75th Conference on Glass Problems

November 3 – 6 | Greater Columbus Convention Center | Columbus, Ohio USA

The glass industry’s trusted conference for 75 years

www.glassproblemsconference.org
PM, SO\textsubscript{x} AND NO\textsubscript{x}
IN ONE SYSTEM

CERAMIC FILTER SYSTEMS ARE THE NEW STANDARD
FOR GLASS FURNACE EMISSIONS CONTROL

AIR–FUEL FURNACE EMISSIONS
UltraCat catalyst filter system treats particulate, SO\textsubscript{2}, HCl, metals and NO\textsubscript{x} in a single all-on-one system.

OXY–FIRED FURNACE EMISSIONS
UltraTemp standard filter system treats particulate, SO\textsubscript{2}, HCl, and metals in a single integrated system.

- Lower initial capital cost
- Lower operating and maintenance cost
- Higher performance

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OR CONTACT:
Kevin Moss, Business Development Director
801.294.5422 | kevin.moss@tri-mer.com

• Treats any gas flow volume – modules are placed in parallel.
• Multiple modules provide built-in redundancy to ensure up-time. No “ESP bottleneck.”
• Each module has an inlet damper. If a module is taken off-line for service, the other modules treat the entire flow at a temporary higher pressure with no change in performance.

Nano-catalyst embedded in the filter walls destroys NO\textsubscript{x}
Particulate captured on the surface; does not penetrate the surface wall
Inlet gas composition – Particulate PM, Sorbents for SO\textsubscript{2}, HCl, NO\textsubscript{x} + injected ammonia
Welcome to the 75th Conference on Glass Problems (GPC). The 75th Conference on Glass Problems is a content-rich, technically-oriented conference, designed as a high value resource for the glass industry professional.

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

We are committed to expanding the scope and value of technical resources available to serve the glass manufacturing industry. The GPC is unique in the breadth and depth of its technical educational. We set high standards in programming and the publication of the proceedings manuscripts. Participation in the GPC continues to grow by double-digit figures.

As organizers, we strive to provide one of the most extensive platforms for glass manufacturing industry networking and exhibiting in North America, with comprehensive exhibits, hospitality salons, hospitality booths, and other social events. Exhibition space is again sold out. We appreciate the participation and support of the industry’s leading solutions providers.

Evaluations from 74th GPC provided high marks for the conference. More importantly, your input provided direction for planning the conference. A common request was to increase the “real world” problems content from manufacturers. We increased the presentations by manufacturers and encouraged solutions providers to co-present with manufacturers, citing actual data from manufacturing facilities.

Evaluations emphasized the importance of technical education. We have increased these offerings. On Monday, we begin with C. Philip Ross’ popular Fundamentals of Batch and Furnace Operations, which is an excellent short course for engineers early in their careers or for solutions providers looking to understand their clients concerns. Also offered, is the technically-rich short course from Celsian Glass & Solar B.V., Glass Furnace Designs and Furnace Operation—Modeling of Glass Melting & Combustion Processes and Advanced Furnace Control, taught by Andries Habraken and Oscar Verheijen.

Also on Monday, attendees can benefit from a collaboration between the GMIC and the EPA’s ENERGY STAR®, Energy Productivity as a Competitive Edge in Glass Manufacturing. This excellent joint symposium has been organized by some of the leading energy officers of American manufacturing companies to support all manufacturers’ effort to increase energy efficiency in glass manufacturing.

Driven by the success of past symposia, GMIC is again organizing a full-day technical symposium, Hot Sensors—Instrumentation and Control Innovation in Glass Manufacturing. Organized by GMIC’s glass manufacturing and supplier members, this symposium brings together some of the leading experts in the field providing in-depth education on the latest technologies to support critical processes and address current challenges in the glass manufacturing process.

We look forward to your participation and trust you will find it a valuable and rewarding experience.
WHO IS GMIC
The Glass Manufacturing Industry Council (GMIC) is a trade association of the glass industry that includes among its members, representatives of all four sectors: container, fiber, flat, and specialty glass companies as well as leading suppliers to the industry, research institutes, and industry experts. Our goal is to promote the interests, growth, and sustainability of the glass industry. GMIC does for individual companies what they can’t easily do on their own—provide technical education, coordinate technical initiatives, advocate with law makers, and promote the usage and image of glass products as a vital part of society around the globe.

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 to ensure the vitality of the industry through your support of the industry’s trade association. Membership dues are based on company size and category. Contact GMIC’s Executive Director, Robert Weisenburger Lipetz, for full information.

GMIC EXECUTIVE COMMITTEE
Keith Bagarus, RoviSys, President; Steve Badger, Pittsburgh Corning, Immediate Past President; Steve Weiser, O-I, Vice President; Bruno Purnode, Owens Corning, Treasurer; Robert Weisenburger Lipetz, Secretary

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GMIC STAFF
Robert Weisenburger Lipetz, Executive Director
Donna M. Banks, Executive Assistant

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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, productivity and the environment.

PUBLICATION OF THE 75TH GPC PROCEEDINGS
Registered attendees of the 75th Conference on Glass Problems will receive a bound copy of the proceedings, published by The American Ceramic Society and Wiley, and shipped to you mid 2015.

ALFRED UNIVERSITY
The Kazuo Inamori School of Engineering at Alfred University (AU) is a leader in glass and ceramics 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 on 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 situ at high temperatures.

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

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Building on more than twenty years of thermal imaging experience, AMETEK Land has continued to widen its range of temperature measurement solutions with the NIR Borescope. With the NIR Borescope it is possible to use the proven technology of the NIR Thermal Imager to accurately profile the temperature of the entire area with only a small opening in the wall of glass melt tanks. The NIR-b offers continuous, thermal imaging with full temperature measurements within the scene.

PROVEN APPLICATIONS OVER A 65 YEAR HISTORY IN THE GLASS INDUSTRY

FEATURES & BENEFITS

- High temperature measurement accuracy - enables optimum process control using high definition temperature maps
- Simple installation and ease of use - minimizes cost and complexity
- Short wavelength sensor - low sensitivity to emissivity changes; can be used through glass or quartz view ports
- Dedicated software - data points, areas of interest, automated alarms and long term data trending
- 24 Hour, 7 Day Monitoring - Shutterless operation guarantees accurate, reliable data with no blind time

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### Schedule at a Glance

**Monday, November 3, 2014**
- 11 a.m. – 6 p.m. Registration
- 11:30 a.m. – 4:30 p.m. Student Plant Tour
- 12 – 5 p.m. Fundamentals of Batch and Furnace Operations
- 5 – 5:30 p.m. Student Ambassador Meeting
- 5 – 11 p.m. Hospitality Suites*
- 5:30 – 7:30 p.m. GPC Advisory Board Dinner

**Tuesday, November 4, 2014**
- 7:30 a.m. – 5:30 p.m. Registration
- 8 – 9 a.m. Exhibiting
- 9 – 10:30 a.m. Glass Melting Session
- 10:30 – 11 a.m. Exhibiting
- 11 a.m. – 12:30 p.m. Forming Session

**Wednesday, November 5, 2014**
- 8 a.m. – 4 p.m. Registration
- 8 – 9 a.m. Exhibiting
- 9 – 10 a.m. Refractories Session
- 10 – 10:30 a.m. Exhibiting
- 10:30 a.m. – 12 p.m. Sensors and Control Session
- 12 – 1:30 p.m. Lunch & Exhibiting
- 1:30 – 4 p.m. Modeling Session
- 4 – 5 p.m. GMIC Membership Meeting

**Thursday November 6, 2014**
- 7:30 a.m. – 12 p.m. Registration
- 8 a.m. – 4 p.m. Hot Sensors Symposium
- 11:50 a.m. – 12:30 p.m. Lunch

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### EPA ENERGY STAR®/GMIC Joint Energy Symposium - Energy Management as a Competitive Edge in Glass Manufacturing

**Monday, November 3, 2014**
Corporate energy management programs not only save energy and money across operations but also position a company to withstand energy risks. This workshop will help companies take energy programs to the next level and prepare for their energy future.

**12:00 – 12:05 p.m.**
**WELCOME – Robert Weisenburger Lipetz,** Executive Director, Glass Manufacturing Industry Council
**Walt Tunnessen,** CEM, Manager, Industrial Sector Program ENERGY STAR®, U.S. Environmental Protection Agency

**12:05 – 12:45 p.m.**
**Energy Management as a Business Advantage – Peter Garforth,** President, Garforth International
*Having a long-term energy strategy makes good business sense. Learn how to initiate action in your company.*

**12:45 – 1:15 p.m.**
**Building a Corporate Energy Management Program – Walt Tunnessen,** CEM, Manager, Industrial Sector Programs ENERGY STAR®, U.S. Environmental Protection Agency
*Every successful corporate energy program follows certain key steps. Learn about them and how to put them in place in your company.*

**1:15 – 1:45 p.m.**
**Evolving Energy Management at PPG – Jeff Yigdall,** Director, Engineering & International Business, PPG Industries, Inc.
*Learn about how PPG built energy management into its organization and the tools that have been useful in moving the program forward.*

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**1:45 – 2:15 p.m.**
**How to Get Projects Implemented – Bruce Bremer,** President, Bremer Energy Consulting Services, Inc.
*Identifying projects is the easy part. How do successful companies get projects implemented? Learn successful strategies for getting the work done.*

**2:15 – 2:30 p.m.**
**BREAK**

**2:30 – 3:15 p.m.**
**Make Sure Obvious Systems are Addressed – Patrick Jackson,** Manager, Global Energy, Corning Incorporated
*Lighting, compressed air, and motors are all easy targets for savings. This presentation will walk you through how to identify opportunities in each of these systems.*

**3:15 – 4:00 p.m.**
**Benchmarking Energy Use in Glass Manufacturing – Gale A. Boyd,** Director Triangle Census Research Center & Senior Research Scholar, Duke University
*Tracking, baselining and measurement are critical to energy management. Benchmarking uses energy data and enables long-term tracking and goal setting. What is the value of benchmarking energy in an energy program? How do you do it? This presentation will address these questions and lay out an approach that any company can use.*

**4:00 – 5:00 p.m.**
**Plant Energy Assessment Made Easy: Treasure Hunts – Bruce Bremer,** President, Bremer Energy Consulting Services, Inc.
The energy treasure hunt process uses internal staff to identify energy savings at a plant. Learn how to perform a plant energy assessment through a team you assemble.

**5:00 p.m.**
**ADJOURN**
**PROGRAM SCHEDULE**

**Monday, November 3, 2014**

11:30 a.m. – 4:30 p.m.  
STUDENT PLANT TOUR – departs at Greater Columbus Convention Center

**Fundamentals of Batch and Furnace Operations Short Course**  
12 – 5 p.m. | E160

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

**Glass Furnace Designs and Furnace Operation—Modeling of Glass Melting & Combustion Processes & Advanced Furnace Control Short Course**  
12 – 5 p.m. | E162

Instructors: **Andries Habraken**, B.ASc, Senior Consultant, Computational Fluid Dynamics, CelSian Glass & Solar B.V. and **Oscar Verheijen**, Senior Consultant, CelSian Glass & Solar B.V.

**EPA ENERGY STAR®/GMIC Joint Energy Symposium—Energy Productivity as a Competitive Edge in Glass Manufacturing**  
12 – 5 p.m. | E160

5 – 5:30 p.m. | E160

5:30 – 7:30 p.m.  
STUDENT MEETING

5 – 11 p.m.

STUDENT MEETING

5 – 11 p.m.

ADVISORY BOARD DINNER

5 – 11 p.m.

**Tuesday, November 4, 2014**

8 – 9 a.m.  
EXHIBITING

9 – 10:30 a.m. | Ballroom 5  
Technical Session: **Glass Melting**  
Session Chairs: **Glenn Neff**, Glass Service USA, Inc. and **Martin Goller**, Corning Incorporated

9 – 9:30 a.m.  
Dr. **Michael S. Pambianchi**, Research Director, Glass Research, Corning Incorporated – **Glass Challenges in Consumer Electronics**

9:30 – 10 a.m.  
**Carol Click**, Manager Glass Science Group, Owens-Illinois, Inc. – **Effect of Dissolved Water on Physical Properties of Soda-Lime Silicate Glasses**

10 – 10:30 a.m.  
**Henry Dimmick Jr.**, Owner and Chief Executive Officer, American Glass Research – **Comparison of SEM/EDX Analysis to Petrographic Techniques for Identifying the Composition of Stone in Glass**

10:30 – 11 a.m.  
EXHIBITING

11 a.m. – 12:30 p.m.  
Technical Session: **Forming**  

11 – 11:30 a.m.  
**Jonathan Simon**, Senior Scientist, Bucher Emhart Glass – **Multi Gob Weight Production**

11:30 a.m. – 12 p.m.  
**Jonathan Simon**, Senior Scientist, Bucher Emhart Glass – **Closed Loop Control of Glass Container Forming**

12 – 12:30 p.m.  
**Steven Brown**, Principal Mechanical Engineer, Bucher Emhart Glass; **Dubravko Stuhne**, Production Technical Specialist, Vetroconsult – “**Hard Glass**” – **Commercial Progress of Thermally Strengthened Container Glass**

12:30 – 2 p.m. | E162  
LUNCH

12:30 – 2 p.m.  
EXHIBITING

2 – 4:30 p.m. | Ballroom 5  
Technical Session: **Energy and Environmental**  

2 – 2:30 p.m.  
**Julien Pedel**, Development Specialist, Praxair, Inc. – **Oxygen Enhanced NOx Reduction (OENR) Technology for Glass Furnaces**

2:30 – 3 p.m.  
**Steven B. Smith**, Independent Consultant – **U.S. Air Regulations Involving Glass Manufacturing**

3 – 3:30 p.m.  
**Richard Pont**, Technical Director, Global Combustion Systems, Ltd. – **New Combustion Technique for Reducing NOx and CO₂ Emissions from Glass Furnaces**

3:30 – 4 p.m.  
**Diego Filippi**, Chemical Engineer, Area Impianti SpA – **Environment and Energy Flue Gas Treatment and Heat Recovery Integrated System in Glass Industry**

4 – 4:30 p.m.  
**Stefan Laux**, Director R&D Praxair, Inc. – **Regenerative Thermo-Chemical Heat Recovery for Oxy-Fuel Fired Glass Furnaces**

4:30 – 5:30 p.m.  
EXHIBITING

7:30 – 11 p.m.  
HOSPITALITY SUITES
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<td>8 – 9 a.m.</td>
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| 9 – 10 a.m.  | Technical Session: **Refractories**  
Session Chairs: Laura Lowe, North American Refractories Company and Larry McCloskey, Anchor Acquisition, LLC |
| 9 – 9:30 a.m.| David Michael, Senior Research Engineer, North American Refractories Company – **Basic Material Developments for Glass Industry Regenerators** |
| 9:30 – 10 a.m.| Sebastien Bourdonnais, Project Manager, Saint-Gobain SEFPRO – **SEFPRO Cruciforms: Modern and Competitive Regenerator Designs for Glass Industry** |
| 10 – 10:30 a.m.| EXHIBITING                                                             |
| 10:30 a.m. – 12 p.m. | Technical Session: **Sensors and Control**  
Session Chairs: Jan Schep, Owens-Illinois, Inc. and Elmer Sperry, Libbey, Inc. |
| 10:30 – 11 a.m.| Yakup Bayram, Chief Technology Officer, PaneraTech, Inc. – **Detection of Early Stage Glass Penetration and Weak Refractory Spots on Furnace Walls** |
| 11 – 11:30 a.m.| Henning Katte, Chief Executive Officer, Ilis GmbH – **Fast and Objective Measurement of Residual Stresses in Glass** |
| 11:30 a.m. – 12 p.m. | Fred Aker, Sales Director West and Marketing Manager, Nikolaus Sorg GmbH & Co. KG – **Feeder Expert Control System for Improved Containers** |
| 12 – 1:30 p.m. | LUNCH  
12 – 1:30 p.m. | EXHIBITING |
| 1:30 – 4 p.m. | Technical Session: **Modeling**  
Session Chairs: Bruno Purnode, Owens Corning and Andrew Zamurs, Rio Tinto Minerals |
| 1:30 – 2 p.m. | Jian Jiao, Associate Engineer, Owens-Illinois, Inc. – **3-D Transient Non-isothermal CFD Modeling for Gob Formation** |
| 2 – 2:30 p.m. | Oscar Verheijen, Senior Consultant, CelSian Glass & Solar B. V. – **Modeling of Heat Transfer and Gas Flows in Glass Furnace Regenerators** |
| 2:30 – 3 p.m. | Liming Shi, Engineer II, Owens-Illinois, Inc. – **Energy Analysis for Preheating and Modeling of Heat Transfer from Flue Gas to a Granule** |
| 3 – 3:30 p.m. | Oscar Verheijen, Senior Consultant, CelSian Glass & Solar B. V. – **Experimental Simulation of Process Steps in Industrial Glass Furnaces** |
| 3:30 – 4 p.m. | Arvind Atreya, Professor, University of Michigan – **Heat Transfer in Glass Quenching for Glass Tempering** |
| 4 – 5 p.m. | GMIC MEMBER MEETING |

**The 76th Conference on Glass Problems**

November 2 – 5, 2015 | Columbus, Ohio

The Exhibit and Technical Sessions will take place in the Greater Columbus Convention Center. The Hospitality Suites will be located across the street at the Hilton Columbus Downtown.
Instrumentation and Control Innovation in Glass Manufacturing
A Symposium Organized by the Glass Manufacturing Industry Council

Thursday, November 6, 2014 | D131
The Hot Sensors Symposium on Instrumentation and Control Innovation in Glass Manufacturing is focused on the latest technologies in the market to support critical processes and address current challenges in the glass manufacturing process. It provides a forum for the audience to gain technical knowledge and exchange experiences with each other in support of the advancement and application of sensors and controls technologies.

Program Committee:
Co-Chairs: C. Keith Bagarus, Director Global Automation, RoviSys; Dale A Gaerke, Director-R&D Controls and Electrical Engineering, I-O; Euan Evenson, Associate Director Program Development, Praxair; Aaron Huber, Furnace Research Manager, Johns Manville; James MacPhee, Senior Engineer, Melting/Fiberizing Sciences, Owens Corning Composite Materials; Erik Muijsenberg, Vice-President, Glass Service Inc.; Glenn Neff, Vice-President, Glass Service Inc.; Robert Roth, Process Control Engineer, O-I; Oscar Verheijen, Senior Consultant, Celsian Glass & Solar B.V.; Jeffery Watts, Global Furnace Operations Leader, O-I; Robert Weisenburger Lipetz, MBA, Executive Director, Glass Manufacturing Industry Council

8:00 – 8:30 a.m.  INTRODUCTION – Historical Review of Sensors and Controls in Glass Manufacturing – Keith Bagarus, Director Global Automation, RoviSys – Symposium Co-Chairman
8:30 – 9:30 a.m.  PROGRAM I – CURRENT NEEDS
8:55– 9:00 a.m.  Q&A
9:00 a.m. – 1:30 p.m.  PROGRAM II – BENEFITS AND APPLICATIONS OF CRITICAL MEASUREMENTS
9:00 – 9:25 a.m.  Using High Temperature Cameras to measure Level, Width, Temperature, Gob, Onion, and other process glass applications in the glass industry – Thomas Canty, President, JM Canty
9:25 – 9:30 a.m.  Q&A
9:30 – 9:50 a.m.  Break
9:50 – 10:15 a.m.  Interferometric Radar Technology for Noncontact Glass Level Measurement – Claudio Viti, Sales Manager, Glass Service Srl and Daniele Mecatti PhD, R&D Engineer, Glass Service Italy
10:15 – 10:20 a.m.  Q&A
10:20 – 10:45 a.m.  Re-engineering TDLAS Sensor Systems for the Glass Industry – Dr. Andrew D. Sappey, CTO, Zolo Technologies
10:45 – 10:50 a.m.  Q&A
10:50 – 11:15 a.m.  Application of Online Energy Balance Monitoring at Industrial Glass Furnaces – Oscar Verheijen, Senior Consultant, Celsian Glass & Solar B.V.
11:15 – 11:20 a.m.  Q&A
11:20 – 11:45 a.m.  Advanced Temperature Sensing Technologies for Improved Glass Conditioning – Nate Youel, Applications Engineer – Optical Temperature Sensing, BASF
11:45 – 11:50 a.m.  Q&A
11:50 a.m. – 12:30 p.m.  PROGRAM II CONTINUED – CRITICAL MEASUREMENTS
12:55 – 1:00 p.m.  Q&A
1:00 – 1:25 p.m.  Industrial Experiences With a Zirconium Oxide Based in-situ CO/O Sensor for Combustion Control – Dr.-Ing. Peter Hemmann, President, STG Combustion Control GmbH&Co KG
1:25 – 1:30 p.m  Q&A
1:30 – 3:20 p.m.  PROGRAM III – CONTROL SYSTEMS
1:30 – 1:55 p.m.  Pixelizing the Image for Batch Line Control – Erik Muijsenberg, Vice President – Glass Service, Chairman ICG TC 21 & 15
1:55 – 2:00 p.m.  Q&A
2:25 – 2:30 p.m  Q&A
2:30 – 2:50 p.m.  Break
2:50 – 3:15 p.m.  The Future of Control Room Design – Paul Krumrich, CEO, Sensory Environment Design
3:15 – 3:20 p.m.  Q&A
3:20 – 3:50 p.m.  Roundtable Panel Discussion - Future Challenges and Innovations – Moderated by Dale A Gaerke, Director-R&D Controls and Electrical Engineering, I-O; Panel Members: Keith Bagarus, Director Global Automation, RoviSys; Thomas Canty, President, JM Canty; Dr.-Ing. Peter Hemmann, President, STG Combustion Control GmbH&Co KG; Paul Krumrich, CEO, Sensory Environment Design; James MacPhee, Senior Engineer, Melting/Fiberizing Sciences, Owens Corning Composite Materials; Daniele Mecatti, R&D Engineer, Glass Service Italy; Erik Muijsenberg, Vice-President, Glass Service Inc.; Robert Roth, Process Control Engineer, O-I; Dr. Andrew D. Sappey, CTO, Zolo Technologies; Oscar Verheijen, Senior Consultant, Celsian Glass & Solar B.V.; Claudio Viti, Sales Manager, Glass Service Italy; Jeffery Watts, Global Furnace Operations Leader, O-I; Nate Youel, Applications Engineer – Optical Temperature Sensing, BASF; Doug Child, Director, US Glass and Solar Industries, Siemens Industry, Inc.
3:50 – 4:00 p.m.  Concluding Remarks – Keith Bagarus, Director Global Automation, RoviSys – Symposium Co-Chairman
**Advanced Control Solutions, Inc.**  
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FlammaTec, spol. s r.o. (Czech Republic) and its daughter company FlammaTec GmbH (Germany) have become leading suppliers of advanced burner technology for glass furnaces. FlammaTec was founded by two partner companies (STG Combustion Control GmbH & Co KG, and Glass Service, Inc.) as a joint venture. After 6 years since its start in 2008, FlammaTec has already supplied well over 1500 burners to over 90 projects on float, container, tableware and special glass furnaces. FlammaTec offers the following burner types:
- Underport Gas Injector, Flex or Freejet
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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.

Frazier-Simplex, Inc.
Booth: 101
P.O. Box 493, 436 East Beau Street, Washington, Pennsylvania 15301
Phone: +1-724-225-1100
www.frazier-simplex.com

Frazier-Simplex, Inc. was founded in 1918 in Washington, PA and has remained under Frazier family ownership for three generations. For over 90 years, Frazier-Simplex, Inc. has had continuous service to the glass industry in equipment and designs from raw materials through glass conditioning. Innovative furnace designs and equipment are just examples of why Frazier-Simplex, Inc. has been a respected member of the world-wide glass community for many years. We are experienced in all types of glass and glass production, from soda lime to borosilicate pharmaceutical glass.

Fuse Tech/Hot Tech Group
Booth: Emerson Burkhart B
3400 Silica Road, Sylvania, Ohio 43560
Phone: +1-419-841-9323
www.fusetech.com

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 laser, Fuse Tech is able to remove debris from port sills as well as the tops of checker packs and 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 operation and refractory problems.

Glass Service, Inc.
Booth: 200
3340 SE Federal Highway, #200, Stuart, Florida 34997
Phone: +1-772 287 6061
www.gsl.cz

Glass Service, Inc. (GS) is a leading global consultant specializing in glass melting/conditioning, furnace control, operation, troubleshooting, and furnace design optimization. GS has developed the successful Expert System, ES III, which has become the leading platform for fully automatic furnace and forehearth control, providing significant cost savings to glass production. Another development of GS, furnace modeling software GFM 4 optimizes furnace design and doubles as a successful troubleshooting tool. The GS laboratory performs defect analyses, and utilizes basic and applied research in its melt testing facilities. Headquarters located in Czech Republic, with offices in Netherlands, Slovakia, United States, and China.
Hardy Process Solutions
Booth: 301
9440 Carroll Park Drive, Suite 150, San Diego, California 92121
Phone: +1-858-278-2900
www.hardsolutions.com
Hardy Process Solutions has been providing customers with process control solutions for over 90 years and is best known for its innovative technology. The company prides itself on its ability to continuously provide superior product quality and excellent customer support. Hardy, an ISO 9001-certified manufacturer, currently services the food, chemical, petrochemical, pharmaceutical, feed & grain, mining & metal, pulp & paper, oil and gas, power, and general automation industries.

Heye International GmbH
Booth: 305
Lohplatz 1, 31683 Obernkirchen, Germany
Phone: +49 5724 26-0
www.heye-international.com
WE ARE GLASS PEOPLE: Heye International, based in Obernkirchen, Germany is one of the foremost suppliers of production technology, high performance equipment and know-how for the container glass industry worldwide. Our mechanical engineering has set the standard in the industry for more than 50 years. The industry expertise, attitude and enthusiasm of the employees of Heye International form the motto “We are Glass people”. The three sub-brands HiPERFORM, HiSHIELD and HiTRUST form the portfolio of Heye International.

Klug Systems by Optimization
Booth: 303
50 High Tech Drive, Rush, New York 14543
Phone: +1-585-321-2300
www.optimation.us
Optimation offers a multi-disciplined design team for any aspect of your batch processing needs, with best practices for equipment arrangements, dust collection, storage, weighing, mixing and transport of batch. The team has tackled a full-range of batch problems, providing leading-edge solutions for end clients. During the feasibility phases of your projects, Optimization can provide services for cost assessment, risk assessment and high-level design. Once capital approval is secured, the design team is available for engineering drawing packages, equipment schedules, site plans and test plans. We offer continuity throughout specification, design, integration, development, implementation, calibration, troubleshooting, startup, debug and production.

Praxair, Inc.
Booth: 201, 203
39 Old Ridgebury Road, Danbury, Connecticut 06810
Phone: 1-800-PRAxAIR
www.praxair.com
Praxair is a leader in innovative oxyfuel technologies for the glass industry. With over 70 years of oxyfuel combustion experience in the glass industry and over 200 oxyfuel projects completed worldwide, our technologies can deliver substantial fuel savings, increased productivity and product quality, reduced NOx emissions and alkali volatilization, and prolonged furnace campaign. Praxair is a Fortune 300 company. We also supply atmospheric, process and specialty gases, high performance coatings, and related services and technologies. Among the gases we supply are oxygen, nitrogen, argon, carbon dioxide, helium, and hydrogen.

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Help us improve the value of the Conference on Glass Problems by filling out our online evaluation.
We are continually striving to improve the quality of the conference. Your feedback from the online evaluation will be carefully considered by the GPC advisory board in designing future conferences.
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https://www.surveymonkey.com/r/75_GPC_All_Attendees
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If you presented an exhibit booth at the 75th Conference on Glass Problems, we would appreciate your feedback to help us continue to improve the exhibiting opportunity. (This survey is for exhibitors only)
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Booth: Bellows B  
3956 Virginia Ave, Cincinnati, OH 45227, Attn: Glass Group  
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www.rhi-ag.com

RHI AG is the world market and technology leader in high-grade ceramic refractory materials. A global player with Austrian roots, RHI employs roughly 8,000 people worldwide at 33 production sites in Europe, North America, Latin America, South Africa and China and is represented by over 70 sales offices in four continents. RHI is the only global refractories supplier to offer products for all aggregates of the basic industry. The RHI umbrella brand combines a series of traditional brands that have been established in the market for many years, including Didier, Veitscher, Radex, Dolomiti Franchi, Interstop and Monofrax.

**RoviSys**  
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1455 Danner Drive, Aurora, Ohio 44202  
Phone: +1-330-995-8103  
www.rovisys.com

As an engineering service company, RoviSys specializes in process control and information automation. We have incorporated state of the art systems around the world for major glass manufacturers. As an independent company, we work with you to design and develop the best solution to meet your needs, not ours. With 400 employees and four locations worldwide we are well suited to provide you with state of the art control and information systems. We have experience in all major sectors of the glass manufacturing industry. From your batch house to your warehouse RoviSys delivers on time, every time.

**Saint-Gobain Sefpro**  
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Phone: +1-502-329-7605  
www.sefpro.com

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!

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At SSOE, our experience spans decades and includes projects with every major glass manufacturer, every aspect of plant operations, and furnace design. We promise to save you time, trouble, and money. We can make this promise because we’ve achieved savings on multiple projects. Over 800 projects completed in the last five years alone. SSOE has worked extensively in the glass industry, and we apply this broad knowledge to come up with the best solution for clients that manufacture containers, specialty glass, fiberglass, float glass, residential shingles and automotive glass.

**Varo Engineers, Inc.**  
Booth: 304  
2751 Tuller Parkway, Dublin, Ohio 43017  
Phone: +1-614-459-0424  
www.varoengineers.com

Varo Engineers, Inc. is a privately owned full service engineering and design consulting firm with 60+ years of experience. We emphasize on customer service, while tailoring to our client’s needs in the industrial, manufacturing, institutional and power generation markets. Our specialties include process applications, material handling systems, furnace design, nuclear services, energy audits and electrical power and controls. We also provide project management and client site services for multidiscipline projects. We serve our clients through a flexible, multidiscipline approach that results in project specific solutions.
As an integrator of information and control system solutions, ACSI engineers in both the United States and Europe 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 Glass, Fiberglass, Container Glass, Tableware, Lighting, Tubing, and Specialty systems. Types of solutions we provide are temperature control, DCS replacement, batching control, glass level control, model based control, packaging & sortation control, and production tracking.

**Allstates Refractory Contractors, LLC**  
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Phone: +1-419-878-461  
www.allstatesrefractory.com  
We are a full-service industrial process general contractor providing all-encompassing solutions for the glass, metals and petrochemical industries.
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Designers, manufacturers, supplies and installers of annealing and decorating Lehr’s also special Lehrs for glass blocks, toughening and car head lamps. Mould pre-heating ovens.

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Phone: +17814280638  
www.areaimpianti.it  
Area Impianti projects, installs and manages flue gases treatment and co-generation turnkey plants worldwide. Area Impianti’s FGT systems boasts of the most advanced technology aimed at reducing emissions of pollutants such as acid gases, dust, dioxins and NOx. The company is mainly present in waste incineration sector, glass industry, foundries, smelters, and cement and tyres incineration factories. The company also designs complete lines of incineration, fermentation and anaerobic digestion that process green and agricultural wastes, sludge and biomass in order to produce electric and thermal energy. The company is certified ISO 9001, 14001, OHSAS 18001 UL and SOA OS 14.

**Borton-Lawson**  
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613 Baltimore Drive, Suite 300, Wilkes-Barre, Pennsylvania 18702  
Phone: +1-570-821-1999  
www.borton-lawson.com  
Borton-Lawson is a leader in engineering consultancy, design, and technical support. For more than 20 years, Borton-Lawson has been the consultant of choice for glass manufacturers. Our licensed professional engineering provide complete project solutions, including project management, procurement services and structural, mechanical, electrical, process, and instrumentation and control engineering. As a leading A/E/C firm, we are proud to rank among the nation’s Top 500 design firms (ENR, 2014).

**Bristol Instruments, Inc.**  
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Phone: +1-585-924-2620  
www.bristol-inst.com  
Bristol Instruments, a leader in optical interferometer-based instrumentation, offers a thickness gauge for glass manufacturers whose development and production processes require precise thickness information. High accuracy and exceptional long-term repeatability result in the most reliable thickness measurement available. The 157 Series Optical Thickness Gauge employs proven technology used in hundreds of research laboratories and manufacturing facilities around the world. The model 157 provides non-contact thickness measurement of a single layer or multiple layers. The system’s accuracy is +/- 0.1 µm and is traceable to NIST standards. Its measurement repeatability is +/- 0.05 µm, and unmatched stability virtually eliminates thermal drift.

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Phone: +1-573-473-2132  
www.emhartglass.com  
Bucher Emhart Glass is the world’s leading international supplier of equipment, controls and parts to glass container industry. With broad-based expertise in glass container forming, glass conditioning, gob forming, ware handling, cold end inspection, refractory parts and quality assurance, the company’s machines and systems are established as standard products worldwide. Emhart Glass also provides installation, training, production assistance, and maintenance related services.

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BWF Group provides the Pyrotex® KE KAT catalyst candle elements for glass furnace emissions to simultaneously perform both particulate and NOx removal in a single process stage. The extremely high chemical resistance of the Pyrotex® KE candle elements also allows for acid gases to be removed by including a dry absorption system. The candle elements are 100% spark resistant, can operate at continuous temperatures of 850ºC and achieve particulate emissions of < 1 mg/Nm3.
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Carmeuse Lime & Stone is a leading manufacturer of lime and limestone/dolomite to the glass industry. Carmeuse has 28 plants that supply and serve most of the USA and Eastern Canada. We also have a technical service laboratory in Pittsburgh PA, staffed by glass industry experts.

Delta Energy Services, LLC
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5555 Perimeter Drive, Dublin, Ohio 43017
Phone: +1-614-339-2600
www.deltaenergyllc.com

Delta Energy Services is a leading international provider of customized Energy Management Services for large industrial energy end-users. We provide strategic procurement, robust and accurate data management, sophisticated price risk management, sustainability and other energy-related services. Delta is a certified Woman Business Enterprise. Headquartered in Dublin, Ohio, Delta has North American offices in Richmond, Virginia, Toronto, Ontario and Montreal, Quebec.

DSF Refractories & Minerals Ltd.
Booth: 21
Friden, Newhaven, Nr. Buxton, Derbyshire, SK17 0DX, United Kingdom
Phone: +44 1629 636 271
www.dsf.co.uk

DSF Refractories & Minerals Limited; established in 1892 in the Derbyshire Peak District is the largest shaped refractory manufacturer in the UK. Recognized as one of the worlds leading suppliers of bonded refractories to the glass industry, products include a wide range of high alumina refractory bricks & shapes based on mullite, andalusite, chamotte, bauxite, spinel and pure alumina. Shapes are manufactured by pressing or casting techniques which are then high fired to give optimum properties in service. The company has a highly knowledgeable sales & technical team with a determination to provide the best solution for our customers.

Edward Orton Jr. Ceramic Foundation, The
Booth: 54
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www.ortonceramic.com

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.

Eurotherm by Schneider Electric
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44621 Guilford Drive, Suite 100, Ashburn, Virginia 20147
Phone: +1-703-724-7300
www.eurotherm.com

Eurotherm by Schneider Electric offers enterprise control systems for the glass industry, in addition to highly advanced process control solutions. Process control systems operate in a timescale appropriate to the production process, whereas Management Information Systems typically provide time delayed information. This delay seriously impacts the decision making process for both management and operators. Eurotherm by Schneider Electric enables the glass industry to transfer productivity data into information in a timely manner, thereby providing both management and operators information indicating real time profitability in a dashboard format. Eurotherm by Schneider Electric will discuss several offerings including Wonderware System Platform, Eurotherm process control, Foxboro field devices and Avantis Asset Management.

F.I.C. (UK) Limited
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Longrock Industrial Estate, Penzance Cornwall, TR20 8Hx, United Kingdom
Phone: +44 01736366962
fic-uk.com

F.I.C design and supply all-electric furnaces and electro-heat applications for glass conditioning and boosting of a wide range of glass types and manufacturing processes, including float, fibre, container, TV panel and borosilicate glasses. Within the range of electrode holders manufactured by F.I.C. is our unique High ‘Q’ holder in which the cooling circuit is replaceable. F.I.C. produces a special HVP (high vapour pressure) forehearth design for volatile glasses such as borosilicate, opal or lead. We also offer the Isothermal Unit which provides very efficient forehearth or distributor boost, improving thermal homogeneity in coloured glasses or for high productivity forehearths in flint glass. ISO 9001 accredited.
Fives Stein, Ltd.
Booth: 32
4A Churchward, Southmead Park, Didcot, Oxon, OX11 7HB
United Kingdom
Phone: +44 1235 811 111
www.fivesgroup.com
Fives Stein Limited is a leading supplier in high-quality melting and conditioning for all types of glass. We design, manufacture, install, commission and service glass plant and equipment tailored to your specific needs. With over 90 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.

GEA Process Engineering, Inc.
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Phone: +1-410-997-8700
www.niroinc.com
GEA Process Engineering offers a wide range of technology for gas cleaning in various industrial markets. This includes dust collection, dry, semi-dry and wet processes for removing SOx and other acid gases, separating heavy metals, dioxins and furans and other relevant off-gas components. Our range of services includes consultancy, engineering, supply, assembly and commissioning of complete plants.

General Glass Equipment Company
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645 South Mill Road, Suite 1, Absecon, New Jersey 08201
Phone: +1-609-345-7500
www.generalglassequipment.com
General Glass Equipment Company is an engineering and manufacturing organization that has dedicated its corporate activities exclusively to the domestic and worldwide glass manufacturing industry for more than 80 years. The activities of the firm encompass virtually every aspect of glass manufacturing from plant design and construction, personnel training, project engineering, and general consultation to innovative product development for manufacturing economies. Our extensive background in the industry offers General Glass clients the benefit of a comprehensive perspective of glass manufacturing on a domestic and an international scale.

Glassworks Hounsell
Booth: 41
Park Lane, Halesowen, West Midlands B63 2QS, United Kingdom
Phone: +44 1384560666
www.glassworkshounsell.co.uk
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GMIC
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Phone: +1-614-818-9423
www.gmic.org
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.

H.C. Starck, Inc.
Booth: 38
45 Industrial Place, Newton, Massachusetts 02461
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www.hcstarck.com
H.C. Starck’s innovative research, engineering development, manufacturing execution, and diverse product portfolio make it a leading manufacturer for the glass melting industry. H.C. Starck is one of the world’s largest suppliers of the refractory metals: molybdenum, tungsten, tantalum, and niobium. Large diameter molybdenum tubing suitable for quartz melting vessels and orifice plates are extruded at its premier extrusion and forging facility. Fabricated products from molybdenum and tungsten include: glass melting electrodes, crucibles, extruded tubes, and other components. H.C. Starck’s molybdenum, with its exceptional purity level (99.95% minimum), has outstanding resistance to chemical corrosion, degradation, and minimal detrimental glass discoloring.
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Phone: +49 9131 9747790
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ilis develops, produces and distributes software solutions, measuring systems as well as automated test equipment for quality assurance in the glass and optical industry. With the measuring and testing equipment of the StrainMatic™ and StrainScope™ series, the company develops imaging polarimeter systems for the automatic and objective measurement of residual stress in glass and plastics. BatchMaker™ and Chroma™ provide the glass industry standardized software solutions for simple and reliable calculation of batch recipes and glass properties, as well as for transmission and color measurement.

Johnson Matthey Noble Metals
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1397 King Road, West Chester, Pennsylvania 19380
Phone: +1-859-276-1570
www.glass.noble.matthey.com
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www.lahtiprecision.com
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By supplying:
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Phone: +1-724-228-9898
USA agent: Argent Enterprises Inc. | Phone: 724-499-5800
www.longwallservices.com
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Phone: +1-585-214-2455  
www.lumetrics.com  
Lumetrics® is the leader in flat glass and tubing measurement. Since 2003 Lumetrics® has worked with all of the leading glass manufacturers in the world in the measurement of their specialty glass products. Lumetrics® OptiGauge™ provides non-contact measurement of single and multilayer glass products including tubing, safety and water glass, float glass, and coatings, even in a tin bath. The OptiGauge™ is used in R&D labs, Quality Control, and online process measurement. Our technology is even used for in-process glass slimming measurements to increase customer throughput by over 30%.

**Luoyang Dayang High-Performance Material Co., Ltd.**  
Booth: 36  
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Phone: +86 13 933586785  
www.dyrefractory.com  
Leading Chinese Fused Cast Materials Manufacturer, 10,000 tons/year salable products of AZS 33, AZS 36, AZS 41, α-β Alumina, and Fused high Zirconia in 88% and 95%.

**Magneco/Metrel, Inc.**  
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223 W. Interstate Road, Addison, Illinois 60101  
Phone: +1-630-543-6660  
www.magneco-metrel.com  
MMI has developed a family of refractory monolithic products referred to as “Metpump” for Glass Furnace Applications. MMI’s unique cement free colloidal silica bonded monolithic refractory products offer an alternative to the electrofused cast blocks for the glass furnace. Metpump Products can be used in five different applications: 1) Major Repairs of the melter and regenerator 2) Full or Partial Crown Construction or Repair 3) Partial Construction of the furnace 4) Partial Repairs of the melter and regenerator 5) Full Construction of the furnace.

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Booth: 50  
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Phone: +1-267-384-5231  
www.magspecinc.com  
Custom manufacturer of saturable reactor based power supplies, design and build custom transformers; capabilities to 3500 KVA, dry-type and water cooled, copper and aluminum, UL recognized insulation systems, high ambient design experience.

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Phone: +1-614-829-1200  
www.mcgillairclean.com  
McGill AirClean has over 40 years of engineering and manufacturing experience helping companies meet stringent air pollution control regulations for boilers, furnaces, incinerators, and a variety of industrial processes in industries such as wood products, pulp and paper, automotive, chemical, pharmaceutical, food, metals, petrochemical, electrical power and steam generation, and solid waste incineration. We have extensive experience and a large number of installations for many types of glass applications. Products and services include dry and wet electrostatic precipitators, fabric filter systems, spray-dry scrubbers, regenerative thermal oxidizers, DeNOx (SCR) reactors, dry reagent injection systems, mobile testing services, and parts and service.

**Mixer Systems, Inc.**  
Booth: 31  
190 Simmons Avenue, PO Box 10, Pewaukee, Wisconsin 53072  
Phone: +1-262-893-5315  
www.mixersystems.com  
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 3500 projects in 42 different countries worldwide since 1945. The planetary mixer works like an egg beater and provides excellent mixing action for colored batches or hard to mix applications where top to bottom mixing action is critical to the end product.

**Motim Fused Cast Refractories Ltd.**  
Booth: 13  
Timföldgyári ut 9-13, Mosonmagyaróvár, 9200, Hungary  
Phone: +1-724-499-5800 | +36 96 574 100  
motim.hu  
Motim Fused Cast Refractories Ltd. is recognized as a world leader producing fused cast AZS and alumina refractories, refractory castables. Our products are used in the glass manufacturing furnaces. More than 95% of our turnover is from export sales. Our traditional markets are Western and Central Europe, but we are present with our products on all continents of the World. Motim is represented in the USA by ARGENT.ENTERPRISES. INC.
Nalco, An Ecolab Company
Booth: 5
1601 W. Diehl Road, Naperville, Illinois 60563
Phone: +1-630-305-2414
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SORG Services USA
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Stoltestr, 23 D-97816, Lohram Main, Germany
Phone: +1-724-366-6513
www.sorg.de
The SORG Group through their member companies can supply turnkey installations from raw material delivery through the glass gob globally. 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 globally. Our latest products include the BATCH3 system comprising often the IRD® Doghouse, EME-NEND® charger and the proven Sorg® Batch Preheating system.

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North American Refractories Company engineers, manufactures and supplies a full-line of refractories to support the most demanding glass making applications. NARCO’s experienced Installation Group provides the Glass Industry with high quality hot and cold repair service as well as hot sealing of new furnaces. Our Glass Support Team is located in Pittsburgh, PA and Cincinnati, OH with Sales Representatives that cover the United States, Latin America, South America, Europe and Asia. Our Glass Support Team works closely with each customer to ensure the best possible refractory solutions are met. We have 17 plant locations in the United States, 1 in the United Kingdom, 1 in Mexico, 1 in China, and 1 in Indonesia.

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PCI Gases is a global leader in on-site oxygen generation systems using a proprietary Vacuum Swing Adsorption (VSA) process. This technology offers many advantages over conventional technology, leading to the lowest operating cost in its class.

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PaneraTech, Inc., is one of the most innovative sensor technology companies in the world, developing unique solutions that far surpass expectations. We are pioneers in developing furnace (melter) wall erosion monitoring sensors that measures wall thickness and images early stage glass penetration below the glass level for preventive maintenance and furnace life optimization.

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Holmfield, Halifax, West Yorkshire, HX3 6SX, United Kingdom
Phone: +44 1422 254472
USA exclusive agent: Argent Enterprises Inc.
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www.parkinson-spencer.co.uk
Parkinson-Spencer Refractories Ltd manufacture and supply refractories, engineer products and systems for the glass industry. Products include:

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- Forehearth channel blocks in zircon-mullite
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PLANSEE will be present at the Glass Problems Conference to discuss the features of their products. Whether its molybdenum glass melting electrodes, tank reinforcements or stirring and gobbing equipment, PLANSEE’s leading edge technologies and high performance materials provide for an efficient glass melting process. For decades PLANSEE has significantly contributed to making glass production more effective and environmentally friendly. As the largest fully integrated partner worldwide for the glass industry, PLANSEE provides its customers with technically advanced designs manufactured from our high performance materials resulting in excellent corrosion resistances, coarse grain structure, and highest purity.

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Poco Graphite’s precision ware handling solutions and unique GLASSMATE® graphite materials can improve performance in container glass production, reduce machine downtime and increase yields. POCO is known for its designs, particularly precision holders and inserts that allow fast accurate machine setup and insert replacement. Inserts are available as semi-finished blanks, or can be precision machined to a specific finish. POCO also offers graphite dead plate assemblies, lehr bars, sweep-out assemblies, and custom components. Application specialists can assist in the selection of the optimum graphite grade based on pickup, application, and length of the production run.

Pyrotek, Inc.
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Dedicated to serving the glass, steel, aluminum and refractory industries. We offer refractory grinding, sawing, drilling, shaping and construction of custom assemblies. We specialize in precision machining of standard shapes.

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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 (FBE, DBE, SBA, EDGE) delivering comprehensive Occupational and Environmental Engineering consulting services to both the public and private sectors.
We are a leading manufacturer of Molybdenum and Tungsten products in China. Replying on years of experiences, advanced techniques, quality equipment, highly efficient manufacture and standard management, we have established a comprehensive system of research, manufacture and marketing of Molybdenum products, which are used in glass melting components. Our products are well known for their excellent properties, have been approved by various international authoritative institutions and have been supplied to customers in many countries.

Sheppee International Limited
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Phone: +44 1904 608999
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Sheppee International is a world leader in Hot Glass Ware Handling for both the container and tableware industries, with over 50 years of experience. Supplying innovative and dependable solutions in the field of hot container conveying, lehr loading, glass contact materials and synchronous drive systems. The Triflex three Axis servo loader offers maximum flexibility for the operator and provides a job storage facility. The MRS-9000 two Axis servo loader is ideal for replacing existing mechanical machines. A full range of ware transfer units have been designed, suitable for handling the smallest pharmaceutical containers up to the largest champagne bottles.

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S.I.G.MA. GROUP, specialized in the production of refractory materials since 1990, supplies the full high quality range of materials for the glass industry including Sillimanite, Mullite, Zircon-mullite, Zircon, High alumina, Fireclay, Fused cast, Insulating, Magnesite, Silica, Special cements and concretes. Sigma Italy produces 3,200 tons/year of shaped pieces and 6,500 tons/year of pressed material. Additionally 5,000 tons/year are produced by our partners and controlled by our technicians both in production and auditing. Sigma SRLU is the new facility located in Plovdiv, Bulgaria commissioned in March 2014 with a manufacturing capacity of 2,500 tons/year of vibrocast shaped pieces.

Special Shapes Refractory Company, Inc.
Booth: 34
1100 Industrial Blvd., Bessemer, Alabama 35022
Phone: +1-205-424-5653
www.ssrco.com
Special Shapes Refractory Company (SSRCo) is a family owned business that manufactures specialized, engineered pre-cast refractory shapes utilizing SSRCo developed refractory mixes for use in the Glass Industry. We offer grinding and finishing services, quick turn-around times for emergency repairs, and with our co-op partners, we can provide refractory solutions that assist our customers for either “hot or cold” repairs. As we move into our second quarter century, SSRCo is still continuing to work on refractory developments, both in refractory material and shape designs, that will continue to help our customers compete in the Global Market.

Tecno5 S.p.A.
Booth: 2
Via Micheli 13-S., Polo di Torrile, Parma, Italy
Phone: +39 0521 317200
www.tecno5.it
Founded more than 20 years ago, in 1986, Tecno5 S.p.A has about 260 machines installed in more than 45 countries. What makes the difference in Tecno5 equipment is the great flexibility and profound experience of an exceptionally active and reliable company. As assistant in know-how and technology experience development, thanks to common projects as well, there is Cerve S.p.A – one of the largest and most famous decorating groups worldwide. Cooperation with Cerve S.p.A is a great, indisputable advantage since it allows to develop new ideas, follow market needs, and at the same time test the machinery.

Toledo Engineering Co., Inc.
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3400 Executive Parkway, P.O. Box 2927, Toledo, Ohio 43606
Phone: +1-419-537-9711
www.teco.com
The TECO Group, consisting of Toledo Engineering Co., Inc., TECOGLAS Ltd., KTG Systems, Inc., KTG Engineering Ltd., ZEDTEC Ltd. EAE tech and Dreicor Inc. specialize in the design and construction of glass melters of all types, including fuel-fired regenerative and recuperative furnaces, oxy-fuel furnaces, electric melters, electric boost systems and forehears and distributors/working end. The TECO Group also provides batch plants, emission control systems and process control systems on a turnkey basis. KTG Engineering Ltd. manufactures many items of furnace equipment such as batch chargers, electrode holders, and spy hole covers, etc.
Tri-Mer Corporation offers the UltraCat Catalyst Filter System for glass furnace emissions. Based on low-density ceramic filters, the technology offers a high-performance approach to removing Particulate, SO$_2$, HCl, and NOx in a single all-in-one system. Acid gases such as SO$_2$, HCl, and HF are removed with dry sorbent injection. NOx is destroyed by nano-bits of SCR catalyst embedded in the filter element in conjunction with ammonia injection. Other pollutants such as metals are effectively captured. If only PM or PM+ SO$_2$/HCl need to be controlled, standard filters without catalyst are highly efficient at temperatures up to 1650°F.

Tsi, inc.
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500 Cardigan Road, Shoreview, Minnesota 55126
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www.tsi.com
The ChemReveal LIBS Desktop Elemental Analyzer from TSI provides rapid and direct quantification of heavy and light elements (e.g. Li, B, Na) in glass without the need for dangerous acids and lengthy digestive processes. The ChemReveal LIBS system also features a high-throughput technician-mode interface that manufacturers and industry scientists expect. For more information, talk to one of our experts today!

Usable Glass Strength Coalition, LLC
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600 N. Cleveland Avenue, Suite 210, Westerville, Ohio 43082
Phone: +1-614-818-9423
www.gmic.org/ugsc.htm
Most glass companies cannot independently support a fundamental research agenda to understand and improve the usable strength of glass. However by working together with pooled funding and shared risk, the opportunity to improve the usable strength of glass is achievable. The UGSC supports fundamental, pre-competitive research on increasing the usable strength of glass across all sectors; provides an opportunity for researchers to develop expertise in industrial applications; develops tools and measurement techniques for the advancement of glass science; and publishes valuable pre-competitive glass research in the public domain.

Umicore AG&Co. KG
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Platinum Engineered Materials, Rodenbacher Chaussee 4, 63457 Hanau-Wolfgang, Germany
Phone: +49 6181 59 8197
www.platinum-engineered-materials.com
Umicore’s business unit Platinum Engineered Materials is a global technology leader for either cast or FKS Platinum materials based single-source, tailor-made, engineered system solutions to the special glass industries. We support key players to reach the best possible performance with their special glass production processes at the interface of our Platinum Group Metal Components and its immediate periphery by means of our Process Excellence Model. Process Excellence translates into total cost reduction (savings), increase of competitiveness (solutions), and reduction of risk (security).

Vesuvius USA
Booth: 16
753 Enterprise Road, Dillon, South Carolina 29536
Phone: +1-843-774-6026
www.vesuvius.com
Vesuvius is a community of experts developing ceramic solutions for every stage of glass production. We are a global leader serving all glass markets and offering customized products and solutions to our customers.

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40 Depot Street, Warner, New Hampshire 03278
www.warnerpower.com
Warner Power’s comprehensive power conversion and magnetics capabilities provide our customers with “turn-key” solutions to a wide variety of demanding glass industry applications. Our custom-designed GreenStar switch mode and Furnastar SCR based power supplies combine active control with custom transformers and other selected components to reduce total cost of ownership and improve product quality.
GreenStar Switch Mode Power Supply:
• Efficiency 90+% and Power Factor 94% down to 50% loading
• Ripple output is less than 1% RMS
Arvind Atreya, Dr., Professor, University of Michigan; Carlos Garcia diamoreno, Program Manager, GE Aviation;  David Everest, PhD, LEED AP, CEE, Siemens Building Technology

Heat Transfer in Glass Quenching for Glass Tempering
Results of an experimental study of heat transfer characteristics in single and two-phase stagnation point flows pertinent to glass quenching in the glass tempering process are presented. Two-phase flows were generated by injecting water mist into the air far upstream of the nozzle exit. This resulted in a temporal and spatially invariant size distribution of the droplets. PIV measurements were made at the nozzle exit to determine the magnitude and uniformity of air velocity profile in both single and two-phase flows. The two-phase flows were also characterized by measurements of drop size distribution and number density using images of droplets resulting from laser induced fluorescence. Steady state experiments were performed for plate heat fluxes ranging from 10 to 50kW/m2, Reynolds number ranging from 2,000 to 122,000 and water/air mass flow ratios up to 4.75%. Single-phase flow results indicate that the Reynolds number dependence of the Nusselt number is ~Re0.68. Two-phase flow results show a maximum heat transfer enhancement of 26%. For plate temperatures above 200°C and for the drop size distributions tested, it was visually determined that the water droplets do not impinge on the plate surface. Therefore, the heat transfer enhancement was attributed to the evaporation of water droplets within the thermal boundary layer. This is an important condition to prevent spatially non-uniform quenching and the resulting shattering of glass. By changing the water/air mass flow ratio, the cooling curve for a two-phase flow can be adjusted to meet the requirements of the industrial process.

Fred Aker, MBA, Sales Director West and Marketing Manager, Nikolaus Sorg GmbH & Co. KG; Erik Muijsenberg, MSC Mechanical Engineering, Vice President, Glass Service, Inc.

Feeder Expert Control System for Improved Containers
Feeder control systems for improved containers in recent years numerous efforts have been undertaken in container glass production to achieve better control and to improve production efficiency. This is especially true in regard to lightweighting glass containers. This in particular requires stable and reproducible conditions in the glass conditioning systems. Repeatability is crucial. Especially the ability to return to known good operating conditions quickly following frequent job changes. SORG and Glass Service will present results concerning ongoing investigations to improve and automate these critical forehearth processes.

Yakup Bayram, Chief Technology Officer, PaneraTech, Inc.; Alexander C. Ruege, Principal Engineer, PaneraTech, Inc.; Eric K. Walton, Chief Scientist, PaneraTech, Inc.; Peter Hagan, Product Development Engineer, PaneraTech, Inc.; Elmer Sperry, Technical Leader, Batch & Furnace Design Engineer, Libbey, Inc.; Dan Cetnar, Furnace Engineer, Libbey, Inc.; Robert Burkholder, Research Scientist, The Ohio State University; Gokhan Mumcu, Assistant Professor, University of South Florida; Steve Weiser, Director of Engineering, O-I, Inc.

Detection of Early Stage Glass Penetration and Weak Refractory Spots on Furnace Walls
Erosion of the refractory lining in molten glass furnaces is a major problem for the glass manufacturing industry. When erosion on the walls is not detected early enough, it may lead to a molten glass leak through the refractory lining and may result in the suspension of production for several weeks. In some cases, a catastrophic accident may also result. The glass penetration typically starts small within the insulation layer and takes anywhere from a few weeks to several months to penetrate through the insulation layer and result in major catastrophic furnace leak. Therefore, detecting an early stage glass penetration within the insulation layer and identifying weak refractory linings will result in safer and longer furnace operation through preventive and proactive maintenance.

To address this major industry need, we are developing a non-destructive sensor technology for tomographic imaging of insulation and refractory lining. This sensor will identify early stage glass penetration into insulation and identify weak refractory spots for preventive and proactive maintenance. We have already developed a sensor that measures the residual AZS thickness on operational glass furnaces. We have also showed the feasibility of mapping interior walls of insulation layers for glass penetration in an operational furnace. Lastly, the same sensor technology is capable of detecting voids and defects in cold refractories.

At the conference, we will discuss the underlying fundamentals behind the proposed sensor technology, the measurement results pertaining to feasibility and in-situ tests on operational furnaces, and the path forward to an integrated sensor system for smart (self-sensing) furnaces.
Sebastien Bourdonnais, Material Science Engineer, Saint-Gobain SEFPRO; David Lechevailer, PhD, R&D Senior Engineer, Saint-Gobain Northboro Research Center; Michel Gaubil, PhD, R&D Manager, Senior Scientist, Sain-Gobain CREE

**SEFPRO Cruciforms: Modern and Competitive Regenerator Designs for Glass Industry**

Modern glass manufacturing has become these years a challenging global market. Energy consumption and environmental regulation are now major concerns. For more than 40 years, SEFPRO has developed innovative solutions for regenerative glass furnaces with highest thermal performances and adapted to different running conditions. This presentation summarizes the state-of-the-art practices with typical designs and choices of materials to match this challenging objective and help glass makers in manufacturing high quality glass at competitive cost. Several design optimizations on the regenerator chambers and on the checkers choice to reach minimum specific consumption will be presented, with guidelines for right checker material choice withstanding a full campaign with minimum maintenance. This suppose the checker pack can perfectly resist to usual operating conditions such as reducing conditions for NOx control, carry over attack and thermal cleaning.

Steven Brown, Principal Mechanical Engineer, Bucher Emhart Glass; Kenneth Bratton, Manager of Forming Process Engineer, Bucher Emhart Glass; Tim Ringuette, Senior Mechanical Engineer; Bucher Emhart Glass; Dubravko Stuhne, Production Technical Specialist, Vetroconsult

**Hard Glass – Commercial Progress of Thermally Strengthened Container Glass**

A developmental program and market introduction is underway between Bucher Emhart Glass and Vetropack Austria. In this program, a new strengthening machine has been installed and is running in Vetropack’s glass plant located in Poechlarn Austria. The market introduction is based on a 330mL beer bottle being produced for a local Austrian brewer that is a light weighted version (200 gram) of an existing returnable bottle (300 gram) a weight reduction of 33%. This paper will present the results of some initial filling line tests together with lessons learned along the way. It will also include the results of a study performed for Bucher Emhart Glass and Vetropack by Stazione Sperimentale del Vetro (Murano, Italy) regarding the differences between annealed and heat strengthened ware in terms of the resistance of the glass to impact and handling induced defects.

Carol Click, Manager Glass Science Group, Global R&D, Owens-Illinois, Inc.; Udaya Vempati, Scientist I, Owens-Illinois, Inc. and Terence Clark

**Effect of Dissolved Water on Physical Properties of Soda-Lime-Silicate Glasses**

Dissolved gases in glass melts are known to influence properties of the melts as well as the resulting glass and dissolved water is thought to be one of the most influential of all the dissolved gases. In this work, the effect of vacuum processing and the ensuing changes in dissolved water concentration on various physical properties of soda-lime-silica glasses were studied. Glass melts with varying dissolved water concentration were prepared by melting frit at atmospheric and sub-atmospheric (=100 torr) pressures at 1450 °C. The physical properties of these melts and the resulting glasses were determined by rotating spindle viscometry, beam bending viscometry, and UV-Vis spectroscopy. The densities of the glass samples were also determined. Results from these experiments are discussed in relation to prior work in the field and the implications of changes in properties on the glass making process are discussed.

Henry Dimmick, Jr., CEO, American Glass Research; Brian Collins, Research Scientist, American Glass Research; Gary Smay, Manager Consulting Services, American Glass Research

**Comparison of SEM/EDX Analysis to Petrographic Techniques for Identifying the Composition of Stone in Glass**

Stones are a problem that can adversely affect glass production in container, flat glass, specialty, and fiberglass manufacturing. Consequently, it is important to quickly and correctly identify the source of the stone and implement appropriate corrective actions. Historically, the analysis of stones required time consuming petrographic analyses. Recently, glass technologists have adopted a method of analyzing stones consisting of a scanning electron microscope (SEM) together with the use of X-ray analysis (EDX). These current methods have the potential of providing accurate, detailed information about the stone in a much shorter time than usual petrographic analyses. This paper compares data derived from analyses of stone identification using an SEM/EDX to the results obtained from petrographic techniques.
Multi Gob Weight Production

Capability of producing multiple containers with different weights on the same machine line can give the glass plant more flexibility of organizing production jobs, save cost on mold equipment, and reduce production lost due to job changes. Bucher Emhart glass has developed the multi gob weight control system including multi weight feeder and the knowledge for how it can be applied. This paper presents recent multi gob weight control algorithm developments and its application with the multi feeder system. The control algorithm makes the multi gob weight set up procedure quick, accurate, and easy for the end user. Plant trial results are included to validate the control algorithm development.

Environment and Energy Flue Gas Treatment and Heat Recovery Integrated Systems in Glass Industry

Flue gas treatment in glass industry is getting more involved and elaborate to meet environmental emission requirements. Traditionally, three compulsory systems are available to abate pollutants and acids (dusts, NOx, SOx): Electrostatic Precipitators, Bag Filters and Ceramic Candle Filters eventually connected to an SCR reactor. Additionally, flue gas treatment specialists are trying to develop new technology solutions to optimize and increase operating and environmental performance, even using the so called “Lost Third” of Energy, coming out with glass furnace gases.

Two typologies of heat recovery are generally possible: thermal and electric; cogeneration is also a third, mixed opportunity. Generally speaking, Rankine cycle is used to produce power normally realized in two ways:
- by means of water steam generation (direct exchange with flue gases);
- by means of organic fluid (indirect exchange, using thermal oil heated by flue gases).

Where reliability and low maintenance are basic decision elements, Organic Rankine Cycles (ORC) are the most common choice and probably the best available technology. New generation organic fluid turbines are becoming more efficient and comparisons on same cases show that yearly power production with ORC is at least as high as traditional steam cycle, with lower investment in terms of manpower and time spent on this “appendix” of the glass furnace.

The subject of the presentation is the evaluation of the most reliable solution in terms of heat recovery linked with FGT, related to a specific plant situation, and a deep analysis of a typical heat path, considering technical and economic aspects.

3-D Transient Non-isothermal CFD Modeling for Gob Formation

To achieve a quality final product in the glass container industry, it is critical to determine the “ideal” glass gob shape to be produced from the feeder after shearing. Large deviations from an ideal gob shape may result in severe consequences for the gob delivery system and molds. The formation of ideal or desired gob shape is dependent upon operational parameters such as glass temperature/viscosity, uniformity, plunger stoke and heat-loss management. A Computational Fluid Dynamics (CFD) model provides an efficient and cost effective way of studying the effects of these parameters when optimizing gob shapes that are subject to the aforementioned operating parameters and conditions.

For the current study, two CFD approaches were used to create a 3-D transient non-isothermal CFD model in order to study the effects of flow and the thermal condition of molten glass on gob formation. In the first approach, a numerical model was developed by utilizing the ANSYS POLYSFLOW solver in conjunction with both the Mesh Superposition Technique and the Lagrangian adaptive re-meshing technique to model plunger motion and gob formation respectively. In the second approach, a hybrid model using both ANSYS FLUENT and POLYSFLOW was developed, in order to achieve higher computational efficiency and a reduction in computational time. The hybrid model consists of two parts: (1) the flow and thermal condition of the molten glass is modeled by FLUENT using the moving deforming mesh technique for plunger motion, and (2) the gob forming process is modeled in POLYSFLOW by mapping/transferring the glass flow and temperature information from FLUENT. The hybrid model used in the second approach shows significant improvement in computational performance with reasonable accuracy.

Fast and Objective Measurement of Residual Stresses in Glass

Mechanical stresses can strongly impair the fracture strength and processing ability of glass products. Testing for residual stresses close to production is therefore an important constituent of quality control. For decades manually operated polariscopes and polarimeters have been the standard method for testing the level of residual stress in glass, e.g. according to ASTM C148. However, the measuring results obtained with such devices are strongly dependent on the operator and therefore subjective. The results of statistical Gage R&R tests show that the reproducibility achieved with this method is not acceptable. A newly developed imaging polarimeter features the objective measurement of inherent stresses in glass — as random sample test or directly in the production process. The camera-based instruments are capable of measuring and visualizing stresses in glass in real time and can be used flexibly wherever conventional polariscopes and polarimeters are still used nowadays. A comprehensive Gage R&R study shows substantial improvements in respect to absolute accuracy and practical reproducibility of the measurement.
Stefan Laux, Director, R&D, Praxair, Inc.; Alonso Gonzalez, President, Pavisa; Enrique Solórzano, Engineering Manager, Pavisa; Cuauhtemoc Lagos, Application Engineer, Praxair Mexico; Gerardo Lugo, Business Development Manager, Praxair Mexico; KT Wu, Development Professional, Praxair Inc.; Robert Bell, Development Engineer, Praxair Inc.; Hisashi Kobayashi, Corporate Fellow, Praxair Inc.

**OPTIMELT™ Regenerative Thermo-Chemical Heat Recovery for Oxy-Fuel Fired Glass Furnaces**
The operation of glass furnaces with oxy-fuel combustion in combination with advanced heat recovery is a compelling low cost solution. Praxair has developed a regenerative heat recovery system for oxy-fuel fired furnaces that uses regenerators in a similar way to which conventional regenerators are used for air preheating. The OPTIMELT™ Thermo-Chemical Regenerator (TCR) technology stores waste heat from the hot flue gas and uses this energy to endothermically reform a mixture of natural gas and recirculated flue gas to hot syngas resulting in efficient thermo-chemical heat recovery.

The TCR system is simple and operated at atmospheric pressure without requiring catalysts or separate steam generation. TCR reduces fuel consumption of an oxy-fuel fired furnace by about 20% and offers an attractive conversion option for existing air-regenerator furnaces, with more than 30% fuel reduction compared to the air-fuel base case. The presentation will highlight key technology development steps and include operational data and results from the first installation of OPTIMELT™ TCR on a 50 t/d commercial container glass furnace.

David Michael, Senior Research Engineer, North American Refractories Company; Laura Lowe, Senior Application Engineer, North American Refractories Company; H. Edward Wolfe, Sr. Mineralogist, North American Refractories Company

**Alteration of Basic Brick in Glass Tank Regeneration**
This paper reviews the chemical reactivity of basic refractories used in glass tank regenerators with V2OS in oil-fired furnaces, with sodium sulfate and with alkali. The rationale for using magnesia brick with high levels of forsterite in situations where V2OS attack is anticipated is given. A post-mortem examination showing depletion of CaO in basic brick exposed to sodium sulfate is shown. Laboratory work on reactivity of basic brick with sodium sulfate is also presented to show the effect of CaO depletion on strength of basic refractories. Alkali attack on forsterite-bonded brick is discussed. A new type of forsterite-bonded brick containing no ZrO2 with properties similar to those of magnesia-zircon brick but with substantially better alkali resistance is introduced.

Michael S. Pambianchi, PhD., Research Director, Glass Research, Corning Incorporated

**Glass Challenges in Consumer Electronics**
The consumer electronics industry is incorporating specialty glass into its products more and more, including display substrates, encapsulation, touch panels, and cover glass. These glasses need to meet demanding attributes while remaining cost effective in an industry with aggressive cost targets. We describe some of the specialty glass opportunities found in consumer electronics and the challenges in addressing them.

Julien Pedel, PhD, Development Specialist, Praxair, Inc.; Uyi Iyoha, PhD, Business Development Manager, Praxair, Inc.; Piero Zucca, Combustion Application Development Engineer, SIAD; Hisahi (Sho) Kobayashi, PhD, Corporate Fellow, Praxair, Inc.; Jaoquin de Diego, European Market Combustion Manager, Praxair Euroholding S.L.; Euan Evenson, Program Development Manager, Praxair, Inc.; Geert Cossen, Project Manager, Praxair, Inc.

**Oxygen Enhanced NOx Reduction (OENR) Technology for Glass Furnaces**
Container and flat glass manufacturers in the USA and EU are facing increasing pressure from regulatory agencies to further decrease NOx emissions from glass furnaces. In the past, air-fired glass furnace operators have been able to reduce NOx emissions and comply with regulations by modifications of the primary air combustion system, such as the optimization of natural gas injection method. However, complying with new European Union NOx targets (~1.5 to 2.4 lb NOx/ton of glass for container glass and ~2.5 to 4 lb NOx/ton of glass for float glass) will be difficult to achieve in many furnaces through these optimization steps. Combustion staging by reducing the stoichiometric ratio (air/fuel ratio) of the primary air-gas flame and introducing a secondary oxidant stream at various locations in the furnace has shown to successfully reduce NOx emissions. Well known approaches are oxygen enriched air injection or cold air staging. However, the use of cold air has a substantial energy efficiency penalty. Praxair has developed Oxygen Enhanced NOx Reduction (OENR) technology which uses a pure oxygen stream to attain NOx emissions levels below 1.5 lb/t, without adversely impacting the energy efficiency of the furnace or disturbing the air-fuel flame, as is sometimes observed with cold air staging. This paper presents and discusses CFD results and data from commercial demonstrations of Praxair’s OENR technology and shows that the technology is a cost effective approach to significantly reduce NOx emissions, while maintaining good glass quality and increasing fuel efficiency.
New Combustion Technique for Reducing NO\textsubscript{x} and CO\textsubscript{2} Emissions from a Glass Furnace

The European Glass Industry has the problem of reducing both CO\textsubscript{2} and other emissions such as NO\textsubscript{x} from its primary regenerative melting furnaces. To address this problem a new combustion concept has been developed by a consortium of GDF-SUEZ, Global Combustion Systems and the University of South Wales with financial assistance from the UK’s Carbon Trust. It comprises a novel, patented firing technique (AUxILIARY FIRING) that reduces NO\textsubscript{x} formation at source on primary regenerative glass melters, while simultaneously reducing fuel consumption and CO\textsubscript{2} emissions. It avoids or reduces the need for post-furnace NO\textsubscript{x} clean-up which can be expensive in capital and increases life-cycle CO\textsubscript{2} emissions.

If confirmed over longer term testing and on cross-fired furnaces, the results of this project will enable the European glass industry to meet upcoming NO\textsubscript{x} emission limits on their primary glass melters by reducing NO\textsubscript{x} formation at source, without the need to install large, expensive and energy-hungry post furnace clean up techniques. Elimination of NO\textsubscript{x} clean-up will yield simultaneous reductions in NO\textsubscript{x} and glass life-cycle CO\textsubscript{2} emissions.

Energy Analysis for Preheating and Modeling of Heat Transfer from Flue Gas to a Granule

To reduce energy consumption of an oxy-fired glass furnace, energy loss via the flue gas and through the furnace walls should be minimized since they account for approximately 40 % of the energy usage. One way to minimize flue gas energy loss is to pre-heat the raw batch materials and/or cullet. Energy analysis was conducted to evaluate the maximum amount of energy recoverable and that required for the pre-heating. The maximum pre-heating temperature was calculated under conditions of constant and reduced rate of natural gas usage. Since the flue gas temperature from an oxy-fired furnace is on the order of 1350°C, the maximum temperature for batch pre-heating that could be potentially employed was above 500 °C. However, handling loose batch at such high temperatures is likely to be physically difficult to accomplish reliably. On the other hand, batch in an agglomerated form, such as granules, may be pre-heated easily. Analysis of the heat transfer from flue gas to a single granule was investigated first through computational fluid dynamics (CFD) modeling. Parameters studied included the average diameter and thermal conductivity of the granule, the inlet flue gas temperature, and the flue gas velocity and composition. The data was used to evaluate the time needed to preheat a single representative batch granule to a given target temperature under various heating conditions. In addition, the time-dependent temperature and velocity distributions for the modeled geometry were determined. The results show that granule diameter and gas velocity both have a significant impact on the rate of granule heating.

Closed Loop Control of Glass Container Forming

Recently developed closed loop control systems offer a new means to help container glass manufacturers meet the ever increasing industry and customer expectations for improved yield and quality. In these closed loop systems the process is automatically adjusted based upon actual measured values. Such closed loop controls, have now been developed and introduced into commercial production in two key areas: 1) Blank Cooling Control and 2) Plunger Up Control in which the blank mold temperatures and the rise/dwell time of the plunger respectively are automatically controlled. The technical development of these new control systems, the challenges that needed to be met, and the experience of glass manufacturers adopting these systems will be presented.
**ABSTRACTS in Alphabetical Order by Speaker Last Name**

**Steven B Smith**, Independent Consultant

**U.S. Air Regulations Involving Glass Manufacturing**

Recently developed closed loop control systems offer a new tool for managing the basics of environmental rulemaking as well as the role of the states. An overview Part 70, Title V permitting is provided, including what various Title V permits exist today, why permit variations occur, and when a state should be notified about work on a permitted process. Greenhouse gas requirements are in place today at the Federal level and at the state level one state has set limits and requirements for controls but various agreements foretell expansion of such rulemaking to other jurisdictions.

**Oscar Verheijen**, Dr., Ir., Senior Consultant, CelSian Glass & Solar B.V.; **Andries Habraken**, Ing., Senior Consultant CFD, CelSian Glass & Solar B.V.; **Heike Gramberg**, Dr.-Ir., CFD Engineer, CelSian Glass & Solar B.V.

**Modeling of Heat Transfer and Gas Flows in Glass Furnace Regenerators**

Improving energy efficiency and cost reduction in glass production are of key importance to maintain glass as a cost-competitive product with environmental sound footprint. Regenerators of glass furnaces have a major impact both on energy efficiency in glass production and investment costs for new glass furnaces. The aim with designing of regenerators is to maximize heat recovery from the hot flue gases (and to preheat combustion air) while minimizing its volume (to limit purchasing expensive regenerator bricks) and ageing. In addition, the type of regenerator bricks applied as function of height in the regenerator (or better: as function of temperature in the regenerator), needs to be chosen such that it can chemically resist the attack/corrosion by the expected flue gas components at the prevailing temperature. Optimal design of regenerators (in view of heat recovery, costs and lifetime) requires detailed 3D CFD simulations in order to determine the turbulent flows in the complete regenerator, the local temperatures of the gases and complex shaped regenerator bricks and the convective and radiative heat exchange between gases and checkers for both flue gas and air phase. This paper reports on results of detailed modeling of regenerators by CelSian’s CFD model GTM-X. Next to 3D-temperature fields, the distribution of flue gas (and air) over the top (and bottom) cross-sectional checker layers, and the longitudinal and lateral flows further through the regenerator, depending on type of checkers and regenerator and port neck design is shown. In addition, critical areas for chemical fouling – either by sodium sulfate condensation or by attack of (especially the binder phases of) refractory material – is discussed as function of flue gas composition.

**Oscar Verheijen**, Dr., Ir., Senior Consultant, CelSian Glass & Solar B.V.; **Hans Van Limpt**, Dr.-Ing., Manager Product Development, CelSian Glass & Solar B.V.

**Experimental Simulation of Process Steps in Industrial Glass Furnaces**

The conversion of raw materials into a homogeneous glass melt without bubbles and inclusions can only be achieved if essential process steps like: melting-in of batch, dissolution of sand and removal of gas bubbles taking place in a glass furnace. Preferably the process conditions in the furnace do not lead to unwanted side effects like refractory corrosion and high emissions. Experimental laboratory set-ups to simulate different process steps in the glass melting process have been developed by CelSian Glass & Solar B.V. and applied to optimize glass furnace operation. The High Temperature Melting Observation System (HTMOS) is used to observe the melting-in, foaming and fining process and to investigate the melting characteristics and gas evolution during heating of the melting batch under a simulated atmosphere. Refractory corrosion in the regenerators and combustion chamber are in many cases a result of high evaporation and carry-over rates. On laboratory scale the impact of batch and glass composition, furnace atmosphere, gas velocities and temperature on evaporation and carry-over rates can be investigated and measures to reduce the evaporation and carry-over rates can be derived. A method is applied to study the corrosion of regenerator refractory materials. Refractory samples are exposed to cooling flue gases that contain alkali compounds, SOx and other flue gas species. Oxidizing as well as reducing conditions can be simulated. Results of these experimental studies such as melting and fining behavior, evaporation kinetics and thermodynamic data, semi-empirical relations from carry-over and refractory corrosion experiments are used in CFD modeling studies to improve the performance of industrial glass furnaces.
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