Vol. 7 | No. 1 | April - June 2019

Kañch

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The All India Glass Manufacturers' Federation

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

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2.5 MM	4.0 MM
2.8 MM	

Recent Awards & Accolades:

- Letter from Hon. Prime Minister Narendra Modi for successfully completing trials of 2mm Fully tempered Solar Glass.
- FT 1000 High-Growth Companies Asia-Pacific 2018.
- 15th FGI Awards for Excellence
- CII BE STAR Recognition Emerging Leader - Excellence in Operations Management
- Capexil Special Export Award

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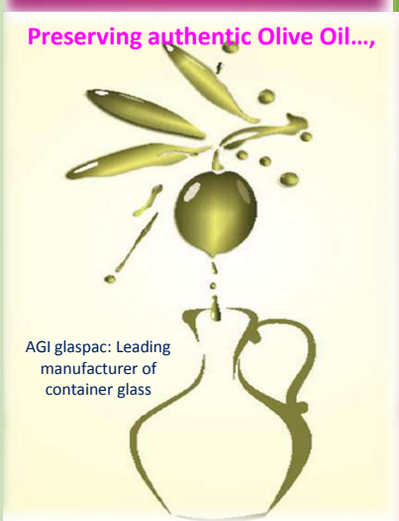
AGI glaspac.....Delighting customers since 1972



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From President's Desk

Executive Committee of the AIGMF met at the Yoga Capital of the World in the foothills of Himalayas on May 3, 2019 at Modi Yoga Retreat, Rishikesh (Uttarakhand). The meeting was hosted by HNG & Industries Ltd. Among main agenda points, discussions were carried on celebrating Platinum Jubilee of AIGMF alongside Ex Com and Annual General meetings in September in Delhi. Launch of other related events as a warm-up before platinum jubilee event i.e. 2nd AIGMF Glass Awards as well as 2nd AIGMF Drawing Competition on theme 'Adopt A Glass Bottle' were also discussed.

Select members of The All India Glass Manufacturers Federation participated at the 30th China International Glass Industrial Technical Exhibition at New China International Exhibition Center (NCIEC), China from May 22-25, 2019. Participation was mainly to study latest technology know how for the overall development of Indian Glass Industry in line with 'Make in India' vision of the Government of India.

Bureau of Indian Standards (BIS) in association with IIT Madras and Glazing Society of India (GSI) organized a workshop on National Building Code of India: Glass and Glazing Aspects on June 28th at Bengaluru. Ms. A Geetha, Joint Director, Town and Country Planning Department (TCP), Govt of Karnataka; and Ms. Jessy Benny, Head BIS, Bengaluru delivered the Chief Guest and key-note address respectively. Experts of NBC delivered six technical presentations on the topic. The workshop saw the participation of 200+ delegates representing private and government building construction and regulation departments, related professionals, and academic institutions. Mr. S. Arun Kumar, Scientist D, CED delivered an overview of NBC & on glass and glazing. The All India Glass Manufacturers' Federation was one of the supporting Associations for the workshop.

Details of 2nd AIGMF Glass Awards as well as 2nd AIGMF Drawing Competition on theme 'Adopt A Glass Bottle' are available on AIGMF website. I request one and all to spread these messages enabling larger participation with web link as www.aigmf.com ■

(Raj Kumar Mittal)
President AIGMF
President U.P. Glass Manufacturers' Syndicate (UPGMS) **and**
Managing Director– Mittal Group of Glass Industries, Firozabad

2nd AIGMF Glass Awards

Supported by:

In recognition of tremendous contribution to Indian Glass Industry, The All India Glass Manufacturers' Federation (AIGMF) announces C K Somany Award for Innovation & Technology and Balkrishna Gupta Award for Exports.

C K Somany Award for Innovation and Technology will be given to an individual who has made significant contributions to the glass industry in the field or fields of manufacturing, product development, environmental factors, business performance/growth, research and development and/or science/ technology.

Balkrishna Gupta Award for Exports will be given to an individual/firm by considering following factors: who have contributed towards identification or growth of new potential markets/volume of exports/ reaching no. of countries or any other area showcasing valuable contribution in Glass exports.

Referral applications can also be submitted by Regional Associations U.P. Glass Manufacturers' Syndicate (UPGMS)- Firozabad; South India Glass Manufacturers' Association (SIGMA)- Hyderabad; Western India Glass Manufacturers' Association (WIGMA)-Mumbai, Northern India Glass Manufacturers' Association (NIGMA)- Bahadurgarh, Haryana and Eastern India Glass Manufacturers' Association (EIGMA)- Kolkata, who may give recommendation for giving award to a likely individual.

AIGMF may also take help of BHU (Ceramic Glass Division), CGCRI (Central Glass and Ceramic Research Institute), CCPS (Confederation of Construction Products and Services) and FOSG (Federation of Safety Glass), for identifying suitable candidates for the award.

2nd award in these categories are likely to be given in September/October 2019 at platinum jubilee celebrations of AIGMF during Annual General Meeting or at glasspex India 2019.

The jury for awards will comprise of:

- Dr. K. Annapurna, Senior Principal Scientist, Glass Division, CSIR-Central Glass & Ceramic Research Institute (CSIR-CGCRI), Kolkata
- Mr. Dave Fordham, Publisher, Glass Worldwide, London (UK)
- Mr. Bharat Somany, Senior Vice President AIGMF and Vice President HNG Industries Ltd., Bahadurgarh (Haryana)
- Mr. M K Bansal, Executive Committee Member AIGMF and Partner, Shri Sitaram Glass Works, Firozabad (UP)
- Mr. Vinit Kapur, Secretary AIGMF, Delhi

Applications are invited at info@aigmf.com from within India from all those connected with glass industry who may submit a brief write-up/CV in support of their candidature latest by July 31, 2019 ■

GLASS News

MICHEL GIANNUZZI ELECTED AS NEW FEVE PRESIDENT

At its Annual General Assembly in June, FEVE elected its executive team for the 2019-21 term of office.

Mr. Michel Giannuzzi, Chairman and Chief Executive Officer of the Verallia Group – one of Europe's leading glass packaging manufacturers for the food and beverage sector, has been elected as President of the association, succeeding Mr. Johan Gorter, CEO of Ardagh Glass Europe. Commenting on his new role, Mr. Giannuzzi said: "Our industry has a unique opportunity right now: as packaging is under scrutiny by consumers for its sustainability and healthy credentials. The glass industry is perfectly positioned to respond to customer and regulatory requirements leveraging the benefits of the Circular Economy".

Today, some 80 billion bottles, jars and flacons are supplied annually to the global food and beverage industry as well as to fragrance, cosmetics and pharma markets. Glass packaging is easily and infinitely recyclable. In the last fifteen years, glass recycling has increased by 139% throughout Europe. Some 1.5 million bottle banks are available across the region and an average of 74% of Europe's glass is collected for recycling, demonstrating the success of the dedicated glass recycling scheme introduced in Europe in the 1970s. These numbers also underline the commitment of the glass industry to attain aggressive recycling rates.

Mr. Giannuzzi added, "As we move towards a more sustainable future, we

have a great opportunity to continue innovating glass production. We are determined to further reduce our industry's environmental footprint, increase quantity and quality of recycled glass, and continue to design new packaging solutions that provide value to our customers and their brands". He concluded: "In my role as President, building on the excellent job done by my colleague Johan Gorter, I want to convey enthusiasm and energy, and further promote sustainability goals, technology innovation, customer proximity and consumer engagement".

In addition, Mr. Vitaliano Torno, President of O-I Europe, has been elected Vice-President of FEVE. Mr. Torno commented: "Our customers thrive on glass as the most sustainable packaging solution. Led by the knowledge and ambition of our industry's employees, we are innovating to help our customers build their precious and renowned brands and become valued partners as well as sustainable producers. I am determined to move the glass industry forward and promote the benefits of glass."

FEVE is the Federation of European manufacturers of glass containers and machine-made glass tableware. Its members produce over 20 million tonnes of glass per year. The association has some 60 corporate members belonging to approximately 20 independent corporate groups. Manufacturing plants are located across 23 European States and include global blue chip and major companies working for the world's biggest consumer brands.

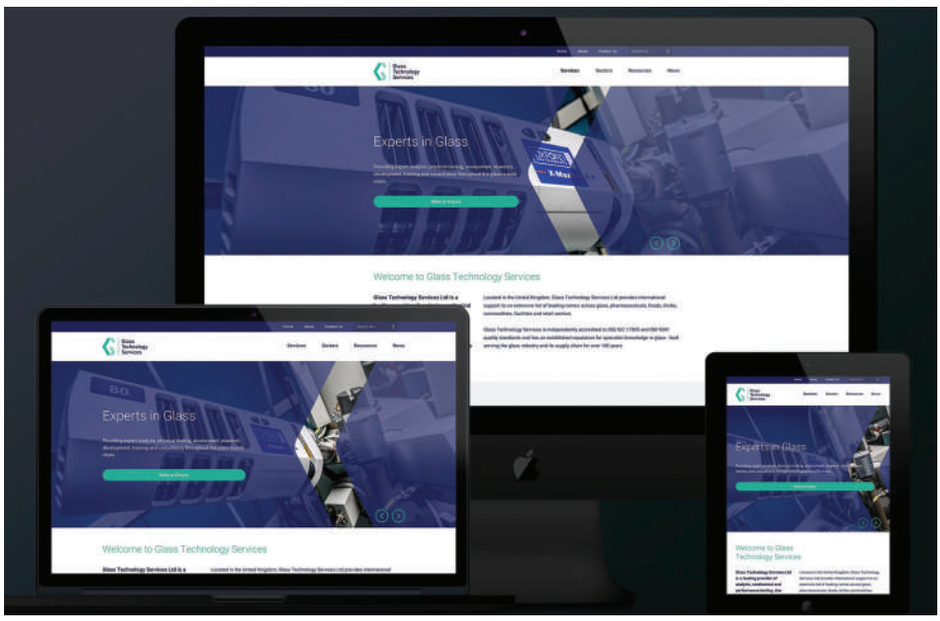
GOPAL GANATRA ELECTED AS PRESIDENT OF CCPS

Mr. Gopal Ganatra has been appointed as President of Confederation of Construction Products & Services (CCPS).

The Confederation of Construction Products and Services is a non-profit organisation which is dedicated to the sustainable growth of construction products sector by working collectively with its members and others to improve quality and efficiency in construction.

Mr. Ganatra is Fellow Company Secretary, a law graduate and MBA in Finance & Marketing from Management Development Institute (MDI), Gurgaon. He has 15 years of experience (all with Asahi India Glass Ltd.) in various

fields of Business Management, Legal Operations, Strategic Finance, Corporate Strategy, Joint Venture Management, Corporate Restructuring, Mergers & Amalgamations, Business Feasibility Studies, Analysts Communications and Presentations, Corporate Communications, Strategic Marketing, Business Operations and Review, MIS, Governance, Risk Management, Internal Audit, IT, HR, New Business Start-up and overall general management.



NEW RESPONSIVE WEBSITE FOR THE EXPERTS IN GLASS

Leading experts in glass, Glass Technology Services, have unveiled a brand-new responsive website – completing their rebranding process and continuing their programme of strategic investments throughout the growing business.

Built with a responsive layout, the new website ensures a consistent cross-device user experience, as well as improved navigation and enquiry processes – making it easier than ever for visitors to access the information they need and contact the experts for technical support.

The rebuild includes a refresh of their free 'glass weight estimator' and 'effective U-value' calculators, which alone receive over 9,500 visitors a month.

Head over to www.glass-ts.com to learn more and see the changes.

The fresh new site showcases Glass Technology Services' wide range of analytical and technical support offered throughout the glass supply chain - including specialist support in pharmaceuticals, food and drink and manufacturing sectors.

Their technical support, which includes training, product verification, performance testing, technical consultancy and routine analysis, enables the world's leading brands to verify their products, troubleshoot issues and pave the way with cutting-edge glass research and new product development.

Business Development Manager, Mr. Phil Marsh said: "We're delighted to unveil the final part of our rebranding - the new website reflects our new branding perfectly and provides a seamless experience for our customers to get the information they need, while showcasing the very best of what our expert teams provide.

"Over a third of visitors use a portable device to access our content and this number is rapidly growing – so, it was essential that we adopted responsive design to ensure our customers and prospective clients receive a consistent experience however they access our site and can easily access the content they need."

Glass Technology Services Ltd., provides analysis, consultancy, testing and research and development support to all parts of the glass supply chain – from raw materials to the end consumer. The experts in glass pride themselves on their reputation, confidentiality and impartiality and are accredited to ISO 9001 and ISO/IEC 17025 standards.

JOIN THE No.1 - POSITIVE TREND IN THE INDUSTRY CONTINUES – EXHIBITOR REGISTRATION NOW OPEN

The world's biggest get-together of all protagonists in the glass industry will once again be held in Düsseldorf from October 20-23, 2020.

At the 26th glasstec - International Trade Fair for Glass Production, Processing and Products – again over 40,000 visitors are expected to come from some 120 countries and in excess of 1,200 exhibitors from over 50 nations. The development of this the world's No. 1 trade fair for glass reflects the positive global trend in the glass sector. The latest figures from the European and the German market serve as an example for the positive development in industry.

As of now companies from the areas of mechanical engineering, industry and skilled crafts can register for glasstec 2020 online.

Exhibitors can register for glasstec using the direct link www.glasstec-online.com/2330

Companies that already participated in 2018 can use already pre-completed and editable forms. The allocation of stand space will start after the registration deadline on December 1, 2019.

For more information on glasstec 2020 go to: www.glasstec.de or www.glasstec-online.com

UK RESEARCH COULD 'CUT EMISSIONS AND SAVE MILLIONS OF POUNDS'

Scientists at UK-based Glass Technology Services have demonstrated techniques that could potentially cut carbon emissions drastically and save the glassmaking industry millions of pounds every year by using waste ash from biomass power plants.

Research in the laboratories in Sheffield has shown that using the ash could cut carbon emissions and replace up to a fifth of the conventional mined and man-made raw materials used to make glass (sand, soda ash and limestone). UK biomass power plants currently produce more than one million tons of waste ash a year.

And now the researchers, working with Sheffield Hallam University, are looking at how they can make the process more efficient, demonstrating to glass manufacturers that they can make quality glass using waste ash which melts at lower temperatures thus saving energy costs, and at the same time cut down on CO_2 emissions.

This could give a massive boost to the manufacture of bottles and jars, float glass for windows, doors and the automotive industry, the glass fibre used in wind turbines, and high-value ceramics.

Glass Technology Services (GTS) is leading two collaborative projects in this area. The first, funded by a £508,000 grant from government department BEIS, the Department for Business, Energy and Industrial Strategy, is looking to develop glass products for the coloured container glass sector. The second, with a £494,000 grant from Innovate UK, the Government's innovation agency, is looking at how the ash could be used in a broader range of applications, including float glass, glass wool and high value ceramics. Both projects are researching how to reduce the glass melting point, cutting the energy required to make the glass, and CO_2 emissions.

Although the UK glass industry is among the most efficient in the world, it generates more than 2 million tonnes of CO_2 a year from burning fossil fuels to power furnaces and from the unavoidable release of CO_2 from raw materials such as limestone during the melting process. The industry has increased productivity and cut carbon emissions by 54% since 1979, and the GTS research is another part of its work to continue improving that figure.

Mr. Rob Ireson, leader of the GTS innovation team, said: "Our research could mean potential savings to the UK glass industry of £1.6m a year in energy costs and CO_2 savings of around 10%.

"Other benefits include less emissions, reducing the impact of mining and the amount of hazardous waste sent to landfill.

"As an industry we are already working hard to improve efficiency across all aspects of glass manufacture. The 2050 'Roadmap' which the trade membership organisation British Glass has produced together with Sheffield Hallam University is leading the way for the sector. It looks at improving furnaces, and the design of the product being manufactured, whether that is bottles and jars or flat glass for buildings. We are also focusing closely on waste heat recovery and recycling.

"So this is very exciting work. If by using waste ash from power stations we can cut down on carbon emissions, reduce the amount of energy needed, and also reduce the waste material we produce, it's a win-win situation for everybody."

SCHOTT REPEATEDLY INCREASES PRODUCTION CAPACITY FOR PHARMACEUTICAL TUBING IN INDIA

The German technology group SCHOTT is investing an additional double-digit million-euro figure into a new glass tank at its tubing manufacturing plant in Jambusar, Gujarat. The expansion follows recent investments at the site including the construction of another additional tank facility just last year. Production of pharmaceutical FIOLAX® tubing from the new tank is scheduled to begin in the second half of 2020.

The capacity expansion is part of the company's global growth strategy of its pharma tubing and packaging business segments. "The pharmaceutical market is booming worldwide with a very high demand for premium pharmaceutical packaging and tubing", comments Dr. Patrick Markschlaeger, Executive Vice President at SCHOTT, Business Unit Tubing. "In order to supply the rapidly growing domestic and Asian market, we are investing once again a multimillion-euro figure in our Jambusar site to increase our manufacturing capacity in India."

FIOLAX® borosilicate glass tubing features a high hydrolytic resistance, which makes it an ideal material for primary packaging of medicines. "Since its development in 1911, FIOLAX® has been established as the gold-standard material for pharmaceutical containers and its behavior with drugs is well researched and proven. In India, it is primarily used to manufacture glass vials and ampoules", adds Mr. Sundeep Prabhu, Vice President Sales & Marketing Jambusar at SCHOTT Glass India Pvt. Ltd.

In line with the company's aim to manufacture zero defect tubing, the tank will feature the unique big data approach perfeXion®. The process, which has been rolled-out globally by SCHOTT since 2017, ensures 100% quality control of each tube on the line by using cameras, laser and IR inspection systems. "In Jambusar we are combining Indian and European technologies and local skills. With the additional tank, we are also adding new workplaces," explains Mr. Georg Sparschuh, Managing Director at SCHOTT Glass India Pvt. Ltd.

The new tank will be built and equipped with the latest state-of-the art machinery according to the high standard of all SCHOTT Tubing production sites. Besides the tank facility, the investment includes an extension of the batch house, warehouses and a new chimney.

GULF GLASS RETURNS TO DUBAI FROM SEPTEMBER 24-26

Gulf Glass, the leading glass event in the Middle East, will return to the Dubai World Trade Centre from September 24-26, 2019, alongside Windows, Doors & Facades Event (WDF), the region's largest dedicated exhibition for the windows, doors and facades industry.

The two exhibitions will run in parallel providing industry professionals a unique platform to source innovative products from around the world, discover the latest technologies, network and learn.

Leading brands including Saint Gobain, BDF Industries, Henry F. Teichmann, Horn Glass Industries, Bucher EMHART Glass, BASF, Forma Glass, Lizmontagens, Asahi India and Godrej already confirmed their participation at Gulf Glass.

The move comes as industry reports forecast growing business opportunities in the Middle East. According to a recent MEED Projects report, in fact, the value of construction projects either in the planning stage or in the delivery stage is estimated at USD 2.7 trillion across the GCC only.

Mr. Muhammed Kazi, Portfolio Event Director at DMG Events, says: "The UAE is expected to witness the major growth in the container glass segment in the coming years, and huge opportunities emerge in the flat glass segment too thanks to its versatile application in the construction industry. The demand for green buildings, solar technologies, and eco-friendly facades innovations for both new and retrofit projects in the Middle East are opening a wealth of opportunities to both local and international manufacturers across the glass, windows, doors and facades industries."

In 2019, over 11,000 participants are expected to meet in Dubai at Gulf Glass and the co-located WDF, where more than 300 exhibiting brands will showcase their products.

The largest glass, windows, doors and facades industry gathering in the Middle East, will also offer a wide

education agenda including free CPD-certified workshops delivered by industry experts across the three days.

The educational sessions will include presentations on challenges in selecting the right glass solutions, managing the aesthetic of glass architecture, latest trends in the use of BIPV glass, energy saving solutions for the glass industry, and advances in smart glass and smart tinting technologies, among others.

Dr. Elmira Ryabova, the President, CEO, CTO and founder of the California-based Advenira Enterprises, Inc., is one of the confirmed speakers at Gulf Glass. Presenting a workshop on "Non-metallic Solar Heat Control Coating for Automotive and Architectural Glass", Dr. Ryabova is an industry leader with extensive experience in thin film technology, and is actively working with a number of top glass manufacturers across the world to enable affordable energy-saving window coating technology for modern architectural and automotive glass industries.

"We have developed UV - and abrasion-resistant solar heat control coating solutions for polycarbonate applications, such as sunroofs, aerospace, and railroads," she says. "While most of these projects are well underway in Europe and Asia, we feel that the Middle East should be our main focus area to introduce non-metallic Solar Heat Control coatings.

"We firmly believe that the UAE and its neighbors will find our coatings extremely attractive, as there is no shortage of bright, hot sunny days throughout a year. Partnerships in the production of energy saving windows, glass and polycarbonate to be supplied locally and globally is our primary goal."

Commenting on her participation as a speaker at Gulf Glass 2019, Dr. Ryabova adds: "We will be happy to share the accumulated knowledge and expertise in Solar Heat Control coatings with all the attendees, and hope that our unique and proprietary SDN® technology will pave the way for environmentally friendly, energy efficient, and lower emission habitat for human kind."

Organised every two years by DMG Events, Gulf Glass is an unmissable one stop shop for all things related to glass. It hosts suppliers of finished products, glass production technology and machinery, glass processing & finishing solutions, measurement, testing & control technology, tools, replacements and spare parts, as well as auxiliary equipment and fitting.

The latest edition of the show, which took place in 2017, welcomed 5,500 participants and over 140 exhibitors from 22 countries.

Gulf Glass is supported by Glass Source (Exclusive Glass Solutions Sponsor), Thomas Bell-Wright International Consultants (Testing & Certification Partner), and Advenira (Workshop Sponsor).

The event is free to attend for industry professionals. To know more about Gulf Glass (September 24-26 2019, Dubai World Trade Centre), Visit: www.gulf.glass

Executive Committee of the AIGMF met at the Yoga Capital of the World in the foothills of Himalayas on May 3, 2019 at Modi Yoga Retreat, Rishikesh (Uttarakhand). The meeting was hosted by HNG & Industries Ltd. Among main agenda points, discussions were carried on celebrating Platinum Jubilee of AIGMF alongside Ex Com and Annual General meetings in September in Delhi. Launch of other related events as a warm-up before platinum jubilee event i.e. 2nd AIGMF Glass Awards as well as 2nd AIGMF Drawing Competition on theme 'Adopt A Glass Bottle' were also discussed.

मोदी 2.0 का पहला बजट: क्या हुआ महंगा और क्या हुआ सस्ता

जुलाई 5 को वित्त मंत्री निर्मला सीतारमण ने मोदी सरकार 2.0 का पहला बजट पेश किया। दो घंटे 10 मिनट के बजट भाषण में निर्मला सीतारमण ने कई नई योजनाओं के एलान के साथ कई वस्तुओं के दाम घटाने और बढ़ाने की घोषणा की।

इस बजट के बाद पेट्रोल-डीजल की कीमतों में बढ़ोतरी होगी। सरकार ने दोनों पर एक रुपये की एक्साइज ड्यूटी में बढ़ोतरी की है, जिसके बाद पेट्रोल और डीजल एक रुपये महंगे हो जाएंगे। साथ ही सरकार ने सोने के इंपोर्ट पर ड्यूटी 10 प्रतिशत से बढ़ाकर 12.5 प्रतिशत किया है।

इनकी बढ़ी कीमतें:

बजट में पेट्रोल, डीजल और सोने के साथ आयातित किताबों पर पांच प्रतिशत का शुल्क बढ़ाया है। इसके अलावा ऑटो पार्ट्स, रबर, पीवीसी और टाइल्स की कीमतों में बढ़ोतरी होगी। साथ ही, तंबाकू उत्पादों पर शुल्क बढ़ाया गया है, जिसके बाद उनकी कीमतों में भी बढ़ोतरी होगी। साथ ही, सोने के अलावा चांदी और चांदी के आभूषणों पर भी लोगों को ज्यादा जेब ढीली करनी पड़ेगी। वहीं बजट 2019 में ऑप्टिकल फाइबर, स्टेनलेस उत्पाद, मूल धातु के फिटिंग्स, फ्रेम और सामान, एयर कंडीशनर, लाउडस्पीकर, वीडियो रिकॉर्डर, सीसीटीवी कैमरा, वाहन के हॉर्न आदि की कीमतों में बढ़ोत्तरी की गई है।

ये हुए सस्ते:

इलेक्ट्रिक कारों को बढ़ावा देने के लिए सरकार ने इलेक्ट्रिक कारों की खरीद पर जीएसटी की दरों को 12% से घटाकर 5% कर दिया है। साथ ही इलेक्ट्रिक कारों को खरीदने में लिये गए लोन के ब्याज पर इनकम टैक्स में 1.5 लाख रुपये तक की छूट मिलेगी। बजट में होम लोन भी सस्ते होंगे। सरकार 45 लाख तक के घर पर साढ़े तीन लाख रुपये की छूट देगी।

इसके अतिरिक्त साबुन, शैंपू, हेयर ऑयल, टूथपेस्ट, डिटरजेंट वाशिंग पाउडर, पंखे, लैम्प, यात्री बैग, सेनिटरी वेयर, **बोतल, कंटेनर,** रसोई के बर्तन, चश्मों के फ्रेम, बांस का फर्नीचर, पास्ता मियोनीज, नमकीन, सूखा नारियल की कीमतों में कटौती की गई है, जिसके बाद इन्हें खरीदना और सस्ता हो जाएगा।

बजट २०१९: कहां मिली राहत और कहां बढ़ा बोझ

सस्ता	महंगा
डिफेंस इक्विपमेंट्स	मार्बल
इलेक्ट्रिक वाहनों और उनके पार्ट्स	वीडियो रिकॉर्डर
धूपबत्ती, चश्मों के फ्रेम, **बोतल कंटेनर**	ऑटो पार्ट्स
होम लोन	सीसीटीवी कैमरा
साबुन, शैंपू और हेयर ऑयल	मेटल फिटिंग
टूथपेस्ट और वाशिंग पाउडर	आयातित किताबें
ब्रीफकेस, यात्री बैग	सोना, चांदी के आभूषण
बर्तन, पास्ता, मियोनीज, नमकीन, सूखा नारियल	टाइल्स
ऊन और ऊनी धागे	पेट्रोल-डीजल

STORE WATER IN GLASS BOTTLES TO KEEP IT FREE FROM TOXINS, CLEANER AND SAFE FOR DRINKING

Some health experts believe that one should consume water stored in clay pots, while some believe storing it in glass bottles is also a healthy way to go.

Glass bottles are preferred over other packaging medium and considered healthier as they are free from contaminants.

Glass bottles contain no chemicals, and also do not absorb the taste or odour of any fruit or beverage stored in them.

Considering climate change and its effects on millions of people worldwide, even a small change in lifestyle that is environmentally friendly can go a long way. Glass can be easily recycled by keeping the environment and our bodies healthier.

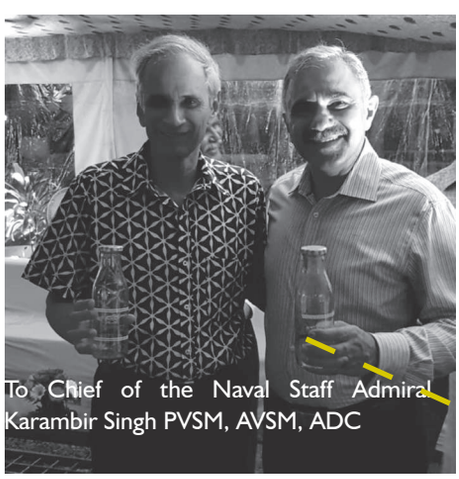
Glass bottles stay cleaner and also are easy to clean. They are also easy to sterilize without the fear of them melting or degrading.

Once you clean and store water in glass bottles in the fridge, they keep the water clean and safe, and you can enjoy fresh, filter clean water without the risk of toxins, chemicals, etc.

SWATCH BHARAT ABHIYAAN: PRESENTATION OF ECO-FRIENDLY GLASS BOTTLES

The All India Glass Manufacturers Federation (AIGMF) gifted glass bottles carrying logo of **'Swachh Bharat Abhiyaan'** as part of its ongoing commitment for clean India campaign.

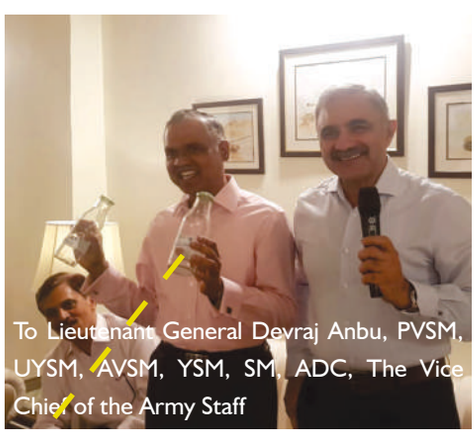
Col. Arun Bahl (Retd.) of Ceracon Engineers, an Affiliate Member and part of the Government Coordination Committee along with Secretary AIGMF gave glass bottles to select government establishments.



To Chief of the Naval Staff Admiral Karambir Singh PVSM, AVSM, ADC

A glass bottle (*specially manufactured by Hindustan National Glass and Industries Ltd.*) with

World Environment Day and Swachh Bharat Abhiyaan (*Clean India campaign*) logos was launched by AIGMF on May 26, 2018 enabling people demand responsible and safe packaging.



To Lieutenant General Devraj Anbu, PVSM, UYSM, AVSM, YSM, SM, ADC, The Vice Chief of the Army Staff

स्वच्छ भारत
एक कदम स्वच्छता की ओर
Glass is 100 % recyclable

To Lieutenant General S K Jha, PVSM, YSM, SM, Commandant Indian Military Academy, Dehradun

To Mr. Harinder S Sikka, Group Director, Piramal Enterprises Ltd. Author of book "Calling Sehmat" on which movie Raazi is based. Producer of movie "Nanak Shah Fakir" winner of three National Awards

AIGMF AT CHINA GLASS 2019

The 30th China International Glass Industrial Technical Exhibition was held at New China International Exhibition Center (NCIEC), China from May 22-25, 2019.

China Glass 2019 attracted 34,329 visitors from 66 countries during the four days event, including 30,279 domestic visitors and 4,050 foreign visitors.

The event had 6 theme exhibition areas including international area, flat glass and glass products, integrated manufacturer, processing equipment, Raw and auxiliary materials and refractory materials, accessories and glass hardwares. Many exhibitors displayed innovative glass products, processing equipment and cutting-edge intelligent manufacturing technology. The exhibits related to intelligent manufacturing, green manufacturing and other new technologies, new products and equipment in the field of building energy conservation has become a hot spot for many visitors. Many manufacturers and research institutions released their latest products during the event. China Building Materials Academy displayed the core material of bio-optical identification chip used in fingerprint identification of smartphone.

China Glass Expo is one of the largest glass-fairs of Asia and is one of the most important international trade fairs for glass production and processing. It was founded in 1986 and is aimed both at professionals as well as to public audiences.

China Glass Expo is held once a year in spring alternately at the sites of Beijing and Shanghai. Main organizer of the China Glass Expo is the Chinese Ceramic Society, founded in 1945 (CCS), which has its registered office in the Chinese capital.

China Glass Expo is the only glass exhibition, which is sponsored by the Government of the People's Republic of China and of Chinese trade organizations. Newest technologies, machinery and glass products in the fields of architectural, industrial glass and glass products for photovoltaic systems were exhibited. The companies that represented at the Expo comprised of large enterprises, small and medium-sized companies.

Select members of The All India Glass Manufacturers Federation (AIGMF) participated at the 30th anniversary event mainly to study latest technology know how for the overall development of Indian Glass Industry in line with **'Make in India'** vision of the Government of India.

Sixteen seminars and product promotion meetings were held during the exhibition. The topics covered intelligent manufacturing in glass industry, environmental protection technology in glass production, energy-saving of furnace, application technology of coating, various innovative technologies and applications in glass processing, new products and technologies in glass printing, etc. According to the statistics of the on-site staff, the seminars attracted nearly 1,000 visitors to be present and the number of technical seminars and audience reached a new high.

China Glass 2020 will take stage at Shanghai New International Expo Centre on April 14-17, 2020, its booth sales work will start in the upcoming July ■

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

AIGMF
THE ALL INDIA GLASS MANUFACTURERS' FEDERATION

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Visit the AIGMF online library of *Glass Worldwide* articles at www.aigmf.com

For weekly news update and highlights of the latest issue of *Glass Worldwide*, visit www.glassworldwide.co.uk

Welcomes New Member

S. No.	Company (Name and Address)	Products/ Services
1.	Mr. Nitesh Goyal **Goyal Glassware Private Limited** A-11, UPSIDE, Indl. Area, Jalesar Road, Firozabad – 283 203 U.P. M : +91 9319053610 E : glassgoel@gmail.com	Manufacturer of Glass Bottles

Membership of the Federation

Members of the Federation are classified into two categories; manufacturers of primary glass articles are enrolled as **Ordinary Members** of the Federation and suppliers to glass industry viz., suppliers of machinery, raw materials, consultants and others connected with glass industry are enrolled as **Affiliate Members**.

Foreign Companies supplying machinery etc., to glass industry are also enrolled as **Affiliate Members**.

Membership forms can be downloaded from www.aigmf.com/membership.php

Members of the Federation are enrolled on the recommendation of Zonal Associations viz.:

- Eastern India Glass Manufacturers' Association (EIGMA)
- Northern India Glass Manufacturers' Association (NIGMA)
- South India Glass Manufacturers' Association (SIGMA)
- Uttar Pradesh Glass Manufacturers' Syndicate (UPGMS)
- Western India Glass Manufacturers' Association (WIGMA)

ADMISSION FEE / ANNUAL SUBSCRIPTION

Ordinary Members:

- Admission fee ₹ 5000/-
- Annual subscription: Single Unit: ₹ 27,500 + GST as applicable
- More than one Unit: ₹ 1,10,000 + GST as applicable
- Applicants for enrollment for a period of five years may pay a consolidated amount of ₹ 1,25,000 for a single Unit and ₹ 5,00,000 for more than one Unit + GST as applicable

Affiliate Members:

- Admission fee ₹ 5000/-
- Annual subscription: ₹ 11,000 + GST as applicable
- Applicants for enrollment for a period of five years may pay a consolidated amount of ₹ 49,500 (including admission fee) + GST as applicable

Affiliate Members from countries other than India:

- Admission fee US $ 200
- Annual subscription: US $ 440 + GST as applicable
- Applicants for enrollment for a period of five years may pay a consolidated amount of US $ 1,650 (including admission fee) + GST as applicable ■

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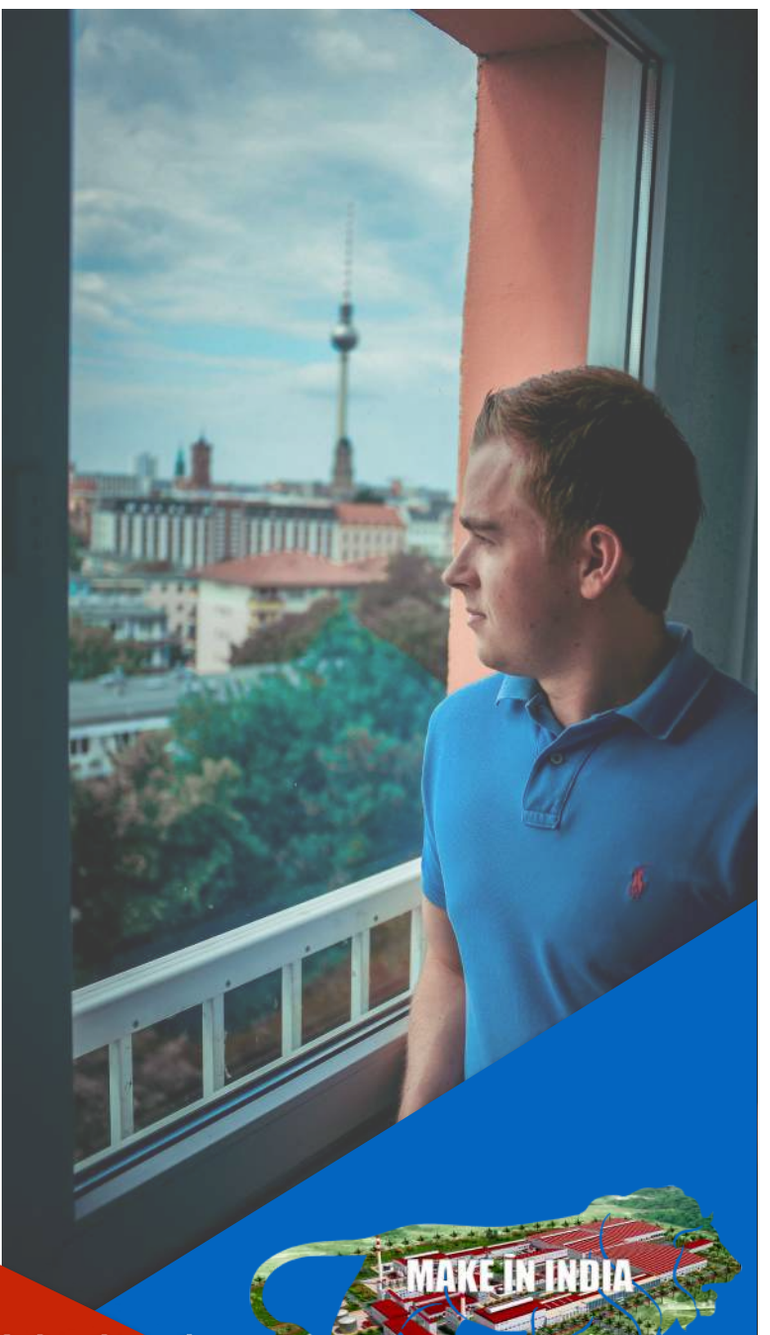

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FEDERATION OF SAFETY GLASS (FOSG) CONCLAVE 2019

(April 6-8, 2019)

FOSG's 9th conclave in the holy city of Amritsar this year witnessed unprecedented success with the largest gathering of processors till date and an all-time-high infusion of new members joining the association.

The conclave began with the attendees paying homage to Late Mr. R.S. Subramanian of Saint-Gobain Glass (India), who was a strong supporter of FOSG and its achievements since the founding days. Mr. Gurmeet Singh, Chairman FOSG, then presented the conclave's theme - Vision 2025 to be the improvement of ROI for its members by focusing the Federation's activities. Throughout the course of the conclave, presentations and panel discussions were directed towards deriving inputs on how to make FOSG's Vision 2025 achievable at the ground level.

During the past few years FOSG had been advocating for strengthening the implementation of RERA and the NBC's recent inclusion of glass as a part of their code with various government representatives. A presentation outlining the association's activities on the subject and the future plans for the same was given by Mr. Sharanjit Singh from GSC Glass Ltd. The panel consisting of Mr. Sadiq Kapadia from Modern Safety Glass, Mr. Ali Asgar from Sapphire Glass, Mr. Parmeshswaran from Madras Tuff Glass India, Mr. Hunaid Kachwala from Zenith Safety Glass, Mr. Rakesh Awasthi from Ozone Overseas and Mr. Chandan Kumar from Kuraray then discussed the likely impact for the strengthening of RERA and NBC's implementation would have on the market. It was concluded that educating and creating awareness amongst local governance bodies and consumers for its effective implementation was crucial as it was bound to increase the consumption of processed glass. It was also suggested by Mr. Sadiq Kapadia for running an awareness campaign through digital marketing for spreading awareness for the end users focusing on risks of not using safety glass in various applications. Mr. Kapadia's suggestions were applauded and was requested to take this responsibility further.

With the increase in consumption / demand for processed glass comes the difficulties attached to credit sales and the timely recovery of dues. The next presentation focused on various means by which credit sales can be recovered successfully. The delayed payments recovery to MSME's via MSME-Samadhaan portal, the trades receivable e-discounting system (TReDS) in addition to FOSG's role in helping with the recovery of money were presented by Ms. Varsha Konidala from Balaji Building Technologies Ltd. Both the audience and the panelist consisting of Ms. Himansee Jain from Fuso Glass, Mr. Palaniappan from Masss Glass India, Mr. Mahesh Agarwal from Agarwal Toughened Glass, Mr. Praveen B from Gaap Tuff Glass and Mr. Hussain Rampurwala from Sapphire Glass participated actively in vocalizing their

issues and viewpoints regarding credit sales and its necessity for conducting business. Although the viewpoints put forth were extremely polarized, they were accepted with professional decorum by all those present. Deeming credit sales to be difficult to eradicate at this stage, the panelist then debated on how FOSG can further succeed with these recoveries by strengthening regional communication amongst members whilst dealing with habitual defaulters.

Yet another short coming of India's adolescent glass processing industry is the lack of knowledge on ones costing. FOSG has strived to educate its members regarding the calculation of manufacturing/post manufacturing costs and how to identify, review, reduce and recover them. Ms. Sheetal Khanna from Gold Plus explained the costing worksheet FOSG has developed to facilitate each individual processor in knowing their own cost. Following this, Ms. Khanna gave a detailed presentation on the terms and conditions of business to print on quotations and invoices, their importance and implications. The panel consisting of Mr. Suresh Shah from Ridhi Sidhi Glasses, Mr. Parmeshswaran from Madras Tuff Glass India, Mr. Chaitanya Madan from Manchu Toughened Glass, Mr. Farhat Kamil from Kaenat Glass, Mr. Sahil Singal from Mirage Toughened Glass and Mr. Robin Mukesh from Birkan Engineering Works discussed the instances during which such explicit terms and conditions have favored them and also concluded a few variations of the same being used by several of them. Several members requested FOSG to make a standard draft of the terms and conditions to be circulated amongst its members who would then select and eliminate points to be published in their documents subsequently.

One of the main focus of FOSG's Vision 2025 in improving the ROI for its members is by the means of optimizing costs. Aptly FOSG had released its android and iOS App in addition to their website's 'lounge' platform to provide a means for inventory sharing and pool purchases that would facilitate lowering expenses. Although the use of these platforms have not been encouraging over the past years, the infusion of a younger tech-friendly members into the association has revived concentration on the same. Ms. Himansee Jain from Fuso Glass India Pvt. Ltd. moderated the panel discussion with panelists consisting of Mr. Farhat Kamil from Kaenat Glass Industries, Ms. Manpreet Kang from J.K. International, Mr. Lokesh Pathak from Art N Glass, Mr. Bhawesh Patel from Swastik Glass and Mr. Sham Ramakrishna from Uma Industries on how these platforms can be made more convenient for its members, highlighting any technical support needed, the benefits that current users have gained from them and the modalities of information exchange on such platforms. Many members who were unaware of such tools available from amongst the audience proactively downloaded the application on their phones and sought for a separate training session to be able to use these platforms efficiently. FOSG then committed to revive its efforts in brining awareness and increasing the activities on the same shortly.

The Indian glass processing industry has seen an exponential surge in new processors majorly in the form of single tempering line plants (STP) all across the country. Mr. Ajay Dhamija from Prolific Glass and Ms. Sheetal Khanna from Gold Plus led the moderation of the panelists consisting of Mr. Parmeshswaran from Madras Tuff Glass India, Mr. Ajay Patel from Krishna Tuff, Mr. Praveen B from Gaap Tuff Glass, Mr. Suryanarayan from Royal Tough Glass, Mr. C. K. Koul from Flair Industries, Mr. Manhar Sethi from B. L. Tuff Glass and Mr. Naresh Kumar from Hegla to discuss their concerns, aspirations and expectations from FOSG in order to increase their participation and

involvement with the association. The discussion concluded that a need for increased frequency of localized meetings was required to improve the understanding and collaboration amongst regional processors.

to sponsor four regional conclaves around the year in additional to the existing annual conclave being conducted. The offer was welcomed and highly appreciated by one and all present. Several processors from their respective localities volunteered to

Next day, early morning arrangements were made to visit the holy site of the Golden Temple and the Jallianwala Bagh memorial site. Upon return, a highly sought presentation from Mr. Yogesh of Aleph was given at the ongoing discussions regarding BIS Marking on processed glass. FOSG had partnered with Aleph to help its members with the BIS certification process in 2018. Mr. Yogesh gave an explicit presentation on the amended BIS 2553-part 1, the code for toughened and laminated safety glass, the procedure for getting the ISI mark, methods of registration, the basic equipment required, their sources, the scheme of testing described in the code, documents required to be maintained, clarity regarding the marking fee, accounting and modes of payment for the same. Several doubts from amongst the audience were clarified and a few carried forward to be further discussed with the BIS committee.

In line with this conclusion, Mr. Syed Zakir Ahmed from ZAK, FOSG's strategic partner, brought with him an enthusiastic atmosphere to encourage one and all present there on the optimistic future in store for this industry. Mr. Ahmed offered

coordinate for making these regional conclaves a fruitful venture. With ZAK's strength in organizing events being aligned with FOSG's conviction towards improving collaboration amongst its members, we foresee a greater success in their future events.

The program then proceeded towards a keynote address on the future of glass industry in general

and the processing industry in particular by Mr. Divyendu Pundhir, Vice President and CEO of Gujarat Guardian Limited, the conclave's host sponsor, followed by their company's presentation as host sponsors, on new products and possibilities with the next generation of coated glass. Mr. Naresh Kumar from Hegla, the conclave's Gold sponsors, highlighted the importance of quality machines for quality processing with his presentation.

Next, the company presentations by Ozone, one of the conclave's Silver sponsor, on new opportunities with new hardware solutions followed by presentation by Dow Inc., Silver sponsors, on quality silicon for making a good insulated glass unit, were given.

The conclave was concluded by reiterating the future of FOSG on where and how the members want to see it in 2025, the challenges and opportunities in achieving Vision 2025 would entail and the steps needed to move in the chosen direction. Conclusions drawn from the panel discussions were highlighted and suggestions for the next conclave were taken from the audience.

The last leg of the conclave on day three was solely focused on knowledge sharing via workshops by the sponsors. Technical experts from Kuraray (Silver Sponsor), Mr. J. Kim and Mr. Rahul Mahajan conducted a workshop on general problems faced in glass processing and the solutions for the same. Last but not the least, Gujarat Guardian Limited's Mr. Praveen Trehan, Plant Manager, and Mr. Vivek Buch, TAC Manager, held the workshop on operational excellence principles, the tools to create sustainable improvements in productions and quality in order to improve profitability and customer satisfaction.

The enthusiasm of the attendees was palpable with their active participation during the panel discussions. It was highly promising to witness the new members along with the next generation of processors taking active roles and responsibilities within the association to improve its strength and effectiveness at the ground level. With this, the future of FOSG seems to be heading in a very optimistic direction.

FOSG
FEDERATION OF SAFETY GLASS

Website: www.fosg.in
Email: vinod.tandon@fosg.in

OUTLINE OF FOSG's VISION 2025

- Increasing the usage of processed glass via the Federation's active engagement with the GoI for the successful implementation of RERA, the National Building Code and the inclusion of processed glass under the Bureau of Indian Standards (BIS).
- Bringing awareness within the industry regarding calculating ones costing appropriately, professionalizing the terms and conditions mentioned in external documents and educating members on the means and importance of timely sales recovery.
- Improving the usage of the FOSG app and website to enable better inventory sharing and pool purchases amongst members to optimize costs.
- Increasing knowledge sharing between processors to help save internal wastages consequently resulting in monetary savings ■

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Glass science and technology expertise recognised

A widely respected expert in the field of glass science and technology for more than five decades, Dr Arun K Varshneya has enjoyed a highly fulfilling career, both as an educator at the New York State College of Ceramics at Alfred University and as an entrepreneur. At Saxon Glass Technologies, he was responsible for developing a strengthened glass cartridge for the EpiPen, a device that is helping to save literally thousands of human lives every year during life-threatening episodes of anaphylactic shock. Dr Varshneya spoke to *Glass Worldwide* (preferred international journal of AIGMF).

Arun Varshneya PhD.

New York State College of Ceramics at Alfred University, founded in 1900 as a land grant institution, features the world's largest and one of the most recognised glass science and engineering programmes at BS, MS and PhD degree levels.

Having spent his entire professional life associated with glass science and technology, Dr Arun K Varshneya can rightly be considered a thoroughbred in the field. His children, nieces and nephews were all encouraged to follow his passion, which even extends to a personalised number plate on his car that identifies him as a 'GLASGURU'.

Brought up in the Indian city of Agra, Arun Varshneya secured a BSc in pure science from the local university. Thereafter, he studied at the Department of Glass Technology at the University of Sheffield, UK, where he was awarded a BSc Tech with Honours in Glass Technology in 1965. He then joined the USA's Case Institute of Technology (now Case Western Reserve University) in Cleveland, Ohio, obtaining an MS and PhD under the advice of the late Professor Alfred R Cooper.

While in Sheffield, Dr Varshneya worked as a student trainee to learn scientific glassmaking at James A Joblings of Sunderland and grinding/polishing/mounting of microscope objectives at W Watson & Sons in Barnet, Herts. After securing his PhD, he joined Ford Scientific Laboratories of Dearborn, Michigan in 1970, working on the science of ion exchange in glass to gain a better understanding of the chemical strengthening process for vehicle windscreens. In 1973, he moved to GE Lighting Business Group of Cleveland, Ohio, where he worked on the science, technology and engineering of lamp glass.

It was in 1982 that Dr Varshneya was invited by the New York State College of Ceramics at Alfred University to join the faculty rank, eventually retiring as an Emeritus Professor in 2010. At Alfred, he effectively taught all the required glass science and technology courses at both undergraduate and graduate levels. This included 'Introduction to Glass Science', 'Industrial Glass and Glass-Ceramics' and 'Glass Transition Range Behaviour', as well as the required senior capstone 'Engineering Operations'. He also taught short courses on fundamentals of glass science and technology to professionals at industrial sites.

Among Dr Varshneya's published works is the textbook, *Fundamentals of Inorganic Glasses*, which is soon to be reprinted in its third edition. He is an invited solo author for the 'Industrial Glass' entry in the Encyclopaedia Britannica, has roughly 160 technical publications and 10 patents. He also co-founded Saxon Glass Technologies Inc in 1996, a business that continues to provide glass chemical strengthening services for pharmaceutical applications.

Hooked on glass!

Among the people responsible for attracting Arun Varshneya to the world of glass science in the first instance were Dr Atma Ram, former Director of the Central Glass & Ceramic Research Institute in Calcutta and Harish Chand Varshnei, owner of Saraikella Glass Works, who recommended studying the subject in Sheffield. "In my final year of the programme, I also had the pleasure of conducting thesis

Originally published in Glass Worldwide, preferred international journal of AIGMF

research under the co-advice of the late Professor Alfred R Cooper (a visiting professor at the time) and the late Dr Michael Cable" Dr Varshneya recalls. "During this research, I discovered the issue of alkali signal loss during electron microprobe analysis of glass, which was a very new machine at the time. I figured out why and provided a solution for it. That research was published in 1966 in *Journal of Applied Physics*; it continues to be cited today" he adds. "I was solidly hooked on glass!"

Starting from his primary education in India, many of Arun Varshneya's teachers have influenced and inspired his career path and success in later life, especially Mr P C Goswami, the high school principal in Agra and Professor Alfred R Cooper of Cleveland, who is described as a guru, mentor and subsequently a friend. "From Mr Goswami, I learnt how to look at a problem, analyse it and then approach a solution while from Professor Cooper, I learnt how to look at both sides of an issue, questioning your own assumptions and apply simple mathematical rigour to research."

Dr Varshneya also emphasises the importance of Darshana, his wife of 45 years. "Although not a glass professional herself, some of her initiatives launched to recognise glass science and technology research at the frontiers would perhaps be appreciated for several years to come!"

Industry recognition

Throughout his career, Dr Varshneya has been honoured to receive the recognition of his peers worldwide. He was thrilled, for example, to receive the President's Award from the International Commission on Glass in 2007, as well as a Distinguished Life Membership from the American Ceramic Society in 2014.

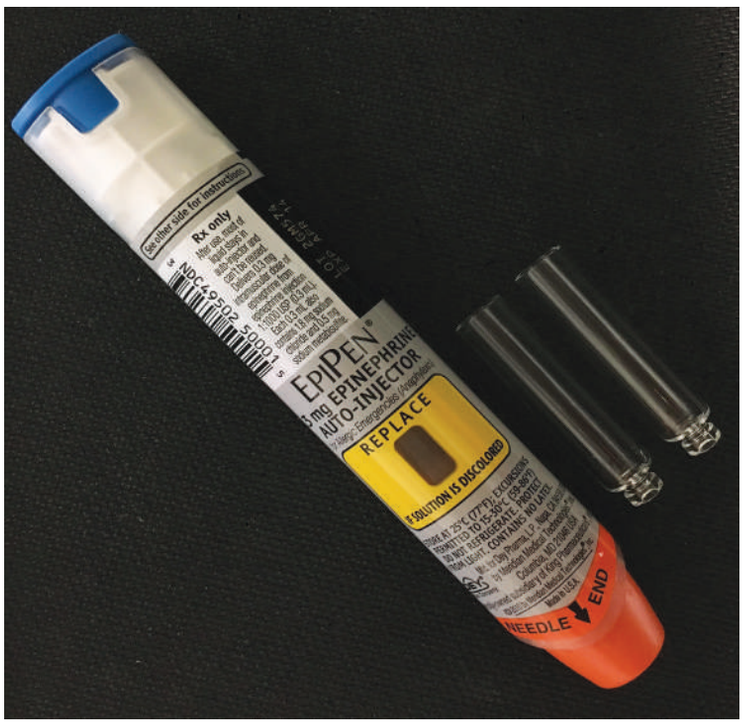
"But the recent presentation of a Society of Glass Technology Honorary Fellowship has a broader significance" he explains. "With this honour, I join some of the most distinguished glass professionals alive. It represents my glass technology education, starting from the UK and coming full circle. There is additionally the feeling of pride that I fill the shoes of Professor Ronald Douglas, former Chair of the Glass Technology Department, who was my first ever teacher of glass and my BSc thesis co-advisor, Professor Michael Cable."

And at the 25th International Congress on Glass in Boston this June, the organisers will arrange a 'festschrift' to honour Dr Varshneya's lifetime of contributions.

A rewarding profession

Prior to his retirement in 2010, the 28 years spent as a professor at Alfred University fulfilled many of Arun Varshneya's professional aspirations, guiding the young and seeing them prosper to become productive members of society. "When introducing myself at a pharmaceutical society meeting in the USA, I commented that if they had any glass professionals on their staff, the chances were that a third of them had probably received some of their education in glass from me" he confirmed.

Similarly, his entrepreneurial work as President and CEO with Saxon Glass Technologies Inc has been equally satisfying. The business was started in 1996 when a pharmaceutical company making the EpiPen device approached Alfred University to overcome a cracking problem of the Type I borosilicate glass cartridge during medicine filling and administration. After the successful demonstration of trial runs, a shop was set up at the



EpiPen with a Type I sodium borosilicate glass cartridge.

Ceramic Corridor Innovation Center to meet the challenge from the New York State legislature to help with the economic growth of the region. Based on Dr Varshneya's experience of research in ion exchange strengthening, the company produced a strengthened glass cartridge under the registered trademark 'Ionex' that delivers epinephrine from the EpiPen autoinjector with near-zero probability of glass fracture during administration.

According to Arun Varshneya, the high reliability of the device after chemical strengthening of the glass cartridge instilled greater confidence, contributing to a market increase from approximately one million units per year to nearly 24 million units in 2017. "We own 100% of the EpiPen glass strengthening market" he confirmed. "The device helps save thousands of human lives in distress due to a potential extreme allergic reaction to beestings, peanuts and shell foods."

Besides the EpiPen, Saxon Glass Technologies hopes to be involved in developing pharmaceutical Type I borosilicate glass vials for injectables that are chemically strengthened

The Hall of Glass Science & Engineering annexe at Alfred University.

glass WORLDWIDE

Originally published in Glass Worldwide, preferred international journal of AIGMF

to reduce the occurrence of glass chipping and cracking during transportation and filling. “Our goals are to use our high horse-powered glass engineering science to develop premium products that serve mankind” Dr Varshneya explains.

In addition, he believes there are other consumer glass markets where chemical strengthening could be usefully employed. Examples under various trademarks ‘Ion-Klad’, Frankenstein and ‘Ion-Armor’ include hurricane-resistant glass windows, vehicular transparencies for armour and non-armour use, solar energy collector glass plates and lightweighted glass containers. “The major challenges of course are the high cost of the strengthening process, coupled with the customer expectation of a strengthened glass. Some general public education is needed to convey that there is no such thing as an unbreakable glass. Just like hearts, glass will break when sufficient tensile stress is applied!”

Call for enhanced social awareness

“As professionals, we need to pay attention to bringing enhanced social awareness to glass science and technology” says Arun Varshneya. “Glass lenses for ophthalmic use, microscopes and telescopes, light bulbs, glass windows and optical fibres for telecommunication are examples of products that have contributed greatly to the comforts of modern civilisation. Instead of digging out of the earth, these products are made from environmentally-friendly materials but there is an enormous science and technology involved in the successful making of them.” According to Dr Varshneya, some basic education about glass should be introduced at middle school level.

In addition, he calls on fellow professionals to recognise that professional personality is only part of a wholesome persona. “You must play team sports or acquire a taste for playing musical instruments or learn to sing to enjoy a fuller life” he contends. Having been taught English poetry by a proper English lady, Brenda Carpenter, at St John’s College, Agra during his early education, he takes particular pleasure in reciting romantic era English poems one after the other, all by heart.

Arun Varshneya also expresses concern about the low participation levels within the Society of Glass Technology. “Perhaps there are too many glass meetings worldwide, while many professionals tend to confine themselves to their immediate areas of interest but as an Honorary Fellow who was both an academe and an entrepreneur, I hope to attract greater glass industry participation into programmes that would certainly benefit individuals and businesses alike.” ●

Crane set ups and molten salt tanks inside Saxon Glass Technologies.

Alfred’s Ceramics Corridor Innovation Center, which houses Saxon Glass Technologies Inc.

About the author:
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Conditions of Glassification or Vitrification – Part I

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Abstract

Glasses are wonder materials in all sorts of forms and sizes that have a variety of application in our day-to-day life as various forms of container glasses as well as in the construction industry as doors and windows as float glasses and also as insulation fibres. In all these cases in the commercial arena, we mainly deal with simple soda-lime-silica glasses, but there are more simpler glasses like pure silica, pure boron trioxide glasses that need our attention when we talk about glass structure, particularly for an in-depth study of structure-property relations. For this purpose we need to study the conditions of vitrification that was propounded about 90 years ago which is still valid and act as a role model while discussing such issues of structure and properties. In Part-I of this article, we deal with Goldschmidt criteria and then some important points on Zachariasen rule of glass formation, In the Part-II of this article, more on the latter issue will be elaborated.

INTRODUCTION

It has been emphasized in many previous articles in Kanch **[1]** that the glass structure is very important in understanding various properties of glasses for different applications. Even compositional engineering is performed to modify the glass structure in the chemical sense that gives rise to a relation with certain physical properties as well. In order to take it further, it is necessary to look into the structural aspect of glass formation or vitrification that was founded on crystallographic concept.

Numerous tentative mechanisms have been put forward to explain the formation, or rather non-formation of glasses. This could be arranged in mainly two broad classes: (a) the formalisms involving the structure of glasses, i.e. the geometry of the constituent elements in the glass, the forces involved in the bond formation between the element, etc. (b) the other formalisms are based on the general kinetics that neglects the approach towards the structure of glass in the first approximation.

It has been found historically that the structural approach was first developed and it has given birth to different criteria of the formation of glass or vitrification process. Considering a large number of chemical entities or compounds give rise to glass formation, it is not quite easy to find out the criteria that could be equally applied to such a diverse range of compounds. In such a case of practical importance in real life, the oxide glasses that are most common in industrial sector, such as container glass, float glass, fibre glass, etc, have retained all the particularity. Here, some of the criteria are discussed below:

1. GOLDSCHMIDT CRITERIA

This particular proposal was put forward in 1926. While searching the condition of vitrification of simple oxide glasses of stoichiometry A_mO_n, Goldschmidt has initially thought that the criteria could be the ratio r_A/r_O of the 'ionic radius' of the cation and oxygen in such oxide glasses. He also calculated that this ratio could be between 0.2 and 0.4. After classical consideration of the rules of crystal-chemistry for the ionic structure, the ratio r_A/r_O is in direct relation with coordination number of the central cations **[2-4]**. The proposed interval implies a coordination of 4, i.e. tetrahedral. For example, in silicate glasses, the central cation is silicon (Si) atom whose coordination number is 4+ and therefore silicon is coordinated with 4 oxygen ions in oxide glasses. The Table I shows the relation between this ratio and coordination number.

2. ZACHARIASEN RULE:

This formalism that is very well known to the glass scientists was proposed a few years after the above criteria in 1932. An example that is

Table 1: Relation between Cation/ Anion Ratio and Coordination Number

Cation/Anion Ratio	Coordination No.
0 - 0.155	2
0.155 - 0.225	3
0.225 - 0.414	4
0.414 - 0.645	6
0.645 – 0.732	8

more complete on different cases show that the Goldschmidt criteria are actually insufficient. Such an example is BeO which fully satisfies the above criteria, but it is impossible to form glasses. Then, Zachariasen took up the challenge with empirical reasoning and established a range of rules that had a profound implication and influence for the entire research on glasses in the future **[5-7]**.

This analysis was founded on the following considerations:

(a) The inter-atomic bond strength in the glasses as well as in crystalline materials must be identical. This was proposed by considering that the mechanical strength which is dependent on inter-atomic bond strength of both glassy and crystalline materials were very close to each other. For example, the inter-atomic bond strength between Si-O bond in glasses and crystal is very similar making the mechanical strength of pure silica glass and that of silica crystal (quartz) quite similar to each other. Here is an example that a given property measurement could decipher the inner structural aspects of glasses **[1]**.

(b) As in the crystalline materials, the glasses must also be formed by a 3-dimensional network structure, but the diffused character of the X-ray diffraction spectra show that this network is neither symmetric nor periodic as evident in the corresponding crystal. This also shows that there is no long-range order in the glasses, as shown by their counterpart in crystals. In 1932, this idea of the absence of long-range order in glasses was quite revolutionary, as also evident by an extensive work on X-ray diffraction investigations on different types of glasses.

It could be thought that the glass-network has one molecule or rather a system of elementary molecular shell, e.g. SiO_4 tetrahedra in silicate glasses. The disorder in the network introduces a 'distribution' of bond-strength. The progressive bond breakings with the application of thermal energy explain the decrease of viscosity (or rather increase of fluidity). So, it is clear that the decrease of viscosity occurs with the progressive disturbance of the ordered structure. Hence, this disorder also explains that the enthalpy of disordered glass is always higher than that of the crystal.

The structure could be analysed in terms of polyhedral coordination of cations (e.g. Silcon) surrounded by the variable number of oxygen anions. In the crystallized oxides, the face or the edges of the polyhedra could not be common. Zachariasen found the manner in which the polyhedra must be joined to a disordered glass network, apparently like a crystal - but the long-range order is missing.

In the particular case of different forms of crystalline silica, i.e, quartz, cristobalite, tridymite, etc. the network is constructed by the tetrahedral silica that is joined by their corners. In the vitreous silica, the network is made of the same building unit SiO_4 tetrahedra joined by their corners, but the consecutive mutual orientation must be variable – that is not the case of a crystal where it is uniform all throughout the network.

So far we have talked about only SiO_2 glasses. In case of a network of type A_2O_3 or pure borate glasses (B_2O_3), it is a triangular boron network (BO_3). Here, the disorder is introduced without bringing the triangles too near to each other around the boron cation. This is due to the fact a closer arrangement would provoke an unnecessary increase of internal energy or enthalpy in the glass network.

For example, if the crystalline structure was made with the help of the same AO_3 units, but it was linked by the edges that will be the case for a stoichiometry of oxide AO. In such a situation, it will be impossible to introduce the disorder without increasing the internal energy too much. So, it is a question of 'internal energy' that guides the basic principles of the condition of vitrification. In a systematic investigation of the structure formed by different polyhedral coordination, Zachariasen has shown that an oxide forming glass must satisfy an entire set of 'rules' as follows:

A. The number of oxygen anions surrounding the cation 'A' must be small,
B. No oxygen anion must be linked to more than 2 cations,
C. The polyhedra can have common corners, but not the edges or faces,
D. At least 3 corners of each polyhedron could be shared with those of the other polyhedra.

In subsequent review of his work, Zachariasen framed the stoichiometric rule of oxides that could form glasses. For example, the oxides, such as AO (like CaO, MgO, BaO, etc.) and A_2O (like K_2O, Na_2O, Li_2O, etc.) could not satisfy the previous rules and thus would not form glasses, i.e. the oxides of the group I and II. Surprisingly, the only exception seems to be H_2O in the form of 'Ice' that could be disordered or glassy.

The above rules (B), (C) and (D) are satisfied for the following:

i) in the sides of type A_2O_3, e.g. B_2O_3, as this oxide forms triangles with oxygen anions at the apex in the three corners of a triangle around a boron cation,

ii) in the oxides of types AO_2 or A_2O_5, i.e. SiO_2 and P_2O_5, as these oxides form tetrahedral of oxygen anions around the Si or P cations,

iii) in the oxides of types AO_3 and A_2O_7, as they form octahedral structure with oxygen anions around the cation, etc.

In the latter case, as there is no example of glass formation in such groups, Zachariasen has finally concluded that only the triangular and tetrahedral structures satisfy the rule (A) which made it more specific:

The number of oxygen anions in oxide glasses around the cation 'A' is 3 or 4. This makes the new rule more specific in terms of the coordination number.

By a systematically examining the property of coordination of various cations in different oxides that have been crystallized, Zachariasen also concluded that only B_2O_3, SiO_2, GeO_2, P_2O_5, Al_2O_3, Sb_2O_3, P_2O_5, Sb_2O_5, etc. were sensitive to be amorphous. In this period of investigation, most of these oxides were really vitrified, i.e. under the glassy state. They satisfy all the 'rules' (A) to (D), as explained above, e.g. the structure of SiO_2 and GeO_2 is based on the tetrahedral (AO_4) and those of the oxides of Al_2O_3 and As_2O_3 are based on the octahedral (AO_6). In case of fluoride glasses, the most common is BeF_2 which has tetrahedral structure (BeF_4).

It should be pointed out that before this period, multi-component commercial glasses based on various combinations of oxides were already in existence from different glass plants, but no theory of glass formation or vitrification was known. Therefore, Zachariasen also tackled this problem of glass formation with oxides that were more complex and obtained by adding the above oxides with other alkaline and alkaline-earth oxides.

Zachariasen then slightly modified the previous 'rules' that would satisfy the formation of a glass:

X) A glass sample must contain sufficient percentage of cations that are surrounded by the tetrahedral or triangles of oxygen anions,

Y) These tetrahedral or the triangles must only have the common corners, but not the faces or edges,

Z) Some of these oxygen anions must be linked to → only two of these cations and must not form the bonding with any new cation in the glass structure.

The last revised rule (Z) has significance in that the oxide glass must contain enough quantity of cations that will vitrify by itself, e.g. silica, boron oxide, etc. If we try to cool the boron trioxide melt even very slowly, it always results in the form of glass, i.e. it has a tendency for vitrification more favourably than other oxides. The other cation could replace them in an isomorphous substitution.

To the cations B_3+, Si_4+, P_5+, As_5+, it is easier to add Al_3+ that are capable of replacing Si_4+ in an isomorphous manner, but it is worth noting Al_2O_3 by itself does not form glasses. It makes these observations very interesting indeed considering the above 'rules' that are fundamental to our understanding of glasses.

CONCLUSIONS

Our general understanding of day-to-day commercial glasses gives us knowledge on simple soda-lime-silica glasses. In order to have a better understanding of such glasses, we must try to get insights on simpler glasses like pure silica, pure boron trioxide, etc. to know about their structure. In order to do that we must acquire the knowledge about the condition of vitrification, even before we attempt to gather information on the process of vitrification. Here, we have tried to elaborate on Goldschmidt criteria and Zachariasen rules on glass formation that is so extensive that it will be taken up in Part – II.

ACKNOWLEDGEMENTS

To write about the fundamental aspects about glass formation, it is felt necessary to remember the outstanding contributions of two of my Late Professors, viz. R. W. Douglass and A. Paul of the Department of Glass Technology, University of Sheffield (UK) in various fields of research related to glass science.

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Sustainable industries in a hydrogen-based economy

Last March, GlassTrend organised a two day study tour 'Towards sustainable furnace technologies for steel, glass and ceramics', during which four sites from different industrial sectors in the Netherlands (glass, steel, gas and ceramics) were visited. According to AnneJans Faber, the main goals of this study tour included information exchange on the latest low carbon furnace technologies in the different high temperature process sectors and 'learning from each other'.*Glass Worldwide* (preferred international of AIGMF) reported.

At Libbey, Leerdam, the OPTIMELT furnace, a waste heat recovery process in the glass industry, was visited. By injection of natural gas in the hot flue gases in a regenerator of an oxy-fired glass tableware furnace, high temperature syngas is produced and then burnt in the furnace. The hot syngas mixture has as higher caloric value than natural gas. Around 15% energy saving and corresponding CO_2 reduction have been demonstrated to date.

Later that day, at Tata Steel in IJmuiden, a short symposium was organised, followed by a tour of one of the steel factories on the vast premises of Tata Steel. The keynote lecture was presented by Professor Ad van Wijk, sustainable energy entrepreneur and part-time Professor, Future Energy Systems at Delft University of Technology. His message is that at first, 'blue' and then 'green' hydrogen will become the main energy carrier in a low carbon economy.

Already within about 10 years from now, 'green' hydrogen, produced by electrolysis in offshore wind power plants, will become economically competitive with natural gas (see table 1). The key advantages of hydrogen versus electrons as an energy carrier are the efficient storage and transport possibilities of hydrogen, by making use of the existing infrastructure for natural gas (see figure 1) and of available gas storage locations and technologies.

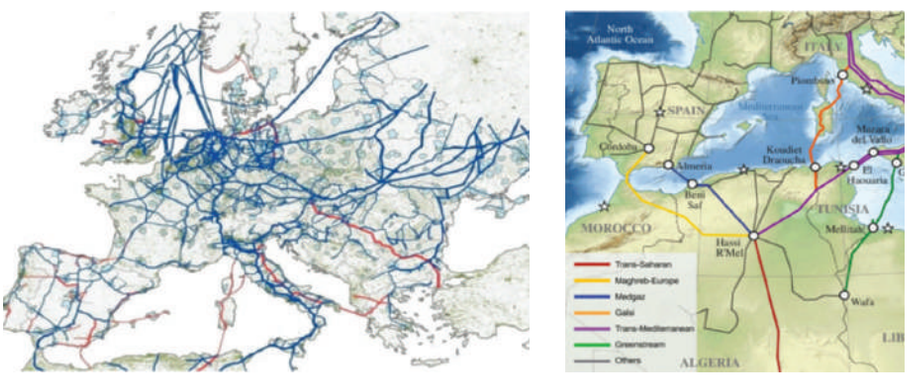

Figure 1: European gas infrastructure (source: Delft University of Technology).

50% CO_2 emission reduction

Tata Steel presented a paper on the HIsarna ironmaking process, developed within a large European project, in which many competing steel companies have co-operated. The HIsarna ironmaking process is a direct reduced iron process, in which iron ore is processed almost directly into liquid iron or hot metal. The process does not require the manufacturing of iron ore agglomerates such as pellets, nor the production of coke, which are necessary for the blast furnace process. Without these steps, the HIsarna process is more energy-efficient and has a considerably lower carbon footprint than traditional ironmaking processes. In 2018 Tata Steel announced it has demonstrated that more than 50% CO_2 emission reduction is possible with HIsarna technology, without the need for carbon capture technology.

CelSian presented a paper on the transition to CO_2 neutral glass furnaces and concluded that a combination of durable hydrogen and electricity from renewable sources will enable the energy transition in the glass industry. In the coming years, co-firing of natural gas with hydrogen may enable a gradual transition to a low-to-zero-carbon combustion process. The technological challenges of hydrogen combustion in glass furnaces were outlined and a new inter-sectoral development project was announced; 'Hydrogen as fuel for direct industrial heating processes', with the former Gasunie Research (now DNV-GL) as lead party.

Offshore Wind Hydrogen Production

70-80% of hydrogen cost is electricity cost

	Investment cost	Efficiency	Electricity Price Offshore Wind	Hydrogen Price
Till 2020	600-1.000 Euro/kW	70-75%	40-50 Euro/MWh	3.5-5 Euro/kg
2020-2025	400-600 Euro/kW	75-80%	30-40 Euro/MWh	2-3 Euro/kg
2025-2030	300-500 Euro/kW	80-85%	25-35 Euro/MWh	1.5-2.5 Euro/kg
After 2030	<300 Euro/kW	>85%	20-30 Euro/MWh 10-20 Euro/MWh	1-1.5 Euro/kg 0.5-1 Euro/kg

Table 1: Price scenarios of durable hydrogen production (source: Delft University of Technology, 2019).

Originally published in Glass Worldwide, preferred international journal of AIGMF

Figure 3: CO+ laser sensor for controlling the combustion process of gas mixtures.

Renewable energy technology

On the second day of the tour, the renewable energy technology and gas laboratory of DNV GL (formerly Gasunie Research) in Groningen was visited. This site has 5000m^2 of dedicated gas laboratories. In the 0.5 MW combustion furnace, combustion processes with natural gas-hydrogen mixtures are studied.

The above-mentioned inter-sectoral project proposal was presented by DNV-GL in detail. The main topics of this project will include fuel adaptive burner control systems when using hydrogen/natural gas mixtures, effect of hydrogen on heat transfer and NO_x control strategies. CelSian will support the experimental studies by installing the CO+ laser sensor at DNV-GL's test furnace (figure 3) and by 3D CFD modelling calculations of heat fluxes, temperature profiles etc.

Increased hydrogen supply for ceramics

The final production site visited was the factory of Wienerberger Narvik near Venlo. Wienerberger AG is the world's largest producer of bricks and number one in the clay roof tile market in Europe. The factory tour showed state-of-the-art production processes for roof tiles, including the application of glazes.

Representative from the Technical Centre for the Ceramic Industry (TCKI) presented a paper on scenarios for future sustainable ceramic kilns by gradually increasing hydrogen supply to the burners. The challenges of energy transition in the ceramic industry include future Wobbe index 'jumps' in the combustion gas supply, control of NO_x from hot hydrogen-rich flames and control of CO_2 originating from the clay raw materials.

Surprisingly, during this 800km GlassTrend round trip across the Netherlands, no geographical borders were crossed. However, all participants will confirm that many mental borders and borders between different industrial sectors were crossed! ●

The GlassTrend group visits the Tata Steel site in the Netherlands.

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Conditions of Glassification or Vitrification – Part II

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Abstract

It has been established for a long time that both from scientific and application viewpoints, glasses are very useful materials for a variety of applications in our daily lives as well as in different industrial usages, as they have the optical transparency, chemical inertness, mechanical strength required for handling, etc. Apart from very special glasses, such as optical glasses for our eyes and fibre-optics for communication as well as for cell-phone covers, TV sets, etc, the majority of glasses consist of simple soda-lime-silica glass. For most common silicate glasses, the distribution of silica tetrahedra in a disordered manner is important for an understanding of a basic knowledge on their properties. For this purpose we need to study the conditions of vitrification that was propounded about 90 years ago which is still valid and act as a role model while discussing such issues of structure and properties. In Part-I of this article, we dealt with Goldschmidt criteria and then some important points on Zachariasen rule of glass formation, In the Part-II of this article, more on the latter issue will be elaborated.

INTRODUCTION

In Part-I of the article on the issue of 'conditions of vitrification' in glasses, Goldschmidt criteria on the role of ionic radius ratio vis-à-vis coordination of different cations were discussed **[1-3]**. These cations are important in glass formation as the fundamental building blocks. Zachariasen rule was also discussed as to why some cations are glass-forming and others are not **[4-6]**. These cations have a modifying role.

In a series of articles in Kanch **[7]** it has been shown that the glass structure is very important in obtaining an in-depth knowledge on various properties of glasses for different applications. Even compositional engineering has been performed to modify the glass structure in the chemical sense that gives rise to a relation with certain physical properties as well. In order to take it further, it is necessary to look into the structural aspect of glass formation or vitrification that was founded on crystallographic concept.

Zachariasen rules need to be further visited in order to understand the role of glass-forming and glass-modifying oxides along with some intermediate oxides. All these oxides form various kinds of glasses for different applications that are all known to us. It is also known that a simple soda-lime-silica glass has a very wide application in the commercial and industrial world. When simpler glasses are understood, it is easier to know more about the other simple glasses as well, such as borate glasses, borosilicate glasses with exotic modern applications, etc. In this part-II of the article some structure will be shown to map this evolution in the real glasses.

ELABORATION ON ZACHARIASEN RULE

Zachariasen has conferred a name for the cations, such as Si^{4+}, Ge^{4+}, B^{3+}, as the "glass-forming cations" or 'glass formers' linked to oxygen's anions that forms the main network of amorphous structure of glass, which is totally disordered, i.e. the order present in the corresponding crystal is lost in terms of periodicity, bond angles, etc.

The use of the terms of glass-forming network glass-former and that of network-modifier of the oxides which do not form the glass by themselves is done by Zachariasen **[6]**. The behaviour of these network-modifier oxides in the overall glass-structure is a subject of an extensive study in the field of glass research. Here, for a glass-forming silicate tetrahedral network, a typical tetrahedral unit is show in Figure 1.

It is seen from Fig. 1, that Si atom looks larger than oxygen. This is an error in the diagrams given in many monographs in the internet,

as the diameter of silicon is only 0.41 Armstrong units, whereas that of oxygen is 1.40 Armstrong units. This tetrahedral structural unit is the fundamental building block of silicate glass and silica crystal like quartz, except that in a glass these units are randomly distributed, i.e. not in a periodic manner as in the crystal.

In Fig. 2, the structure of a pure "crystalline" silica network is shown with a series of SiO_4 tetrahedra, and it is quite clear that the atomic arrangement is done with regular periodicity, i.e. all silicon atoms are equally spaced apart, which has to be distorted to form pure silica glass.

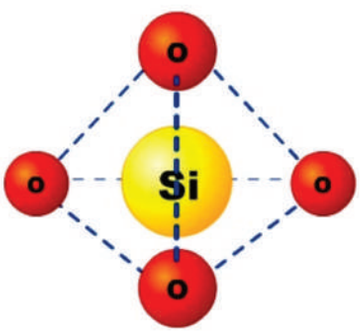

Fig. 1: Silica tetrahedra in a pure silicate glass.

The random network of silica tetrahedra are shown in Figure 3, where it is clearly noted that not only periodicity is lost, but also the bond angles and its distribution so that glass is formed with appropriate viscosity.

As one adds a network-modifier oxide, e.g. Na_2O to the network-forming silica, the "extra" oxygen coming from such modifier participate in the overall glass-structure. This participation of 'extra' oxygen introduced by the Na_2O molecules occurs by the breaking of certain number of bonds. It means that for the addition of each molecule of Na_2O in a local structure of two SiO_4 tetrahedral joint is broken, as this extra oxygen anion has to be accommodated in the Si-O-Si structure that becomes of the order of $Si\text{-}O^{-}\ldots{}^{-}O\text{-}Si$.

Hence, the number of non-bridging oxygen anions in the overall structure increases, i.e. instead two negative charges of oxygen anions participating in the bonding (i.e. Si-O-Si), one negatively charged still remains to be participating. This negative charge of two oxygen anions are balanced be a pair of two positively charged Na^+ cations nearby. So, the overall charge balance, or electrostatic charge neutrality, is maintained in the glass structure.

In course of melting of silicate glass containing Na^+ cations, the network of silica tetrahedra is found to be progressively depolymerised with the consequence that the alkaline cations, such as Na^+, K^+, Li^+, etc. are always found nearby to the broken bonds which are 'pushed' to be created due to such addition, or rather due to the excess supply of oxygen. It should be noted that for each supply of extra oxygen, there are two bonding oxygen anions become single bonded or rather negatively charged. As this 'negative charge' is balanced by a 'positive cation', one needs two cations and hence A_2O type of alkali (where A stands for Na, K, Li, etc.) are needed.

This mechanism of the 'rupture' of doubly bonded Si-O-Si network drives us to a glass structure of silicate glasses containing Na_2O or other alkali oxides that are laden with two types of oxygen anions. Some oxygen anions are linked to Si cation that are called 'bonding oxygen' and some oxygen anions are linked to only one silicon cation that are called 'non-bonding' oxygen or 'single-bonding'. The same mechanism is evident, when one adds alkaline earth oxide (i.e. divalent cation such as, Ca^{2+}, Mg^{2+}, Ba^{2+}, etc.) to a silicate glass.

In the above case, it is sufficient to add only one Ca^{2+} ion that creates extra oxygen anion per addition of

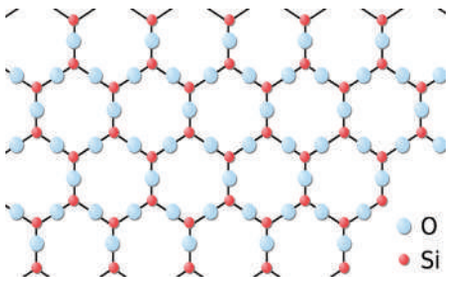

Fig. 2: The periodic crystalline lattice structure of SiO_2 in two-dimensions.

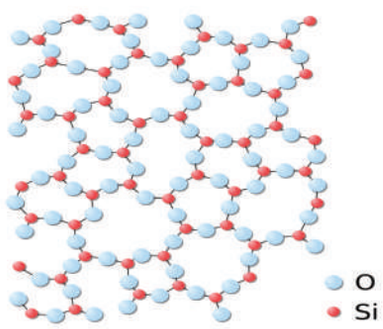

Fig. 3: The random network structure of glassy SiO_2 in two-dimensions. Note that, as in the crystal, each Silicon atom is bonded to 4 oxygen atoms, where the fourth oxygen atom is obscured from view in this plane.

one mole of CaO. This could create two negatively charged oxygen anions that are non-bonding. Here, two negatively charged oxygen anions or rather two non-bonding oxygen could be electro-statically balanced by doubly positively charged Ca^{2+} ion present nearby the broken network. In this manner, many oxides containing cations could be introduced inside the silicate or borate or germanate glass-forming network. Such oxides are known as glass-modifier oxides. Essentially, they are alkaline (Na_2O, K_2O, Li_2O, etc) or, alkaline-earth oxides (CaO, MgO, BaO, etc.).

Apart from glass-formers or glass-modifiers, as mentioned above, there is also another type that exists in the field of glass formation. These are also the oxides that depending on the glass composition, they behave either as 'glass-former' or as 'glass-modifier'. They are usually called the 'intermediate' oxides. In actual practice, here is a Table that gives this classification of main important

oxides that are involved in the glass formation:

Table I: Classification of different Oxides

Formers	Modifiers	Intermediates
SiO_2	Li_2O	Al_2O_3
GeO_2	Na_2O	PbO
B_2O_3	K_2O	ZnO
P_2O_5	CaO	CdO
As_2O_3	MgO	TiO_2
As_2O_5	BaO	
V_2O_5		

Thus, the chemical formula of an oxide glass can be generalized in the form: A_nB_mO. In this formula, n and m simply represent the 'glass-former' atoms (A) and 'glass-modifier' (B) per oxygen atom. It should be noted that if one glass network is formed from only 'tetrahedra' wherein at least three corners are shared, this would signify that the value of 'n' will be between 0.33 and 0.5.

Zachariasen has also suggested that the modifier cations are more or less placed on the 'holes' of the network which are created in the course of formation of a vitreous network and that the distribution of these cations is also 'random'. He has also proposed his 'structural model' even before the investigations of 'glass structure' by X-ray diffraction started, which was initiated just a little after this model was proposed by a group of scientists notably Warren **[8]**, at M.I.T. (USA), who brought a very encouraging support to these ideas of Zachariasen.

The model of "continuous disordered network" of Zachariasen-Warren have attracted the attention of scientists all over the world in glass science for a couple of decades since the period of investigations, and this model still finds references for a dominant adaptation of such a concept on the structure of glass. In reality, the method of X-ray diffraction could not bring a definite proof for Zachariasen model, but it could be seen that there was no apparent contradiction against this hypothesis.

There is, however, an apparent contradiction so far the non-oxide glasses are concerned, e.g. chalchogenide glasses containing various combinations of sulphur, selenium, arsenic, etc. and gel-based glasses from molecules in aqueous solutions. A number of deviations have come to the surface against Zachariasen model via investigations. On the contrary, oxide glasses containing octahedral units (such as titanate or tellurite glasses) have been found to be possible. Considering this model cannot be generalised for all sorts of systems, it has been attempted to relate inter-atomic bonding within the glass structure with the vitrification or glass-formation.

As indicated in the previous article that our main aim is to understand the glass structure of simple soda-lime-silica glasses. This is shown in Fig. 4, where it is clearly seen how sodium ions are accommodated inside the holes that are created in the vitreous network during the glass formation on cooling the melt, when the viscosity of the melt is adequate to make such structural arrangement is possible.

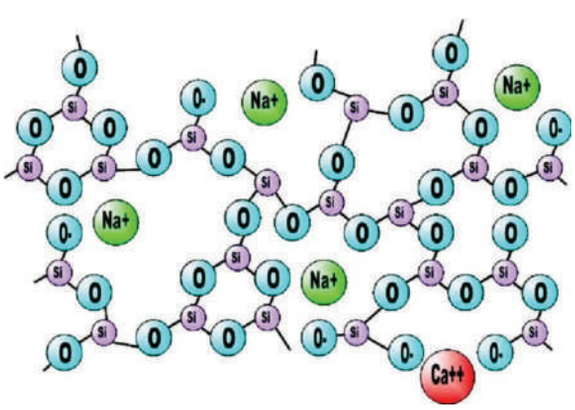

Fig. 4: Soda-Lime-Silica Glass Structure

CONCLUSIONS

Condition of vitrification with pure structural unit of silica or other oxides have been elaborated. With an eye on commercial soda-lime-silica glasses, the structure has also been explained vis-à-vis the role of alkali oxide with monovalent cation and alkaline earth oxides with divalent cation taking the position on the holes created in the vitreos network of silica on cooling the melt to balance the electrostatic charge. This has implications on the overall structure of glasses with consequence on various properties that are useful for a variety of interesting applications not only for our daily lives, but also for many technical usages.

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Fibreglass in Civil Engineering Construction

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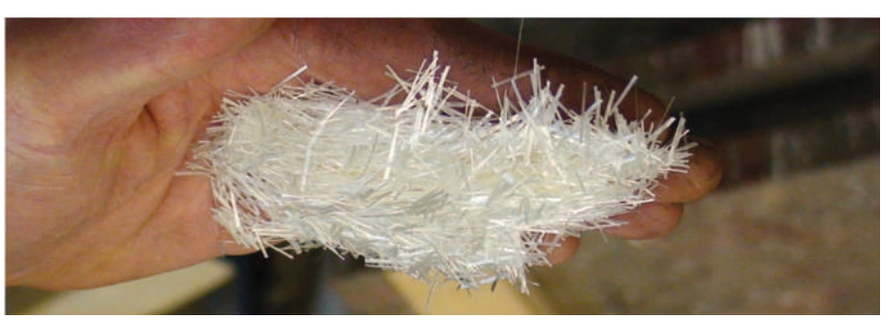
Glass fibres are made of extremely fine fibres of glass, formed when thin strands of silica-based or other formulation glass is extruded into many fibres of small diameters suitable for textile processing. Glass fibres are light weight having low susceptibility to moisture, high electrical and thermal insulating and mechanical properties, and high impact, corrosion and fire resistance. They also have high resistant to cracks in concrete.

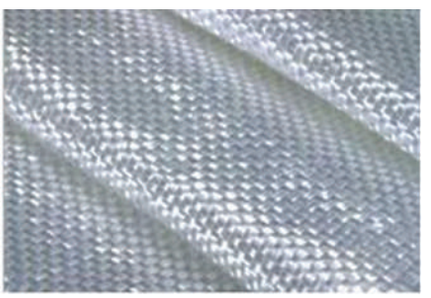
Glass fibres can be divided into two major groups according to their geometry as continuous fibres used in yarns and textiles, and the discontinuous fibres used for insulation and filtration etc. Glass fibres can be randomly arranged, flattened into sheet or woven into a fabric. Textile glass fibres may be formed from molten glass directly from the furnace, or the molten glass may be fed first to a machine that forms glass marbles. Continuous fibres can be produced through the continuous filament process. In staple fibre process, as the molten glass flows through the bushings, jets of air rapidly cool the filaments.

Fibreglass is a common type of fibre reinforced plastic where glass fibres act as reinforcement. Fibreglass textiles are commonly used as a reinforcement material for moulded and laminated plastics while fibreglass wool made from discontinuous fibres for thermal insulation and acoustics. Glass wool was invented in 1932-33 by Rusel Games in the trade name of 'Fibreglass' for thermal insulation in the buildings. Fibre reinforced plastic (FRP) or Glass fibre reinforced plastic (GFRP) are the terms normally used for manufacturing various products.

The basic raw materials for fibreglass products include natural minerals and chemicals, major ingredients being silica sand, limestone, and soda ash. Other ingredients may include calcined alumina, borax, feldspar, nepheline syenite, magnesite, and kaolin clay, among others. Silica sand is used as the glass former, and soda ash and limestone help primarily to lower the melting temperature. Other ingredients are used to improve certain properties, such as borax for chemical resistance. Waste glass, also called cullet, is also used as a raw material.



Glass Fibres



Fibreglass woven Roving Mat

Fibreglass chopped strand mat

TYPES AND FORMS OF FIBREGLASS

Fibreglass can be classified based on the raw materials and applications. Based on raw materials and their proportions, it can be classified as;

i. **A-glass**: Also called as alkali glass has "A" glass fibres with little or no boron oxide.

ii. **C-glass**: Also known as chemical glass, has very good resistance to chemical attack used for glass staple fibres and insulation.

iii. **E-glass**: Also called as electrical glass, is a very good insulator of electricity. E-glass is alumina-borosilicate glass with very little alkali oxides and most commonly used for glass reinforced plastics.

iv. **AE-glass**: This is alkali resistant glass.

v. **S glass**: Also known as structural glass, it has good mechanical properties and high tensile strength.

Other types may be as D glass for its Dielectric constant and R glass as alumino silicate without magnesium and calcium oxides with high mechanical requirements as reinforcement.

As fibreglass has high mechanical strength, good electrical insulation properties, naturally incombustible, low coefficient of linear expansion, compatibility with organic matrices, non rotting, non corrosive, and low thermal conductivity, it is durable, safe, non-corrosive and high insulation material for energy conservation also.

Fibreglass is available as fibreglass tape, fibreglass cloth and fibreglass rope based on the applications.

APPLICATIONS OF FIBREGLASS

Fibreglass is used in many applications like beverage industry, chemical industry, cooling towers, docks and marinas, food processing industry, gas cylinders and other applications, fountains and aquariums, and industries where chemical corrosion is expected. Apart from this, it is used in civil engineering applications largely as below;

i. Water storage tanks
ii. Septic tanks
iii. Domes for the buildings
iv. Roofing sheets
v. Door frames and shutters
vi. Canopies
vii. Chimneys
viii. Water supply pipes
ix. Wastewater and sewerage pipes
x. Gratings
xi. Fibre reinforced composite columns
xii. Cooling towers
xiii. Sculptures and statues
xiv. Dustbins
xv. Furniture
xvi. Glass fibre woven fabric for rehabilitation and retrofitting of columns/beams
xvii. In textile and other forms in repair and rehabilitation of heritage structures
xviii. GFRC panels/blocks

In one of the project executed by CPWD, fibreglass reinforced panels/ blocks were used in National Institute of Securities Markets (NISM) for cladding. Fibreglass is going to have large civil engineering applications in future.

FIBREGLASS REINFORCED PANELS/BLOCKS

Fibreglass reinforced (GFR) panels are used on walls installed directly over solid surfaces or on the frame,

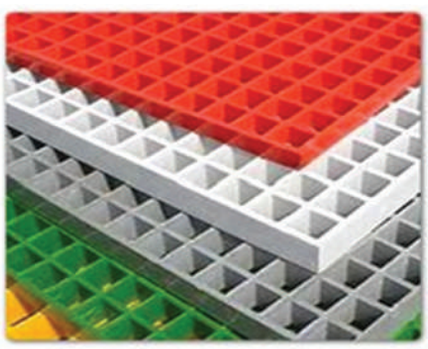
Fibreglass roofing

Fibreglass door shutters

Fibreglass sheets

Fibreglass cooling towers

Fibreglass pipes



Fibreglass gratings

and ceilings. They are moisture resistance, easy to clean, and provide durable and scratch resistant surface. These panels are made of polyester resins reinforced with fibreglass and can be formed in any desired shape as per architectural and artistic requirements. They are also light weight hence fixing and installation becomes easy. Since they have stain and scratch resistance surface, and are waterproof, they can also be provided on external surface. Some of the advantages of fibreglass reinforced panels are;

- GFR panels provide a strong scratch resistant surface.
- They can be cleaned easily using regular detergents, high pressure washers, or even by using steam.
- They are lightweight and easy to install.
- They can be installed with fasteners/adhesives or on frames.
- They are waterproof, corrosion free and have improved chemical resistance.
- They can be installed over any existing wall surface, or on substrate.
- They have high impact resistance from shattering and scratches.
- They can be manufactured according to required shape and design.
- They are economical compared to natural stones.
- They replace natural materials hence are environment friendly.

FIBREGLASS REINFORCED PANELS APPLICATIONS

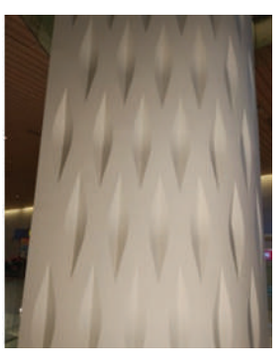
The panels/blocks can be used in interior and exterior applications. They can be installed over new and existing walls including wall cladding, and almost on all types of substrates, however the installation method used may vary. Such panels/blocks were used in cladding of orientation centre of NISM Patalganga, Mumbai. Similarly such blocks have been used in Terminal 2 of airport, Mumbai.

FIBRE REINFORCED CONCRETE

Addition of glass fibres results into increase in tensile strength and durability, and reduction in voids/ permeability of concrete. Fibres also have excellent resistance to creep. When small, closely spaced and uniformly dispersed fibres are added to concrete, they act as crack arrester and substantially improve its properties. They control plastic shrinkage cracking and drying shrinkage cracking.

When fibres are added in concrete, it is called fibre reinforced concrete (FRC) which consists of cement, concrete, and discontinuous, discrete,

Fibreglass panels



Fibreglass composite moulding

GFR panels in Orientation centre, NISM

Panels in T2 international Airport, Mumbai

uniformly dispersed suitable fibres. Though in FRC, fibres may be of various types such as steel fibres, polypropylene fibres, asbestos fibres, carbon fibres, and glass fibres. Glass fibres are chemically inorganic, light weight, green material, having excellent electronic, heat and sound insulation properties, high bending, pulling, and pressure resistance, high temperature resistance, low hydroscopy, high chemical and biological resistance, and low density, have no harmful substance but are to be handled carefully and mixed as per the designed requirements. Glass fibre reinforced concrete (GFRC) lacks ductility and is difficult to self mix. GFRC has wide applications in restoration of old and heritage structures, particularly facade, moulding and cornice restoration.

Fibreglass has very little contraction and as such when used with resins, polymers and epoxy, products may be subjected to some warping during curing or use, if proper care not taken. Safety precautions are also to be taken when glass fibres are being used directly like in insulation or in the manufacturing of products made from fibres.

CONCLUSIONS

Glass fibres have been in use for a long time in various applications being light weight, corrosion free, water proof, and resistant to chemicals, fire, temperature and heat. They have also been used with a combination of other materials to manufacture roofing sheets, furniture, water tanks, door shutters, cooling towers, pipes and gratings etc.

In repair, retrofitting and restoration of civil engineering structures, they can be successfully used in the form of GFRC blocks and mouldings due to properties like light weight, easy to be moulded and weather resistant. As large number of buildings in India of pre-independence period will need restoration, use of GFRC is expected to rise. GFRC is also useful in retrofitting of structural members of a building as they are economic and also do not increase size of members significantly. Also, GFRC blocks can be used in cladding as replacement of natural stones.

Awareness is required to be generated among architects and engineers about wide applications of fibreglass products and their uses.

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Consumer engagement in sustainable consumption lifestyle

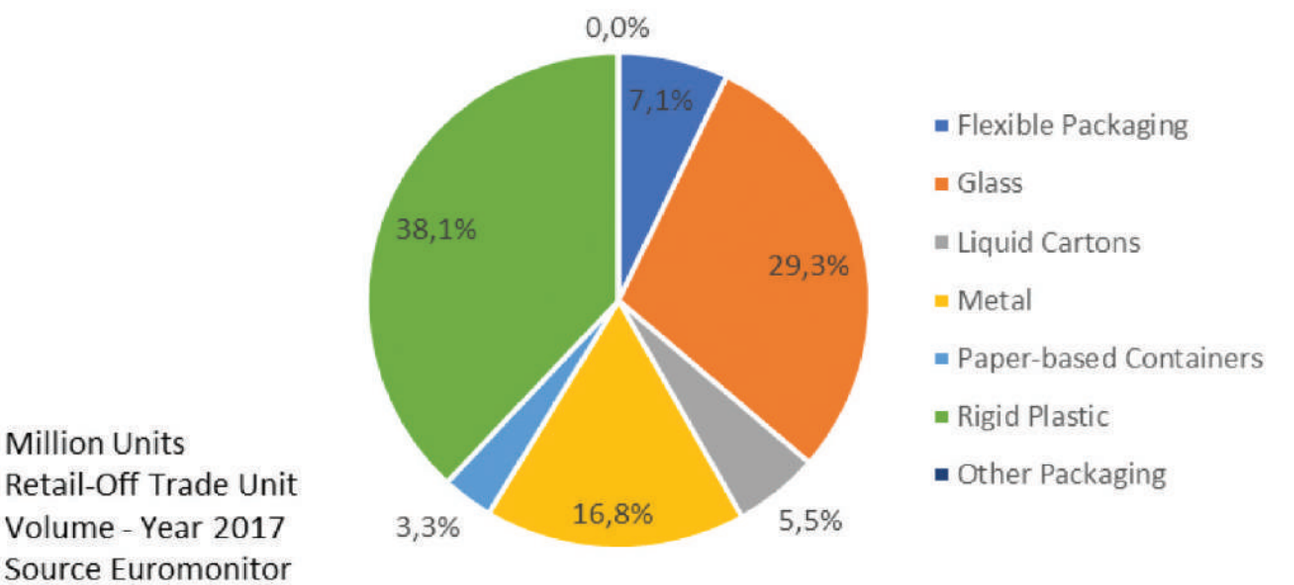
FEVE reported to *Glass Worldwide* (preferred international of AIGMF) that glass packaging demand continues to grow in Europe, driven by consumer engagement in sustainable consumption lifestyle.

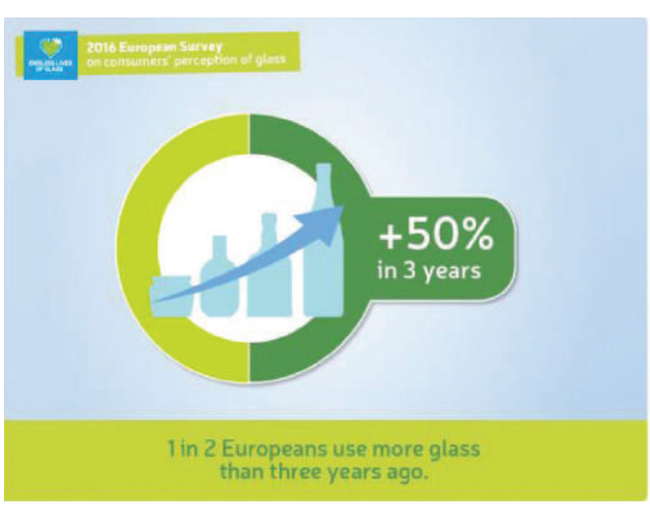
Glass packaging production in Europe grew by 1% in volume (tonnes) and by 1% in unit terms in the first half year 2018 compared to the previous half year, according to data published by the European Container Glass Federation, FEVE.

The growth is in line with full year 2017 data, which recorded a growth of 2% in weight terms and 2.4% in units and compares favourably with historical trends since 2012.

Between 2012-2017, production has increased by almost 1.7 million tonnes (8.3% increase) or 6.4 billion units (8.9% increase). Generally, all food and beverage market segments experienced demand growth for glass and the outlook is also very positive for the flaconnage sector for perfumery, cosmetics and pharmacy.

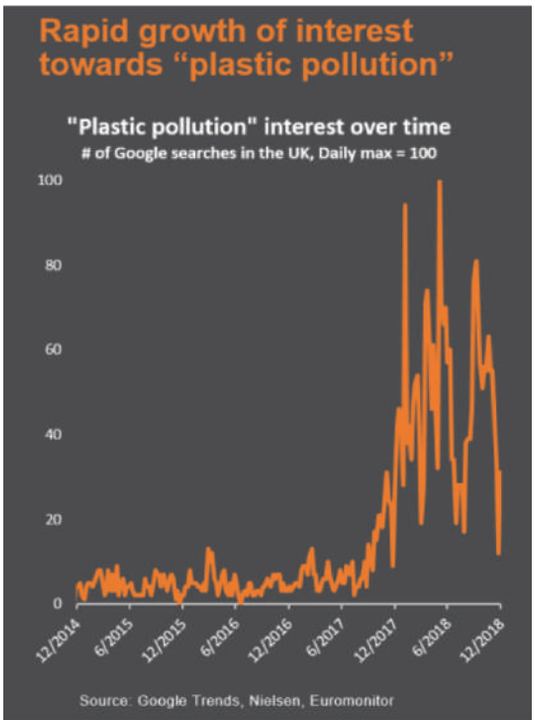
"We are encouraged by this positive trend, which confirms our





InSites consumer research, 2017 www.friendsofglass.com.

Originally published in Glass Worldwide, preferred international journal of AIGMF



https://trends.google.com/trends/explore?date=all&geo=GB&q=%2Fm%2F0n54621

Google search trends on 'plastic pollution in the UK' in the last four years.

belief that brands and consumers are switching to glass for environmental reasons" comments Adeline Farrelly, FEVE Secretary General.

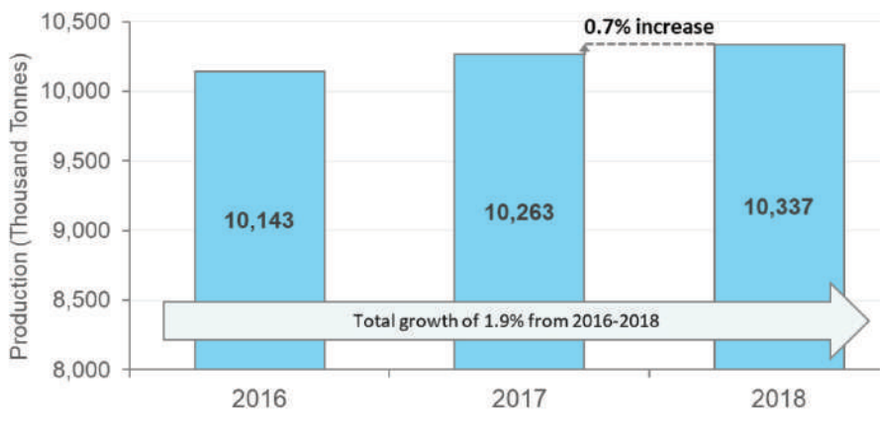
This positive market dynamic for glass reflects an increasing consumer engagement with environmental causes. Consumers – and particularly millennials – are increasingly aware of the impact their daily lifestyle can have on the environment: 'Plastics pollution' was among the most searched topics on Google in 2018 in the UK.

Sustainability is no longer a 'buzzword', now consumers see a direct link between their purchasing behaviour and major environmental issues and they want to know more about the products they buy and the way brands behave. According to a Unilever survey carried out in 2017, more than one in five (21%) of the people surveyed said they would actively choose brands if they made their sustainability credentials clearer on their packaging and in their marketing. A recent Europe-wide survey carried out with the Friends of Glass community states 78% of Europeans pay more attention on the environmental impact of their daily life and actions.

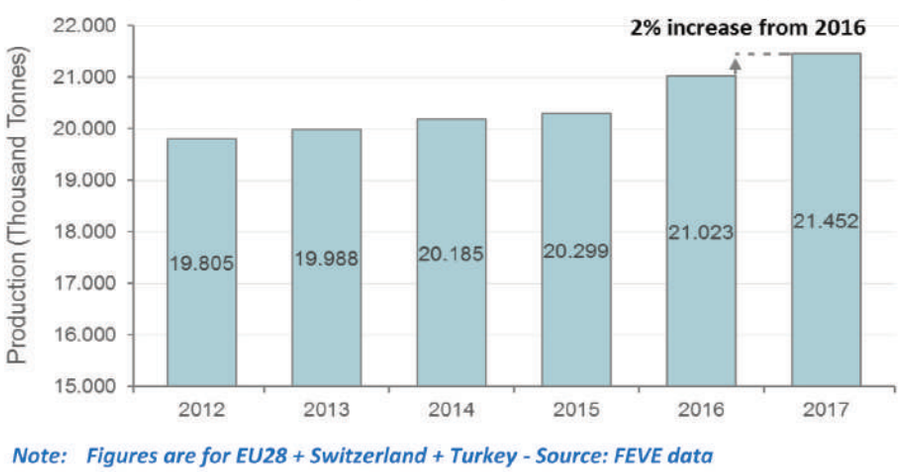
Due to the level of media and political attention on 'marine littering', not only plastics but all packaging materials have come under the spotlight and consumers are increasingly attentive to the way products are packed. In fact, this can drive product choice: the Friends of Glass research reveals that 73% of Europeans rate glass as the most ocean-friendly packaging, 78% rank it among top packaging choices when buying their food and beverage products and one in every two consumers say they use more glass than three years ago.

"This increased trust in glass from consumers is heartening for our industry" says Adeline Farrelly. "We are constantly making efforts to optimise the unique recycling properties of glass into a business model that is an authentic example of a circular economy. We work hard to improve our production technologies and product characteristics, to reduce energy use and minimise any environmental impact by using recycled glass."

Glass is more than ever the leading packaging material for spirits, wines and beer, while it is increasingly gaining share in the food, water and dairy sectors. It the second leading packaging material in Europe in terms of volume. The industry is strongly committed to champion glass as packaging of the future. ●



Glass container half year production for food and beverages in Europe. These figures are for EU28, Switzerland and Turkey.



Glass container year production for food and beverages in Europe. These figures are for EU28, Switzerland and Turkey.

FEVE
The European Container Glass Federation

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glass WORLDWIDE

The World Soda Ash Conference 2019

(September 24-26, 2019)
Cannes, FRANCE

IHS Markit's annual soda ash conference for 2019 is set to take place on September 24–26 in Cannes, France, and this year the theme of the conference will be sustainability. The recent history of the soda ash market has been turbulent, with the market balance and prices across the world's major soda ash producing and consuming regions being buffeted by a number of factors. One factor, which is beginning to have more of an impact on the soda ash market, is sustainability, and it is expected that its impact will only increase in the coming years. The following is a brief overview of the recent events that have shaped the soda ash market, with a particular focus on how sustainability will play an ever greater role in the future.

Market attention in 2017 and 2018 was focused heavily on how new supply from Turkey was going to impact the market. Ciner Group, a Turkish based producer, expanded production at its site in Beypazari, Turkey by 500,000 mt in March 2017. This was followed by the start-up of a new soda ash production facility at Kazan, also in Turkey, with an annual soda ash capacity of 2.5 million mt. Both plants are low-cost Trona based facilities, with most of the new production sold mostly to the export market. The favourable production costs at both plants meant they can supply most of the world's major import markets competitively. This opened up an opportunity for soda ash buyers to push for lower prices for their annual contracts in 2018, which many achieved, as producers feared that an over-supply in the market would develop. To give an idea of the scale of the impact 3 million mt of new capacity would have on the soda ash export market, the total volume of soda ash exported worldwide in 2018 was 16.2 million mt.

However, despite the fears of producers, this oversupply did not materialise in 2018. In fact, the year ended with many market participants reporting that the opposite was true, and that soda ash markets were tight. As a result, prices for 2019 annual contracts in all regions saw a sharp incline, as producers took advantage of a tightening market. So how did the market veer so far from its expected course in 2018?

The answer to this question comes in three parts. Firstly, the new plant at Kazan suffered a number of delays to its start-up, only reaching full capacity in the latter stages of 2018. This had the result of lessening the impact this glut of new supply had on the export market. Secondly China, which makes up approximately 41% of global demand and 44% of global supply, saw net exports fall from 1.4 million mt in 2017 to 1.1 million mt in 2018, due to internal supply issues. China's supply issues were impacted by environmental checks, imposed by the government to improve industrial waste and emissions. This saw soda ash producers in China reduce their operating rates, or in some cases shut down plants, as their facilities were

assessed. Demand was also impacted as soda ash end users, particularly flat glass producers, suffered the same fate. This led to large fluctuations in soda ash price and availability, whilst their costs were impacted by checks on producers of raw materials such as coke and coal. This ultimately led to Chinese producers exporting less soda ash.

The third part of the answer, came from the fact that world demand excluding China,which had remained fairly stable in recent decades, saw unprecedented levels of growth reaching 2.9% in 2017 and 2.8% in 2018. One of the driving forces behind this new demand has come from industry's ever growing focus on sustainability.

One soda ash demand sector that has seen a major impact from this focus on sustainability is the container glass sector. Over recent years, there has been a growing public consciousness of the impact that waste plastics are having on the environment. Recycling rates for plastic bottles in most countries remain low, particularly when it comes to recycling plastic bottles into new bottles. This is partly due to the fact, that in many cases, it is difficult to recycle plastic bottles back into food-grade packaging plastic. Much of the plastic used to produce bottles therefore finds its way into landfill or even out of the waste stream altogether and into the wider environment. Glass, on the other hand, is infinitely recyclable, with recycle rates in some parts of Europe reaching close to 100%. The issue however is complicated, as the amount of recycled glass, or cullet, used to make new bottles is often impacted by its availability,which is in turn dependant on the local recycling infrastructure.

Regardless of the practical and environmental implications of moving to using glass packaging over plastic packaging, it remains the case, at least in some markets, that public perception is resulting in growing demand for glass bottles. This is being helped by a growing willingness to take action by governments, such as the UK's move to ban single-use plastics by 2042 and India's pledge to do the same by 2022. Whether this positively impacts soda ash demand or not is also complicated. This is because as glass recycling rates increase, demand for soda ash falls.

The energy sector is also being transformed by a need for greater sustainability. With energy generation remaining one of the biggest contributors to global warming, governments and energy providers are looking to renewable energy to take a greater share of the global electricity output. One renewable energy source that has a direct impact on soda ash is solar power. Although solar power made up 2.23% of the worlds electricity generation in 2018, its share is increasing rapidly, with IHS Markit expecting it to almost double to 4.21% by 2023. To do this, glass will be needed to produce photovoltaic panels, increasing the demand for soda ash. Flat glass producers are already moving to meet this new demand, with NSG, one of the world's largest flat glass producers, breaking ground on a new solar glass in the US this year. The plant will be the first new float glass line in the US since 1980, highlighting the impact this sector could have even on mature markets like the US.

Closely linked to the renewable energy sector is the lithium carbonate sector. Lithium carbonate is used to make lithium ion batteries, which are being increasingly utilised as energy storage units for intermittent renewable energy sources such as solar energy. Demand for lithium ion batteries is being driven to an even greater extent by the growth of electric vehicle uptake, particularly in China. As governments look to decarbonise the transportation sector it is expected that electric vehicle demand will continue to grow, driving the demand for batteries and hence lithium carbonate.

Demand from the lithium carbonate sector impacts soda ash, as it is a major raw material in the production of lithium carbonate. Much of the world's production of lithium carbonate is located in a region between Chile and Argentina, so although its overall impact on global demand may be small, its impact on South America's market has been transformative. Demand for this sector in South America has grown at an average

annual rate of 12.7% since 2013 and is expected to grow at an average rate of 19.3% over the next 5 years. This will mean that soda ash demand from the lithium carbonate sector will go from making up 6.5% of all of South America's soda ash demand in 2013 to 19.3% by 2023. Lithium carbonate does however compete with lithium hydroxide, which is often favoured as a battery material, and since lithium hydroxide does not use soda ash as a raw material, this may slow soda ash demand growth from this sector in the future.

Energy production that still relies on the burning of fuel to generate electricity is also having an impact on soda ash demand. A number of governments over recent years have looked to implement legislation to reduce the amount sulphur dioxide/ sulphur trioxide (SOx) emissions from industry. Burning fuels, such as coal or in waste for the purposes of energy production, can lead to high SOx emissions, a major cause of acid rain. One way of mitigating these emissions is to use a SOx scrubber unit, which uses a sorbent material to react with SOx emissions in the waste stream to remove them before they enter the atmosphere. One particularly effective sorbent material is sodium bicarbonate. This is produced either by diverting soda ash production into sodium bicarbonate or by the conversion of soda ash. Thanks in major part to its use as a sorbent material, annual growth in demand for soda ash in this sector is expected to average 3.1% over the next 5 years.

Despite the boost to soda ash demand these sustainability driven end uses have provided, there are some less optimistic trends beginning to play out globally that may act as a counter balance and a drag on growth. The global economic outlook is much less positive currently than it was 12 months ago. Since much of the world's soda ash demand is linked to economic growth due to its use as a raw material in architectural glass, and autoglass, slower economic growth is likely to signal slower soda ash demand. Automobile production levels are already beginning to see significant declines in a number of markets and this is leading to a slowdown in autoglass output.

On the supply side there have been a number of soda ash capacity plans announced recently which may also impact future supply-demand dynamics. Ciner has announced that it is to expand its current soda ash operations in Wyoming by 800,000 mt., in the coming years, before building another 2.5 million mt plant in the region in a JV with Sisecam by 2024. Solvay, the world's largest soda ash producer is to add 500,000 mt of soda ash capacity across its soda ash plants over the next 2 years.

How these structural and cyclical changes to the soda ash market impact the balance of supply and demand over the coming years remains to be seen. But one thing is certain, the impact of sustainability on this market is only going to increase.

By attending the World Soda Ash Conference 2019, you can find out more about how these factors will impact the soda ash market in the coming years. ■

For a full list of speakers, from both IHS Markit and industry players, and details on how to book your place, please visit the following link: https://ihsmarkit.com/events/World-Soda-Ash-Conference-2019/overview.html

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The issue will be widely distributed at glasspex & glasspro India Exhibitions 2019.

To book advertisement space, mail to info@aigmf.com by August 30, 2019.

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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.

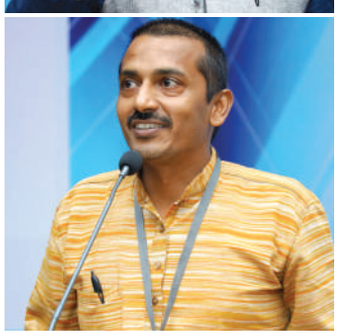
Articles of Association of the AIGMF were amended in September 1992 to enroll foreign companies as Affiliate Members of the Federation ■

One-day National Workshop on National Building Code of India: Glass and Glazing Aspects

(June 28, 2019)

In continuation to the grand success of the two One-day National Workshops on 'National Building Code: Glass and Glazing Aspects' held in Mumbai and New Delhi, Glazing Society of India (GSI), jointly with Bureau of Indian Standards (BIS) and Indian Institute of Technology Madras (IITM) organized the third edition of the One-day National Workshop in Bengaluru on June 28, 2019 at Ramaiah Institute of Technology. The Workshop was supported by the entire Glass and Glazing Fraternity including The All India Glass Manufacturers' Federation, Federation of Safety Glass, Confederation of Construction Products & Services, Glass Academy and uPVC Windows and Doors Manufacturers Association.

The objective of this workshop was to educate the entire construction value chain on the codes and provisions given in NBC 2016 on the use of glass and glazing systems in Indian Buildings and thereby enabling the implementation of the same.



The gathering was welcomed by Mr. G N Gohul Deepak, Director, Glazing Society of India and the program objectives were briefed by Mr. Arun Kumar, Scientist D, Civil Engineering Department, Bureau of Indian Standards (BIS). Ms. A Geetha, Joint Director, Town and Country Planning, Technical Cell, Urban Development Department, Govt of Karnataka; and Ms. Jessy Benny, Head BIS Bengaluru delivered the Chief Guest and keynote address respectively. The vote of thanks was delivered by Mr. Omkar Powar, Research Scholar, Structural Engineering, Indian Institute of Technology Madras.

The workshop comprised of 3 technical sessions addressed by experts from BIS, industry and the academia. The expert speakers include Mr. S Arun Kumar, BIS; Prof. Monto Mani, Member, Panel for Sustainability of NBC 2016; Mr. Sandeep Goel, Member, Panel for

Fire Protection of NBC 2016; Mr. Omkar Powar, Research Scholar, Indian Institute of Technology Madras; Mr. Antony John, Member, Panel for Glass and Glazing of NBC 2016 and Mr. Sharanjit Singh, Member, Glass, Glassware and Laboratoryware, Technical Committee of BIS.

The audience comprised of over 200 delegates including Architects, Civil Engineers, Builders, Developers, Consultants, Contractors, Glass Processors, Manufacturers, Govt Officials and other professionals. The third workshop on NBC: Glass and Glazing aspects successfully concluded with excellent feedback from the participants.

AIGMF gave a glass water bottle (*specially manufactured by HNG & Inds. Ltd.*) to each participant as part of its ongoing commitment for Swachh Bharat Abhiyaan (clean India campaign) ■

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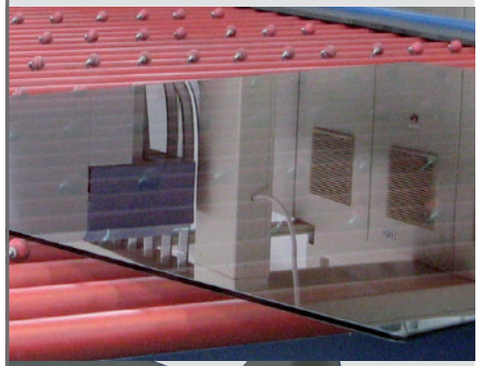

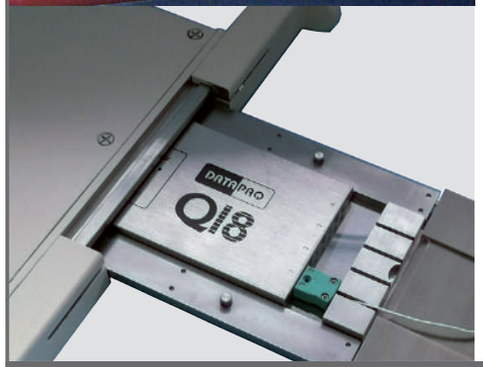

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Theme - ADOPT A GLASS BOTTLE

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*Refer terms and conditions

TERMS & CONDITIONS

1. The entrant should be aged between 7-16 years
2. Drawing can be made on a sheet of paper or on a digital medium, like a laptop, tablet or smartphone. In any case, a soft/e-file in high resolution needs to be submitted with AIGMF
3. All entries need to be mailed at info@aigmf.com with a copy of Aadhar, Passport or School ID (as Address and Date of Birth proof), alongside email ID and contact number
4. AIGMF has the rights to use the submitted drawings for its social media channels, newsletters, publications i.e Kanch and Glass Worldwide, reports, etc.
5. Any false information provided within the context of the contest by an entrant, concerning identity, address, telephone number, email address, ownership of right or non-compliance with these rules, will result in the immediate elimination of the entrant from this contest
6. The last date to submit the entries is July 20, 2019 (Date is subject to change)
7. There is no entry fee for this contest

PRIZE DETAILS

First Prize: ₹10,000 **Second Prize: ₹ 7,000** **Third Prize: ₹ 5,000** Appreciation: **First 100 entries will be gifted a glass bottle**

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