NORMAG - LABORATORY GLASSWARE

GENERAL

All in this catalogue described semi-finished products for manipulators as tubes, tubing, connecting pieces (e.g. with grinding, flanges), stopcocks and valves, and all ground devices (e.g. column components), components (e.g. reaction vessels) and apparatus are made of Borosilicate glass 3.3, the common material in technical glass construction. Remarkable features of Borosilicate glass 3.3 are an utmost chemical resistance to all media, a low thermal coefficient of linear expansion as well as its resistance to temperature.

All our products are recognisable at our brand:

This brand stands for:

- After taking over the NORMAG - Labor- und Verfahrenstechnik GmbH and its know how we supply semi-finished products for glassblower as ground devices, components and apparatus for laboratory technique in the well known and recognised excellent quality of this company.
- The supplied products are only manufactured from Borosilicate glass 3.3, the only material we use in our production. This is also valid for those semi-finished products (tubes, rods, ground ends) which are not marked because of technical reasons.
- All dimensions without tolerances indicated in this catalogue are mounting sizes and serve only for orientation.

PROPERTIES OF BOROSILICATE GLASS 3.3

Chemical composition

The used Borosilicate glass 3.3 for glassware has approximately the following composition:

Component	% by weight
SiO_2	80.6
B_2O_3	12.5
NaO	4.2
Al_2O_3	2.2
Trace elements	0.5

The very wide use of this material in the chemical and pharmaceutical industries and in other related areas bases on the chemical and thermal properties (see DIN ISO 3585). These properties together with a great number of other benefits distinguish Borosilicate glass 3.3 from other materials of construction.
The special characteristics are:

- Smooth, non-porous surface
- Catalytic indifference
- No adverse physiological properties
- Neutral taste and smell
- Non-flammability
- Transparency

Chemical Resistance

The chemical resistance of Borosilicate glass 3.3 makes it much more comprehensive than that of all other known materials. It is highly resistant to water, salt solutions, organic substances, Halogens as Bromine and Chlorine and many acids. Exceptions are hydrofluoric acid, concentrated phosphoric acid and strong alkaline solutions. They cause appriciable surface removal at higher temperatures. But Borosilicate glass 3.3 can be employed at ambient temperature for solutions up to 30 % concentration without problems.

Classification of Borosilicate glass 3.3 according to the relevant analysis methods: (see DIN ISO 3585)

Hydrolytic resistance at 98 °C	Hydrolytic resistance grain class ISO 719-HGB 1
Hydrolytic resistance at 121 °C	Hydrolytic resistance grain class ISO 720-HGA 1
Acid resistance	Deposit of Na_2O<100 µg/dm² to ISO 1776
Alkali resistance	Alkali resistance class ISO 695-A2

Physical properties

Borosilicate glass 3.3 differs from other construction materials not only because of its almost universal corrosion resistance but also because of its very low thermal expansion coefficient. Expensive procedures to compensate thermal expansions are not needed.

The most important physical properties are listed below (see DIN ISO 3585)

Middle linear thermal coefficient of expansion	$\alpha_{20/300} = (3.3 \pm 0.1) \times 10^{-6}\ K^{-1}$
Middle thermal conductivity between 20 and 200 °C	$\lambda_{20/200} = 1.2\ W\ m^{-1}K^{-1}$
Middle specific heat capacity between 20 and 100 °C	$C_{p\ 20/100} = 0.8\ kJ\ kg^{-1}\ K^{-1}$
Middle specific heat capacity between 20 and 200 °C	$C_{p\ 20/200} = 0.9\ kJ\ kg^{-1}\ K^{-1}$
Density at 20 °C	$p = 2.23\ kg\ dm^{-3}$

Mechanical properties

The permissible tensile strength of Borosilicate glass 3.3 includes a safety factor which takes into account practical experience on behaviour of glass and, in particular, the fact that it is a brittle material. It is not able to equalise stresses occurring at local irregularities or flaws, as happen in the case of ductile materials such as metals. The safety factor also takes in account additional processing of components (ground sealing surface), handling of the glass (minute surface damage) and permissible pressures and temperatures to which it may be subjected in use.

The design figures indicated below and specified in EN 1595 therefore apply to permissible tensile, bending and compressive stress to which glass components may be subjected taking into account the likely surface condition of glass in service.

Strength parameters	Tensile and bending strength	$K/S = 7\ N\ mm^{-2}$
	Compressive strength	$K/S = 100\ N\ mm^{-2}$
Modulus of elasticity		$E = 64\ kN\ mm^{-2}$
Poisson's ratio (transverse concentration figure)		$\nu = 0.2$

Optical properties

The transmission of UV light, which has a great importance for photo-chemical reactions, lies in the middle spectrum somewhat higher than that of normal window glass.

Should light-sensitive substances be processed, so the use of brown coated Borosilicate glass 3.3 is recommended. This permanent coat reduces the UV light transmission to a minimum.

PERMISSIBLE OPERATING CONDITIONS

Components and apparatus are not only employed at room temperature and normal pressure, but also under vacuum, slight overpressure and/or at higher temperatures causing stresses at the tube walls. To balance these stresses, the wall thickness must have a certain size which must not fall below.

Due to the given wall thickness, the allowed operating conditions regarding operation pressure and operation temperature need to be limited.

Permissible operating temperature

Borosilicate glass 3.3 only deforms at temperatures which approach its transformation temperature (approx. 525 °C) and up to this point it retains its mechanical strength. The permissible operation temperature is considerably lower - normally around 200 °C- for glass components, provided that there is no sudden temperature shock.

At sub-zero temperatures tensile strength tends to increase. Therefore, Borosilicate glass 3.3 ca be safely used at temperatures as low as -80 °C.

Thermal shock

Rapid changes in temperature across the walls of glass components should be avoided during operation. They result in increased thermal stress in the glass which has an adverse effect on the permissible operating pressure of the components. Although it is not possible to give a definite figure applicable to all the operating conditions which occur in practice. A maximum permissible thermal shock of 120 °C can be taken as a general guide.

Permissible operating overpressures

Glass components in all nominal sizes that are basically cylindrical, domed and spherical can be used with full vacuum (-0.1 bar), provided they are not specially marked otherwise.

The permissible temperature difference between internal (product side) and external side is 180 °C, provided otherwise is not marked.

TUBE ENDS

All tube ends, exceptions not considered, are preferably connected with ground joints (conical or spherical) or with laboratory flanges. Should be required additional special connecting elements (e. g. clamps), please see the corresponding pages in catalogue part "Semi-finished products" chapter 3.

For laboratory flat flanges, especially used for reaction vessels, we offer a connecting piece that is both support and connection.

Safety flat flanges are used as connectors to temper jackets. The corresponding flange connections are described in catalogue part "Semi-finished products" chapter 3.

Threaded tube ends, preferably in type GL, are used when hoses are employed for feeding or draining the product or when measuring units are necessary. Test tubes and bottles are also available with thread.

The mentioned exceptions are high vacuum flanges in catalogue part "Semi-finished products" chapter 3 and the Rotulex connecting system, described in the same chapter.

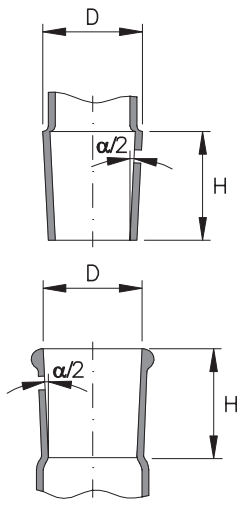
If other usual flanges for glassware are required, they will be also available.

All important dimensions of ground joints, laboratory and safety flat flanges and GL-threads are listed in the table below.

Dimensions of conical ground tube ends

Nominal size	NS	5/13	7/16	10/19	12/21	14/23	19/26	24/29
Diameter	D	5	7.5	10	12.5	14.5	18.8	24
Inclination	$\alpha/2$				1:10			
Length	H	13	16	19	21	23	26	29

Nominal size	NS	29/32	34/35	45/40	60/46	71/51	85/55	100/60
Diameter	D	29.2	34.5	45	60	71	85	100
Inclination	$\alpha/2$				1:10			
Length	H	32	35	40	46	51	55	60

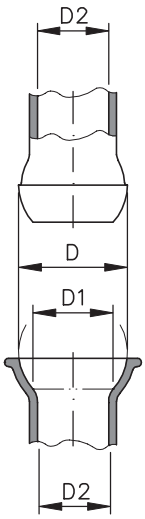


Dimensions of spherical ground tube ends in inches

Nominal size	S	13/2	13/5	19	29
Diameter[1)]	D	12.700	12.700	19.050	28.575
Diameter	D1	3.3	6.2	10.5	17.5
Diameter	D2	2	5	9	15

Nominal size	S	35	40	51	64
Diameter[1)]	D	34.925	38.100	50.800	63.500
Diameter	D1	23	28	34	45
Diameter	D2	20	25	30	40

[1)] Sizes of the ground ball see also DIN 12 244 part 1

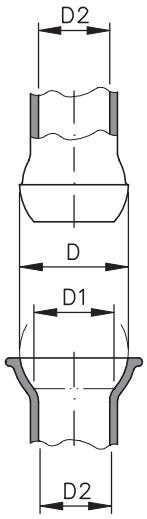


Dimensions of spherical ground tube ends in Millimetres

Nominal size	KS	12/3	12/5	18	28
Diameter[1)]	D	12.0	12.0	18.0	28.0
Diameter	D1	8	8	13	22
Diameter	D2	3	5	10	18

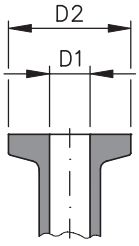
Nominal size	KS	35	50	55	75
Diameter[1)]	D	35.0	50.0	55.0	75.0
Diameter	D1	28	38	42	54
Diameter	D2	24	34	38	49

[1)] Sizes of the ground ball see also DIN 12 244 part 1

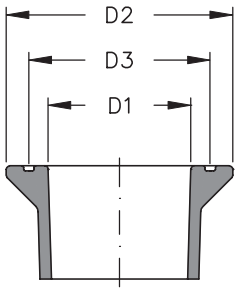


Dimensions of high vacuum small flanges

Nominal size	DN	10	16	25	40	50
Diameter	D1	10	16	25	40	50
Diameter	D2	30	30	40	55	75



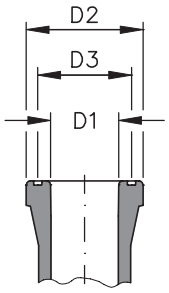
Dimensions of laboratory flange tube ends



Nominal size	DN	60	100	120	150	200
Diameter	D1	63	100	122	148	205
Diameter	D2	100	138	158	184	242
Diameter	D3[1)]	80	115	137	161	220

[1)] In every connection only one part (e.g. vessel) has a groove.

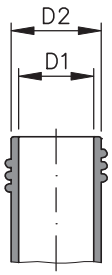
Dimensions of safety flat flange tube ends



Nominal size	DN	15	25	40	50	80
Diameter	D1[1)]	17	26.5	38.5	50	76
Diameter	D2	29	42.5	57.5	70	99.5
Diameter	D3	23	34	48	60.5	88

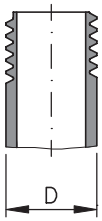
[1)] D1 does not correspond with the smallest diameter

Dimensions of thread tube ends



Nominal size	-	GL 14	GL 18	GL 25	GL 32	GL 45
Diameter	D1	8.5	10.5	17	21.5	34.5
Diameter	D2	12	16	22	28	40

Dimensions of tube ends with metric thread



Nominal size	-	M8	M10	M12	M16	M20	M24
Diameter	D	8	10	12	16	20	24

DOUBLE JACKET GLASS COMPONENTS

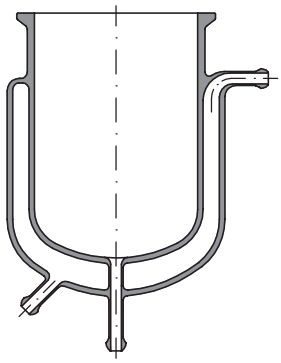
Double jackets fulfil several purposes in thermal processing. They serve either for heating or cooling of the product during the process or they have an insulating function.

Provided it is possible regarding to the construction, both sides of the double jacket are sealed. The different expansion of inner and outer cylinder during the operation is compensated by internal bellows (see pict. 4)

Components with ground tube ends have an integrated socket or ground cup in the double jacket. Sockets or ground cups are integrated in the double jacket if the components have ground tube ends. Cone and ground ball are not integrated in small nominal sizes.

Components which are fitted with a safety flat flange at product side allow a double jacket design up to the tightness area.

You will find double jacket components in the appropriate chapter of this catalogue.



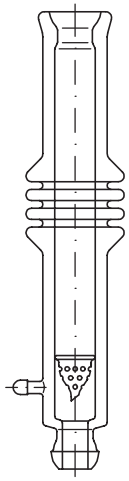
Pict. 3 Both sides of the double jacket are sealed

Temper jackets

When the connections of the temper jacket are fitted with safety flat flanges, olives as connectors are available.

Insulating jacket

Different components for the laboratory technique (e.g. columns) are available with special insulating jackets. In this case, the inner side of the jacket is silver coated and the jacket space itself is evacuated (10^{-6} mbar). The loss of heat is reduced to a minimum. Design of the jacket see pict. 4.



Pict. 4 Double jacket with bellow

Permissible operating conditions

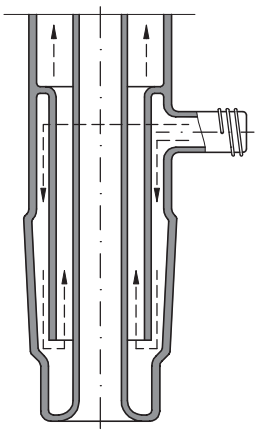
The permissible operating overpressures mentioned at page 4 are also valid for the inner parts of double jackets. Due to the construction, there are divergences regarding to the permissible operating temperature in the inner component and the permissible operating conditions in the jacket.

Permissible operating temperature

For temper jackets consisting of one part and sealed on both sides, the permissible operating temperature in the jacket must not exceed 200 °C. The maximum permissible temperature difference between jacket temperature and ambient temperature should not be more than 180 °C. The product temperature should not be higher than 50 °C as the product temperature.

Permissible operating overpressure

For temper jackets consisting of one part and sealed at both sides, the permissible overpressure is -1 to +0.1 bar.



Pict. 5 Heatable tube ends with temperable ground cone

SPECIAL MATERIALS

In some cases, other materials than Borosilicate glass 3.3 are used for components in laboratory technique e.g. PTFE or metallic materials.

- We are widely experienced in this area, so that it will not be a problem to meet the specific requirements.

PTFE

The function of the component made of PTFE decides, what type of PTFE will be used: pure PTFE, modified PTFE, glass fibre reinforced or coal fibre reinforced PTFE. Process technical reasons are also a decisive factor. What type of material is used, see the description of the respective component.

Other synthetic material

Besides PTFE, other synthetic materials are used in laboratory technique, e.g. silicone rubber.

Metallic material

The range of usable metallic materials is large and reaches from chrome-nickel steel, enamel steel to titan, Tantalus or Hastelloy. The required corrosion resistance defines the choice of the material.

Information about the specific properties of the materials you will receive on request.

Further materials

In special cases, we also use other materials like graphite, ceramics etc. Construction and process relevant reasons define together with the special requirements of the customer the type of these materials.

Due to our experiences with those corrosion resistant materials we have a wide know how in this area and so we are able to advise you on this.