

CONFERENCE GUIDE

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glass
WORLDWIDE

82nd Conference on Glass Problems

where the glass manufacturing industry meets

November 1 – 4, 2021
Greater Columbus
Convention Center
Columbus, Ohio USA

*GPC is the largest glass
manufacturing event in
North America, attracting
global manufacturers and
suppliers to exchange
innovations and solutions*

glassproblemsconference.org

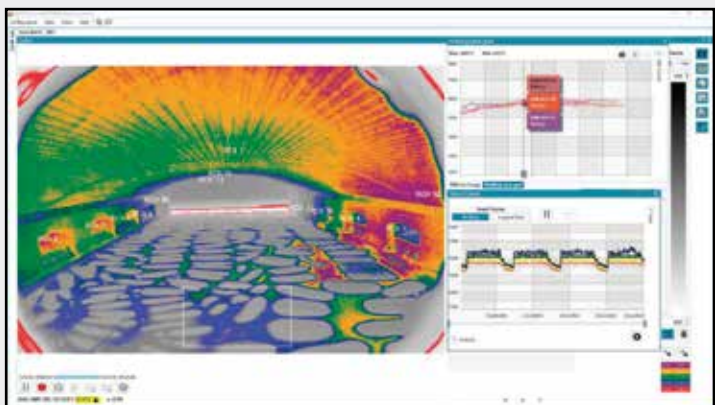
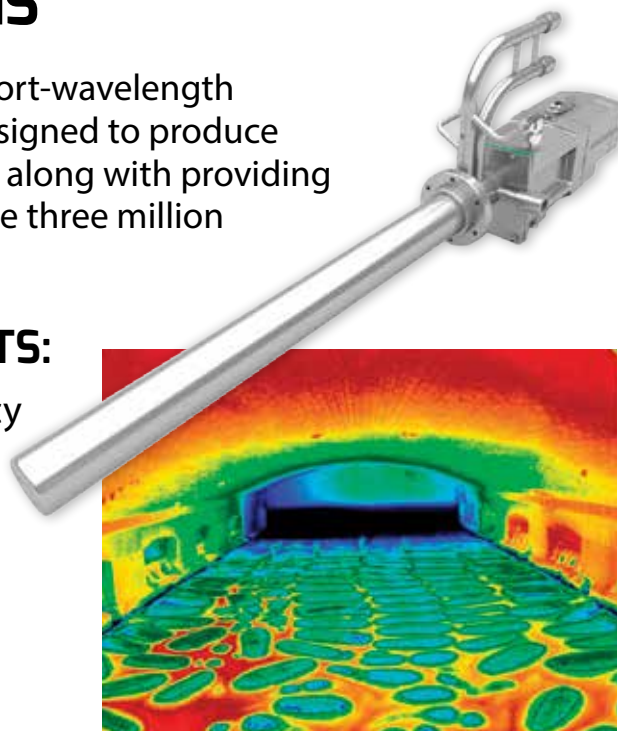
NIR-BORESCOPE-2K-GLASS

RETURN PRECISE TEMPERATURE MEASUREMENTS IN GLASS FURNACE APPLICATIONS

The NIR-Borescope-2K-Glass (NIR-B-2K-Glass) is a short-wavelength radiometric infrared borescope imaging camera, designed to produce high definition (1968 x 1476 pixels) thermal images, along with providing accurate temperature measurements from any of the three million temperature points in the image.

NIR-B-2K-GLASS FEATURES AND BENEFITS:

- High-Temperature Measurement Accuracy
- Short Wavelength Sensor
- Optional Auto-Retract System
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- Export License Free



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The innovative IMAGEPro software is an advanced image processing software for controlling, monitoring, analysing and capturing imager data.

IMAGEPro-glass is a Windows PC software system that enables configuration of imager, display properties and advanced temperature analysis options and supports multiple simultaneous imagers. Free 30-day trial available for extensive testing.

DISCOVER OUR BROAD RANGE OF NON-CONTACT TEMPERATURE MEASUREMENT AND COMBUSTION & EMISSIONS SOLUTIONS FOR YOUR PROCESS

82nd Conference on Glass Problems

November 1 – 4, 2021 Greater Columbus Convention Center Columbus, Ohio USA



Bob Lipetz, MBA
Conference Director
Glass Manufacturing
Industry Council



S. K. Sundaram, PhD
Program Director
Alfred University

GMIC MEMBER COMPANIES

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CertainTeed Corporation

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Gallo Glass Company

Glass Service USA

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SORG USA

TECO

Tri-Mer Corporation

Vitro Architectural Glass

Welcome to the 82nd Conference on Glass Problems (GPC). I'm sure you agree that it is good to be back in Columbus. Our online experience last year reminds us how important it is for the glass manufacturing industry to have a place to meet and exchange ideas.

The Glass Manufacturing Industry Council (GMIC), the leading all segments trade association, in partnership with Alfred University, the leading American glass teaching and research institution, co-organize the conference, with programming direction provided by an active industry advisory board.

GPC technical sessions address manufacturing issues, citing real world data from manufacturers and solutions providers. Additional value-rich resources are available, such as our two short courses on Electrical Glass Melting and on Fundamentals of Batch and Furnace Operations. The GMIC/GlassTrend organized technical symposium, Automation in Glass Manufacturing, is presented as a full day session, which allows us to offer a deep examination of the topic. The GPC proceedings manuscripts are made available to attendees and for publication.

Our excellent networking and exhibiting opportunities are as valuable as our technical sessions. At the GPC, leading solutions providers come together with all segments of glass manufacturers at our, booth exhibits, social events, hospitality salons and booths.

We are grateful for the sponsors who support the conference, for the time and effort of the conference organizers, and for you, the glass manufacturing industry professionals for which this conference is dedicated. We trust you will find the 82nd Conference on Glass Problems a valuable and rewarding experience.

THANK YOU SPONSORS!



Making our world
more productive

OUTSTANDING INSIDE
Refractory Solutions



82nd Conference on Glass Problems

November 1 – 4, 2021 Greater Columbus Convention Center Columbus, Ohio USA

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WHO IS GMIC

The Glass Manufacturing Industry Council (GMIC) is a trade association founded and funded by the glass industry to create opportunities to advance competitiveness and profitability across all manufacturing segments. GMIC includes among its members, representatives of container, fiber, flat and specialty glass companies, as well as leading suppliers to the industry, research institutes, and industry experts. GMIC provides beneficial services to companies, including: enhancing companies' business development and technical development, providing technical education, coordinating technical initiatives, providing industry intelligence, workforce development and promoting the usage and image of glass products.

If you are a glass industry manufacturer, supplier, or research organization, and you are not presently a member, we encourage you to join GMIC now, as an effective means to further your strategic goals in the industry. Contact GMIC's Executive Director, Bob Lipetz, for full information.

GMIC EXECUTIVE COMMITTEE

Executive Committee: **Brian Naveken**, TECO, President; **Scott Cooper**, O-I, Vice President; **Andrew Richardson**, Messer North America, Immediate Past President; **Lance Lemings**, Treasurer; **Bob Lipetz**, GMIC, Secretary

GMIC BOARD OF TRUSTEES

Ken Bratton, Emhart Glass; **Rob Hofman**, RoMan Manufacturing; **Glenn Neff**, Glass Service, USA; **Marie D. Kistler**, Air Products and Chemicals; **Dave Ulmer**, SORG Services USA; **Keith Bagarus**, RoviSys, Inc.; **Aaron Huber**, Johns Manville; **Euan Evenson**, Linde; **Priyadarshi Desai**, Guardian Glass; **Roberto Cabrera**, Vitro Architectural Glass; **Martin Goller**, Corning Incorporated; **Kevin Cook**, Selas Heat Technology; **Bruno Purnode**, Owens Corning; **Ryan Bockbrader**, Libbey, Inc.

GMIC MISSION

Facilitate, organize and promote the interests economic growth and sustainability of the glass industry through education and cooperation in the areas of technology, and the environment.

ALFRED UNIVERSITY

The Kazuo Inamori School of Engineering at Alfred University (AU) is a leader in glass and ceramic education. Established in 1900 as the New York State School of Clayworking, the School has a long-standing history of providing industry a workforce well-educated in the manufacturing of glass and ceramic materials. Today, the School offers BS and MS degrees in five disciplines. Biomaterials Engineering, Ceramic Engineering, Glass Engineering Science, General Materials Science and Engineering and Mechanical Engineering as well as doctoral degrees in the materials disciplines.

The School also serves industry by advancing the forefront of ceramics and glass research. In addition to maintaining an active portfolio of federally funded research, the faculty routinely collaborate with industry or projects ranging from fundamental research through product/process development. Interactions with industry are conducted through the Center for Advanced Ceramic Technology (CACT) and the Center for High Temperature Characterization (CHTC). The CACT facilitates collaboration between industry and academia with the goal of creating economic impact for the CACT's industrial partners. The CHCT is a user facility that provides research unparalleled access to equipment designed for characterizing materials in the situ at high temperatures.

More information about the Kazuo Inamori School of Engineering: <http://engineering.alfred.edu>

S.K. Sundaram, Inamori Professor of Materials Science and Engineering Alfred University

SAVE
THE
DATE

OCTOBER 31 – NOVEMBER 3, 2022

The 83rd Conference on Glass Problems

Greater Columbus Convention Center and the Hilton

Columbus Downtown in Columbus, Ohio, USA

PROGRAM SCHEDULE

SUNDAY, OCTOBER 31, 2021

6 p.m. GPC ADVISORY BOARD DINNER

MONDAY, NOVEMBER 1, 2021

12 – 4:30 p.m. STUDENT PLANT TOUR –
OWENS CORNING NEWARK

SHORT COURSES

Columbus Hilton Downtown Hotel

FUNDAMENTALS OF BATCH AND FURNACE OPERATIONS

Monday, November 1, 2021 | Noon – 5 p.m.

Instructor: **C. Philip Ross**, President, Glass Industry Consulting International (GICI)

The course is an introduction to the principles of commercial glass production employed in Batch & Furnace operations by US Glass producers. Raw Materials, Glass Technology & Properties, Melting Furnaces, and Environmental Issues will all be touched upon. Suggested attendees could be vendors or newer individuals to glass manufacturing seeking an introduction to the issues faced in glass production.

ELECTRICAL GLASS MELTING – AN INTRODUCTION

Monday, November 1, 2021 | Noon – 5 p.m.

Instructors: **René Meuleman**, Business Development Director and **Corinne Claireaux**, PhD, Glass Scientist, Academy Manager, CelSian Electricity will play a major role in the ongoing energy transition to reduce CO₂ emissions. Although electric melting of glass is an old technology, many aspects have to be considered to create an efficient system that is suitable for each specific glass production. This crash course focuses on supply and hardware, from the electrical grid down to the electrodes and beyond, to provide you with a pragmatic level of understanding of the whole system. We will start from the very basics of electrical energy to make sure that all who are interested can participate. The course will be a summary of our frequently running “Electric systems for glass melting training course” but we will still try to give you sufficient food for thoughts in case you are considering to install electrical furnace boosting systems or if you intend to potentially increase your electrical melting power.

As time will be limited, we will briefly discuss:

- Purpose of electrical boosting, from sustainability to flexibility
- Heat transfer to the glass: efficiency of electricity vs combustion
- Selecting the correct type of transformer
- Cables or busbar
- Electrode material, types, holder, and cooling systems
- Melting zone, barrier and throat boosting
- How to choose the proper electrical system for your specific application
- Transformers to the choice of the electrode current density and control system consideration

Noon – 4:30 p.m.

Noon – 5 p.m.

5 – 5:30 p.m.

5 – 11 p.m.

TUESDAY, NOVEMBER 2, 2021

8 – 8:45 a.m.

8:45 – 9 a.m.

9 – 10:30 a.m.

Session Chairs: **Bob Lipetz**, MBA, Conference Director, Glass Manufacturing Industry Council and **S. K. Sundaram**, PhD, Program Director, Alfred University

9 – 9:30 a.m.

9:30 – 10 a.m.

10 – 10:30 a.m.

10:30 – 11 a.m.

11 – 12:30 p.m.

Session Chairs: **Larry McCloskey**, Consultant, Anchor Hocking and **Eric Dirlam**, Director of Furnaces, Ardagh Group

11 – 11:30 a.m.

11:30 a.m. – 12 p.m.

12 – 12:30 p.m.

12:30 – 2 p.m.

12:30 – 2 p.m.

STUDENT PLANT TOUR – HOLOPHANE CORPORATION, Acuity Brands Glass Plant – Newark, Ohio

EXHIBITOR AND HOST SET UP

STUDENT MEETING

HOSPITALITY SUITES

EXHIBITING

OPENING REMARKS: PLENARY SESSION

– **Bob Lipetz**, MBA, Conference Director, Glass Manufacturing Industry Council

– **S. K. Sundaram**, PhD, Program Director, Alfred University

TECHNICAL SESSION: PLENARY

The United Nations International Year of Glass – 2022, **Manoj Choudhary**, Adjunct Professor of Materials Science & Engineering, **The Ohio State University/United Nations**

With COVID an Ongoing Dilemma, Especially from a Manufacturing Standpoint, **Elizabeth Nagel**, Plant Engineering Manager, **Corning Inc.**

e-Balancing the Issue-Driven Sustainability Dialogue that is Hurting Glass. How We Got Here and What We Do About It, **Randy Burns**, O-I Chief Sustainability and Corporate Affairs Officer, **O-I**

BREAK & EXHIBITING

TECHNICAL SESSION: REFRACTORY

Mullitisation – The Key to Regenerating Regenerators, **Christopher Windle**, Technical Director, **DSF Refractories & Minerals, Ltd.**

Know What's in Your Furnace: All Bonded AZS Refractory Brick Are Not the Same, **J Terry Fisk**, Senior Scientist/Owner, **JTF Microscopy Services, LLC**

How Efficient Non-Destructive Control of FC AZS will Support High Quality Glass Melting, **Pierrick Vespa**, R&D Project Leader, **SEFPRO**

LUNCH

EXHIBITING

82nd Conference on Glass Problems

TUESDAY, NOVEMBER 2, 2021 (cont)

2 – 4:30 p.m.

TECHNICAL SESSION: DATA, CHEMISTRY, ENERGY

Session Chairs: **Justin Wang**, Senior Process Engineer, Guardian Industries; **Chris Tournour**, Senior Glass Process Engineer, Corning Inc.

2 – 2:30 p.m.

Your New Problem Began Two Years Ago: Tracking Refractory Performance and Glass Infiltration Over Time with Data, **Alexander Ruege**, PhD, Chief Engineer, VP, Data Analysis and Reporting Division, **PaneraTech, Inc.** and **Jon Wechsel**, Technical Solutions Manager, **PaneraTech, Inc.**

2:30 – 3 p.m.

Advanced Power Control Technologies for Electronically Powered Glass Furnaces, **John Boomer**, Industry Manager – AC Power Systems, **Spang Power Electronics**

3 – 3:30 p.m.

Ultrafast Glass Engineering, **S. K. Sundaram**, PhD, Program Director, **Alfred University**

3:30 – 4 p.m.

Electrical Glass Melting and Boosting Solutions of the Future Designed for Efficiency, Flexibility and Micro-Grid Capability, **Mikael Le Guern**, Global Business Development Manager for Glass, **Schneider Electric**

4 – 4:30 p.m.

Heat Exchanger on Glass, **Martin Schroeter**, Product Manager, **Tri-Mer Corporation**

4:30 – 5:30 p.m.

EXHIBITING

5:30 – 7:30 p.m.

FREE TIME

7:30 – 11 p.m.

HOSPITALITY SUITES

WEDNESDAY, NOVEMBER 3, 2021

8 – 9 a.m.

EXHIBITING

9 – 10:30 a.m.

TECHNICAL SESSION: PLENARY

Session Chairs: **Bob Lipetz**, MBA, Conference Director, Glass Manufacturing Industry Council and **S. K. Sundaram**, PhD, Program Director, Alfred University

9 – 9:30 a.m.

Solving Quality Problems Associated with Pharmaceutical Glass Containers, **Robert Schaut**, Scientific Director, **Corning, Inc.**

9:30 – 10 a.m.

Collaboration within Competitive Spaces, The Future of the Glass Industry, **Aston Fuller**, General Manager, **Glass Futures, Ltd.**

10 – 10:30 a.m.

The Green Story of Cardinal FG, **Milo Renberg**, Technical Manager, **Cardinal FG**

10:30 – 11 a.m.

BREAK

11 a.m. – 12:30 p.m.

TECHNICAL SESSION: ENERGY/ COMBUSTION

Session Chairs: **Glenn Neff**, Vice President, Glass Service USA; **Uyi Iyoha**, PhD, Associate Director Business Development & Strategic Accounts, Linde, Inc.; **Jan Schep**, Director of Corporate Engineering, O-I

11 – 11:30 a.m.

Hydrogen as Fuel for the Glass Industry, What are the Challenges?, **Oscar Verheijen**, Team Lead R&D Training, **CelSian**

11:30 a.m. – 12 p.m.

Thermoelectric Waste Heat Recovery in an Oxyfuel Melter, **Adam Polcyn**, Manager S Research, **Vitro Architectural Glass**

12 – 12:30 p.m.

Carbon Reduction Strategies, **Corrine Claireaux**, PhD, Glass Scientist, Academy Manager, **CelSian** and **Andries Habraken**, Team Lead Process Automation, **CelSian**

12:30 – 2 p.m.

LUNCH

12:30 – 2 p.m.

EXHIBITING

2 – 4 p.m.

TECHNICAL SESSION: SENSORS/ENERGY

Session Chair: **Glenn Neff**, Vice President, Glass Service USA

2 – 2:30 p.m.

Carbon Reduction Comparison Electric or Hydrogen Power, **Erik Muijsenberg**, Vice President, **Glass Service, Inc.**

2:30 – 3 p.m.

All-Electric Melting Back to the Future, **C. Phillip Ross**, President, **Glass Industry Consulting**

3 – 3:30 p.m.

Technical and Economic Investigation of Next Generation Fuels for Glass Melters, **Shrikar Chakravarti**, Business Development, **Linde, Inc.**

3:30 – 4 p.m.

In-furnace Thermal Imaging Survey of a Float Furnace for Combustion Optimization, **Philippe Kerbois**, Global Industry Manager-Glass, **Ametek Land** and **Neil Simpson**, Independent Consultant to **Ametek Land**

8 a.m. – 12 p.m.

HOST TEARDOWN

2 – 4 p.m.

EXHIBITOR TEAR DOWN

4 – 5 p.m.

GMIC MEMBER MEETING

IN MEMORY OF CHUCK DRUMMOND

MSE Associate Professor and Fellow of the American Ceramic Society, Charles “Chuck” Drummond is remembered for 40 years of outstanding teaching coupled with innovative research in glass.

A dedicated steward to the glass manufacturing community, Professor Drummond was a long-time organizer of the Annual Conference on Glass Problems and earned the American Ceramic Society’s Cramer Award for his outstanding contributions in advancing ceramic engineering



NEW EDITION NOW ON SALE

THE GLASS MANUFACTURING INDUSTRY COUNCIL GLASS MANUFACTURING INDUSTRY REPORT

THIRD EDITION

A detailed and comprehensive reference source for intelligence on the glass manufacturing industry produced by the Glass Manufacturing Industry Council

Expert Segment Analysis - Comprehensive Data – Emissions Regulations Summary - Recycling

Spreadsheets of GMIC Members HQs, Plant Lists & Global Supplier

EXPERT SEGMENT ANALYSIS

Not to be missed! World renowned experts in container glass, float glass and fiberglass manufacturing segments provide in-depth detailed analyses of recent history, current global disruptions, technical advancements, major players, and future trends.

INDUSTRY DATA

Contained in the report are vital metrics broken out by glass manufacturing segments; float, fiber, container, and specialty glass, detailed as historical trends, industry predictions, graphs, tables, and analysis.

- | | | | |
|---------------------------|---|---|--|
| - Production volumes | - Energy usage and cost | - Operational data - COGS, margin, payroll, capital, etc. | - Major manufacturing company profiles |
| - Revenue volumes | - Recycling analysis and trends | - Operating ratios and other relevant financial and industry benchmarks | - Inventory turnover |
| - Market share by segment | - Glass end markets data and trends | - Historical trends | - Plant utilization |
| - Market share by region | - Competitive industries comparative analysis | - Industry predictions | - Research & Development |
| - Capital expenditures | | | - Value added |
| - Production facilities | | | and other relevant metrics... |
| - Employment & salaries | | | |

SPECIAL SECTION ON EMISSIONS REGULATIONS

A detailed and comprehensive survey of emissions regulations relevant to glass manufacturing in North America and Europe, along with recommended best available techniques

CONTACT LISTS

- GMIC glass manufacturing members headquarters list – Now available as a spreadsheet!
- GMIC glass manufacturing members factory list – Now available as a spreadsheet!
- Supplier lists – alphabetical and by category



Visit The Report Website To Place Orders
<https://gmic.org/glass-manufacturing-industry-report/>

Contact Bob Lipetz For Additional Information
614-818-9423 Boblipetz@gmic.org

82nd Conference on Glass Problems

AUTOMATION IN GLASS MANUFACTURING

A symposium organized by the Glass Manufacturing Industry Council and GlassTrend



Thursday, November 4, 2021 | Hilton Columbus Downtown



DESCRIPTION: To sustain their competitive advantage, today's glass manufacturers must take advantage of the latest advancements in automation, digitization, and smart manufacturing. Challenged by the need to reduce emissions, extend furnace campaigns, and make production more efficient, it's critical that manufacturers have full knowledge of current innovations in automation tools. This symposium, co-organized by the Glass Manufacturing Industry Council and GlassTrend, is presented by leading experts in this field who provide a detailed examination of sensors, industrial artificial intelligence, data analytics, controls, remote management, and other automation tools invaluable to efficient sustainable glass manufacturing.

SESSIONS: The Future of Glass Manufacturing symposium will have four sessions, Sensors, Industrial Artificial Intelligence and Data Analytics, Controls, and Remote Management.

AUDIENCE: Glass Manufacturers, Refractory and Equipment Suppliers, Sensors and automation suppliers, Raw Material and Energy Suppliers, Design Engineers, Process Engineers, Academics, and Glass Researchers, Technology, Process Design, Analysis, and Improvement.

OBJECTIVES: The participants should come away from the symposium with knowledge of the current technologies and future trends in automation in glass manufacturing.

SYMPOSIUM DIRECTOR: **Bob Lipetz**, MBA - Executive Director, Glass Manufacturing Industry Council

ASSISTANT TO THE DIRECTOR: **Donna Banks**, Executive Assistant, Glass Manufacturing Industry Council

PROGRAM CO-CHAIRS: **Keith Bagarusn**, Director, Global Automation – RoviSys [GMIC Board of Trustees];

Bruno A Purnode, Leader Melting & Fiberizing Technology; Senior Technical Staff – Owens Corning [GlassTrend managing Board]

PROGRAM COMMITTEE

- **Ryan A. Bockbrader**, Director, Engineering Process, Libbey Glass, LLC
- **Paul Castañuela**, Global Leader - Automation & Controls, Engineered Products, Johns Manville
- **Mathieu Hubert**, Development Associate, Corning [Representing Glass Trend]
- **Sanjay Mansukhani**, Principal Engineer, Advanced Process Control, Digital Transformation, Owens Corning Advanced Manufacturing
- **Ivan Solis Martinez**, Engineering Project Manager, Vitro Architectural Technology
- **Glenn Neff**, Vice President, Glass Service USA
- **Udaya K. Vempati**, Vice President – Analytics and Automation Discipline Leader, O-I
- **Oscar Verheijen**, Team Lead R&D Training, CelSian Representing GlassTrend]

SYMPOSIUM SCHEDULE:

- 8 – 8:15 a.m. WELCOME – **Bob Lipetz**, Executive Director, Glass Manufacturing Industry Council and **Oscar Verheijen**, Senior Consultant, CelSian, GlassTrend Chairman
- 8:15 – 9:45 a.m. **SESSION I – SENSORS**
Chairman – **Oscar Verheijen**, Team Lead R&D Training, CelSian
- 8:15 – 8:40 a.m. *NIR Camera and Inspection Results* – **Erik Muijsenberg**, Vice President, Glass Service, Inc.
- 8:40 – 8:45 a.m. Q&A
- 8:45 – 9:10 a.m. *State-of-the-art of Advanced Sensors for Process Automation* – **Oscar Verheijen**, Team Lead R&D Training, CelSian
- 9:10 – 9:15 a.m. Q&A
- 9:15 – 9:40 a.m. *Digitalization Robotization as a Mean to Further Strengthen and Automate the Forming Process* – **Paul Schreuders**, CEO, XPAR Vision
- 9:40 – 9:45 a.m. Q&A
- 9:45 – 10:15 a.m. BREAK
- 10:15 – 11:30 a.m. **SESSION II – INDUSTRIAL ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS**
Chairman - **Udaya K. Vempati**, Analytics and Automation Discipline Leader, O-I
- 10:15 – 10:55 a.m. *Big Data, Machine Learning, and Artificial* – **Bryan DeBois**, Director, Industrial AI, RoviSys, Inc.
- 10:55 – 11 a.m. Q&A
- 11 – 11:25 a.m. *20% Reduction of Down Time with AI-Powered PdM* – **Shannon Friedman**, Sales Engineer, Senseye, Inc.
- 11:25 – 11:30 a.m. Q&A
- 11:30 a.m. – 12:30 p.m. LUNCH

IN MEMORY OF RON ARGENT

Ronald "Ron" D. Argent will be remembered for his considerable contributions to glass manufacturing. In 1978, Ron emigrated to the United States to form KTG, USA. Traveling 300 days a year, Ron was instrumental in building relationships with companies globally. After 20 years, Ron left for Frazier-Simplex serving as its company President. In the 1990's, Ron focused his efforts on the hand-blown glass industry. The industry lost "the glassman", but his impact will likely be felt for many years to come.



12:30 – 1:30 p.m.

SESSION III – CONTROLS

Chairman – **Sanjay Mansukhani**, Principal Engineer, Advanced Process Control, Digital Transformation, Owens Corning Advanced Manufacturing

12:30 – 12:55 p.m. Digital Twins - *Simulation Models to Streamline Design, Analysis, and Operations* – **Michael Sarvo**, Support Manager, Rockwell Automation and **Sameer Kher**, Senior Director, Product Development ANSYS

12:55 – 1 p.m. Q&A

1 – 1:325 p.m. *Digitalization Brings Plant Wide Automation to the Next Level* – **John Ryan**, Glass Industry Manager, Siemens and **Heinz-Josef Lennartz**, Glass Industry Manager, Siemens AG

1:25 – 1:30 p.m. Q&A

1:30 – 2 p.m. BREAK

2 – 3:30 p.m.

SESSION IV – REMOTE MANAGEMENT

Chairman – **Paul Castañuela**, Global Leader - Automation & Controls, Engineered Products, Johns Manville

2 – 2:25 p.m.

Security – **Scott Reynolds**, PE, Manager, Industrial Security, ITD - Johns Manville

2:25 – 2:30 p.m. Q&A

2:30 – 2:55 p.m.

How Mixed Reality, 3D Visualizations and Laser Scanning Allow Onsite and Offsite (remote) Experts to Work Together – **Steven Ostrowski**, 3D Laser Scanning and Mixed Reality – Trimble, Inc.

2:55 – 3 p.m. Q&A

3 – 3:25 p.m.

Accelerate Innovation from Edge to Cloud to Improve Operations – **Timothy McCain**, Digital Partner Program Manager – Rockwell and **Mark Beckmann**, Director Industry Solutions - Microsoft

3:25 – 3:30 p.m. Q&A

3:30 – 3:45 p.m.

CONCLUDING REMARKS

Keith Bagarus, Director Global Automation, RoviSys, Inc.

3:45 p.m.

SYMPOSIUM ENDS



HOSPITALITY HOSTS

Hospitality Booth & Salon Hosts

Takes place at the Hilton Columbus Downtown

Monday, November 1 | 5 – 11 p.m.

Tuesday, November 2 | 7:30 – 11 p.m.

Lower Level



ADVANCED CONTROL SOLUTIONS, INC.

Booth #HB105, 401

As an integrator of advanced control system solutions, ACSI engineers are able to provide customers with quality technical engineering, system design, factory acceptance, installation supervision, commissioning services, and training. Our knowledge can be applied to Float, Fiber, Container, Tableware, Lighting, Tubing, and Specialty glass systems. Types of solutions we provide are DCS replacement, Process Mapping, Flexible Batching, Temperature Control, and Model Based Control.

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BASF CORP TEMPERATURE SENSING

Booth #HB103

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CANTY

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Using high temperature cameras to measure flame, level, width, temperature, GOB, onion, and other process applications. Fiberglass stream width and speed. Stone detection for molten glass. Knurl control to reduce waste.

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ERTL COMBUSTION

Booth #Emerson Burkhardt A

ERTL Combustion is an industry leader in the design and fabrication of pipe trains, burners, valves and combustion components. Our competent staff and inventory strategy allow us to provide high quality service while maintaining short lead times. In addition to complete systems, we rebuild existing equipment for budget-sensitive projects. Founded in 1996, ERTL is large enough to provide world-class products while maintaining personalized service and industry-leading responsiveness.

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Phone: +1-765-622-9900

www.ertlcombustion.com

HOSPITALITY HOSTS

FLAMMATEC

Booth #HB202

FlammaTec, founded by STG and Glass Service in 2008, supplies natural gas and oil delivery systems utilizing advanced burner technology for glass furnaces.

Over 4,500 burners have been installed on float, container, tableware and special glass furnaces. When replacing conventional burners, FlammaTec's advanced LoNOx burners improve heat transfer and efficiency, and lower emissions:

- Underport Gas Injector, Flex or Freejet
- Underport Gas/Oil Dual Injector, Flex or Freejet
- Underport Heavy Oil Injector
- Sideport Gas Injector, Flex
- Oxy/Gas Burner
- New Hydrogen Carbon Free Burner

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Phone: +420 571 498 566

www.flammatec.com

FOSBEL, INC.

Booth #HB304, HB306

Fosbel Provides Innovative Glass Furnace Maintenance

Solutions. Fosbel offers a wide range of repair and inspection services and has conducted more than 2,500 repairs to virtually every type of glass furnace around the world. In addition to Ceramic Welding technology to repair refractory at operating temperature, Fosbel has also developed many innovative hot repair solutions including Port Floor Restoration, Checker Cleaning, Dual Crown Overcoating and Hot Bottom Repairs. Fosbel's experienced engineers and technicians are familiar with almost any furnace condition, and repairs are conducted in an effective and efficient manner, providing improved energy efficiency while minimizing production downtime.

20600 Sheldon Road, Brook Park, OH 44142, USA

Phone: +1-216-362-3900

www.fosbel.com

FRAZIER-SIMPLEX, INC.

Booth #HB101

Engineering Design. Construction. Project Management. Consulting. Manufacturer of Custom Equipment.

436 East Beau Street, Washington, PA 15301, USA

Phone: +1-724-225-1100

www.frazier-simplex.com

FUSE TECH/HOT TECH GROUP

Booth #Emerson Burkhart B

Fuse Tech's core business is Ceramic Welding and Refractory Repair on both cold and hot furnaces. We also have equipment to photograph inside the furnace for use in damage and operation evaluation. Through the use of high pressure water lasers, Fuse Tech is able to remove debris from port sills as well as the tops of checker packs, flues and tunnels. Hot Tech will help you with your Refractory and Operational Problems. Specializing in drilling, rebuilds, hot repairs, cold repairs, diamond chainsawing, burner block replacements and overcoats. Fuse Tech/Hot Tech also is a source for Consulting on furnace and refractory problems.

3400 Silica Rd., Sylvania, OH 43560, USA

Phone: +1-419-841-9323

www.fusetech.com

GLASS SERVICE

Booth #HB200

Glass Service (GS) is a leading global consultant for glass melting/conditioning furnace and forehearth design, control, operation and troubleshooting. Glass Furnace Modeling (GFM) simulated design optimization software and Expert System ES III™ automatic control provide cost savings. The high-resolution infrared/visual camera with unique AI software, paired with ES III™, allows furnace operators to tap into Industry 4.0 standards. It provides fully automatic monitoring and control of temperatures and the batch blanket (270 references worldwide).

GS labs analyze 2,000+ defects yearly, and offer melt testing utilizing basic and applied research.

Headquartered in Czech Rep with offices in Netherlands, France, USA, Japan, China and Russia.

Rokytnice 60, 755 01 Vsetin, Czech Republic

Phone: +420 571 498 511

www.gsl.cz/

HARBISONWALKER INTERNATIONAL

Booth #HB11

HarbisonWalker International (HWI) provides the largest manufacturing capacity to the glass industry in North America. Over 85 years of research and development in the glass market have enabled us to pioneer innovative glass solutions. Every day around the world, our people and products stand up to the challenges and pressures of every job. Our world-class refractory products perform to the highest degree. And by bringing intensity, reliability and passion to work every day, we're able to provide superior value to our customers and their businesses.

1305 Cherrington Parkway, Suite 100, Moon Township, PA 15108, USA

Phone: +1-412-375-6600

thinkHWI.com

HOSPITALITY HOSTS

HFT

Booth #Bellows B, #108

HFT is a design-build turnkey, EPC company with a long history of providing quality project solutions to global glassmakers. From Batch Plant and Furnace through to Cold End and Utilities. HFT has delivered over 2,100 successful projects for float glass, fiberglass, container glass, press glass, and specialty glass producers since 1947.

HFT's services include Design, Engineering, Project Management, Scheduling, Procurement, Construction, Hot Repairs, Cold Repairs, Upgrades, and Audits.

3009 Washington Road, McMurray, PA 15317, USA

Phone: +1-724-438-9550

www.hft.com

LILJA CORP.

Booth #HB205, HB207

Lilja Corp. is an assertive leader in industrial and glass furnace construction. Our managers, supervisors and craftsman are known industry wide for their high standards, performing quality work, meeting project schedules and a commitment to a safe working environment. We are a full service general engineering contractor, specializing in the construction of processing, manufacturing and warehousing facilities, glass melting furnaces and all related systems and industries. Lilja Corp. has been serving the needs of the glass industry for over 35 years. with offices located in the US and Canada.

229 Rickenbacker Cr., Livermore CA 94551, USA

Phone: +1-925-455-2300

www.liljacorp.com

LINDE

Booth #HB204, HB206

Linde is a leading global industrial gases and engineering company. We live our mission of making our world more productive every day by providing high-quality gases, gas applications, technologies and services. This includes oxygen supply systems, OPTIFIRE® low NOx burners, and efficiency-driven technologies for glass melting, forming, and surface treatment. Our line of OPTIMELT® Waste Heat Recovery Technologies can reduce fuel consumption by 20% to 30% compared to oxy-fuel and air-fuel furnaces.

10 Riverview Dr., Danbury, CT 06810, USA

Phone: 1-844-445-4633

www.lindeus.com/glass

RHI MAGNESITA

Booth #Bellows A

RHI Magnesita is the global leading supplier of high-grade refractory products, systems and services. With a vertically integrated supply chain, from raw materials to refractory products and full performance-based solutions, RHI Magnesita supplies to a wide range of industrial markets, including the glass industry. Seeking to strengthen our position in the US market, we recently acquired a new production plant in Missouri, which will provide quicker solutions for North American customers.

3956 Virginia Avenue, Cincinnati, OH 45227, USA

Phone: +1-513-527-6178

www.rhimagnesita.com

ROVISYS

Booth HB301, #HB303, #301

Global system integrator with 30 years of experience. RoviSys executes projects for manufacturers on float, display, container, fiber, specialty & ceramic processes. We are platform independent, offering solutions on all control or data platforms. Our services include design/engineering, electrical & installation supervision, onsite commissioning/startup & training. RoviSys provides services in all major process areas: batch house, hot/cold end, business layer (MES/ERP/reporting/analytics) & IT.

1455 Danner Drive, Aurora, OH 44202, USA

Phone: +1-330-995-8103

www.rovisys.com



HOSPITALITY HOSTS

SEFPRO

Booth #HB201, HB203, HB300, HB302

SEFPRO is glad to support glassmakers' success by delivering top quality refractory products and services that give you the advantage. Thanks to our worldwide network and outstanding innovation power, you can trust us for meeting your ever evolving needs. Tell us about your projects – working together, we can and will make the difference!

87 Corhart Road, Buckhannon, WV 26201, USA

Phone: +1-502-439-9179

www.sefpro.com

TANAKA PRECIOUS METALS

Booth #HB305

TANAKA is Japan based precious metals manufacturer. We have obtained the leading share in the Asian market for more than 135 years. We provide special platinum materials that are able to withstand harsh operating conditions to a variety of high-grade glass manufactures such as LCD glass, optical lenses and glass fiber, etc.

Sales and engineering support is available globally including the U.S.

235 Vineyard Ct., Ste. 150, Morgan Hill, CA 95037, USA

Phone: 1-408-779-0461

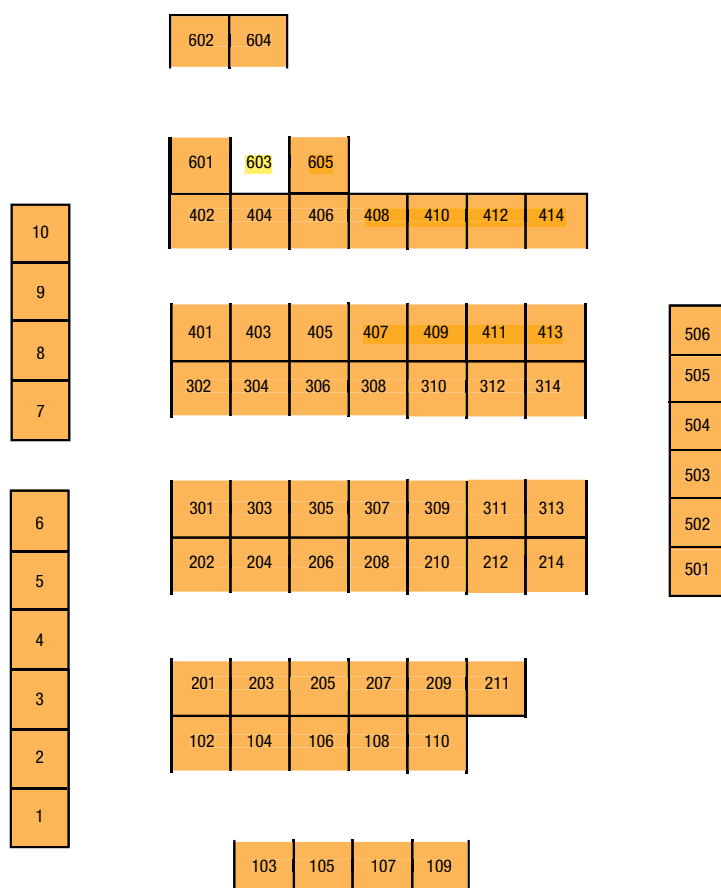
tanaka-preciousmetals.com/us/



EXHIBITORS

Tuesday, November 2 | 8 a.m. – 5:30 p.m.
10:30 – 11 a.m.
12:30 – 2 p.m.
4:30 – 5:30 p.m.

Wednesday, November 3 | 8 a.m. – 2 p.m.
10:30 – 11 a.m.
12 – 2 p.m.



AIRPRO FAN & BLOWER CO.

Booth #604

AirPro Fan & Blower Company is a fast-growing industrial fan manufacturer, offering centrifugal fans for process air applications. Founded in 2002, AirPro is privately held and 100% Employee-Owned.

Thousands of customers depend on AirPro fans to keep their operations going. With a mission to be the #1 most reliable fan manufacturer, AirPro builds the highest quality fans, prioritizes on-time delivery, and offers a 3-year warranty on all products!

425 W. Davenport St., PO Box 543, Rhinelander, WI 54501, USA

Phone: 715-365-3267

www.airprofan.com

ALLSTATES REFRACTORY CONTRACTORS LLC

Booth #105

Allstates Refractory Contractors, LLC is a full-service industrial process general contractor serving the glass, metals and petrochemical industries since 1995. We provide expert technical services including engineering and manufacturing. ARC has licensed safety professionals to assure our clients of our commitment to a safe work environment. With a combined experience of 100 years, our staff is highly regarded as experts in the online repair of melting and heat treatment furnaces and ovens.

P.O. Box 256, Waterville, Ohio 43566, USA

Phone: 419-878-4691

www.allstatesrefractory.com

AMERICAN CERAMIC SOCIETY

Booth #603

The American Ceramic Society is the leading professional membership organization for ceramic and glass materials scientists, engineers, researchers, manufacturers, plant personnel, educators, and students. The Society serves more than 10,000 members worldwide.

550 Polaris Parkway., Ste. 510, Westerville, Ohio 43082, USA

Phone: +1-866-721-3322

www.ceramics.org

AMETEK LAND

Booth #3

AMETEK Land has been manufacturing precision measurement instrumentation since 1947. We are specialists in infrared non-contact temperature measurement for the glass industry. From single point pyrometers to thermal linescanners to process thermal imaging cameras, AMETEK Land provides innovative total temperature measurement capabilities.

150 Freeport Road, Pittsburgh, PA 15238, USA

Phone: +1-412-826-4467

www.ametek-land.com

ADVANCED CONTROL SOLUTIONS, INC.

Booth #401, HB105

As an integrator of advanced control system solutions, ACSI engineers are able to provide customers with quality technical engineering, system design, factory acceptance, installation supervision, commissioning services, and training. Our knowledge can be applied to Float, Fiber, Container, Tableware, Lighting, Tubing, and Specialty glass systems. Types of solutions we provide are DCS replacement, Process Mapping, Flexible Batching, Temperature Control, and Model Based Control.

8750 Resource Park Drive, Sylvania, Ohio 43560, USA

Phone: +1-419-843-4820

www.acsitolledo.com

EXHIBITORS

ANTONINI S.R.L.

Booth #307

Antonini s.r.l. is an Italian company specialized, from over 60 years, in annealing and decorating lehrs, tempering lines, mould preheating ovens and other accessories for hollow glass industry. Designers, Manufacturers, Suppliers and Installers of Annealing and Decorating Lehr's also special Lehrs for Glass blocks, Toughening and Car Head Lamps.

Phone: +39 0571 93221

Via Medaglie Oro della Resistenza, 2 Empoli, Florence 50053 Italy

www.antoninisrl.com

BARNETT TECHNICAL SERVICES

Booth #309

Leading Edge instrumentation for Chemical & Materials Analysis. For the glass industry we distribute Orihara Surface Stress meters and Luceo Polariscopes to measure strain in glass. We also offer benchtop micromanipulators for failure analysis and thermal analyzers through Transient Plane Source instruments.

5050 Laguna Blvd., Suite 112-620, Elk Grove, CA 95758, USA

Phone: +1-510-052-7383

www.barnett-technical.com

BATCH HOUSE, LLC

Booth #503

Batch House LLC is a global, full service design/build company dedicated to the batching and material handling process of a glass plant. Our services include complete turnkey batch plants, equipment, fabrication as well as process, safety and silica audits. Our team can provide engineering, fabrication, equipment, construction, construction management and commissioning services. Services includes all disciplines, civil/structural, mechanical, process, electrical and process controls.

5195 Hampstead Village Center Way, New Albany, OH 43054, USA

Phone: +1 614-600-1850

www.Batchhouse.com

BROOK ANCO CORPORATION

Booth #308

Since 1958, Brook Anco Corporation has been providing precision measuring and manufacturing solutions. We offer industrial microscopes, cameras, software, automated image analysis, surface characterization, and metrology instruments.

7536 West Murray Drive, Cicero, New York 13039, USA

Phone: +1-315-288-4992

www.brookanco.com

CALCEAN MINERALS LLC

Booth #504

Calcean Aragonite, high performance calcium carbonate applicable to a variety of industries including high purity Glass. Research and innovation drive our product development, but our company identity is guided by our commitment to sustainability. Our products are created in the spirit of carbon footprint reduction, carbon sequestration and sustainability, without sacrificing performance. Products made with Calcean all benefit from reduced carbon footprints and replacing non-renewing elements.

140 Thomas Drive, Gadsden, Alabama 35904, USA

Phone: +1-678-642-7719

www.calcean.com

C.B. MECHANICAL LLC & PART FOR LEHRS LLC

Booth #305

C.B. Mechanical LLC and Part for Lehrs LLC provides highly efficient services to the glass manufacturing industry with expertise in full turnkey installations. We install, rebuild, repair and service all types of Decorating and Annealing Lehrs, Antonini, Bowman, Pennekamp JJ Day, Old Emhart, and Surface Combustion. We also provide all Lehr associated components including but not limited to: Cold-End Finish, Single Line, AP5 (Coating Hoods), Controls, Instrumentation, Utility Mold Ovens. As your top certified OEM supplier, C.B. Mechanical & Part for Lehrs provides parts globally for all makes of lehrs, this includes all burners and burner repair.

521 North Plum Street Albany IN 47320, USA

Phone: 1-765-321-2011

www.partforlehrs.com

CELSIAN

Booth #403

CelSian is an independent glass consultancy firm for optimizing your melting process. We support the industry with CFD software (projects), trainings and various R&D projects in the area of energy and emission reduction, glass quality and process design optimization.

Achtseweg Zuid 241-A, Building TZ, Eindhoven, NB 5651 GW, Netherlands

+31 40 249 0100

www.celsian.nl

EXHIBITORS

CEMTEK KVB-Enertec

Booth #10

CEMTEK KVB-Enertec™, Inc., a leading supplier of custom-engineered continuous emissions monitoring systems (CEMS) and Data Acquisition Handling System (DAHS), and a provider of expert support for compliance and noncompliance applications. The integration of industry-leading CEMS and DAHS under one roof gives our clients access to exceptional products, support, and response times.

3041 South Orange Ave., Santa Ana, CA 92707, USA
Phone: +1-714-437-7100
www.cemteks.com

CHIZ BROS. REFRACTORY AND INSULATION SPECIALISTS

Booth #602

Chiz Bros. offers a wide range of stock and custom refractory and insulation products to meet customer needs. As a Unifrax Distributor, our warehouse is fully-stocked with ceramic fiber blankets, board, paper, ropes and modules. In the glass industry, Chiz Bros specializes in insulation board and blanket back up, as well as a full range of Silica based products. In addition Chiz Bros can help with fabricated insulation panels and heat shields.

2117 Lincoln Blvd., Elizabeth, PA 15037, USA
Phone: 412-384-5220
www.chizbros.com

CLEAN AIR TECHNOLOGY, LTD.

Booth #207

FLKCAT is an innovative leading manufacturer of ceramic catalytic and non-catalytic fiber filters. Filters are used for monitoring and controlling air pollution such as particles, acid gas, NOx, SOx, and Dioxin removals. Founded in Taiwan in 2013 and successfully grown to production capacity of 100,000 filters per year. FLKCAT employs over 110 highly trained employees. More than 50 successful installations across various industries with many installed in Glass furnace exhaust systems. Contact FLKCAT for new projects and for replacement filters.

Mughis Naqvi, P. Eng., Consultant for Clean Air Technology
630 W. Duarte Road, Suite 202, Arcadia, CA 91007, USA
Phone: 630-715-3585
www.cat-filter.com/?lang=en

DIAS INFRARED CORP.

Booth #203

Solutions for non-contact temperature measurement, infrared cameras, line cameras, pyrometers, calibration sources, pyroelectric detectors and system solutions.

75 Sterling Street, West Boylston, MA 01583, USA
Phone: +1-774-261-8699
www.dias-infrared.com

DURA TEMP CORPORATION

Booth #212

Dura Temp is an industry-leading supplier of hot ware handling solutions for glassmakers worldwide. From the gob forming area through thelehr loader, Dura Temp offers superior materials, quick-change parts and assemblies, and technical experience that allow glassmakers to achieve optimum results in the hot end. Dura Temp is also the authorized distributor of SEFPRO Expendable Items in the United States and Canada.

949 S. McCord Road, Holland, OH 43528, USA
Phone: +1-419-866-4348
www.duratemper.com

EDWARD ORTON JR. CERAMIC FOUNDATION, THE

Booth #8

The Edward Orton Jr. Ceramic Foundation manufactures pyrometric products and thermoanalytical instruments. In addition, the Foundation operates an independent material testing laboratory specializing in refractory, glass, whiteware, and advanced ceramic materials.

6991 Old 3C Highway, Westerville, OH 43082, USA
Phone: +1-614-895-2663
www.ortonceramic.com

EUROTHERM BY SCHNEIDER ELECTRIC

Booth #306

Eurotherm by Schneider Electric is a global manufacturer of instrumentation, systems and services designed for the efficient operation of industrial processes. For the global glass industry we design, build and install scalable process and power solutions, specifically designed to aid efficiency and save energy.

44621 Guilford Drive. Suite 100 Ashburn, Virginia 20147 USA
Phone: 703-724-7300
www.eurotherm.com/glass-manufacturing-process-solutions

F.I.C. (UK) LIMITED

Booth #312

F.I.C. is the leading technology supplier in melting and conditioning of ultra, high quality glass. With proven designs of all sizes of electric furnaces and electro-boost systems. We have extensive experience in the TFT and cover glass markets as well as float glass, 'E' glass fibre and all specialist glasses such as borosilicate, high alumina and zero alkali glasses. We can supply all types of electrodes including tin oxide and molybdenum and associated holders and electrical connection systems. Our High 'Q' holder has a removable waterway and our Maxi 'Q' holder is designed to operate continuously in molten glass above 1600°C and are ideal for top electrode systems as well as on-the-run replacement for competitors failed holders.

Longrock Industrial Estate, Penzance, Cornwall, TR20 8HX UK
Phone: +44 (0) 1736366962
www.fic-uk.com

EXHIBITORS

FIVES IN GLASS

Booth #6

Fives in Glass is a leading supplier of engineering solutions for high quality melting and thermal conditioning for all types of glass. We design, manufacture, install, commission and service glass plant and equipment tailored to your specific needs.

With over 100 years of experience in a wide range of glass processes and applications all over the world, we can provide a complete range of services. We provide full support and training for your teams, on our equipment, to assist with your full-scale glass production needs.

We are part of the Fives, an industrial engineering group, who design and supply machines, process equipment and production lines for the world's largest industrial groups. The group has over 8,300 employees worldwide and an annual turnover in excess of \$2 billion.

4A Churchward, Southmead Park, Didcot, Oxon, OX11 7HB, UK
Phone: +44 1235 811 111
Glass.fivesgroup.com

GLASS MANUFACTURING INDUSTRY COUNCIL (GMIC)

Registration Area

GMIC is a trade association of the glass industry that includes among its members, representatives of all four sectors: Flat, Container, Fiber and Specialty Glass Companies as well as leading suppliers to the industry, research institutes and industry experts. Our goal is to promote the interests and growth of the glass industry.

550 Polaris Parkway, Suite 510, Westerville, OH 43082, USA
Phone: +1-614-523-3033
www.gmic.org

HERAEUS

Booth #302

Heraeus specializes in the manufacture of platinum, gold, iridium, and specialty metal parts for the glass industry. With over 150 years of experience in precious metals and worldwide operations, Heraeus has the capability to provide the highest quality products in the most sophisticated designs. Items include stirrers, liners, electrodes, crucibles, cladding, and other custom designed parts, in high strength alloys and grain stabilized materials, specifically designed for glass manufacturing. All of our products are backed by our expertise and world-class technical support.

Heraeusstr. 12-14, 63450 Hanau, Germany
Phone: 201-647-8672
heraeus.com

HFT

Booth #108, #Bellows B

HFT is a design-build turnkey, EPC company with a long history of providing quality project solutions to global glassmakers. From Batch Plant and Furnace through to Cold End and Utilities. HFT has delivered over 2,100 successful projects for float glass, fiberglass, container glass, press glass, and specialty glass producers since 1947.

HFT's services include Design, Engineering, Project Management, Scheduling, Procurement, Construction, Hot Repairs, Cold Repairs, Upgrades, and Audits.

3009 Washington Road, McMurray, PA 15317, USA
Phone: +1-724-438-9550
www.hft.com

HOLLAND MANUFACTURING CORP.

Booth #202

Since 1973, the Holland Manufacturing Team has been working toward our vision to be the most innovative, customer-driven refractory shapes provider in the industry. Although relatively new to the glass market, Holland's reputation for high quality and performance is quickly spreading throughout all segments of the industry. Our carefully engineered refractory compositions – and proprietary ISO-Tuff Manufacturing Process – allows us to produce shapes with exceptional aesthetic qualities; impressive physical properties; and adherence to very tight dimensional tolerances.

P.O. Box 261, South Holland, IL 60473, USA
Phone: +1-708-849-1000
www.hollandmanufacturing.com

HOTWORK USA

Booth #1

Worldwide supplier of glass furnace heating, expansion control supervision, regenerator sulfate burnout, glass draining with hot water recycling, wet cullet filling, screened cullet filling, furnace cooldowns, contraction control supervision, hold pots, and electronic crown rise monitoring. The only continuous operating Hotwork heatup company since 1965 and proud sponsor of The Phoenix Award Committee.

223 Gold Rush Rd., Lexington, KY, 40503 USA
Phone: +1-859-276-1570
www.hotwork.com

JADCO MANUFACTURING, INC.

Booth #406

JADCO Manufacturing, Inc. is an ISO-certified provider of premium wear products to combat even the most severe impact and abrasion challenges. In addition, our world-class Fabrication Services deliver innovative, superior results...no matter how custom, complex, or demanding your requirement. Our CHROMEWEELD, chromium-carbide overlay plate (offered in multiple chemistries), stands up to the toughest abrasion wear conditions; our QT-PLUS® wear steel outlasts commodity AR wear steel 3-5 times.

PO Box 465, Zelienople, PA 16063, USA

Phone: +1-724-452-5252

jadcomfg.com

JENIKE & JOHANSON

Booth #205

Jenike & Johanson is the world's leading company in powder and bulk solids handling, processing, and storage technology. Over the past 55 years, we've tested over 13,000 unique powders and bulk solids and worked on more than 7,500 projects, giving our team the broadest real-world and in-depth experience in the industry to address a wide variety of bulk material handling and engineering needs.

400 Business Park Dr., Tyngsboro, Massachusetts, 01879, USA

Phone: +1-978-649-3300

jenike.com

JOHNSON MATTHEY

Booth #201

We offer a complete range of precious metal solutions to the glass industry. From platinum and iridium fabrications through to our proprietary ACT™ coating, we are able to positively influence both the efficiency of your process and the quality of your glass. As well as exceptional products, we offer unparalleled technical expertise, ensuring you achieve your goals in the most demanding of industries.

1401 King Road, West Chester, PA, 19380, USA

Phone: 1-610-648-8042

matthey.com/markets/glass

LAHTI GLASS TECHNOLOGY OY

Booth #110

Lahti Glass Technology Oy is one of the leading suppliers of glass raw material handling systems. A member of Zippe Group of Companies.

Lahti Glass Technology Oy serves the producers of:

- Float glass, flat and figured glass
- Container and tableware glass
- Insulation and reinforcement fiberglass
- Solar glass / low iron glass
- Flat screen, TV and other technical glass
- Borosilicate and water glass, and other special glass

By supplying

- Complete batch plants and cullet systems
- Weighing, dosing and mixing systems and components
- Control systems and components
- Cullet return systems
- Plant modernizations and control system upgrades

Ahjokatu 4A, 15801 Lahti, Finland

Phone: +358 400 352 605

www.lahti-glass.fi

LHOIST NORTH AMERICA

Booth #103

Lhoist is a leading supplier of calcium based products for batch feed and air pollution control. Sorbacal® engineered hydrated lime sorbents are designed for air pollution control applications, and designed for glass production. Sorbacal® is a highly reactive sorbent for SO₂, SO₃, HCl, HF and Se removal, yielding reduced dosages and disposal than other hydrated limes. Due to engineered particle and chemical properties, Sorbacal® sorbents are proven in ESP, fabric filter, and ceramic filter applications. Lhoist can provide low cost injection equipment for trials, acid gas, data analysis, and application experts to identify and implement an optimized air pollution control solution.

5600 Clearfork Main Street, Suite 300

Fort Worth, Texas 76109, USA

Phone: +1-682-774-2037

www.lhoist.com



EXHIBITORS

MCGILL AIRCLEAN, LLC

Booth #2

McGill AirClean has over 50 years experience engineering, manufacturing, and installing air pollution control equipment. In the glass industry alone, we have over 250 installations worldwide controlling many different pollutants such as particulates, heavy metals, acid gases (SOx, HCl, HF, and Boron), VOCs, and NOx. Our products and services include dry and wet electrostatic precipitators, fabric filter systems (including catalytic filters), spray dry and dry injection acid gas scrubbers, regenerative thermal oxidizers, DeNOx reactors (SCR), mobile testing services, and parts and service.

1777 Refugee Road, Columbus, OH 43207, USA

Phone: +1-614-829-1200

www.mcgillairclean.com

MIXER SYSTEMS, INC.

Booth #102

Mixer Systems is an American manufacturer of four types of mechanical batch mixers for the glass, refractory and ceramic industries. Located near Milwaukee, Wisconsin USA., we have supplied over 4,200 projects in 51 different countries worldwide since 1955. The Turbin mixer is a low profile, pan mixer that features angled mixing paddles that mixes around a circle for a constant, intensive mixing action. The Planetary mixer has a stationary pan and utilizes a counter current mixing action for difficult to mix applications when thorough dispersion is critical to the end product. The horizontal shaft mixer is a paddle mixer that is lower cost / lower maintenance than the pan mixers. The twin shaft mixer utilizes twin, horizontal shafts with multiple mixing paddles per shaft. It is a very intensive mixer with cycle times as little as 60 seconds and discharge times of 10 seconds.

190 Simmons Avenue, Pewaukee, WI 53045, USA

Phone: +1-262-893-5315

mixersystems.com

NEW HUDSON CORPORATION

Booth #501

Performance and Innovation for more than 50 years. New Hudson Corporation has led the glass industry in supplying complete lines of high quality lehr rollers for the float glass process. Our rollers are installed in over 250 lines throughout the world and are well known to perform for multiple campaigns while producing high quality glass. According to customers, once they're installed rest easy and forget about them, knowing your lehr roller performance will assist in increasing your yields.

57077 Pontiac Trail, New Hudson, Michigan 48165, USA

Phone: +1-248-437-1701

www.newhudson.com

NEW YORK BLOWER COMPANY

Booth #314

NYB has over 130 years experience designing and manufacturing fans for the Glass industry. Fans range from cataloged axial and centrifugal, to custom engineered products for specific application requirements. Typical design features include heavy duty materials, abrasion-resistant construction, and reinforced housings. Additional services include preventative maintenance, engineering analysis, aftermarket retrofits, and field services. Replacement parts or units can be reversed engineered.

7660 Quincy St., Willowbrook, Illinois 60540, USA

Phone: 630-794-5700

www.nyb.com

NIPPON SANSO HOLDINGS CORPORATION (TNSC)

Booth #204

For more than 40 years, TNSC a group company of Nippon Sanso Holdings Corporation (NSHD) has developed advanced oxygen combustion technologies in various industries with hundreds of successful installations and operations. Our "Innova-Jet" system can reduce fuel consumption by 40% while reducing emissions.

Our "Innova-Jet Swing" is an oxygen-enriched burner for innovative preheating processes that will improve heat area expansion and it has no mechanical moving parts.

Toyo Bldg., 1-3-26 Koyama, Shinagawa-ku, Tokyo 142-8558, Japan

Phone: +1-81-551-42-4734

www.nipponsanso-hd.co.jp/en

OPTRIS INFRARED SENSING, LLC

Booth #104, 106

Optris is a world leader in remote infrared temperature measurement with an extensive line of pyrometers and thermal imaging systems for glass applications. Optris will feature our G7 thermal imaging camera which has been spectrally optimized for glass temperature measurement. Our new PIXConnect software produces high resolution thermal images using a special line scan function that allows the camera to look through small spaces to identify subtle thermal variations across the glass sheet.

200 International Drive, Suite 130, Portsmouth, NH 03801, USA

Phone: (603) 766-6060

Optris.com

EXHIBITORS

PANERATECH, INC.

Booth #404

Your partner for monitoring the state of your refractories. We offer innovative solutions to determine refractory thickness with constant IoT sensors as well as portable equipment. SmartMelter data is used to extend furnace life by timing repairs optimally and finding glass infiltration while it is still manageable.

4125 Lafayette Center Drive, Suite 200, Chantilly, VA 20151, USA
Phone: +1 703-719-9666
www.paneratech.com

PLANSEE USA LLC

Booth #211

Plansee is known for strong refractory metals and is the largest fully integrated partner for the glass industry. We provide glass melting electrodes, stirrers, nozzles and glass tank reinforcements made from our own high purity molybdenum and tungsten powders which result in higher glass quality and lower cost of ownership.

The purity of our powders combined with our forging process create coarse, closed grains which reduce creep and fight corrosion providing longer operation.

East Coast Sales & Marketing Manager: David.Hoskins@plansee.com (508-446-5327)

West Coast Sales & Marketing Manager: Gaurav.Singh@plansee.com (508-530-2585)

115 Constitution Blvd., Franklin, MA 02038, USA
Phone: +1-508-553-3800
www.plansee.com

RAMSEY PRODUCTS CORPORATION

Booth #209

Ramsey Products has supplied glass conveying chain to bottle producers and glass equipment manufacturers for almost 50 years. Today, we offer the widest range of production proven silent glass conveyor chains of any company in the world.

135 Performance Drive, Belmont, NC 28012, USA
Phone: +1-704-394-0322
www.RamseyChain.com

RATH GROUP

Booth #405

The RATH Group, a worldwide active producer and provider of high quality refractories, offers a comprehensive product range for the glass container industry including regenerator chambers, furnaces, distributors, forehearth and the original Emhart Glass System for feeder expendables.

Walfischgasse 14, Postfach 42, Vienna A-1015, Austria
+43/1/5134427-2110
www.rath-group.com

ROCKWELL AUTOMATION

Booth #9

At Rockwell Automation, our strategy is to bring The Connected Enterprise to life. We integrate automation and information across the enterprise to help industrial companies and their people be more productive and sustainable. Our portfolio includes hardware, software, and services to provide support from product R&D to design simulation to operations and maintenance. With reliability being a focus, our lifecycle services will support you throughout a furnace campaign.

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Phone: +1-248-230-0563
www.rockwellautomation.com

ROVISYS

Booth #301, HB301, HB 303

Global system integrator with 30 years of experience. RoviSys executes projects for manufacturers on float, display, container, fiber, specialty & ceramic processes. We are platform independent, offering solutions on all control or data platforms. Our services include design/engineering, electrical & installation supervision, onsite commissioning/startup & training. RoviSys provides services in all major process areas: batch house, hot/cold end, business layer (MES/ERP/reporting/analytics) & IT.

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Phone: +1-330-995-8103
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SAFETY CONTROLS TECHNOLOGY (SCT)

Booth #214

Safety Controls Technology, Inc. (SCT) provides safety and health services for glass demolition and rebuild sectors including clients that have requirements to comply with local, state or federal regulations. SCT is a Woman-Owned Business Enterprise delivering comprehensive Occupational and Environmental Engineering consulting services to both the public and private sectors.

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Phone: +1-440-449-6000
www.sct.us.com

EXHIBITORS

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Booth #5

Sigma, a family company in its third generation, has been operating in the refractory market since 1990 working with passion and flexibility since then.

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Via delle Grigne, 12/A, Locate Varesino, CO 22070, Italy

Phone: 39 0331 823195

www.sigmaref.it

SOCIETY OF GLASS TECHNOLOGY

Booth #310

The Society of Glass Technology (SGT) exists to serve people who are interested in the production, properties or uses of glasses, whether from a commercial, aesthetic, academic or technical viewpoint. It is a non-profit making organisation serving a worldwide membership publishing journals and text books, organising meetings, symposia and conferences on glass related topics, coordinating the activities of special interest groups and technical committees, and providing a communication framework geared to the needs of the glass community. The SGT holds Furnace Solutions in Stoke on Trent in early June every year.

Society of Glass Technology (SGT), 9 Churchill Way, Chapeltown Sheffield S35 2PY, UK

Phone: +0114 2634455

www.sgt.org

SORG USA

Booth #402

The SORG Group through their member companies can supply turnkey installations and equipment from raw material delivery through the glass gob worldwide. This includes all aspects of the furnace lifetime cycle. From sustainable designs, construction, services, repairs, through demolition at the end of the campaign. SORG through EME, Nikolaus Sorg GmbH & Co. KG, and SKS delivers Made In Germany solutions to all sectors of the glass industry. Our latest products include the LoM burners (Low Momentum, Low Maintenance oxy-fuel burners) and the updated 340S+ forehearth system.

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www.sorg.de

SPECIAL SHAPES REFRACTORY COMPANY, INC

Booth #304

Special Shapes Refractory Company (SSRC) is a family-owned business that manufactures specialized, engineered pre-cast refractory shapes and un-shaped monolithic refractory products utilizing SSRC developed mixes for use in the Glass Industry. Our pre-cast and un-fired monolithic refractory materials include light weight insulating mixes, fireclay, sillimanite and andalusite grades, 12-33% AZS mixes, Zircon, alumina, and alumina-chrome products that can be installed for most Glass Melter applications. We continue to offer grinding and finishing services, quick turn-around lead times for emergency repairs, and with our co-op partners, can provide refractory solutions that assist our customers for either "hot or cold" repairs. We continue to work on refractory developments, both shaped and un-shaped, that help our customers compete in the Global Market.

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Phone: +1-205-424-5653

www.ssrco.com

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Booth #4

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Phone: +1-201-616-9301

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Booth #7

SSEO Group is the project delivery firm for your engineering and construction management needs. SSEO's glass experience spans 50 years and five continents, working with glass manufacturers on every type of glass plant project. Our capabilities include batch house, furnace, production line, packaging, utilities and environmental. From container glass, to specialty glass, fiberglass, and float glass, our experienced staff apply their knowledge and familiarity to come up with innovative solutions.

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Phone: 567-218-2234

www.ssoe.com

EXHIBITORS

SYMPHONY INDUSTRIAL AI

Booth #303

Symphony IndustrialAI plant performance applications span asset predictive maintenance and process health and optimization, maintaining high availability of equipment, extending the life of capital assets, and reducing process variability. Symphony IndustrialAI solutions provide high value to its users by driving variability out of processes and optimizing operations for throughput, yield, energy efficiency, and sustainability.

1050 NE Hostmark St., Suite 101, Poulsbo, WA 98370-7538, USA
Phone: +1-715-571-5464
www.symphonyindustrial.ai

TOLEDO ENGINEERING CO., INC.

Booth #601

The TECO Group has served the glass industry since 1927 with comprehensive knowledge of all aspects of the glass manufacturing process and all types of glass; always innovating to support the challenges glass manufacturers face, i.e. lowering emissions; higher quality requirements for low-iron in solar glass; lowering total cost of ownership; and technical issues demanding the assistance TECO can provide using our extensive modeling capabilities. Put our experience and expertise to work for you.

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Booth #208, 210

The Tri-Mer system design and catalytic filters are the combination with a long-term track record on glass emissions, with over nine years of operating history on float, container, and tableware plants. No other system has undergone almost a decade of evolution and improvement. Currently three dozen glass furnaces are meeting regulatory requirements with the Tri-Mer system. Particulate (PM), SO₂, HCl, metals, and NO_x are removed in a single all-in-one system. Acid gases such as SO₂, HCl, and HF are treated with integrated dry sorbent injection. NO_x is destroyed by nanobits of SCR catalyst embedded in the filter walls in conjunction with integrated ammonia injection. Tri-Mer offers turnkey services: design engineering, in-house manufacturing, integrated controls, CEMs, mechanical/electrical/civil installation, commissioning, and power generation options. Technical Field Services, the ace team of Tri-Mer field professionals, provide unequalled service support and execute custom maintenance agreements. Tri-Mer is the largest supplier of ceramic filter systems in the world, with more installed filters than all other suppliers combined.

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Phone: 989-723-7838
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VACUUM PUMP & COMPRESSOR, INC.

Booth #502

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VESUVIUS

Booth #313

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115 Hwy 301, Suite B, Dillon, SC 29536 USA
Phone: 843-774-6026
www.vesuvius.com/en/index.html



EXHIBITORS

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Booth 311

A leader manufacturer of High Current Conductors including Battery and Custom Bus Bar Copper Connectors, Engineered Furnace Secondary Power Connectors, Bus Bar Systems, Laminated Shunts, Water Cooled Power Cables, Resistance Welding Cables, High Current DC Switches, Industrial Rubber Hose and Tubing, and a wide variety of custom engineered products. For more on Watteredge Products please visit www.watteredge.com

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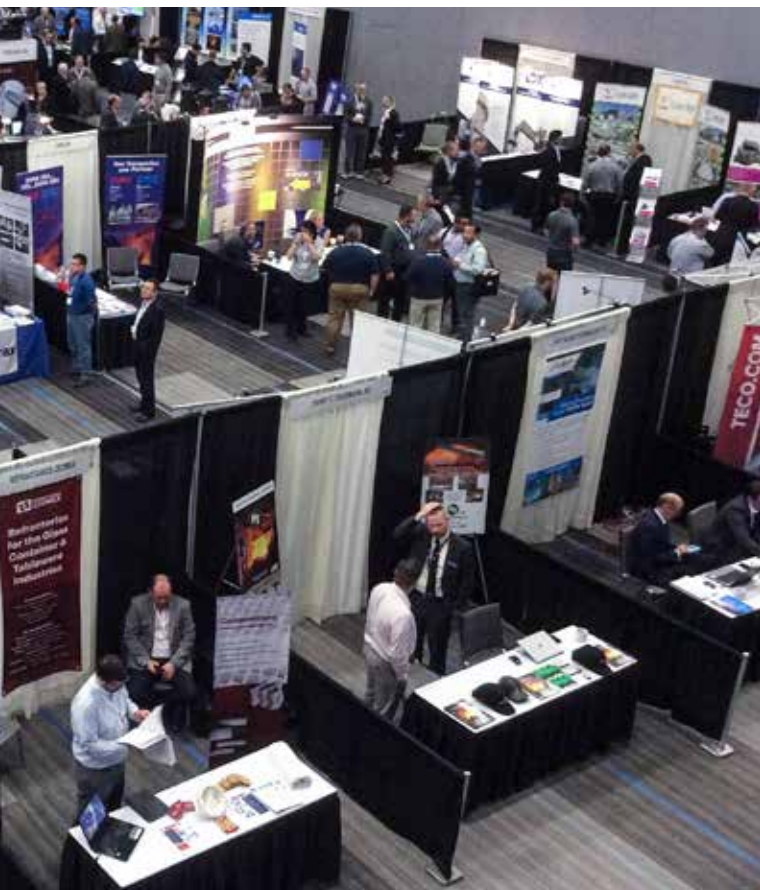
Booth #206

Wear-Concepts, is a specialty manufacturer, supplier and installer of wear resistant and material flow improvement products for your material handling systems. Wear-Con provides impact/sliding abrasion resistant, corrosion/sticking resistant solutions including; wear plates, pipe & elbows, ceramics, wear compounds and a multitude of unique solutions to reduce your downtime and help you get the most from your equipment. Wear Specialists are available to listen, consult and advise you.

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WE APPRECIATE YOUR FEEDBACK

Sincerely,
Bob Lipetz, MBA
Conference Director

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John Boomer, Industry Manager, Spang Power Electronics

Advanced Power Control Technologies for Electrically Powered Glass Furnaces

Electric power supplies have been used for several decades to apply electric energy /

heat to molten glass for boosting applications in a combustion furnace and melt applications within an electric furnace. As the industry moves toward greener melting technologies resulting in a higher utilization of electricity there is a need to maximize efficiency and minimize the capital costs associated with adding more electric power. The purpose of this presentation is to discuss power supply technologies that improve energy efficiency and optimize capital investment while delivering precise and stable control of power, current and/or voltage to electrodes within a glass furnace.

Technology advancements that will be presented include:

SCR based systems using Auto-tap control on a multi-tapped transformer. This solution provides a broad range of adjustable voltage while keeping power factor near unity. Also discussed will be the application critical ability to sense the DC voltage at the power supply output and eliminate or drive it deliberately to a customer's preferred non-zero DC offset.

IGBT based systems used for converting a balanced three-phase input to a single-phase output. In addition to the phase conversion, the presenter will discuss how the technology is used to maintain phase synchronization in a multi-power supply common furnace and offer high frequency options tailored to customer specific glass compositions.

Common to both technologies, the presenter will discuss how each improves energy.

Randy Burns, O-I Chief Sustainability and Corporate Affairs Office, O-I

Re-balancing the Issue-driven Sustainability Dialogue that is Hurting Glass. How We Got Here and What We Do About It?

Where is Thomas Khun when we need him? Today's sustainability dialogue would have you believe the sustainability "paradigm" has shifted. That products with hydrocarbons as ingredients or that require toxic processes to derive their base are better for people, plant, and our collective prosperity than glass, an endlessly recyclable product that is made from pure, natural ingredients and won't harm people or the planet.

We arrived at this moment by allowing an unbalanced and uncorrected dialogue to be spread, one that has created the illusion of a paradigm shift. The solution lies in a unified glass-advocacy voice to re-balance the dialogue—and correct the record. That solution requires active participation by the industry from end-to-end.

Shrikar Chakravarti, Business Development, Linde, Inc.

Technical and Economic Investigation of Next Generation Fuels for Glass Melters

Due to the increased emphasis on sustainability, glass companies are looking for ways to substantially reduce CO₂ emissions from their operations. One approach is through use of low carbon fuels, examples of which include renewable hydrogen, biofuels, biomass-derived syngas, and renewable ammonia. In particular, hydrogen is considered as the fuel of the future to eliminate CO₂ emissions from combustion of hydrocarbon fuels. Large scale demonstration projects have been announced in Europe. Several utility companies are considering blending hydrogen into existing natural gas distribution pipelines and eventually considering them for use with 100 percent hydrogen. Since hydrogen production from fossil fuels (e.g. NG) results in significant CO₂ emissions, to qualify glass operations to be CO₂ – free, clean hydrogen production with low carbon intensity must be used. Two common clean H₂ production methods currently under consideration are NG-based steam methane reforming with carbon capture and sequestration (blue H₂) as well as electrolysis with renewable power (green H₂).

However, there are several challenges to the adoption of H₂ as a fuel in glass melting operation including:

1. Cost-effective generation and supply of clean H₂,
2. Modification of fuel piping and burner systems, and
3. Understanding impact of higher water vapor concentration in furnace atmosphere on glass chemistry.

This paper addresses the first two challenges:

The first part describes methods of clean hydrogen generation mentioned above. H₂ requirements for glass furnaces will primarily be determined by multiple factors including furnace size, number of furnaces at a given site and cullet rates. Techno-economic assessments for use of clean H₂ as fuel in glass melting will be presented for specific cases, e.g. float / container, one / multiple furnaces. The price of clean H₂ will be based on published projections from sources such as International Energy Agency and International Council on Clean Transportation will be used. This section will conclude with a high-level description of the logistics involved in H₂ supply for a short-term demonstration project using H₂-based combustion in glass production will also be provided.

The second section discusses results from the ongoing experimental work on combustion using H₂, blends of H₂ and NG as well as biofuels. Results will be presented from an experimental study focused on characterizing performance for a portfolio of commercial oxy-fuel burners supplied by Linde for use in the glass industry utilizing these fuels and blends. This will also include observations and guidelines regarding analytical measurements of furnace flue gases used for combustion control and emissions monitoring.

Manoj Choudhary, Adjunct Professor of Materials Science & Engineering, The Ohio State University

The United Nations Internal Year of Glass – 2022

On May 18, 2021 the United Nations General Assembly formally approved a resolution declaring the year 2022 “The International Year of Glass”. This is a seminal and celebratory moment for the global glass community. It is noteworthy that this is the first time that United Nations has accorded such a recognition to a specific material and represents an acknowledgment of the vital role glass has played and will continue to play in the advancement of human society. The UN resolution is the culmination of the vigorous leadership of the International Glass Commission president, Alicia A. Duran, and enormous efforts of many individuals and organizations from all over the world. The vision for the International Year of Glass originated with L. David Pye in 2018 after organizing a special issue of The Int. Journal of Glass Science with the theme of Glass and Light during the 2015 UN International Year of Light, and a series of activities spanning 2016-2018 centered on the theme of the “Glass Age” which included joint presentations at various international glass forums with Manoj K. Choudhary. This presentation will provide background information on the UN resolution and discuss the scientific, technological, and economic significance of glass, a vitally important material for meeting the challenges of climate change and developing equitable and sustainable society. Also highlighted is the role glass has played in arts and advancing human civilization throughout the history and will conclude with an outline of various events planned around the world to celebrate the year 2022 as the International Year of Glass.

J. Terry Fisk, Senior Scientist/Owner, JTF Microscopy Service, LLC

Know What's in Your Furnace: All Bonded AZS Refractory Brick Are Not the Same

Refractory manufacturers can and do select from a large menu of different ingredients to arrive at the same bulk chemistry in their final product. Chief among these are zircon vs zirconia for the ZrO_2 source and kaolin/clay, andalusite, mullite, fused mullite, calcined alpha-alumina, tabular alumina or electro-fused alumina grain for the Al_2O_3 source; and usually two or three different aluminous raw materials are used in a single product. Silica is added by default as a natural ingredient of zircon, kaolin/clay, andalusite and mullite but it is sometimes also added as quartz, colloidal silica or sodium silicate to aid in the binding process. Another ingredient finding increased use in bonded AZS products is recycled or scrap fused cast AZS grain as larger grained “grog” added to the product. These ingredients and the combinations thereof all behave differently when exposed to alkali vapors or glass contact situations inside the hot glass furnace. The bonded AZS product line also includes similar products used as patch mortars and hot bottom repair materials. Certain ingredients such as the clay and silicas will corrode or dissolve faster than others. Zircon usually dissociates to silica glassy phase and crystalline “fish egg” or acicular ZrO_2 , sometimes even dendritic ZrO_2 . Mullite and the fine-grained calcined alpha-alumina can partially dissolve and re-crystallize as mullite or secondary hexagonal plates of alpha-alumina. Alkali-rich vapors of sodium and to a lesser extent, potassium, will react with the alumina and silica enriched glassy phase to form nepheline, carnegieite or perhaps a leucitic-nepheline solid solution phase if there is enough potassium. The fused AZS grain additive, zirconia phase and

larger fused mullite, tabular alumina and/or electro-fused alumina aggregates have a greater propensity to survive intact. The laboratory technician or process engineer responsible for daily petrographic analysis of the stone defects coming off the line must know the entire list of refractories used in the construction of the furnace as well as what those refractories look like under the PLM (polarized light microscope). This paper will include example photomicrographs of several stones originating from different bonded AZS refractory materials and include photomicrographs of a few thin-sectioned AZS brick and castable products to show the wide range of ingredients and micro textures that characterize these products in their original state.

Aston Fuller, General Manager, Glass Futures, Ltd.

Collaboration with Competitive Spaces, The Future of the Glass Industry

During a time of global upheaval, there is a need to work together to solve the most difficult challenges that the industry faces, namely those which require radical change to resolve the sustainability questions. This paper highlights the key questions and poses some thoughts on the solutions, not only to technology but also to collaborations themselves where competitors have common interests. In discussing this topic, the author aims to highlight the urgency around ensuring that a new approach to problem solving is discussed within the industry. Key to this argument is the hypothesis that without effective collaboration the glass industry will fail to make the changes required to be seen as a sustainable industry which will lead to negative impacts on the industry itself, but that with the changes, great success could befall the glass industry.

Andries Habraken, Team Lead Process Automation, CelSian

Carbon Reduction Strategies

CelSian has developed a new method for predicting the presence of bubbles in the glass melt and the resulting bubble count in the final product by means of a bubble size distribution model (BSM). With the bubble size distribution model, the transport of bubbles in the glass melt is simulated in a continuous way.

By continuous we mean that the presence of bubbles is calculated as the amount of bubbles in the entire glass melt per volume during the normal simulation (not as a post processing step after the simulation). This allows for interaction between bubbles, chemistry and the actual glass properties in the melt (density, heat absorption, viscosity, etc.). On each location in the melt it is calculated how many bubbles per kg of glass it contains, what the typical size distribution of those bubbles is and what the gas content inside the bubbles is.

The BSM is combined with chemistry (redox) calculations in the glass melt, in which case we also keep track of the gas species' concentrations in the bubbles. These gases can react with each other in the bubble and/or they can react with the species in the surrounding glass through a surface reaction on the bubble-melt interface. Thus, the bubble growth due to fining as well as the bubble rise due to buoyancy and bubble release on the melt surface is calculated accurately and in detail.

Phillippe Kerbois, Global Industry Manager-Glass, AMETEK Land
In-furnace Thermal Imaging Survey of a Float Furnace for Combustion Optimization

When an independent float glass manufacturer had an environmental emission challenge using through-port gas burners, they initially approached Simpson Combustion and Energy Limited. There was a marginal improvement following several site visits and basic furnace optimisation, but no adjustment could change the flame shape for one burner. A new gas nozzle design was manufactured, and in parallel, a five-day AMETEK Land in-furnace near infrared thermal imaging survey was performed. It is believed that this paper will be the first presentation of in-furnace thermal imaging in a float furnace. It is also believed that this is the first presentation of in-furnace thermal imaging with the inclusion of regenerators. Three days were allowed for the baseline survey; however, the on-site customer support enabled the task to be completed in two days, allowing for an additional day to undertake the burner and furnace optimisation.

The regenerator thermal imaging survey highlighted a strange phenomenon whereby on the port, the flame could not be adjusted, as the checker pack had lifted defying gravity! Bizarrely and coincidentally the lifting had created an internal regenerator by-pass flue which enabled a path of least resistance for cold combustion air in such quantities that the burner adjustments were ineffective! A conventional photographic survey confirmed the lifting of the refractory but could not indicate the formation of the by-pass flue.

The twin nozzle through-port flat flame gas burner was first developed in the early 90s and helped facilitate the conversion of float furnaces from oil to natural gas. Two impacting jets create a flat flame. This paper will show examples of the nozzles tested and developed as a result of this study. The in-furnace thermal imaging survey camera was positioned at the waist and port target wall for both the firing and exhaust side, generating four thermal images of one flame. This paper will demonstrate how this thermal survey method can be used as a furnace optimisation and a combustion development tool.

The final formal report and presentation to the float manufacturer and their local environmental authority justified continued work on primary emission reduction methods

Mikael LeGuern, Global Business Development Manager for Glass, Schneider Electric

Electrical Glass Melting and Boosting Solutions of the Future Designed for Efficiency, Flexibility and Micro-Grid Capability

With trends toward electrification and reduction of greenhouse gas emissions, we anticipate that the size of the electrical boosting and melting systems in glass furnaces will continue to grow especially for container glass and eventually also for flat glass furnaces. As a result, the architecture of those electrical melting and boosting systems needs to be carefully designed to be as energy efficient as possible with less losses (reduce line currents) but also flexible enough to adjust to changing requirement and throughput. CAPEX, OPEX and reduced leadtimes are also part of the equation. The economical aspect and return on investment are also critical part to make those solutions viable. We believe that flexibility and granularity of control will be key. Instead of very large zones of control of 2-3MW each, systems with multiple smaller zones of controls (500 to about 1200MW) will

provide the versatility and agility needed for the boosting systems of the future. The principle is that each zone controls a pair or set of electrodes with a SCR based power supply operating in load tap changer. The taps are carefully chosen to improve power factor and harmonic distortion. With such boosting systems, we can then implement Microgrid solutions to accelerate a return on investment. Tied to a flexible boosting system, Microgrid solutions will allow for example to implement an advance tariff management strategy based on TOU rates or a demand charge reduction strategy. Microgrid solutions on such boosting system can predict peaks and high tariff periods and save on energy cost by starting to adjust boosting zone setpoints or even temporally shed some zones. Advanced model such as MPC (model predictive control) on top of the furnace process control system will help determine how long those strategies can be implemented without affecting glass quality. Another important tool is Demand Side Management which is a temporary downward adjustment of the electrical consumption to contribute among other things to the grid security and optimize the electricity system by decreasing punctually or by shifting the electricity consumption (load shifting) of the electrical boosting system according to market opportunities. This can tremendously help reduce the energy bill and even create new revenue streams by the participation to capacity reserves tenders. You essentially get paid to use and occasionally reduce or shed loads on a flexible furnace electrical boosting system.

Erik Muijsenberg, Vice President, Glass Service, Inc.

Carbon Reduction Comparison Electric or Hydrogen Power

With the fear of Global Warming and plans for CO₂ reduction the interest in alternative furnace designs such as Hybrid electric melting is getting more attention. The generation of electricity by renewable energy sources is of course a great help here as it brings costs of Electricity finally down and will be CO₂ free. In Europe the average generation of electricity by renewable resources is already above 40% coming from wind, solar, hydro and bio. Electricity storage however is complex and expensive, while transporting energy in the form of a gas via pipes is cheaper than via Electric wires. An alternative renewable energy carrier is Hydrogen. Hydrogen can be generated via Electrolyzes using Electricity, this conversion however is only in range of 65%. After this the Hydrogen can be burned in a glass melting furnace with a typical efficiency of 50%. The paper will show our studies if the future will be more likely using Electric heating or Hydrogen combustion. Results of mathematical modeling show the efficiency of the different technologies.

KEYWORDS: CFD Modeling, Electric, Hydrogen, Super Boosting, CO₂ reduction, Furnace design, Control & Optimization

Adam Polcyn, Manager S Research, Vitro Architectural Glass

Thermoelectric Waste Heat Recovery in an Oxyfuel Melter

Between 2004 and 2008, PPG Industries (now Vitro Flat Glass LLC), in collaboration with Pacific Northwest National Laboratory and with sponsorship from the US Department of Energy, led a project to recover waste heat from the exhaust stream of a float glass oxyfuel melting tank using thermoelectric generators (TEG). The work was motivated by materials advances that promised improved efficiency of thermoelectric conversion, and by the large and accessible waste heat stream available from float glass oxyfuel melters. As part of the project, PPG designed and demonstrated a pilot process for waste heat recovery from the melter exhaust stream using commercially available TEGs and heat pipe technology. The pilot process operated in the exhaust stream of the oxyfuel melter located in Meadville, Pennsylvania, for three months. The details of the pilot process design and demonstration will be reviewed. In addition, the implications of this work for the current imperative for increased efficiency and sustainability in glass melting processes will be considered.

Milo Renberg, PE, Technical Manager, Menomonie, Wisconsin Float Facility; Kelly Busch, President, Cardinal FG Division

The Green Story of Cardinal FG

Cardinal's products have provided cutting edge technology for our customers that allows them to supply window systems that are the most energy efficient in the world. Starting with Cardinal's Low E energy efficient coatings and warm edge Insulating Glass Units, these systems have reduced the heating and cooling loads of buildings and houses throughout the US and Canada. We have continued to improve our products over the years by investing in R & D, research systems, hiring/training employees that are experts in their fields and building new energy efficient plants. These products have saved a tremendous amount of energy usage by improving the efficiency of the final window and door systems thus reducing the overall emissions to the environment. In conjunction with all these energy efficient products, Cardinal FG has invested more time, money and resources to reduce the emissions and environmental impact at each of its five float plants with a vision of having them achieve a minor source status for emissions. Cardinal FG would be the first and only float glass company in the US to operate all of its plants as a minor source and having succeeded doing so in a voluntarily fashion. This program will involve a \$60M expenditure and will allow the plants to increase tonnage by 25-50 tons per day. This effort has been a complete and total success to-date as well as realizing a couple of interesting glass-making observations along the way. This is a great environmental story.

C. Philip Ross, President, Glass Industry Consulting

"All-Electric Melting Back to the Future, ...Again"

For a variety of reasons, today's glass industry is being challenged to find ways of melting to reduce CO₂ in the near future. Non-traditional methods, such as Hydrogen fuels are currently being studied. Another approach is significant use of electricity. This presentation will review key principles for consideration, and some lessons learned in the 1970's - when the industry implemented all-electric melting for a different long-term concern.

Alexander Ruege, PhD, Chief Engineer, VP Data Analysis and Reporting Division, PaneraTech, Inc.

Your New Problem Began Two Years Ago: Tracking Refractory Performance and Glass Infiltration Over

In glass melting furnaces, disruptive leaks can occur with little to no warning once molten glass reaches the light, outermost insulation materials on sidewalls and bottoms. The rate of wear of the materials behind the outermost insulation on operating furnaces have not been quantified in the past given the limited tools to do so. However, SmartMelter radar-based technology is able to see into those previously unreachable inner materials. With SmartMelter, we have shown that some furnaces have lasted over two years even when glass has penetrated firebrick bottom carrier layers or backup materials on sidewalls. To reach such lifetimes, regular SmartMelter monitoring was carried out and focused maintenance activities were completed based on remaining material thicknesses.

In this paper we examine several case studies from SmartMelter data which illustrate the material wear and glass migration over time in these inner refractories such as firebricks, flux, and bonded materials. We will show that once glass was discovered to have contacted these bottom and sidewall materials, continued operation was possible for longer than originally anticipated. Focused maintenance activities such as where to precisely add cooling wind or overcoat tiles to protect the asset with minimum resources will be illustrated. We will discuss how the SmartMelter solution can help identify focused maintenance activities and overall repair plans by using refractory wear information from over 800,000 data points on 200 different glass furnaces across the world.

Given this new knowledge, we now have a better understanding of just how well specific refractory materials perform within sidewall and bottom backup packages under many different operating conditions in the glass manufacturing industry. Identifying when and to what extent glass makes its way into the backup materials provides a data driven assessment of the health of the asset and gives a manufacturer the confidence to either continue to operate safely or make the best-informed repair decision.

Martin Schroeter, Product Manager, Tri-Mer Corporation

Heat Exchanger on Glass

In 2018, Tri-Mer commissioned an emission control system in the exhaust of the regenerative Line No. 1 float glass furnace at the Guardian Glass Carleton, Michigan float glass plant. Since glass furnaces undergo an aging process, volumetric flows and temperatures increase when the furnace approaches end of life. The efficiency of emission control systems, however, depends on maintaining an exhaust volumetric flow and temperature in a narrower window, and has to be controlled by a gas conditioning system.

Gas conditioning systems can use different methods to adjust the exhaust temperature, all having their advantages and disadvantages. At their Carleton site, Guardian favored a staged implementation of air-cooled heat exchanger, considering the success and challenges with uncontrolled heat rejection by uninsulated duct as part of the gas conditioning system in their Line No. 2 emission control system, which was commissioned by Tri-Mer 3 years earlier. Using controlled heat rejection by heat exchanger avoids the introduction of any further media foreign to furnace exhaust, like quench air or water, and helps in reducing the size of the emission control system. Modular design of the heat exchanger ensured adjustability to exhaust volumetric flow and temperature requirements throughout furnace life.

This paper will guide through the decision process that led to the integration of the heat exchanger into the Carleton Line No. 1 exhaust, presenting the learning curve from start-up to continuous operation. The conclusion will outline the final concept of integration and will give an outlook into the future of waste heat recovery.

S.K. Sundaram, PhD, Program Director, Alfred University

Ultrafast Glass Engineering

Glass processing and shaping can be accelerated by using intense electromagnetic radiation, e.g., femtosecond (1 fs = 10⁻¹⁵ s) laser pulses and millimeter waves (MMW) in post-processing. Frequency, repetition rate, amplitude, peak energy, and fluence of femtosecond lasers can be varied to achieve tight focus over a wide range of energies deposited into materials. Continued development of the ultrashort laser oscillators enables broad coverage of the peak power/average power space. Average powers of up to 100 W with pulse durations of 300-900 fs and repetition rates of up to 2 MHz are available for industrial use. These pulses have been successfully applied for melting, heat-treating, annealing, cutting, drilling, micromachining, and micro- and nanostructuring glasses for various applications. Recently, these pulses have been used to strengthen silicate glasses and change coordination of the glass structure in post-processing. MMWs are non-ionizing electromagnetic radiation of 30-300 GHz frequencies. These waves, generated by a gyrotron, can be used in near-line-sight applications. Gyrotrons with greater than 50% efficiencies and megawatt average power levels are commercially available. These waves have been used for melting, heat-treating, and drilling of various glasses and minerals. While laser technology is limited in terms of access to depth required for

bulk materials processing, MMWs overcome this physical limitation. In addition, MMWs do not require optical quality surfaces and interfaces for transmission and coupling. These technologies offer unprecedented opportunities but require investment and disruptive adaptation by the glass industries. An overview of these technologies, cost implications, and future trends will be presented.

Oscar Verheijen, Team Lead R&D Training, CelSian

Hydrogen as Fuel for the Glass Industry, What are the Challenges?

Energy-intensive industrial production processes, for example in the glass, food, and ceramic sectors, have a major challenge to decarbonise existing heating processes. A fast and sustainable route to reduce the carbon intensity of these processes is to replace natural gas with hydrogen. Within this presentation the role of hydrogen in the future energy system will be described and potential hydrogen markets will be presented. Furthermore, the state-of-the-art knowledge regarding hydrogen and hydrogen/natural combustion and burner performance will be discussed to allow a gradual transition from natural gas to hydrogen within the glass industry. In addition, the presentation will also address the challenges for the glass industry when applying hydrogen combustion affecting heat transfer, furnace lifetime, and product quality.

Pierrick Vespa, R&D Project Leader, SEFPRO

How Efficient Non-Destructive Control of FC AZS will Support High Quality Glass Melting

As leader of fused cast product manufacturers, SEFPRO has developed efficient nondestructive control process and methodology to guarantee product quality and traceability.

In this presentation we will detail the different technologies we are using, linking the features they quantify to their impact on application properties. Hence, we will discover how block color control is crucial to obtain good glass contact properties, we will see that an optimized block filling, controlled thanks to radar waves, is required to maximize furnace lifetime or also that optical tools enable reliable joint face analyses to ensure a limited corrosion inside joints. Finally, we will see that thanks to the ongoing digitalization of refractory manufacturing process and through these new measurements, SEFPRO will be able to offer refractory solutions to support glass melting technology transition towards low carbon processes but also towards more severe conditions for refractory materials.

Christopher Windle, Technical Director, DSF Refractories & Minerals, Ltd

Mullitisation- The Key to Regenerating Regenerators

For nearly 170 years the groundbreaking (Siemens)regenerative principle of pre-heating combustion air to save fuel has been integral to efficient industrial scale glass melting.

Whilst the principle is enshrined the regenerative design has evolved by iterative steps to deliver the optimum efficiency and maintain that efficiency over furnace campaigns sometimes up to 20 years.

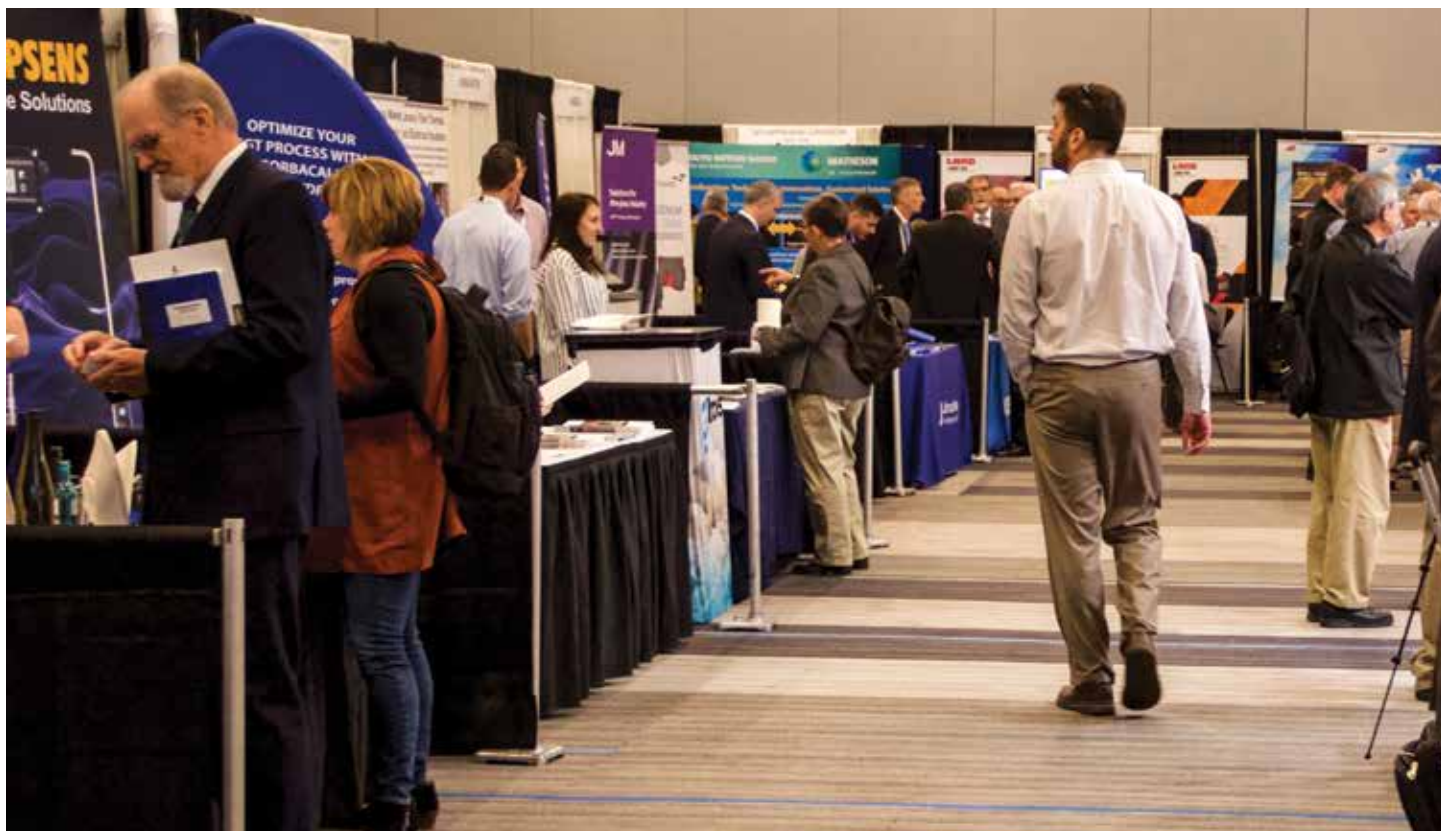
Regenerator construction is a challenge for refractory manufacturers; thermo-mechanical, thermo-chemical, REDOX, thermal shock resistance, thermal expansion and conductivity are all criteria to be considered. The regenerator central core of checker bricks absorb the energy of exiting flue gases and imparts this energy back into the combustion air stream; raising it's temperature to 900 to 1200degC. This process is contained and supported by a stable insulating and supporting refractory box which must withstand temperatures ranging from 1550°C down to 300°C.

Whilst the principal purpose of the regenerator is to provide pre-heated combustion air; regarding thermo-chemical interactions, regenerators inadvertently act as chemical catalysts and particulate absorbers of carry-over from the glass melting process; the refractories have to withstand these interactions creating protective barrier layers in some circumstances. The chemical function of the regenerator is sometimes overlooked, however changes in REDOX state can have unforeseen consequences for the regenerator refractories.

This paper will review the complex and exhaustive considerations applied to ensuring the most thermo-mechanically and thermo-chemically stable box to house and support the heat exchanging regenerator core. The inherent duality of alkali resistance and thermo-mechanical resistance afforded by mullitisation of andalusite is explored in detail, outlining the latest andalusite characteristics available and how these are providing innovative microstructures mimicking higher cost alternatives.

Specifically, the steps taken to develop materials capable of withstanding alkali salt penetration and the associated "cubing" degradation of rider/spanner tiles are highlighted. This has been a major issue for many glass market sectors and many manufacturers as previously non-problematic zones have become problematic. Novel concepts (glazing) and materials (low permeability) are being employed to the latest construction designs. It is also acknowledged that oxy-fuel; hybrid and electric melting will not require the time honored regenerative design however decarburisation will be gradual, 40% reduction in emissions by 2030 rising to net zero emissions by 2050.

Many furnaces will therefore undergo their regenerative penultimate or ultimate rebuild over the next decade, however the regenerative system by that time will be 200 years old, how many technologies have that duration. For the immediate future refractories based on the mineralogy of mullitised andalusite will ensure the optimum performance and longevity of regenerators in response to modern glassmaking operations.



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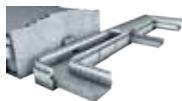
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