GLASS

Glass is an amorphous substance having homogeneous texture. It is a hard, brittle, transparent or translucent material. Glass has been extensively used in building construction since long for glazing doors, windows, curtain walls and for insulation and for decoration. Rapid advances in glass technology have opened up newer avenues of its use in the construction industry.The most common types used in building construction are sheet, plate, laminated, insulating, tempered, wired and patterned glass.

- **PRINCIPAL CONSTITUENTS**

The raw materials used in manufacturing glass are sand, lime (chalks) and soda or potash which are fused over 1000°C. Oxides of iron, lead and borax are added to modify hardness, brilliance and colour. The functions of the various ingredients are as follows.

Silica: is used in the form of pure quartz, crushed sandstone and pulverised flint; should be free from iron contents for best quality glass. Since it melts at very high temperatures (1710°C) carbonates of sodium or potassium are added to lower down the fusing temperature to about 800°C. These also make liquid silica more viscous and workable.

Lime: is used in the form of limestone, chalk or pure marble and sometimes marl. The addition of lime makes the glass fluid and suitable for blowing, drawing, rolling, pressing or spinning. It also imparts durability and toughness to glass. Excess of lime makes the molten mass too thin for fabrication.

Soda: acts as an accelerator for the fusion of glass and excess of it is harmful.

Potash: renders glass infusible and makes glass fire resistant.

Lead Oxide: imparts colour, brightness and shine. When 15–30% of it added to substitute lime it lowers the melting point, imparts good workability, while its transparency is lost with the glass becoming brittle and crystalline.

Cullet: It is broken glass of the type desired to be manufactured that is added to the raw materials to bring down cost of production.

- **MANUFACTURE**

Glass is manufactured in the following four steps:

a) **Melting:**

The raw materials lime, soda and sand — separately cleaned, ground, sieved (called ‘Batch’) in definite proportion and mixed with water are fused in a continuous type (tank) furnace or batch-type (pot) furnace. The charge in the first stage melts, forming a bubbly, sticky mass, and as the temperature is raised (1100°C–1200°C) it turns to a more watery liquid and the bubbles rise to the

surface. The melting process in case of ordinary soda-glass involves the following series of reactions:

$$CaCO_3 + SiO2 \longrightarrow CaSiO_3 + CO_2 \uparrow$$

$$Na_2CO_3 + SiO2 \longrightarrow Na_2SiO_3 + CO_2 \uparrow$$

When all the carbon dioxide has escaped out of the molten mass, decolourisers such as MnO_2 or nitre (KNO_3) are added to do away with ferrous compounds and carbon. The colouring salts are added at this stage. Heating is continued till the molten mass is free from bubbles and glass balls. As the glass cools (800°C), it is ready to be drawn or floated to its desired thickness and size at the other end of the furnace as shown by a flow diagram in Fig.1

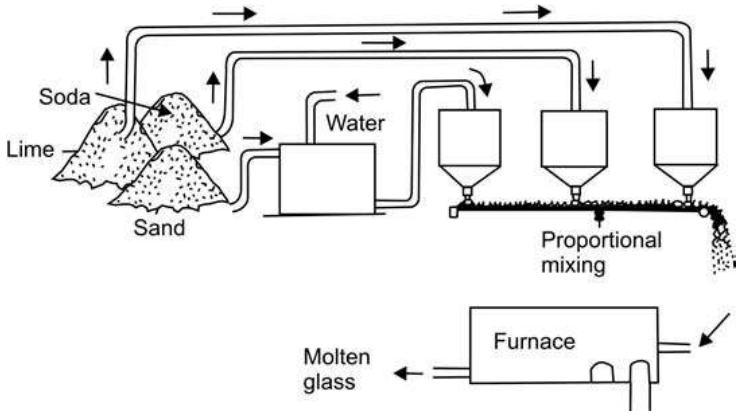
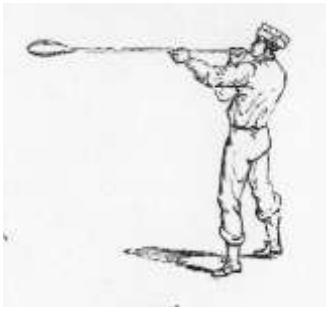


Figure-1 Glass Manufacturing Process

b) Forming and Shaping

The molten glass can be fabricated to desired shapes by any one of the following methods:

Blowing:



A 2 m long and 12 mm diameter blow pipe is dipped in the molten glass and taken out. It is held vertically and is vigorously blown by the operator. The sticking molten glass takes the shape of a hollow ball. On cooling it is reheated and the blowing operation repeated a number of times till the desired articles are ready.

Flat drawing:

Iron rod is dipped into molten glass and moved sideways to form a plate of glass which is then passed between rollers to form glass sheet.

Rolling:

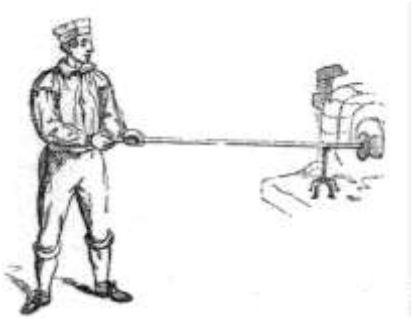
Molten glass is poured over flat iron table which has rollers fitted at one edge. The molten glass is rolled into glass plate.

Compression moulding:

Articles of irregular shape are molded by pressing molten glass into moulds. This gives glass of belter quality.

Spinning:

A machine is used to spin the molten glass. This gives very fine glass fibers. These glass fibers are extremely thin and very strong, do not shrink or expand, are unaffected by water, fire or insects and are used for heat, sound and electricity insulation.



Annealing:

Glass articles are allowed to cool under room temperature by passing through different chambers with descending temperature. If cooled rapidly, the articles are likely to crack.

- **Classification of Glass:**

Depending upon the constituents glasses are classified as soda-lime glass, lead glass and borosilicate glass.

Soda-Lime Glass:

It is also known as soda-ash glass, soda glass or soft glass. Soda-lime glass is obtained by fusing a mixture of silica, lime and soda. The quality of this glass can be improved by adding alumina and magnesium oxide and the glass is then called crown glass. This is the most common type of glass used in doors, windows and for making glass-wares such as bottles.

Lead Glass:

It is also known as flint glass and is obtained by fusing a mixture of silica, lead and potash. It is free from iron impurities and is colourless. Lead glass has high shining appearance and can take polish. It is not affected by temperature. Electric bulbs, optical glasses, cut glass, ornamental glass works and radio valves are some of the articles made from it.

Boro-Silicate Glass:

It is obtained by fusing a mixture of silica, borax, lime and felspar. The examples are pyrex glass and heat resisting glass. Boro-silicate glass can withstand high temperatures and is most suitable for making laboratory equipments and cooking utensils.

- **COMMERCIAL FORMS**

Glass is marketed in various commercial forms to suit varying field requirements. Some important commercial forms of glass are discussed below:

(i) **Sheet glass.** This is the variety most extensively used in engineering works. It is available in various thicknesses ranging from 2 mm to 6.5 mm and up to 1750 × 1100 mm size. Following three classes of it are produced:

- Ordinary Glazing Quality (O.Q). It is used for general glazing.
- Selected Glazing Quality (S.Q). It is better than O.Q and is used for better quality work.
- Special Selected Quality (S.S.Q). It is used for superior quality work as for show cases and cabinet making.

It is used for glazing of doors, windows and for partitions.

(ii) **Plate glass.** It is made in thicknesses varying from 3 mm to 22 mm and sizes up to 2750 × 900 mm. It is stronger and more transparent than the sheet glass. It is ground and polished. Following three classes of it are produced:

- Ground Glass Quality (G.G). Used for cabinets, show cases, shop fronts, counters and shelves.
- Selected Glazing Quality (S.G.). Mostly used in making mirrors.
- Special Selected Quality (S.Q.). Superior quality for high class work wind screen of vehicles.

(iii) **Tempered plate glass**. Plate glass is heated and then suddenly cooled to temper it. Tempered glass is 3 to 5. Although not unbreakable, it resists bending stress better than plate glass and, when broken, the pieces are relatively small in size. It is used extensively in sports arenas, sliding doors and curtain walls or in making table tops, shelves, counters etc. etc.

(iv) **Wired glass.** is produced by embedding wire nets 0.46 to 0.56 mm into the centre of sheet glass during casting. The minimum thickness of wired glass is 6 mm. When broken it does not fall into pieces. It has higher melting point than ordinary glass. Wired glass is used for fire resisting doors and windows, for sky lights and roofs. A special example of this is wired-refrax glass which transmits 100 per cent more light than the other glasses.

(v) **Laminated glass.** Two or more glass plates, with intervening layers of transparent plastics, are bound under effects of heat and pressure. This type of glass does not fly off in splinters when it breaks. It thus ensures safety at places where glass is liable to shatter. Laminated safety glass used in glazing windows and doors of buildings and land transport available in 4 to 20 mm thickness.

(vi) **Bullert proff glass:** is produced by placing vinyl plastic and glass in several alternate layers and pressing them with outer layers of glass. It is used in banks, jewellery stores and display windows.

(i) **Insulating glass.** Two layers of glass separated by 6 mm to 12 mm of dehydrated air are hermetically sealed to provide heat insulation-and to ensure transmission of light. It is used in glazing doors and windows.

(ii) **Coloured glass.** By adding oxides of metals to molten glass, the finished product gets coloured. Coloured glasses are used for decoration work in building construction. Glasses with light tints are used to cut off sun.

(iii) **Heat absorbing glass**. It has bluish green tinge and cuts off ultra violet rays of sun. It is used in glazing windows of railway carriages and in buildings where heat of sun is desired to be cut. Calorex is a patent product available in market.

(iv) **Flint Glass**. It is lead glass which shines and takes up good polish. It is used for cut glass work, as optical glass, for making electric bulbs and valves etc.

(v) **Ground glass.** One face of plate of sheet glass is made rough by grinding. The idea is to render it translucent so that it transmits light but provides privacy by obstructing vision. It is used for glazing doors and windows of toilets and bed rooms etc.

(vi) **Block glass.** These are hollow sealed glass blocks made by fastening together two halves of pressed glass. They are made 10 cm thick and 15 cm, 20 cm and 30 cm square in sizes. Their edges are sealed with grit bearing plastic material so that a good bond is provided with mortar. Ribs, flutes or prisms are cast on one or both their faces so as to render them translucent and free from glare. These blocks provide heat and sound proof partitions.