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CONVENTION 2008

We the people


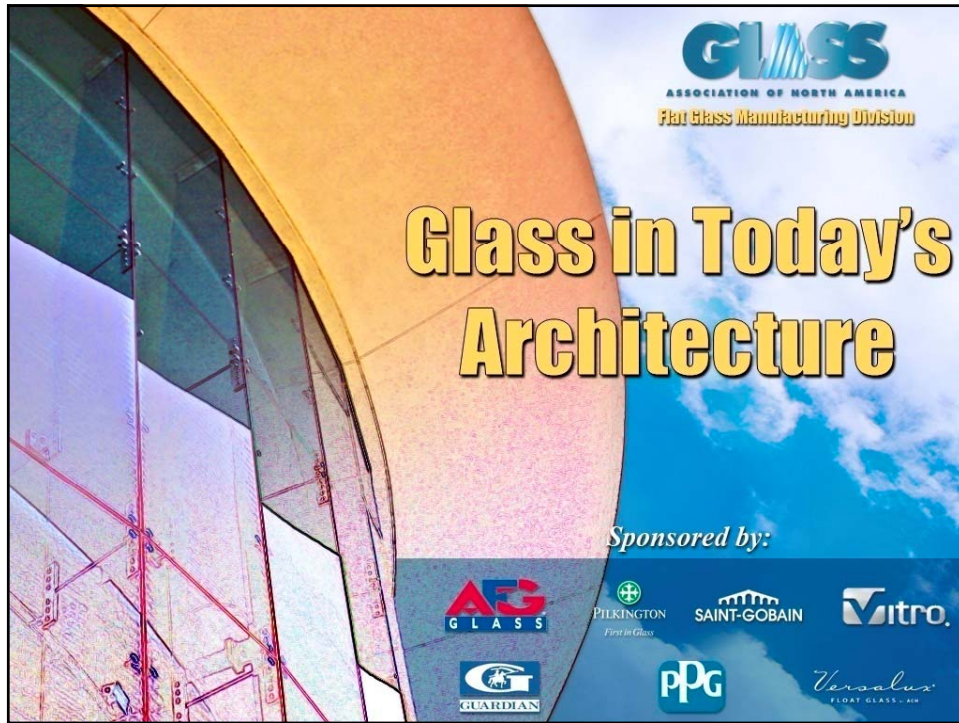
Glass in Today's Architecture Flat Glass Manufacturing Process

Glass Association of North America
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Learning Objectives

Participants will be able to:

- Explain the history of flat glass manufacturing
- Summarize the make-up of the flat glass materials
- Describe the flat glass manufacturing process
- Provide details on various glass substrates
- Comprehend flat glass quality standards

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Glass in Today's Architecture

The History of Glass

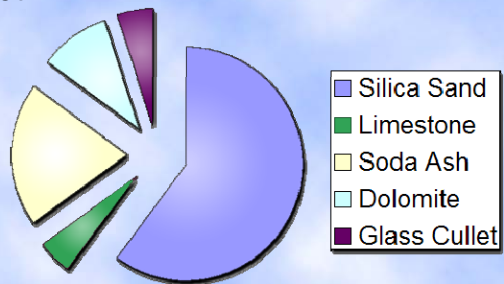
- ▶ Discovered over 4,000 years ago
- ▶ 7th century Syrians – crown method lump of molten glass spun to flat shape
- ▶ Early 20th century – sheet glass drawn vertically out of molten glass
- ▶ Plate glass – molten glass poured onto table, rolled to flatten – ground & polished into a plate
- ▶ 1959 – float glass - molten glass flows from furnace onto bath of molten tin formed to continuous ribbon of glass
- ▶ 1960's and beyond – multi-color, insulating, heat-treated glass

Glass in Today's Architecture

Flat Glass Manufacturing

Batch Materials

- ▶ Silica Sand
- ▶ Limestone
- ▶ Soda Ash
- ▶ Dolomite
- ▶ Glass Cullet



Glass in Today's Architecture

Flat Glass Manufacturing

- ▶ Over time, 100% of the internal cullet is recycled
- ▶ Typically 15-30% of a given batch is cullet



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Flat Glass Manufacturing

Process

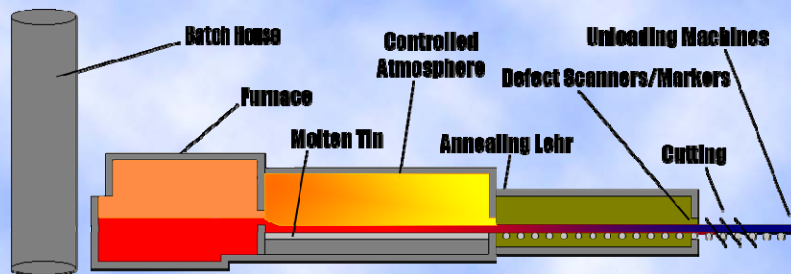
- ▶ Batch heated to 2900° F
- ▶ Natural gas is the principal means of firing the flat glass furnace in North America
- ▶ Molten mass leaves conditioning zone at 1900° F



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Flat Glass Manufacturing

Float Glass Line



Glass in Today's Architecture

Flat Glass Manufacturing

Annealing

- ▶ **Slowly cooling the ribbon of glass from 1100° F to 200 ° F**



Glass in Today's Architecture

Flat Glass Manufacturing

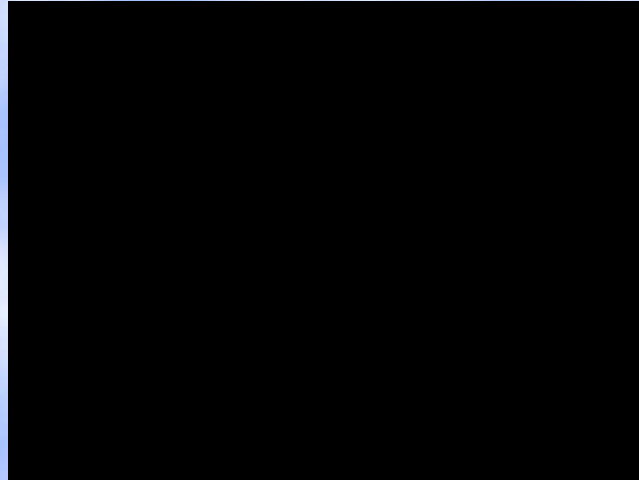
Float line operation:

- ▶ **24 hours a day**
- ▶ **7 days a week**
- ▶ **365 days a year**
- ▶ **For 10 years +**
- ▶ **Typical furnace produces between 300 - 600 tons of glass per day**
- ▶ **In a year, a typical furnace produces enough glass that a 1 foot wide ribbon circles 3/4th of the Earth at the equator.**



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Flat Glass Manufacturing



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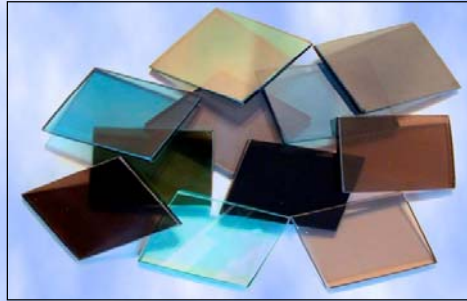
Flat Glass Manufacturing

- ▶ **Batch materials for tinted glass substrates include selenium, cobalt, etc.**
 - ▶ **Other trace materials can be used**

Glass in Today's Architecture

Glass Substrates

- ▶ Clear
- ▶ Green
- ▶ Grey
- ▶ Bronze
- ▶ Blue
- ▶ Blue Green
- ▶ Low Iron
- ▶ High Performance Substrates



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Tinted Glass Substrates

- ▶ Design / development of spectrally selective substrates
 - ▶ Goal is to achieve solar control and high-visible light-transmission
- ▶ Some tinted glass substrates perform better than others in their reaction to solar radiation
- ▶ Varied aesthetic and performance requirements

Glass in Today's Architecture *Specialty Glass Substrates*

- ▶ **Low-Iron Glass**
 - ▶ Typically used for color neutrality, absence of green cast



Glass in Today's Architecture *Specialty Glass*

- ▶ **Patterned Glass**
 - ▶ Produced by passing molten glass ribbon through roll(s) with patterned surface
 - ▶ Used for decorative purposes



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Specialty Glass

- ▶ **Wired glass**
- ▶ **Produced by introducing a welded steel mesh into molten glass with rollers**
- ▶ **Fire-rated glazing material**
 - ▶ **Has limited fire-rating abilities**



Glass in Today's Architecture

Glass Thicknesses

- ▶ **Design choices for glass thickness is guided by ASTM E 1300 – *Standard Practice for Determining Load Resistance of Glass in Buildings***

	1/8"	5/32"	3/16"	1/4"	5/16"	3/8"	1/2"
Clear	✓	✓	✓	✓	✓	✓	✓
Green	✓	✓	✓	✓	✓		
Grey	✓	✓	✓	✓	✓	✓	✓
Bronze	✓	✓	✓	✓	✓	✓	✓
Blue				✓	✓	✓	✓
Darker Green	✓		✓	✓	✓	✓	✓
Darker Grey	✓		✓	✓			
Darker Blue		✓		✓	✓	✓	✓
Low Iron	✓	✓	✓	✓	✓	✓	✓



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Flat Glass Quality

- ▶ **ASTM International consensus standardization process**
- ▶ **ASTM C 1036-06 – *Standard Specification for Flat Glass***
- ▶ **Additional ASTM standards are available for fabricated glass products – www.astm.com**



Glass in Today's Architecture

Flat Glass Manufacturers

North American flat glass manufacturers

- ▶ **AGC**
- ▶ **Cardinal Glass Industries**
- ▶ **Guardian Industries Corp.**
- ▶ **Pilkington North America, Inc.**
- ▶ **PPG Industries, Inc.**
- ▶ **Saint-Gobain Glass**
- ▶ **Vitro America, Inc.**
- ▶ **Zeledyne**