Impressive flexibility from new forehearth

Emhart Glass' advanced 340 forehearth offers a highly flexible conditioning system with better cooling and heating, performance and fuel efficiency.

The forehearth has a key function in manufacturing high quality glass containers. As well as transporting molten glass to the feeder it "conditions" the glass stream, ie it heats and cools the molten glass to give it a correct and homogeneous temperature at the outlet to the feeder.

Gas burners flaming from the side heat the glass surface by radiation, while air vents create specific cooling zones. Well-conditioned glass helps ensure that gobs cut by the shear are stable when delivered to the forming machine.

Cooling concepts

To provide maximum cooling capability it was determined that the 340 might need a combination of cooling methods. Free radiation cooling uses openings in the roof of the forehearth to allow heat from the glass to radiate into space.

This offers the highest cooling capability but is also the most difficult to control and produces high levels of disruptive convective movement in the glass stream. The openings in the forehearth roof must be highly controllable to provide even cooling over the entire centre of the molten glass stream.

Convection cooling injects a stream of air into the rear central portion of the forehearth cooling zone to lower the temperature of the internal central roof refractory, allowing the molten glass to radiate heat to its surface. It has many advantages, but overall efficiency is reduced when the cooling air mixes with the combustion gases at the side of the forehearth. Also the atmosphere over the glass will be "leaned" and could give problems when making amber glass.

Muffled cooling was pioneered by Emhart Glass. It uses a thin refractory radiation plate set over a hole in the forehearth superstructure roof. A refractory cooling tunnel is placed over the radiation plate and cooling air is injected into the tunnel to cool the topside of the plate. The heat is removed through the plate and by the cooling air passing over the plate's surface. This method maintains consistent internal atmosphere but the area of the radiation plates limits the cooling capacity.

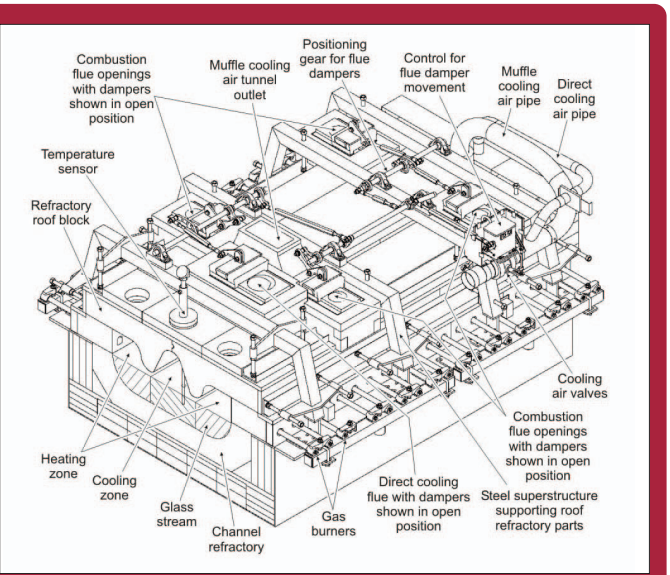
Emhart designers discovered that proper placement of the exhaust flues and control of internal pressure in the forehearth could overcome some of the difficulties in controlling combustion gases and cooling air.

The 340 Forehearth

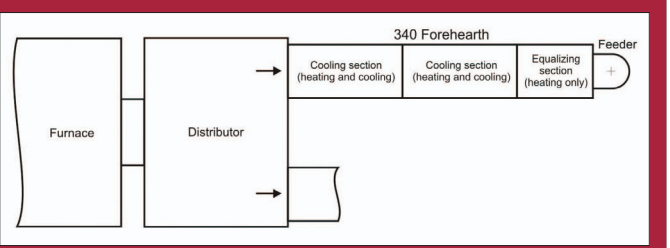
Based on analytical and computer studies, the 340 Forehearth was designed with a unique dual cooling scheme that includes an advanced form of convection cooling and muffled cooling to provide a predicted 20% more cooling capability than a typical muffled cooling design. An advanced damper control system was designed to control the internal back pressure in the forehearth and also to heat the central glass stream. Emhart designed a high-pressure combustion system with increased heating capacity to manage the heat losses in the forehearth and provide controllable heating of the central glass stream.

The Emhart Glass 340 Forehearth uses many basic features from the 540 Forehearth, for instance the cross sectional shape of the refractory roof. This shape divides the molten glass stream into three unique areas. The two outside areas heat the glass to balance the structural heat losses while the central section cools the hotter glass stream core. This highly optimised roof design provides good separation of combustion and cooling gases.

▲ *Fig 3. Three containers produced with the 340 Forehearth.*



▲ *Fig 1. The 340 Forehearth cooling section.*



▲ *Fig 2. Layout of the 340 Forehearth.*

The 340 Forehearth has five controllable flue openings. Four side exhaust flues control the back pressure in the combustion chambers (on the sides) while a central damper controls the internal cooling air exhaust opening. A single computer input positions all the cooling and combustion dampers in unison and also moves the cooling air supply control valve.

The cooling air is split on exiting the valve into two feed pipes, a 102mm or 152mm diameter pipe for the muffle cooling tunnel and a 51mm diameter pipe for the internal or convection cooling.

All flue openings have cleanable damper blocks that slide over the top of the flue to regulate the internal back pressure. Condensate forms on the damper blocks and might fall back into the glass causing defects, but the 340 Forehearth uses a new self-cleaning damper flue design that eliminates this problem by removing the condensate.

Where cooling is not required the side combustion damper blocks can be closed and the central damper opened further to force hot combustion gases to the central chamber. This is effective in shortening job change times and for low pulls with high gob temperatures.

Testing the 340

In January 2003, Emhart Glass installed and commissioned the first 340 Forehearth. It is a 914mm wide, 7.3m long unit with two 2.7m cooling sections and a 1.8m equalising section and operates on a green glass line. Its design allows it to operate over a very wide tonnage and temperature range. The largest container made on this line is a 1.4kg, 4 litre, handled wine jug and the smallest is an 85g sauce bottle.

Since January the unit has consistently produced thermal efficiencies of 95% or better, and the customer reports better pack rates and faster job change times.

The 340 Forehearth system represents the future of forehearth technology but is available from Emhart Glass today.

* *Emhart Glass, Connecticut, USA.*
Tel: +1 860 814 4010. Fax: +1 860 814 4170.
Website: www.emhartglass.com