Infrared Pyrometry
in the Glass Industry

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Terms used in Glass Industry

Distributor: Distributes glass from melt tanks to forehearths. One melt tank typically feeds 2-4 forehearths.

Forehearth: Allows homogenization of glass and controls decrease of melt temperature to provide proper viscosity for "gobs".

Gob: A viscous volume of semi-molten glass which is cut from a stream of molten glass flowing from the forehearth. Gobs are continually cut into the proper volume and weight for the vessel being formed in a mould.

Lehr: Large annealing furnace for bottles which controls cool-down rate after mould station

Mould: A metal shell (usually in two halves) with the inside in the shape of the desired vessel into which the "gobs" are directed. They are discharged when sufficiently cooled to retain their shape. Typical mould interior surface temperatures are 300 - 500°C.

Orifice: Drain holes at the end of forehearth which are sized to produce the proper volume of molten glass (gob) to produce the desired vessel.

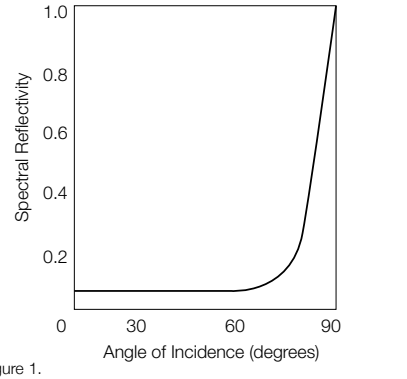

Figure 1.

In the molten state, glass becomes mostly opaque in the visible spectrum. Infrared pyrometers operating in the near infrared, 1 micron (µm) can get a good average temperature over several centimetres into the glass.Instruments filtered for 2.2 µm can read 5 or 6 centimetres into a "gob" or melt, and 3.9 µm is recommended for smaller gobs and thin stream pours.

For sheet glass work, or at lower temperatures, glass is too transparent for shorter wavelength measurements. 8 to 14 µm is commonly used when reflectance is not a problem. One problem in the 8 to 14 µm region is reflectance (not a problem at 5 µm or 7.9 µm) which runs about 15% (r = 0.15) and requires special attention to ensure that heaters or other objects significantly hotter than glass cannot be read by reflection. Plate glass annealed between a double row of heaters, for example, would preclude the use of an instrument with this 8 to 14 µm spectral range. Instead, an instrument sensitive at 5 µm could read temperature without errors due to reflection. The 5 µm instrument would read to a depth of about 1 mm, the 7.9 µm instrument would read the surface only.

Approximate Depth of Measurement in Clear Glass vs. Wavelength

Wavelength (µm)	Depth of Measurement (mm)
0.7 to 1.0	100 to 125
2.2	50 to 75
3.9	10
5.1	1.5
7.9	Surface
8 to 14	Surface

Application	Temp	Fixed sensor	Portable sensor
Melt tanks & Furnaces Distributors Hearths	1180-1300°C	TL-GAI-18	Thermosight GL
Gobs	1100-1200°C	Convir TL-TI5-12	Thermosight GL
Bottle moulds	250-500°C	PU301	PyroPen
Lehrs	100-200°C	PU301	PyroPen
Plate Glass Annealing & Heat Treating	500-800°C	TL-TI5-12	Thermosight GL
Refractories	Any	Any appropriate temperature range	Any appropriate temperature range
Plant Maintenance	10-200°C		Pyropen

In a float line, the 8 to 14 µm portable units have proven to be excellent tools for measuring the uniformity of the sheets. If reflections from hot refractories or flames, such as in melt tanks, etc., cause false readings, a 5 or 7.9 µm unit should be used. The 5 µm is desirable because it measures a very short distance into the glass and is relatively unaffected by air currents, etc.

Sensors operating in the 2.2 µm region are excellent for monitoring and contributing to the control scheme of melt tanks, distributors and forehearths. This wavelength is somewhat impervious to flame impingement. It also lends itself well to the measurement of clamshell mould interiors, although an oxidised exterior or the inner surface of paste moulds can be read with instruments of any wavelength.

Bottles exiting a lehr can be read with 8 to 14 µm units employing an averaging mode with an emissivity of 0.85. A 5 µm or 7.9 µm instrument would have an emissivity of 0.98. Readings would be more accurate using 5 µm or 7.9 µm because emissivity changes less as a function of angle of incidence at these wavelengths. (Reflectance increases as the angle between the plane of the glass and the line of sight decreases). See Figure 1.

Recent experience at a glass company provided the following information:

1. A Pyropen using an emissivity setting of 1.0 is excellent for clamshell moulds in bottle plants. Emissivities are much lower on finely polished moulds such as those used to create smooth surfaces on kitchenware. This type of application is not advised.
2. "Gobs" can be difficult, as many plants use a two-orifice (per forehearth) system. Job changes often result in the distance between orifices changing, and if the job changes are too frequent, operators may find re-aiming the sensing heads a nuisance. The best wavelength for gobs seems to be 3.9 µm. The TL-TI4-10 provides accurate gob temperature measurements using a 3.9 µm filter. Alternatively, a TL-TI5-12 will measure from 100 to 1200°C with a spectral range of 5.1 µm.
3. A TL-TI5-12 was tested on annealing and tempering operations, such as bottles exiting from the lehr and plate glass tempering. Good results were achieved measuring thin glass with this sensor.