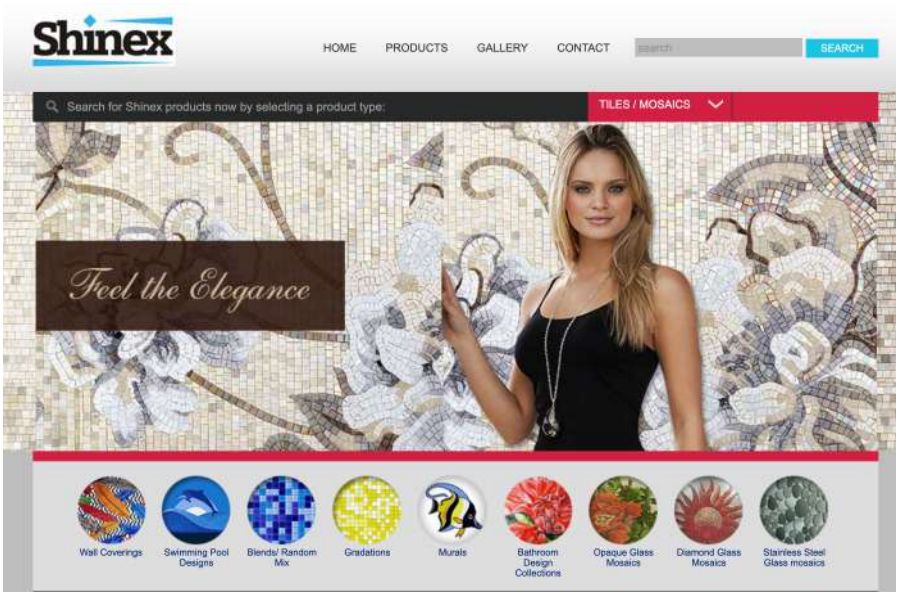


STUDY MANUFACTURING OF MOSAIC GLASS TILES

Study visit at Manufacturing plant of Shinex Global, Nagpur

ABSTRACT

Understanding in detail various stages of manufacturing of architectural mosaic glass tiles used in making of various murals.

By: Khushi Dave

Factory visit under guidance of Mr. Sachin Palsokar, Founder and Director of Shinex Global, Nagpur

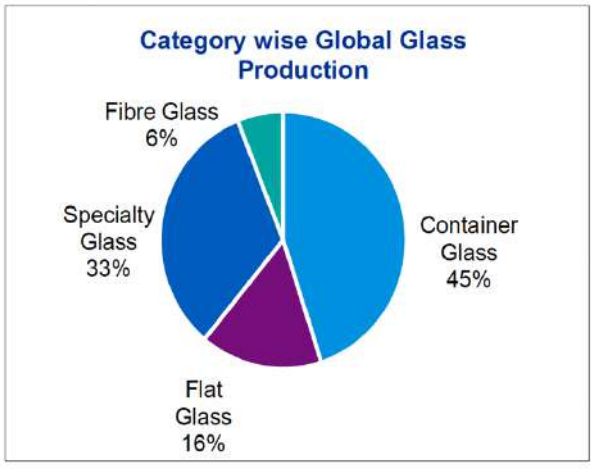
Introduction:

Glass is an inorganic transparent product made from silica sand, limestone, soda ash and sodium carbonate. It differs in colour, density and quality based on further chemical composition. Its properties of transparency, scattering, absorption and thermal response allows multiple applications.

Glass is a global product with utility in small, medium and hi-tech applications ranging from household mirrors, solar panels, optical fibre to radiation shielding glasses in nuclear facilities. It is perhaps most widely known for its extensive use in glass windows and bottles. It is increasingly being used in construction applications. Tempered glass, in particular, is being employed in roofing applications as well as in manufacturing of glass windows. In developing countries, tempered glass is replacing standard glass in roofing applications on account of its high strength properties. Nowadays, even waste glass in the powder form is gaining usage as part replacement of cement in concrete, a trend set to gain momentum over the coming years.

The world glass industry generates a revenue of USD 75 billion and is still evolving in terms of performance (structure stability in terms of chemical, physical and thermal effects), energy usage, emissions, furnace design and environmental friendly technology. One of the main reasons for the growth of glass industry is that it provides a very attractive packaging alternative. In Europe, the largest producer of container glass (bottles, jars, etc.), glass stands for 34% of total packaging market for beverages and has an annual growth rate of 4.2%1. More than 90 per cent of glass industry products are sold to other industries. Glass manufacturing is significantly dependent on the building construction sector, car manufacturing and the food and beverage industry. However, there are also smaller volume sectors that produce high-value technical or consumer products.

Different glass products require different furnace designs ranging from recuperative, regenerative to oxy-fuel vis-à-vis the combustion system used. Furnaces in turn uses different types of refractories that range from acidic, alkaline to inert type based on oxide species contained. Refractories are further connected to diverse parameters as raw material selection, batch moisture and/or other furnace parameters that need research, development and improvements.

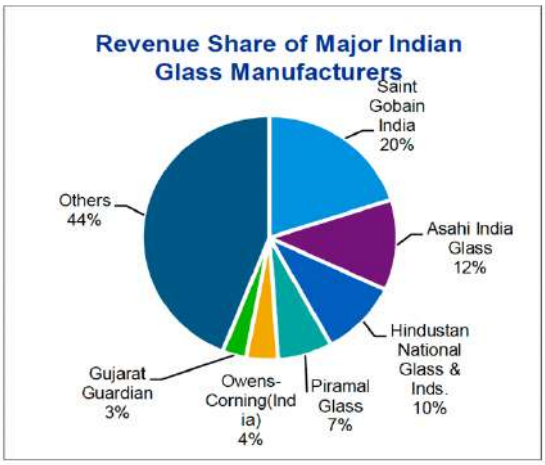


Global Glass Industry

Consumption of glass is highest in countries such as Europe, China and North America, that together account for almost 74 per cent of global demand for glass2. Europe is the most mature glass market and has the highest proportion of value added products. The major glass producing countries in the world are Germany, USA, UK, China and Japan while the major importing countries are USA, Germany, Japan, France, Italy and Australia.

Rising demand from wide applications in residential and commercial infrastructure projects, increasing demand for glass substrate from automotive & transportation sector, growth in electronics and semiconductor industry, infrastructure development in emerging economies, have propelled the demand for glass over last few decades.

The most common products manufactured in the global glass industry are flat glass, glass containers, and fiberglass and specialty products such as lenses, optic fibres, mirrors, and glassware and TV tubes. Lower quality float and sheet glass production is gradually being replaced by high quality float glass across the globe. The top 5 global companies account for production of almost 60-70% of the total high quality float glass in the world. These companies are NSG/Pilkington, Saint-Gobain, Asahi and Guardian 3. Asia Pacific is expected to remain the largest float glass market due to increase in urbanization, strong housing demand and increasing investment by glass manufacturers in this region



Indian Glass Market Overview

The glass industry in India has made a steady progress since independence and has matured a lot over last few decades. The glass making methodologies prevalent in the country ranges from traditional mouth blown, basic hand-made practices to modern electric techniques of glass melting/making. This reflects the diversity and expanse in the sector with a varied range of entrepreneurial establishments including Micro, Small, Medium and Large enterprises in the sector. The growth in glass sector has been primarily driven by India's booming automotive and construction sector. As per ASSOCHAM report, glass industry was estimated at around USD 4.9 bn in 2015 with the share of organized market standing at 55%.

Exports of glass & glassware in India decreased to 100.54 USD million in 2016 from 385.36 USD Million in 2015. Exports of glass & glassware in India averaged 294.37 USD Million from 1996 until 2016, reaching an all-time high of 701.82 USD million in 2014 and a record low of 53.22 USD million in 1998.4Majority of the items that are exported from Indian market are bottles and jars, glass fibres, glass beads, float glass and sheets, electrical fittings, etc. Lately the growth has been sluggish in the glass sheet and glass fibre whereas the growth in the glassware sector has been on an upscale.

The glass industry is mostly confined to Uttar Pradesh, Maharashtra, West Bengal, Bihar, Jharkhand and Punjab. Ceramic industries in Uttar Pradesh mainly produce sheet glass, hollow and pressed wares (bulbs, chimneys, reflectors and motor headlights), while Bengal and Maharashtra are famous for glass tubes, test- tubes, beakers and flat glass. Punjab predominates in the production of hollowware and scientific and precision goods.

The most common types of glass are made primarily with soda ash and silica, as well as other additives. Indian is one of the world's fastest growing Soda ash market driven by India's high economic growth rate. The per capita consumption of container glass in India is 1.8 kg as compared to 17 kg consumption in the developed countries. This reflects a huge potential to be capitalized upon in the Indian glass market.

The industry is characterized by the increasing use of processed and high-performance glass in the automotive and architectural sectors because the Indian customer has become more aware about the importance of glass in effectively addressing the concerns of safety and energy efficiency.

Manufacturing plant visit of Shinex Global at Nagpur India

In order to understand the manufacturing process of architectural glass tiles in detail, I visited the manufacturing plant of Shinex Global at Butibori, Nagpur, India. I was guided by Mr. Sachin Palsokar, founder and Director of Shinex Global.

As said by Mr. Sachin Palsokar, ***"Shinex Global Mosaics is the perfect blend of Art and Technology. The Glass mosaic murals are created using the World's best craftsmanship with the latest technology to produce and manufacture it."***

Architectural Glass Manufacturing Process:

The glass mosaic murals manufacturing process consists of following key stages

1. Cutting of low iron glass to required size tiles
2. Cleaning of glass tiles for colouring
3. Addition of paint for required colour
4. Preheating and Heating of tiles
5. Annealing
6. Creation of finished product

Stage 1: Cutting of low iron glass to required size tiles

Different products require different types of glass. Two common categories are low-iron and clear. Common perception is that clear glass is the most transparent, however, this actually is not the case. Although clear glass does not have substantially high iron content, it does have more than low-iron glass.

These higher iron levels produce a greenish tint appearance, which gains prominence as the glass thickens. This is a result of the natural presence of iron oxide from elements such as sand, or from the cask or container whereby the glass was actually melted. Despite being a logical process, this can cause issues within certain applications.

While clear glass is suitable for projects not requiring high-level displays or added decorative elements, low-iron glass is likely the better choice for markerboards, frameless glass walls and glass dividers.

Hence, to manufacture glass mosaic murals Shinex Global, uses low iron glass as basic raw material.

Low iron Glass:

Float glass manufacturers create low-iron glass, also known as extra-clear glass or optically clear glass, by reducing the amount of iron in the molten glass formula. This type is more transparent than regular glass, and doesn't have that greenish tint. In fact, modifying the iron content can increase the light transparency by 5 to 6 percent.

Low-iron glass also increases the flow of natural light, for added, seamless continuity between spaces.

With a clearer canvas, back-painting is much smoother, making the finished product the exact shade for your project. Therefore, architects and designers prefer glass fabricators to use low-iron glass when color-matching.

Since the edgework of low-iron glass is less green than clear glass, it's not just suited for colour matching—it is also appropriate for retail display cases and shelves—leading to opportunities for potential conversion through compelling product displays.

The characteristics of low-iron glass are as follows:

- Extreme transparency
- High light transmission
- Achromatic edges
- Light transmission is higher than clear float glass, with heavy thicknesses in particular (low-iron glass increases light transmission by 3-4%, reaching 7-8% with thicknesses above 8 mm)
- Enhanced glass aesthetics and brightness
- Allows for a perfect colour restitution when observed through the glass surface
- Available in 15 and 19 mm thickness

In this stage low iron glass is cut into required size tiles.

Picture 2: Clear Glass Vs Low iron glass

Stage 2: Cleaning of glass tiles for colouring

Colouring glass isn't always as easy as adding a certain amount of a particular element or compound to glass. Impurities in the glass may require a decolourizer to precipitate out iron and sulphur compounds so the glass starts out clear. Two common decolourizers are manganese dioxide and cerium oxide. Even then the chemical composition of the glass plays a large role in the colours produced by additives.

Picture 3: Cleaning Section

In this stage the cut glass tiles are cleaned thoroughly and dried, before the paint for required colour of the batch is applied.

Stage 3: Adding paint to provide required colour to tiles:

This is one of the most important stage for architectural mosaic glass murals preparation as it can impact the display impact of the architectural glass.

Key factors contributing to observed colours are:

- Absorption/Reflection Spectrum of Material (transparent, opaque, diffuse scattering)
- Spectrum of Light Source (various light bulbs, sun, etc.)
- Spectral Detection Sensitivity of Eye (most sensitive to green/yellow, least at violent and red ends)

Sources that contribute to colour of glass are as follows:

- Ionic (charge transfer, ligand field)
- Metal Colloids (Au, Ag, Cu, As, Sb, Pb, others)
- Semiconductor Particles (primarily Cd based)
- Insulator Particles (opal glasses)
- Defects (radiation, solarization)

List of some colourants used for adding colour to glass:

Colour	Colourant
White	Antimony Oxide; Tin dioxide; Arsenic compounds
Red	Gold Chloride; Copper + Tin, Selenium + Cadmium
Pink	Selenium Compounds; Erbium compounds
Purple	Manganese oxide; nickel neodymium; gold + tin(II) chloride
Blue	Cobalt; Copper Oxides
Green	Iron oxides; Chromium
Amber or Orange	Iron oxides; Carbon oxides; Manganese oxide; Titanium; Sulphur compounds

Picture 4: Drying and Painting section

Picture 5: Full view of washing, drying and painting section

Preheating and Heating Section:

Post application of pain the glass tiles are arranged on ceramic tiles and are fed to electric furnace.

Electric heating and melting is an epitome of efficiency. The energy is fed directly into the glass and even the top surface of the glass remains cold. Efficiencies above 75% are the norm. But availability and cost of electric energy have been the major constraints worldwide causing this technology to take a back seat. Now however with photovoltaic solar panels bringing in cheap and affordable power, the time is not far when the world at large will shift to electric furnaces.

Electric furnaces receive all of the energy through electrical heating, and not by combustion systems. Electric current is passed through the glass by means of electrodes and the glass is heated. Due to the design of these furnaces, are suitable for special glass production like glass tiles used by Shinex for mosaic murals.

Picture 6: Tiles fed to furnace for preheating and heating

Stage 5: Annealing:

This is a very important process and if not carried out properly, can lead to breakage of glass articles under very slight shocks or disturbances. If glass articles are allowed to cool down rapidly, the superficial layer of glass cools down first as glass is a bad conductor of heat. The interior portion remains comparatively hot and it is therefore in a state of strain.
Annealing can be done in two ways:

- Annealing Lehr: The annealing kiln called Lehr is constructed in such a way that there is gradual decrease in temperature from one end of flue to the other. The red-hot articles of glass are allowed to enter at the hot end of Lehr and they are slowly moved on travelling bands. They become cool when they reach the cool end of flue. This method is useful for large scale production. At Shinex this method is used for annealing.

- Oven Treatment The red-hot glass articles are placed in ovens where temperature can be controlled. After placing the glass in ovens, the temperature is slowly brought down. This method is useful for small scale production.

Picture 7: Annealing Section

Stage 6: Finishing:

The cooled glass obtained after annealing are subjected to a number of operations such as cleaning, polishing, grinding, rounding edges, etc., for bringing them to a useable form.

Picture 8: Full length view of electric furnace

In Conclusion:

The visit under the guidance of Mr. Sachin Palsokar, provided me a practical insights into converting a colourless low iron glass into colourful mosaic glass tiles that are used to make various beautiful glass mosaic murals to make this world a better place to live.