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Project Summary

Batch Pretreatment Process Technology for Abatement of Emissions and Conservation of Energy in Glass Melting Furnaces: Phase IIA, Process Design Manual

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In glass manufacturing, the use of the furnace stack gases to preheat the glass batch showed promise in early feasibility studies for reducing energy costs and reducing particulate discharged to the stack. This study investigated the environmental effectiveness of the concept on an operating regenerative furnace exhaust gas stream and identified the capture potential of a packed bed column with and without electrical enhancement. Also characterized were the optimum operating parameters for the pelletizing operation.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

A 1973 study of the glass manufacturing process concluded that batch preheating with furnace stack gases is a potential option for controlling glass manufacturing pollution while reducing energy consumption. The potential for faster glass melting with this process would compound the energy savings and return the materials normally lost from the stack as particulate pollution back to the melting tank.

A jointly funded project was formally initiated in 1977 to develop and demonstrate the capability of glass batch preheating. The Department of Energy, Corning Glass Works, and the U.S. Environmental Protection Agency jointly sponsored and funded this effort. That project involved preliminary laboratory studies and development of a process design manual. The project was completed in late 1981 and reported in EPA-600/7-81-038, May 1981.

Since the laboratory experimentation adequately defined only the energy conservation potential of the concept, the report on that project recommended additional research be conducted to further define the pollution capture potential of the concept. This present project was designed to accomplish that recommendation and includes conducting pollution capture studies on a packed bed using operating commercial regenerative furnace exhaust gases with agglomerated glass batch pellets. Also included are results of the pollution capture potential of the packed bed when it is electrostatically enhanced. Conclusions are developed on the particulate pollution capture potential of the packed bed with and without electrical enhancement, on SO_x capture efficiency of the packed bed, and on glass product quality.

During Phase I of this project, particulate capture tests were conducted on a miniature packed bed of pellets using burner exhaust gases laden with commercial grade sodium sulfate particulates to simulate particulate emissions frpm a glass furnace. The results were not considered conclusive because the small-sized bed may have introduced wall effects on the particulate capture characteristics and because the sodium sulfate particulates used were not representative of the usual submicron-size condensation products in an actual production furnace environment. Thus, it was recommended that further work be carried out to conduct a more representative test program using a large-size bed and actual soda-lime furnace exhaust gases.

Tests were conducted using a 0.76-m-diameter × 1.52-m-deep bed and using a slipstream of gases from a soda-lime container furnace operated by Thatcher Glass Manufacturing Company in their Elmira, NY, plant. The soda-lime pellets used in the tests were approximately 1.3 to 1.6 cm in diameter. The testing period lasted 6 weeks and 19 tests run were completed.

The objectives of these tests were to:

1. determine particulate capture efficiencies in the packed bed and electrified filter bed using EPA-approved pollution testing procedures,
2. determine the particulate size distribution of the emissions at the inlet and outlet of the packed bed, and
3. evaluate the effects of particulates captured by the pelletized batch with regard to the pellet's meeting characteristics.

Pilot Plant Design and Equipment

A schematic of the packed bed pilot plant is shown in Figure 1. About 5% of the volume of the operating commercial furnace flue gas was passed through a duct to the packed bed. The duct was designed to include a damper for controlling gas flow through the packed bed system. The gases coming out of the packed bed were drawn into a electrified filter bed (EFB) pilot unit. The system was used to complement the collection efficiency of the packed bed. The sampling locations in the system were (1) upstream of the packed bed, (2) between the packed bed and the EFB, and (3) after the EFB. All sampling ports were located at least eight diameters of straight ducting upstream and two diameters of straight ducting downstream of the sampling ports. The duct material from the flue to the EFB was made of stainless steel to provide for high-temperature operation and to minimize corrosion inside the duct.

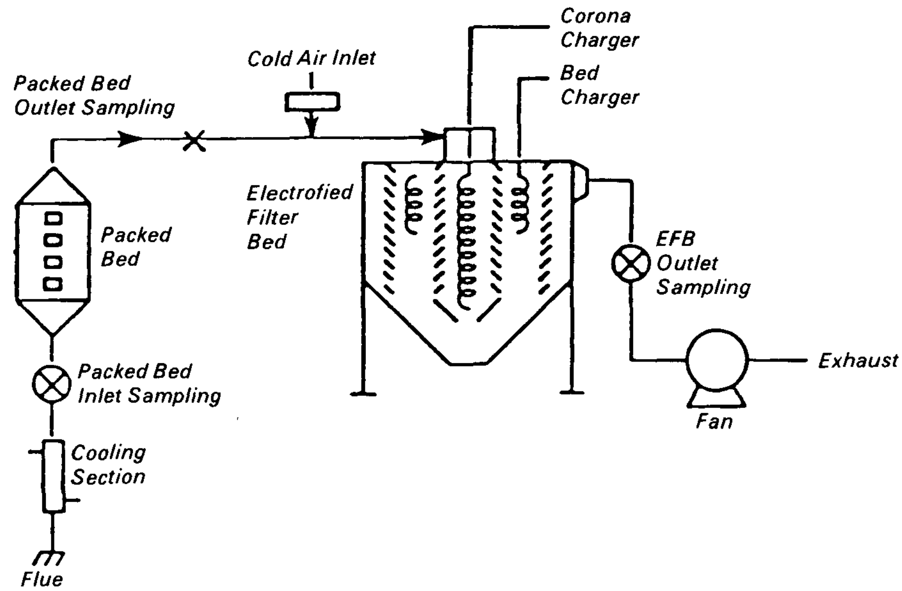

Figure 1. *Schematic test set-up.*

The pellets in the packed bed (Figure 2) were supported by a stainless-steel wire mesh screen welded to the bottom of the cylindrical portion of the packed bed. Four access doors (approximately 15 cm × 30 cm) on the side of the packed bed were designed for sampling, loading, and unloading the pellets into the packed bed.

Testing Strategy and Experimental Conditions

The overall strategy of the bed testing was to move toward maximizing the bed capture efficiency by setting the operating conditions for each experiment. Additional experiments were also conducted to establish reproducibility of testing and scale-up parameters. The bed study variables were bed depth, gas velocity, and gas temperature (Table 1). The size distribution of the particulates in flue gases was dictated by the furnace operating conditions during testing; however, the particle size distribution at the inlet of the packed bed remained relatively constant. The specific operating conditions for the packed bed testing are shown in Table 1.

Conclusions

The following conclusions are based on work with the 1.37-m-diameter pan pelletizer:

- Pan angle has a significant effect in determining pellet size.
- The optimum pelletizing rate in a 1.32-m-diameter pan is 635 kg per hour with a depth-to-diameter ratio of 0.26. This rate is 80% of the maximum.
- The pelletizer can be operated without operator attention provided

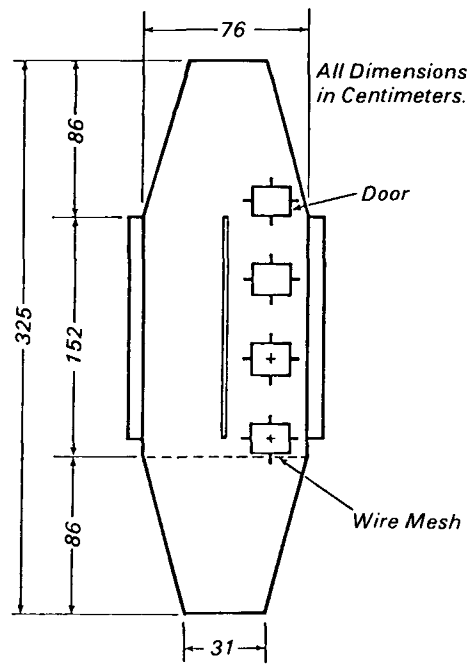

Figure 2. *Packed bed dimensions, in centimeters.*

Table 1. Range of Experimental Variables

Function Studied	*Units*	*Range*
Packed Bed:		
Bed depth	*m*	*0.6-1.5*
Gas velocity	*m/sec*	*0.6-1.8*
Gas temperature	*°C*	*260-370*
EFB:		
Gas volume	*m^3/min*	*25-200*
Gas temperature	*°C*	*150-260*
Bed voltage	*Kv*	*0-9.5*
Corona current	*mA*	*1.5-3.0*

proper control of batch and water feed rates is provided.

- Pelletizer wear, adding approximately 40 ppm iron into the batch, does not cause color problems when the pellets are melted.
- 70% to 80% of the water in pellets should be removed from pellets in the belt dryer before they enter a shaft dryer or preheater.
- Wet soda-lime pellets will stick together when subjected to heat in excess of 225°C in a belt dryer.
- Fines generated in the shaft dryer, which were not carried out in the exhaust gas, amounted to 3% to 5% of the weight of the pellets.
- Approximately 1.3 cm is the optimum diameter pellet for durability in handling.
- Crushing strength of a pellet decreases as the size of the pellet increases.
- In a production system, wet pellets should be screened to remove occasional batch chunks generated in the pelletizer.
- Wet pellet strength exceeded that needed for handling between the pelletizer and belt dryer.
- The surface of dried pellets had 30% to 42% more SO_4 than the inner core.
- Inertial capture is the dominant mechanism for soda-lime furnace particulates in the packed bed.
- An increase in the packed bed depth increases particulate capture. An increase in gas velocity increases particulate capture. A decrease in gas temperature has little effect on packed bed capture.
- An increase in bed voltage in EFB increases particulate capture.
- SO_2 capture in the pellet bed (EFB) was about 75%.
- The concept of pollution capture from soda-lime furnace emissions using electrified filter bed technology was shown to be feasible.
- With the use of the gravel or soda-lime pellets as collection media, the particulate collection is greater than 95%.
- The EFB needs more power to obtain the same collection efficiency that the gravel bed obtains because of the electrical properties of the pellets.

The full report submitted in fulfillment of Contract No. 68-02-2640 by Corning Glass Works under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Batch Pretreatment Process Technology for Abatement of Emissions and Conservation of Energy in Glass Melting Furnaces: Phase IIA, Process Design Manual," (Order No. PB 85-216 554/AS; Cost: $13.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
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