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

79th Conference on Glass Problems
where glass manufacturers meet

November 5 – 8, 2018
Greater Columbus Convention Center
Columbus, Ohio USA

CONFERENCE GUIDE
glassproblemsconference.org
More installed systems than all other suppliers combined
Nearly a decade in glass: container, flat glass, tableware

The proven solution for air-fuel and oxy-fuel gas furnace emissions:
PM, NOx, SOx, HCl, HF, metals, mercury, hex chrome, dioxins/furans, VOCs, CO

Talk with Technical Sales Director Kevin Moss, Booth 305, or call 989-321-2991
Welcome to the 79th Conference on Glass Problems (GPC), which is devoted to glass manufacturing, an industry whose products are as essential as they are ubiquitous. It’s fitting that the scope of this conference is equally extensive, covering a wide range of industry interests.

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.

GPC technical sessions address manufacturing issues, citing real world data from manufacturers and solutions providers. Additional value-rich resources are available, such as our two short courses on Combustion and on Fundamentals of Batch and Furnace Operations. Offering the technical symposium, Asset Durability and Cost Control for Glass Manufacturing Furnaces, as a full day session, allows us to offer a deep dive into the topic. As a technical conference, the proceedings manuscripts are made available to attendees and for publication.

Almost as valuable as what is learn in lecture halls, is perhaps, the best opportunity for glass manufacturing industry networking and exhibiting in North America, where leading solutions providers come together with all segments of glass manufacturers at our social events, booth exhibits, hospitality salons and booths.

We are grateful for the sponsors who support the conference, for the time and effort of the conference organizers, and for you, the glass manufacturing industry professionals for which this conference is dedicated. We trust you will find the 79th Conference on Glass Problems a valuable and rewarding experience.
WHO IS GMIC
The Glass Manufacturing Industry Council (GMIC) is a trade association founded and funded by the glass industry to create opportunities to advance competitiveness and profitability across all manufacturing segments. GMIC includes among its members, representatives of container, fiber, flat and specialty glass companies, as well as leading suppliers to the industry, research institutes, and industry experts. GMIC provides beneficial services to companies, including: enhancing companies’ business development and technical development, providing technical education, coordinating technical initiatives, providing industry intelligence, workforce development and promoting the usage and image of glass products. If you are a glass industry manufacturer, supplier, or research organization, and you are not presently a member, we encourage you to join GMIC now, as an effective means to further your strategic goals in the industry. Contact GMIC’s Executive Director, Bob Lipetz, for full information.

GMIC EXECUTIVE COMMITTEE
Executive Committee: Keith Bagarus, RoviSys, Inc., President; Rob Hofman, Roman Manufacturing, Immediate Past President; Martin Goller, Corning, Incorporated; Vice President; Steve Weiser, O-I Treasurer; Bob Lipetz, GMIC, Secretary

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GMIC STAFF
Bob Lipetz, Executive Director
Donna Banks, Executive Assistant

CONTACT GMIC
550 Polaris Parkway
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+1-614-523-3033 | info@gmic.org | www.gmic.org

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

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

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

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

Alastair Cormack, Interim Dean, Engineering Alfred University, cormack@alfred.edu
S.K. Sundaram, Inamori Professor of Materials Science and Engineering Alfred University, sundaram@alfred.edu

SAVE THE DATES
The 80th Conference on Glass Problems
October 28-31, 2019 | Columbus, Ohio
The Exhibit and Technical Sessions will take place at the Greater Columbus Convention Center
The Hospitality Suites will be located across the street at the Hilton Columbus Downtown.

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October 26-29, 2020 | Columbus, Ohio
The Exhibit and Technical Sessions will take place at the Greater Columbus Convention Center
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We are working with you to make glassmaking simpler, safer, and more efficient than ever before. We are proud to be a part of this journey together with you.

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PROGRAM SCHEDULE

SUNDAY, NOVEMBER 4, 2018
6 p.m.  GPC ADVISORY BOARD DINNER

MONDAY, NOVEMBER 5, 2018
12 – 4:30 p.m.  STUDENT PLANT TOUR — ANCHOR HOCKING

SHORT COURSES

MONDAY, NOVEMBER 7, 2016
Columbus Hilton Downtown Hotel

FUNDAMENTALS OF BATCH AND FURNACE OPERATIONS
Monday, November 5, 2018 | Noon – 5 p.m.
   Instructor: C. Philip Ross, President, Glass Industry Consulting International (GICI)
The course is an introduction to the principles of commercial glass production employed in Batch & Furnace operations by US Glass producers. Raw Materials, Glass Technology & Properties, Melting Furnaces, and Environmental Issues will all be touched upon. Suggested attendees could be vendors or newer individuals to glass manufacturing seeking an introduction to the issues faced in glass production.

COMBUSTION
Monday, November 5, 2018 | Noon – 5 p.m.
The course will review the basics of air fuel then oxy-fuel combustion and application in glass melting applications. Under-port, side-port, through-port regenerative and recuperative burners will be covered with a view to furnace optimization for energy and emissions. Finally oxy-fuel and advanced control will be discussed.

5 – 5:30 p.m.  STUDENT MEETING
5 – 11:00 p.m  HOSPITALITY SUITES AT HILTON

TUESDAY, NOVEMBER 6, 2018
8 – 8:45 a.m.  EXHIBITING
8:45 – 9 a.m.  OPENING REMARKS
   – Bob Lipetz, MBA, Conference Director, Glass Manufacturing Industry Council
   – S. K. Sundaram, Ph.D., Program Director, Inamori Professor of Materials Science and Engineering Alfred University

9 – 10:30 a.m  TECHNICAL SESSION: PLENARY
   Session Chairs: Bob Lipetz, MBA, Conference Director, Glass Manufacturing Industry Council and S. K. Sundaram, Ph.D., Program Director, Inamori Professor of Materials Science and Engineering Alfred University
   9 — 9:30 a.m.  Mathieu Hubert, PhD, Senior Development Scientist, Corning Research and Development Corporation — Challenges and Progress in Understanding Glass Melting
   9:30 — 10 a.m.  David Rue, Consultant — Cullet Supply Issues and Technologies
   10 — 10:30 a.m.  J.W. McCamy, Sr. Scientist / Group Leader Advanced Manufacturing Technologies, Vitro Flat Glass — Glass Surface Modifications for New Products in the 21st Century

10:30 – 11 a.m.  BREAK & EXHIBITING
11 – 12:30 p.m.  TECHNICAL SESSION: PLENARY
   Session Chairs: S. K. Sundaram, PhD, Program Director, Inamori Professor of Materials Science and Engineering Alfred University and James Uhlik, Director of Technical Services, Toledo Engineering Co., Inc.
   11 – 11:30 a.m.  Luke Kutilek, Research Engineer (Retired), PPG Architectural Glass — Flat Glass Manufacturing before Float — thru Archival Images of Glass Manufacturing
   11:30 a.m. – 12 p.m.  James Nordmeyer, Vice President Global Sustainability, Owens-Illinois, Inc. — Towards the Path to De-Carbonization and Legislative Challenges
   12 – 12:30 p.m.  Gerald Hunt, Flu Gas Treatment Specialist, Lhoist North America — Dry Sorbent Injection System Optimization and Cost Reduction Potential through Data Analysis

12:30 – 2 p.m.  LUNCH
12:30 – 2 p.m.  EXHIBITING
2 – 4:30 p.m.  TECHNICAL SESSION: MELTING AND COMBUSTION
   Session Chairs: Jan Schep, Global Furnace Design Discipline Leader, Owens-Illinois, Inc., Uyi Iyoha, PhD, Business Development Manager, Praxair, Inc., and Michelle Korwin-Edson, PhD, Senior Scientist, Owens Corning
   2 – 2:30 p.m.  Oscar Verheijen, Consultant, CelSian Glass & Solar BV — Glass Melt Quality Optimization by CFD Simulations in Practice
<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker/Title</th>
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<tbody>
<tr>
<td>2:30 – 3 p.m.</td>
<td>Erik Muijsenberg, H. P. H, Vice President, Glass Service, Inc. — <strong>Model Predictive Control and Monitoring of the Batch Coverage and Shape and it Effects upon the Crown Temperature. Can this be Correlated to the Overall Glass Quality and Stability in a Glass Furnace?</strong></td>
</tr>
<tr>
<td>3 – 3:30 p.m.</td>
<td>Mark D’Agostini, PhD, Senior Research Associate &amp; Manager, Combustion Technology Development, Air Products and Chemicals — <strong>Optimization of Energy Efficiency, Glass Quality and NOx Emissions in Oxy-Fuel Glass Furnaces through Advanced Oxygen Staging</strong></td>
</tr>
<tr>
<td>3:30 – 4 p.m.</td>
<td>Gaurav Kulkarni, Development Specialist, Combustion R&amp;D, Praxair, Inc. — <strong>Staged, Oxy-Fuel Wide Flame Burner to Mitigate Refractory Port Fouling and Foaming in Glass Furnaces</strong></td>
</tr>
<tr>
<td>4 – 4:30 p.m.</td>
<td>Mark Bennett, Glass Sector Lead, AMETEK Land and Neil Simpson, Combustion and Energy, Ltd. — <strong>Industry 3.9 Thermal Imaging using the Near Infrared Borescope (NIR-B)</strong></td>
</tr>
<tr>
<td>4:30 – 5:30 p.m.</td>
<td>EXHIBITING</td>
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<tr>
<td>5:30 – 7:30 p.m.</td>
<td>FREE TIME</td>
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<tr>
<td>7:30 – 11 p.m.</td>
<td>HOSPITALITY SUITES</td>
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**WEDNESDAY, NOVEMBER 7, 2018**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker/Title</th>
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<tbody>
<tr>
<td>8 – 9 a.m.</td>
<td>EXHIBITING</td>
</tr>
<tr>
<td>9 – 10:30 a.m.</td>
<td>TECHNICAL SESSION: REFRACTORIES</td>
</tr>
<tr>
<td></td>
<td>Session Chairs: Laura Lowe, Sales Representative, HarbisonWalker International and Larry McCloskey, Consultant, Anchor Hocking</td>
</tr>
<tr>
<td>9 – 9:30 a.m.</td>
<td>Stefan Postrach, PhD, Head of Technical Marketing, RHI Magnesia REFEMEX — <strong>INNOREG: Going Beyond of a Well-known Solution for Thermal Regenerators</strong></td>
</tr>
<tr>
<td>9:30 – 10 a.m.</td>
<td>Emile Lopez, R&amp;D Engineer, Manager of Customer Assistance Services in SGR Provence SEPRO — <strong>New Diagnosis Approach for Glass Furnace Post Mortem Analysis Supported by 3D Scan</strong></td>
</tr>
<tr>
<td>10 – 10:30 a.m.</td>
<td>Bryn Snow, Manager, Applications Technology, Glass Industry, HarbisonWalker International — <strong>Digitally Mapping the Future of Glass Furnaces with Lasers</strong></td>
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<tr>
<td>10:30 – 11 a.m.</td>
<td>EXHIBITING</td>
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<tr>
<td>11 a.m. – 12:30 p.m.</td>
<td>TECHNICAL SESSION: FORMING</td>
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<td>Session Chairs: Adam Polcyn, PhD, Senior Research Manager, Vitro Architectural Glass and Kenneth Bratton, Manager of R&amp;D, Bucher Emhart Glass</td>
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<tr>
<td>11 – 11:30 a.m.</td>
<td>Ruediger Nebel, Sales Manager USA, Middle and South America, Nikolas SORG GmbH &amp; Co. KG — <strong>SORG 340S+ Forehearths - Improvements and Operational Data</strong></td>
</tr>
<tr>
<td>11:30 a.m. – 12 p.m.</td>
<td>Wolf Kuhn, PhD, Senior Process &amp; Development Expert, Fives Stein — Energy Recovery with a New Type of Tin Bath Cooler</td>
</tr>
<tr>
<td>12 – 12:30 p.m.</td>
<td>Vincenzo M. Sglavo, PhD, Professor, Materials Science &amp; Technology, University of Trento — <strong>Chemical Strengthening of Silicate Glasses: Dangerous and Beneficial Impurities</strong></td>
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<tr>
<td>12:30 – 2 p.m.</td>
<td>LUNCH</td>
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<tr>
<td>12:30 – 2 p.m.</td>
<td>EXHIBITING</td>
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<tr>
<td>2 – 4 p.m.</td>
<td>TECHNICAL SESSION: ENVIRONMENT</td>
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<td>Session Chairs: Glenn Neff, Vice-President, Glass Services USA, Inc. and Phil Tucker, Senior Research Engineer, Johns Manville</td>
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<tr>
<td>2 – 2:30 p.m.</td>
<td>Frank Schuurmans, Furnace Engineer, Libbey Royal Leerdam &amp; Dr. Stefan Laux, Director of the Application Equipment Group of Research &amp; Development, Praxair — <strong>Operating Experience with the OPTIME™ Heat Recovery Technology on a Tableware Glass Furnace</strong></td>
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<tr>
<td>2 – 3:30 p.m.</td>
<td>Mike Meyer, Applications Engineering Manager, RoboVent — <strong>Mitigation Options for Respirable Crystalline Silica: Engineering Controls vs. Personal Protection</strong></td>
</tr>
<tr>
<td>3 – 3:30 p.m.</td>
<td>Stuart Hakes, Chief Executive, FIC UK, Ltd. — <strong>The Future of Glass Melting in a World Where Stringent Reductions of Carbon Dioxide and NOX, SOX Require 600 tpd All-Electric Furnaces and/or the Role of Super Boosting</strong></td>
</tr>
<tr>
<td>3:30 – 4 p.m.</td>
<td>GMIC MEMBER MEETING</td>
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<td>4 – 5 p.m.</td>
<td>EXHIBITING BREAKDOWN</td>
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**THURSDAY, NOVEMBER 8, 2018**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker/Title</th>
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<tr>
<td>8 a.m. – 4 p.m.</td>
<td>GMIC SYMPOSIUM — <strong>Asset Durability and Cost Control for Glass Manufacturing Furnaces</strong></td>
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<tr>
<td>5 – 9:30 p.m.</td>
<td>EXHIBITING BREAKDOWN</td>
</tr>
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</table>
Hilton Columbus Downtown, November 8, 2018

Description: Glass manufacturing furnaces are typically the most valuable assets in a glass plant. In today’s world, we are faced with higher demands for furnaces to be more flexible and to yield superior glass quality, while operating at ever increasing cullet percentages and production pull rates. A high level of attention and maintenance is required to provide asset durability, control cost and an optimized lifetime without sacrificing glass quality and energy efficiency.

The Asset Durability and Cost Control for Glass Manufacturing Furnaces symposium is focused on the latest technologies in the market to support efforts to increase the campaign life of glass manufacturing furnaces, while controlling costs and maintaining glass quality. It provides a forum for the audience to gain technical knowledge and exchange experiences with each other to promote efficient, safe, reliable and sustainable operations.

Audience: Glass manufacturers, Glass equipment suppliers, Design Engineers, Engineering Service providers, refractory suppliers, and construction firms.

Objectives: The participants should come away from the symposium with knowledge of developments in furnace operations and maintenance techniques and technologies for glass manufacturing furnaces.

PROGRAM COMMITTEE
- Jan Schep, Director of Corporate Engineering, Furnace Engineering & Design – O-I
- Steve Weiser, Total Systems Cost Community Leader – O-I
- Elmer Sperry, Technical Leader Furnace Operations, Glass Development – Libbey
- Keith Bagarus, Director Global Glass Automation – RoviSys
- Euan Evenson, Senior Development Associate – Praxair
- Shivakumar Kadur, Glass Melting & Furnace Technology Leader – Owens Corning
- Lance Lemings, Sr. Director of Operations – Gallo
- Chris Tournour, Sr. Melting Engineer, Thermal Processing Engineering – Corning
- Roberto Cabrera, Global Technology Director – Vitro Architectural Glass
- Glenn Aspholm, Project Manager – Johns Manville
- Bob Lipetz, MBA - Executive Director, Glass Manufacturing Industry Council

SYMPOSIUM SCHEDULE:
8 – 8:15 a.m.   WELCOME – Bob Lipetz, Glass Manufacturing Industry Council and Jan Schep, O-I

8:15 – 10:40 a.m.   SESSION I – OPERATIONS
Glenn Aspholm, Program Chair
8:15 – 8:40 a.m.   Leak Emergencies – Procedures, Training and Equipment – Angus Crane, Executive Vice President, General Counsel, NAIMA
8:40 – 8:45 a.m.   Q&A
8:45 – 9:10 a.m.   Influence of Carry Over and Prevention (Case Study) – Oscar Verheijen, Consultant, CelSian Glass & Solar B.V.
9:10 – 9:15 a.m.   Q&A
9:15 – 9:40 a.m.   Furnace Operations (Pressure Control, Operational Stability, Operational Fundamentals) – Jeff Watts, Corporate Furnace Discipline Leader, O-I
9:40 – 9:45 a.m.   Q&A
9:45 – 10:15 a.m.   BREAK
10:15 – 10:40 a.m.   Furnace Fill Procedures, Cullet, Sizing, Do’s and Don’ts – Demetrius Rankin, Glass Industry Manager, Hotwork or Jon Preneta, Sales Engineer, Hotwork
10:40 – 10:45 a.m.   Q&A
10:45 a.m. – 12:45 p.m.   SESSION II – DESIGN
Jan Schep, Program Chair
10:45 – 11:10 a.m.   Major Versus Minor Repairs: A Case Study – Brian Naveken, Furnace Design Engineer, TECO
11:10 – 11:15 a.m.   Q&A
11:15 – 11:40 a.m.   Cooling Wind Systems for Glass Melters: Design, Maintenance and Humidification – Christian Wittmann, Director Construction and Utility Department, Horn Glass Industries AG
11:40 – 11:45 a.m.   Q&A
11:45 a.m. – 12:45 p.m.   LUNCH
12:45 – 2:30 p.m.  SESSION III – MAINTENANCE
Elmer Sperry, Program Chair

12:45 – 1:10 p.m.  Hot Repairs – Glass Contact – Case Study – Roger Weilacher, President, Glass Design

1:10 – 1:15 p.m.  Q&A

1:15 – 1:40 p.m.  Hot Repairs – Melter/Regenerator Superstructure – Don Shamp, President, Fuestech

1:40 – 1:45 p.m.  Q&A

1:45 – 2:10 p.m.  Furnace Life Extension Techniques (O2 Boost, Life Extension, Pull Reduction – Neil Simpson, Consultant

2:10 – 2:15 p.m.  Q&A

2:15 – 2:30 p.m.  BREAK

2:30 – 4:30 p.m.  SESSION IV – FURNACE INSPECTION
Chris Tournour, Program Chair


2:55 – 3 p.m.  Q&A


3:25 – 3:30 p.m.  Q&A

3:30 – 3:55 p.m.  Annual Inspection Procedure – Frank Shuurmans, Batch & Furnace Engineer, Libbey, Inc.

3:55 – 4 p.m.  Q&A

4 – 4:25 p.m.  Maximizing Furnace Campaigns through Inspections, Audits, & Corrective Actions – Kevin Lievre, Manager of Engineering & Refractory Services, Fosbel, Inc.

4:25 – 4:30 p.m.  Q&A

4:30 – 4:45 p.m.  CONCLUDING REMARKS
Jan Schep, O-I

4:45 p.m.  SYMPOSIUM ENDS
An overview of cullet recycling in the US with a review of opportunities to increase cullet recycling through technical developments.

Based on the latest available data and interviews with dozens of experts in every stage of the cullet chain of custody. This report follows cullet from consumers back to the glass plants with an analysis of the challenges at each processing step. A close look is presented of ways technical challenges could be addressed to increase the two glass manufacturing industry challenges of increased cullet supply and higher quality. Appendices provide up-to-date resource information on cullet recycling.

The Glass Manufacturing Industry Council
White Paper on Cullet Utilization and Opportunities is funded entirely by GMIC and is provided to all interested parties at no charge.

TOPIC AREAS
- Glass recycling rates
- The cullet chain of custody
- Post-consumer glass
- Waste haulers
- Material Recovery Facilities (MRFs)
- Cullet suppliers
- Glass companies
- Cullet Sorting and Sensors
- Ways to increase cullet recycling
- Ways GMIC could support cullet recycling
- Alternate cullet applications

Download the white paper at:
http://gmic.org/symposia/
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Based on the latest available data and interviews with dozens of experts in every stage of the cullet chain of custody. This report follows cullet from consumers back to the glass plants with an analysis of the challenges at each processing step. A close look is presented of ways technical challenges could be addressed to increase the two glass manufacturing industry challenges of increased cullet supply and higher quality. Appendices provide updated resource information on cullet recycling.

Glass recycling rates
The cullet chain of custody
Post-consumer glass
Waste haulers
Material Recovery Facilities (MRFs)
Cullet suppliers
Glass companies
Cullet Sorting and Sensors
Ways to increase cullet recycling
Ways GMIC could support cullet recycling
Alternate cullet applications

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HOSPITALITY HOSTS

Hospitality Booth & Salon Hosts
Takes place at the Hilton Columbus Downtown

Monday, November 5 | 5 – 11 p.m.
Tuesday, November 6 | 7:30 – 11 p.m.

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FUSE TECH/HOT TECH GROUP

Emerson Burkhart B

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

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Phone: +1-419-841-9323
www.fusetech.com
GLASS SERVICE
HB200
Glass Service (GS) is a leading global consultant for glass melting/conditioning, furnace control, operation, troubleshooting, and furnace design. Mathematical modeling GFM software (design optimization) and Expert System ESIII (automated furnace and forehearth control) provide cost savings and ease of operation. GS labs analyze 2,000+ defects yearly, and offer melt testing utilizing basic and applied research. Headquarters in Czech Rep with offices in Netherlands, USA, China and Slovakia
3340 SE Federal Highway, #200, Stuart, FL 34997 USA
Phone: +1-772-287-6061
www.gsl.cz/

HARBISONWALKER INTERNATIONAL
HB11
HarbisonWalker International (HWI) provides the largest manufacturing capacity to the glass industry in North America. Over 85 years of research and development in the glass market have enabled us to pioneer innovative glass solutions. Every day around the world, our people and products stand up to the challenges and pressures of every job. Our world-class refractory products perform to the highest degree. And by bringing intensity, reliability and passion to work every day, we’re able to provide superior value to our customers and their businesses.
1305 Cherrington Parkway, Suite 100, Moon Township, PA 15108
Phone: +1-412-375-6600
http://thinkHWI.com

HENRY F. TEICHMANN, INC.
HB14, Booth #605
Since 1947, Henry F. Teichmann engineering, technical service, purchasing, construction and project management teams have been committed to providing turnkey services for batch plants, complete glass plants, electric furnaces, container glass furnaces, float glass furnaces, fiber glass furnaces, foam glass furnaces, sodium silicate furnaces, pressed glass melting services, hand glass processes, tableware and lighting products.
3009 Washington Road, McMurray, PA 15317
Phone: +1-724-941-9550
www.hft.com

HONEYWELL THERMAL SOLUTIONS
HB103
Honeywell Thermal Solutions has united the industry’s leading brands to provide the most comprehensive portfolio of burners, valves, sensors, and controls for glass applications globally. From burners to complete systems, we provide combustion solutions for every process in the glass plant.
1665 Elmwood Rd., Rockford, IL 61103, USA
www.thermalsolutions.honeywell.com

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HB205, HB207
Lilja Corp. is an assertive leader in industrial and glass furnace construction. Our managers, supervisors and craftsman are known industry wide for their high standards, performing quality work, meeting project schedules and a commitment to a safe working environment. We are a full service general engineering contractor, specializing in the construction of processing, manufacturing and warehousing facilities, glass melting furnaces and all related systems and industries. Lilja Corp. has been serving the needs of the glass industry for over 35 years with offices located in the US and Canada.
229 Rickenbacker Cr., Livermore CA 94551
Phone: +1-925-455-2300
www.liljacorp.com

MAGNECO/METREL, INC.
HB307
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 traditional refractory technology used in the glass furnace. Metpump products can be used in cold or hot applications for emergencies or scheduled maintenance for full construction, major repair, cold partial repair, hot repairs and precast, prefired, ready to use ceramic shapes.
223 W. Interstate Rd., Addison, IL 60101 USA
630-543-6660
www.magneco-metrel.com

PRAXAIR, INC.
HB204, HB206
Praxair offers a full range of industrial gases and technologies that may enable substantial fuel savings, increase your productivity, prolong your furnace campaigns, and more. Praxair’s OPTIMELT™ thermochemical regenerator system can help recover waste energy by converting fuel into hot syngas, allowing you to use 20% to 30% less fuel to melt glass compared to oxy-fuel and air-fuel furnaces. Praxair also offers OPTIFIRE™ wide flame burners. These burners generate highly luminous, wide flames that enhance heat transfer to the melt and reduce the number of burners required. The low momentum flames minimize alkali volatilization, reduce particulate emissions and reduce crown corrosion. When integrated with Praxair’s OPTIFLO₂™ vacuum pressure swing adsorption oxygen generation technology, significant savings in electricity consumption can be achieved.
10 Riverview Dr., Danbury, CT 06810, USA
Phone: 1-800-PRAXAIR
www.praxair.com/glass
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**RHI MAGNESITA**

Bellows A

RHI Magnesita is the new global leading supplier of high-grade refractory products, systems and services. With a vertically integrated supply chain, from raw materials to refractory products and full performance-based solutions, RHI Magnesita supplies to a wide range of industrial markets, including the glass industry. Our experienced and dedicated team provides commercial and technical expertise in the glass industry, ready to serve the glass producers of the world in all market segments.

3956 Virginia Avenue, Cincinnati, OH 45227 USA
Phone: +1-513-527-6178
www.rhimagnesita.com

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HB301, HB303, Booth #102

Engineering process control and information solutions for the glass industry. We offer solutions on all major platforms and technologies to meet your facility and corporate needs. From your batch house through your hot end, and in your warehouse, RoviSys has improved glass manufacturing worldwide for over 20 years.

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Phone: +1-330-995-8103
www.rovisys.com

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HB201, HB203, HB300, HB302

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Phone: +1-502-329-7605
www.sefpro.com

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Bellows E

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

1001 Madison Avenue, Toledo, Ohio 43604
Phone: 567-218-2234
www.ssoe.com

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HB305

Varo Engineers, a Salas O’Brien company, is a full service multi-discipline engineering and design consulting firm. With over 500 employee owners across the U.S. in 18 locations, we provide solutions for our partners in the heavy industrial, manufacturing, utility and power generation industries. As an ISO 9001:2015 certified company, we emphasize on continuous improvements and understand that success is measured from your point of view.

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Phone: 614-459-0424
www.varoengineers.com
ADVANCED CONTROL SOLUTIONS, INC.
Booth #401, HB105
As an integrator of advanced control system solutions, ACSI engineers are able to provide customers with quality technical engineering, system design, factory acceptance, installation supervision, commissioning services, and training. Our knowledge can be applied to Float, Fiber, Container, Tableware, Lighting, Tubing, and Specialty glass systems. Types of solutions we provide are DCS replacement, Process Mapping, Flexible Batching, Temperature Control, and Model Based Control.
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Phone: +1-419-843-4820
www.acsitoledo.com

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1625 Sharp Point Drive, Fort Collins, CO 80525
Phone: +1-970-221-0108
www.advanced-energy.com
EXHIBITORS

AIRPRO FAN & BLOWER CO.
Booth #604
AirPro Fan & Blower Company specializes in industrial fan technology. We design and manufacture fans to service process air needs for glass plants and other industrial applications. With a customer-focused approach, AirPro can help with new fan equipment, repair/refurbish of existing fans, field service, and expedited fans and/or fan parts for crisis situations and unplanned plant outages.
P.O. Box 543, Rhinelander, WI 54501
Phone: 715-365-3267
www.airprofan.com

ALLSTATES REFR ACTORY CONTRACTORS LLC
Booth #201
Allstates Refractory Contractors, LLC is a full service industrial process general contractor serving the glass, metals and petrochemical industries. We have the best safety record in our market segment and currently have three licensed safety professionals on staff to assure our customers of our commitment to a safe work environment. Our staff is highly regarded as experts in the online repair of melting and heat treatment furnaces and ovens.
P.O. Box 256, Waterville, Ohio 43566
Phone: 419-878-4691
www.allstatesrefractory.com

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Booth #606
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550 Polaris Parkway, Ste. 510, Westerville, Ohio
Phone: +1-866-721-3322
www.ceramics.org

AMERICAN GLASS RESEARCH
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603 Evans City Road Butler, PA USA 16001
Phone: +1-724-482-2163
www.americanglassresearch.com

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Phone: +1-412-826-4467
www.ametek-land.com

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As a professional fused refractory producer, we provide high-quality fused cast zircon corundum (AZS 33, 36, 41), α-β Alumina (ZC-M) & monolithics, excellent solution and prompt service for glass industry worldwide. Products are sold to over 30 countries and regions.
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Bengbu City, Anhui Province, China 233010
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www.csrazs.com

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Phone: +1-724-499-5800 | aeinc@windstream.net
Via Medaglie d’Oro della Resistenza 2-50053 EMPOLI Loc
PONTE a ELSA (FL) ITALIA
Antonini phone: +39 0571 93221
www.antoninisrl.com

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+1-724-499-5800
www.aeincglass.com
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Batch House LLC is a global, full service design/build company dedicated to the batching and material handling process of a glass plant. Our services include complete turnkey batch plants, equipment, fabrication as well as process, safety and silica audits. Our team can provide engineering, fabrication, equipment, construction, construction management and commissioning services. Services includes all disciplines, civil/structural, mechanical, process, electrical and process controls.  
5195 Hampstead Village Center Way, New Albany, OH 43054, USA  
Phone: +1 614-600-1850  
www.Batchhouse.com

**BORTON-LAWSON**  
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Borton-Lawson, a full-service, multi-disciplinary engineering firm has been providing solutions in the glass industry since 1994. Our projects have ranged in size from full furnace rebuilds to upgrades or replacements of ancillary systems. Our design and construction support services encompass all facets of engineering including civil, structural, refractory, electrical, mechanical, automation, environmental, surveying, and procurement and construction administration services. Our High-Value Process Approach and use of the latest 3D laser scanning and design technologies makes Borton-Lawson the right choice to add full-service engineering support to your project team.  
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Phone: +1-570-821-1999  
www.borton-lawson.com

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Bucher Emhart Glass is the world’s leading supplier of advanced technologies for manufacturing and inspecting glass containers. Its portfolio consists of glass-forming and inspection machinery, systems, components, spare parts, refractory, advice and services for the glass container industry. Bucher Emhart Glass uses its innovative strength to ensure that glass remains the ideal packaging material for food, beverages, cosmetics and pharmaceutical products. Bucher Emhart Glass refractory products are supplied to a wide variety of glass industries, including the glass container fiberglass, pressed ware, stemware, hand glass, and specialty glass industries. With its long history of quality and craftsmanship, Bucher Emhart Glass refractories are preferred by glass manufacturers throughout the world.  
Emhart Glass SA, Hinterbergstr. 22, 6330 Cham, Switzerland  
+1-573-437-2132  
www.buchereemhartglass.com

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As a global supplier of high-calcium and dolomitic lime and limestone, Carmeuse Lime & Stone, provides customers with high purity magnesium and calcium products with consistent chemistry and controlled sizing to better assist them in the manufacture of glass and fiberglass. With over 150 years in the industry, our reputation has been built on our quality products, dependable customer support, reliable logistics support and our unrivaled level of technical service.  
11 Stanwix Street, Pittsburgh, PA 15220, USA  
Phone: +1-866-780-0974  
www.carmeusena.com

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USA Approved Representative: Argent Enterprises Inc  
Phone: +1-724-499-5800 | aeinc@windstream.net  
521 North Plum Street Albany IN 47320, USA  
Phone: 1-765-321-2011  
www.partforlehrs.com

**CELSIAN GLASS & SOLAR BV**  
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CelSian Glass & Solar B.V. is a technology and knowledge provider to the glass & solar market. Our products and services aim to deliver value to the glass manufacturing chain in the areas of:  
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• Process optimization  
• Knowledge transfer  

Zwaanstraat 1, Building TZ, Eindhoven, noord brabant 5651 CA, Netherlands  
+31 40 2490100  
www.celsian.nl
EXHIBITORS

CEMTEK KVB-ENERTEC
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Cemtek KVB-Enertec provides a single source for reliable, accurate, and cost effective emissions monitoring for compliance and process improvement. We specialize in CEMS design, integration, field services and spare parts. Cemtek’s experience includes all Source and Ambient sections of 40 CFR Part 50, 51, 60, 63 and 75 monitoring and reporting requirements. Please contact us at 800-400-0200 for a quote on CEMS equipment, CEMS field service or CEMS parts. 3041 S. Orange Avenue, Santa Ana, CA 92707
Phone: 714-437-7100
www.cemteks.com

CHIZ BROS. REFRACTORY AND INSULATION SPECIALISTS
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Chiz Bros. offers a wide range of stock and custom refractory and insulation products to meet standard and customized customer needs. As a Unifrax Distributor, our warehouse is fully-stocked with ceramic fiber blankets, board, paper, ropes and modules. In the glass industry, Chiz Bros specializes in insulation board and blanket back up, as well as a full range of Silica based products. In addition Chiz Bros can help with fabricated insulation panels and heat shields.
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Phone: 412-384-5220
www.chizbros.com

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Design and manufacture of standard and custom laboratory and “big batch” scale electric glass melt furnaces for glass R&D and specialty glass producers around the world. 40+ years of experience in this field. An ISO 9001:2015 certified company. Control systems are Intertek certified UL508A compliant.
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Phone: +1-303-433-5939
www.deltechfurnaces.com

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Dustex® is a global supplier of air pollution control (APC) solutions. Our experienced staff designs engineered systems, under the Dustex® and Geoenergy® brands, that control Particulate Matter, Heavy Metals, Acid Gases, and NOx. Our technologies for the glass industry include: High Temperature Pulse-Jet Filters utilizing Ceramic or Catalytic Filter Elements, Dry Sorbent Injection (DSI) Systems, Wet Electrostatic Precipitators (ESPs), Regenerative Thermal Oxidizers (RTOs), and SNCR systems.
60 Chastain Center Blvd. NW, Suite 60, Kennesaw, GA 30144 USA
Phone: +1 770-429-5575
www.dustex.com/
EXHIBITORS

EDWARD ORTON JR. CERAMIC FOUNDATION, THE
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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.
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Phone: +1-614-895-2663
www.ortonceramic.com

EUROTHERM BY SCHNEIDER ELECTRIC
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Eurotherm by Schneider Electric is a global manufacturer of instrumentation, automation systems, and services designed for the efficient operation of industrial processes. Since 1965 the Eurotherm brand has provided specialized process and power control solutions for the glass industry, which in combination with Schneider Electric portfolio offer a one-stop automation and power shop for glass manufacturers. Learn more about our EPower™ Controller and EPack™ compact SCR power controller ranges.
44621 Guilford Drive. Suite 100 Ashburn, Virginia 20147 US
Phone: 703-724-7300
www.eurotherm.com/glassproblems

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F.I.C. is the leading technology supplier in melting and conditioning of ultra, high quality glass. With proven designs of all sizes of electric furnaces and electro-boost systems, we have extensive experience in the TFT and cover glass markets as well as float glass, 'E' glass fibre and all specialist glasses such as borosilicate, high alumina and zero alkali glasses. We can supply all types of electrodes including tin oxide and molybdenum and associated holders and electrical connection systems. Our High ‘Q’ holder has a removable waterway and our Maxi ‘Q’ holder is designed to operate continuously in molten glass above 1600°C and are ideal for top electrode systems as well as on-the-run replacement for competitors failed holders.
Longrock Industrial Estate, Penzance, Cornwall, TR20 8HX UK
Phone: +44 (0) 1736366962
www.fic-uk.com

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Fives Stein Limited is a leading supplier of engineering solutions for high quality melting and thermal conditioning for all types of glass. We design, manufacture, install, commission and service glass plant and equipment tailored to your specific needs.
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We are part of the Fives, an industrial engineering group, who design and supply machines, process equipment and production lines for the world’s largest industrial groups. The group has over 8,300 employees worldwide and an annual turnover in excess of $2 billion.
4A Churchward, Southmead Park, Didcot, Oxon, OX11 7HB, UK
Phone: +44 1235 811 111
http://Glass.fivesgroup.com

GEA GROUP
Booth #211
GEA offers a variety of integrated designs and technologies for glass furnace emissions. We take a plant-specific approach to custom design the optimal solution for each particular site. With decades of experience across several industries, we utilize various filtration techniques for particulate removal and dust transport. For SO2 and other acid gases, GEA provides several scrubbing techniques using a variety of configurations and reagents. NOx removal can be provided in conjunction with particulate removal, with the flexibility to increase removal rates for future considerations if desired.
9165 Rumsey Road, Columbia, MD 21045
Phone: +1-410-997-8700
www.gea.com

GLASS MANUFACTURING INDUSTRY COUNCIL (GMIC)
Registration Area
GMIC is a trade association of the glass industry that includes among its members, representatives of all four sectors: Flat, Container, Fiber and Specialty Glass Companies as well as leading suppliers to the industry, research institutes and industry experts. Our goal is to promote the interests and growth of the glass industry.
550 Polaris Parkway, Suite 510, Westerville, OH 43082
Phone: +1-614-523-3033
www.gmic.org
EXHIBITORS

GLASSWORKS HOUNSELL
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+44 1384560666
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17629 El Camino Real, Suite 300, Houston, TX 77058, USA
Phone: +1-281-228-5161
www.topsoe.com

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Henan Reftech Industrial Co., Ltd. (Hereafter abbreviated as Reftech) is a high-tech company integrated with research and sale of super quality refractories, and providing group services to oxy-fuel glass furnaces as its core business. The company is located in the refractories production center of China — Xinmi, Henan province.
No. 1 Jinghua Road, Xinmi City, Henan Province, China 452385
Phone: 0086 13525926953
www.reftech.vip

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

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Phone: +1-708-849-1000
www.hollandmanufacturing.com

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Phone: +1-724-452-5252  
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Phone: 1-610-648-8014  
https://matthey.com/markets/glass

**LAHTI GLASS TECHNOLOGY OY**  
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- Container and tableware glass  
- Insulation and reinforcement fiberglass  
- Solar glass / low iron glass  
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- Complete batch plants and cullet systems

**L.G.P. INTERNATIONAL, LLC**  
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5041 Payne Ave., Dearborn, MI 48126  
Phone: +1-248-444-2289  
glass-properties-lab.com

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Phone: +1-800-365-6724  
www.lhoist.us

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Phone: 330-405-3040  
www.ljstar.com
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Longwall Services Inc. manufactures and supplies products for the glass industry including:
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• Glass/Bottle Breakers
• Bottle Sinkers
• SMART Brush Belt Cleaners
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The 80th GPC will be October 28-31, 2019 at the Greater Columbus Convention Center in Columbus, Ohio. Deadline for submission of abstracts is January 24, 2019
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**Industry 3.9 Thermal Imaging using the Near Infrared Borescope (NIR-B)**

AMETEK Land design and manufacture infrared temperature measurement instrumentation. Our current product range for glass melt tanks is based on the Near Infrared Borescope (NIR-B) thermal imaging camera.

With over 100,000 continuous temperature measurements the NIR-B offers huge potential for data capture. This paper discusses the interpretation and management of that data required for full Industry 4.0 standards of quality, control and autonomous operation.

Recent field data are presented and reviewed to demonstrate the ability to optimize operations. We find that in practice (as in theory) the batch really does want to go where it is colder. While the longitudinal thermal profile remains the most critical in terms of pull, yield and energy, the NIR-B also offers ability to easily review the transverse thermal profile which is critical in oxy-fuel furnace applications. With real-time image interpretation and integration into a control system it is possible to create immediate deviation alarms when the hot spot moves from the theoretical position to optimize product quality.

As a further level of operational improvement, the NIR-B offers the potential to identify areas of high NOx production. This can be displayed visually using a special ‘NOx palette’ in the thermal imaging software, or it can be detected automatically and signaled to the control system. While maintaining the production of high quality glass, NOx emissions can be optimized by controlling the peak flame intensity with benefits to both environment and operational efficiency.

Mark D. D’Agostini, PhD, Senior Research Associate and Manager, Combustion Technology Development | Air Products and Chemicals, Inc.; William J. Horan, Lead Commercial Technology Engineer, Glass Applications | Air Products and Chemicals, Inc.

**Optimization of Energy Efficiency, Glass Quality and NOx Emissions in Oxy-Fuel Glass Furnaces through Advanced Oxygen Staging**

Oxygen staging is a recognized technique for adjusting oxy-fuel flame properties by delaying introduction of a portion of the combustion oxygen into the burner flame as it discharges into the furnace. While benefits such as increase of flame length and luminosity, and reduction of NOx emissions can be achieved through oxygen staging, reduction in flame momentum and inefficiencies in fuel / oxygen mixing have historically been problematic when attempting to extend the proportion of staged oxygen above about 70% of the stoichiometric oxygen requirement. Recent advancements in fuel and oxygen mixing control by an Air Products research team have, however, led to the development of a new burner technology, Cleanfire® HRx,™ capable of staging nearly 100% of the burner oxygen while maintaining flame momentum and preserving optimal fuel / oxygen mixing. Results of several recent commercial installations of the HRx burner have indeed verified the ability to attain higher melting efficiency, lower NOx emissions and greater flame length control than prior art staged oxy-fuel burners, while also reducing foam formation, thereby leading to more efficient removal of glass defects in the refining section of the melter. Operational properties of the HRx burner are introduced, and commercial demonstration results are presented.

Mark D. D’Agostini, PhD, Senior Research Associate and Manager, Combustion Technology Development | Air Products and Chemicals, Inc.; William J. Horan, Lead Commercial Technology Engineer, Glass Applications | Air Products and Chemicals, Inc.

**Optimization of Energy Efficiency, Glass Quality and NOx Emissions in Oxy-Fuel Glass Furnaces through Advanced Oxygen Staging**

The quality of a glass melting process is determined by the melting-in performance, the sand grain dissolution and the removal of gas bubbles by fining. For a good quality it is essential that each trajectory/path starting from batch charging to the throat or waist of the tank shows complete melting and fining. Each part of the glass melt, ending in the product, should be exposed during sufficiently long time to a temperature for good fining.

The fining onset temperature and melting performance for an industrial glass depends on the batch composition, sand grain size, type and amount of fining agent, furnace atmosphere and the redox number of the batch. Laboratory experiments are carried out to determine the most important parameters at industry-near conditions for industrial batches.

We have shown in previous presentations how the software works, and what information it uses. Most important is the fact that these techniques are used by glass producers to optimize the daily process and support the operators in the plant. In this presentation feedback is given from users in the field, on how the software was used for troubleshooting in a running plant. One industrial application example for float glass furnace will be presented and discussed.

Stuart, Hakes, Chief Executive | FIC UK, Ltd

**The Future of Glass Melting in a World Where Stringent Reductions of Carbon Dioxide and NOX, SOX Require 600 tpd All-Electric Furnaces and/or the Role of Super Boosting**

The paper will briefly review the drivers pushing the glass industry to reduce the level of emissions from the furnace and how we can achieve below the best current fuel efficiency levels of the best furnaces. In particular the paper will examine how we might achieve below 3.0 Gi/tonne (2.58 MMBTU/ US ton) with the use of super-boosting and/or all-electric furnaces capable of mainstream tonnages in the range of 300 – 600 tonnes per day. The paper will review where we have come from and examine the various different technologies and assess their viability. Electric melting could allow the industry to reduce the carbon dioxide by 80% if the electricity is generated by renewable sources as is increasingly likely based on the experience in Europe and elsewhere.

Mathieu Hubert, PhD, Senior Development Scientist | Corning Research and Development Corporation; Irene Peterson, PhD, Senior Research Associate | Corning, Incorporated

**Challenges and Progresses in Understanding Glass Melting**

Improving glass melting and the batch-to-melt conversion have been a challenge ever since glass has been produced by mankind. Understanding the impact of the choice of raw materials (composition, grain size distribution, purity, etc...), melting temperatures and atmosphere is of critical importance for industry in order to produce glass products with good quality in the most efficient way (both in terms of energy and environmental footprint). In the past years, and with the improvement of analytical techniques available,
important progress has been made in the understanding of batch-to-melt kinetics. In this paper, recent developments in the field will be presented, and the gaps remaining will be discussed.

Gerald Hunt, Flue Gas Treatment Specialist | Lhoist North America; Melissa Sewell, Ste Genevieve, Plant Manager | Lhoist North America; Ian Saratovsky, PhD, Director Flue Gas Treatment Solutions | Lhoist North America

Dry Sorbent Injection System Optimization and Cost Reduction Potential through Data Analysis

Dry sorbent injection (DSI) technology is low capital cost acid gas (SO2, HCl, SO3/H2SO4) control technology that is extensively utilized in the power industry as well as a multitude of industrial plants due to new and increasingly more stringent emissions regulations. While some glass manufacturing facilities plan to or are currently installing a DSI system, several glass production facilities have been operating a DSI system for a few years.

Following the DSI system installation and commissioning, long term DSI performance data collection and analysis often receives less attention. However, on-going collection and analysis of DSI performance data often identifies opportunities to optimize DSI performance (i.e. reduce sorbent consumption), identify correlations between operational variations and DSI performance/SO2 emission profile or simply verify that the DSI system is performing as expected. This paper will highlight DSI case studies that demonstrate the benefits of routine DSI data analysis and how they can result in improved cost effectiveness and reduced potential of a failed compliance test.

Wolf Kuhn, PhD, Senior Process & Development Expert | Fives Stein

Energy Recovery with a New Type of Tin Bath Cooler

The cooling of a float ribbon in a tin bath requires the extraction of a significant amount of energy. This energy is evacuated by the wall losses and overhead coolers. On a 800 tpd float line, a total amount of 5.5 MW has to be extracted from the ribbon in the tin bath. The overhead coolers at the bath entrance and the narrower end section contribute with about 1.5MW. Conventionally, water is used as heat transfer fluid in the coolers which has important consequences. The increase of the water temperature has to stay limited to avoid the creation of vapor pockets. This makes a recovery of the cooling energy very difficult. Furthermore, the external temperature of the steel coolers remains quite low which triggers condensation of the volatile species in the tin bath atmosphere. The up built of condensation layers causes a drift in the cooling rate. Frequent cleaning of the coolers is required to avoid defects on the ribbon by dropping condensates.

A new type of overhead cooler will be presented that overcomes the condensation problem and allows recovering the cooling energy of the ribbon at a higher fluid temperature. As heat transfer fluid, air was chosen but other gases could be used. The design of the coolers guarantees a homogeneous cooling over the width of the ribbon. Moreover, the cooling rate can be adjusted by the flow rate of the air. The cooling power is equivalent to the conventional water coolers but the cooling air is recovered at a temperature of 200-300°C. This opens the gate for energy recovery by different methods. Electricity generation by ORC, addition of the preheated air to the combustion air and preheating of the combustion gas are discussed. Even if only 50% of the 1.5MW of cooling energy are recovered by the tank combustion, a reduction of 1.5% of the energy consumption is achieved. Further advantages of the new type of cooler are given by its stable, adjustable cooling rates and the absence of condensation on its surface.

Gaurav Kulkami, Development Specialist, Combustion R&D | Praxair, Inc.; Uyi Iyoha, PhD, Director, Business Development & Strategic Accounts | Praxair, Inc.; Patrick Diggins, Business Development Manager | Praxair, Inc.; Shrikar Chakravarti, PhD, Associate Director, Technology Commercialization | Praxair, Inc.; Gregory J. Panuccio, R&D Development Associate | Praxair, Inc.; Arthur Francis, R&D Development Associate | Praxair, Inc.

Staged Oxy Fuel Wide Flame Burner to Mitigate Refractory Port Fouling and Foaming in Glass Furnaces

Staged oxy-fuel combustion is widely applied in glass furnaces to reduce NOx emissions. In staged combustion, fuel and primary oxygen are introduced into the combustion zone in a sub-stoichiometric ratio to produce a fuel rich flame, which is fully combusted with separately injected secondary oxygen. As part of the OPTIFIRE™ burner platform, Praxair has developed and deployed several staged oxy-fuel burners in commercial glass furnaces. One of the recent offerings, the Gen III Wide Flame Burner, brings several benefits including the following:

- Highly luminous flame which enhances heat transfer to glass melt,
- Low momentum flame which reduces particulate emissions and crown corrosion,
- Wide flame pattern resulting in fewer burners per unit area of melter
- Light weight design, and
- “Quick-release” feature for easy installation and removal of the metallic burner insert

Some glass furnaces operate under more severe conditions which can reduce productivity, increase burner maintenance costs, and decrease burner lifetimes. For example, staged oxy-fuel combustion can prove to be difficult to operate in furnaces with high concentrations of glass volatiles. In such furnaces, the burners can experience rapid buildup of condensate on the O2 ports which can cause plugging of the ports and/or corrosion of the burner refractory hot face. Eventually, this buildup can get to a point where no gas flows through the ports and manually dislodging it could also cause severe damage to the hot face.

It has also been observed that oxy-fuel glass furnaces typically experience more foaming than conventional air-fuel furnaces. Foam can build up rapidly in the refining zone due to minor upsets in operating conditions. During such an event, the dissipation of foam bubbles could be hindered by the oxygen rich atmosphere over the glass surface that is created by the staged combustion burners.

This paper discusses burner enhancements and novel configurations developed to address the aforementioned operational issues of staged burners in oxy-fuel furnaces. A newly developed variant of the Wide Flame Burner designed to mitigate condensate buildup and prevent refractory port fouling is discussed, along with a way
to leverage the “quick-release” feature of the Gen III Wide Flame Burner to create a reducing atmosphere over the glass surface to aid in rapid reduction of the foam layer. Results from tests at commercial glass furnaces are presented.

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**Luke Kutilek**, Research Engineer (Retired) | PPG Architectural Glass

**Flat Glass Manufacturing before Float – thru Archival Images of Glass Manufacturing**

Flat glass manufacturing before the Float process is surveyed through archival images of glass manufacturing. This photographic study covers the following glassmaking methods:

- Hand-blown Cylinder Glass (1850-1925)
- Machine-drawn Cylinder Glass (1910-1935)
- Vertically-drawn Sheet Glass (1910-1983)
- Plate Glass Cast from Pots (1850-1945)
- Continuous Rolled Plate Glass (1922-1968)
- Twin-Grinding of Plate Glass (1945-1968)

All of these glassmaking techniques were ultimately replaced by the Float Glass process.

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**Emile Lopez**, Sefpro R&D Engineer | Saint Gobain CREE; **Jean Gael Vuillermet**, Sefpro R&D Engineer | Saint Gobain CREE; **Michel Gaubil**, PhD, Senior Scientist Sefpro Glass Refactory Expert | Saint Gobain CREE

**New Diagnosis Approach for Glass Furnace Post Mortem Analysis Supported by 3D Scan**

In glass industry, post mortem glass furnace analysis is always a particular time to examine corrosion profile, corrosion process and to make a link with glass furnace life event. The use of 3D scan and all the information that can be derived and calculated from raw data Scan is a significant source of information; Sefpro R&D team developed methodology for data analysis such as corrosion profile on global view but also at individual block scale that provide precise information for glassmaker. We will discuss this based on industrial case. Moreover, on top of that, post mortem refractory corrosion analyses give precious complementary information to understand the final refractory shape. Chemistry, crystallographic and microstructure evolution of refractory material would indicate the way they have been corroded and point out some possible sources (such as raw material, fuel, temperature level ...) that occurred during furnace life. Practical case will be discussed. Finally, all these information help to improve refractory choice and allow glass furnace design improvement for next campaign.

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**Mike Meyer**, Applications Engineering Manager | RoboVent

**Mitigation Options for Respirable Crystalline Silica: Engineering Controls vs. Personal Protection**

OSHA’s new permissible exposure limits for respirable crystalline silica take effect in June 2018. For many companies in the glass and ceramics industry, compliance with the new rule will require new methods of mitigation. This session will explore mitigation options for silica-containing dusts, including engineering and environmental controls and personal protection. Topics will include:

- An overview of the new OSHA rule and common silica dust-producing processes
- How to measure air quality and determine exposure levels
- The “do’s and don’ts” of handling silica-containing dust, including facility cleaning and disposal guidelines
- A discussion of engineering control vs. Personal Protective Equipment (PPE), and when to use each
- Engineering control options, including source capture and ambient systems, and how to match them to processes
- System design considerations for maximum effectiveness and energy efficiency
- Considerations in selecting and using PPE for silica dust-producing processes
- Putting together a comprehensive mitigation strategy for respirable crystalline silica dust

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**Model Predictive Control and monitoring of the Batch Coverage and Shape and It Effects upon the Crown Temperature. Can this be correlated to the Overall Glass Quality and Stability in a Glass Furnace?**

Glass Service, a.s. (GS), has added to its Model Predictive Control (MPC) toolbox that is a Proprietary Software to monitor the batch coverage within a melter which will correlate this image to the control of the melter to improve the furnace stability and glass quality. Further steps include the GS MPC control of the batch charging and the combustion process using the MPC.

The new GS Expert System Software ES 4.0 uses high resolution cameras with infra-red capabilities to give us an automatic batch analysis and smart software to interpret the batch coverage. The batch coverage is modeled together with the other multi-input and multi-output process variables that can become a more thorough control option to increase the furnace stability and to improve glass quality. The GS Expert System can correlate this automatic batch coverage analysis with the crown temperature changes by the Infrared Image Analysis into the ES 4.0 control.

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**Ruediger Nebel** Sales Manager, USA, Middle and South America | Nikolas Sorg GmbH & Co. KG; **Juergen Groessler**, Manager Glass Conditioning Department | Nikolas Sorg GmbH & Co. KG

**SORG 340S+ Forehearths – Improvements and Operational Data**

This paper will present and highlight recent improvements made to the SORG 340S forehearth. This is a system that has been successfully implemented 270 times to date and is a standard for mass produced glass containers around the globe.

The new 340S+ is a further development to meet even more stringent customer glass conditioning demands.

Improvements are not limited to operations. The system has been redesigned for easier construction and heatup. This is made possible through modifications to the superstructure and steel bracing.
that allow for installation savings.

A new cooling design allows us to reduce the number of fans thus lowering operating and investment costs.

In addition to the currently available options, the 340S+ superstructure allows for optional top electrodes in the equalizing section which can be installed and removed on the fly. This offers more flexibility and higher homogeneity when melting colored glass. This also eliminates the need for having sidewall electrodes in the glass during the entire campaign when they are only needed occasionally. The most recent operational results will be presented as well.

James Nordmeyer, Vice President Global Sustainability | O-I

Towards the Path to De-Carbonization and Legislative Challenges

Abstract not submitted by Author

Stefan Postrach, PhD, Vice President Marketing – Process Industries | RHI Magnesita, Elias Carrillo, PhD, Technical Marketing Manager – Glass | RHI Magnesita

INNOREG: Going Beyond of a Well-known Solution for Thermal Regenerators

Today the expectation from a Glass Furnace Regenerator is optimal performance while balancing between capital building costs, energy savings, and maximum campaign life. Most glass producers rely on well-known and proven checker shapes and arrangements, yet there remains the question whether regenerator checker brick design has reached a dead end. Fluted wall checker bricks are known to have potential for improving pack efficiencies. RHI Magnesita has adapted this concept and improved the checker shape by increasing the specific heat transfer area for the upper checkers of the regenerator. Furthermore, the lower checkers have been improved by increasing the flue size to limit the inherent fouling resulting from alkali sulfate condensates. These new shapes used together in the correct zones of the regenerator are an essential part of the newly developed INNOREG concept intended to improve the performance of the regenerator.

To validate this concept a new semi-analytical approach is taken to tackle the solution of the equations governing the regenerative heat exchange. An algorithm using analytical expression solutions together with border values and initial regenerator conditions enable recurrence equations to be used in the calculation of brick and gas temperatures. This algorithm is implemented in standard software. This approach allows the furnace designer to easily compare the thermal performance of regenerator layouts by changing design parameters including regenerator geometry, checker brick shape formats, and also to assist in the location of the partition of a checker pack in suitable refractory grades for the different zones. Using this computing tool, RHIM has managed to compare the thermal behavior of existing regenerator concepts currently used in market to the new concept. The results show that the new RHIM layout is as efficient as or better than known designs, despite limiting the use the high thermal performance brick to above the liquid alkali sulfate condensation temperature and the use of the larger flue size checker brick in lower parts of the checker to minimize the plugging.

David M. Rue, Consultant | Chicago, Illinois USA

Cullet Supply Issues and Technologies

Post-consumer glass, or cullet, is fully recyclable, but inefficiencies in each step of the chain of custody decrease the fraction of glass returned to glass manufacturers. In the recycling process, cullet passes from consumers to waste haulers, then to material recovery facilities (MRFs), next to glass recyclers, and finally back to glass companies. Different economic and social drivers impact the fraction of glass recovered in each link in the chain of custody. In recent years, the fraction of glass recycled in the United States has been stagnant. Higher cullet recycling rates will require decreasing the amount of glass sent to landfills, improving cullet quality, making more marketable cullet available, and supplying cullet at competitive prices. Equipment improvements at MRFs are critical in segregating more of the glass from the waste stream and generating a cleaner cullet stream. Glass recyclers accept cullet from the MRFs and use a variety of sorters, dryers, sensors, and automation systems to distribute cullet into multiple streams that meet glass manufacturer requirements. Magnetism, eddy currents, x-ray fluorescence (XRF), density, particle size, visible light, hyperspectral imagining, and other techniques are employed to meet specifications. Continuous improvement is needed in automation and diagnostics, faster and more accurate sensors, on-line sensors, and advanced quality assurance protocols to supply cullet at ever higher quality standards at market-driven prices. These advancements are needed to increase the fraction of post-consumer cullet recycle and to satisfy the two drivers of cullet recycle, lower costs and higher quality.

Frank Schuurmans, Batch & Furnace Engineer | Libbey, Inc.; Stefan Laux, PhD, Director R&D | Praxair, Inc.; Elmer Sperry, Global Lead Furnace Design | Libbey, Inc.; Sho Kobayashi, PhD, Corporate Fellow | Praxair, Inc.

Operating Experience with the OPTIMELT™ Heat Recovery Technology on a Tableware Glass Furnace

Following successful commercialization of Praxair’s OPTIMELT™ regenerative Thermo-Chemical Regenerator (TCR) system on a 50 tpd container glass furnace in Mexico, the TCR system has been in commercial operation on an oxy-fuel fired tableware glass furnace at Libbey Leerdam in The Netherlands since November 2017. This paper will briefly introduce the implementation of the TCR heat recovery system at Libbey Leerdam and review the engineering design and integration with the oxy-fuel furnace. The operational experience, performance, and glass quality results from the first year of TCR operation will be summarized and compared to the results of the conventional oxy-fuel furnace without the TCR. Preliminary results show significant fuel savings when the TCR system is in use.
Chemical Strengthening of Silicate Glasses: Dangerous and Beneficial Impurities

Ion-exchange process has gained remarkable interest during the last years for chemical strengthening silicate glasses because of its suitability and flexibility in the reinforcement of components with different geometry and thickness. During a typical industrial process, sodium atoms contained in the glass are substituted by potassium ions diffusing from molten potassium nitrate at temperatures below the strain point of the glass, thus creating a bi-axial residual compressive stress in the material surface which strengthens the component. Several variables like glass composition, molten bath composition, temperature and time can affect the efficiency of the ion-exchange process. An interesting aspect regards the presence of impurities in the bath, introduced with the raw salt or accumulated during the process, rarely considered in the past at least from a scientific or technological point of view as responsible for the resulting chemical, physical and mechanical performance. The problem stated here is of direct industrial significance since the strengthening is strictly related to the efficiency of the ion-exchange process.

In this work commercial soda lime silicate float glass and sodium borosilicate glass were considered and the effect of variable sodium, magnesium and calcium concentration in the molten bath on the efficiency of the ion exchange process was analyzed. Commercial potassium nitrate salts from different sources were also considered. The chemically strengthened samples were characterized in terms of potassium penetration profile, residual stress and mechanical strength. The addition of limited quantities of silica was also studied as possible remedial action for non-efficient salts.

Digitally Mapping the Future of Glass Furnaces with Lasers

Throughout history, some of the best solutions that have been introduced to the Glass Melting operations have come from other industries. It is in the heritage of refractory users to learn from what has worked for others. The readily used materials such as magnesite and silica were actually first used in steel melting applications. The installation of castables and shotcretes were first used in other industries as well before being introduced into glass. The Glass Industry has also set the stage in refractory technologies such as the development of Fused Cast Refractories which are now used as solutions to severe applications in the steel industry. Some influences even come from outside the industry, such as High Emissivity Coatings from NASA technology developments. Now the newest technology available in laser mapping of refractory linings is finding applications in the Steel market in the measurement of the residual thickness and contours of refractory linings. This is becoming standard practice in transfer ladle and furnace applications. The technology of scanning accuracy in lasers has progressed at a staggering rate since the initial introduction in 1975 and its integration with process data points can yield a better understanding of refractory wear over time, make process improvements, and could even be utilized to evaluate new materials. This evaluation of the technology as it applies to high temperature applications will discuss the opportunity for glass makers to gain a deeper understanding of their operations and their refractories performance.

Continuously Measuring CO and O2 to Optimize the Combustion Process

Current glass furnaces are equipped with only point measurement oxygen sensors in the flue gas channels or are not equipped with any sensor measuring the flue gas composition at all. Though, only by measuring both CO and O2 the completeness of the combustion process can be determined without having a too high oxygen/air excess and avoid excessive NOx formation. To anticipate on more stringent legislations on energy consumption and emission levels CelSian developed a sensor to be able to optimize the combustion efficiency in the furnace.

Requirements for the sensor are withstanding the harsh conditions of the flue gas, measuring values of the concentrations of CO and O2 being representative for the average combustion process, be fast and sensitive and needing limited interference for maintenance.

The developed sensor was tested at one of the Ardagh glass plants in The Netherlands. By tuning the burner settings and oxygen/fuel ratio the optimal combustion settings were found by having some CO (1000 ppm) in the flue gas channel without compromising furnace lifetime by increasing refractory corrosion. The energy consumption decreased about 2%. At the same time the savings on oxygen were around 2% as well. Additional side effect was a decrease in NOx emission by operating closer to the stoichiometric conditions.

The sensor is now installed already at 10 locations with different glass and furnace types.
MEASURING TEMPERATURE TO IMPROVE PRODUCT QUALITY AND PROCESS CONTROL THROUGHOUT THE GLASS MAKING PROCESS

Introducing AMETEK Land’s new innovation for the glass industry: an enhanced thermal imaging Near Infrared Borescope (NIR-B) with a pneumatic auto-retract system designed specifically for use in glass-melt tanks.

The NIR-B Glass is a short wavelength radiometric infrared borescope imaging camera, designed to produce high definition (656 x 494 pixel) thermal images, along with providing accurate temperature measurements from any selected points in the image.

The camera measures temperatures in the range 1000 to 1800 °C (1832 to 3272 °F) and is suitable for float glass, container glass, borosilicate glass and fibre glass melt furnaces.

The auto-retract system is designed to auto-retract and protect the thermal imager from damage by overheating in the event of loss of water flow, air pressure, electricity supply or high borescope tip temperature alarm. The system has an air reservoir (accumulator) to ensure full retraction in the event of loss of air.

PROVEN APPLICATIONS OVER A 70 YEAR HISTORY IN THE GLASS INDUSTRY

FEATURES & BENEFITS

- High temperature measurement accuracy - enables optimum process control through enhanced thermal imaging
- Short wavelength sensor - low sensitivity to emissivity changes
- Dedicated software - data points, areas of interest, automated alarms and long term data trending and system inter-connectivity (DCS, OPC)
- Real time thermal data combined with high resolution visual image - allows true real time batch control, flame optimisation and the opportunity to improve energy efficiency without degrading refractory lifetime
- 24 Hour, 7 Day Monitoring - Shutterless operation guarantees accurate, reliable data with no blind time

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Improving combustion can enable you to increase glass production, reduce fuel consumption, enhance glass quality, and reduce emissions, such as NOₓ, SOₓ, CO₂, and particulates. Let Air Products’ in-house modeling and melting experts help you get there.

For more than 70 years, we’ve delivered safe oxygen solutions, from our very first oxygen enrichment applications to our continuously evolving portfolio of low-emissions Cleanfire® oxy-fuel burners. You can count on Air Products for reliable gas supply and to help optimize your production—just like we have done for hundreds of furnaces all over the world.

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