Rapid Conditioning for the Next Generation Melting System

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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
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.
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.
• Heat on a channel floor creates slow convective 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.
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 conventional 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

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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 $\mu = 2.2$
Time = 25 min

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