Innovations of Glass Melting Methods in USA

Glassman Europe
13 May 2009

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Executive Director
Outline

- Structure of GMIC
- Melting Technologies
- Additional Direction
  - Waste Heat Recover
  - Alternative Energy Sources
GMIC Membership

- Four Glass Categories (20) (2007 – International)
  - Container
  - Flat Glass
  - Fiberglass (Insulation and Textile)
  - Specialty
- Associate Members (22)
- University (11)
- Affiliate (13)
  - Individuals, Consultants, Small Research Groups
Submerged Combustion Melter

- **Primary Features**
  - Metal Box – Watercooled Walls
  - Oxy-Fuel Burners
    - Low Capital Cost
    - (-60%)
  - Low Footprint
    - (6-8 X Pull Rate for equivalent area)
  - High Efficiency, Low Emissions
    - (20% more efficient)
    - High Flexibility
      - 4 hours hot to cold or cold to hot
  - New products, markets, business models
    - IMM – first commercial Application
    - Water Glass

- Work on Refining project
SCM – Pilot Melter
Submerged Combustion Melter

1- Batch charger;
2- Refractory lining;
3- Water cooled panels;
4- Melting zone;
5- Exhaust;
6- Melt outlet;
7- Submerged oxygas burners;
8- Batch material (sloped pocket of batch)
Cross-Cutting Applications

- Steel Industry – Electric Arc Furnace Dust
- Aluminum – Spent Aluminum Potliner
- Forest Products – Black Liquor Gasification
- Cement – Blended and Specialty Cements
- Chemicals – Sodium Silicate
- Waste Vitrification – Portable – Move to location
- Mineral Wool – Original Application
- Nuclear Waste Stabilization – Increase Cost-Effectiveness
Indiana Melting and Manufacturing, LaPorte, IN
Melter Sidewall
Additional Innovative Research Projects

➢ Oxy-Fuel Front End
Development/Demonstration of Advanced Oxy-Fuel Front End
Additional Innovative Research Projects

- Oxy-Fuel Front End
  - Fewer Burners
  - 61% Reduction in Total Energy Usage
  - 64% Reduction in CO2 Emissions
  - No Adverse Impact on Productivity
Proposed CGM Project

- Linde proposal – seeking partners
- Benefits of CGM combined with SCM
- Segmented design:
  - Melter
  - Refiner
  - Thermal Conditioning
- Objective: increase pull of furnace by 100% for a given size.
High Performance Modular Design - 1

MELTER

18 ft

CGM

Throat

REFINER

18 ft

Throat

THERMAL CONDITIONING

Specific Pull Rate
1.5 ft²/ston
6.5 mton/m²

Hydrogen/Oxygen
Submerged Combustion Assist

Hydrogen/Oxygen Sonic Refining
High Performance Modular Design - 2

- **MELTER**
  - CGM
- **REFINER**
  - Hydrogen/Oxygen Submerged Combustion Assist
  - Refining Shelf
  - Hydrogen/Oxygen Sonic Refining
- **THERMAL CONDITIONING**

Specific Pull Rate:
- 1.5 ft²/ston
- 6.5 mton/m²
Expected Benefits

- Similar design as existing furnaces
- Convert with same footprint
- Energy reduction at lower capital cost
  - 10% energy reduction
  - 25% reduction in capital costs
- Double throughput
# Strength of Glass

<table>
<thead>
<tr>
<th>Condition of Glass</th>
<th>lb/Square Inch</th>
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<tbody>
<tr>
<td>Surfaces ground and sandblasted</td>
<td>&lt; 4,000</td>
</tr>
<tr>
<td>Pressed Articles</td>
<td>3,000 – 8,000</td>
</tr>
<tr>
<td>Blown Ware:</td>
<td></td>
</tr>
<tr>
<td>Hot Iron Molds</td>
<td>4,000 – 9,000</td>
</tr>
<tr>
<td>Paste Molds</td>
<td>5,000 – 1,500 10,000</td>
</tr>
<tr>
<td>Inner Surfaces</td>
<td>15,000 – 40,000</td>
</tr>
<tr>
<td>Drawn tubing or rod</td>
<td>6,000 – 15,000</td>
</tr>
<tr>
<td>Window Glass</td>
<td>8,000 – 20,000</td>
</tr>
<tr>
<td>LCD (0.65 mm)</td>
<td>~45,000</td>
</tr>
<tr>
<td>Annealed fibers</td>
<td>10,000 – 40,000</td>
</tr>
<tr>
<td>Freshly drawn</td>
<td>30,000 – 400,000</td>
</tr>
<tr>
<td>Gorilla Glass (Apple iPhone)</td>
<td>100,000-200,000</td>
</tr>
<tr>
<td>Telecommunications Fiber</td>
<td>&gt;100,000</td>
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Glass Strength Contest

Strength in GLASS

4,000 feet above the Colorado River, you'll find

So, what would you do with stronger glass?

All glass Skywalk at the Grand Canyon allows visitors to look straight down at the Colorado River 4,000 feet below.

Details and updates at www.materialadvantage.org

1st Prize: $20,000
2nd Prize: $10,000
3rd Prize: $5,000

What about environmental impact? How might glass change our future?

The Glass Manufacturing Industry Council, the Glass & Optical Science, Science and Technology Center for Glass Research, and the NSF International Materials Institute on How Glass Will Change Our Future.

All prizes must be used for glass-related research or education. Prizes are open to all United States residents, 18 years of age or older, and must be used within one year of the award date.

For more information, visit www.materialadvantage.org.
Possible New Markets for Ultra-Strong Glass

- Ultra-Thin film Solar Cells
- Energy Storage
- Glass Balloon Satellites
- Liquid Mirror Telescopes
- Structural Supports
Ultra-Strong Glass

Hexagonal Close Packing of Buoyant Glass Spheres

Insland Anchored to Sea Floor

Power Plants Used to Produce Fresh Water as well as Store Energy

Commercial Real Estate

Wildlife Refuges for Plants and Wildlife
Glass Strength – Next Steps

- Bi-Annual Contest
- Meetings/Conferences
  - “Towards Ultrastrong Glass (Germany) – September 2008
  - “Roadmap Brainstorming” conference (Europe) – Spring 2009
  - Global Conference – at PacRim/GOMD/ICG (Vancouver) – June 2009
- Brain Trust
  - Identify experts around the world with interest/knowledge in glass strength.
  - http://glass-fracture.org
Additional Developments

- Waste Heat Recovery
  - Pre-Heat Batch/Cullet
  - Distributed Generation
  - Glass Plant as Power Plant
- Solar Energy
- Alternative Fuels
  - Coal Gasification, Landfill Gas
Calderon – Pilot Gasifier
Repowering Existing Coal Burning Power Stations

Calderon Clean Coal Technology for the Co-Production Of Liquid Transport Fuel, Electric Power and Oxamide*

*Oxamide is a super-fertilizer and a substitute for UREA; it possesses slow release properties

Patents Issued; Other Pending