Vol. 7 | No. 3 | October - December 2019

Kañch

Quarterly Journal of **The All India Glass Manufacturers' Federation**

Bi-lingual

Special Feature

Upcoming Events

(Page # 18)

Main Story

glasspex & glasspro: Creating a New Story on the Growth Path

AIGMF's 13th International Conference on Glass Industry 4.0

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PHARMAPACKAGING

PREMIUM QUALITY REFLECTED IN GLASS

GLASS TUBING

GLASS TUBING COMPLIANCE

- ARSENIC EXTRACTIONS
- ASTM 438-90
- JP
- USP
- EP

Nipro NSV51
Clear Borosilicate Type I Exp. : 51

Nipro BSA60
Amber Borosilicate Type I Exp.: 60

Nipro W33
Clear Borosilicate Type I Exp. : 33

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Nirmal Glasstech Industries

'Nirmal Glasstech Industries' feels immense pleasure to host the Executive Committee Meeting of AIGMF on March 21, 2020 at Jaipur.

All Members are requested to participate in the special session on *'Investment Opportunities in Rajasthan'*

Largest Manufacturer & Exporter In India

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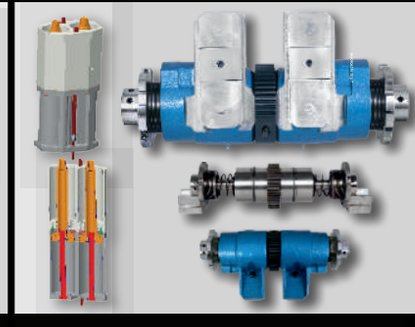

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Quarterly Journal of Glass Industry, published and printed by Vinit Kapur on behalf of The All India Glass Manufacturers' Federation from 812, New Delhi House, 27 Barakhamba Road, New Delhi – 110001 and printed at New United Process, A-26, Ph-II, Naraina Indl. Area, New Delhi-110028

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Editor MOHAN LALVANI

Complimentary copy for Members / Government Departments / NGO's and those connected with Glass Industry

Others: Price (excluding bank charges):

Indian Companies : ₹ 125 per copy
Annual Subscription ₹ 450

Foreign Companies : US$ 25 per copy
Annual Subscription US$ 80

Kañch

Quarterly Journal of **THE ALL INDIA GLASS MANUFACTURERS' FEDERATION**

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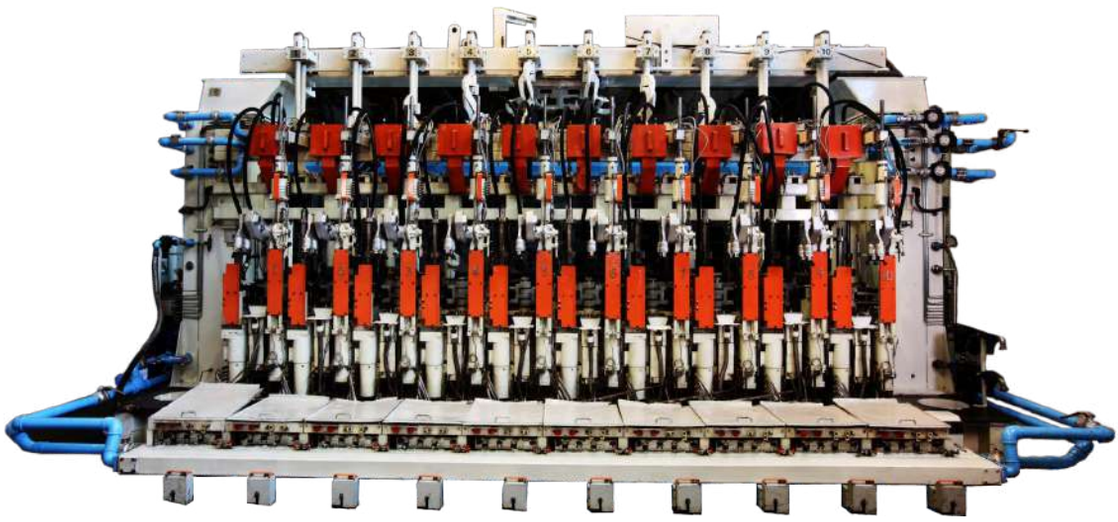
Contents

Shamvik Glasstech

Serving the Glass container industry since **1973**



Our Product Range

I. S. 10 Sec. Machine

Mechanical:

- I.S Machines
- Ware Transfer ★ Stacker ★ Feeder
- Spares for above.

Electronic:

- € - Timing System with Valve Blocks.
- Multi motors Inverter Drive ★ € - Pusher with PLC.
- Spares for above.

I. S Parts, Variables, Mechanisms

- Gob Distributor ★ Neck Ring mechanism (std. & Anti backlash)
- Quick Change Plunger mechanism
- Cams for Funnel, Baffle & Blow Head mechanism
- CC Invert & Take Out mechanism with upper & lower cushion cartridges
- Delivery equipments: (Scoop, Trough & Deflector) for 4¼", 5", 5½" & 6 ¼" cc for SG, DG 85 mm, 3", 3 5/16" & 4¼" cc TG M/c.
- Variables: 4¼" & 5", 5½" & 6 ¼" cc for SG & DG, 85mm, 3", 3 5/16" & 4¼" cc for TG M/c.
- Oil immersed MOC Linkages,
- Blow Mould Cooling mechanism & Vacuum on Blow side.
- ON/OFF Control Valve on Blank Side
- Pneumatically controlled individual Wind Cooling System
- Conversion Kits: (I) Feeders from 944 to 994 with 360° differential (81 type)
  (II) I.S M/c. from SG to DG & vice versa

ISO 9001 : 2008 CERTIFIED COMPANY

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From President's Desk

On an invitation by the Secretariat, VITRUM 2019 (*International Trade Fair for machinery, equipment and systems for flat and hollow glass, glass and finished products for the industry*), I participated at Fiera Milano, Italy from Oct 1-4, 2019. The 2019 edition saw Vitrum's role as the "Home of Associations" strengthened, again offering Associations participation for networking. AIGMF was amongst 22 Associations from 17 countries who participated with the cost of travel and lodging covered by the Italian Trade Agency.

Former Presidents: Mr. Sanjay Ganjoo, Mr. S C Bansal and Mr. Sanjay Somany released AIGMF 2020 calendars on the theme 'Adopt a Glass Bottle' at the Executive Committee Meeting held on Dec 21 at Hotel Lemon Tree, Delhi. Calendars were sent to all mainline Secretaries of GoI, Members of Parliament, AIGMF members, important official and Govt. contacts. Under CSR initiative and to mark Platinum Jubilee, AIGMF gifted 75 glass bottles with Swachh Bharat (clean India) logo to Hotel Lemon Tree.

Mr. S C Bansal, Executive Committee Member and Former President AIGMF; along with Secretary AIGMF handed over Budget representation to Mr. Gopal Krishna Agarwal, National Spokesperson of the Bhartiya Janata Party (Economic Affairs) at BJP Headquarters on January 7. Mr. Bansal also presented a glass bottle with Swachh Bharat logo and 'Adopt a Glass Bottle' themed AIGMF calendars along with Glass News and Kanch.

AIGMF participated as a supporting association in the Pac-process India and Food-pex India trade fair organised by Messe Dusseldorf (India). 9,925 visitors came to the Pragati Maidan exhibition centre in New Delhi from Dec 12-14 – around 2,000 more than attended the debut in India's capital two years ago. 201 exhibitors presented their offerings across a total of 11,400 sq. mtrs. AIGMF was allocated stall # 11G50 from where it distributed special issue of Kanch, Glass News and Glass Bottles with Swachh Bharat logo to all exhibitors and select visitors.

The 6th edition of glasspex INDIA & 3rd edition of glasspro INDIA, organized by Messe Dusseldorf (India) in conjunction with Glass Bulletin was held from October 10-12, 2019 at Bombay Convention & Exhibition Centre, Mumbai. glasspex INDIA & glasspro INDIA witnessed the participation of 195 companies from 14 countries, bringing together 5,547 trade visitors and 150 conference delegates. The key highlight of glasspex INDIA was the AIGMF's 13th International Conference on Glass Industry 4.0, which was supported by the Glass Worldwide Magazine and powered by VDMA & Messe Dusseldorf (India). The two-day AIGMF Conference hosted 15 sessions and three additional Q&A sessions that brought together stakeholders of the industry on a single platform, allowing the exchange of ideas that added value to Indian glass ecosystem at large.

Next Executive Committee meeting (*to be hosted by M/s Nirmal Glasstech Industries, Affiliate Member of AIGMF*) is scheduled to be held on March 21 at Hotel Taj: Jai Mahal Palace, Jaipur. Apart from Industry interaction and a special session on investment opportunities in Rajasthan, a touring exhibition on 'Adopt a Glass Bottle' would-be put-on Display. I invite all members to participate and be a part of interesting discussions ■

President AIGMF

President U.P. Glass Manufacturers' Syndicate (UPGMS) **and**

Managing Director– Mittal Group of Glass Industries, Firozabad

THE 12th WORKSHOP FOR NEW RESEARCHERS IN GLASS SCIENCE AND APPLICATION

ICG
International Commission on Glass

GLASS FORMATION, STRUCTURE, AND PROPERTIES
&
Rheology: viscosity and relaxation

MONTPELLIER (France), 6th-10th JULY 2020

The workshop will be composed of two interwoven threads.

The first thread will overview fundamentals in glass science emphasising structure-property relationships, experimental techniques, material simulations and tools that probe structure. Specific properties and applications will be discussed e.g. optical behaviour, transport phenomena, nucleation and crystallisation, and strength.

The second thread will focus on the viscosity of commercial and geological glass forming melts, measurement methods and models to describe the temperature and composition dependence. Next viscoelastic behaviour near the glass transition, T_g will be described, particularly in the context of glass fabrication processes such as fibre making and pressing.

The lecturers will be world experts in their fields. A significant aspect of the workshop will be student-centred projects that will help participants to develop their understanding by applying what they know to specific issues.

Organization: **Prof. J. M. Parker,** University of Sheffield, UK
Prof. B. Hehlen, University of Montpellier, France
Prof. R. Conradt , uniglassAC GmbH Co., Germany

Is this for you ?

If you are a new PhD or Masters student or have recently started research in the glass industry then the answer is yes.

- Normal fee: 900 €
- Reduced fee: 350 € for students and academic staff.

The fee includes 2 coffee breaks and a lunch per day, a welcome reception and conference dinner.

- Lodging and meals : 250 €

The fee includes 6 nights lodging with breakfast in a student residence at the University. Final date for lodging reservation is 15/05/2020.

- The textbook of the Montpellier summer school (recommended) : "*Teaching Glass Better*": 45 € (10% discount)

A programme and more detailed instructions concerning travel and the accommodation will appear on the ICG web site. (www.icglass.org)

Pre-registration: **Deadline 15 / 04 / 2020**
By simple email to: **verres2020@mycema.fr**
Registration: **Deadline 15 / 05/ 2020**

Participants will be limited to:
50 in total with no more than
20 For Glass Rheology

cnrs

LABORATOIRE CHARLES COULOMB MONTPELLIER

GLASS News

PRE-BUDGET CONSULTATION-2020 – STAKEHOLDERS' DIALOGUE

Mr. S C Bansal, Executive Committee Member and Former President AIGMF; along with Secretary AIGMF handed over Budget representation to Mr. Gopal Krishna Agarwal, National Spokesperson of Bhartiya Janata Party (Economic Affairs) at BJP Headquarters on January 7.

Mr. Bansal also presented a glass bottle with Swachh Bharat (clean India) logo and 'Adopt a Glass Bottle' themed AIGMF calendars along with Glass News and Kanch.

Stakeholder meeting comprised of representatives from FICCI, ASSOCHAM, CII, Delhi School of Economics, Glass/Cement/Steel/Solar/Wind/Textile/Labour Associations that lasted for almost 2 hours.

Calendars were sent to all mainline Secretaries of GoI, Members of Parliament, AIGMF members, important official and Govt. contacts

AIGMF 2020 CALENDARS ON THE THEME 'ADOPT A GLASS BOTTLE'

Former Presidents (L-R) Mr. Sanjay Ganjoo, Mr. S C Bansal and Mr. Sanjay Somany released AIGMF 2020 calendars on the theme 'Adopt a Glass Bottle' at the Executive Committee Meeting held on Dec 21 at Hotel Lemon Tree, Delhi.

Calendars are based on select drawings made by school children, on the theme of Glass Packaging being Environmentally Friendly and aiding the Swachh Bharat Abhiyaan (Clean India Campaign).

Under CSR initiative and to mark Platinum Jubilee, AIGMF gifted 75 glass bottles with Swachh Bharat logo to Hotel Lemon Tree on Dec 21

KEY HIGHLIGHTS OF UNION BUDGET OF INDIA 2020-21

Finance Minister Ms. Nirmala Sitharaman presented Union Budget of India on Feb-1.

Following are the key highlights:

- 150 higher educational institutions to start apprenticeship embedded degree/diploma courses by March 2021
- Rs. 27300 crore allocated for 2020-21 for development and promotion of Industry and Commerce
- **Customs Duty is being increased from 10% to 20% on household goods and appliances including glassware and glassbeads for creating a level playing field for MSME and promoting Make-in-India**
- Five new smart cities proposed to be developed
- Exporters to be digitally refunded duties and taxes levied at the Central, State and local levels, which are otherwise not exempted or refunded
- All Ministries to issue quality standard orders as per PM's vision of "Zero Defect-Zero Effect" manufacturing
- Rs.100 lakh crore to be invested on infrastructure over the next 5 years
- A single window e-logistics market to be created
- Focus to be on generation of employment, skills and making MSMEs competitive
- Rs.1.7 lakh crore proposed for transport infrastructure in 2020-21
- Delhi-Mumbai Expressway and two other packages to be completed by 2023
- Chennai-Bengaluru Expressway to be started
- Large solar power capacity to be set up alongside rail tracks, on land owned by railways
- High speed train between Mumbai and Ahmedabad to be actively pursued
- Expansion of national gas grid from the present 16200 to 27000 km's proposed
- Deposit Insurance and Credit Guarantee Corporation (DICGC) permitted to increase Deposit Insurance Coverage to Rs. 5 lakh from Rs. 1 lakh per depositor
- New and simplified personal income tax regime proposed:

Taxable Income Slab (Rs.)	Existing Tax Rate	New Tax Rate
0-2.5 Lakh	Exempt	Exempt
2.5-5 Lakh	5%	5%
5-7.5 Lakh	20%	10%
7.5-10 Lakh	20%	15%
10-12.5 Lakh	30%	20%
12.5-15 Lakh	30%	25%
Above 15 Lakh	30%	30%

  - Around 70 of the existing exemptions and deductions *(more than 100)* to be removed in the new simplified regime
  - Remaining exemptions and deductions to be reviewed and rationalised in coming years
  - New tax regime to be optional - an individual may continue to pay tax as per the old regime and avail deductions and exemptions
- Tax rate of 15% extended to new electricity generation companies
- Dividend Distribution Tax (DDT) removed making India a more attractive investment destination
- Start-ups with turnover up to Rs. 100 crore to enjoy 100% deduction for 3 consecutive assessment years out of 10 years
- Window for MSME's debt restructuring by RBI to be extended by one year till March 31, 2021

- Rs 22000 crore to cater to the equity support to Infrastructure Finance Companies such as IIFCL and a subsidiary of NIIF
- Turnover threshold for audit increased to Rs. 5 crore from Rs. 1 crore for businesses carrying out less than 5% business transactions in cash
- 100% tax exemption to the interest, dividend and capital gains income on investment made in infrastructure and priority sectors before 31st March, 2024 with a minimum lock-in period of 3 years by the Sovereign Wealth Fund of foreign governments
- Additional deduction up to Rs. 1.5 lakhs for interest paid on loans taken for an affordable house extended till 31st March, 2021
- Instant PAN to be allotted online through Aadhar

भारत सरकार का केंद्रीय बजट: 2020-21

केन्द्रीय वित्त मंत्री श्रीमती निर्मला सीतारमण ने संसद में वित्त वर्ष 2020-21 का केंद्रीय बजट पेश किया:

- 150 उच्च शिक्षण संस्थान मार्च 2021 तक अप्रेंटिसशिप युक्त डिग्री/डिप्लोमा पाठ्यक्रम शुरू कर देंगे।
- उद्योग और वाणिज्य के विकास एवं संवर्धान हेतु वर्ष 2020-21 के लिए 27300 करोड़ रुपये आवंटित।
- पांच नवीन 'स्मार्ट सिटी' विकसित करने का प्रस्ताव।
- उड़ान योजना के तहत 100 और हवाई अड्डों का 2024 तक पुनर्विकास।
- **एमएसएमई के लिए स्तरीय कार्यक्षेत्र के सृजन और मेक इन इंडिया को बढ़ावा देने के लिए काँच के बर्तन और काँच की मालाओं पर सीमा शुल्क 10 प्रतिशत से बढ़ाकर 20 प्रतिशत किया।**
- राष्ट्रीय गैस-ग्रिड को वर्तमान के 16200 से 27000 किलोमीटर के विस्तार का प्रस्ताव।
- बैंको द्वारा एमएसएमई के उद्यमियों के लिए सहायक ऋण प्रदान करने हेतु नई योजना:
  - –इसे अर्थ-प्रतिभूति के रूप में गिना जाएगा।
  - –एमएसएमई के लिए क्रेडिट गारंटी ट्रस्ट के माध्यम से पूरी गारंटी होगी।
  - –सरकार द्वारा तदनुसार सीजीटीएमएसई के लिए धन जुटाया जाएगा।
- भारतीय रिजर्व बैंक द्वारा एमएसएमई की ऋण पुनर्संरचना हेतु विन्डो को 31 मार्च तक एक वर्ष के लिए बढ़ाया जाएगा।
- विकास को गति प्रदान करने के लिए कर-ढांचा सरल बनाया गया, अनुपालन सरल बनाया गया और मुकदमेबाजी कम हुई।
  - व्यक्तिगत आयकर:

कर योग्य आय के स्लैब (रुपये)	मौजूदा कर दरें	नई कर दरें
0 से 2.5 लाख	छूट	छूट
2.5 से 5 लाख	5%	5%
5 से 7.5 लाख	20%	10%
7.5 से 10 लाख	20%	15%
10 से 12.5 लाख	30%	20%
12.5 से 15 लाख	30%	25%
15 लाख से ऊपर	30%	30%

  - मौजूदा छूट और कटौतियों (100 से अधिक) में से लगभग 70 को नये सरलीकृत प्रणाली में हटा दिया जाएगा।

- कारपोरेट बांडों में एफपीआई की सीमा को 9 प्रतिशत से बढ़ाकर 15 प्रतिशत किया गया।
- 15 प्रतिशत कर दर नई बिजली उत्पादन कंपनियों को प्रदान किया जाऐगा।
- होल्डिंग कंपनी को उसकी सहायक कंपनियों से प्राप्त लाभांश के लिए छूट की अनुमति।
- 100 करोड़ रुपये तक के कुल कारोबार वाले स्टार्ट अप को 10 वर्षों में से लगातार तीन आकलंन वर्ष के लिए 100% छूट का लाभ।
- ई-सॉप्स पर कर भुगतान से राहत।
- एमएसएमई से कम नकदी वाली अर्थव्यवस्था को बढ़ावा देने के लिए कुल कारोबार की उच्चतम सीमा में पांच गुना वृद्धि करके मौजूदा एक करोड़ रुपये से 5 करोड़ रुपये करने का प्रस्ताव। यह वृद्धि केवल उन व्यवसायियों के लिए प्रयोज्य होगी जो अपने व्यवसाय संबंधी लेनदेन में 5% से कम नकद का प्रयोग करते हैं।
- आधार के जरिए तुरंत पैन का ऑनलाइन आवंटन।
- 1 अप्रैल 2020 से परीक्षण के तौर पर सरलीकृत विवरणी का क्रियान्वयन किया जाएगा। इस विवरणी को फाइल करना आसान बनाया जाएगा। इसकी विशेषताओं में शून्य विवरणी के लिए एमएमएस आधारित फाइलिंग, विवरणी पूर्व फाइलिंग उन्नत इनपुट कर केंद्रित प्रवाह और समग्र सरलीकरण संग्रह।

MASCOT ENGINEERING CELEBRATES GOLDEN JUBILEE

On Oct 9, Mascot Engineering Company commemorated the company's 50th Anniversary by staging a dinner and cocktail reception at Planet Godrej, Mumbai. The event was well attended by a cross-section of the Indian glass industry and Mascot's European principals.

Founded in 1969 by its Chairman, Mr. Mohan Lalvani, Mascot Engineering Co., is among a select group of organisations representing leading international equipment and materials suppliers to the Indian and Sri Lankan glass manufacturing industry. Today, the company represents many leading suppliers from Germany and other European countries including Accuramech, Ambeg, EME, Guangzhou Ling Nan Refractory Co. Ltd., IMACA, Pennekamp, Optical Inspection System, PD-Refractories, Rosario c2c and SORG.

MASCOT is a one stop shop for Soda Lime Glass and specialty glass like Borosilicate, Opal, Fiber, Lead Crystal, Pyrex, Silicate Glass. It provides turnkey solutions for Container Glass, Tubing, Flat Glass, Tableware, Fiber Glass and Opal ware.

AIS FELICITATES ARCHITECTS AND DESIGNERS OF TOMORROW AS IT ANNOUNCES WINNERS OF THE 1ST AIS GLASS DESIGN OLYMPIAD

Asahi India Glass Limited (AIS), India's leading automotive and building glass company, offering end-to-end solutions across the automotive and architectural glass value chain has always believed in reshaping the architectural landscape.

AIS had recently launched the first edition of 'AIS Glass Design Olympiad' (GDO), which is aimed at students from reputed architectural institutes in Mumbai and Ahmedabad. AIS GDO is a great opportunity for architectural students to showcase their talents on a large industry platform.

After receiving an overwhelming response from the institutes and the students where many entries were received, AIS and its esteemed panel of judges were finally able to unveil the winners in a star studded showcase held on Jan 25, 2020 at Fortune Select Exotica, Mumbai, held in the presence of leading architects from the industry - Ar. Prem Nath of Prem Nath and Associates and Ms. Mala Singh MD, PEC Greening India, one of the country's leading Green Building and Sustainability Consultants.

The awardees were as follows: 1st Prize: Ms. Divyanshi Gupta & Mr. Chaitanya Joshi (team) – Bharati Vidyapeeth College of Architecture, Navi Mumbai; 2nd Prize: Ms. Michelle Chokshi – SAL College of Architecture, Ahmedabad and 3rd Prize: Ms. Swara Ganatra - SAL College of Architecture, Ahmedabad.

The winners received exciting cash prizes and trophies from AIS.

Speaking at the occasion Mr. Vikram Khanna, COO – AIS, said "It's been an honour and privilege for us to organize AIS Glass Design Olympiad. I would like to take this opportunity to thank all the eminent architects who helped us curate this event. I am sure we will take the future GDOs to new heights. I would also like to thank Ms. Mala Singh and Ar. Prem Nath – our Chief Guest for the day, for their presence at this event."

Ar. Vivek Bhole, Curator – GDO said, "It was great associating with AIS GDO as a Curator. I thoroughly enjoyed this journey with AIS team and hope to be part of many more GDO events in future."

Ar. Prem Nath, who was Chief Guest at the GDO Finale said, "I congratulate AIS on putting up an event like this, which helps budding architects of tomorrow to showcase their talents in front of industry leaders."

AIS will help the students and their projects get good exposure across the platform to facilitate a good name in some key architectural firms.

SCHOTT KAISHA ADVANCES TOWARDS INDIA'S PHARMA VISION 2020 WITH ITS BRAND-NEW PLANT IN HIMACHAL PRADESH

October 23, 2019: In an endeavour to make India a global leader in the pharma sphere and Himachal Pradesh the country's next "Industrial Hub", SCHOTT KAISHA, the premium manufacturer of glass pharma packaging products is setting up yet another manufacturing facility in the country, it's very first in Himachal Pradesh. The Indo- German joint venture had recently signed an MoU with the Himachal Pradesh government for setting up its most advanced facility, in order to especially cater to the demands of the growing northern market.

During the Domestic Roadshow under the 'Rising Himachal Global Investors Meet' in Chandigarh, the MoU was signed between SCHOTT KAISHA and Mr. Jayram Thakur, Hon'ble Chief Minister of Himachal Pradesh. Himachal Pradesh is ranked third amongst global pharmaceutical hubs, manufacturing more than 150 bulk drugs and exporting to over 200 countries. SCHOTT KAISHA recognising the state's contribution to pharma sector, plans to invest over INR 50 crores on the plant to set up production capacity of 360 million ampoules and 70 million vials. The plant is expected to be operational by April next year.

Medicine spending in India is projected to grow 9-12 per cent over the next five years, enabling India to become

one of the top 10 countries in terms of medicine spending. SCHOTT KAISHA, with its existing plants in Daman and Gujarat, is a preferred partner for most of the leading pharmaceutical companies in India, due to its 'best quality for users all over the world' ethos.

The new plant in Baddi would further add to SCHOTT KAISHA's overall production capacity of three billion pieces of primary pharmaceutical packaging products. The plant would also lead to job creation in the industrial area as SCHOTT KAISHA plans to employ around 100 people within the first few months.

Discussing about his current investment in the state, Mr. Rishad Dadachanji, Director of SCHOTT KAISHA, said "Pharmaceutical Packaging is a growth area in India and Baddi is home to many pharmaceutical companies, including some of our key clients. In fact, the state meets 35 per cent of demand for pharma products in Asia. In the past few years, Himachal Pradesh has done exceptionally well in attracting investments to build a concrete industrial base for the pharma sector. Being a pioneer in the field of pharmaceutical glass packaging, SCHOTT KAISHA looks forward to set up its gold standard manufacturing processes in the region, and strengthen the state's efforts but not only setting up a plant but also by producing products which meet the global standards."

Indian healthcare sector, one of the fastest growing sectors, is expected to cross US$ 372 billion by 2022. In fact, India's pharmaceutical exports stood at US$ 17.27 billion in 2017-18 and are expected to reach US$ 20 billion by 2020.

This move also comes at a time when the domestic market is increasingly facing a threat posed by low quality pharma packaging products. SCHOTT KAISHA recognises the need for quality products in a price sensitive market, and thus, has always been a frontrunner in introducing new and innovative solutions. This year, the company hosted over 500 customers, partners and prospects through a 5-city roadshow across India to discuss latest technological innovations and trends. SCHOTT KAISHA's current and upcoming investment strategy for India is based on growing together with the industry and involving the entire supply-chain in its pursuit to bring top notch innovation in the domestic market.

PACPROCESS & FOODPEX INDIA HELD IN DELHI

The All India Glass Manufacturers' Federation participated as a supporting association in the Pac-process India and Food-pex India trade fair organised by Messe Dusseldorf (India).

9,925 visitors came to the Pragati Maidan exhibition centre in New Delhi from December 12-14 – around 2,000 more than attended the debut in India's capital two years ago. 201 exhibitors presented their offerings across a total of 11,400 sq. mtrs.

At the second Packaging Design, Innovation and Technology conference (PDIT2), 35 speakers offered visitors a substantial wealth of knowledge. The topics ranged from packaging design and sustainability to smart packaging. India is also affected by the growing pressure on the industry to ensure packaging is recyclable and reusable. At the same time, the food industry benefits from more sustainability thanks to the increasing use of packaging that extends shelf-lives, reduces food waste and increases food safety. PDIT2 aspired to provide sound information on each topic and to avoid superficial sales presentations. The conference was organised by IPP Star in cooperation with the Active & Intelligent Packaging Industry Association (AIPIA) and in its second year, PDIT2 was held in New Delhi for the first time.

Pac-process India and Food-pex India events were supported by a wide range of associations, some of which are national, among them the Authentication Solution Providers' Association – ASPA, the Plastics Machinery Manufacturers Association of India – PMMAI, **The All India Glass Manufacturers' Federation – AIGMF,** the Trade Promotion Council of India – TPCI, and the Indian Paper Corrugated & Packaging Machinery Manufacturers' Association – ICPMA. International associations are also involved, among them the VDMA, the Metal Containers Manufacturers Association – MCMA, Flexible Packaging Europe, the Istanbul Chemical & Chemical Product Exporters' Association – IKMIB, the Global Aluminium Foil Roller Initiative as well as amec envasgraf and CCPIT.

AIGMF was allocated stall # 11G50 from where it distributed special issue of Kanch, Glass News and Glass Bottles with Swachh Bharat logo to all exhibitors and select visitors.

EUROPEAN GLASS PACKAGING INDUSTRY TO BOOST EU GLASS COLLECTION FOR RECYCLING TO 90% BY 2030 AND "CLOSE THE GLASS LOOP".

The European glass packaging industry sets in motion "Close the Glass Loop" - a major stewardship programme to boost glass 'collection for recycling' rates to 90% by 2030 in the EU. The move comes as a proactive response to new EU rules to increase net recycling targets for glass packaging to 75% by 2030.

Today, over 76% of glass packaging placed on the European market is collected for "bottle to bottle" recycling, already putting the circularity of glass in a league of its own.

Industry CEOs have unanimously agreed to set up the "Close the Glass Loop" programme with the common ambition to achieve an EU-wide 90% collection for recycling target for glass packaging by 2030. The programme will be shaped in the coming months with value chain partners, with initial discussions on collaboration already underway. The official platform launch is planned in June 2020.

"Our goal is to keep increasing the sustainability credentials of the glass packaging solutions we provide to our customers and consumers," stated FEVE President Mr. Michel Giannuzzi. "We are proud to lead 'Close the Glass Loop', an industry-wide initiative that will have real benefits for the market and our planet alike: it is our call for action to deliver an ambitious Circular Economy Action Plan for glass."

This initiative will bring together the different stakeholders of the glass collection and recycling loop under a common European platform with a twofold objective of closing the collection gap and improving the quality of recycled glass (cullet), so that resources remain productive in a bottle-to-bottle manufacturing loop. More availability of good quality cullet means a more resource-efficient production process, providing a premium level, safe and truly recycled packaging material.

It all starts with collection. The "Close the Glass Loop" programme will boost collection and involve the many committed European and national partners, from municipalities, to glass processors and industry customers, including the Extended Producer Responsibility schemes operating across EU Member States. "To be successful, we need to work locally in every EU Member State, while sharing best practices and raising ambitions via a European platform. We don't believe in a single European model for glass collection, but we do believe in a single ambition," stressed Mr. Michel Giannuzzi.

"We are very proud to have been able to set the foundations for such an ambitious programme, which has a very strong support inside the membership and perfectly matches the objectives of both the UN Sustainable Development Goals (SDGs) and the European Green Deal of the new European Commission," stated Ms. Adeline Farrelly, Secretary General of FEVE.

The production of glass packaging for food, beverages as well as in the pharmaceutical, perfumery and cosmetics sector with an endlessly recyclable, reusable and permanent material translates to less consumption of natural resources, less waste and less use of energy in line with the Sustainable Consumption and Production Goal (SDG 12). At the same time, glass recycling directly allows the industry to dramatically reduce energy consumption and CO_2 emissions, in line with the Climate Action Goal (SDG 13).

AGI GLASPAC TO INVEST MORE IN TELANGANA

Container glass manufacturer AGI glaspac, the packaging products division of Hindustan Sanitaryware & Industries Ltd., is investing about Rs. 150 crore for upgrading technology at its two plants in Telangana.

This will allow the company to make light-weight and contemporary glass containers and consumer products, said Mr. Rajesh Khosla, its President and Chief Executive Officer.

The company has been in operation since 1972. It's Bhongir unit has a capacity to melt 1,000 tonnes per day and the one in the city at Borabanda has a capacity of 600 tonnes per day. "We are using full capacity at both

the units. We are investing about Rs. 150 crore to upgrade technology. This will allow us to make lightweight and contemporary products, which are seeing a rise in demand," he said adding the ongoing spend will be completed by April this year.

The company is also working to increase the use of recycled component to about 75 per cent gradually from the current 35 per cent. "We are hoping to up recycled component to about 50 to 60 per cent in two years. The recycling in the industry now is low mainly because glass containers are with consumers and getting them back into the system is not economical," he said adding that consumers disposing them right can trigger an economic cycle.

"Glass is not dead. For instance, some plastic and stainless steel containers are prone to leaching effects. These concerns are forcing some to think on sustainable options," said Mr. Khosla adding that many are looking at total cost involved including for disposal and recycling into account while selecting containers.

"There are some overlapping areas for plastic and glass. There is possibility some people will shift for glass and we will continuously try to up this percentage," he said adding glass seeing innovation on design, on weight, colouring and aesthetics is also aiding in demand rising.

The company is working with a few international firms for recycling the bottles in the beverage segments. "We can use some additives that will make a container anti-bacterial. We are working on this. In times to come, there is a possibility of technology also coming into play. The glass containers can have a QR code or a chip which can tell if the contents in them have expired or indicate where they are in the recycling chain. These are just concepts as of now and no such products exist now," said Mr. Khosla.

The company employs about 3,500 people directly and 10,000 indirectly. It now counts beer and liquor manufacturers, pharma manufacturers, food players, soft drinks and others as its clients. Indian apart, it ships products to North America, Europe, Africa as well as APAC regions.

SCHOTT INAUGURATES NEW PRODUCTION FACILITY AT ITS GUJARAT PLANT, PRODUCTION CAPACITY TO INCREASE BY 50%

On Nov 29, SCHOTT AG inaugurated its new glass tank facility in Jambusar, Gujarat following an investment of €21 million last year. The company forecasts a rapid growth trend for high quality glass material in the pharma industry, and has thus committed additional investments of €26 million for yet another tank facility in 2020.

Each of the new production facilities with a combined investment of €47 million, will double the capacity of SCHOTT Glass India's manufacturing plant, allowing the group to produce its highly specialised FIOLAX® tubing material for both domestic and export demands.

SCHOTT began the construction of its first new facility last year on the occasion of completing two decades of operations in India. The facility finished construction within a record time of one year, enabling employment of another 100 skilled local workforce. The new set-up brings together SCHOTT's state-of-the-art technology and Indian ingenuity together to produce pharmaceutical packaging and tubing equipment in line with 'Industry 4.0' standards.

Talking about SCHOTT Glass India's future plans, Managing Director, Mr. Georg Sparschuh shared, "While domestic market remains our key focus, our India plant also caters to the Asian market, thereby contributing

to pharmaceutical industry exports and the Indian government's vision of becoming a global pharmaceutical hub. SCHOTT also takes cognizance of the Indian Health Ministry's initiative to provide affordable and accessible healthcare to its citizens. In this regard, we wish to be part of such initiatives by contributing to the pharmaceutical value chains and by providing high-quality glass products for pharma packaging, ensuring highest global safety standards."

SCHOTT's success story runs parallel to India's phenomenal performance in the World Bank's Ease of Doing Business Rankings, where India jumped 14 places this year to be ranked 63rd out of 190 countries.

"We are among the benefactors of the efforts made by the Government of India in creating an environment conducive for international businesses to invest and set up manufacturing facilities. We plan to continue investing in India as a part of Make in India, as we believe there is great potential in our Indian facilities becoming the hub for providing pharmaceutical equipment for global pharmaceutical supply chains as well. SCHOTT is also collaborating with Indian universities and training institutes to focus on skilling, preparing trainees to match the demands of future Industry 4.0 requirements," said Dr. Patrick Markschläger, Executive Vice President, SCHOTT AG, Business Unit Tubing.

Dignitaries from the German Consulate, Mumbai, key partners and industry associations such as the CII also graced the inauguration of the new facility.

On the occasion, Mrs. Marja Einig - Deputy Counsul General, German Consulate, Mumbai commended the efforts and said, "SCHOTT is playing a pivotal role in giving a fillip to our efforts in strengthening the Indo-German partnership. Time and again, SCHOTT has showcased its commitment towards India. With its expanded operations in the country, it is catering to the needs of the Indian health industry and contributing to the Indian government's initiatives such as Make in India and Pharma Vision 2020."

धरती पर हरियाली बिखेर रहा कांच का ये पारखी

सुहागनगरी में बने कांच के उत्पादों की चमक सात समंदर तक बिखेरने वाला कांच का ये पारखी धरती को हरा भरा करने में भी जुटा हुआ है।

एक दशक में दो लाख से अधिक पौधे लगा चुके निर्यातक ने सड़क किनारे से खेत तक छोटी-छोटी कई हरित पटिकाएं विकसित कर ली है। जो आंखों को भी सुकून देती है।

प्रमुख निर्यातक मुकेश बंसल (टोनी) शहर के लिए एक जाना पहचाना नाम है। उनके द्वारा तैयार किए गए कांच उत्पादों की मांग विदेशों में काफी है। वह अमेरिका, लंदन जैसे देशों में हर साल लाखों का माल भेजते है। चाइना के कांच उत्पादों को टक्कर देने के लिए वह प्रयोग भी करते रहते है। इस सब में व्यस्त रहने के बाद भी वह प्रकृति के गोद को हरा भरा करने का समय निकाल लेते है। हर साल 20 हजार से अधिक पौधे लगाना अब उनके जीवन का हिस्सा बन गया है। वह 10 साल से ऐसा कर रहे है। हजारों पौधे लगाने के लिए वह पहले से तैयारी करते है।

पौधारोपण की शुरूआत उन्होंने अपनी जन्मभूमि और कर्मभूमि से किया। पैतृक गाव कनवारा, अपने कारखाने सीताराम ग्लास, औद्योगिक क्षेत्र मीरा चौरहा के पास सतगुरू वाटिका मे काफी पौधे लगवाए है। इसके साथ ही हजरतपुर के निकट गढ़ी जाफर, मोती का नगला, नागऊ चौराहा पर राजा का ताल पुलिस चौकी के निकट एसआरके इंटर व डिग्री कॉलेज में छोटी-छोटी हरित पट्टिकाएं विकसित की है। उनके लगाए गए हजारों पौधे अब पेड़ बनकर पर्यावरण का संरक्षण और शीतलता दे रहे है।

मुकेश बंसल ने मलेशियाई साल, पॉपूलर, नीम, शमी और शीशम के साथ ही आम, अमरूद, नीम, बेल और बेर जैसे फलदार पौधे भी लगाए है। उनका कहना है कि फलदार पौधे होने से पक्षियों को भोजन मिलता है। पक्षी भी पर्यावरण संरक्षा के लिए जरूरी है। देखरेख के लिए उन्होनें कई कर्मचारी लगा रखे है। समय-समय पर वह खुद भी जायज़ा लेने जाते है।

आपको बता दें कि श्री मुकेश बंशल ट्रांसनीर ओवरसीज़ के प्रमुख निर्यातक हैं। ट्रांसनीर देश की एकमात्र कांच उत्पादक इकाई है जो अपनी ही बनी कांच की बोतल में जापानी टेक्नॉलाजी से फिल्टर्ड स्वच्छ पेय जल ग्राहको को प्रदान करा रही है।

श्री बंसल ने यह कदम प्रधानमंत्री के स्वच्छ भारत अभियान के चलते पर्यावरण को और स्वच्छ बनाने के हेतु उठाया है।

कांच उद्योग विकास केंद्र का होगा कायाकल्प

दिनाँक 9 दिसम्बर 2019 को उत्तर प्रदेश के फिरोजाबाद जिले में स्थापित काँच उद्योग विकास को हाइटेक करने के लिए विकास आयुक्त सूक्ष्म, लघु एवं मध्यम उद्यम मंत्रालय, भारत सरकार के निर्माण भवन, नई दिल्ली स्थित कार्यालय में एक बैठक सम्पन्न हुई। इस बैठक में फिरोजाबाद ग्लास मैन्युफैक्चरर्स एंड एक्सपोर्ट एसोसियेशन के अध्यक्ष श्री मुकेश बंसल (टोनी), एक्सपोर्ट काउंसिल फॉर हैण्डीक्राफ्ट के प्रतिनिधिगण, विकास आयुक्त कार्यालय के निदेशक श्री संजीव चावला, उपनिदेशक टूल रूम श्री यजपाल सिंह, काँच उद्योग विकास केन्द्र के प्रधान निदेशक श्री संजीव चिनमली, टीसीएम केपीएमजी टीम लीडर श्रीमति पुनीता बंसल, पीएमयईवाई के डा. मिलंद मजूमेंद्र, एनसीडीपीडी के निदेशक श्री राकेश कुमार श्रीवास्तव, एनसीडीपीडी के उपनिदेशक श्री राजेश रावत, यूपीजीएमस के सचिव श्री संजय अग्रवाल, लघु उद्योग भारती फिरोजाबाद शाखा के अध्यक्ष श्री हेमंत अग्रवाल बल्लू, ग्लास बैंगल सिंडिकेट के श्री हेमंत अग्रवाल, ग्लास एक्सपोर्टर श्री राजेन्द्र गुप्ता, श्री पुष्पेन्द्र जैन, श्री बिपिन अग्रवाल तथा श्री दीपक उपस्थित थे।

उक्त बैठक में काँच उद्योग की तरक्की पर मंथन किया गया। काँच उद्योग विकास केन्द्र, फिरोजाबाद को नवीन तकनीकियाँ अपनाने पर विशेष बल दिया गया ताकि फिरोजाबाद काँच उद्योग को काँच उत्पादन से जुड़ी आधुनिक तकनीक उपलब्ध हो सके तथा फिरोजाबाद काँच उद्यमियों को काँच की गुणवत्ता सहित विविध तरह की जाँच कराने हेतु दूरस्थ शहरों में न जाना पड़े। साथ ही काँच उद्योग विकास केन्द्र को कुछ नवीन परियोजनाओं की मंजूरी भी दी गई।

इसके अतिरिक्त उक्त बैठक में निम्न निर्णय भी लिये गये:

- भारत सरकार से स्वीकृत बजट से सीडीजीआई फिरोजाबाद में अंतराष्ट्रीय मानक की लैब स्थापित की जायेगी।
- उद्योग को फर्नेस डिजाइन से आडट प्लानर एवं फर्नेश रिपेयर टैक्नोलॉजी उपलब्ध कराई जायेगी। एक्सपोर्ट सीडीजीआई में रखे जायेगे।
- चूड़ी कारखानों की पॉट फर्नेश की टैक्नोलॉजी जर्मन की कंपनी से विकसित कराई जायेगी।
- काँच उद्योग में वेस्ट हो रही एनर्जी की बचत को आधुनिक तकनीक उपलब्ध कराई जायेगी।
- एक कलस्टर टैक्नोलॉजी सिस्टम प्रोग्राम कराया जायेगा।
- काँच का डिफैक्ट सीडीजीआई में चैक कराया जायेगा।
- बेहद कम कीमत पर ग्लास फर्नेश की एमआरआई सीडीजीआई में संभव हो सकेगी। वर्तमान में यह एमआरआई मुबई, बड़ौदा में प्राइवेट कंपनी से मनमाने चार्ज पर काराई जाती है।
- हस्तशिल्प, आईएस मशीन ऑपरेटर एवं नई तकनीक ईपीसीएच के सहयोग से मुफ्त प्रदान की जायेगी।

(News Source: AIGMF Research Team/World Wide Web)

AIGMF at VITRUM 2019

On an invitation by the Secretariat, VITRUM 2019 (*International Trade Fair for machinery, equipment and systems for flat and hollow glass, glass and finished products for the industry*), President Mr. Raj Kumar Mittal participated at Fiera Milano, Italy from Oct 1-4, 2019.

The 2019 edition saw Vitrum's role as the "Home of Associations" strengthened, again offering Associations participation for networking. AIGMF was amongst 22 Associations from 17 countries who participated with the cost of travel and lodging covered by the Italian Trade Agency ■

AIGMF

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glasspex & glasspro: Creating a New Story on the Growth Path

(October 10-12, 2019)

glasspex
GLASS PRODUCTION TECHNOLOGIES & PROCESSES
INDIA

The 6th edition of glasspex INDIA & 3rd edition of glasspro INDIA, organized by Messe Dusseldorf (India) in conjunction with Glass Bulletin was held from October 10-12, 2019 at Bombay Convention & Exhibition Centre, Mumbai.

The event gave proof to be a one-of-its-kind show in the glass sector and as the most comprehensive and reputed global platform where India's key industry players of the flat glass, container glass & table ware came together to discuss industry trends, challenges and market insights including the Indian regulatory framework. Both trade shows presented product launches, innovations and augmented the forethought through the exhibition, its conference and a special Award night.

glasspex INDIA & glasspro INDIA witnessed the participation of 195 companies from 14 countries, bringing together 5,547 trade visitors and 150 conference delegates.

The event had the presence of key dignitaries like Mr. R K Mittal,

President of AIGMF, Mr. Sanjay Somany – Former President of AIGMF, Mr. Gyan Madani, Chairman of Mumbai Chapter, Builders Association of India (BAI), Ms. Birgit Horn, Director and Global Head, Occupational Safety & Health and Glass Technologies-Messe Düsseldorf GmbH, Mr. Lakhan Singh, Editor & Publisher of Glass Bulletin Magazine and Mr. Dave Fordham from Glass Worldwide.

Speaking on the occasion of the opening ceremony of 6th edition of glasspex and 3rd edition of glasspro India 2019, Ms. Birgit Horn, stated: "It is an honor for me to welcome you as the Director of glasstec - the globally leading event for the glass industry - and as the representative of Messe Düsseldorf. Thanks to the exceptional work done by our team of Messe Düsseldorf (India) and with the support of our esteemed partners, we are able to present the complete value chain of the glass industry under one roof. glasspex INDIA has developed into the Indian glass industry leading event. It is the meeting point for exchanging ideas, contact making and business deals. glasspro INDIA has setup a strong vision with glass bulletin.

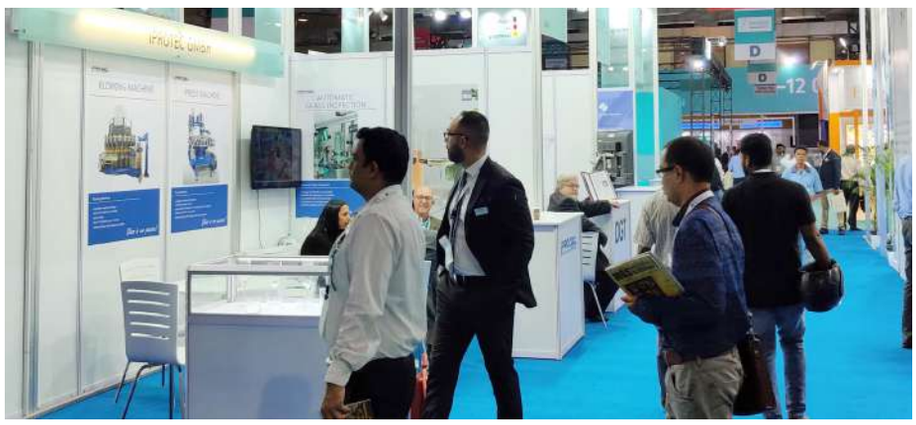
Both shows are providing the most efficient platform to support the technological development and the business trade in the Indian glass market. We thank our partners, associations for this great support and cooperation. Through the combined efforts we are able to put together this exhibition."

glasspro
FLATGLASS PROCESSING, PRODUCTS & ACCESSORIES
INDIA

Glimpses of glasspex INDIA

GLASS PRODUCTION TECHNOLOGIES & PROCESSES

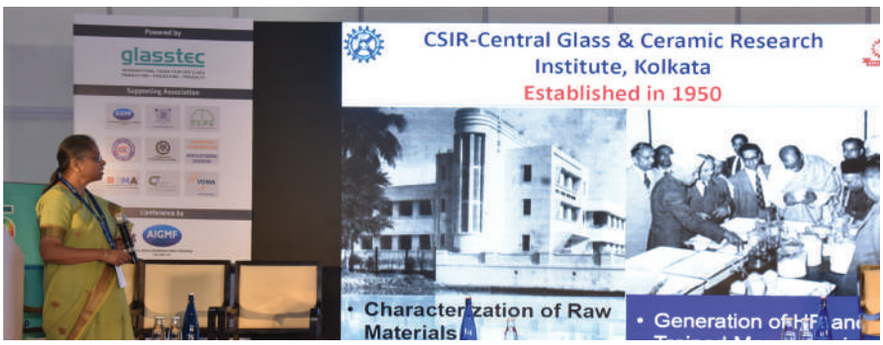
(October 10-12, 2019)



Glimpses of glasspro

FLATGLASS PROCESSING, PRODUCTS & ACCESSORIES INDIA

(October 10-12, 2019)



glasspex
GLASS PRODUCTION TECHNOLOGIES & PROCESSES
INDIA

The key highlight of glasspex INDIA was the AIGMF's 13th International Conference on Glass Industry 4.0, which was supported by the Glass Worldwide Magazine and powered by VDMA & Messe Dusseldorf (India).

The 13th edition of glass conference program included various industry discussions, new insights pertaining to the sector and best practices. The conference topics included:

- Glass- a vital building material for Smart Cities
- Glass aiding Swachh Bharat Abhiyaan (clean India campaign)
- Modern Automation Systems in Batch Plants and Cullet Recycling Plants
- Glass Marking - When Traceability Becomes an Obligation
- SORG Forehearth Systems: The SORG 340S+® Forehearth and the SORG® Coloring Forehearth System
- Glass Recycling – Potentials for Indian Glass Manufacturers
- Fully Automatic Lines for Chemical Strengthening of Glass
- Sophisticated Glass Handling and Processing in the Era of Industry 4.0
- National Building Code: Glass and Glazing Aspects AND Emerging Regulations
- Refractory Materials Challenges in Sodalime Glass Feeders
- Energy Savings in Glass Making: The Importance of Correct Vacuum Setting
- Aesthetics and Functionality through Glass
- Industry 4.0: A Pragmatic Approach

- Furnace optimisation and NOx reduction

The two-Day AIGMF Conference hosted 15 sessions and three additional Q&A sessions that brought together stakeholders of the industry on a single platform, allowing the exchange of ideas that added value to Indian glass ecosystem at large.

The AIGMF conference was staged at the backdrop of a touring exhibition (Adopt a Glass Bottle) of select drawings made by school children, on the theme of Glass Packaging being Environmentally Friendly and aiding the Swachh Bharat Abhiyaan (*Clean India Campaign*).

Unveiled at the platinum jubilee (75-years) event of the AIGMF on Sept 27, 2019 by Mr. Rattan Lal Kataria, Hon. Minister of State for Jal Shakti & Minister of State for Social Justice and Empowerment, Online entries from children of 7-16 years were invited for Drawing Competitions on the captioned theme, held to commemorate World Environment Day 2018 & International Youth Day 2019, wherein over 4000 students participated from across India.

As the National Apex Body of the Glass Industry, the AIGMF undertakes socially responsible steps as a voluntary service to society, thereby bringing increased awareness of Glass being a safe and 100% recyclable packaging material.

Mr. Dave Fordham, Publisher, Glass Worldwide (*preferred journal of AIGMF in association with Kanch*) was moderator for all sessions of the high profile content driven conference, which highlighted the key issues and developments by Industry experts from both National & International companies.

Glimpses of glasspex

GLASS PRODUCTION TECHNOLOGIES & PROCESSES INDIA

(October 10-12, 2019)

Glimpses of glasspro

FLATGLASS PROCESSING, PRODUCTS & ACCESSORIES INDIA

(October 10-12, 2019)

glasspex
GLASS PRODUCTION TECHNOLOGIES & PROCESSES
INDIA

The key attraction of glasspro INDIA was the 4th Glass Bulletin Awards organized by Glass Bulletin Magazine and supported by Messe Dusseldorf (India).

The Glass Bulletin Awards, organized in cooperation with glasspro INDIA, congratulated 29 prizewinners (in 12 prize categories) for their great contribution towards industry growth.

The trade show received full support by leading Industry Associations to execute an excellent exhibition. These included The All India Glass Manufacturers' Federation, Confederation of Construction Products and Services, Builders Association of India, The Madras Glass & Plywood Merchants Association, Chhattisgarh Glass Association, Ludhiana Glass Dealers Association, Noida Glass Traders Association, Rajkot Glass Merchant Association and Glazing Society of India.

glasspex INDIA & glasspro INDIA are resolutely focused on the future and aims to establish itself as the benchmark event in glass production technologies & processes and flat glass processing, products & accessories in the Indian market ■

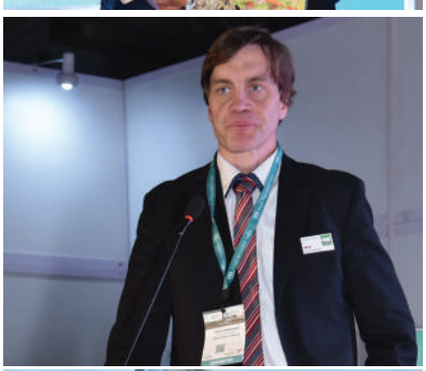
Select photos and presentations can be downloaded from : http://www.aigmf.com/past-events.php.

glasspro
FLATGLASS PROCESSING, PRODUCTS & ACCESSORIES
INDIA

Glimpses of glasspex

GLASS PRODUCTION TECHNOLOGIES & PROCESSES INDIA

(October 10-12, 2019)



Glimpses of

glasspro

FLATGLASS PROCESSING, PRODUCTS & ACCESSORIES

INDIA

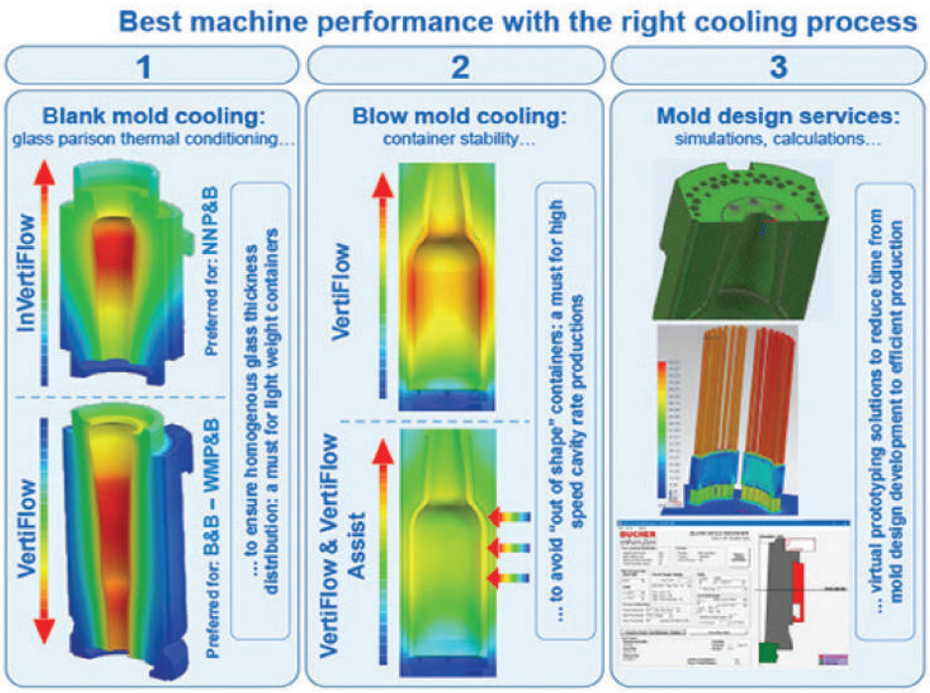
(October 10-12, 2019)

Mould design: The importance of mould cooling

In the first of a series of four articles in *Glass Worldwide* (preferred international journal of the AIGMF), DominqueDominique Vassaux explains the importance of mould cooling, its influence on the performance of the IS process and on container quality.

It is a reality that some container manufacturers are struggling with knowhow issues: Senior employees are retiring and younger generations are not gaining the necessary knowledge, leading to critical situations that affect production efficiencies, with machines not performing as expected. The most affected areas in a glass plant are the production and the mould design departments.

Regardless of how experienced the production personnel are and how sophisticated a forming machine is, if mould design is not correctly developed for a specific container and for a specific cooling system, production efficiencies will be badly affected. Mould design knowledge is key to ensure good performance and efficient production runs at a glass plant.



Cooling overview.

Blank side influences

The glass thickness distribution of a container is defined mainly at the blank side, as the thermal conditioning of the parison will directly influence the 'stretching behaviour' of glass into its final container shape. Cold glass on the parison 'skin' will hardly stretch, leading to thicker areas, whereas hotter glass on the parison will stretch easily, leading to thinner areas on the container.

This stretching behaviour is directly influenced by mould design and by process stability on the machine, as both factors affect the heat extraction from glass to mould:

- Mould design: Design of the parison shape (internal cavity of blank mould) and temperature distribution profiles on the blank mould cavity, vertically and horizontally.
- Process stability: Gob quality (shape, temperature, loading), production timing (blank mould/ glass contact time duration), blank and blow side process parameters and the human factor to avoid process deviations on the machine, or by means of the latest BEG intelligent close loops systems.

Blow side factors

At the blow side, as much heat as required needs to be extracted from glass, in order to ensure that the newly formed container does not lose its shape when leaving the blow mould. In that sense, blow mould/glass contact time duration, temperature distribution on the blow mould cavity and final blow (design of the blow head) are the main factors influencing heat transfer from glass. At the same time, it should be noted that the blow mould must not be overcooled.

As can be seen, for both blank and blow sides, heat transfer from glass to mould is important. The blank side to ensure correct glass thickness distribution on the final container and the blow side to ensure containers are 'stable enough' not to lose their shape over the dead plate.

Bucher Emhart Glass provides solutions for adequate mould cooling conditions. This includes equipment parts, as well as mould design training and modelling services to assist glass plants to maximise productivity and increase container quality. ●

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Originally published in Glass Worldwide, preferred international journal of AIGMF

Programme (as on February 20, 2020)

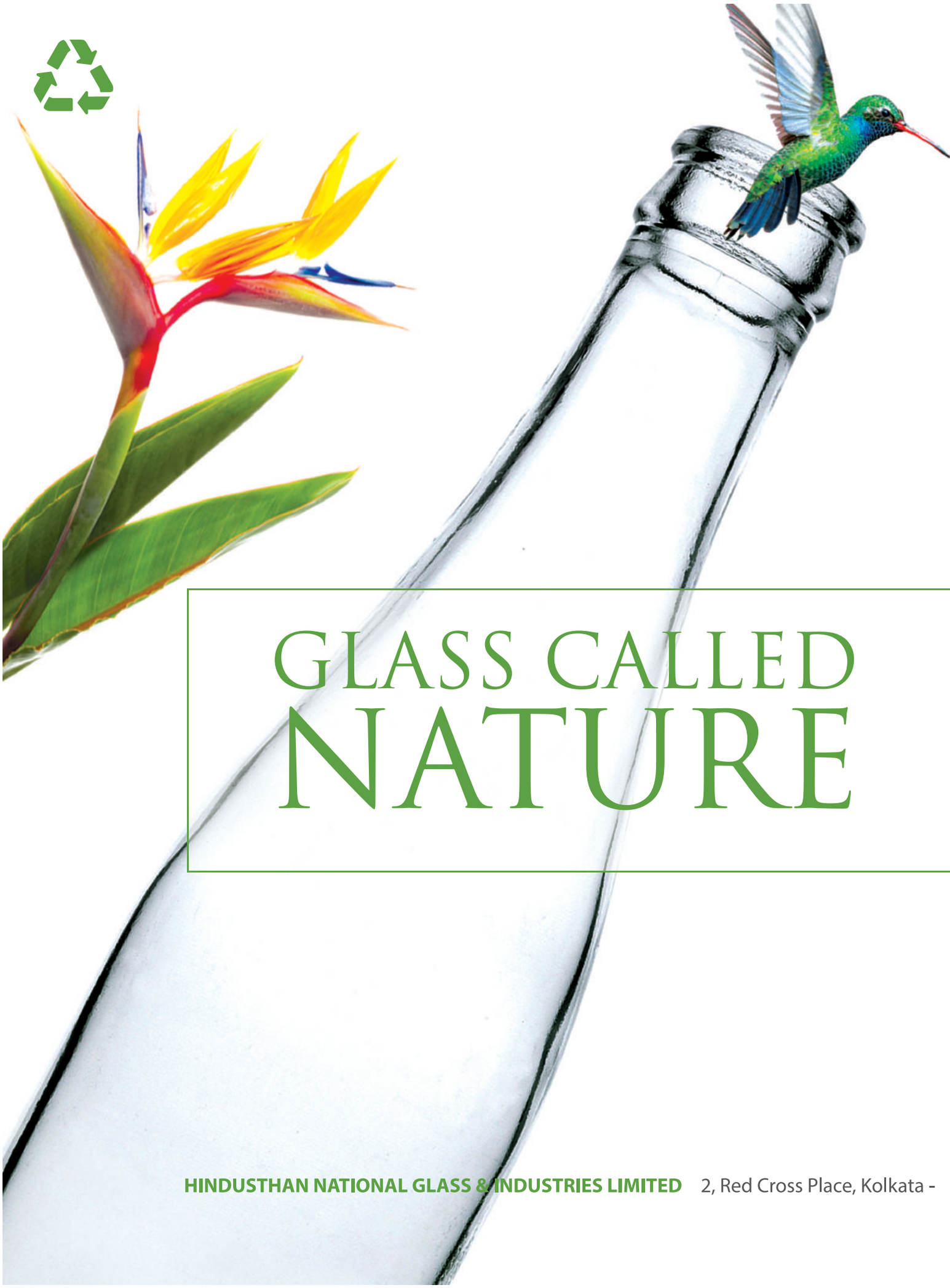
for meeting of the **AIGMF Executive Committee**

at Hotel Taj: *Jai Mahal Palace, Jacob Road, Civil Lines, Jaipur*

(March 21, 2020)

(to be hosted by M/s Nirmal Glasstech Industries, Affiliate Member of AIGMF)

1145 hrs	**Registration** - Tea/Coffee
1200 hrs	**Review Meeting:** Promotion of Container Glass
1230 hrs	**Display of Exhibition on"Adopt a Glass Bottle"** - *A touring exhibition of select drawings made by school children, on the theme of Glass Packaging being Environmentally Friendly and aiding the Swachh Bharat Abhiyaan (Clean India Campaign)* - *Unveiled at the platinum jubilee (75-years) event of the AIGMF on Sept 27, 2019 by Mr. Rattan Lal Kataria, Hon. Minister of State for Jal Shakti & Minister of State for Social Justice and Empowerment* - *Online entries from children of 7-16 years were invited for Drawing Competitions on the captioned theme, held to commemorate World Environment Day 2018 & International Youth Day 2019, wherein over 4000 students participated from across India*
1245 hrs	**Technical Presentation** By Mr. Leo Diehm, Technical Manager, Bucher Emhart Glass Followed by one-to-one interaction with Indian companies
1400 hrs	Lunch
1430 - 1630 hrs	Sightseeing / Shopping at Johari Bazaar
1645 hrs	**Executive Committee Meeting** a) Agenda b) Presentation / short video by Nirmal Glasstech Industries *(on main line of business and solutions for Glass Industry)*
1730 hrs	**Interactive session with Industry Minister/Director/Secretary, Industries** - Welcoming Chief Guest - Address by the Minister/Chief Guest - Opportunities for Glass Industry in Rajasthan *(covering all Subsidies and Raw Materials)* - Question and Answers - Glass bottles gifting ceremony to Chief Guest and Hotel Taj (*under Swachh Bharat initiative*) - Vote of Thanks - Group Photo / Media Interaction
1930 hrs	**Gala Dinner** - Cultural show



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- Capexil Special Export Award

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Toughened or Tempered Glass – Part II

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Abstract

Glasses are considered as toughened or tempered if they do not break into smaller uneven sharp pieces to cause damage to human body. This is done by keeping the surface of a glass sheet under compressive stress and the interior of the glass under the tensile stress, just below the surface. Such a high compressive stress on the surface with the tensile stress in the interior of the glass generates strength in the glass piece. This also determines the manner of breakage under external impact or force. In the Part-I of the article, basic ideas on toughening was presented to highlight the importance of this particular part of the manufacturing process of tempered glass. In the Part-II of the paper, the theory of tempering or toughening with a short description of the process and some applications will be discussed.

INTRODUCTION

In the manufacture of 'car windscreen', the process of thermal toughening has been used for many years, and it is also the process that involves an interaction between glass flow and heat transfer, as described before in several articles of Kanch **[1,2].** As float glasses are mainly used for thermal toughening for 'car windscreen' application, they assume special significance **[3]**. Thermal properties of glasses, in general, have also been discussed **[4-6]**. It is known that a large amount of stresses are produced during the manufacture of container or float glasses. These stresses are normally relieved by annealing after the products are fabricated by making them pass through a hotter zone to a relatively colder zone of an annealing furnace or lehr.

In the case of thermal toughening, the effect of the flow consists of a partial relaxation of those stresses that are produced by the temperature gradients set up in the glass during the process. In the molten condition, the glass is at a temperature over 1550^{0}C, After somewhat cooling the glass that is a part of the process - to reduce fluidity or increasing the viscosity, this viscous glass is subjected to some kind of mechanical forming process, or rather to some type of mechanical forces, while setting up a "thermal gradient" to achieve the desired viscosity for forming. This causes the stresses in the more viscous form – as the glass piece cools down.

It should be made clear here that it is absolutely essential to reduce the temperature of the "forming process". Unless the temperature is reduced from that of the molten condition, the viscosity will not be adequately high enough making the glass more fluid or floppy causing manufacturing defects, particularly in case of container glasses. So, it is clear now that to increase the desired level of viscosity, the temperature is intentionally reduced thereby creating a lot of stresses due to "thermal gradient" thus imposed on the glass under fabrication. This background is necessary to understand the 'thermal toughening' process.

The Process →

The glass sheet to be toughened is heated to a uniform temperature between 705 and 800^{0}C when its viscosity is of the order 105 N s/m2. It is normally done within a chamber with glass panels in the front so that the glass plate can be seen from outside. Then, the "Air Jets" are directed at the two surfaces of the plate which rapidly cool the surface layers to below the annealing temperature, i.e. to a level of viscosity of 1012 N s/m2. With this level of temperature or viscosity - the surface layers are then effectively solid whilst the central layers still have a temperature well above the annealing temperature.

Forced cooling is continued for some time, after which the glass is allowed to cool naturally to room temperature. The result of this treatment is to induce a high compressive stress in the surface layers of the glass balanced by a tensile stress in the interior. Since glass fractures only when the surface is in tension, the surface compressive stress produced by toughening must be neutralized first - by externally

applied forces. Thus the glass is stronger to an extent depending on the magnitude of the surface stresses.

Temperature gradients in an elastic solid give rise to stresses which disappear only when the gradients are removed. Similar gradients applied to a glass with a viscosity of 105 N s/ m2 are rapidly relieved by "viscous flow". As the glass is cooled during the toughening process, stresses produced by the temperature gradients are relieved more rapidly in the 'hotter inner layers' than at the 'surface'. With falling temperature throughout the sheet, stress relaxation rates decrease quite rapidly until eventually the whole sheet is below the annealing temperature. Then, it becomes a case for dealing with an elastic solid. Further stress released by flow is negligible but the stresses change as a result of the changing temperature distribution in the sheet. From this brief qualitative description, as perhaps expected, the analysis of this process to predict in detail the "changing stress distribution" - in the glass plate as it cools - represents a very complicated problem.

Tempered safety glass which has been laminated often does not fall out of its frame when it breaks – usually due to the anti-splinter film applied on the glass, as normally seen in the grocery store meat case.

An alternative chemical toughening process involves forcing a surface layer of glass at least 0.1 mm thick into compression by ion exchange of the sodium ions in the glass surface with potassium ions, measured by the ionic radii that are 30% larger, by immersion of the glass into a bath of molten potassium nitrate. Chemical toughening results in increased toughness compared with thermal tempering and can be applied to glass objects of complex shapes **[6,7]**.

A large number of investigations have been done in order to understand how flaws affect the stress at which a material will fracture. All materials contain defects, and in brittle materials such as glasses, these defects act as tiny pre-existing cracks, which could propagate through the material to cause fracture. The propagation of these cracks is dependent on an energy balance, which leads to a critical crack length. The stress at which a glass fractures depends on the size of the largest flaws present, i.e. the larger the flaw, the lower the fracture stress. For commercial soda-lime-silicate glass, the behaviour is dominated by the surface defects, and the condition of the surface of the glass controls its strength. If steps are taken to remove or avoid the presence of defects, then the glass can be very strong. However, without special precautions, the strength of the glass is rather low and can show substantial statistical variations **[4,5]**.

In 1965, the necessary theory was developed by Lee et al **[8]** but some refinements in the numerical methods were needed. This was introduced by Narayanaswamy and Gardon in 1969 **[9]**. These improvements were needed before good agreement could be obtained between experimentally measured stress distributions at various times after the cooling has started and the distributions calculated from the theory at different times. A very close agreement was achieved.

The calculations require information on various physical properties of the glass. In particular, one needs to know the effect of temperature on the rate of stress release.

The Theory →

The theory is developed by assuming that the glass shows a visco-elastic response only to shear stresses but that it shows an elastic behaviour in pure dilatation. The stress to be calculated is that parallel to the sheet surfaces. In the model, x1, x2 and x3 were chosen as axes such that x2 and x3 are in the mid-plane of the glass-sheet and x1 is considered as perpendicular to the surfaces (i.e. in the z-direction).

In a sheet cooled symmetrically on both surfaces with zero surface tractions and which is large relative to its thickness. The stress denoted by U11 and all shear stress components are zero. The two remaining stress components U22 and U33 are equal, i.e. U22 = U33 = U. Thus, the problem is reduced to calculate the distribution of the stress U throughout the sheet at any specified time during cooling.

Certain relationships are determined by simple considerations of geometry, continuity and balance of internal forces. These apply irrespective of whether one is dealing with an elastic or visco-elastic material. Thus the principal strains e22 and e33 are independent of position throughout the sheet thickness. The distribution of volumetric strain, (E = e11 + e22 + e33), through the sheet thickness is calculated from the temperature distribution by making use of the assumption of elastic behaviour in pure dilatation.

Thus, the volumetric strain is the sum of the volumetric strain due to the stress and the volumetric strain due to thermal expansion or contraction. The other important relationship involves the use of the well known superposition principle for calculating stresses in a visco-elastic material, i.e. the stress is evaluated by a convolution integral of a product of two terms, the first being obtained from the stress relaxation function of the material and the second from the

way in which the strain in the material has varied with time.

In 1963, Kurkjian **[10]** in USA did an extensive work via simulation of experimental data along with computed data from the theory. They plotted a series of curves from 10 to 10,000 seconds for temperatures between 473 and 533^{0}C. It was shown that "normalized stress relaxation" curves at various temperatures were trending down with time, and also the curves were in the upper position as the temperature decreases, i.e. the 'normalised stress' is higher for lower temperatures. To note that the strain pattern resulting from tempering can be observed by viewing through an optical polarizer, such as a pair of polarizing sunglasses.

Figure-1: Safety approval markings on an automobile vent window made for a Chrysler car by PPG.

Figure-2: Police van with screen protector

Therefore, it has been possible to obtain equations from which stress distributions could be calculated at any time during the toughening process. Very good agreement between theory and experiment has been obtained. This work is perhaps the most impressive achievement so far in the analysis of a glass manufacturing process. It represents a very successful combination of excellent contributions by a number of workers providing the experimental information, the material properties, and the necessary theory combined with the development of numerical methods carefully designed to avoid the pitfalls that initially belittled much of the value of the theory.

Some Applications →

Tempered glass is used when strength, thermal resistance, and safety are important considerations. The passenger vehicles, for example, have all three requirements. Since they are stored outdoors, they are subject to constant heating and cooling as well as dramatic temperature changes throughout the year. Moreover, they must withstand small impacts from road debris such as stones as well as automobile accidents. Due to large, sharp glass shards would present additional and unacceptable danger to passengers, tempered glass is used so that if broken, the pieces are blunt and mostly harmless. The windscreen or windshield is instead made of laminated glass, which will not shatter into pieces when broken while side windows and the rear windshields are typically tempered glass.

Other typical applications of tempered glass include: Balcony doors, Athletic facilities, Swimming pools, Facades, Shower doors and bathroom areas, Exhibition areas and displays, Computer towers or cases, Buildings and structures.

Tempered glass is also used in buildings for unframed assemblies, such as frameless glass doors, structurally loaded applications, and any other application that would become dangerous in the event of human impact. Tempered and heat strengthened glass can be 3 to 7 times stronger than annealed glass. In the USA, the building codes require tempered or laminated glass in several situations including some skylights, near doorways and stairways, large windows, windows which extend close to floor level, sliding doors, elevators, fire department access panels, and near swimming pools. Some more applications need to be elaborated and are given below:

a) Household uses

Tempered glass is also used in the home. Some common household furniture and appliances that use tempered glass are frameless shower doors, glass table tops, replacement glass, glass shelves, cabinet glass and glass for fireplaces.

b) Food service

"Rim-tempered" indicates that a limited area, such as the rim of the glass or plate, is tempered and is popular in food service. However, there are also specialist manufacturers that offer a fully tempered/toughened drink-ware solution that can bring increased benefits in the form of strength and thermal shock resistance. In some countries these products are specified in venues that require increased performance levels or have a requirement for a safer glass due to intense usage.

Tempered glass has also seen decreased usage in bars and pubs, particularly in the U.K. and Australia, to prevent broken glass being used as a weapon. Tempered glass products can be found in hotels, bars, and restaurants to reduce breakages and increase safety standards.

c) Cooking and baking

Some forms of tempered glass are used for cooking and baking. Manufacturers and brands include Glasslock, Pyrex, Corelle, and Arc International. This helps in making baked products, cakes and pastries of different shapes and sizes. This is also the type of glass used for oven doors for visibility from outside, which is very common these days.

d) Mobile devices

Most touch-screen mobile devices and tablets use some form of toughened glass, such as Corning's Gorilla Glass, as do some aftermarket screen protectors for these devices. These pieces have a huge market.

CONCLUSIONS

Toughened glasses encompass a huge range of products and applications with some newer applications, such as screen protection for mobile devices. However, the most important one is for 'car windscreen' wherein the market volume is large. This market of course is subject to fluctuation with the changing patterns of automobile demand. The theory in brief has been given with a short description of the process and some new applications.

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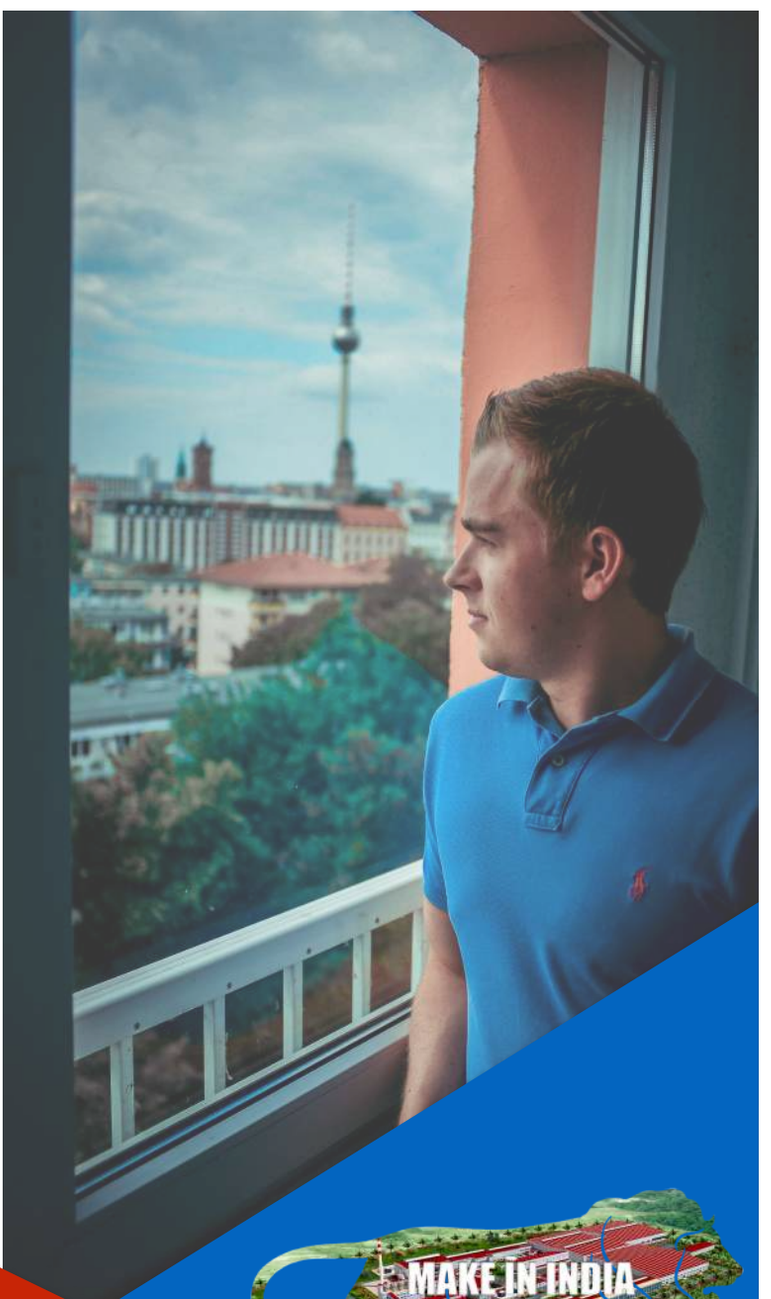

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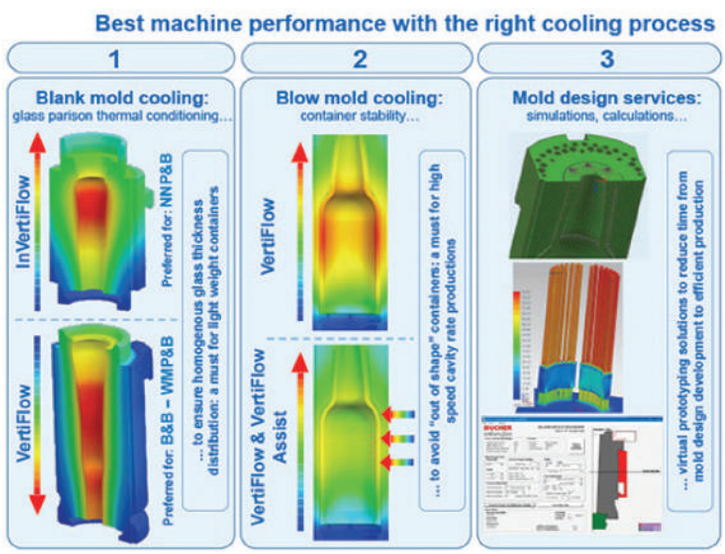
Mould design: Blank mould cooling options

In the second of a series of four articles in *Glass Worldwide* (preferred international journal of the AIGMF), Dominique Vassaux considers the importance of mould cooling, its influence on the performance of the IS process and on container quality. He explains the different cooling needs depending on the type of production process.

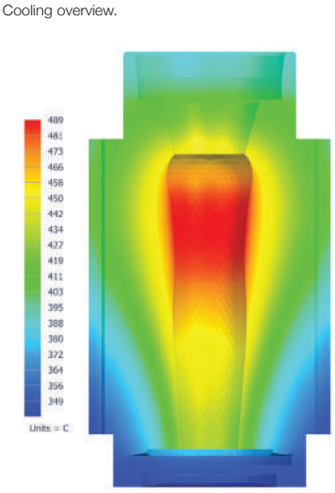
The blank side VertiFlow system directs cooling air from top to bottom of the blank mould, whereas the blank side InVertiFlow system directs cooling air in the opposite direction. As a result, the temperatures are much colder at the top of the blank mould when using blank side VertiFlow, whereas it is colder at the bottom when using InVertiFlow. Both systems are very flexible as the cooling air entry and exit positions can be defined without much constraint, giving the mould designer a direct influence on the vertical temperature distribution of the blank mould.

Cooling the blank mould by means of vertical holes provides increased cooling efficiency (compared to traditional radial stack cooling), as more heat can be extracted from the mould but also improved container glass thickness distribution since the cooling holes ensure an even horizontal temperature distribution and the correct vertical temperature gradient on the blank mould cavity. This second benefit is key when producing very lightweight containers.

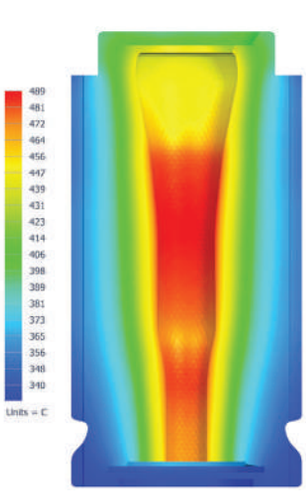
Obviously, the vertical blank mould temperature distribution must be tailored to suit the parison thermal conditioning requirements, which is mainly a function of the production process: ▸



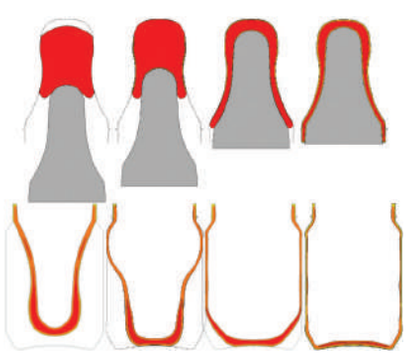
Cooling overview.



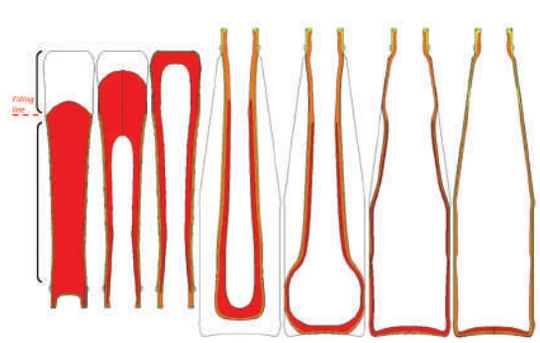
Blank side InVertiFlow ToC profile.



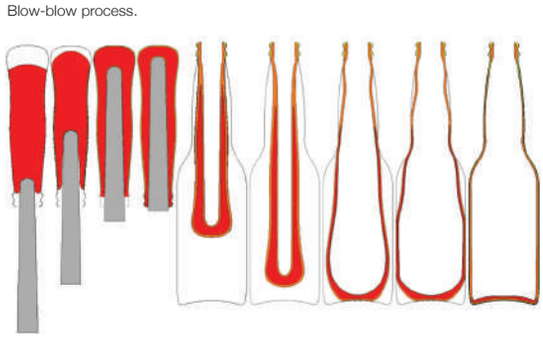
Blank side VertiFlow ToC profile.



Widemouh press-blow process.



Blow-blow process.



Narrow neck press-blow process.

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- **Blow-blow (BB):** In order to counterbalance the mould/glass contact time difference 'below and above' the glass filling line and consequently, improve the settle wave mark on the final container, cooling must be focused at the top of the blank mould, in particular on the filling line region (where the glass stops inside the blank cavity). At the same time, less cooling is given on the neck and shoulder areas of the blank cavity, to ensure smooth forming behaviour of the shoulder at the blow side.
  Bucher Emhart Glass (BEG) recommends blank side VertiFlow for the BB process, as it makes the top of the blank mould much colder than the bottom.
- **Narrow neck press-blow (NNPB) process:** Most of the cooling air needs to be focused at the lower part of the blank mould cavity, in order to guarantee enough glass thickness in the neck and shoulder of the formed container, avoiding hollow necks and thin shoulders.
  BEG recommends blank side InVertiFlow for the NNPB process, as it maximises cooling at the bottom of the blank mould to maintain cold glass in the neck and shoulder of the parison.
- **Widemouth press-blow (WMPB):** Cooling air must be focused on the neck ring for jar productions to guarantee finish stability, avoiding dimensional defects on the finish.

BEG recommends blank side VertiFlow for WMPB jar production, as some VertiFlow cooling holes can be used to cool down the neckring in the blank mould closed position, allowing increased cooling capacity and temperature homogeneity at the neckring cavity.

In general, in case a glass plant produces a mix of containers with all production processes, BEG recommends blank side VertiFlow cooling, as it provides total flexibility from a clamping and cooling perspective. However, the mould designer must understand the importance of configured cooling holes design, in order to balance correctly the vertical temperature distribution to suit the need of the parison thermal conditioning for each production process. Therefore, training at BEG is key in order to achieve best cooling performance. ●

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About

The All India Glass Manufacturers' Federation

The All India Glass Manufacturers' Federation was founded in 1944. The Federation is made up of five Regional Associations viz.

Eastern India Glass Manufacturers' Association **(EIGMA)**-Kolkata

Northern India Glass Manufacturers' Association **(NIGMA)**-Haryana

South India Glass Manufacturers' Association **(SIGMA)**-Hyderabad

Uttar Pradesh Glass Manufacturers' Syndicate **(UPGMS)**-Firozabad and

Western India Glass Manufacturers' Association **(WIGMA)**-Mumbai

The Federation was incorporated under the Companies Act, 1956 (No. 1 of 1956) as a Limited Company on 15-6-1970.

The main aims & objectives of the Federation are:-

- To encourage, promote and develop the manufacture of glass articles of all kinds and to safeguard and protect the interests of glass industry and glassware business in India.
- To form a common link amongst Glass Manufacturers' in India and thus develop a spirit of mutual help and cooperation with one another.
- To promote the 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 export and import thereof.
- 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 decrease the cost of production and increase the national wealth.
- To collect necessary information and data and propagate it for the benefit of 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 grant of special facilities for the Glass Industry.
- To draw Government or public attention to the difficulties in the way of Glass Industry and to solve other problems confronting it and to solicit their help and support through concerted action.
- To organise a united front on behalf of all glass manufacturers and thus strive to gain all those advantages which may not be possible through individual effort.

All those engaged in the manufacture of glass and glass articles are enrolled as **Ordinary Members** of the AIGMF and those associated with the Glass Industry are enrolled as **Affiliate Members** of the Federation.

Almost all glass manufacturers including many in the small scale sector are 'Ordinary' Members of the Federation.

Articles of Association of the AIGMF were amended in September 1992 to enroll foreign companies as Affiliate Members of the Federation ■

Mould design: Combined blow mould cooling

In the third of a series of four articles in *Glass Worldwide* (preferred international journal of the AIGMF), Dominique Vassaux explains the importance of mould cooling, its influence on the performance of the IS process and on container quality.

Standard blow side VertiFlow equipment introduces cooling air at the base of the blow mould (via the bottom plate) and directs it upward to the top of the blow mould. The superiority of the BEG standard VertiFlow cooling is the total freedom on the cooling holes patterns. Depending on the body diameter of the container, the number and the diameter of the cooling holes must be correctly defined, as well as the correct distance between the mould cavity and the cooling holes. Patterns made of two rows of cooling holes with a distance of 12mm-17mm between the mould cavity and the cooling holes give the best cooling results.

A typical blow mould temperature distribution is illustrated. When using standard VertiFlow cooling, the bottom part of the blow mould is much colder than the body/shoulder part. This can be a drawback in production, as the mould extracts more heat from the glass in the bottom part and less heat in the body/shoulder part. This results in stiff glass in the heel/bottom part and soft glass in the body/shoulder part of the newly formed container.

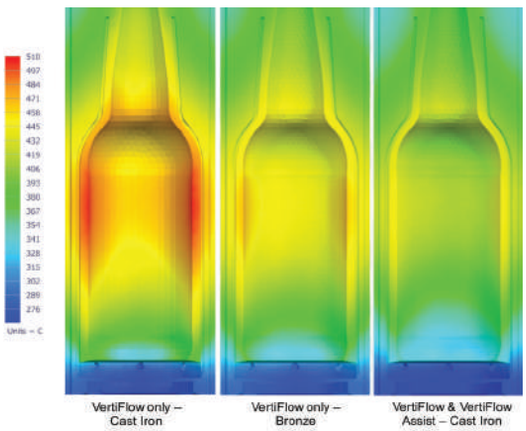
The use of configured holes (or isolation grooves) along the length of the holes helps to make the vertical temperature more uniform but the tendency still shows that the bottom part will be colder than the body/shoulder area. In addition, it is important to note that standard VertiFlow cooling can only be used when the blow mould is closed, just after the final blow event. This limitation in total cooling duration sometimes leads to blow mould cooling restrictions (mainly in NNPB).

Additional cooling

In order to improve cooling at the blow side, BEG introduced 'VertiFlow Assist', which is an 'add on' cooling system to be used together with the standard VertiFlow cooling.

VertiFlow Assist is available on both AIS and NIS machines. On the AIS machine, the cooling air is supplied radially to the blow mould via the mould holder insert, whereas it is supplied vertically to the second row of cooling holes on the NIS machine.

Since standard VertiFlow and VertiFlow Assist can be timed independently, not only is it possible to significantly reduce the overall blow mould temperatures (up to 80°C in the shoulder area of a TG 4 ¼in blow mould) but the capability is provided to influence this 'combined cooling' system, in order to balance the temperatures vertically. This feature makes it possible for the production operator to achieve a homogenous temperature distribution within 20°C along the vertical and horizontal axes of the blow mould. This decrease in temperature amplitude (minimum, maximum) generates less stress in the mould material, leading to an increase in mould lifetime (up to 20%). It also results in potential speed increases of up to 5%, depending on the type of container produced.

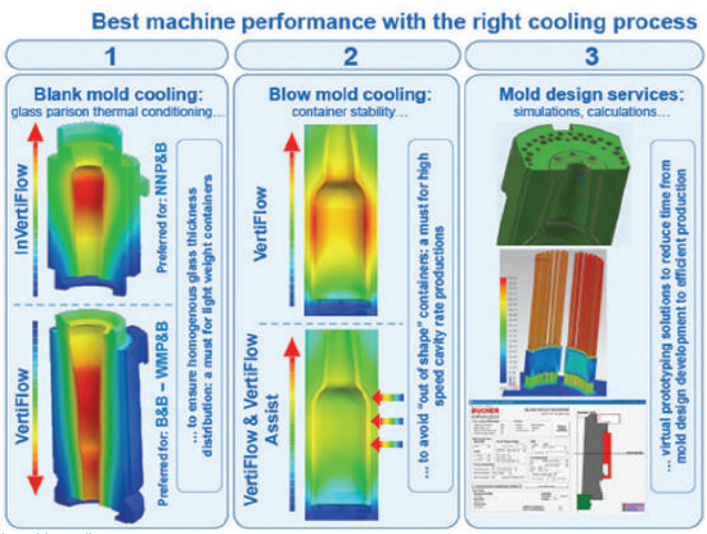


Cooling overview.

Temperature control

Looking into the near future, closed loop systems will enable the operator to control blow mould temperatures automatically, not only in amplitude but also in vertical temperature gradient distribution. If the temperature measuring system detects too high temperatures in the shoulder region, only the VertiFlow Assist duration will increase, lowering the temperatures in the shoulder of the mould.

In the same logic, in case the bottom part will be too cold, the closed loop system will only reduce the standard VertiFlow duration, warming up the heel region of the mould. In addition, having this first closed loop system to ensure homogenous blow mould temperatures, a second closed loop system between the BEG FlexRadar system and the thermal parison conditioning (total blank mould closed duration and/or blank mould cooling duration) can be used, in order to have direct control on the vertical glass thickness distribution of the container. ●



Blow side cooling.

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Mould design services

In the fourth of a series of articles in *Glass Worldwide* (preferred international journal of the AIGMF), Dominque Vassaux explains the importance of mould cooling, its influence on the performance of the IS process and on container quality.

To ensure best cooling performance of the mould equipment and consequently, to ensure the required heat removal from glass, cooling fans need to provide the correct air requirements to the forming machine in regards to air pressure versus volume. At the blow side, the design of blow heads will have a direct impact on how soft the glass of a newly formed container is when leaving the blow mould.

The latest computerised simulation software will help designers to predict the various cooling and forming processes on a forming machine, to decrease time from concept to final produced containers.

Cooling fan specification

To achieve optimal mould cooling performance on the forming machine, cooling air must be correctly supplied from the cooling fan(s) to the forming machine. In that sense, the cooling fan specification must always suit the cooling requirements of the moulds, not the other way around. Very often, people think that more air volume (bigger fan size) will give better mould cooling results. This is not always the case.

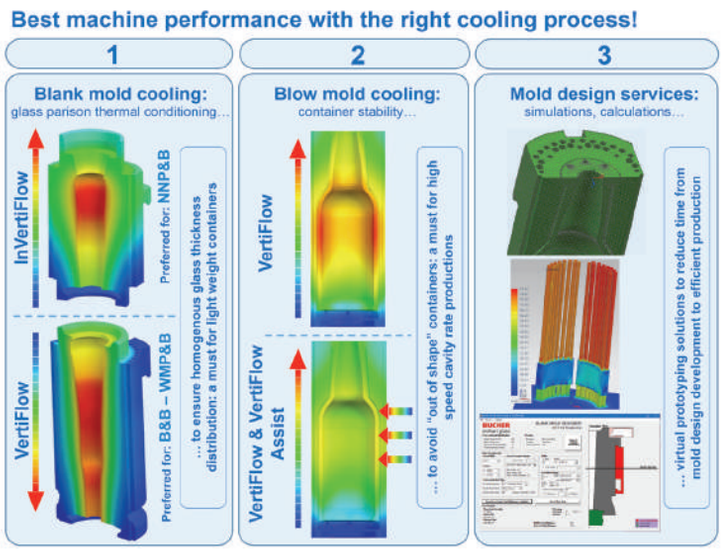
It is important to size the fan correctly in both pressure and volume, according to the latest BEG cooling air requirements specification. Volume undersized cooling fans will lead to mould cooling problems on the forming machine. However, oversized fans will also create severe issues to mould cooling. Not only will an over specified cooling fan heat up the cooling air (surges of pressure, which can even damage the fan installation), so that hot air with temperatures up to 70°C is supplied to the machine to cool down the moulds but the total air pressure also drops at the forming machine inlet. This leads to reduced air velocities inside the vertical cooling holes of the moulds, resulting in reduced heat transfer coefficients and consequently, poor cooling efficiencies of the moulds.

Oversized cooling fans generate much higher operating energy costs. Considering a 10-section triple gob machine, a cooling fan for a radial stack cooling machine (IS type) will consume approximately 250kW, whereas a cooling fan for a 'full VertiFlow' machine (AIS/NIS type) will consume approximately 90-120kW. Using VertiFlow cooling enables an energy cost reduction of at least 100-130kW, which corresponds to an annual saving of around €100,000 per cooling fan (based on an average cost of €0.1/kWh). In that sense, a cooling fan designed for a stack cooling machine must not be used on a 'full VertiFlow' forming machine (AIS/NIS) for energy reasons, as well as for poor cooling efficiency reasons that can strongly affect production performances on the machine.

For best mould cooling performance and energy cost reduction, BEG recommends that glass plants invest in cooling fans of variable speed drive type and rotary vane control, following the company's latest cooling air requirements specification.

Importance of blow head design

Blow head design is very often misunderstood, leading to certain glass cooling restrictions when inappropriate designs are used. The blow head arm supplies compressed air to the blow head's tube, having a specific inner bore diameter. This air usually exhausts via two holes having another specific inner diameter. The relationship between the inlet and outlet areas on the blow head design is very important, because it will directly influence the resulting internal pressure inside the container during the final blow process, as well as the mass flow volume of final blow air. These two aspects play an important role in removing heat from the recently formed container at the blow side and therefore need to be taken carefully into account to ensure high quality containers.



Optimum machine performance with the correct forming process.

For a typical 28mm diameter finish design, for example, good results are achieved when using an inner tube diameter of 8mm, with two exhaust holes of 5mm diameter. Considering an inlet pressure of 1.6 bar at the blow head arm infeed, the resulting internal pressure inside the newly formed container will be approximately 1.2 bar (see accompanying images). This pressure is required to push the glass wall thickness against the blow mould cavity, in order to extract heat from glass to the blow mould.

By increasing the two exhaust holes from 5mm to 6mm, the total exhaust area will accordingly be increased (keeping an internal tube diameter of 8mm). However, this will result in a reduced internal pressure of 0.9 bar during the final blow process, instead of 1.2 bar as previously. Consequently, the glass wall is pushed less against the mould cavity, exchanging less heat to the mould, so that glass remains softer when leaving the blow mould. This can lead to dimensional defects (leaners, out-of-round), as the newly formed container can deform.

The ratio between blow head infeed and exhaust is an important parameter to control, in order to ensure correct heat removal from glass at the blow side.

It is important to note that the length of the blow head's tube will also influence glass cooling at the blow side, as it can influence the air velocity distribution inside the newly formed container during the final blow process. The ideal length of the tube depends primarily on the container shape (long neck or high shoulder container), as well as on the maximum straight stroke given by the blow head mechanism on a machine. Forming machines with longer straight stroke (NIS/AIS) will allow the use of 80mm long tubes, which is a real asset to position the tube at the shoulder 'entrance radius' on long neck containers. In comparison with the use of a short tube, this will generate additional convection cooling in the

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glass WORLDWIDE

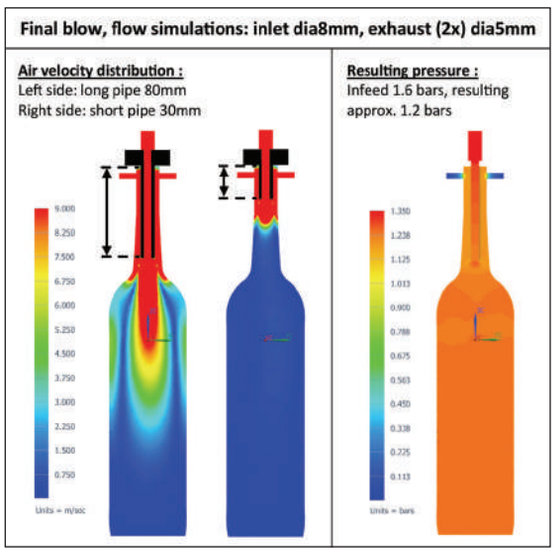
shoulder and top body part of the container and consequently, extract additional heat from the glass during the final blow process (see images).

The use of blow side vacuum will also help maximise cooling efficiencies at the blow side. Not only does the vacuum process enable faster contact between glass and blow mould cavity, leading in an increased heat removal from glass to mould (because longer contact time equals longer heat removal from glass) but it actually helps to ensure that no air is entrapped in the blow mould cavity, in particular in the gap between the mould cavity and the glass wall. Having the correct resulting internal pressure inside the container during the final blow process, a perfect contact between the glass wall and the blow mould cavity is key to remove heat efficiently from the glass.

Future of mould design: Modelling and simulation

In the future, mould designers should evolve to become true process engineers, not only designing curves on CAD software but also fully understanding the IS process and being capable to better interact with production staff on the forming machines. This evolution in mentalities is key in order to increase production efficiencies, especially to reduce the development time from concept to final produced glass containers.

To facilitate that evolution, new software solutions and packages will need to be developed and correctly introduced to glass plants. Computerised designs provide for precise and predictable applications of mould cooling, blow head designs, cooling tube designs, as well as the glass forming process to predict theoretical glass thickness distribution. This virtual prototyping process is certainly a long-term development process. Each glass plant will experience a learning curve that depends mainly on the willingness of mould designers and IS operators to accept a new technology, which does not work against them but instead, helps those reaching faster, higher efficiencies on forming machines. ●



Final blow flow simulations; inlet diameter 8mm, exhaust (2x) diameter 5mm.

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Photochromism and Glasses – Part I - General

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Abstract

Photochromism has quite a long history. Its application in glasses is also well-known. Apart from sunglasses for the protection of our eyes as well as a fashion item, particularly in a sunny area, there are also many other exotic applications of photochromism. This will be discussed in the Part – I of this paper along with some interesting examples. Broadly, it comes under the category of coloured glasses, which has been discussed in some details in the past in Kanch. There will be more description about coloured glasses in future issues of Kanch including on coloured glasses photochromic glasses and other compounds of technical interest.

INTRODUCTION

Whenever we talk about glass, the word "transparency" comes to our mind. Among the two most important applications, let us remind ourselves the following: Firstly, these transparent glasses are used both as container glasses for drinking water, fruit juices and for some people, beers and other drinks, and they are also contained in different types of container bottles with or without aesthetic appeal with further usage as jars, pans, bowls, trays, plates, etc. Secondly, they are also used as 'float glasses' as transparent windows for getting more light inside the building, room separators in offices, staircase sideways in commercial buildings and Malls, etc. This has been discussed in the past in many articles in Kanch **[1-4]**.

Apart from this extra-ordinary transparency with a lot of clarity, there are some high value glasses with much more optical clarity, known as optical glasses for our eyes. Moreover, using known theory of the propagation of light through glassy medium coupled with ligand field theory of various transition metal ions (Fe, Cu, Cr, Co, etc.), we are interested to describe the behaviour of coloured glasses **[5]**. In this category, photochromic glasses assume special significance, which has a variety of applications including 'sunglasses' for the protection of our eyes from sunlight.

Basically, "Photochromism" is considered as the 'reversible transformation' of a chemical species between two forms by the absorption of electromagnetic radiation that is normally called photo-isomerization, where the two forms have different absorption spectra **[6,7]**. Trivially, this can be described as a reversible change of colour upon exposure to light. After giving a brief description of its history, some applications will also be discussed below.

THE HISTORY

In the late 1880, photochromism was discovered that included research work by Markwald, who studied the 'reversible change' of color of 2,3,4,4-tetrachloronaphthalen-1(4H)-1 in the solid state. He labeled this phenomenon as "phototropy". In the next 70 years there was some progress in this field of research, and this name was used until the 1950s, when an Israeli scientist, Yehuda Hirshberg, of the famous Weizmann Institute of Science proposed the term "photochromism" **[8]**.

Photochromism can take place in both organic and inorganic compounds, e.g. in inorganic silicate glasses and it also has its place in biological systems, e.g. retinal in the vision process.

THE APPLICATIONS

Sunglasses →

It can be made as a polymer lens. In 2005, it was reported that attaching flexible polymers with low glass transition temperature, e.g. siloxanes or poly (We all know about Sunglasses that is one of the most famous reversible photochromic applications, i.e. colour changing lenses for sunglasses as found in eyeglasses. There are some limitations in the use of PC technology and the largest limitation is that the materials cannot be made stable enough to withstand 1000 of hours of outdoor exposure and hence at this moment, the long-term outdoor applications are not proper.

The speed at which the system goes to on-state (i.e. coloured) and back to off-state (i.e. normal) is called the switching speed. The switching speed of photochromic dyes is highly sensitive to the rigidity of the environment around the dye. As a result, they switch most rapidly in solution and slowest in the rigid

environment butyl) acrylate, to the dyes allow them to switch much more rapidly in a rigid lens **[7, 8]**. Some compounds such as 'spirooxazines' are attached with siloxane polymers, and they switch at near solution-like speeds, even though they are in a rigid lens matrix. This is a slight development in the whole process.

Supramolecular Chemistry →

Photochromic units have been employed extensively in supramolecular chemistry. Their ability to give a light-controlled reversible shape change means that they can be used to make or break molecular recognition motifs, or to cause a consequent shape change in their surroundings. Thus, photochromic units have been demonstrated as components of molecular switches. The coupling of photochromic units to enzymes or enzyme cofactors even provides the ability to reversibly turn enzymes "on" and "off", by altering their shape or orientation in such a way that their functions are either "working" or "broken".

Data Storage →

The origins of the field date back to the 1950s, when Yehuda Hirshberg developed the photochromic spiropyrans and suggested their use in data storage **[8]**. Since that time, there have been many investigations by various academic and commercial groups, particularly in the area of 3D optical data storage which promises discs that can hold a terabyte of data. Initially, issues with thermal back-reactions and destructive reading dogged these studies, but more recently more-stable systems have been developed.

Novelty Items →

Reversible photochromism are also observed in a variety of applications such as toys, cosmetics, clothing and industrial applications. If necessary, they can be made to change between desired colors by combination with a permanent pigment.

Solar Energy Storage →

Researchers at the Center for Exploitation of Solar Energy in the Department of Chemistry at the University of Copenhagen (Denmark) are studying the Photochromic Dihydroazulene–Vinylheptafulvene System. This is being done for possible application to harvest solar energy and store it for significant amounts of time. Although storage lifetimes are attractive, for a real device it must of course be possible to trigger the back-reaction, which calls for further iterations in the future.

After a few applications, it is quite pertinent to get an 'overview' on this interesting subject of photochromism.

The Overview →

Photochromism does not have a

rigorous definition, but is usually used to describe compounds that undergo a reversible photochemical reaction where an absorption band in the visible part of the electromagnetic spectrum changes dramatically in strength or wavelength. In many cases, an absorbance band is present in only one form. The degree of change required for a photochemical reaction to be dubbed "photochromic" is that which appears dramatic by eye, but in essence there is no dividing line between photochromic reactions and other photochemistry.

Therefore, while the trans-cis-isomerization of azobenzene is considered a photochromic reaction, but the analogous reaction of stilbene is not. Since photochromism is just a special case of a photochemical reaction, almost any photochemical reaction type may be used to produce 'photochromism' with appropriate molecular design. Some of the most common processes involved in photochromism are pericyclic reaction, cis-trans isomerization, intra-molecular hydrogen transfer, intra-molecular group transfers, dissociation processes and electron-transfer (oxidation-reduction).

Another requirement of 'photochromism' is two states of the molecule should be thermally stable under ambient conditions for a reasonable time. All the same, nito-spiropyran - that generally back-isomerizes in the dark over ~10 minutes at room temperature - is considered 'photochromic'. All photochromic molecules back-isomerize to their more stable form at some rate, and this back-isomerization is accelerated by heating. There is therefore a close relationship between photochromic and thermochromic compounds. The timescale of thermal back-isomerization is important for applications, and may be molecularly engineered. Photochromic compounds considered to be "thermally stable" include some diarylethenes, which do not back-isomerize even after heating at 80^{0}C for 3 months.

Since photochromic chromophores are "dyes", and operate according to well-known reactions, their molecular engineering to fine-tune their properties can be achieved relatively easily using known design models, i.e. quantum mechanical calculations, and experimentation. In particular, the tuning of absorbance bands to particular parts of the spectrum and the engineering of thermal stability has received much attention.

Sometimes, and particularly in the dye industry, the term "irreversible photochromic" is used to describe materials that undergo a permanent color change upon exposure to ultraviolet or visible light radiation. Due to the very definition of photochromics that are reversible, there is technically no such thing as an "irreversible photochromic" - this is loose usage, and these compounds are better referred to as "photochangable" or "photoreactive"

dyes.

Apart from the qualities already mentioned above, several other properties of photochromics are important for their use. These include "quantum-yield", "fatigue resistance", photostationary state, and polarity and solubility. The 'quantum yield' of the photochemical reaction determines the efficiency of the photochromic change with respect to the amount of light absorbed. The quantum yield of isomerization can be strongly dependent on conditions. In photochromic materials, fatigue refers to the loss of reversibility by processes such as photo-degradation, photo-bleaching, photo-oxidation, and other side reactions.

All photochromics suffer fatigue to some extent, and its rate is strongly dependent on the activating light and the conditions of the sample. Photochromic materials have two states, and their inter-conversion can be controlled using different wavelengths of light. Excitation with any given wavelength of light will result in a mixture of the two states at a particular ratio, called the photo-stationary state. In a perfect system, there would exist wavelengths that can be used to provide 1:0 and 0:1 ratios of the isomers, but in real systems this is not possible, since the active absorbance bands always overlap to some extent. In order to incorporate photochromics in working systems, they suffer the same issues as other dyes. They are often charged in one or more state, leading to very high polarity and possible large changes in polarity. They also often contain large conjugated systems that limit their solubility.

CONCLUSIONS

Apart from many applications of photochromic materials described above, it should be pointed out that many inorganic substances also exhibit photochromic properties, often with much better resistance to fatigue than organic photochromics. In particular, silver chloride is extensively used in the manufacture of photochromic lenses. Other silver and zinc halides are also photochromic. Yttrium hydride is another inorganic material with photochromic properties. Therefore, it is apparent that there is a large number of organic and inorganic compounds which could be used as photochromic materials for a variety of applications.

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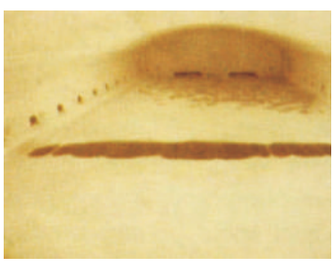







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Optimum design concept for energy-efficient furnaces

Xuqing Xie discusses the AGCC approach to furnace design to reduce energy costs and CO_2 emissions.

It was in July 2018 that Asahi Glass changed its name to AGC Inc. The group's wholly-owned AGC Ceramics (AGCC) subsidiary started making refractories in 1916 and provides products and services in the fields of glass, aluminium, cement and incineration etc.

Dating from 1976, the AGCC engineering business has built various glass furnace types, including recuperative, side-port, end-port and oxy-fuel combustion furnaces for container, tableware and sodium silicate glasses. Reducing fuel consumption is becoming increasingly important to protect the global environment. The AGCC design concept contributes to the management of these issues.

Energy saving design

Fossil fuel is used as the main energy source to melt containers, tableware and sodium silicate. To reduce fuel consumption, it is necessary to improve the insulation and heat recovery efficiency. These improvements should be realised while considering the balance with glass quality and furnace life. AGCC has addressed this issue for many years and has achieved several successes.

Ecolead is the name of the AGCC design. Figure 1 shows actual energy consumption results for furnaces, when comparing side-port, general end-port and Ecolead furnace designs without electric boosting. The X axis is the furnace pull, while the Y axis shows the unit consumption. As a general rule, the unit consumption of an end-port furnace is better than from a side-port design. Ecolead is better than the general end-port. For example, for a pull of 200 tonnes/day, the unit consumption of the end-port design is over 10% less than a side-port. But the unit consumption of Ecolead is +5% less than the end-port.

Xuqing Xie addresses the 42nd ASEAN Glass Conference in Yogyakarta, Indonesia, in September 2018.

Efficiency and cost of electric boost

Electric boosters can heat glass effectively and are widely used. Since the glass is directly heated by electricity, it is efficient and can easily realise pull and glass quality improvements.

The blue line in figure 2 shows the change of total energy consumption against the amount of electricity in a 250 tonnes/day furnace that uses gas combustion and electric boost. Energy consumption is improved by increasing electrical power, because electricity is directly applied to the glass.

On the other hand, the red line in figure 2 shows the change of total energy cost for gas and electricity calculated by equation 1. Gas and electricity costs are calculated using

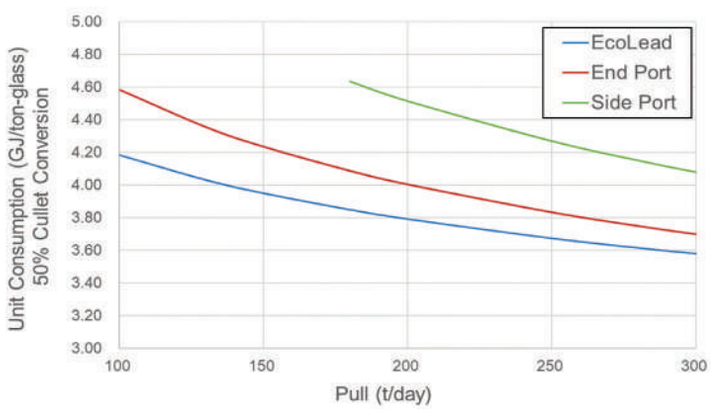

Figure 1: Unit consumption comparison of glass furnaces (without electric boost).

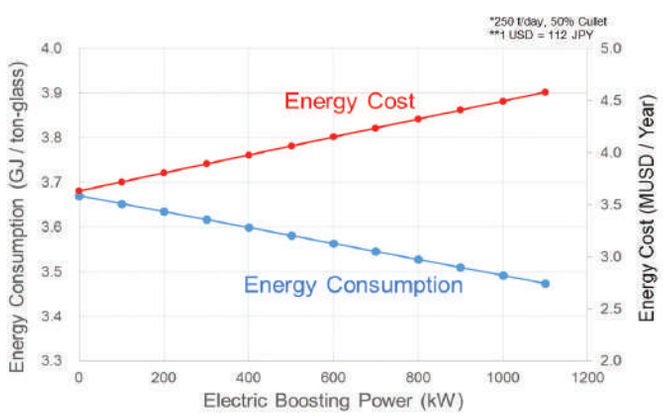

Figure 2: Relationship between energy consumption and cost in Japan.

Equation 1: Cost calculation equation.

ASEAN FEDERATION OF GLASS MANUFACTURERS

This article is based on a paper presented by Xuqing Xie at the 42nd ASEAN Glass Conference in Yogyakarta, Indonesia, held in September 2018. **www.aseanglass.org**

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prices in Japan. As the power of the electric boost increases, the amount of gas used can be reduced but the total energy cost increases. This is due to the fact that the efficiency of electrical energy is better than gas combustion and the price of electricity is more expensive than gas. In the Japanese market, therefore, fossil fuel is used as the main energy source and electricity is used as necessary.

CO_2 emissions comparison

Fossil fuels emit CO_2 as shown in equation 2, so the CO_2 emission of each energy source should be considered:

$C_xH_y + (x+y/2)\ O_2 \rightarrow x\ CO_2 + y/2\ H_2O$ ... equation 2

Table 1 shows the comparison results of CO_2 generation of each energy source in Japan. The CO_2 emission factor in table 1 is a value indicating the average CO_2 emission from city gas, fuel oil C and electricity in Japan. Results of the three summarised cases show that city gas is the lowest CO_2 generator, while electricity and fuel oil C are almost the same. This means that using electricity does not necessarily lead to CO_2 emission reduction in Japan.

Because most power generation in Japan uses fossil fuel, there is CO_2 emission at the power plant. The loss of electrical transmission gives the effect to energy efficiency. In fact, it must be considered on a case-by-case basis, depending on the country and location where the furnace is constructed.

Electricity has low CO_2 emissions in the furnace. However, it cannot remove CO_2 emissions totally because the fossil fuel is also the energy source for power generation. So, CO_2 is generated in power generation plants and sending loss from the power plant to the furnace increases CO_2 emissions.

Energy source for power generation in Japan and ASEAN

Figure 3 shows the energy source for power generation in Japan and ASEAN. In Japan, almost 75% of power generation is generated from fossil fuel. For Indonesia, the Philippines and Thailand, fossil fuel is also the main energy source for power generation; Indonesia is over 85%, the Philippines is nearly 70% and Thailand is also over 85%. In these countries, the CO_2 emission factor and energy cost appear very similar.

As a general rule, the life of a glass furnace is very long, sometimes more than 15 years. Figure 4 provides a perspective of the world's electricity demand. Energy demand is expected to increase in the future but fossil fuels will still be the main energy source for power generation, at more than 50%. Under this trend, the use of energy saving furnaces is very important. AGCC will continue to create a value through ceramics technology to protect the global environment.

Insulation material and design

AGCC's key material for insulation is called THERMOTECT (TMT). In 2015, this material received the grand prize for excellent energy solutions in Japan. It has many excellent properties such as high thermal insulation at high temperatures, low ageing degradation and human body-friendly (non-refractory ceramic fibre).

AGCC uses TMT for ports, regenerator walls, breast walls and crowns, as shown in figure 5. The material has already been adopted in many furnaces. Customer feedback is that TMT exhibits no degradation compared with conventional insulation materials, as in the example of figure 6 (continued on page 92).

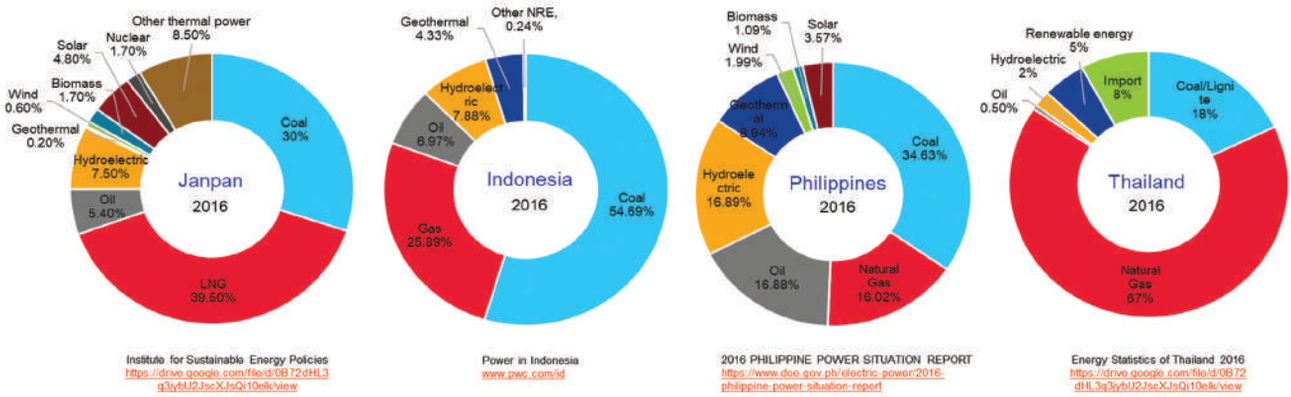

Figure 3: Energy sources for power generation in Japan and ASEAN.

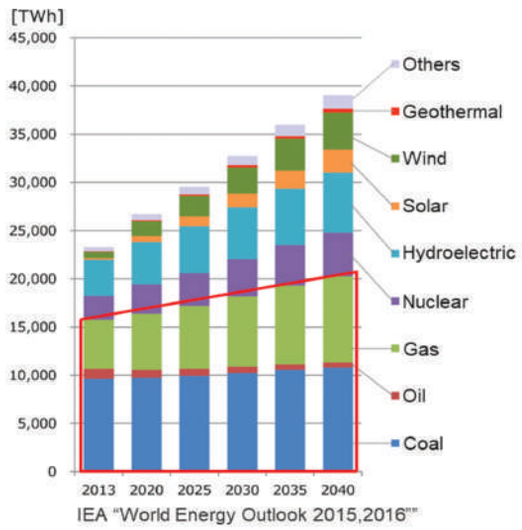

Figure 4: Global electricity demand.

Conclusions

In order to reduce energy costs and CO_2 emissions, it is important to combine optimal energy sources, depending on conditions in every country and location. Reducing fuel consumption is becoming increasingly important to protect the global environment.

In addition, the combination of materials and design technologies must be balanced and energy saving needs must be addressed in the future. ●

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	CO_2 Emission Factor (t-CO2/GJ)	Energy Efficiency	CO_2 Generation (t-CO2/GJ)
City Gas	0.050	40%	0.13
Fuel Oil C	0.072	40%	0.18
Electricity	0.144	85%	0.17

CO_2 Emission Factor / Energy Efficiency = CO_2 Generation

Table 1: CO_2 generation comparison for each energy source in Japan.

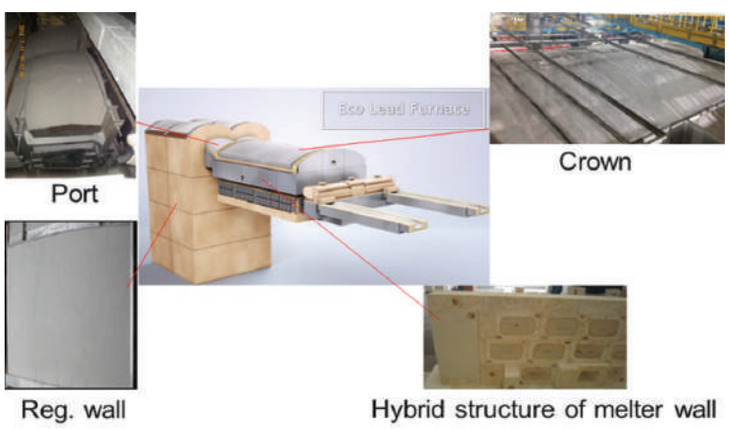

Figure 5: THERMOTECT application for glass furnaces.

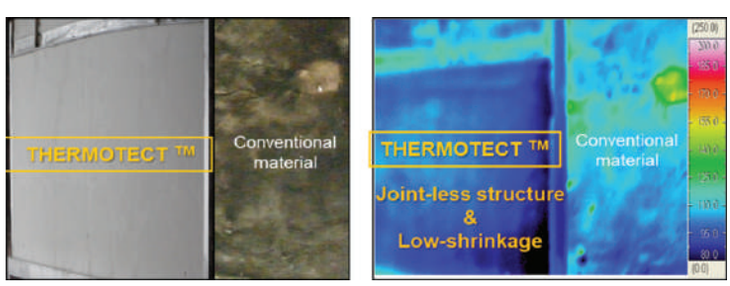

Figure 6: Thermo viewer imager comparison between TMT and conventional insulation materials after 2.5 years' use.

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Usable Glass Strength Coalition review

UGSC
Usable Glass Strength Coalition

Originally speaking to *Glass Worldwide* (preferred international AIGMF journal), Alastair Cormack and Robert Weisenburger Lipetz discussed the benefits of industry coalition funding of fundamental research in usable glass strength.

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The Usable Glass Strength Coalition (UGSC) was an industry-led consortium, providing an opportunity for companies that participate in the glass industry to share the costs and potential benefits of fundamental research into usable glass strength. The shared vision was that most glass companies cannot independently support a fundamental research agenda to understand and significantly improve the usable strength of glass. However, by working together with pooled funding and shared risk, the opportunity to significantly improve the usable strength of glass would be achievable.

Over its seven year history, the coalition was able to support two university-based research projects that, in turn, generated five research publications and helped prepare four students for careers in the glass industry. This article describes the rationale and history behind the coalition's formation, as well as the products of the enterprise.

Alastair Cormack PhD, Van Derck Fréchette Professor of Ceramic Science, Founding Dean, The Inamori School of Engineering at Alfred University.

Robert Weisenburger Lipetz MBA, Executive Director, Glass Manufacturing Industry Council.

Why fundamental research in glass strength?

Although a ubiquitous and extremely versatile material, it is well known that glass is subject to a fundamental flaw: It fractures. This is because it is brittle and once cracks begin to propagate, they cannot be stopped, unlike metals, in which dislocations limit crack propagation. To make glass strong enough to use, extra weight is added. If it was possible to understand the fundamental science behind why glass factures and hence prevent it, glasses could be created that are tens or hundreds of times stronger in use. As a result, innovative manufacturing processes could be designed that would make current glass products much lighter. In addition, new products could be developed for applications that previously required metallic materials such as steel. The use of glass as a material would be revolutionised and there would be a huge impact on sustainability objectives.

Table 1 compares the theoretical, intrinsic strength of glass (actually, silica) and the usable strength for some common products. As is well known, glass is highly susceptible to the generation of surface flaws during manufacturing and handling. The flaws are sources of the cracks which lead to fracture. As a result, the usable strength of glass is only a fraction of its potential. Note that silica fibres, prepared and measured under carefully controlled, environmentally-free conditions have been found to have intrinsic strengths as high as 11-13 GPA, rising to 14 GPa at liquid helium temperatures. However, typical glass applications realise only 0.5% of the intrinsic strength. So far, engineering solutions, such as improved processing techniques (ie more automation, less handling by humans) and secondary treatments like thermal and chemical tempering, have only pushed the strength envelope to under 10% of intrinsic strength.

Condition of glass	Strength (lb/in²)	Strength (MPa)
Theoretical	2,000,000	17,000-18,000
Pressed articles	3000-8000	21-56
Blown ware	4000-9000	30-63
• Inner surface	15,000-40,000	105-280
Drawn tubing or rod	6000-15,000	42-105
Glass fibres		
• Freshly drawn	30,000-400,000	207-2758
• Annealed	10,000-40,000	69-280
Window glass	8000-20,000	56-138

Table 1: Theoretical versus usable strength of glass.

Even modest gains in glass strength translate to significant efficiencies. Less raw material is needed to make the same products. Less energy is required, creating cost savings and reducing emissions. Stronger glass means lighter products and more applications. Transportation costs are reduced. Storage is more efficient. Products can be packaged, transported and used with greater safety. Stronger, lighter glass vastly multiplies its possible applications for products and makes them more efficient. A breakthrough in fundamental understanding, leading to the production of stronger glass, would be a game changer.

With recent developments in experimental and theoretical techniques in mind, a group came together to try and address the problem. The origins of the present initiative go back almost 20 years.

History and organisation

In 2007, The Glass Manufacturing Industry Council (GMIC), American Ceramic Society's Glass and Optical Materials Division (GOMD), Center for Glass Research (CGR) and National Science Foundation (NSF) issued the following contest challenge to the brightest international university students: "If glass of any type were available at 50 times its current strength, what new products, engineering opportunities or cost savings could emerge into the marketplace?"

The contest received 47 papers from 28 universities in five countries. First Prize went to Armin Dillert of Friedrich Alexander University in Erlangen. His concept for 'Flexible Thin Solar Panels' demonstrated the potential of combining the fundamental benefits of glass with super-thin, super-strong glass. Second prize winner, Julieann Heffernan of the New Mexico Institute of Technology provided a

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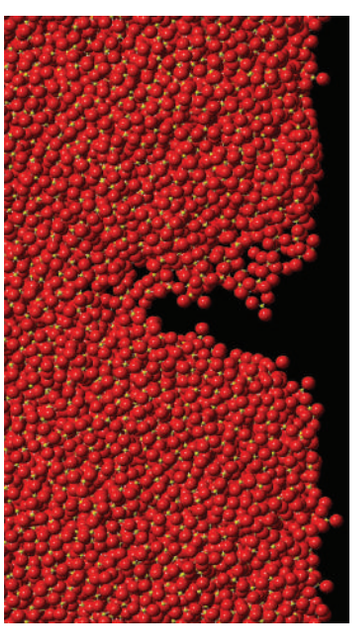
convincing argument for the conversion of rooftops from traditional asphalt shingle to glass. But as her analysis showed, this would not be cost-effective without significant increases in the usable strength of glass.

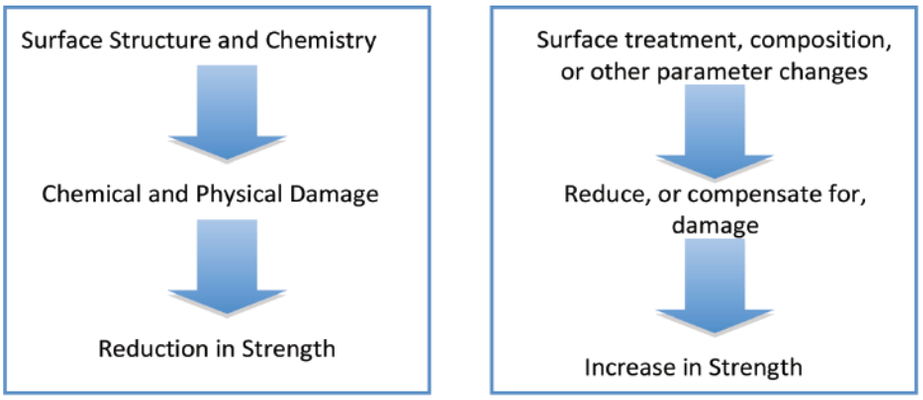
Around that time, the development of several cutting edge research tools has advanced to where they can be exploited for glass strength research. Unfortunately, government funding to rigorously put these techniques and capabilities to use in understanding glass strength was not readily available and research was sporadic. Although university researchers had good ideas for advancing glass strength research, they found few avenues for funding, particularly in the USA; most of the progress was being made in Europe and Japan. Discussions with the usual sources of funding, like the US DoE, DoD and NSF, revealed little enthusiasm for funding research in glass, which was generally seen as a mature field.

A loose group of university, industry and agency members, including Dr Chuck Kurkjian, formerly of Bell Labs and Michael Greenman, then Executive Director of the GMIC, had been meeting at various conferences to discuss how to move forward. At that time, it became clear that without strong support from the glass manufacturing industry, little was going to happen.

The PacRim 2009 meeting in Vancouver, BC became the tipping point. After a full day symposium on glass strength, wheels were put in motion to establish a consortium of glass companies, later to become the UGSC. This led to follow-up meetings at Alfred University and Penn State, resulting in the coalition vision statement: 'Glass companies cannot independently support a fundamental research agenda to understand and significantly improve the usable strength of glass. However, by working together with pooled funding and shared risk, the opportunity to significantly improve the usable strength of glass is achievable.'



A crack propagates into the glass from a surface flaw.



Research Roadmap. The left graphic summarises the two phases of research, providing a route to understanding what causes the reduced usable strength of glass. The first focusses on glass surface structure and chemistry, while the second addresses mechanisms of chemical and physical damage as they relate to usable strength reduction. The right graphic is acorollary, emphasising a way to increase the usable strength by taking advantage of the research outcomes funded by the coalition.

Initial seed funding from Corning, Johns Manville, Owens-Illinois, Owens-Corning, Saint-Gobain Containers, Annheuser-Busch/InBev, International Partners in Glass Research, Coca-Cola, Diageo, Emhart and Rio Tinto Minerals was used to support the development of formal operation and participation agreements and a research roadmap.

At a meeting in Savannah, Ga in 2011, led by Alastair Cormack (Alfred University), the Coalition Research Team affirmed the need for a programme of basic research, focusing on the question of how and where flaws nucleate in glass. The objective was to gain a deeper, fundamental understanding of the relationship between surface structure, surface chemistry and the strength of glass, illustrated in a two-step graphic. The first step starts with understanding surface atomic structure, since that is where the flaws of interest start. A critical component of this is understanding the effect of chemistry on surface structure and subsequently, how surface structure is impacted by chemical and physical damage. And that, of course, leads to reduction in strength. Therefore, the first goal of the research roadmap was to have the researchers explain why glass shows a reduction in strength, ie the role that surface structure and chemistry plays in reducing the strength of glass. This is the thrust of the RFP issued in March 2013.

To operate effectively, administration, management and IP oversight mechanisms were needed.

A home for the coalition was needed and the most logical choice was the Glass Manufacturing Industry Council. GMIC was already a recognised glass industry representative, co-ordinating a number of technical projects and many of the companies participating in the UGSC discussions were its members. The UGSC was incorporated as a wholly-owned for profit subsidiary of GMIC in 2011. Under this arrangement, UGSC participation was separate from GMIC membership. Research findings were shared only among UGSC participants and not with GMIC members until the findings were made public. The nature of the UGSC activities were spelt out in an operating agreement and the rights and responsibilities of participants in a participation agreement. The UGSC had its own independent board of directors that oversaw research focus and management.

Traditionally, when research is funded through universities, the university is assigned the intellectual property (IP) and a royalty free license is granted to the sponsor. Although initial thoughts centered on the idea that generated knowledge would be owned by the participants, after many iterations of drafts of the operation agreement having been reviewed by various legal and IP experts, representatives of coalition companies' management and legal departments, UGSC leaders concluded that it would be too difficult to gain consensus on the ownership of IP by the participants. An operating agreement was produced, in which IP generated directly by UGSC-funded research would become public domain, consistent with the view that the supported research was to be pre-competitive in nature.

UGSC participants received the following benefits: Coalition participants enjoyed no less than one year exclusive early access to the research body of work. Participants exclusively set the coalition research agenda and selected research projects for funding. Participation dues and corresponding voting power were determined by annual glass sales. A company with more than a billion dollars in annual glass sales had dues of $40,000. However, that also gave four votes on the board of directors. Companies providing less support had fewer votes on the board. One hundred percent of UGSC revenue came from participants' dues. These funds paid for the university research contracts, as well as administrative expenses. Various companies participated in ▸

the coalition over its seven year history, including 3B, Coca-Cola, Diageo, Johns Manville, Owens Corning, PepsiCo, Sun Chemical, Rio Tinto Minerals, Owens-Illinois and Annheuser-Busch InBev.

Products

Scientific research produces outcomes that can be either tangible or intangible. In the case of the research sponsored by the UGSC, tangible outcomes include students (undergraduate, graduate and post-doctoral) educated in glass science who subsequently become employed within the glass industry, publications in the archival literature describing the work done for the benefit of future generations of glass scientists, as well as technical presentations at national and international scientific conferences.

Two projects were supported by the coalition during its lifetime. The first, at The Pennsylvania State University, was entitled 'Controlling and understanding reactive surface sites on multi-component glasses', with PIs Carlo G Pantano and Seong H Kim. The second was at the Colorado School of Mines, entitled 'Fundamental Understanding of Strength Limiting Flaws in Multi-Component Glass', with PI Ivar Reimanis. Both RFPs attracted more than a dozen high quality proposals, each making the final choice quite difficult.

The UGSC funding led directly to five publications:

- Probing Hydrogen-Bonding Interactions of Water Molecules Adsorbed on Silica, Sodium Calcium Silicate and Calcium Aluminosilicate Glasses, J Phys Chem C (2018), 122, 17792–17801, Sheth et al.
- Characterisation of surface structures of dealkalised soda lime silicate glass using x-ray photoelectron spectroscopy, specular reflection, attenuated total reflection infrared and sum frequency generation spectroscopies, J Non-Crystalline Solds, 474 (2017) 24-31, Sheth et al.
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- Zero Stress Ageing in Notched Multi-Component Glass Fibers, Journal of the American Ceramic Society (2018), Van Sant et al.

Two more are in preparation. More than a dozen talks, including invited presentations at national and international meetings, such as the International Congress on Glass, The American Ceramic Society's Glass and Optical Division Conferences and the Conferences on Glass Problems, held every year, were based on work supported by the coalition. Both the graduate student and post-doc who worked on the Penn State project are now employed by major glass companies in the USA. The CSM project supported an undergraduate student and a research assistant professor.

UGSC support also enabled the university groups to acquire additional pieces of equipment to enhance their research capabilities.

Less quantifiable outcomes include closer relationships between university researchers and industry practitioners and informal networking.

One thing that became clear is the merit of using a combination of experimental techniques to characterise glass surfaces and the difficulty of probing just the top few Ångstroms to identify clearly the active sites. There is a lot more work to be done if the atomic structures associated with flaw creation are to be properly understood.

Summary

The UGSC can be seen as a contemporary model for industrially-funded precompetitive research. It brought together a group of companies, ranging from large manufacturers to users and suppliers, with the specific purpose of focusing on a single – but critically important – property of glass, namely its (mechanical) strength, with the goal of understanding its fundamental scientific orgins and thus how to improve it.

A key point is that such coalitions spread the cost. They enable companies to be involved in long-term research, when they have no relevant in-house capability or cannot devote adequate resources to run their own research projects. As noted above, it produced a number of positive outcomes, in the form of people educated to work in the glass industry and several contributions to the scientific literature, whose merits are being recognised by being cited in the work of others. Furthermore, it enabled the application of novel techniques such as vibrational sum frequency generation spectroscopy and atomic probe tomography to glass surfaces, experiments which would probably not have been performed without the input from the coalition.

To be successful, the coalition required the active participation of individuals within the various companies, who could champion the notion of precompetitive, long-term research to their senior management. It is believed that the coalition's approach to IP should serve as a model for future industry-based funding efforts. The idea is that, because its nature was defined to be precompetitive, the results and data generated by the UGSC-sponsored research would enter the public domain after a period of time, during which company participants would be able to determine whether IP could be created by further research, which built on the output of the UGSC-sponsored research. Such further research would be conducted by the company in its own facilities.

A weakness of this approach is that the longevity and critical size of the coalition is dependent on continuing support from corporate participants. Ongoing budget commitments from participants of more than a year at a time can be hard to sustain. This is not, perhaps, entirely surprising in an industry that is often thought to be a mature commodity market, particularly in the flat glass and container segments. As personnel changes within companies occured, continuing support for the coalition sometimes experienced a change in priority. Matching university-based research time spans against the shorter ROI horizon of commercial enterprises proved to be a limiting factor.

In retrospect, this initiative proved that the industry can collaborate on longer-term research missions of mutual benefit. It developed a successful model of organisation that could easily be applied to future coalitions. Organising around an industry trade association proved to be a practical structure and streamlined administration. It also showed that sharing the early research results but eventually relinquishing the IP to the public, relieved the coalition of the burdens that would come with attempting to form an IP sharing partnership.

It is to the industry's benefit that new research techniques were applied to research as a result of the coaltion's interests. Ultimately, the coalition demonstrated that the technical and intellectual capacities of universities can be initiated more rapidly and with better focus on industry's interests, when the industry comes together to fund precompetitive fundamental research. ●

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Originally published in Glass Worldwide, preferred international journal of AIGMF

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