

# TECHNICAL INFORMATION

Borosilicate glass represents unmatched standardized glass for construction of plant and piping in the chemical, dyestuff, food pharmaceutical, petrochemical industries. Its steadily 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<sub>2</sub>) Magnesia (MgO) and Lead oxide (PbO) are 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.

SiO <sub>2</sub> - 80.6%	B <sub>2</sub> O <sub>2</sub> - 12.5%
Na <sub>2</sub> O - 4.2%	Al <sub>2</sub> O <sub>3</sub> - 2.2%

## RESISTANCE TO CHEMICAL

Borosilicate glass is inert to almost all materials except Hydroflouric acid (HF) Phosphoric acid(H<sub>3</sub>PO<sub>4</sub>) and hot strong caustic solutions. Of these. Hydroflouric acid has the most serious effect, even when it is present in PPM (parts per million) in solutions. Where as 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.

## PHYSICAL AND THERMAL PROPERTIES

### Linear coefficient of thermal expansion

The coefficient of thermal expansion of borosilicate glass over the temperature 0-300°C is 3.3 x 10<sup>-6</sup>/°C. This is very low when compared with other glasses and metals. That is why, borosilicate glass is often called low expansion borosilicate glass.

### Specific heat

Specific heat between 25°C and 300°C is average to be 0.233Kcal/Kg, °C

### Thermal Conductivity

Thermal conductivity is 1.0 Kcal/hr,m°C. Over the permissible operating temperature range.

### Mean Specific Heat

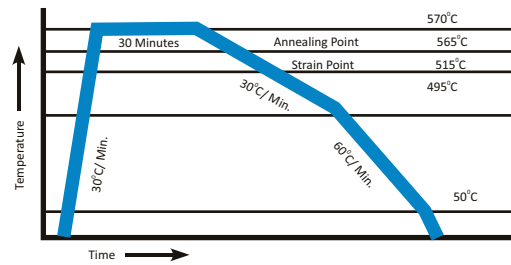
Mean specific heat capacity between 20°C and 200°C is 0.98 KJ/Kg K.

## DENSITY

Density of glass at 20°C (J)=2.23g/cc  
 Modulus of elasticity (E)=6.3 KN/mm<sup>2</sup>  
 Poissions ratio=0.2

## ANNEALING

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



## RESHAPING

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

Lower cooling temperature	10 <sup>21</sup> poise	515°C
Upper cooling temperature	10 <sup>13</sup> poise	565°C
Softening point	10 <sup>7</sup> poise	795°C
Reshaping point	10 <sup>4</sup> poise	120°C

## 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 700kg/cm<sup>2</sup> 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.

## OPTICAL PROPERTIES

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

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

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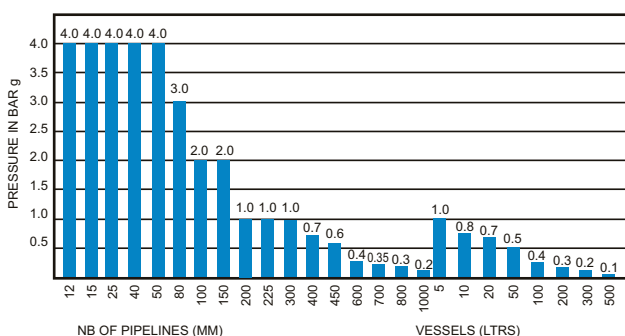
## PERMISSIBLE OPERATING CONDITIONS

### Working Pressure For Glass Pipelines & Vessels

The permissible internal operation 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.



### Working 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 upto 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.

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.

## 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<sup>9</sup>ohm/cm at temperature of 200°C. The dielectric coefficient varies with current frequency.

## COMPOSITE MATERIALS

The last two decades have seen the new or 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.

### Borosilicate glass/PTFE

Borosilicate Glass with PTFE is of particularly 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.

Service temperature of PTFE is considered as -50°C to +200°C

## TIGHTENING TORQUE

Diameter	Maximum bolt-tightening torque* in Nm for couplings with backing flanges	
	Made of Plastic (K)	Made of 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.

