Expert Series:
Manufacturing Process for Float Glass

GUARDIAN® GLASS

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History

Flat glass (also known as float glass) refers to sheets of raw glass commonly used today in the automotive and building construction industries. Beginning in the 1960s, the preferred method of making flat glass evolved from sheet glass and plate glass to float glass. The basic manufacturing process of these methods remains the same and involves combining raw materials under high temperature to produce molten glass.

The sheet glass process involved drawing the glass ribbon vertically out of the molten glass pool and then cooling to a hardness that could touch the drawing rollers. While, at the time, sheet glass offered lower cost and higher-gloss appearance, it had undesirable distortion from inconsistent viscosity of the molten glass.

In order to eliminate the distortion, the plate glass method was developed. Plate glass involved feeding molten glass horizontally through continuous rollers and then grinding/polishing its surfaces to eliminate roller marks and optical distortion. While this method provided better optical quality, it had much higher cost than sheet glass. Despite the improvements in the sheet and plate glass process, the glass industry endeavored to develop a new method that provided higher quality and lower cost.

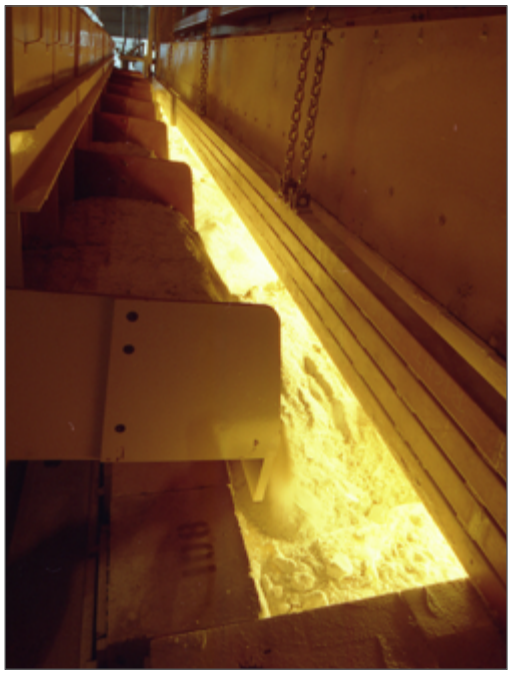
Float Glass

In 1959, the float glass process was launched by Pilkington. The float glass technology rapidly replaced the older glass manufacturing methods and transformed glass production around the world. Today, the vast majority of flat glass utilized is manufactured by the float glass process.

Making float glass begins with a mixture of the raw materials based on approximately 50% silica sand, soda ash, limestone, rouge and dolomite. These materials are mixed in huge agitators and processed into a mixture at a batch house. A blend comprised of around 80% of the mixture and 20% recycled scrap glass, also known as cullet, is fed into the furnace and melted at around 2900˚F (1,600˚C).

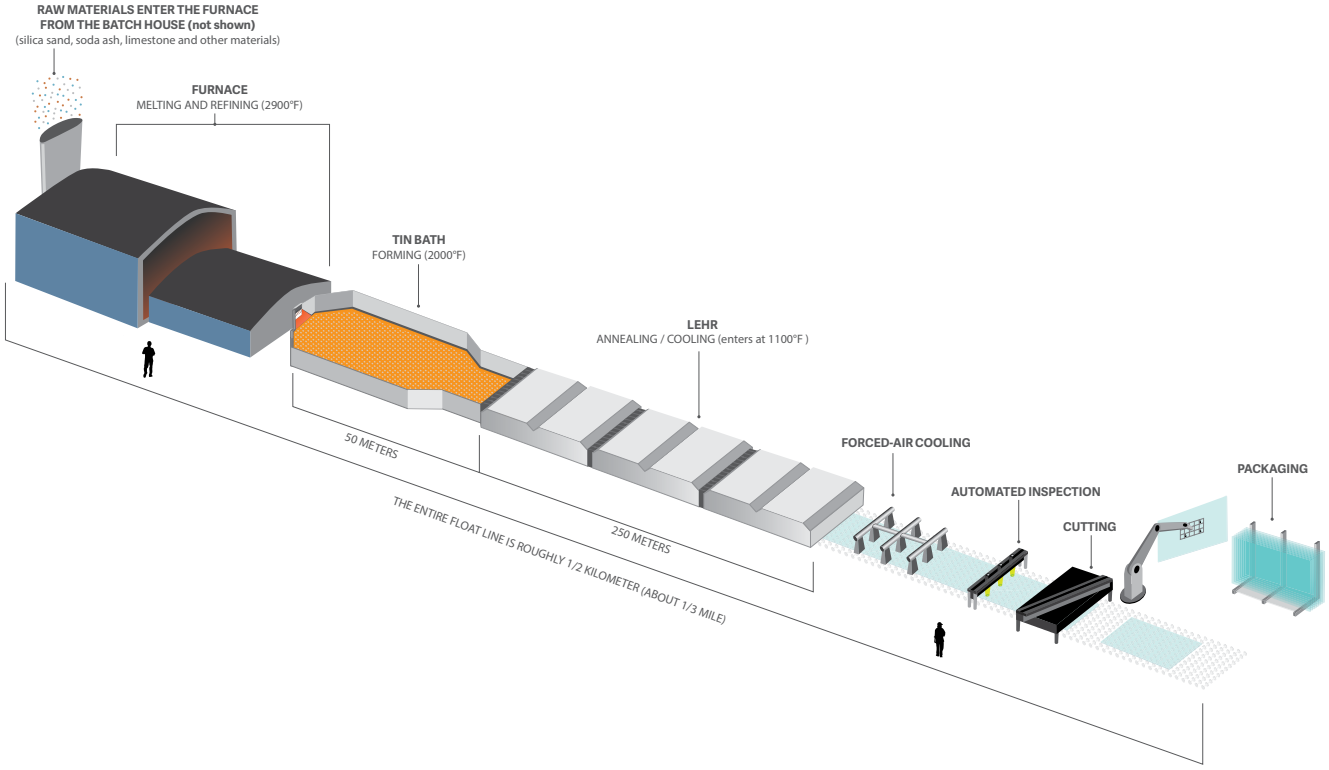
Float Glass Mixture

The molten glass is fed into the conditioning basin and begins to cool to approximately 2200˚F (1,200˚C) before flowing over a refractory spout into the tin bath. This mixture is constantly fed, or “floated”, onto a molten tin bath.



While on the tin bath, the molten glass “floats” and spreads out evenly over the surface of a liquid tin. Due to the inherent surface tension of the liquid tin, and the fact that glass has less density than tin, the molten glass does not sink into the tin bath, but rather floats on the surface. This method offers glass flatness and limits distortion. At the end of the tin bath, the temperature is reduced from about 2000˚F (1,100˚C) to 1100˚F (600˚C) and turns a viscous mass of molten glass into a solid glass ribbon.

During the cooling process, the temperature of the glass ribbon is reduced to ambient temperature through controlled cooling in an annealing lehr to ensure that no permanent stress remains in the glass. During the annealing process, the glass ribbon temperature is still approximately 125°F (50°C) and further cooled by forced air.

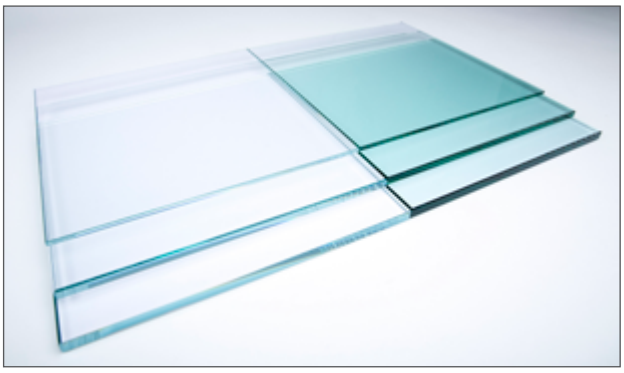


A laser or image camera is used during an inspection process to identify blemish such as inclusions, bubbles and other defects. Once detected, defects are cut out of the glass and sent to the batch house via the cullet return system to be used in the mixture of raw material. Float glass quality is addressed in ASTM C1036 Standard Specification for Flat Glass.

At the end of the float production line, the glass ribbon is trimmed at both edges to remove the attenuator marks and cut to jumbo, stock sheet or customer-specific dimensions. After cutting, the float glass is sprayed with a separation powder to prevent the individual glass sheets from sticking together and to avoid scratches when it is stored in glass packs during transportation. Sheets of glass can be immediately processed (fabricated), stored for future processing or shipped to customers.

The common size of float glass sheets produced by Guardian Glass is 96" x 130" (2.4m x 3.3m) or 102" x 130" (2.6m x 3.3m) or jumbo sizes of 130" x 204 (3.3m x 5.18m) or 130" x 240" (3.3m x 6m). Common thicknesses range from 1.7mm – 19mm. Specialized float lines can also produce thinner or thicker glass.

Low-iron Glass



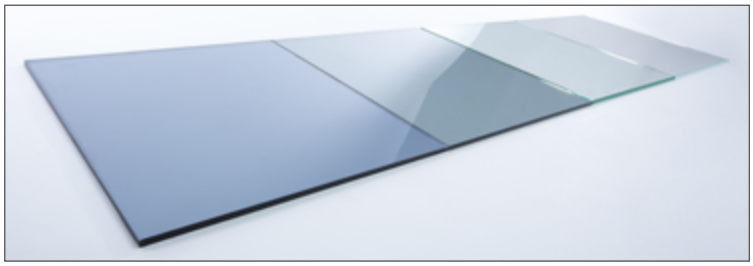
Low-iron float glass refers to glass with significantly lower iron content that results in a more neutral appearance and slightly higher light transmittance than standard clear float glass. The manufacturing process used to create low-iron glass reduces iron oxide content from raw material, resulting in less green color and ultra-transparent glass in comparison to standard clear glass. Because the green cast of standard clear glass is amplified at the edge as size and thickness increases, low-iron glass is often used for frameless applications with exposed glass edges call for strikingly clear edges.

While there is not industry standard specification for the content of iron in low-iron glass, ASTM C1036 standard defines low-iron glass as below:

> *3.2.18 low-iron glass, n – glass formulated to have transmittance in the visible spectrum higher than that of clear glass of the same thickness.*

Typically, standard clear float glass produced in conformance with ASTM C1036 standard has a visible light transmittance of approximately 89% for 6 mm thickness while low-iron glass has a visible light transmittance of approximately 90% or higher for the same thickness.

Tinted Glass



Tinted glass is made by adding various colorants to the normal, clear raw material batch to create a desired color. The following table provides some examples of metal oxides added to the basic formula of glass to get a variety of colors.

Table 1

Tinted Float Glass — Additional Colorants	
Color	Metal Oxide Added
Green	Iron
Bronze	Iron & Sulfur; or Selenium
Blue	Copper & Cobalt
Gray	Selenium, Cobalt & Iron

Tinted glass has lower solar transmittance and higher solar absorptance than standard clear and low-iron float glass. It is often used to reduce solar heat gain from entering the building and achieved specific aesthetic intent. Its high solar absorptance can result in higher risk of thermal induced breakage, heat-treating is commonly required for tinted glass to help mitigate the risk of thermal breakage.

General Properties of Soda Lime Float Glass

The following table presents the average mechanical and physical properties of soda lime float glass:

Table 2

Mechanical And Physical Properties of Soda Lime Float Glass		
Property	U.S. Customary Unit	Metric Unit
Density	156 lbs/ft^3	2,500 kg/m^3
2Hardness (Knoop)	0.78 - 0.86 x 10^6 psi	545 - 605 kg/mm^2
Poisson's Ratio	0.22 - 0.23	0.22 - 0.23
Young's Modulus	10.4 x 10^6 psi	72 GPa
Shear Modulus	4.3 x 10^6 psi	30 GPa
Bulk Modulus	6.5 x 10^6 psi	45 GPa
Elongation (%)	< 0.1%	< 0.1%
Thermal Conductivity (at 2 °C)	0.578 BTU/(hr · ft · °F)	1.00 W/(m · K)
Coefficient of Linear Thermal Expansion (room temp to 350° C / 660° F)	4.7 - 5.0 x 10^{-6}/°F	8.5 - 9.0 x 10^{-6}/°C
Specific Heat	0.20 Btu/(lb ·°F)	837 J/(kg ·K)

Learn More About the Manufacturing Process of Float Glass

If you need more information, Guardian's Technical Services group is available to assist with addition questions about the Manufacturing Process of Float Glass. Please contact Guardian at https://www.guardianglass.com/us/en/contact or call 855-58-GLASS (45277).

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