Rapid Conditioning for the Next Generation Melting System

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Gas Technology Institute, Owens Corning, Johns Manville
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Project Objective

- To test and evaluate the most promising approaches to rapidly condition the homogeneous glass produced from the submerged combustion melter
- Conditioning means removing entrained bubbles down to the size and concentration required for a specific product
- To design a pilot-scale NGMS system for fiberglass recycle

The Next Generation Melting System (NGMS) replaces a single large melting tank with a segmented process that integrates a highly-efficient, low-cost high intensity melter with a rapid conditioning step to produce glass of needed quality

Glass – A Vital American Industry

- Importance to US
  - 150,000 employees
  - $28.4 billion/year in shipments
  - $2.0 billion/year in capital expenditures
  - 250 trillion Btu/year consumed
  - $1.4 billion/year in energy costs
- 20 million tons produced per year in US
  - 50% - containers
  - 25% - flat glass
  - 15% - fiberglass
  - 10% - specialty glass

Technical Approach

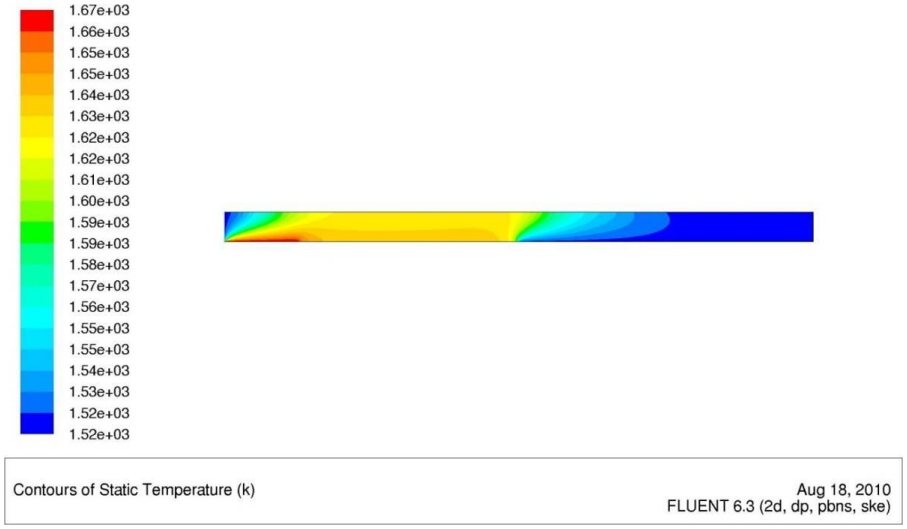
- Currently glass takes 25 hours to melt and refine in a single large refractory tank that can cost >$25 million
- The much smaller submerged combustion melter (SCM) has water-cooled walls, requires <3 hours residence time, has lower emissions, reduces energy per ton of glass, and costs under $5 million
- Glass compositions can be changed quickly in an SCM and the unit can be started and stopped as needed, features not possible with current melters
- Bubbles left in SCM glass must be removed in a second refining step

Rapid Refining of Glass

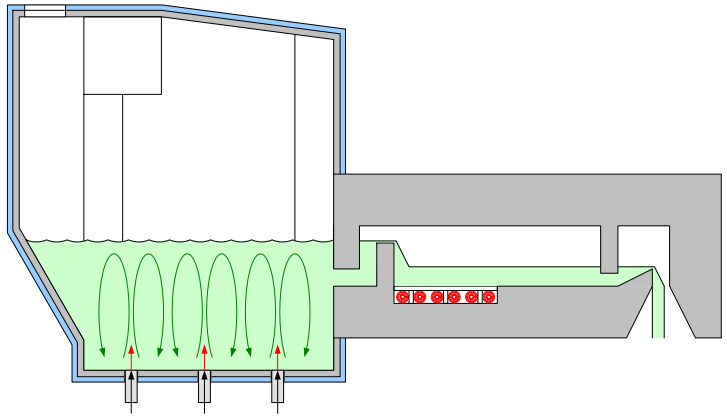
- The refining step must be low cost, compatible with SCM, scalable, require no new materials, and achieve container glass quality in <30 min residence time
- Many refining approaches were considered and tested and then dismissed for not meeting all objectives
- The patent-pending process thermal convective rapid refining (TCRR) was then developed – modeled, tested with simulated fluids, and studied in batch glass tests
- How is it done today, and what are the limits of current practice?
- Testing has been carried out at GTI with engineering support and glass raw materials provided by partners Owens Corning and Johns Manville

Thermal Convective Rapid Refining

- Heat on a channel floor creates slow convestive that gently pushes bubbles upward. Bubble are then broken on the surface by a second burner
- Glass is clarified 10-20 faster than bubbles rise by buoyancy alone



TCRR Channel Temperature Profile



Pilot SCM-refiner configuration under fabrication for continuous rapid refining tests

Transition and Deployment

- Submerged melting and NGMS are of interest to
  - Many glass industry segments (fiber, container, flat, specialty)
  - Companies making other products by melting – mineral wool, sodium silicate, waste vitrification, etc.
- NGMS is more flexible than other melters
  - Starting and stopping at will and rapid composition changes allow for new business models
  - Can serve as a primary melter, a pre-melter, or a supplemental melter for smaller volume products
  - Highly corrosive materials can be melted that cannot be melted in convetional melters
  - Scrap fiberglass, mineral wool 'shot', and other waste can be melted

Transition and Deployment

- Parallel paths
  - GTI is conducting trials for glass companies so benefits of SCM can be demonstrated
  - GTI is actively marketing SCM to companies producing products needing little or no refining
  - 3 demonstration plants and several research melters have been built and are enabling long duration testing and modification for commercial deployment
  - Rapid refining testing success will open a much broad market to the NGMS technology
- Licensing and partnership arrangements are on-going and being actively pursued by the GTI Commercialization Director

Measure of Success

- Rapid refining success will enable the Next Generation Melting System to produce fiber, container, and some specialty glasses. The refiner increases energy by <10%
  - Large cost savings will free up capital for business expansion
  - Emissions will be >50% lower than best current melters
  - Energy savings of 5% will keep product cost competitive
- Impact of NGMS with 20% market penetration
  - Capital cost savings of $80 million per year
  - Energy savings of 2.5 trillion Btu per year

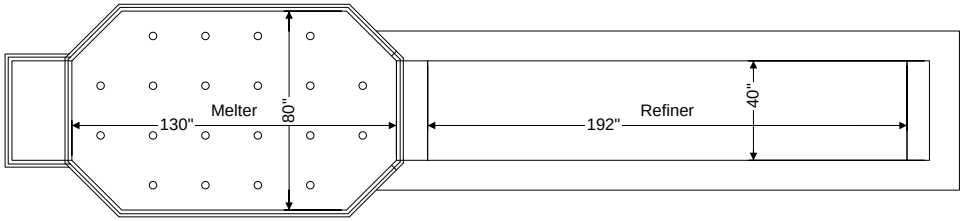
Project Management & Budget

- Total project length – 8 years
  - Delays in DOE allocation of funds
  - Delays developing preferred rapid conditioning approach
- Project is nearly complete – End date of June 2014
  - Single remaining Task – complete 2 continuous rapid refining tests
  - Success measured by stable operation and quality of glass achieving at least fiberglass quality in <30 min. refining time

Total Project Budget	
DOE Investment	$1,509,000
Cost Share	$813,000
Project Total	$2,322,000

Results and Accomplishments

- 5 ton/h Fiberglass melter designed –
  - 80% lower capital
  - 50% lower NO_X
  - 5% energy savings



- Near fiberglass quality reached with 30 min thermal convective refining time

Log μ = 2.2
Time = 25 min

- More tightly controlled conditions of continuous thermal convective refining are expected to further improve product glass quality