LAND

AMETEK®

TEMPERATURE MEASUREMENTS IN GLASS TEMPERING APPLICATION NOTE

Tempered glass – sometimes called toughened or safety glass – is glass which has been heat-treated and then rapidly cooled, in a controlled manner, in an air quench section. This process makes the glass much more resilient than plain flat glass.

Producing tempered glass free of visual distortions requires a uniform temperature to be achieved across the whole surface of each glass lite. This requires accurate temperature monitoring across the entire width of the glass.

USES OF TEMPERED GLASS

AUTOMOTIVE WINDOWS

APPLIANCES SUCH AS OVEN DOORS AND REFRIGERATOR SHELVES

ARCHITECTURAL GLASS FOR BUILDINGS

GLASS DOORS AND SHOWER DOORS

GLASS COOKWARE

MOBILE PHONE AND TABLET SCREENS

WHY IS GLASS TEMPERED?

Plain glass is easily broken and breaks into shards which can cause serious injury.

Tempered glass is much harder to break and, if broken, it produces small, harmless dice-shaped pieces. This makes tempered glass ideally suited to applications where human safety is an issue.

However, if the process is not properly monitored and controlled, the heat treatment involved in tempering can introduce visual distortions.

Generally, customers reject distorted glass, which inflicts replacement costs on suppliers and affects their reputation for providing a quality product.

Distortions are particularly noticeable in architectural glass, which is also one of the largest markets for tempered glass.

The only way to ensure the glass is free of visual deformities is to ensure the same uniform temperature is reached over the entire surface of each lite.

APP NOTE

Over-extending the heating time may reduce breakages, but can have a negative effect on the glass quality.

THE TEMPERING PROCESS

Before tempering, the glass must be cut to the desired size, as operations such as etching or edging after the heat treatment can result in strength reductions or product failure.

The glass is examined for imperfections, then the sharp edges are removed by an abrasive, such as sandpaper, and the glass is washed.

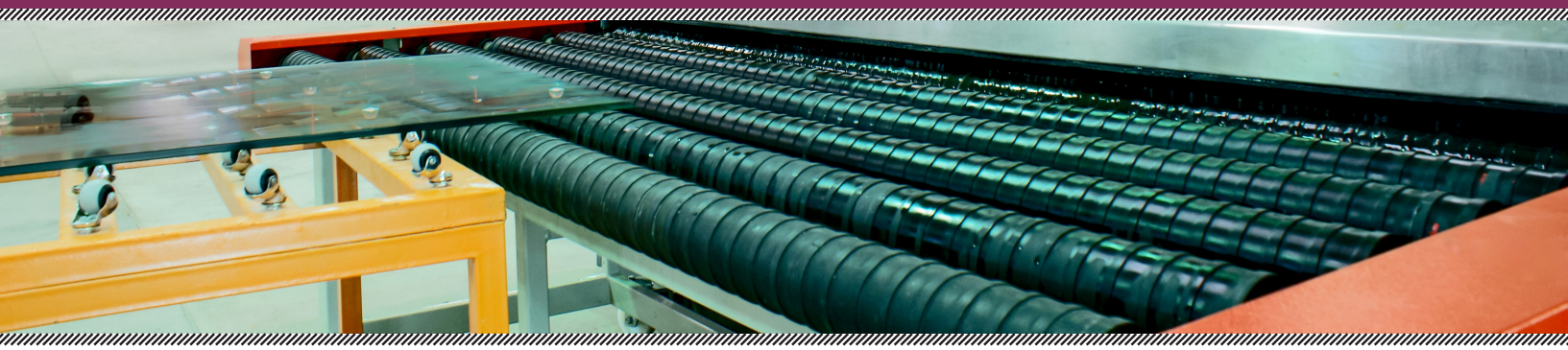
Next, the glass is heated in a tempering oven to more than 600°C (the industry standard is 620°C). It then undergoes rapid, high-pressure cooling through blasts from air nozzles.

This process, called quenching, lasts just seconds and cools the outer surface of the glass much more quickly than the centre. As the centre cools, it tries to pull back from the outer surfaces.

The result is that the centre remains in tension, while the outer surfaces go into compression, providing the tempered glass with its strength.

Ideally, each sheet of glass should have minimal temperature variation. This provides the same even stress across the glass, ensuring distortion-free viewing.

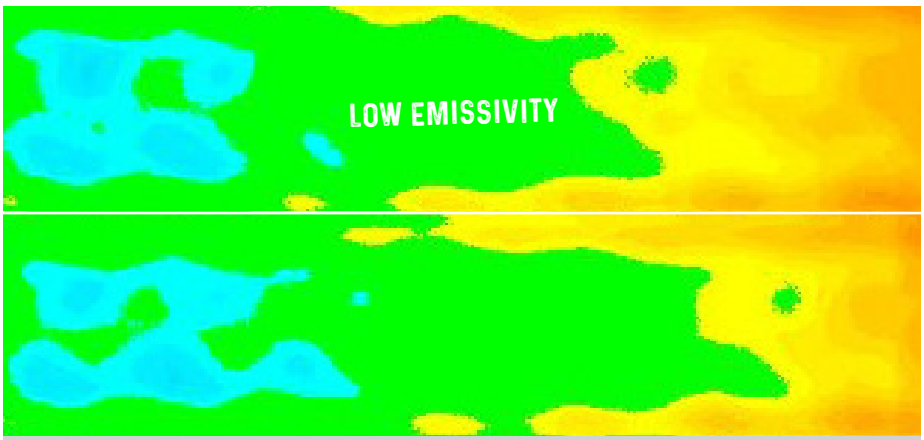
A thermal image of each lite as it enters the quench allows adjustment of the heating profile to maintain a uniform glass temperature.



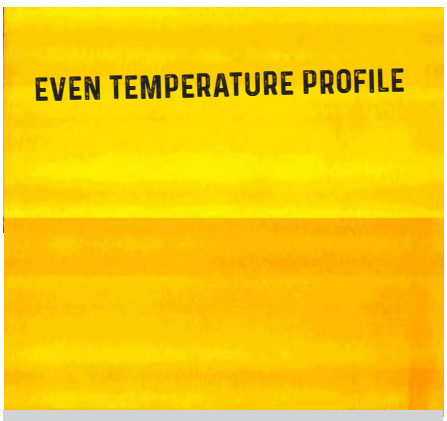
LOW EMISSIVITY THERMAL IMAGES

These thermal images show Low Emissivity (Low E) glass lites using the AMETEK Land measurement system, with a temperature scale set to 620 °C, ±5 °C. Measurements within this range are shown in green. Hotter areas are yellow or red, while colder areas are blue.

The lites were travelling from left to right. Most of the glass is close to 620 °C and appears green, but the leading edge is yellow, closer to 640 °C. Towards the tail in the middle there is a colder blue area at around 610 °C. This is sufficient variation to cause concern for a tempered glass manufacturer.



THERMAL IMAGES OF LOW E GLASS



THERMAL IMAGES OF LOW E GLASS

In this set of images, a much more even temperature profile has been achieved, though as the yellow colour indicates, it is around 15°C higher. This may also cause concern.

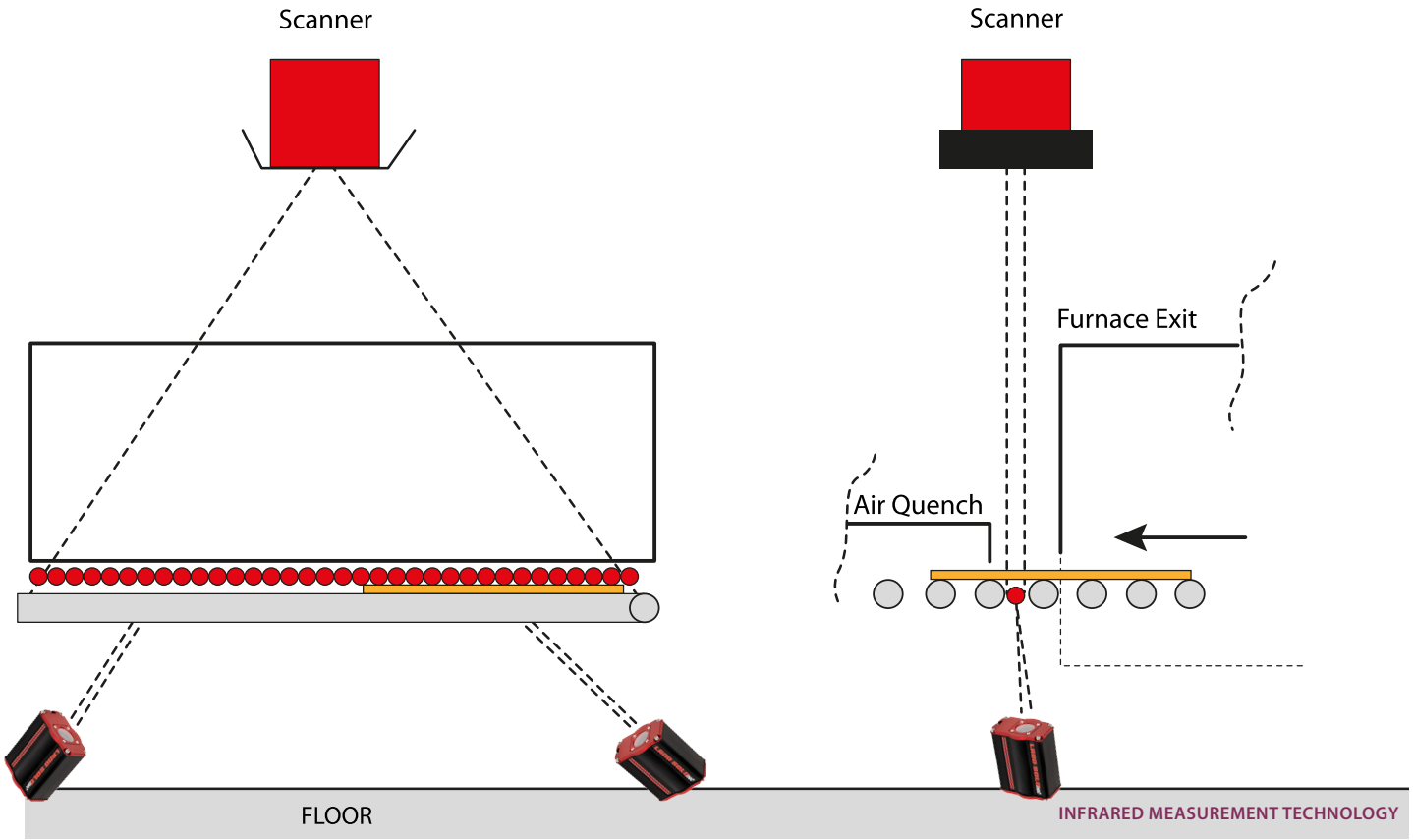
Thermal images produced for each batch of lites effectively provide a temperature profile of the furnace. Trends from batch to batch can reveal if one side of the furnace is running cooler than the other.

Changing the distribution of lites is often the simplest way to adjust the furnace temperature profile – placing larger lites on the hotter side of the furnace will draw heat away from this area, evening out the temperature.

Batch timing and other thermal controls can also be adjusted to reliably produce lites with a uniform thermal profile within the required temperature range.

By measuring the true temperature of Low E glass, the thermal profile of the furnace can thus be controlled in an informed way, ensuring the consistent production of high-quality, distortion-free glass.

AN ACCURATE SURFACE MEASUREMENT



INFRARED MEASUREMENT TECHNOLOGY

The gap between the furnace exit and the air quench entrance can be very narrow, often as small as 10 cm, so a linescanner is the ideal instrument to use at this point.

Glass lites entering the tempering furnace are often a mixture of sizes and are randomly placed. A linescanner such as the AMETEK Land LSP-HD 50 can easily monitor the glass as it passes through the narrow gap, scanning continuously across all the glass lites, typically at 150 scans per second.

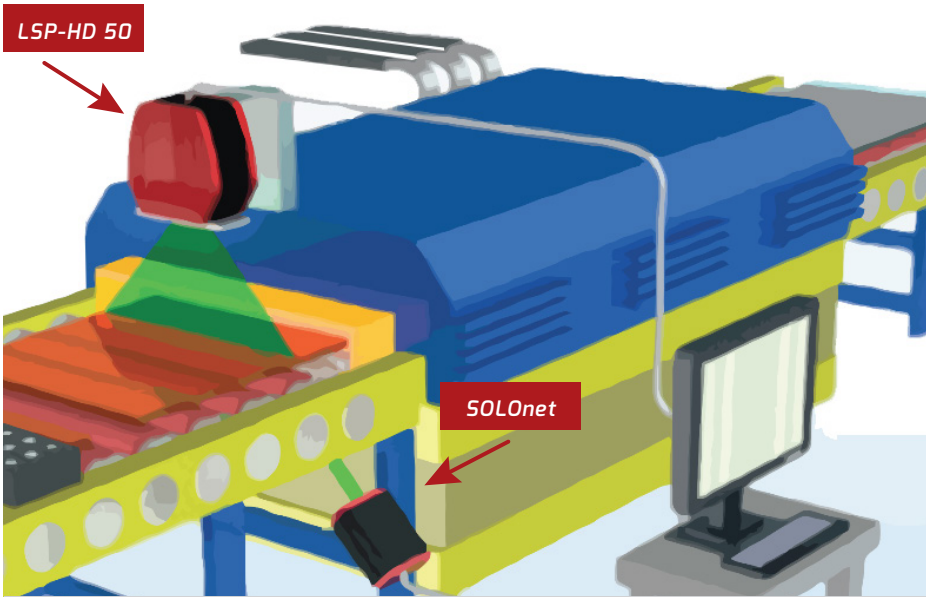
Single-spot thermometers are not suited to this measurement, as they may miss the glass lites and cannot monitor for a uniform temperature across the width of the glass.

Two or three temperature bias sensors – typically the AMETEK Land SOLOnet SN5 – may be installed on the underside of the process to provide a compensating measurement for any surface coating on the glass.

In recent years, Low E glass has been increasingly used for windows. Low E glass prevents much of the sun's non-visible radiation from entering the building. It also retains existing heat inside the building, reducing energy costs for the end user.

Low E glass does not emit much of its energy, and there are hundreds of different grades, all with different emissivity values, so a single compensation value cannot be used for all glass types.

Using an imaging system with highly stable electronics and sufficient gain to compensate for Low E glass is essential to achieve accurate compensated temperature measurement of each batch.



LSP-HD 50 MOUNTED ABOVE THE GAP BETWEEN THE FURNACE EXIT AND BEFORE THE QUENCH

CHALLENGES OF LOW EMISSIVITY GLASS

APP NOTE

The LSP-HD 50 can operate accurately with cooling in ambient conditions up to 60°C.

Mapping Low Emissivity (Low E) glass can be a challenge. Infrared thermometers are non-contact instruments that sense emitted radiation and convert the received signals into an accurate temperature measurement. Low emissivity means there is very little emitted radiation for the infrared instrument to measure.

When emissivity is low, reflectivity is high, so background sources of radiation can easily add extraneous signals to the measurement. An incorrect estimate of emissivity may lead to very large errors in temperature reading, so active emissivity compensation is required.

In addition, Low E glass is produced in the same furnaces as uncoated glass, so there is a huge variation in emissivity for any temperature measurement system to cope with.

AMETEK Land's solution compensates for each batch of glass and the emissivity value of that specific batch. First, a contact closure signal is taken from the furnace controls, signalling the start of the batch exiting the furnace, and the end of the batch.

Then, the underside temperature correction – as measured by one, two or three underside sensors – is applied. Only one of the sensors needs to have seen the glass lite for this to work correctly.

Operators typically mark the input roller with stripes to ensure a lite will pass over at least one of the sensors.

This 'true temperature' system is a big advantage to users of the LSP-HD 50, enabling the manufacturer to produce better quality tempered glass with fewer visual distortions, reducing waste product, increasing profit, and enhancing reputation.

THE LSP-HD 50 LINESCANNER

A compact infrared linescanner, the LSP-HD 50 can provide highly accurate temperature measurements even when the gap between the furnace and air quench is a narrow one.

It is able to scan 1000 data points at 150 scans per second, enabling detection of the smallest temperature variations, and is plug-and-play compatible with LANDSCAN WCA software for advanced analysis.

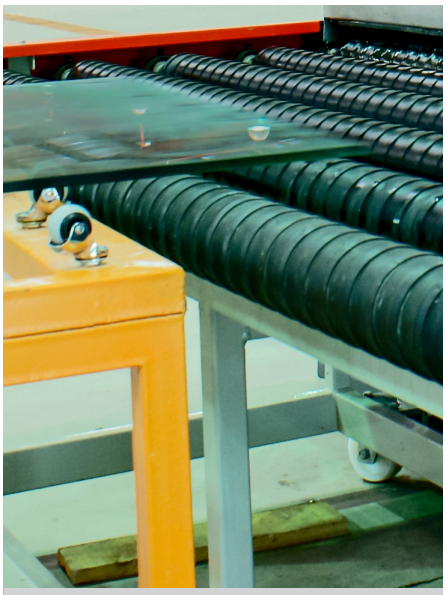
The LSP-HD 50 operates accurately without cooling in ambient conditions up to 60 °C and will continue to operate outside its specifications up to 70 °C. A mounting/cooling assembly is available.

Highly stable electronics provide the LSP-HD 50 with sufficient gain to compensate for very low emissivities, below 0.3.

When viewing Low E glass, an innovative reflector plate fits to the underside surface of the LSP-HD 50 enclosure.

This deflects much of the hot updraft at the furnace exit, and also prevents the LSP-HD 50 from seeing its own reflection, ensuring accurate measurements.

IN ADDITION TO GLASS TEMPERING, THE LSP-HD 50 IS IDEAL FOR MEASUREMENTS ON GLASS FLOAT LINES, FORMING AND BENDING PROCESSES, GLASS COATING AND SOLAR PANEL MANUFACTURE.



GLASS FLOAT LINES

FORMING AND BENDING PROCESSES

SOLAR PANEL

LSP-HD 50 FEATURES AND BENEFITS

FEATURES	BENEFITS
High-resolution optical system	Full-width measurement helps identify & analyse problems
Industry-leading 150 Hz scan speed	Process modelling improves process control
Designed to operate in harsh industrial environments	Accurate thermal records for product quality data
Plug-and-play installation via single Ethernet cable	Real-time thermal displays
Range of data output formats	Easy connection to process control system

AMETEK LAND SOLUTIONS FOR GLASS TEMPERING:

LSP-HD 50

Ethernet-controlled compact infrared linescanner, designed to produce advanced thermal images on moving processes.

LINESCANNING

SOLOnet SN5

Highly accurate, cost-effective single-spot infrared pyrometers, easily customised to meet precise measurement and control requirements.

FIXED SPOT PYROMETERS

FLT5B

Flexible, accurate infrared pyrometer specifically designed for surface temperature measurements on glass float line applications.

FIXED SPOT PYROMETERS

AMECARE
PERFORMANCE SERVICES

AMETEK Land's AMECare Performance Services ensure peak performance and maximum return on investment over the life of your equipment.

We will deliver this by:

- Proactively maintaining your equipment to maximize availability.
- Optimizing solutions to meet your unique applications.
- Enhancing user skills by providing access to product and application experts.

AMETEK Land's global service network provides unparalleled after-sales services to ensure you get the best performance and value from your AMETEK Land products. Our dedicated service centre teams and on-site engineers are trained to deliver the highest standard of commissioning, maintenance and after-sales support.

DOWNLOAD THE LSP-HD BROCHURE NOW: WWW.AMETEK-LAND.COM

LAND AMETEK®

CONTACT US

www.ametek-land.com

land.enquiry@ametek.com

We are fully committed to Quality Assurance. See all our accreditations at AMETEK-LAND.COM/QUALITY

MARCOMS_DOC-00119 Glass Tempering Application Note Rev 3