

# New Technology for Processing of Large Glass Sizes, Types and Shapes

## Mr. Mauri Leponen

Director

Architectural Glass Industry

Tamglass Ltd. Oy

## Keywords

## Abstract

The latest changes and modifications in the architecture, architectural design and construction methods set new challenges in to the glazing structures. The large glass sizes, LOW-E coatings including the so called super LOW-E's need to be tempered to meet the design of the latest architectural solutions and applications. The new technological methods in glass tempering are summarised along with the physical limitations in engineering and processing.

## Driving forces

The growing use of glass brings entirely new challenges and requirements to the safety glass market. It is natural that the main use is related in to the tempered glass, which is dominating the safety glass market. The popularity and use of energy-efficient windows has increased very quickly in Europe during the past decade. In Northern Europe and particularly in Scandinavia, energy-efficient windows have been used for more than 25 years. The obvious reason for this is the cold climate conditions, which has basically forced to use the glazing solutions with best thermal characteristics like insulated glass units and double facades. The normal insulated glass units (IG) have not been even enough for years and new glass types had to be developed. The tendency has been natural due to the high-energy price and the comfortable development in house design. The breaker in the use of coated glass has been Germany, where new heat insulation regulations were redefined in 1995 in a way, which in practice meant standardisation of the use of Low-E glass in windows.

The German regulations are based on energy balance considerations where the heat coming through the window is taken into consideration as

well. Other European countries followed at a somewhat slower pace but now it is fair to say that the use and application of Low-E glass has become standard in many European countries. The next breakthrough will most probable happen in UK, where the legislation is under development and it is expected to come out in very near future. It is obvious that the development continues over the whole EU countries with few years time.

Low-E glass applications have increased on other continents as well. Today more than 90 percent of all windows sold in North America are insulated glass units and that high percentage is expected to rise even further. Some marketing research indicates that 20 percent of all windows in the U.S. today make use of low emissivity glass and that proportion is expected to grow by more than 50 percent over the next five years. The window structures in the Asia-Pacific area are mainly single-glazed. This market, however, will probably witness an increased demand for insulating units as air conditioning becomes standard and building codes more strict.

In the near future the most important conclusion and driving forces from the development point of view are

- energy control (LOW-E)
- large windows with maximum daylighting and "miniframes"
- smart windows and glazing with integrated solar panels
- increasing safety and security

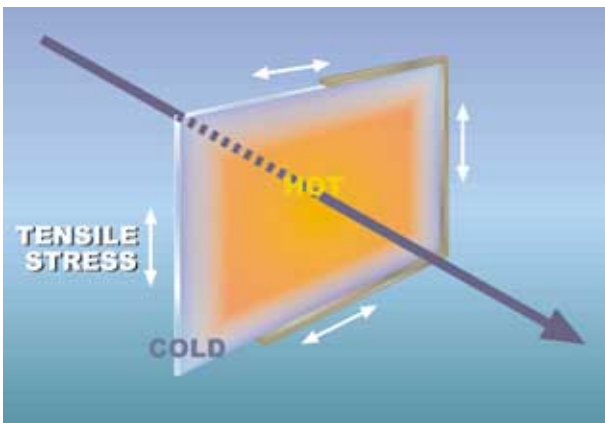
## Large windows and daylighting

The use of low emissivity glass has helped preserve the energy efficiency of window structures and it has thus sustained the trend in office and other commercial construction applications which moves towards larger glass surfaces and better daylighting properties. This

results in to the high thermal stress in to the window construction, which can be seen normally as a glass breakage. The solution to avoid thermal breakage in large window structures is tempering process, which increases the thermal resistance more than two times when compared in to the float glass.



Picture 1: Example of the today's glazing.



Picture 2: Thermal stress in large window application structure.

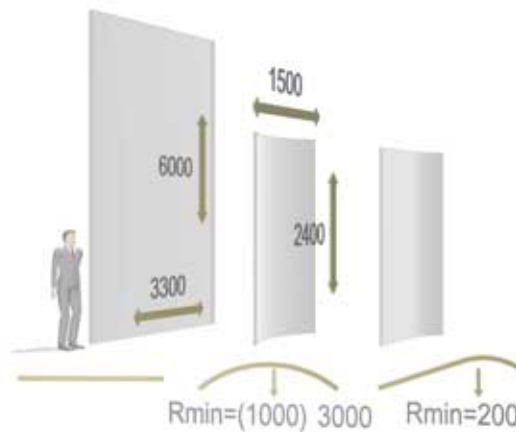
## Ever larger dimensions and processors

The designers and architects have found the large windows and shapes as a natural part of their design tool. Part of this process has been the need to bring natural day light in to the buildings. The large glass surfaces are the most natural way to provide it. Less frames will support the idea of the architects in designing the artistically glorious result.

The forerunners of this have been the development mainly in Europe and Far East. These areas covers more than 90 % of the so called large sized flat tempering furnaces in the whole world which is the result of the demand in the market by building design offices.

Manufacturers of tempered glass have faced

the pressure from the market. It is obvious that the tempering machinery manufacturers are thus also faced with the challenge of developing new processes which are better and more easily controlled and allow flexible production of varying large glass sizes and wide thickness variation. Mixed production, which is so important from a competitive point of view, and the trend towards shorter delivery times place stringent demands on streamlined co-operation between glass manufacturers, glass processors and manufacturers of tempering machinery.



Picture 3. Large glass dimensions in construction design

## The large glass sizes and processing

The processing of Low-E in itself requires special attention and care which in turn emphasises the responsibility and capability of the whole process chain like

- durability and lifetime of the coating
- transportation
- pre-processing
- tempering process
- post processes.

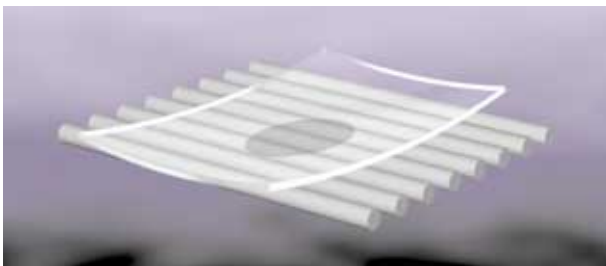
The machinery manufacturers of the tempering furnaces will see challenge as it locates in the middle of process chain.

Normally the traditional tempering systems on the field will not be sufficient in supporting the large glass sizes in heating phase. The reason for this is the heat transfer and its ratio in big glass sizes between the edges and middle part of the glass. Typically the effect in the furnace is that the large glass size is bending as the middle part of the glass will not get enough heat when compare in to the sides.

This effect can be seen in traditional furnaces and so called convection furnaces where the high air flow is increasing the heating of the edges while passing along the edges of the glass (picture 4). This phenomena is maximised for thin glass and

LOW-E coatings.

According to the test, experiments and tens of supplied furnaces in large sizes, the new heating technology with feedback calculation are controlling the phenomena and the flatness can be reached by focusing the heat (radiation and convection) with profiles to provide same heating speed in the middle part of the glass and near the edges (picture 5).



Picture 4. Example of the glass bending Picture.



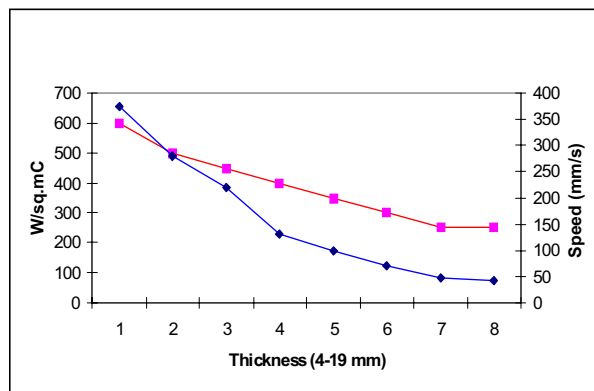
Picture 5. Focused heating.

It is obvious that the quenching is as important part as the heating. Typically this part is not taken care or it is not studied by the manufacturers. The longitudinal air flows along the whole big glass surface requires a special attention. The air distribution from the top and bottom part of the quench has to be distributed differently than in the normal furnace sized.

It is very typical that the large glass sizes are requested in many thickness and glass type variations. Depending on the thickness the tempering process should be adjustable not only for the heating control but also for pressure and speed control of transfer speeds. The following table (picture 6) shows the study of the relation between the transfer speed and heat transfer factor for each thickness variation (large glass size - clear float).

Bending process

The bending process of large glass sizes is common to the flat glass tempering in the heating



Picture 6. Transfer speed and heat transfer relation.

phase. The large glass sizes in construction field are more and more including LOW-E coatings. The driving factors are same as for the flat glass:

- energy control (LOW-E)
- large windows with maximum delighting and "miniframes"
- new value added products for the market
- bent shapes in buildings and appliances
- increasing safety and security

The bending and tempering in large sizes has been made traditionally by using

- vertical furnaces with mould or
- box type furnaces with mould

The advantages of the mentioned systems are reasonable low investment level and on the contrary high mould cost and low capacity per glass piece. It natural as the buildings are not standardised and the glass sizes in the same building may have various radius and sizes.

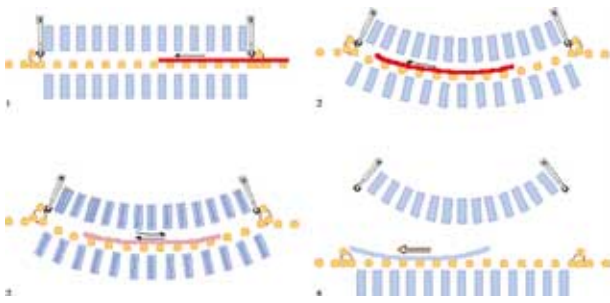
The latest technology which has been successfully used in high quality OEM /ARG market for automotive is available for large dimensions in architectural applications. The advantages of the mouldless system are

- constant radius including IG applications
- repeatability for heat strengthened /tempered and laminated glass
- radius more than 15 -20 meter under control
- LOW-E capability depending on the heating technology
- No mould cost per piece
- Flexible production
- Thin glass tempering down to 3. 8 mm
- Flat glass option

When regarding to the heating phenomena it can be noted that it is same for bent and flat glass tempering. Depending on the shape of the glass, type and size the same rules are requested in heating control.

Mouldless bending of large glass sizes

The bending solution for mouldless bending and tempering requires high repeatability and



Picture 7. Example of the mouldless bending and tempering system for large glass sizes

flexibility which can be reached by

- mechanically precise solutions (joints, bearings, locking systems..)
- bending controlled by a computer
- bending of the glass mostly by gravity and assisted only ( for example by the press wheel system)
- controlled air distribution ( area and timing ) on the large glass surface

### References

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