Quarterly Progress Report
12/20/97-8/20/98
DE-FG01-97EE15680
Advanced Glass Industries
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Project Objectives - Third and Fourth Quarters
- Elimination/reduction of the use of mold release powder
- Improvement of temperature control and data acquisition
- Improve operator working conditions
- Maximize energy efficiency

Technical Milestones
- Construction completed on engineering prototype
- First sample data acquired for energy usage, temperature control and reduction of molding powder for rotary prototype
- Manufacturing data acquired for in-house prototype of gas furnace
- Materials testing data acquired for hearth plate

Summary
Electric rotary furnace prototype has been built and will be on-site by the end of September. Additional space has been leased to insure a clean environment for testing. Preliminary data for candidate hearth plate material supports the hypothesis that wetting of the glass may be controlled by temperature and surface chemistry.

Key issues are manpower and data reporting for trial period. Experimental design will be critical in order to maximize knowledge while minimizing manpower hours.
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Objective 1: Materials Testing

As the key material parameter for the success of the rotary furnace, the hearth plate material was selected during the initial in-house screening. After an on-site visit to the subcontractor manufacturing the rotary furnace prototype, the following actions occurred:

- High density, ½ inch Calcium Silicate slab with a maximum use temperature of 2000° F was chosen as the hearth plate material for the prototype.
- Additional insulation of the hearth plate has been incorporated using low density, 2 inch ceramic fiber.
- Channels were incorporated into the hearth plate support grid to reduce the heat sink effect that was observed during our visit.
- A recommendation was made and incorporated into the prototype for a cooling blower to further insure uniform hearth temperature.

As mentioned previously, we have explored options for different release powders. In the past several weeks, we have begun an alternate approach that is focusing on the metals used for the dies and tools. The hypothesis is that if the metal used has essentially zero expansion, we should be able to keep the temperature of the glass below the softening point while on the hearth plate and then use the tool and die for the final heating/pressing.

Objective 2: Prototype Development

Progress has been made for both prototypes. Unfortunately, the results for the gas prototype are not as positive as for the electric one.

- The gas furnace fire brick remained the same material as what we have used for all other gas furnaces since we were unable to find an alternate replacement with better properties.
- Although our design incorporated independent burners for more accurate temperature control, this was an occurrence where theory met reality. We are renters in a fairly old building. Throughout our stay in this building, we have had to continually modify the gas delivery lines in order to have enough gas for our molding operation with the correct amount of pressure. It turns out that the new design with the independent burners lowered the gas pressure of the lines to such a level that the remaining manufacturing furnaces could not operate. We need to have our skilled molders involved in these experiments and they are working overtime hours to meet production deadlines. Our plan is to table this experiment until we move into our own building (December 1998) and then do all of the necessary hook-ups to insure that future designs will have this ability.
- The electric rotary furnace prototype will be on our dock as of Sept. 14th, 1998. Both myself and our Chief Engineer visited the subcontractor in the middle of June to inspect the furnace before shipping. During this visit, we made several technical suggestions for improving the design:
  1. Raised the height of the furnace to normal working level (about 2 feet additional).
  2. Opened the doorway at the pressing station to give the molder more arm room for paddling.
3. Added channels to the frame holding the hearthplate to increase the air flow and reduce the tendency for a heat sink effect which would reduce the benefits associated with zone heating.

4. Additionally, added a blower system to maintain hearth temperature.

5. Suggested that the walls of the heating zones be redesigned to channel the heat reducing the heat loss to the environment (and thus the worker).

- At this time, we are renting the heating unit from the subcontractor. This unit will capture the heating profiles for each zone as well as for each experimental run.

**Objective 3: Testing Protocols and Methods**

We will be acquiring significant amounts of data during this quarter. We have purchased another computer with large memory capabilities. We have acquired software specifically for plotting data and are in the process of training on these programs.

Our subcontractor conducted several material tests for us with the prototype on their site. Using two common glass types (BK-7 and SF-2), they were able to heat the glasses to the point of softening, maintain that status through the pressing stage and not see sticking occur on the hearth plate. Although this is very preliminary data, it does agree with our hypothesis that with the right material and with a temperature gradient in the zones of the hearth plate, we may be able to eliminate the release powder.

**Summary and Technical Milestones**

- Even with reengineering of the rotary prototype, we are still on-schedule.
- Preliminary data supports the ability to eliminate and/or reduce release powder.
- Gas furnace prototype design is tabled until January of 1999 due to building constraints.
- Rotary furnace prototype is complete and will be ready for testing in October.
- Prototype modifications have been made in first model reducing engineering costs.
- New avenue of material study has been targeted for reducing/eliminating release powder which focuses on having the glass below the wetting temperature and using different materials for the tools and dies.

We have previously mentioned that we have applied for an ATP grant which would allow us to make a further leap in technology that would build on the knowledge that we have acquired in this program. Although we did not make it through the selection process for the Photonics Program, we were strongly recommended to enter the open program solicitation.