Forehearth subsystem advances

John McMinn* describes how recently introduced forehearth subsystems are used with 340 Forehearth technology to provide a unique contribution to glass conditioning technology and improve conditioning effectiveness.

When it was introduced in 2002, the Emhart Glass 340 Forehearth offered response speed with thermal conditioning precision. With recorded thermal efficiency values of 100%, the 340 Forehearth quickly became a standard for leading glass producers worldwide.

The engine for any forehearth system is its basic design. The combustion and control subsystems can enhance the performance of a well-designed forehearth but cannot compensate for a flawed forehearth concept. Conversely, poorly designed or inadequate forehearth subsystems can adversely degrade forehearth performance. Today, recently introduced forehearth subsystems from Emhart Glass have blended with the 340 Forehearth technology to provide a unique contribution to the conditioning process.

Combustion systems
Superficially the requirements of a forehearth combustion system are modest, requiring the mixing of air and gas in a predefined ratio. Maintaining a consistent and correct air/gas ratio is vital to forehearth performance and energy usage. Too much air acts as a coolant introduced through the burner nozzles, which results in cold glass at the sides of the forehearth. Too much gas, with insufficient oxygen to combust during entry into the forehearth, also acts as a coolant at the sides of the forehearth.

Most forehearth combustion systems are based on the aspirator, in which combustion air passes through a constriction causing a negative pressure that draws gas into the air stream. The amount of gas entering the air stream is theoretically proportional to the flow of the air through the constriction. These systems, while simple in design and relatively inexpensive, suffer from problems related to inconsistent air/gas ratio of the aspirator system and the influence of back pressure on the air/gas ratio.

Blocked or restricted nozzles are an unfortunate but common aspect of forehearth operation. The task of maintaining the proper nozzle port area by removing and cleaning the nozzles is time consuming and disruptive to the glass conditioning process.

Blocked or restricted nozzles are extra cause for concern when using aspirator combustion systems since the air/gas ratio is affected by the degree of restriction of the nozzle port area.

There is no such thing as a non-blocking nozzle; however, Emhart Glass has developed a system that maintains the air/gas ratio irrespective of the integrity of the nozzle port area. This uses a constant combustion airflow measurement to maintain the air/gas ratio. A single combustion loop is illustrated in Fig 1. The combustion airflow rate is controlled via an actuated control valve (A) before passing through a flow metering device (B). This device sends two signals to the gas proportioning valve (C), which continually maps the flow rate of the combustion air. The system automatically compensates for any variation of combustion air through a corresponding change in gas flow, maintaining the correct air/gas ratio at all manifold pressures and flow rates. The air and gas, in the correct proportions, are then fed to a mixer (D) before entering the burner manifold system.

Control systems
Through innovative design and application of advanced subsystems, Emhart Glass has been able to provide forehearth solutions to all sectors of glass forming. These products reflect the technical requirements and system architecture preferences of geographically diverse manufacturers, as well as the need to consider commercial restraints associated with others. To respond to this diversity a range of control solutions, from single forehearth control to a multiple forehearth/distributor SCADA-based control, are now available.

Single forehearth control systems
The Emhart Glass HWC800 was introduced in 2000 as a cost-effective single forehearth control system. Based on the Honeywell UMC800, the HWC800 control system is a basic negative feedback system offering heat only and heat/cool PID control loops. In this system, control to all zones is
accomplished using a single multi-loop controller that also features a graphic LCD display and keyboard user interface.

With up to 16 analogue control loops the HWC800 can accommodate up to 64 universal analogue inputs, 16 analogue outputs, and 96 digital inputs or outputs. The system allows setpoint programming, alarm processing, PID control, advanced control, auto tuning, Boolean logic, and math computation. The system also has the capacity to allow forehearth setpoints to be stored as downloadable recipes for particular machine jobs.

The HWC800 is comprised of a CPU with two serial communication ports, power supply and a backplane assembly capable of supporting up to 16 input or output modules. These modules support both analogue and digital inputs and outputs. A serial RS485 communication card can be added to support both slave data exchanges with a host PC for centralised operation/data management and/or communications over a Modbus RTU to other equipment.

Multiple forehearth/distributor control systems

The Emhart Glass HWC900 is a SCADA-based multi-loop forehearth/distributor control system originally based on the Honeywell HC900 processor controller. The HWC900 is a fully functional SCADA-based control system featuring a distributed architecture typically made up of a master computer station with graphical user interface, main control cubicle for all control inputs and outputs, and locally mounted forehearth operator stations.

To meet the variety of customer control architecture requirements, the HWC900 is now part of a suite of control solutions that includes the HWC900H, the HWC900S, and the HWC900R. The HWC900H is based on the Honeywell HC900 Multi-loop processor with RSView SCADA software. The HWC900S is based on Siemens PCS7 technology with WinCC SCADA software, and the HWC900R is based on Rockwell ControlLogix processors and RSView SCADA software.

Several HWC900 units have been successfully commissioned in the USA and Mexico. The first Rockwell based system will be commissioned in the Middle East this year.

The HWC900R offers dual hot standby Allen Bradley ControlLogix processors. In this system, one processor maintains the control function while being mapped by the other. In the event of processor failure the control function is transferred simultaneously to the other processor, thus ensuring the control integrity for all forehearts and distributor zones.

All I/O is terminated in local panels and fed via Allen Bradley Flex I/O units to the processors over a dual redundant ControlNet Network. This configuration significantly reduces the required cabling between the forehearts and the central control room. In addition, the dual network facility enhances the system integrity.

The I/O panels also are fitted with power supplies for the necessary field equipment and can, if desired, be fitted with operator HMIs to allow local access to the system. The operator interface includes a 14-inch TFT touch screen providing a subset of the main SCADA screen suite, which permits access to data archiving, and a range of pre-defined control screens including data trending, job recipe, system alarms, forehearth diagnostics, and system set-up.

Regardless of the control architecture used, the 900 control suite offers 340 Forehearth advanced control strategies that encompass cascade and bias strategies to control the vertical and lateral glass stream temperature.

Conclusion

Together, the unique design of the Emhart Glass 340 Forehearth and its advanced combustion and control system, allow glass makers to optimise the glass conditioning process. The result is an innovative system that is both well suited for future production requirements, as well as current needs.

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