LABORATORY TECHNOLOGY WITH BOROSILICATE GLASS 3.3

Borosilicate glass 3.3 is widely used as a material for process technology in the chemical and pharmaceutical industries as well as in a number of related areas such as beverage and electroplating technology.

There are numerous reasons for this:

- The transparency of borosilicate glass 3.3 enables constant visual monitoring of ongoing processes.
- Borosilicate glass 3.3 is also practically corrosion-resistant to almost all media, especially strong acids. The materials used as standard in combination with borosilicate glass 3.3, such as PTFE, are also almost universally corrosion-resistant.
- The smooth and non-porous surface largely prevents deposits and incrustations.
- In contrast to metals, the catalytic indifference of borosilicate glass 3.3 prevents catalytic reactions. Taste and odour influences are excluded.
- Glass is physiologically harmless.
- Borosilicate glass 3.3 is not flammable.
- The glass can be recycled.
- Borosilicate glass 3.3 is also used in the laboratory for almost all applications. There is no need to change the materials in contact with the product during scale-up in pilot and production plants.
- Thanks to the high temperature and thermal shock resistance, the properties remain practically unchanged over the entire temperature range.
- Borosilicate glass 3.3 is an approved and proven material for the construction of pressure vessels.

NORMAG utilises the outstanding material properties of borosilicate glass 3.3 in combination with PTFE in an entire manufacturing programme. The well-engineered and consistently applied modular system of standard-compliant functional parts covers the entire laboratory range up to the production scale of DN 600 included in the separate "PROCESS TECHNOLOGY" catalogue.
A key feature of this modular system is the high reliability of NORMAG's continuously developed high-quality connections for all components.

This is realised by means of the

- Taper/ground joints (NS joints), NS 5/13 to NS 100/60
- Rotulex connections (KS connections), SP 13 - SP 90
- GL thread (GL connection), GL 14 - GL 100
- High-vacuum small flanges (HF connections), NW 10 - NW 60
- Laboratory flanges (LF connections) NW 60 to NW 200
- Ball and socket (KF) and safety flat flange (PF) connections up to DN 600,
- that are suitable and proven from laboratory to production scale
- Temperable flange ends with deflector, type NORMAG.

The entire programme of components and appliances available as standard is described in the previous chapters. Technical information on the material, processing and application is provided below in this chapter.

PROPERTIES OF BOROSILICATE GLASS

Chemical composition

Borosilicate glass 3.3 is a standardised material with approximately the following chemical composition:

	DesignationContent in wt %
SiO_2	80,6
B_2O_3	12,5
NaO	4,2
Al_2O_3	2,2
Trace elements	0,5

Table 10.1: Chemical composition of borosilicate glass 3.3

Chemical resistance

The chemical resistance of borosilicate glass 3.3 is given for almost all products. It is highly resistant to water, salt solutions, organic substances, halogens such as chlorine and many acids. Borosilicate glass 3.3 can be used at room temperature without difficulty in combination with alkalis up to a concentration of 30 %. Only a few substances such as hydrofluoric acid, concentrated phosphoric acid and strong alkalis at higher temperatures are known to cause noticeable erosion of the glass surface. A classification of the material borosilicate glass 3.3 according to the relevant test methods leads to the following result (see also ISO 3585 and EN 1595):

Chemical resistance of borosilicate glass 3.3	
Water resistance at 98 °C W	Semolina water resistance class ISO 719-HGB 1
Water resistance at 121 °C	Semolina water resistance class ISO 720-HGA 1
Acid resistance	Release Na_2O < 100 $^{mg/dm2}$ according to ISO 1776
Alkali resistance	Alkali resistance class ISO 695-A2

Table 10.2: Chemical resistance of borosilicate glass 3.3

Surface erosion depends on the respective operating conditions and media. It is not possible to make a general statement about surface erosion.

Thermal properties

Borosilicate glass 3.3 is not only characterised by its almost universal corrosion resistance compared to other apparatus construction materials, but also by its very low coefficient of thermal expansion. Complex measures to compensate for temperature-induced thermal expansion are therefore not necessary. The most important thermal properties for apparatus engineering are listed below (see also DIN ISO 3585 and EN 1595):

Physical properties of borosilicate glass 3.3	
Mean linear coefficient of thermal expansion	α 20/300 = (3.3 ±0.1) x $^{10-6\ K-1}$
Average thermal conductivity between 20 and 100 °C	λ 20/100 = 1.2 W $^{m-1K-1}$
Average thermal conductivity between 20 and 200 °C	λ 20/200 = 1.3 W $^{m-1K-1}$
Average specific heat capacity between 20 and 100 °C	$_{cp}$ 20/100 = 0.84 kJ $^{kg-1\ K-1}$
Average specific heat capacity between 20 and 200 °C	$_{cp}$ 20/200 = 0.98 kJ $^{kg-1\ K-1}$
Density at 20 °C	ρ = 2,230 kg $^{m-3}$

Table 10.3: Physical properties of borosilicate glass 3.3

Mechanical properties

Borosilicate glass 3.3 is an approved and proven material for the construction of pressure vessels. The strength characteristics of borosilicate glass 3.3 permitted for the design are given in the following table. The characteristic values include a safety factor, the so-called K/S factor, which takes into account practical experience of the strength of glass and in particular its properties as a brittle material. In practical applications, it must be taken into account that borosilicate glass 3.3, as a brittle material, cannot relieve stress peaks at irregular transitions and the smallest cracks. The special features of borosilicate glass 3.3 also include the negligible temperature dependence of the strength and the significantly higher compressive strength than tensile strength.

This experience has been taken into account in EN 1595 and the following characteristic values for the permissible loading of glass components due to tensile, bending and compressive stresses have been defined as a basis for calculation, whereby a surface condition under unfavourable practical operating conditions has been taken into account as a conservative approach.

Mechanical properties of borosilicate glass 3.3	
Density at 20 °C	ρ = 2,230 kg $^{m-3}$
Strength parameter for tensile and flexural strength	K/S = 7 N $^{mm-2}$
Strength parameter for compressive strength	K/S = 100 N $^{mm-2}$
Modulus of elasticity	E = 64,000 N $^{mm-2}$
Poisson's ratio	v = 0,2

Table 10.4: Mechanical properties of borosilicate glass 3.3

Optical properties

Borosilicate glass 3.3 is an optically transparent material with a correspondingly high transmission of radiation in the visible wavelength range. For some applications such as photochemical reactions, light transmission in the ultraviolet range is also of great importance. Borosilicate glass is suitable for applications such as photochemical chlorination (absorption in the 280 - 400 nm range), whereas other materials such as quartz glass should be used for applications with shorter wavelengths. The use of amber-coated borosilicate glass is recommended for processing light-sensitive substances. This permanently applied special coating largely reduces UV light transmission.

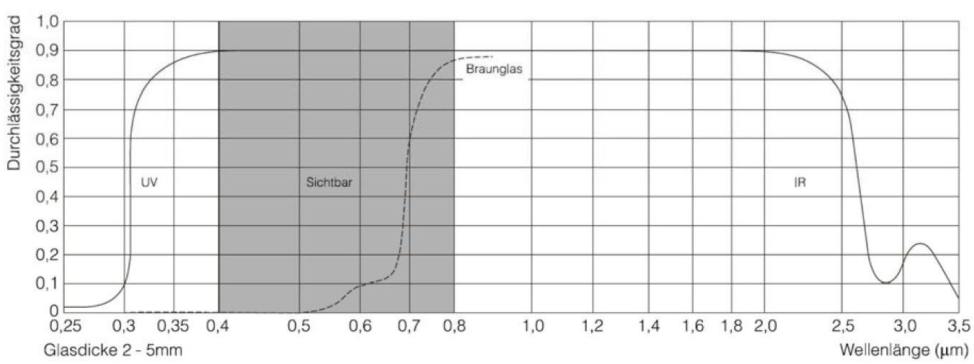


Figure 10.1: Transmission curves for borosilicate glass 3.3

PERMISSIBLE OPERATING CONDITIONS

Permissible operating temperature

Borosilicate glass 3.3 exhibits almost ideal elastic behaviour up to temperatures close to the transformation temperature of over 500 °C and retains its mechanical strength up to this temperature. However, the permissible operating temperature range for standard applications is limited to -50 to +200 °C due to the PTFE sealing material used and to avoid temperature shocks. At temperatures below the freezing point, an increase in tensile strength can be observed, so that borosilicate glass 3.3 can also be used at lower temperatures in combination with suitable seals. Conversely, it can also be used at temperatures above 200 °C.
Separate consideration regarding the permissible temperature range is required for jacketed vessels. Please contact our specialist department to discuss such applications and other special cases.

Temperature shock

Rapid changes in the media temperature in the interior or exterior lead directly to changes in the wall temperatures, which must be avoided. Additional thermal wall stresses occur, which reduce the permissible operating overpressure of the respective glass component. In extreme cases, such a so-called temperature shock can lead to spontaneous glass breakage.
The resistance of the glass to temperature changes essentially depends on the operating conditions and the wall thicknesses. There is therefore no generally binding value for all operating conditions. A general guideline value of max. 100 K applies as a conservative permissible value for rapid temperature changes. Usually, such temperature changes are not achieved in a short time with heating/cooling devices, so that the permissible temperature difference must only be considered in the case of deviations from this standard for jacketed vessels or jacketed pipes. However, it is essential to observe the permissible temperature shock when filling or spraying a hot glass component with cold liquid and in the event of possible cold water splashes from outside onto a hot glass component wall. The glass components should only be cooled slowly, usually by natural heat dissipation to the surrounding air, taking into account the operating conditions.

Determination of the wall temperature difference

The following information is the basis for determining the wall temperature difference Δϑ W and thus for calculating the wall thickness.

Principles for calculating the wall temperature of borosilicate glass 3.3	
Permissible operating temperature	Tzul = -50 / +200 °C
Permissible temperature difference between indoor and outdoor areas	ΔϑM ≤ 180 K
Internal heat transfer coefficient	$_{\alpha i}$ = 1,200 Wm-2K
External heat transfer coefficient	$_{\alpha a}$ = 11.6 Wm K^{-2}
Heat transfer coefficient jacket space Jacket vessels	$_{\alpha i}$ = 70 Wm K^{-2}

Table 10.5: Basis for calculating the wall temperature of borosilicate glass 3.3

The media temperature difference $_{\Delta\vartheta M}$, see Figure 1.2, should not be confused with the wall temperature difference $_{\Delta\vartheta W,}$ which is decisive for the strength calculation and can be determined from the media temperature difference, wall thickness, geometry and internal and external heat transfer coefficients. With a value of 1,200 $^{Wm-2K-1}$, the specified internal heat transfer coefficient αi largely and conservatively covers the cases that occur in practice. The external heat transfer coefficient $_{\alpha a}$ has a significantly greater influence on the wall temperature difference $_{\Delta\vartheta W}$, which corresponds to a building with draughts or an outdoor installation protected from the wind.

In addition to this standard case for containers and pipelines, the following cases for glass components and apparatus must be observed with $_{\alpha i}$ for liquids and vapour and $_{\alpha a}$ for the environment:

- Tanks, pipelines, generally single-walled components
  - Liquid inside
  - Air environment (exposed to draughts indoors, protected from wind outdoors)
- Capacitors
  - in spirals / inner tubes Liquid
  - around spirals / inner tubes Steam
  - Air environment (draught in the building, protected from the wind outdoors)
- Heat exchanger
  - in spirals / inner tubes Liquid
  - around spirals / inner tubes Liquid
  - Air environment (draught in the building, protected from the wind outdoors)

NORMAG LAB & PROCESS GLASS

- Jacketed pipes and vessels
    - Liquid inside
    - Jacket liquid

Ambient air (draught in the building, protected from wind outdoors) If deviations from larger heat transfer coefficients are possible in your application, please consult our experts for clarification.

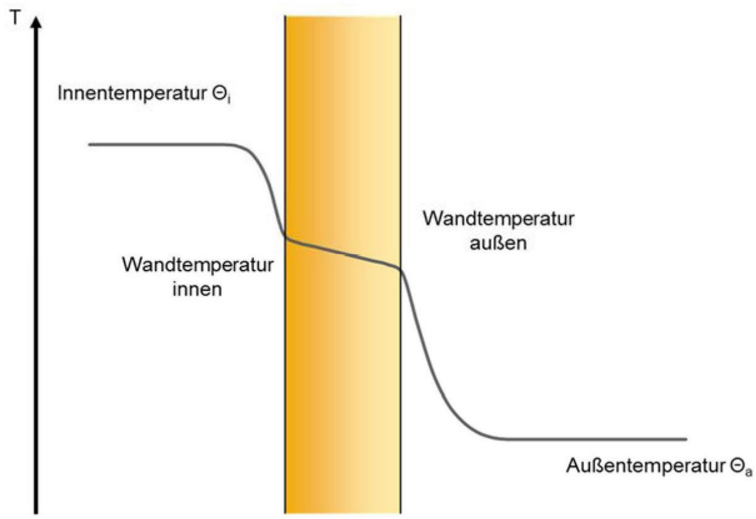


Figure 10.2: Temperature curve through glass wall for borosilicate glass 3.3

Permissible operating pressure

Glass components of all nominal sizes and flange types specified on page 10.1 can be used at full vacuum in the product chamber, unless they are specially labelled. The permissible operating overpressure of glass components depends on the specified general operating conditions and the main nominal diameter or volume of the balls as well as the flange type. To simplify handling, the following applies as standard for the permissible operating pressure range:

Nominal diameter dependencies Permissible operating pressures	
Taper/ground joints (NS joints)	-1/+0.1 barg
Rotulex connections (KS connections)	-1/+0.5 barg
GL thread (GL connection),	-1/+0.5 barg
High-vacuum small flanges (HF connections),	-1/+0.5 barg 1)
Laboratory flanges (LF connections)	-1/+0.1 barg 1)
Ball and socket (KF) and safety flat flange (PF) connections	-1/+6 (0.5) barg 2)

Table 10.6: Nominal diameter dependencies permissible operating pressures

1) Depending on the nominal diameter and clamp ring/gasket, higher permissible operating pressures are possible
2) See catalogue PROZESSTECHNIK, chapter 10 for nominal diameter-dependent information on the permissible

operating pressure Reduced pressures, if applicable, are indicated for the corresponding components.

The interiors of heat exchangers are dealt with separately in chapter 6 in the respective product descriptions. The cooling coils of heat exchangers are generally suitable for an operating pressure of up to 1 barg on the tube side, provided that a flange system suitable for this operating pressure is provided. Suitable protective devices are required for excess gas pressure in glass apparatus.

Dimensioning of glass components

The starting point for the strength calculation of all borosilicate glass 3.3 components listed in this catalogue is the temperature difference $_{\Delta\vartheta W}$ in the wall, which is calculated from the permissible temperature difference $_{\Delta\vartheta M}$ between the outside space (environment) and the inside space (product space) for the boundary conditions specified above.

The strength calculation itself is based on the AD2000 regulations and EN 1595.

Labelling of the glass components

The labelling of components made of borosilicate glass 3.3 that can be used for pressure vessels is based on the Pressure Equipment Directive 2014/68/EU and the standard EN 1595 ("Pressure equipment made of borosilicate glass 3.3"). Additional information on the component is for quality assurance purposes (traceability, correct use by the customer, etc.) and has been agreed with the notified body. Articles listed in the catalogue are given a simplified logo, with the article number referring to the permissible operating conditions stated in this catalogue.

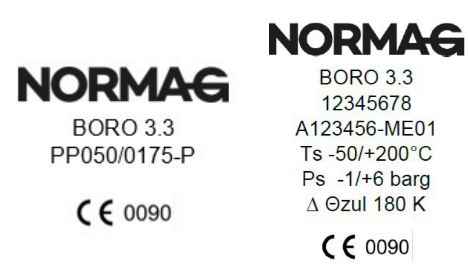
Table 10.7 and the associated illustrations show the corresponding labelling of the glass components and the corresponding meaning.

Notwithstanding Table 10.7, components with main nominal diameters of DN 15 and DN 25 and permissible operating pressures of up to 0.5 barg may not be CE marked (see Article 4, Paragraph 3 of Directive 2014/68/EU).

The following information can be found on the labelling:

Labelling	Meaning
Manufacturer logo	-
Boro 3.3	Glass quality borosilicate glass 3.3
12345678	Production number
PP 050/0175-P	Standard article number
A 123456 ME 01	Special section with catalogue operating conditions
PS = -1/+6 bar	Permissible operating overpressure deviating from the catalogue
TS = -50/+200 °C	Permissible operating temperature deviating from the catalogue
ΔΘM ≤ 180 K	Permissible temperature difference deviating from the catalogue
CE 0090	Identification number of the notified body

Table 10.7: Labelling of glass components



TA-Luft certificates

The safety flat flange (PF) and collar flange or ball and socket flange (KF) connection and pipe end systems are proven, high-quality systems that have been continuously adapted by NORMAG to meet the increased requirements and are fully compatible with existing installations. Accordingly, the two flange systems from NORMAG have been qualified as high-quality connection systems and fittings in accordance with TA-Luft for the entire nominal diameter range.
The corresponding certificates can be found in the attached illustrations

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ZERTIFIKAT

Nr. 30148604/FH/27.02.15

Nach den Vorgaben der VDI-Richtlinie 2440 (Ausgabe November 2000) wurde das Flanschverbindungssystem vom Typ

KF (Zeichnung NLP S 05 0037) und
PF (Zeichnung NLP S 05 0036)

der Firma

NORMAG Labor- und Prozesstechnik GmbH
Auf dem Steine 4, D-98693 Ilmenau

auf die Einhaltung des Dichtheitskriteriums 1.0 · 10^{-4} mbar · l/(s · m) unter folgenden Randbedingungen geprüft:

Auslagerungstemperatur:	200	°C
Auslagerungszeit:	48	h
Prüfdruck (absolut):	1	bar
Messzeit:	24	h

Die mit einem Helium-Massenspektrometer am Ende der Messzeit gemessene Leckagerate betrug

9.2 · 10^{-6} mbar · l/(s · m),

das Flanschverbindungssystem erfüllt, damit das geforderte Dichtheitskriterium der VDI 2440 und kann als hochwertiges Dichtsystem im Sinne der TA-Luft betrachtet werden.

Dieses Zertifikat gilt nur in Zusammenhang mit unserem Prüfungsbericht 3014864/-.

Lauffen, 27. Februar 2015

amtec Messtechnischer Service GmbH

Dipl.-Ing. F. Herkert

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ZERTIFIKAT

Nr. 30148603/FH/27.02.15

Nach den Vorgaben der VDI-Richtlinie 2440 (Ausgabe November 2000) wurde das Faltenbalg-Eckventil

VE, Typ PF/KF (Zeichnung NLP S 06 0095)

der Firma

NORMAG Labor- und Prozesstechnik GmbH
Auf dem Steine 4, D-98693 Ilmenau

auf die Einhaltung des Dichtheitskriteriums 1,0 · 10^{-4} mbar · l/(m · s) geprüft.
Die mit einem Helium-Massenspektrometer am Ende der Meßzeit nach einer 48-stündigen Auslagerung bei 100 °C gemessene Leckagerate betrug

9.3 · 10^{-5} mbar · l/(m · s),

das Flanschverbindungssystem erfüllt damit das geforderte Dichtheitskriterium der VDI 2440 und kann als hochwertiges Dichtsystem im Sinne der TA-Luft betrachtet werden.

Folgende Faltenbalgventile mit gleicher Bauart von Ventilsitz und Faltenbalg können ebenfalls als hochwertig im Sinne der TA-Luft betrachtet werden:

Ventiltyp	Ventilbezeichnung	Zeichnungsnummer
VS	Durchgangsventil, Typ PF/KF	NLP S 06 0096
VD	Auslaufventil, Typ PF/KF	NLP S 06 0097
VP	Druckhalteeckventil, Typ PF/KF	NLP S 06 0098
VOF	Überlaufventil, Typ PF/KF	NLP S 06 0099
VT	Dreiwegewechselventil, Typ PF/KF	NLP S 06 0100
VSL	Probenahmeventil, Typ PF/KF	NLP S 06 0102
VCE	Regelventil, Typ PF/KF	NLP S 06 0103
VE...-O10	Eckventil, Typ KF, frühere Ausführung	NLP S 06 0104
VS...-O10	Durchgangsventil, Typ KF, frühere Ausf.	NLP S 06 0105

Dieses Zertifikat gilt nur in Zusammenhang mit unserem Prüfungsbericht 3014863/- und den dort niedergelegten Prüf- und Randbedingungen.

Lauffen, 27. Februar 2015

amtec Messtechnischer Service GmbH

Dipl.-Ing. F. Herkert

Figure 10.3: TA-Luft certificates for connections and fittings

Technical tightness

High-quality connections from NORMAG in defined constructive designs in accordance with TRBS 2141, TRBS 2152, Part 2, and TRGS 722 can be used as "technically tight" and, in combination with utilisation and maintenance instructions, even as "permanently technically tight".
This applies to connections of type:

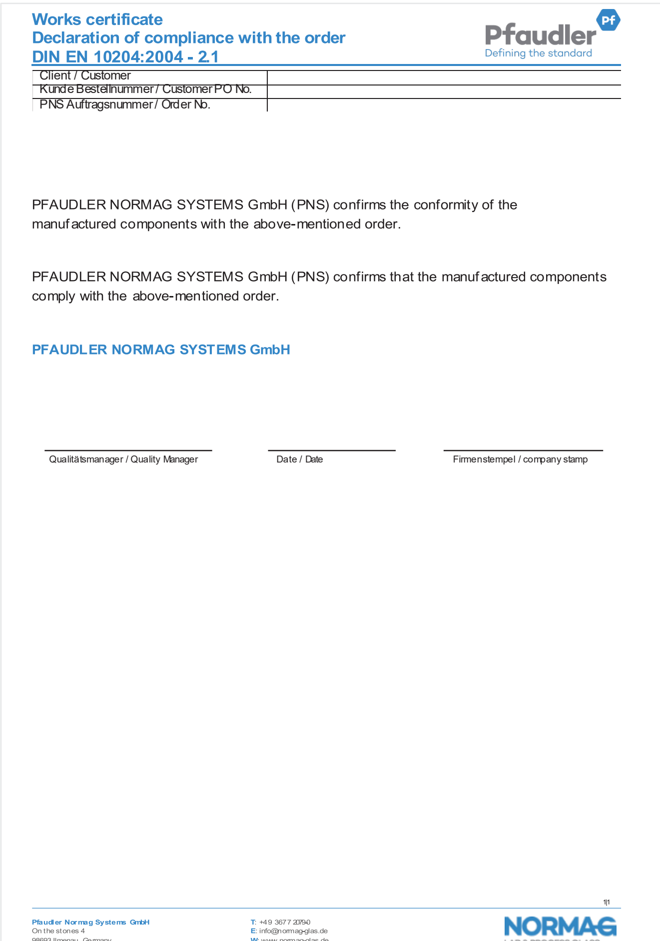
- Rotulex connections (KS connections)
- High-vacuum small flanges (HF connections)
- Safety flat flange (PF)

In some cases, this can significantly simplify operations as a customer service. For example, for permanently technically sealed equipment and systems, the outside of the system can be designed as EX zone-free in coordination with the customer's notified body, even if the interior of the system is subject to EX conditions.
Our specialised department will be happy to support you with the design and implementation of appropriate systems.

Material certificates 2.1 and FDA

The safety flat flange (PF) and collar flange or ball and socket flange (KF) connection and pipe end systems are proven, high-quality systems that have been continuously adapted by NORMAG to meet increased requirements and are fully compatible with existing installations.

Accordingly, NORMAG also issues 2.1 material certificates and FDA material certificates for the PTFE components used for the glass components.



Works certificate
Declaration of compliance with the order
DIN EN 10204:2004 - 2.1

Pfaudler
Defining the standard

Client / Customer	
Kunde Bestellnummer / Customer PO No.	
PNS Auftragsnummer / Order No.	

PFAUDLER NORMAG SYSTEMS GmbH (PNS) confirms the conformity of the manufactured components with the above-mentioned order.

PFAUDLER NORMAG SYSTEMS GmbH (PNS) confirms that the manufactured components comply with the above-mentioned order.

PFAUDLER NORMAG SYSTEMS GmbH

Qualitätsmanager / Quality Manager — Date / Date — Firmenstempel / company stamp

1|1

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On the stones 4
98693 Ilmenau, Germany

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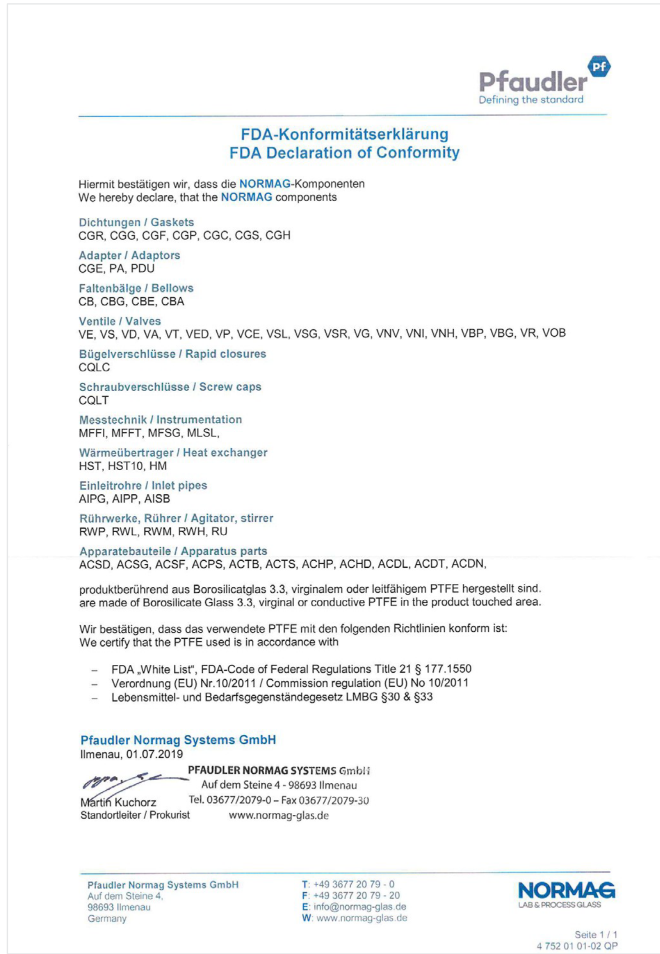

Pfaudler
Defining the standard

FDA-Konformitätserklärung
FDA Declaration of Conformity

Hiermit bestätigen wir, dass die NORMAG-Komponenten
We hereby declare, that the NORMAG components

Dichtungen / Gaskets
CGR, CGG, CGF, CGP, CGC, CGS, CGH

Adapter / Adaptors
CGE, PA, PDU

Faltenbälge / Bellows
CB, CBG, CBE, CBA

Ventile / Valves
VE, VS, VD, VA, VT, VED, VP, VCE, VSL, VSG, VSR, VG, VNV, VNI, VNH, VBP, VBG, VR, VOB

Bügelverschlüsse / Rapid closures
CQLC

Schraubverschlüsse / Screw caps
CQLT

Messtechnik / Instrumentation
MFFI, MFFT, MFSG, MLSL,

Wärmeübertrager / Heat exchanger
HST, HST10, HM

Einleitrohre / Inlet pipes
AIPG, AIPP, AISB

Rührwerke, Rührer / Agitator, stirrer
RWP, RWL, RWM, RWH, RU

Apparatebauteile / Apparatus parts
ACSD, ACSG, ACSF, ACPS, ACTB, ACTS, ACHP, ACHD, ACDL, ACDT, ACDN,

produktberührend aus Borosilicatglas 3.3, virginalem oder leitfähigem PTFE hergestellt sind.
are made of Borosilicate Glass 3.3, virginal or conductive PTFE in the product touched area.

Wir bestätigen, dass das verwendete PTFE mit den folgenden Richtlinien konform ist:
We certify that the PTFE used is in accordance with

- FDA „White List", FDA-Code of Federal Regulations Title 21 § 177.1550
- Verordnung (EU) Nr.10/2011 / Commission regulation (EU) No 10/2011
- Lebensmittel- und Bedarfsgegenständegesetz LMBG §30 & §33

Pfaudler Normag Systems GmbH
Ilmenau, 01.07.2019

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Figure 10.4: Material certificates for material according to 2.1 and FDA conformity

COATING OF GLASS COMPONENTS

NORMAG Labor- und Prozesstechnik GmbH offers coatings for glass components to protect them from surface damage, chipping and impact. This coating can be applied to new and used glass components regardless of their shape. Components that have already been coated can also be decoated for repairs or further processing, for example for attaching additional nozzles.

The coatings generally have the following properties:

- Surface protection thanks to cushioning outer coating (increased impact resistance) and minimisation of scratch damage
- Splinter protection by preventing splinters from being thrown thanks to a well-adhering coating with high elasticity
- Leakage protection or greatly reduced liquid leakage from damaged glass components by holding the mould together, except in the event of excessive damage
- The permissible operating pressure and temperature shocks are not increased
- The coatings maintain the transparency of the glass component
- The permissible operating temperature can be reduced
- Depending on the application in the EX or non-EX area, the appropriate coating must be selected

NORMAG offers three types of coating:

Option C1: Transparent coating, non-conductive

- PU-based coating
- Permissible temperature range -40/+140 °C, briefly up to 160 °C
- Very good transparency
- Good conditional chemical resistance to oils, greases, petrol and a large number of
- Solvents, water and weak alkalis
- UV resistance
- Not suitable for the use of highly charging media in EX areas in accordance with Directive 2014/34/EU and TRGS 727
- Order identification by index "-C1", e.g. PP050/0200-K-C1

Option C2: Transparent high-temperature resistant coating, non-conductive

- PFA-based coating
- Permissible temperature range -40/+200 °C
- Very good transparency
- Very good chemical resistance to oils, greases, petrol and a wide range of solvents as well as to water and weak alkalis
- UV resistance
- Not suitable for the use of highly charging media in EX areas in accordance with Directive 2014/34/EU and TRGS 727
- Order identification by index "-C2", e.g. PP050/0200-K-C2

Option C3: Transparent dissipative coating

- PU-based coating with conductive active group
- Permissible temperature range -40/+140 °C, briefly up to 160 °C
- Very good transparency
- Good conditional chemical resistance to oils, greases, petrol and a variety of solvents as well as to water and weak alkalis
- UV resistance
- Surface resistance < 109 Ohm, also suitable for use with highly charging media in EX areas in accordance with Directive 2014/34/EU and TRGS 727
- Order identification by index "-C3", e.g. PP050/0200-K-C3

The conductive coating can be earthed in various ways. On the one hand, a metallic contact can be connected to the component to be earthed, e.g. a metallic clamp. On the other hand, earthing can also be possible via adjacent conductive collar seals with an earthing lug, see Figure 10.5.

Our experienced engineers will be happy to answer any questions you may have on this subject.

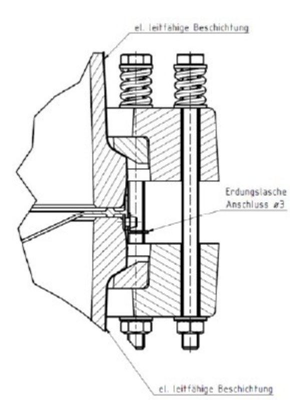

Figure 10.5: Exemplary connection of conductive coating with collar seal and earthing lug

MISCELLANEOUS

GMP-compliant installations

For GMP requirements in the construction of systems, the corresponding equipment and components must be selectively designed - often as an application-specific special design - and suitable materials must be selected.
Key objectives in the GMP-compliant design are a design with minimal dead space to ensure extensive emptying and simple and effective CIP cleaning. In addition, FDA material certificates are typical for all PTFE and plastic parts that come into contact with the product.

Glass systems in the EX area

The ATEX Directive 2014/34/EU and the electrostatic directive TRGS 727 apply to the use of glass systems in hazardous areas. In principle, there are no restrictions as long as the components used are selected in accordance with the relevant Ex zones. Glass components can be used directly for the outer EX zone 1 (IIA/B) and 2 (IIA/B/C). Additional measures are only required for outer EX zone 1 (IIC), for example a conductive coating on the glass components combined with appropriate earthing. In general, the requirements of TRBS 2153 must also be observed if there is a risk of electrostatic charging due to non-conductive media in the system, e.g. PTFE components. Accordingly, depending on the component dimensions, the earthing of external metallic parts (M8 screws up to the standard lengths used here do not need to be earthed) and the use of conductive PTFE components with earthing may be required.
PTFE components made of dissipative material and with earthing option are available as standard (option -M2).

Repairs

To carry out repairs, please download the current version of our clearance certificate from our website www.normag-glas.com and fill it out and send it to us with the component to be repaired.

RISK ANALYSIS / RESIDUAL RISKS

For all components and equipment in the PROZESSTECHNIK catalogue, the hazard analysis was carried out in accordance with the Machinery Directive and the Pressure Equipment Directive 2014/68/EU. The following points must be observed to avoid additional hazards that cannot be ruled out due to improper use:

- In general, people who are in the danger zone must wear protective equipment. This includes at least safety goggles, helmets and safety shoes.
- Borosilicate glass 3.3 is an almost universally resistant material. Nevertheless, alkalis, hydrofluoric acid and concentrated phosphoric acid can cause erosion. If wall thickness erosion is to be feared, the required minimum wall thickness must be checked at regular intervals.
- Corrosion on the glass surface can reduce the permissible operating overpressure. The glass component must be replaced if there is a strong, white haze or a noticeably rough surface.
- Raw materials and unstable fluids that can decompose or react very quickly require special safety measures when using glass systems.
- The permissible operating conditions must be observed. Additional measures may be required by the customer to ensure compliance, such as bursting discs or safety valves, overfill protection as well as temperature and pressure limiters.
- The permissible operating pressure must also not be exceeded during leak tests, functional tests and commissioning.
- The maximum operating temperature for glass components must be observed and, if necessary, e.g. in the case of electrical heating or exothermic reaction, ensured by suitable measuring and switch-off devices.
- In order not to exceed the maximum permissible temperature shock of 120 K for glass systems, the glass system must not be operated in the area of a sprinkler system. In the event of fire, the activation of the sprinkler system can lead to glass breakage.
- Additional loads, such as reaction forces, strong contraction or expansion of expansion joints due to excess or negative pressure and vibrations at nozzles, are not permitted. Connecting cables must be connected to the glass system using expansion joints without tension.
- Mechanical protective measures:
    - The tubular frame in which the equipment or system is mounted also serves as a protective device against damage caused by external influences and as protection against accidental contact. System parts located outside the frame should be protected against mechanical damage.
    - System parts that can reach a surface temperature of more than 60 °C during operation and are located outside the system frame must be provided with contact protection.
    - Protective walls, splash guards and coated glass components can be provided as additional secondary protective measures.
- In the case of heat exchangers, damage to the exchange packs of coil heat exchangers or the exchange tubes of shell-and-tube heat exchangers can result in the service medium and product mixing. Special safety measures are therefore required for temperature control media, which can then react under pressure and temperature.
- It is recommended not to reuse seals from standard connections. PTFE components such as bellows should also be replaced if there are signs of heavy wear (surface of seat worn away, cracks)

INSTALLATION AND COMMISSIONING

The pipe connections used by NORMAG have excellent assembly properties. Glass installation can therefore also be carried out by inexperienced persons without any problems. Of course, NORMAG will be happy to provide advice. However, NORMAG's installation service can also be utilised for the installation of glass systems.
Our experienced and trained glass fitters guarantee that the systems we supply are installed professionally and quickly.
As a rule, the system is tested for leaks with a vacuum test after installation is complete. Specifications and protocols for determining leakage rates and the corresponding requirements for a leak test can be prepared and provided by our specialist department on a project-specific basis.

The following specifications and installation instructions must be observed when installing glass connections:

Installation specifications for various flange types	
Taper/ground joints (NS joints)	Installation instructions NLP (section NS)
Rotulex connections (KS connections)	Installation instructions NLP (section KS)
GL thread (GL connection),	Installation instructions NLP (section GL)
High-vacuum small flanges (HF connections),	Installation instructions NLP (section HF)
Laboratory flanges (LF connections)	Installation instructions NLP (section LF)
Ball socket (KF) and safety flat flange (PF)	Table 10.9 (following)

Table 10.8: Installation specifications for different flange types

When installing KF and PF glass connections, the maximum tightening torques according to Table 10.9 must be observed

DN	PF connection connectiontype CP, CS	KF connection type CP, CS	KF typeCA
15	1,5	1,0	1,0
25	2	1,5	2,5
40	2	1,5	3,5
50	2	1,5	3,5
80	2	2	3,5
100	2	2	4,5
150	3	3,5	4,5
200	4	4	4,5
225	4	-	-
300	4	4	4,5
400	7	7	-
450	7	7	-
600	12	10	-

Table 10.9: Maximum screw tightening torque* in Nm for PF and KF glass connection systems

* The specified screw tightening torques are only required for the maximum operating overpressures and can be reduced for lower pressures.

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