ACSI's Gob Temperature Control Strategy

Conventional methods of controlling gob temperature do not include direct gob temperature measurements. The operator monitors the equalizing thermocouple measurements as a reference and adjusts individual forehearth zones in an attempt to maintain a stable glass temperature before it enters the forming process. The actual gob temperature can only be assumed or measured with a conventional optical pyrometer which is often unreliable and incapable of being used for closed-loop control.

To eliminate the uncertainty of the actual gob temperature, ACSI and BASF have developed a solution that accurately measures and controls the gob temperature. The system utilizes direct measurement of each gob through the use of the Exactus® advanced Gob Temperature Sensor (GTS) produced by BASF. By combining the measurement from the GTS with ACSI's advanced Model Predictive Control (MPC), exceptional gob temperature stability and control is achieved at the point of entry to the forming process. This solution has provided significant benefits for Container Glass Customers, including reduced variation in the production process and reduced gob temperature recovery time after a job change.

FEATURES

- Direct control of gob temperature
- Feedback and Feed forward
- MPC understands dead time
- Feed forward control

BENEFITS	**ACTUAL CUSTOMER RESULTS**
• Reduced variability of gob temperature	300% reduction in gob temperature variation
• Improved temperature stability	2% improvement in Pack
• Faster compliance to setpoint changes	Reduced job change time 7hrs to 2-3 hrs
• Faster recovery from disturbances	50% less time to achieve stability

Optimization Tools

By combining the advanced technology of ACSI's control strategy and BASF's Exactus® pyrometer, ACSI is able to offer companies the necessary tools needed to achieve tighter Gob Temperature Control. The Exactus pyrometer is capable of providing an extraordinary level of temperature detail for each and every gob. Exactus technology provides the maximum and average temperature of each passing gob, analog output representing the gob temperature, the ability to view gob temperature profile graphs, measurements of temperature uniformity of a single gob and an indication of gob length and position relative to one another. Exactus has the ability to capture up to 1000 readings per second. This can lead to, decreased downtime, faster changeovers, improved yield, and high profitability.

Conventional methods of process control, such as PID, require that an operator adapt to variables in the manufacturing environment such as changes in the ambient air temperature, process upsets, and pull rate which can all affect the efficiency of output and product quality. Rather than asking an operator to adjust the changes, it is more efficient to have a model based controller adapt automatically for better control without requiring loop tuning. In addition to adapting to changes, ACSI's Model Predictive Control models feedforward inputs and updates control actions to quickly stabilize temperature variation. Signals are fedforward into the control model to provide advanced warning of process upsets. The model can then make the necessary changes before the upset reaches

the local zone, and in most cases, it can completely eliminate the upset before it is sensed by the local zone.

How it Works?

1. Measuring Gob Temperature
Conventional pyrometers are not fast enough to provide the average or maximum temperature of free-falling gobs and if a handheld is used, the measurement results can depend upon where the operator aims or stands making them unreliable. An Exactus pyrometer provides a quick response time as well as highly accurate results.

2. Gob Temperature Control
Gob temperature measurement is used as the process variable for a control loop where an operator can enter a desired Gob temperature setpoint. A model based control loop determines a new setpoint for the mass flow temperature.

3. Mass Flow Temperature
Mass flow temperature is a composite of the nine triplex readings in the conditioning zone of the forehearth. The desired MFT is adjusted by the Gob temperature control model.

4. Controlling Forehearth as a Unit
Model based controllers are used to adjust zone heating and cooling values to maintain the desired MFT.

5. Rear Zone Disturbance Rejection (Feed Forward)
Feed Forward models are used to minimize incoming temperature disturbances. These models eliminate the effect of job changes on adjacent forehearths and melter upsets.

By combining the advanced technologies of MPC and Exactus, ACSI is able to offer container manufacturers a solution that tightly controls the glass temperature at the point of entry into the forming process. This new type of control allows the plant to minimize container defects, improve production efficiency, and significantly reduce the gob temperature recovery time after a job change.