Data Sheet and Properties

Introduction

Borosilicate glass 3.3 is specified as a standard glass - it contains mainly sand, calcium carbonate and sodium carbonate. High quality sand, dehydrated borate boric acid, alumina and salt are used in its manufacture and strict control is applied to ensure the specifications for purity and consistency of these materials are maintained. Because of its resistance to heat, corrosion and thermal shock borosilicate glass 3.3 is used extensively in science and industry.

Chemical Composition

The following is a typical analysis of borosilicate glass 3.3 (Element % by weight):

SiO_2	80,60%	MgO	0,05%
B_2O_3	12,60%	Fe_2O_3	0,04%
Na_2O	4,20%	CaO	0,10%
Al_2O_3	2,20%	Cl	0,10%

Physical Properties

Coefficient of Expansion	33×10^{-7}/K (20°C - 300°C)		
Specific Heat	$0,8 \times 10^3$ J/kg K^{-1} (20°C)		
Thermal Conductivity	1.13 W/m K^{-1} (20°C)		
Density	2.23×10^3 kg/m^3		
Poisson Ratio	0.22 (25°C - 400°C)		
Young Modulus	65 MPa (25°C)		
Rigidity Modulus E	64×10^3 MPa		
Vickers Hardness (DPH)	580 Kg/mm^2 (50 gr Gew.)		
Relative Hardness	1.52 (vgl. KN-Glas = 1.0)		
Refractive Index	1.474 Sodium D - Line		
Dielectric Constant	4.6 (1 MHz and 20°C)		
Loss Factor	2.6 % (1 MHz and 20°C)		
Log_{10} Volume Resistivity	15 Ohm - cm/s (20°C)		
Surface Resistivity*	10^{13} Ohm s · cm^{-2} * at 50% Humidity		
Tensile Strength*	35 - 100 MPa * Max. values		
Specific Heat	750 at 20 °C	960 at 50 °C	1090 J/kg · K at 300 °C
Transformation Point (t_g)	525 °C		

Pharmaceutical Properties

Borosilicate glass 3.3 meets the pharmaceutical resistance classifications Class I and Type I according to international, German and European Pharmacopoeia (DAB10, EurAB, USP XXIII).

Thermal Expansion

The coefficient of linear thermal expansion is one of the characteristic properties of borosilicate glass and is defined as the change in unit length per degree rise in temperature. The thermal expansion is $33 \times 10^{-7} \cdot K^{-1}$ (20°C - 300°C) and is controlled to a tolerance of $\pm$ 0.1 x $10^{-7} \cdot K^{1}$.

Maximum Temperatures

In general it is recommended, that the strain point of (515°C) be regarded as the maximum safe operating temperature of borosilicate glassware 3.3. For some shapes and for a relatively time this limit can be exceeded, but at 580 °C there is danger of deformation and in case of sintered glassware the porous structure may be changed. At high temperatures the glass may acquire permanent stress on cooling and this may result in subsequent breakage. If it is suspected that permanent stress has occurred, the article should be annealed making references to the annealing process explained below. Permanent stress can greatly reduce the mechanical and thermal resistance!

Drying

Drying of the soaked filters can be undertaken either in air or in a dry box at temperatures not exceeding 100°C.

Annealing

The annealing of glass is the process by which it is heated to and held at a controlled temperature 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. Please refer to our separate information regarding the annealing of Borosilicate Glass 3.3.

ROBU Glasfilter-Geräte GmbH
Schützenstrasse 13
D - 57644 Hattert
Germany

Tel. : .. 49 - (0)2662 - 8004-0
Fax : .. 49 - (0)2662 - 8004-40
Email : info@robuglas.com
Web : http://www.robuglas.com

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Temperature Shock Resistance

If a temperature gradient is applied to the glass, stresses are set up - the hotter glass being under compression and the cooler under tension. The magnitude of stress depends on the temperature difference which in turn depends on the glass thickness. ATTENTION: Abrasions greatly reduce the temperature shock resistance.

Viscosity

Although borosilicate glass 3.3 has no defined softening point, there are four points in the viscosity- / temperature relation which have accepted definitions according to (ISO 7884-2/-3/-4):

Strain Point 515 °C		
Viscosity (η)	$10^{14,5}$	dPa · s
Annealing Point 565 °C		
Viscosity (η)	$10^{13,0}$	dPa · s
Softening Point 820 °C		
Viscosity (η)	$10^{7,6}$	dPa · s
Working Point 1250 °C		
Viscosity (η)	$10^{4,0}$	dPa · s

Chemical Resistance

The chemical resistance of borosilicate glass is better than that of many other materials. It shows resistance to water, acids and alkalis, salt, organic substances as well as chlorine and bromine. Hydrofluoric acid, concentrated phosphoric acid and strong alkalis attack the glass surface at higher concentrations and temperatures. The following are typical results of tests undertaken to international standards:

Resistance-Classifications

Hydrolytic Class*	HGB 1	(ISO 719, DIN 12111)
*Na_2O - weight loss	≤0,01 µg	(Grain 300-500µ at 98 °C)
Hydrolytic Class	HGA 1	(ISO 720, Grain at 121 °C)
Pharmac. Glasstype	1	(USP23, DAB10, EurAB)
Acid Class*	1	(DIN 12116)
*Na_2O - weight loss	≤100 µg	(ISO 1776)
Alkali Class	A2	(ISO 695, DIN 52322)

Safety Advice

When working with glassware always wear protective glasses and protective gloves to avoid injuries. Use a safety screen, -hood or similar protection when working with glassware subject to pressure or vacuum. Be prepared, that reagents may leak from a broken vessel. Please heed these guidelines in combination with the respective state-specific regulations for the use of glassware in the laboratory.

ROBU-GLAS® FILTER Made in Germany

ROBU Glasfilter-Geräte GmbH
Schützenstrasse 13
D - 57644 Hattert
Germany

Tel. : .. 49 - (0)2662 - 8004-0
Fax : .. 49 - (0)2662 - 8004-40
Email : info@robuglas.com
Web : http://www.robuglas.com