业的每个人齐心协力，使之更加具有吸引力，让像Hunprenco这样的公司开展学徒制。

GW：您如何看待公司未来的进一步发展？

近年来，Hunprenco目睹了Filey工厂的重大扩展。在2016年增加了冲头和冷却器部门的产能后，我们又扩大了该业务的精密工程部门。

我们建立了最先进的热喷涂部门，安装了包括HVOF和等离子喷涂等设备，以及传统的火焰喷涂设备。 这使我们公司能够提供多种高科技涂层，从碳化物到氧化物，以及其它行业的金属涂层，在这些行业中，磨损和腐蚀是影响部件寿命的主要因素。 为了辅助机构，我们还委托一个大型实验室对所有涂料的机械，结构和化学性质进行测试和审核。

公司现在有两家彼此靠近的制造工厂，占地 6200 平方米。我们获得了额外的楼房进行扩建，这使我们能重组并最大限度地提升效率。这里仍有许多可用的土地，未来还可以执行很多计划。●

Eddie Neesom MBE与他的妻子 Marilyn 一起，仍积极效力于家族企业。

Eddie Neesom MBE （大英帝国员左勋章获得者）开发了不同的制造柱塞的方法，并且在过去的50年中不断投资于新机器和技术，以保持Hunprenco在市场上的领先地位。

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如何有效提升能效，降低排放，同时兼顾产品质量与生产灵活性

无论生产何种玻璃制品，通常大多数窑炉由熔化炉、精炼炉/通路和冷却区组成。正如杰西卡·艾恩斯（Jessica Irons）提到的那样，文中的一些解决方案将有助于在工艺过程中降低排放并提升能效，同时兼顾产品质量。

玻璃制造是一个复杂且具有挑战性的工艺过程，需要消耗大量能源。随着人们越来越关注排放及工业应用中的能效问题，玻璃制造厂商也从能效和排放的细微改善中获益良多。

当然，大部分能量强度是源于制造工艺需要维持足够高的温度以保证产品的品质。因此，随着环保法规日趋严格，玻璃行业也更关注燃烧技术，希望在保证玻璃品质的同时减少氮氧化物的生成。

不管生产何种产品，通常大多数窑炉都由熔化炉、精炼炉/通路和冷却区组成。文中的一些解决方案将有助于在工艺过程中降低排放并提升能效，同时兼顾产品质量。

减少氮氧化物，提升能效

在熔化炉中，通过使用分级燃烧的技术并结合氧气来助燃，将有助于改善排放并提高燃烧效率。全氧燃烧带来的较高火焰温度会在大多数应用环境中有效提升热量和辐射热传递。较为典型的一些改进包括提升热效率，提高加工速度，提高产品质量，减少废气量和减少污染物排放。

霍尼韦尔Honeywell公司的Oxy-ThermFHR玻璃燃烧器（图1）利用一项获得专利的氧气分段技术来减少在高温窑炉中氮氧化物的形成。通过对氧气进行深度的分段控制，通常可将氮氧化物的浓度控制在低于传统富氧燃料燃烧器的浓度水平。通过减少总废气量，所生成的氮氧化物的总量通常低于空气-燃料燃烧的水平。

图2为Oxy-Therm LE - 氧气分级，锥形火焰燃烧器。

在蓄热式热熔炉应用中，能显著改善氮氧化物排放的是利用霍尼韦尔天时Honeywell Eclipse公司双气体喷射技术的Brightfire 200燃烧器。该产品的设计是通过一个燃烧器来喷射两股不同的气流，从而抑制氮氧化物的形成，同时改善火焰调节。它的设计目的是改善热传递，降低能耗；减少氮氧化物排放；改善易用性、安装和调节操作；同时提高了火焰调节和性能的灵活性。

在某一应用案例中，在大型浮法玻璃窑炉上使用底烧结构的Brightfire 200燃烧器，与马蹄焰窑炉和横火焰窑炉上的其他燃烧器相比，氮氧化物含量减少了15%-25%。在另一应用案例中，在马蹄焰窑炉上的氮氧化物含量大幅降低，氮氧化物降幅大于20%，并且达到了该应用案例所要求的小于550mg/Nm3的目标。图3为带有安装支架的Brightfire 200燃烧器。

调节火焰特性和改变熔化炉内热点释放位置的能力在能效方面已显示出极大的优势。在某一瓶罐窑炉的案例中，玻璃下方的电助熔设备减少了10%以上，天然气用量略有减少，同时对产品不产生影响。

下一代通路技术

在瓶罐窑炉和玻璃纤维窑炉中，通路是确保玻璃具有适当温度和稠度的关键步骤，以便可以制成特殊的容器形状（例如酒杯和啤酒瓶），或制成用于隔热的细纤维材料以及结构部件。

通路燃烧器具有先进性能的关键在于，通路通道的宽度范围内配备了合适数量的燃烧器，具备使玻璃维持在适当温度的相应能力，具有适合燃烧室的正确火焰长度以及正确的燃烧器/耐火砖组合设计。

图1：Oxy-Therm FHR可调氧气分级，平焰燃烧器。

图2：Oxy-Therm LE氧气分级，锥形火焰燃烧器。

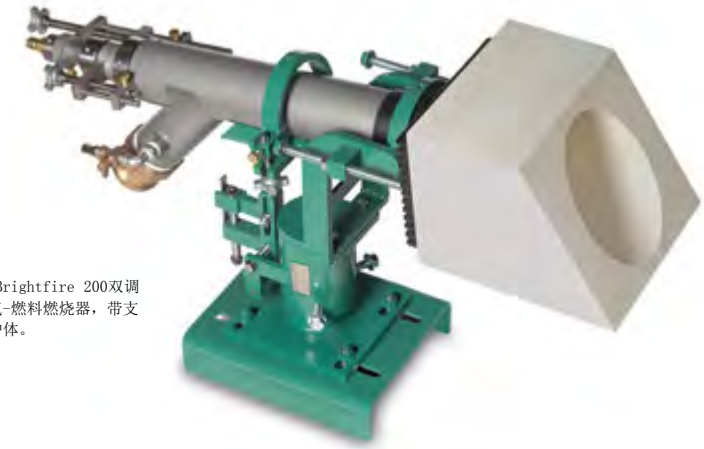

图3：Brightfire 200双调节空气-燃料燃烧器，带支架和炉体。

图4：全新的Primefire FH通路技术（前排右侧）对比上一代技术（后排左侧）。

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正确的燃烧器/耐火砖组合设计有助于保证燃烧器的燃烧性能，减少所需的维护工作，延长燃烧器/耐火砖产品寿命。由于通路应用案例可使用多达数百个燃烧器，因此使用最新技术来保证生产过程的完整性和产品的质量至关重要。PrimeFire FH（图4）是采用霍尼韦尔Honeywell公司全新一代纯氧通路技术的燃烧器产品。它具有正在申请专利的独到的燃烧器/耐火砖组合设计，可实现所有上述目标，无需进行维护，使用寿命比上一代技术延长50%。此外，根据应用案例的不同，确切的排放性能可能会有所不同，但与纯氧燃烧与空气-燃料燃烧相对比，排放量减少了80%，燃烧效率提升了60%。

图5：SER自预热式单端辐射管燃烧器用于锡槽辅助加热

通过边缘加热保持产品品质

在浮法玻璃窑炉中，一个关键步骤是锡槽加热，玻璃在该锡槽中漂浮于熔化锡床上，从而可以生产出无缝、平坦、高品质的玻璃板。较难控制的区域是边缘，因为边缘更容易冷却。这可能会导致玻璃出现质量问题，而且在最坏的情况下，生产可能会停滞，通常增加电加热元件为窑炉提供更多的热量。

但是，通过使用高能效的自预热式辐射管燃烧器，玻璃制造商可以使用不同形式的辅助加热装置，而且该辅助加热装置可在窑炉运行时进行安装，同时这有助于显著提高温度均匀性，即使在边缘区域也是如此。此外，还可防止生产停滞，防止造成产品损失，如图5所示。

复杂性和灵活性

在浮法玻璃应用中，有时在窑炉的工作部需要更多的热量。这可能会给制造过程增加复杂性，因此可将霍尼韦尔Honeywell公司的一体式高速ThermJet燃烧器安装在带有集成控制装置和助燃空气的推车上，并可将其放置于现场，以便在需要时进行加热或协助清洗蓄热室硫酸盐。该燃烧器配有一个特殊的锥体，此锥体安装在一个带有完整控制面板、鼓风机、软管和安全装置的推车上，因此可以很方便地在工厂附近搬运，以满足工厂的需要。

该系统（图6）包括空气和燃气软管，用于在远离燃烧控制推车的位置来远程安装燃烧器。推车上包括助燃空气鼓风机和天然气系统，此系统包含火焰监测和点火组件。该解决方案不同于承包商所提供的常见加热解决方案，后者需要7×24小时人工监控，而且可能没有全套的安全功能。

图6：移动式Heat up加热系统。

结论

玻璃行业，由于能源成本的上升，排放及产品质量要求的提高，以及不断变化的生产需求，因此，开发具有更低能耗和排放，并且具有高度灵活性的加热系统已成为关注的焦点。

高效、高速工业燃烧器的出现使玻璃制造商能够优化加热应用方案，包括边缘加热、工作部/澄清和窑炉烘炉。

纯氧燃烧器、分级燃烧器、双燃料入口空气-燃料燃烧器和高速炉燃烧器代表了工业燃烧器技术的最新进展，这些技术包括提升了热传递从而降低能耗；减少了氮氧化物排放；便于使用、安装、调节和维护；提高了火焰性能的灵活性。●

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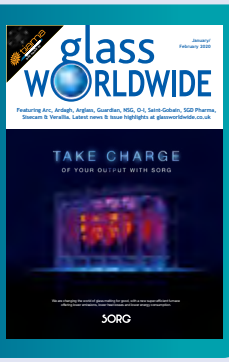

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