PROCESS AND PILOT PLANTS IN BOROSILICATE GLASS 3.3

Borosilicate Glass 3.3 is a well-established and widely used material for process and pilot plants in the chemical and pharmaceutical industry as well as in many related industries such as beverage or precious metal refinery industry.

There are many reasons for the wide application range of borosilicate glass in these industries:

- The transparency of Borosilicate Glass 3.3 enables continuous visual control of processes.
- Borosilicate Glass 3.3 is corrosion resistant against nearly all media, especially against strong acids. The materials usually used together with Borosilicate Glass 3.3, mainly PTFE, have a similar corrosion resistance.
- The smooth and non-porous surface avoids fouling and encrustation.
- Unlike metals, the catalytic indifference of Borosilicate Glass 3.3 avoids catalytic reactions. Influences on taste and smell can be precluded.
- Glass has no adverse physiological properties.
- Borosilicate Glass 3.3 is not flammable.
- Recycling of the glass is possible.
- Borosilicate Glass 3.3 is widely used in laboratories as well. Therefor no change of material is necessary for the scale-up to pilot and process plants.
- The properties of glass remains nearly unchanged for the whole permitted standard temperature and pressure range.
- Borosilicate Glass 3.3 is an approved and proven material in the construction of pressure equipment..

NORMAG uses the excellent material properties of Borosilicate Glass 3.3 in combination with PTFE in a complete manufacturing system. This well-established and consequently used construction set of components is conform to the main European directives for a range from DN 15 to DN 600.
Essential for the construction set is the high reliability and wide pressure resistance of the connections for the components. This statement is based on the use of the well-established buttress ends ball & socket (KF) and safety flat plan flange (PF), which are in the design 2012 fully compatible to existing flanges and further optimised.
The whole program of components, which can be delivered as standard, is described in the previous chapters. Technical Information of the material, its production and its application are part of this chapter.

PROPERTIES OF BOROSILICATE GLASS 3.3

CHEMICAL COMPOSITION

Borosilicate Glass 3.3 is a standardized material with the approximate composition as in table 10.1:

Component	composition in weight %
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 nearly all products. It is highly resistant in water, salt solutions, organic substances, halogens as chlorine and many acids. Borosilicate Glass 3.3 can be used at room temperature without problems for basic solutions up to a concentration of 30 weight %. Only for a few media such as hydrofluoric acid as well as concentrated phosphoric acid and strong basic solutions at higher temperatures are substantial abrasion of the glass surface known.
A classification of the material Borosilicate Glass 3.3 according to common research methods had the following results (see ISO 3585 and EN 1595):

Hydrolytic resistance at 98 °C	Hydrolytic resistant grain class ISO 719-HGB 1
Hydrolytic resistance at 121 °C	Hydrolytic resistant grain class ISO 720-HGA 1
Acid resistance	Deposit of Na_2O < 100 mg/dm^2 to ISO 1776
Alkali resistance	Alkali resistance class ISO 695-A2

Table 10.2: Chemical resistance of Borosilicate Glass 3.3

The surface corrosion depends on the individual operating conditions and media. A general statement on the surface corrosion is not possible.

THERMAL PROPERTIES

Borosilicate Glass 3.3 is characterized compared to other construction materials not only by ist nearly complete corrosion resistance but although by its very small thermal expansion coefficient. Thus, extensive actions to compensate thermal expansions are not necessary.
For the construction of apparatuses are the most important thermal properties listed up in table 10.3 (see DIN ISO 3585 and EN 1595):

Mean linear thermal expansion coefficient	$\alpha_{20/300}$	= (3,3 ± 0,1) x 10^{-6} K^{-1}
Mean thermal conductivity between 20 and 100 °C	$\lambda_{20/100}$	= 1,2 W $m^{-1}K^{-1}$
Mean thermal conductivity between 20 und 200 °C	$\lambda_{20/200}$	= 1,3 W $m^{-1}K^{-1}$
Mean specific heat capacity between 20 and 100 °C	$c_{p\ 20/100}$	= 0,84 kJ kg^{-1} K^{-1}
Mean specific heat capacity between 20 and 200 °C	$c_{p\ 20/200}$	= 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 parameters of Borosilicate Glass 3.3 for the construction are listed up in the following table 10.4. Within the parameters is a safety factor included, the so-called K/S-factor, who comprises the practical knowledge about the strength of glass and its properties, especially its brittleness. For practical application needs to be considered that Borosilicate Glass 3.3 as a brittle material cannot reduce tension peaks at small cracks or scattered transitions. Especially for Borosilicate Glass 3.3 is the neglectable temperature dependence of the strength parameters and the significantly higher compressive then tension strength.

These experiences are considered in the EN 1595. As the basis for the design of glass components are the enclosed properties for the permitted tension, bending and compressive strength fixed in the EN 1595. As a conservative approach, the surface consistency has been in worst-case practical conditions while elaborating these design values.

Density at 20 °C	ρ	=	2.230	kg m^{-3}
Strength parameter for tension and bending 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	ν	=	0,2	

Table 10.4: Mechanical properties of Borosilicate Glass 3.3

OPTICAL PROPERTIES

Borosilicate Glass 3.3 is an optical transparent material with a corresponding high transparency of radiation in the visible wavelength zone.
For some applications such as photochemical reactions is the light transparency in the ultraviolet range of great importance. For applications such as the photochemical chlorination (absorption in the range of 280 – 400 nm) is Borosilicate glass suitable, for applications in the shorter wavelength range are other glasses like quartz glass advantageous.
For the production of light sensitive substances is brown-coated Borosilicate glass recommended. For these permanent special coatings, the UV light transparency is widely reduced.

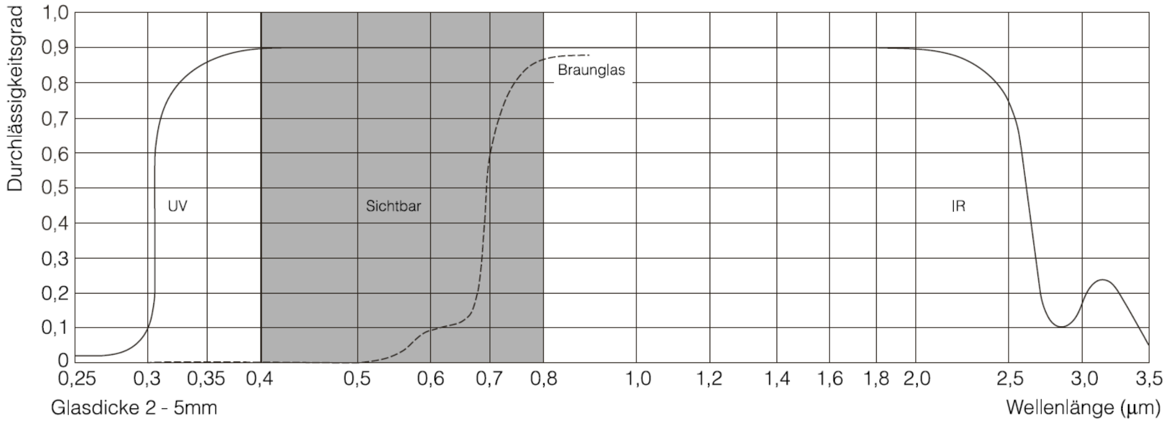


figure 10.1: Transmission curves for Borosilicate Glass 3.3

PERMISSIBLE OPERATING CONDITIONS

PERMISSIBLE OPERATION TEMPERATURE

Borosilicate Glass 3.3 has nearly ideal-elastic behaviour up to temperatures close to the transformation temperature above 500 °C and keeps up to this temperature its mechanical strength. Due to the use of PTFE as gasket material and in addition to avoid temperature shocks is the permissible temperature range for standard applications limited to –50 up to +200 °C.
For temperatures below the freezing point the tension strength rises, so that Borosilicate Glass 3.3 in combination with suitable gaskets can be used at even lower temperatures as well. Vice versa are applications for temperatures above 200 °C possible.
A special consideration for the permissible temperature range as well as for the temperature shock is for jacketed vessels necessary. Therefore and for other special applications please contact our specialist department.

TEMPERATURE SHOCK

Rapid changes of the media temperatures inside or outside of glass components lead to quick changes of the wall temperature, which should be avoided. Additional thermal tensions in the glass wall occur reducing the permissible operation pressure of the corresponding component. In extreme cases, this so-called temperature shock results in a spontaneous breakage of the glass.
The resistance of glass to temperature changes depends mainly on the operation conditions and the wall thickness. There is no general recommended safety factor for all possible operation conditions. A recommended and in most cases conservative value for quick temperature changes is max. 100 K. Such quick temperature changes will typically not occur with heating / cooling units. Thus, the temperature shock needs to be considered only for deviations from this standard case for jacketed vessels, tubes or heat exchangers.
It is necessary to consider the permissible temperature shock for various applications. Examples are filling applications or injection of cold liquids onto hot glass components as well as for the case of possible cold drops onto a hot glass wall. It is unavoidable that the cooling down of glass components needs to be in any cases within the given permissible operation data, typically by natural heat flow to the surrounding atmosphere.

DETERMINATION OF THE WALL TEMPERATURE DIFFERENCE

The following data are the basis for the determination of the wall temperature difference $\Delta\vartheta_W$ and due to that the wall thickness calculation.

Permissible operation temperature	T_{zul}	= -50 / +200 °C
Permissible temperature difference between inside to outside	$\Delta\vartheta_M$	≤ 180 K
heat transfer coefficient inside	α_i	= 1.200 $Wm^{-2}K$
heat transfer coefficient outside	α_a	= 11,6 $Wm^{-2}K$

table 10.5: design basis for the wall temperature calculation for 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 important for the mechanical strength calculation. The wall temperature difference $\Delta\vartheta_W$ can be determined with respect to the media temperature difference, wall thickness, geometry, as well as inner and outer heat transfer coefficient. The listed up inner heat transfer coefficient α_i of 1.200 $Wm^{-2}K^{-1}$ covers the most in reality occurring applications conservative. A significantly larger influence on the wall temperature difference $\Delta\vartheta_W$ has the outer heat transfer coefficient α_a. The given value of 11,6 $Wm^{-2}K$ corresponds to a building with infiltration respectively an outside installation which is wind protected.

Beside these standard applications for vessels and piping are for α_i for liquids and vapour as well as for α_a for the surrounding the following cases for glass components and apparatuses to be considered:

- Vessels, piping, generally single wall components
  - inside liquid
  - surrounding air (inside building with infiltration, outside wind protected)
- condensers
  - inside spirals / tubing liquid
  - outside spirals / tubing vapour
  - surrounding air (inside building with infiltration, outside wind protected)
- heat exchanger
  - inside spirals / tubing liquid
  - outside spirals / tubing liquid
  - surrounding air (inside building with infiltration, outside wind protected)
- Jacketed vessels and pipes
  - inside liquid
  - jacket liquid
  - surrounding air (inside building with infiltration, outside wind protected)

Please consider if for your application deviations to larger heat transfer coefficients are possible. For these cases, please contact our specialists for support.

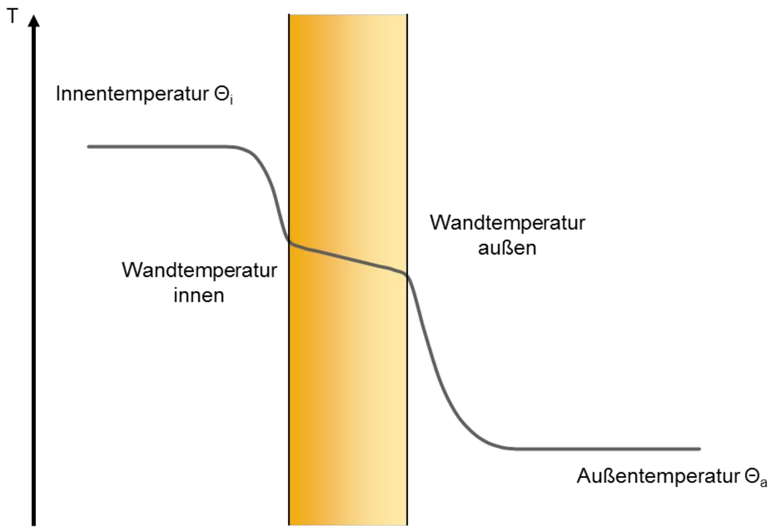


figure 10.2: temperature shape across a glass wall for Borosilicate Glass 3.3

PERMISSIBLE OPERATION PRESSURE

Glass components can be used even for full vacuum inside the component for all diameters, if they are not otherwise marked.
The general permissible overpressure of single wall glass components is listed up in table 10.6 depending on the general operation conditions and the diameter of the component respectively the volume of flasks. For double or multiwall components, such as jacketed vessels or heat exchangers, individual permissible operation conditions are required. Please contact therefore our specialists for support.
Standard gaskets of type CGR for the whole range as well as other PTFE standard components at room temperature are permitted for the listed pressure range as well. For deviating applications, please contact our specialists for support.
In case of gaseous over pressure in glass, suitable safety devices are necessary.

Main diameter DN	15	25	40	50	80	100	150	200	225	300	400	450	600
Glass comp. Ps (bar)	6	6	4	4	3	2	2	1	1	1	0,5	0,5	0,5

table 10.6: permissible overpressure for single wall glass components

Volume (l) / diameter D (mm)	10/280	20/350	50/490	100/610	200/750
Flask Ps (bar)	1	1	0,5	0,5	0,5

table 10.7: permissible overpressure for flasks

Connection diameter DN	15	25	40	50	80	100
Valves with bellows Ps (bar) at room temperature	6	6	4	4	3	2
Valves with bellows Ps (bar) for permissible temp. range	3	3	3	2	1,5	1,5

table 10.8: Valves with bellows

DIMENSIONING AND CALCULATION OF GLASS COMPONENTS

Basis for the mechanical strength calculation of all glass components of this catalogue is the maximum permissible temperature difference $\Delta\vartheta_W$ through the wall which is calculated based on the temperature difference $\Delta\vartheta_M$ between the outer side (surrounding) and the inner side (product zone) for the given conditions.

The mechanical strength calculation is based on the directives AD2000-Regelwerkes and EN 1595.

MARKING OF GLASS COMPONENTS

Basis for the marking of components made of Borosilicate Glass 3.3 suitable for pressure vessels is the Pressure Equipment Directive 97/23EG as well as the norm EN 1595 ("pressure vessels made of Borosilicate Glass 3.3"). Additional data on the glass component are due to quality control requirements (traceability, correct use of customer, etc.) and are agreed on with the Notified Body. Items, that are part of the catalogue, have a simplified marking. Based on the item number, the permissible operating conditions can be found in the catalogue.

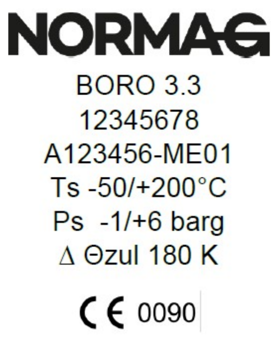
In table 10.9 and the corresponding figures is the marking of glass components and the meaning illustrated.

Deviating from table 10.9 will components with the main diameter DN 15 and DN 25 marked without CE-Logo (see article 3, paragraph 3 of the guideline 97/23/EG).

The marking will provide you the following information:

Part of mark	**Meaning**
Supplier-Logo	-
Boro 3.3	Glass quality Borosilicate Glass 3.3
12345678	Batch serial number
PP 050/0175-P	Standard item reference number
A 123456 ME 01	Special component with catalogue operation conditions
PS = -1/+6 bar	deviating permissible pressure to catalogue
TS = -50/+200 °C	deviating permissible temperature range to catalogue
$\Delta\Theta_M \leq 180$ K	deviating permissible temperature difference to catalogue
CE 0090	CE mark with Notified Body's identification number

table 10.9: marking of glass components



SAFETY FLAT FLANGE SYSTEM (PF) AND BALL SOCKET SYSTEM (KF)

FLANGE GEOMETRY

Components and buttress ends made of Borosilicate Glass 3.3 do have in practical applications - besides covering the permissible pressure and temperature requirements – to transfer the required sealing force from the backing flanges to the gasket. Further requirements are for example the TA-Luft requirements for the complete connection concerning maximum leakage rate – resulting in enhanced tolerance and surface requirements especially in the sealing zone of the buttress end – or as another example GMP-requirements with a corresponding design of the inner buttress end and gasket form.
For all these requirements for connections and buttress ends, the safety plan flange system (PF) and ball-socket system (KF) are well established. Both flange types have been from NORMAG continuously adjusted to these rising requirements, keeping full compatibility to existing types.

The PF-flange with its fire polished sealing area and precise groove for the gasket covers a production range from DN 15 to DN 150 while the KF-flanges cover a production scale from DN 15 to DN 600 with its smooth ground-sealing surface. For the diameter range from DN 200 to 600 is the KF-flange system used for both flange systems as in existing installations.

figure 10.3: Connection system PF and KF for Borosilicate Glass 3.3 in the pilot plant and production scale

The most important dimensions of the PF and KF buttress ends are listed up in table 10.9 and 10.10, based on the enclosed sketches of the buttress ends.

DN	D1	D2	D3	D4	Typ
15	17	23	30	16,5–17,5	B,C
25	24	34	44	22,75–25,25	B,C
40	40	51	62	38,2–41,8	B,C
50	50	63	76	48–52	B,C
80	82	96	110	77,5–82,5	B,C
100	102	116	130	97,6–104,4	B,C
150	155	169	184	147–155	B,C
200	205	220	233	196,2–205,8	B,C
300	304	321	338	294,9–307,1	B,C
400	408	465		394,9-407,1	D
450	457	526		438,5–459,5	D
600	615	684		587,5–612,5	D

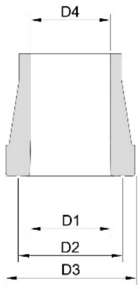
Tabelle 10.9: Dimensions of **KF** flange system

DN	D1	D2	D3	D4	Typ
15	15	23	28,6	16,5–17,5	A
25	26	34	42,2	24,75–27,25	A
40	39	48	57,4	37–40,2	A
50	50	60,5	70	48–52	A
80	78	88	99,2	74,5–79,5	A
100	108	120,5	132,6	97,6–104,4	A
150	159	172	185	147–155	A
200	203	220	233	196,2–205,8	C
300	304	321	338	294,9–307,1	C
400	408	465		394,9-407,1	D
450	457	526		438,5–459,5	D
600	615	684		587,5–612,5	D

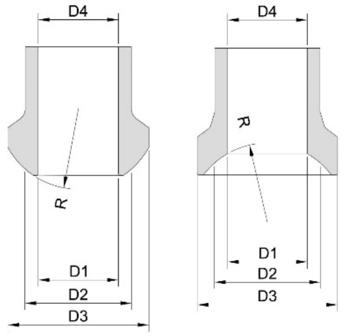
Tabelle 10.10: Dimensions of **PF** flange system

DN 15-300

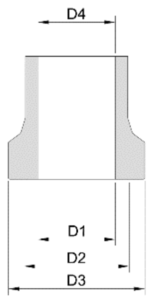
A



B

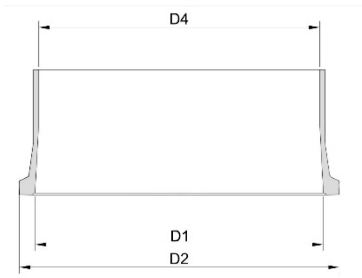


C



DN 400-600

D



TA-LUFT CERTIFICATE

The connections systems for buttress ends safety plan flange (PF) and ball socket flange (KF) are well-established and high qualitative flange systems. With respect to full compatibility to existing applications has NORMAG the flanges and connection systems further developed due to the rising requirements for these systems.
Correspondingly are both flange systems from NORMAG certified as „high quality connection system“ and „high quality valve systems“ due to TA-Luft recommendations for the whole diameter range.
The corresponding certificates are in figure 10.4.

amtec

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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 $1.0 \cdot 10^{-4}$ 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

$9.2 \cdot 10^{-6}$ 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

amtec

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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 $1,0 \cdot 10^{-4}$ 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

$9.3 \cdot 10^{-6}$ 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

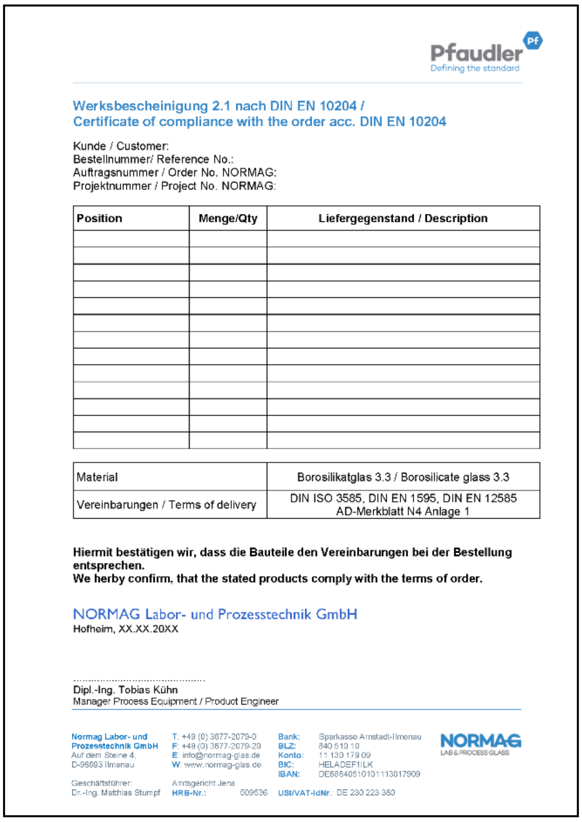
amtec Messtechnischer Service GmbH

Dipl.-Ing. F. Herkert

figure 10.4: TA-Luft-certificates for connections and valves

MATERIAL CERTIFICATES 2.1 AND FDA

The connections systems for buttress ends safety plan flange (PF) and ball socket flange (KF) are well-established and high qualitative flange systems. With respect to full compatibility to existing applications has NORMAG the flanges and connection systems further developed due to the rising requirements for these systems.
Correspondingly, we can provide for both flange systems from NORMAG material certificates 2.1 and FDA material conformity certificates for PTFE components.
Examples for the corresponding certificates are in figure 10.5.



Pfaudler
Defining the standard

Werksbescheinigung 2.1 nach DIN EN 10204 /
Certificate of compliance with the order acc. DIN EN 10204

Kunde / Customer:
Bestellnummer/ Reference No.:
Auftragsnummer / Order No. NORMAG:
Projektnummer / Project No. NORMAG:

Position	Menge/Qty	Liefergegenstand / Description

Material	Borosilikatglas 3.3 / Borosilicate glass 3.3
Vereinbarungen / Terms of delivery	DIN ISO 3585, DIN EN 1595, DIN EN 12585 AD-Merkblatt N4 Anlage 1

Hiermit bestätigen wir, dass die Bauteile den Vereinbarungen bei der Bestellung entsprechen.
We herby confirm, that the stated products comply with the terms of order.

NORMAG Labor- und Prozesstechnik GmbH
Hofheim, XX.XX.20XX

....
Dipl.-Ing. Tobias Kühn
Manager Process Equipment / Product Engineer

Normag Labor- und Prozesstechnik GmbH
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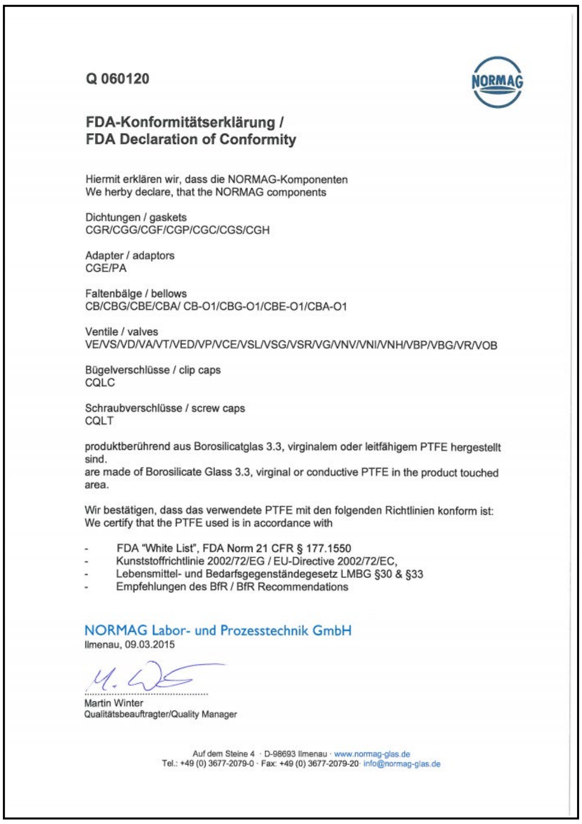
NORMAG LAB & PROCESS GLASS
Geschäftsführer: Dr.-Ing. Matthias Stumpf
Amtsgericht Jena HRB-Nr.: 509536
USt/VAT-IdNr.: DE 230 223 380



Q 060120

NORMAG

FDA-Konformitätserklärung /
FDA Declaration of Conformity

Hiermit erklären wir, dass die NORMAG-Komponenten
We herby declare, that the NORMAG components

Dichtungen / gaskets
CGR/CGG/CGF/CGP/CGC/CGS/CGH

Adapter / adaptors
CGE/PA

Faltenbälge / bellows
CB/CBG/CBE/CBA/ CB-O1/CBG-O1/CBE-O1/CBA-O1

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

Bügelverschlüsse / clip caps
CQLC

Schraubverschlüsse / screw caps
CQLT

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 Norm 21 CFR § 177.1550
- Kunststoffrichtlinie 2002/72/EG / EU-Directive 2002/72/EC,
- Lebensmittel- und Bedarfsgegenständegesetz LMBG §30 & §33
- Empfehlungen des BfR / BfR Recommendations

NORMAG Labor- und Prozesstechnik GmbH
Ilmenau, 09.03.2015

....
Martin Winter
Qualitätsbeauftragter/Quality Manager

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figure 10.5: material certificates 2.1 for Borosilicate Glass 3.3 and FDA-conformity for PTFE components

CAOTING OF GLASS COMPONENTS

For the protection of glass components to surface demolition, splinters and impacts offers NORMAG coatings of the outer surface of the glass components. These coatings can be added independent from the form onto used and new glass component. Already coated glass components can be decoated for repairs and for example to add an additional nozzle.

Coatings do have the following properties to be considered from the customer:

- Surface protection due to dampening effect of the coating on the outside of the glass component (enhances impact resistance) and minimization of scratches.
- Splinter protection by avoidance of splinter throw due to good adhering coating with high elasticity.
- Leakage protection respectively significantly reduced liquid leakages of damaged glass components due adhesiveness of the components by the coating, except for large demolitions.
- Without enhancement of permissible operation pressure and temperature shock.
- The coating keeps transparency of the glass components.
- The operation temperature might be reduced according to the permissible temperature for the coating. This does not reduce the permissible operation temperature of the glass component itself with respect to the mechanical strength calculation.
- The coating type for EX or non-Ex applications needs to be chosen individually according to the process conditions.

NORMAG offers three types of coating systems:

- <u>Option C1:</u> Transparent coating, non-conductive
  PU-based coating
  Permissible temperature range -40/+140 °C, short term up to 160 °C
  Very good transparency
  Good conditional chemical resistance to oils, fats, benzine and various solvents as well to water and weak caustic solutions
  UV-consistency
  Not suitable for applications of strong electrostatic loading media in EX-zones according guideline 2014/34/EU and TRGS 727
  Order code index „-C1“, for example PP 50-0200-F12-C1

- <u>Option C2:</u> Transparent high temperature coating, non conductive
  PFA-based coating
  Permissible temperature range -40/+200 °C
  Very good transparency
  Very good conditional chemical resistance to oils, fats, benzine and various solvents as well to water and weak caustic solutions
  UV-consistency
  Not suitable for applications of strong electrostatic loading media in EX-zones according guideline 2014/34/EU and TRGS 727
  Order code index „-C2“, for example PP 50-0200-F12-C2

- Option C3: Transparent conductive coating
  PU-based coating with conductive activated group
  Permissible temperature range -40/+140 °C, short term up to 160 °C
  Very good transparency
  Good conditional chemical resistance to oils, fats, benzine and various solvents as well to water and weak caustic solutions
  UV-consistency
  Surface resistance < 10^9 Ohm, suitable for applications even with electrostatic loading media in the EX-zone according to guidelines 2014/34/EU and TRGS 727
  Order code index „-C3“, for example PP 50-0200-F12-C3

  Earthing of the conductive coating can be made by various methods.
  On one hand a metallic conductive contact together with an earthing wire can be connected directly with the glass component, for example with a bracket. On the other hand earthing can be made via a conductive gasket with earthing lid and contact to the conductive coated surface of the glass components, see figure 10.3.

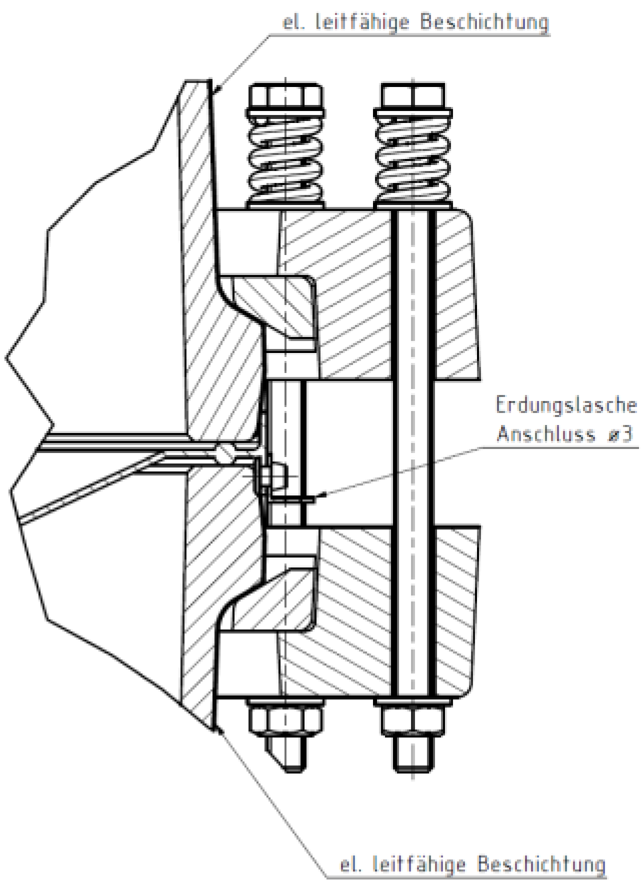

figure 10.3: Exemplary connection with a conductive coating, conductive gasket and earthing connection

In case of questions our specialists will gladly support you.

VARIOUS

GMP CONFORM INSTALLATIONS

For GMP applications of components and apparatuses is special attention necessary in the design of the components – in many cases is a special non-standard design necessary – and in the selection of appropriate materials.
A dead-space minimised construction to ensure a nearly complete draining as well as a simple and effective method for CIP cleaning are key targets in the GMP-design of components and apparatuses. In addition, FDA material certificates for PTFE components are provided.

GLASS UNITS IN EX-ZONES

For applications of glass units in EX-zones are the ATEX-guideline 2014/34/EU as well as the guideline for electrostatics TRGS 727 of importance. Generally there are no limitations in the use of glass components and apparatuses if the corresponding components are chosen with respect to the existing EX-zones. Glass components can be used directly in the outer EX-Zone 1 (IIA/B) and 2 (IIA/B/C). Only for the outer EX-Zone 1 (IIC) are additional requirements to be considered. Examples are the conductive coating of glass components combined with a corresponding earthing. If for - as a standard non-conductive materials - electrostatic loading might occur then the requirements according to TRBS 2153 needs to be considered in addition. Depending on the dimension of the component correspondingly earthing of outer metal parts (screws M8 including all standard length do not need earthing) as well as the use of conductive PTFE-components with earthing might be required.
Components made of conductive PTFE with earthing contact can be delivered as a standard (Option – M2).

REPAIRS

For repairs please download the release certificate from our homepage
www.normag-glas.com and send this document together with the component to be repaired to NORMAG.

RISK ANALYSIS / REMAINING RISKS

For the components and apparatuses in the catalogue PROZESSTECHNIK a general risk analysis has been made with respect to the machinery directive and especially the PED 97/23/EC. To exclude additional risks due to improper use the following residual risks have to be considered from all customers:

- Persons in the danger zone around the glass unit have to wear protective clothing, especially safety goggles. Additional information can be given on demand.
- Borosilicate Glass 3.3 is a material resistant to virtually all chemical attack. Nevertheless, alkaline solutions, hydrofluoric acid and concentrated phosphoric acid can cause some erosion. If there is any concern that there may be a reduction in wall thickness, the required minimum wall thickness should be checked at regular intervals.
- Corrosion on the glass surface can reduce the surface tension and result in a reduced permissible pressure. In case of strong and milky turbidity or a palpable rough surface, the glass component should be replaced.
- Substances and unstable fluids, that can decompose or quickly react, need special safety precautions in the use of glass plant.
- Permissible operating conditions need to be in accordance with the corresponding paragraph in this chapter. The compliance needs to be ensured if necessary by means of additional measures such as bursting discs or pressure relief valves, over-fill prevention as well as temperature or pressure limiters. The permissible operating pressure should be observed in every case, including when leakage tests, function tests and start-up of the plant are done.
- The maximum permissible operating temperature for glass components need to be in accordance with the corresponding paragraph in this chapter. The temperature should be observed and where necessary, e.g. for electrical heating or exothermic reaction, ensured by the use of suitable measuring and protective equipment.
- For non-insulated plants operating at temperatures in excess of 120 °C the thermal shock limit could be exceeded by cold water sprayed onto the equipment by a sprinkler system. To avoid this, sprinkler heads should not be mounted near unprotected glass plant or the plant needs to be protected for example with a transparent shield. In the event of a fire high temperatures may arise which could also result in breakage of the glass.
- No extra loads, such as reaction or mechanical forces on side branches, are permitted. Bellows included in interconnecting pipework can avoid extra loads.
- Mechanical damage / protective measures: The tubular structure supporting the equipment or plant also provides protection against damage from external sources and prevents other items coming into contact with it. Parts of the plant that are located outside the structure must be protected against mechanical damage. Parts of the plant, which can reach a surface temperature higher than 60° C in operation and which are located outside the support structure, must be provided with protection against contact or corresponding operation advices.
  Additional safety devices are available in the form of safety screens, spray guards, coated and wrapped glass components.
- For heat exchangers a damage to the coil batteries in coil type heat exchangers or the heat exchange tubes in shell and tube heat exchangers might occur a mix of the service fluid and product. In case this mixture reacts resulting in the generation of higher pressure and temperature, protections should be made to keep the media separate.

- If glass connections will be opened the use of new gaskets is recommended. PTFE-components such as bellows should be replaced in case of first signs of damages (erosion of seat area, scratches).

ASSEMBLY AND START-UP

The PF- and KF-connections do have very good assembly properties. Glass assemblies can be done without problems from less experienced persons, of course with possible support from NORMAG. In addition NORMAG or partner companies can provide training of your staff. For the installation of a new unit the experienced fitters from Pfaudler Normag Systems or partner companies should be contacted for a quick and correct assembly.
Typically a leakage test will be made after the assembly of a glass unit.
For the assembly of glass connections please do not exceed the permitted torques according to table 10.11. The values given are for greased screws. Due to the combination of stainless-steel screws and stainless-steel nuts greasing of screws is recommended.

DN	**PF connection type CP, CS, CC**	**KF connection type CP, CS, CC**	**KF connection type CA**
15	1,2	1,2	-
25	1,2	1,2	1,8
40	1,2	1,2	-
50	1,2	1,2	1,8
80	1,2	1,2	1,8
100	1,2	1,2	1,8
150	2,4	2,8	3,2
200	2,8	2,8	3,2
225	2,8	-	-
300	2,8	2,8	3
400	5	5	-
450	5	5	-
600	8	8	-

Table 10.11: Maximum torque for screws* in Nm for glass connection systems

* The given maximum torques for screws are only necessary for the maximum permissible operating conditions. They can be reduced for operations at lower conditions.

WEIGHT LIST

The weight list of the components in the catalogue «PROZESSTECHNIK 2012» is ordered alphabetically.

All weights listed up are, if not otherwise marked, in kg and are net weights. Deviations are due to the production methods possible.

We reserve the right for technical changes that might have an influence on the weight.

The weight list can be provided on request.