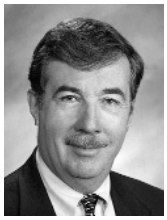


Glass Furnace Simulation Model

Competitive and regulatory pressures are motivating glass manufacturers to seek new ways to improve productivity while reducing furnace energy use and emissions. The pursuit of these goals, however, often leads to conflicting requirements for the design and operation parameters.

To surmount these conflicting requirements, a robust, validated, computational model of glassmelting furnaces is being developed. Although 3-D computer models of the individual components of the melting system exist, they have not been coupled into an entire furnace model. This tool will lead to optimization of existing melter operation.

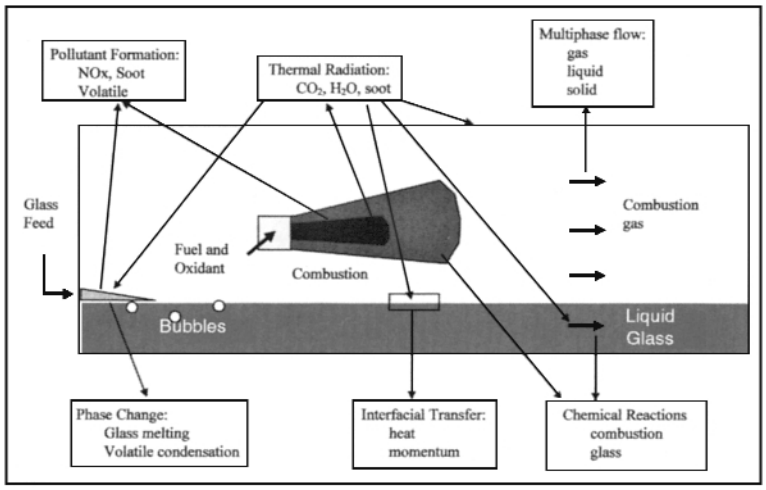
Project Description

The goal is to develop, validate and apply an innovative, 3-D, glassmelting furnace simulation model that provides a more accurate representation of the entire melting process.

One innovative feature of the proposed model is that the newly developed code will directly couple the combustion space with the glass batch/melt through a rigorous spectral radiation model that computes radiant transfer throughout the whole furnace volume, allowing for spectral radiation from combustion species such as H_2O and CO_2, and radiation to and from the crown and glassmelt. This will produce a more accurate model of the entire system.

Argonne National Lab (ANL) is developing the combustion space model. Purdue University is assisting ANL in developing the glass bath model.

The two models, together with a detailed glass batch model, will be synthesized into one code by ANL and validated against existing industrial furnace measurements as well as data from a measurement program conducted on an operating furnace. Once validated, the simulation will be available to be used to optimize furnace performance with regard to energy use, emissions and productivity.



New model will couple and simulate all components of a glassmelting furnace.

Part I

The principal milestones of Part I have been achieved. A CFD-based combustion space model that incorporates a rigorous treatment of spectral radiation heat transfer throughout the whole furnace volume—to and from the crown, glassmelt and glass batch—has been developed.

The glassmelt was modeled with ANL's multiphase reacting flow code, directly incorporating a model of the glass batch. The combustion space and glassmelt models were coupled into an overall furnace model and used to develop a simulation of a Techneglas furnace.

Initial measurements of key performance parameters in the furnace modeled have been made. An initial complete data set has been acquired and used to validate the furnace model. Electric boost and bubbler models are being developed for incorporation into the furnace code.

Part II

Key technical objectives for the Part II follow-on program are to:

- Incorporate glass chemistry models into the glassmelt and to compute and track key solid, gas and liquid species throughout the melt;
- Activate the gaseous phase transport equations built into the glassmelt model with source terms derived from the chemistry models to compute gaseous species production, bubble nucleation and growth, dissolution, and release from the glassmelt surface (foaming);
- Develop and incorporate chemistry and nucleation models of space;
- Develop and incorporate glass quality indices into the simulation to facilitate optimization studies with regard to productivity, energy use and emissions;
- Develop and validate furnace simulations of three additional furnace types used in the industry;
- Conduct a workshop for the entire industry at the conclusion of the program where the code, furnace simulation, and all data and information derived from the program will be made available to all.

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