TECHNICAL INFORMATION

BOROSILICATE GLASS

Borosilicate glass represents unmatched standardized glass for construction of plant and piping in the chemical, dyestuff, food, pharmaceutical and petrochemical industries. Its steady growing use is due to many advantages over conventional materials.

- Outstanding corrosion resistance
- Smooth pore free surface
- Transparency
- Catalytic inertness
- No effect on taste and odour
- Physiological inertness

Borosilicate glass is chosen for its unique chemical and physical properties. Borosilicate glass can be considered as being composed of Oxides, Silica (SiO_2), Magnesia (MgO) and Lead oxide (PbO) as the principle modifiers/fluxes.

The chemical and physical properties of any glass depends on a varying degree on chemical composition of glass.

CHEMICAL COMPOSITION

The composition of borosilicate glass used for chemical plants has following approximate composition.

Component	Approximate Content
SiO_2	80.6%
B_2O_3	12.5%
Na_2O	4.2%
Al_2O_3	2.2%

MECHANICAL PROPERTIES

The lack of ductility of glass prevents the equalization of stresses at local irregularities or flaws and the breakage strength varies considerably about a mean value. This latter is found to occur at a tensile strength of about **700 kg/cm²**. In order to allow for the spread of breaking stress, a large factor of safety is applied when determining the wall thickness requirement to allow operation up to values given in the table of working pressure.

RESISTANCE TO CHEMICALS

Borosilicate glass is inert to almost all materials except Hydrofluoric acid (HF), Phosphoric acid (H_3PO_4) and hot strong caustic solutions. Of these, Hydrofluoric acid has the most serious effect, even when it is present in PPM (parts per million) in solutions.

Where phosphoric acid and caustic solutions cause no problems when cold but at elevated temperature corrosion occurs. In case of caustic solutions, upto 30% concentration can be handled safely at ambient temperature.

Under actual operating conditions, the effect of turbulence and traces of other chemicals in the solution may increase or decrease the rate of attack. So it is not possible to give exact figures for corrosion by caustic solutions.

RESHAPING

In the below given table, it shows characteristic temperature at a determined viscosity, essential for glass reshaping.

Characteristic	Viscosity	Temperature
Lower cooling temperature	10^{14} poise	515°C
Upper cooling temperature	10^{13} poise	565°C
Softening point	10^{7} poise	795°C
Reshaping point	10^{4} poise	1200°C

PHYSICAL & THERMAL PROPERTIES

Thermal Expansion (0–300°C)
3.3×10^{-6} /°C

Specific Heat (25–300°C avg)
0.233 Kcal/kg·°C

Thermal Conductivity
1.0 Kcal/hr·m·°C

Mean Specific Heat (20–200°C)
0.98 KJ/kg·K

DENSITY

Density (20°C)
ρ = 2.23 g/cc

Modulus of Elasticity
E = 6.3 KN/mm²

Poisson's Ratio
0.20

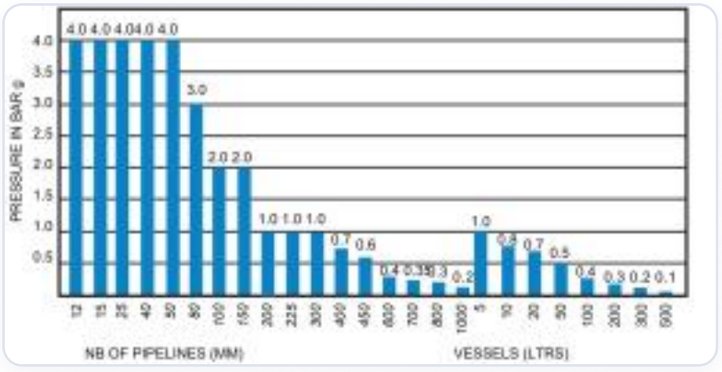
PERMISSIBLE OPERATING CONDITIONS

Working Pressure For Glass Pipelines & Vessels

The permissible internal operating pressure depends upon the nominal diameter of the glass components and on working temperature.

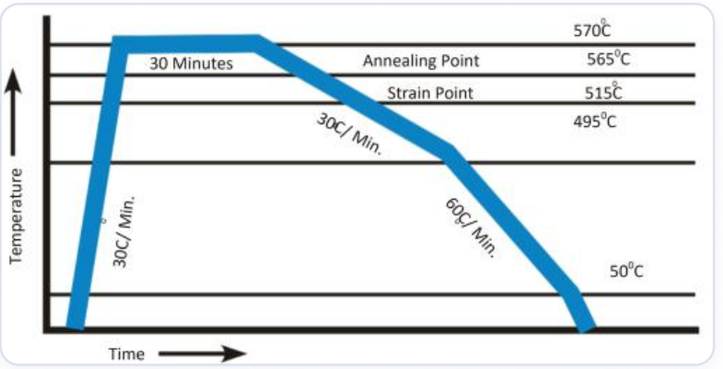
In case of unit with various combination like vessels, filters, heat exchangers, the over all permissible internal gauge pressure is always governed by the component with the lowest permissible operating gauge pressure; all components are suitable for full vacuum.

Bar is a measure of absolute pressure. The figure given for maximum recommended working pressure represents pressure above atmospheric.



ANNEALING

Annealing of glass is the process where the glass is heated and kept for a defined period of time to relieve internal stresses. Careful cooling under controlled conditions is essential to ensure that no stresses are reintroduced by chilling/cooling.



OPTICAL PROPERTIES

Borosilicate glass shows no appreciable absorption in the visible region of spectrum and therefore appears clear and colourless.

In photochemical processes, the transparency of ultra violet is of particular importance. It follows from the transmittance of material in UV region that photochemical reactions such as Chlorination and Sulpho Chlorination can be performed in it.

OPERATING TEMPERATURE

Borosilicate glass retains its mechanical strength and will deform only at temperature which approach its strain point. The practical upper limit for operating temperature is much lower and is controlled by the temperature differentials in the glass which depends on the relative temperature of the contents of the equipment and the external surroundings. Provided borosilicate glass is not subject to rapid change in temperature, creating undue thermal shock, it can be operated safely at temperatures up to **250°C**.

It must be realised that in complete plants, composed not only of borosilicate glass, but also include other materials such as PTFE. The recommended max. operating temperature is **200°C**. Operating temperatures may have to be modified so as to compensate for the effects of other factors such as pressure, thermal cycling, rapid heating & cooling etc.

BOROSILICATE GLASS / PTFE

Borosilicate Glass with PTFE is of particular decisive importance for construction of glass installation. For example: in Seals, Bellows, Stirrers, Pumps, Heat Exchangers, Column Inserts etc.

PTFE is used with Glass because of its excellent mechanical & thermal properties. They have near universal fluid compatibility. Wear life when compared with others is very low. Particularly PTFE is maintenance free and have cryogenic stability with non wetting property.

PTFE Service Temperature: –50°C to +200°C

ELECTRICAL CHARACTERISTICS

Glass being a poor electrical conductor, surface conductivity is insignificant and varies with the quantity of water absorbed on glass surface. The specific conductivity is **10^{-10} ohm/cm** at temperature of **200°C**. The dielectric coefficient varies with current frequency.

THERMAL SHOCK

The degree of thermal shock (usually defined as sudden chilling or heating) which it can withstand depends on many factors such as stresses due to operating conditions, stresses imposed in supporting the equipment, the wall thickness of the glass. It is therefore undesirable to give sudden temperature changes. But up to **120°C** can be accommodated.

As sub zero temperature, the tensile strength of borosilicate glass tends to increase and equipment can be used safely at temperatures as low as **–50°C** for XTRONG and components.

COMPOSITE MATERIALS

The last two decades have seen further developments of particularly corrosion resistant plant construction materials. Typical examples of these are PTFE, tantalum, titanium, graphite and of course, Borosilicate 3.3 Glass.

The combination of different corrosion resistant materials with the utilization of the specific advantages of each permits both safe and economic construction.

TIGHTENING TORQUE

Maximum bolt-tightening torque* in Nm for couplings with backing flanges

DN	Plastic (k)	Iron/Steel/ Silumin (S)
12	1	1
15	1	1
25	2.5	2.5
40	2.5	3.5
50	2.5	3.5
80	2.5	3.5
100	3.5	4.5
150	3.5	4.5
200	–	4.5
225	–	4.5
300	–	4.5
400	–	6.5
450	–	6.5
600	–	11
700	–	20
800	–	20
1000	–	22

** The indicated tightening torques apply for ungreased bolts and are required only for the maximum operating pressures. They can be reduced.*

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