# TECHNICAL INFORMATION

Catalogue No 8801 Section 2

BÜCHI – THE WAY TO GET RESULTS!

büchiglasuster

switzerland

Pilot Plant and Reactor Systems

# Index

Page



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# Apparatus and piping construction with borosilicate glass 3.3

Borosilicate glass 3.3 is extremely corrosion-resistant to virtually all media, in particular strong acids. The smooth, pore-free surface practically eliminates deposits and encrustation.

And because it is transparent, glass enables the constant visual inspection of ongoing processes. With comparable sensitivity, the catalytic indifference of borosilicate glass 3.3 – unlike metals – prevents catalytic reactions.

Glass influences neither taste nor odour. Glass is physiologically unobjectionable. Because borosilicate glass 3.3 is also used in the laboratory for almost all applications, the scale-up step from pilot to production systems with büchiglasuster does not involve any change of materials in contact with the medium.

Thanks to its high thermal stability and temperature shock resistance, the properties of borosilicate glass 3.3 remain virtually unchanged across the entire temperature range.

büchiglasuster harnesses the outstanding material properties of borosilicate glass 3.3 in combination with PTFE in a broad product line. The proven modular system composed of standards-compliant parts covers the range from DN15 to DN600.

In this system, the «büchiflex» glass tube connection plays a decisive role. Even though it is pressure-tight and vacuum-tight, the connection remains flexible so that absolutely stress-free piping configurations can be assembled. In most cases, this eliminates the need for compensators and bellows.

büchiglasuster products have been in service around the world for decades. They feature high availability and near-zero maintenance. A broad application spectrum and countless users around the globe provide ample evidence of the ongoing success of the product line.

## The modular büchiglasuster system

Piping and equipment cannot be assembled in one piece but instead are configured using individual components. The modular system is based on a metric grid. This eliminates the need for special lengths or fittings. The standard grid pitch is 25 mm, and the lengths of all components are multiples of this pitch. This allows users to assemble equipment and piping exclusively with standardised components.

For the engineer, the grid system makes planning very convenient while assuring interchangeability. For example, tees can easily be replaced with 90° elbows, elbows with angle valves, valves with crosses, etc. This is a great advantage, especially in laboratories with changing applications and frequent reconfiguration of glassware.

# Chemical properties

All glassware components listed in this catalogue are made of borosilicate glass 3.3 as used in the glass apparatus engineering industry.

In contrast to steel, for example, glass has an amorphous structure. Thus, when two pieces of glass are fused, the molecular grid structure remains unchanged. The commonly observed susceptibility of steel to corrosion in weld zones does not occur in glass.

The resistance of glass to water, neutral and acidic salt solutions, strong acids and acid mixtures as well as to chlorine, bromine, iodine and organic substances is very high. Only hydrofluoric acid, fluoridic solutions such as ammonium fluoride, very hot phosphoric acid and highly alkaline solutions will have an aggressive effect on glass surfaces with rising concentrations and temperatures.

**Chemical composition**

| | |
|---|---|
| SiO | 81 % wt |
| $B_2O_3$ | 13 % wt |
| $Na_2O + K_2O$ | 4 % wt |
| $Al_2O_3$ | 2 % wt |

**Water resistance as per DIN ISO 720 at 121 °C**
Granulometric water resistance class HGB 1

**Acid resistance as per DIN 12116**
Acid class 1

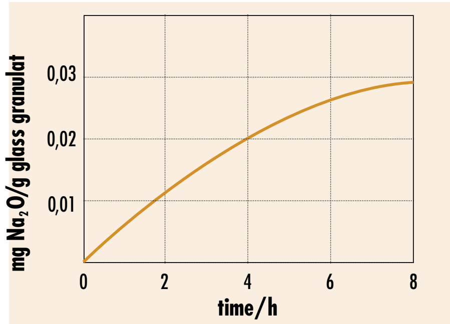
**Alkali resistance as per ISO 695**
Alkali class 2

### Water resistance (hydrolytic resistance):
According to the granulometric titration method at 98 °C, borosilicate glass 3.3 belongs to class HGB 1 (highly chemical-resistant glass) pursuant to DIN ISO 719. This corresponds to a max. alkali transfer of 3 mg pro 1g glass after 1hour of boiling at 98 °C.

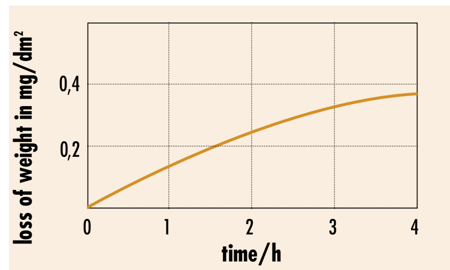
### Acid resistance:
Borosilicate glass belongs to acid class 1 – after the acid resistance test as per DIN 12116, the measured weight loss of fire-polished borosilicate glass surfaces after six hours of boiling in 20% hydrochloric acid is only 0.3 mg/dm².

### Alkali resistance:
According to DIN ISO 695, borosilicate glass 3.3 is assigned to alkali resistance class A2 – after the alkali resistance test as per DIN 52322, ISO 695, the measured weight loss of fire-polished borosilicate glass surfaces is only 134 mg/dm² after three hours of boiling in a mixture consisting of equal parts by volume of sodium hydroxide solution, concentration 1 mol/l, and sodium carbonate solution, concentration 0.5 mol/l.
At lower temperatures, the reaction speeds are so low that hardly any wall thickness degradation occurs even in the course of many years. Long-term tests based on NaOH exposure with a concentration of 1 mol/l (corresponds to 4% by weight of sodium hydroxide, pH value 14) at 50 °C operating temperature exhibited a glass erosion rate of 1 mm after 25 years in a glass tube subject to constant flow.

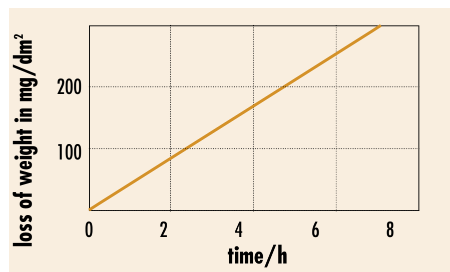
### Water resistance




### Acid resistance




### Alkali resistance




**All data courtesy of Schott-Rohrglas GmbH, D-95660 Mitterteich, Germany**

# Thermal properties

In comparison with other materials, borosilicate glass 3.3 has a low coefficient of thermal expansion. This ordinarily eliminates the need for complex thermal expansion compensation measures and greatly facilitates the configuration of glass piping. Its thermal conductivity is low, however. This has a negative effect particularly where heat transmission is desired, for instance in condensers, and must be taken into account when performing calculations.

| | | |
|---|---|---|
| **Mean coefficient of linear thermal expansion** | | |
| between 20 °C and 300 °C | $\alpha$ | 3.3 ± 0.1 $10^{-6}$ [K] |
| **Mean specific heat** | | |
| between 20 °C and 100 °C | cp | 0.84 [J/gK] |
| between 20 °C and 200 °C | cp | 0.98 [J/gK] |
| **Mean thermal conductivity** | | |
| between 20 °C and 100 °C | $\lambda$ | 1.20 [W/mK] |
| between 20 °C and 200 °C | $\lambda$ | 1.30 [W/mK] |
| **Mean thermal diffusivity** | | |
| between 20 °C and 100 °C | $a$ | 0.65 $10^{-6}$ [m²/s] |

# Mechanical properties

The permissible stress values include a safety coefficient which considers empirical knowledge about the strength behaviour of glass. It must be pointed out that the strength of glass hardly decreases with rising temperatures and that its compressive strength is much higher than its tensile strength.

While the mean breaking strength of borosilicate glass 3.3 with a flawless fire-polished surface is about 70 N/mm², the calculation of glassware components for practical applications (scratches, etc.) must be based on substantially lower strength values. Such values are specified in the AD 2000 bulletin N4 for tensile, bending, and compressive stresses as a function of the surface characteristics to be expected in real-world applications.

These parameters take into consideration that glass differs from other conventional materials (such as metals) in some very significant respects. Because of its brittleness, glass, unlike ductile materials, prevents the equalisation of peak stresses at irregular transitions and microcracks.

When glassware components are heated inside or outside, thermal wall stresses will occur as well. These forces must be carefully considered.

| | | |
|---|---|---|
| **Density** | $\rho$ | 2230 [kg/m³] |
| **Modulus of elasticity** | E | 63 [kN/mm²] |
| **Poisson's ratio (transverse contracting ratio)** | $\nu$ | 0.20 [–] |
| **Transformation temperature DIN 52324** | $\sigma_g$ | 530 [°C] |
| **Calculation factors for permissible stress types:** | | |
| tensile and bending stress (with force) | K/S | 6 [N/mm²] |
| tensile and bending stress (without force) | K/S | 10 [N/mm²] |
| compressive stress | K/S | 100 [N/mm²] |

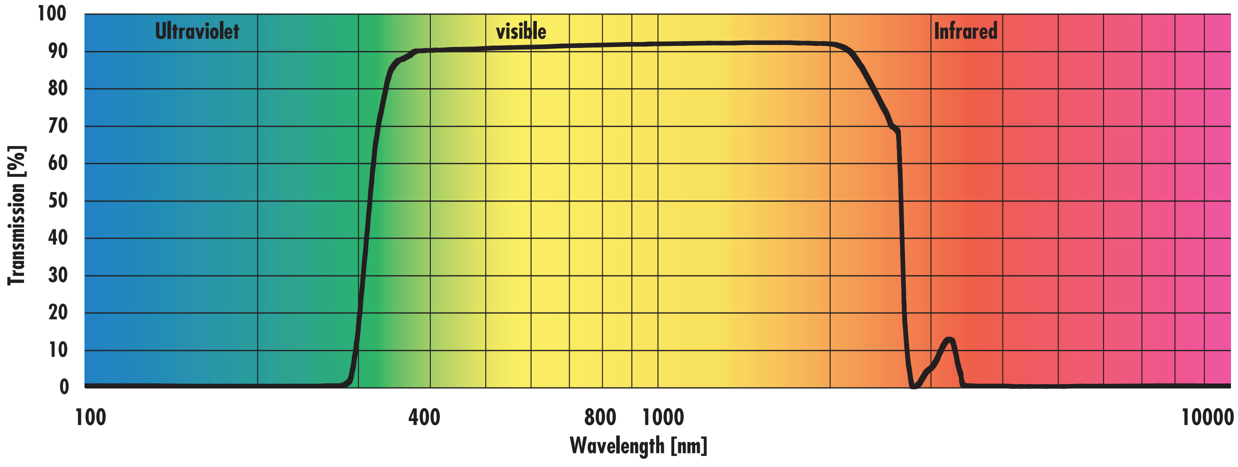
# Optical properties

In the visible light spectrum, borosilicate glass 3.3 does not exhibit significant absorption and thus presents itself as a clear and colourless material. In large thicknesses (axial view of piping), it has a greenish hue.

In photochemical processes, UV transmission is particularly important. As a result of its UV transmission, borosilicate glass lends itself to photochemical reactions such as chlorination and sulfochlorination.

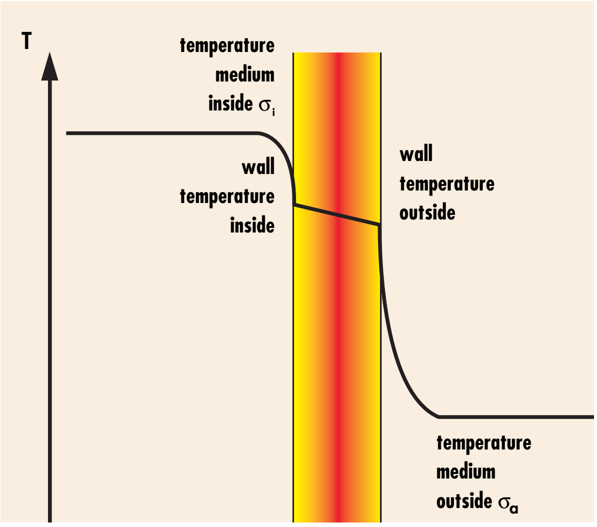
Absorption is negligible in the spectral range of about 310–2200 nm.

**Transmission curve borosilicate glass**



# Permissible operating temperature

Borosilicate glass 3.3 does not deform until it reaches temperatures near its solidification point (higher than 500 °C) and retains its mechanical strength up to this temperature. Mainly because PTFE is the seal material used, however, the permissible operating temperature range is limited to **–60/+200 °C**, not counting thermal shock.




At temperatures below freezing, the tensile strength of borosilicate glass 3.3 tends to rise. For this reason, with adequate precautions, it can be used without danger at temperatures of down to –90°C. Please consult our specialists for advice in this context.

The permissible **medium temperature difference $T_M$** of the temperatures of the medium on the outside σa (air/ambient or medium in the jacket) and of the medium on the inside σi (product) is **180 °C.**

The medium temperature difference $T_M$ must not be confused with the wall temperature difference $T_W$.

# Permissible thermal shock

Fast, shock-like temperature changes of the media on the inside or outside necessarily result in wall temperature changes that must be avoided. They lead to additional thermal wall stresses which can have a negative impact on the permissible operating pressure of plant components. Under extreme circumstances, a thermal shock can cause spontaneous glass fractures.

Temperature shock resistance is vastly dependent on prevailing service conditions and wall thicknesses. For this reason, there is no generally applicable value for all conceivable operating conditions. The permissible value for fast temperature changes has been established at **max. 100 °C.**

Conventional heating and cooling appliances cannot produce such a sudden temperature change in jacket vessels or jacket tubes. If there is a likelihood of fast temperature changes, the permissible temperature difference at the component(s) must be limited accordingly. **Great attention must be paid when filling a hot glass component with a cold fluid, for instance.** The exposure of a hot glass component wall to cold splashwater may present a hazard as well.

Particularly when they are pressurised, glassware components must be cooled only slowly, for example through heat dissipation to the ambient air.

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# Calculation of permissible operating pressure

The permissible operating pressure must always be considered in the context of the application and the installation site. It depends mainly on the nominal diameter as well as on the wall temperature difference $T_W$ and thus on the temperature difference $T_M$ of the media in and around the pressure vessels.

The following conditions provide the basis for determining the permissible operating pressure (and thus the strength parameters):

- The permissible operating temperature is –60/+200 °C.
- The permissible temperature difference $T_M$ of the media inside and around the pressure vessels is limited to 180 °C. This corresponds to the difference between the permissible operating temperature of 200 °C and the room temperature of 20 °C.
- The heat-transfer coefficient $\alpha_a$ at the outside wall determines the wall temperature difference $T_W$ and is thus also influenced by the installation site. Increasing values cause a decrease of the permissible operating pressure or vacuum due to the increase of thermal wall stresses. Based on empirical data, the heat-transfer coefficient $\alpha_a$ at the outside wall is limited to 11.6 W/m²K. This corresponds to:
  - Indoors, exposed to draught
  - Outdoors, with windbreak protection
- Obviously, the heat-transfer coefficient $\alpha_i$ at the inside wall also determines the wall temperature difference $T_W$. It is defined with a value of 1,200 W/m²K. This value covers virtually all cases encountered in a real-world environment.

The permissible operating pressure is calculated (within the scope of the conditions mentioned above) according to AD specifications 2000, in particular AD 2000 Merkblatt N 4, and EN 1595.

**Vessels, piping, etc.**
- Fluid inside
- Air outside (exposed to draught indoors, windbreak protection outdoors)

**Condensers**
- Fluid in coils/internal tubes
- Steam around coils/internal tubes
- Air outside (exposed to draught indoors, windbreak protection outdoors)

**Heat exchangers**
- Fluid in coils/internal tubes
- Fluid around coils/internal tubes
- Air outside around condenser (exposed to draught indoors, windbreak protection outdoors)

**Jacket tubes/jacket vessels**
- Fluid inside
- Fluid jacket
- Air outside (exposed to draught indoors, windbreak protection outdoors)

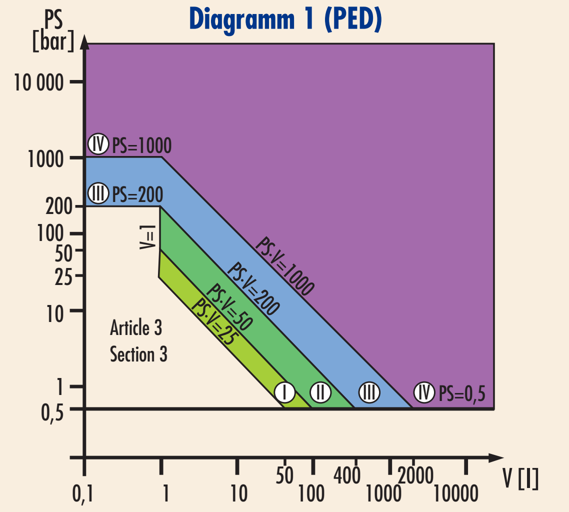
Directive 97/23/EU of the European Parliament and of the Council, the so-called "Pressure Equipment Directive (PED)" as well as EN 1595 also govern the deployment, safety precautions, operation, documentation, and identification of pressure equipment.

The European "Pressure Equipment Directive (PED)" classifies pressure vessels and plant components (subassemblies) in conformance categories I–IV depending on the permissible operating pressure PS, volume V or nominal diameter DN, and the applications (fluids) for which they are intended. Each category requires certain measures regarding testing, identification, and documentation, etc.

Diagram 1: Vessels
Diagram 6: Piping
(Fluid group 1)

**Diagrams 1 and 6 show that pressure vessels and piping up to 0.5 bar positive pressure are generally not assigned to a conformance category. Piping with nominal diameters of DN25 and smaller fall under Article 3, Section 3, even if subject to pressures in excess of 0.5 bar. According to this section, pressure equipment and/or subassemblies must be designed and manufactured with the "sound engineering practices" of the respective country.**

Larger glass vessels must not be operated at positive pressures higher than 0.5 bar. Since a positive pressure of +0.5 bar has become commonplace and safety reasons speak against higher pressures, all glass components today – even smaller ones – are classified only for a positive pressure of max. +0.5 bar.




**Vessels**

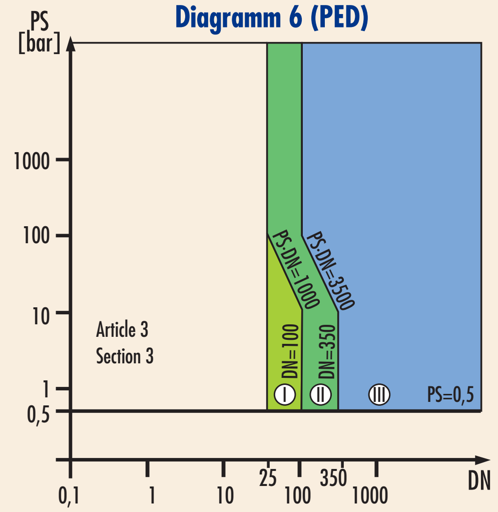
**As per Article 3 Section 1.1 Lit. a) first dash**
Exception: vessels intended for unstable gas and which fall under category I or II according to diagram 1 must be classified under category III

DN15 and DN25 piping without seat valves can be operated at a positive pressure of 4 bar, piping with seat valves at a positive pressure of 3 bar. Some glassware components (such as tubular heat exchangers) fall under category I–IV. These glassware components are appropriately identified. Consult the respective section for details.

In exceptional cases, particularly where smaller glassware components are involved, higher operating pressures may be permissible. These special glassware components will then also be classified under category I–IV. They are marked as outlined in the section entitled "Identification of glassware components and equipment".

Depending on the category, these special glassware components will be governed by Modules A–G. These Modules specify testing, measures, identification, etc. Because of the added effort involved and the longer delivery periods, users should choose not to operate such special glassware components.

## Diagramm 6 (PED)




### Piping

**As per Article 3 Section 1.1 Lit. a) first dash**

Exception: piping intended for unstable gas and which falls under category I or II according to diagram 6 must be classified under category III

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# Synopsis of permissible service conditions

The following section provides comprehensive safety information that pertains to the use of büchiglasuster glassware components:

**Fundamentals**

- The permissible operating pressure is calculated according to AD specifications 2000, particularly AD 2000 Merkblatt N 4, and EN 1595.
- Directive 97/23/EU of the European Parliament and of the Council, the so-called "Pressure Equipment Directive (PED)", as well as EN 1595 are also factored in.

**Maximum permissible service conditions**

| | |
|---|---|
| *Permissible operating temperature* | • –60/+200 °C |
| *Permissible thermal shock* | • max. 100 °C<br>• Avoid filling of hot glassware components with cold fluid, as well as of cold glassware components with hot fluid<br>• Avoid cold water splashes on hot glassware walls, as well as hot water splashes on cold glassware walls<br>• Heat and cool glassware components slowly |
| *Permissible temperature difference* $T_M$ | • 180 °C between media in and around glassware component |
| *Location* | • Indoors, exposed to draught<br>• Outdoors, with windbreak protection |
| *Permissible operating pressure* | • As per the following table |
| *Permissible vacuum* | • Full vacuum to 0 mbar abs. (theoretical) |

## Maximum permissible operating pressure and wall temperature difference $T_W$ of all glassware components from Catalogue 8801:

**Piping (with and without valves)**

| Nominal diameter [DN] | 15 | 25 | 40 | 50 | 70 | 100 | 150 |
|---|---|---|---|---|---|---|---|
| Without seat valves [bar] | +4.0 | +4.0 | +0.5 | +0.5 | +0.5 | +0.5 | +0.5 |
| With seat valves [bar] | +3.0 | +3.0 | +0.5 | +0.5 | +0.5 | +0.5 | +0.5 |
| With ball valve with universal – flange / butterfly valve [bar] | – | +4.0 | +0.5 | +0.5 | +0.5 | +0.5 | +0.5 |
| Wall temperature difference $\Delta T_W$ [K] | 6 | 7 | 8 | 8 | 8 | 11 | 11 |

**Apparatus (without round flask)**

| Nominal diameter [DN] | 100 | 150 | 200 | 300 | 400 | 450 | 600 |
|---|---|---|---|---|---|---|---|
| Apparatus [bar] | +0.5 | +0.5 | +0.5 | +0.5 | +0.5 | +0.5 | +0.3 |
| Wall temperature difference $T_W$ [K]* | 11 | 11 | 11 | 11 | 11 | 8 | 12 |

* smaller deviations possible depending on apparatus design

**Round flask**

| Nominal volume [l] | 6 | 10 | 20 | 50 | 100 | 200 |
|---|---|---|---|---|---|---|
| Round flask [bar] | +0.5 | +0.5 | +0.5 | +0.5 | +0.3 | +0.3 |
| Wall temperature difference $T_W$ [K] | 5 | 5 | 5 | 6 | 6 | 8 |

For details on fundamentals and the classification of glassware components, see the section entitled "Calculation of permissible operating pressure".

# Identification of glassware components and equipment

### Identification of pipings and valves as per Catalogue 8801

Katalog 8801
Borosilicatglas 3.3

Büchi AG
Switzerland

Standard glassware components from Catalogue 8801 are identified with the above logo. All relevant technical information can be found in Catalogue 8801.

### Identification of glassware components as per Catalogue 8801

Katalog 8801
Borosilicatglas 3.3

Büchi AG
Switzerland
−1 / +0.3 bar
blank / plain
−60 / +200 °C
Glasprotect-P
−40 / +120 °C

Standard glassware components from Catalogue 8801 are identified with the above logo. All relevant technical information can be found in Catalogue 8801.

### Identification of special glassware components as per Module A

Borosilicatglas 3.3

Büchi AG
Switzerland
max. PS +0.5 bar
max. TS 200 °C
2xxx ← Jahreszahl entsprechend
△T K
CE

Technical information about special glassware components is provided in separate documents that are delivered with the components.

### Identification of special glassware components as per Modules A1/B+C1/G and others

Borosilicatglas 3.3

Büchi AG
Switzerland
max. PS +0.5 bar
max. TS 200 °C
2xxx-xxxx ← Jahreszahl sowie Fabrikations-nummer entsprechend
△T K
Prüfdruck PT = Betriebsdruck PS
CE 0036

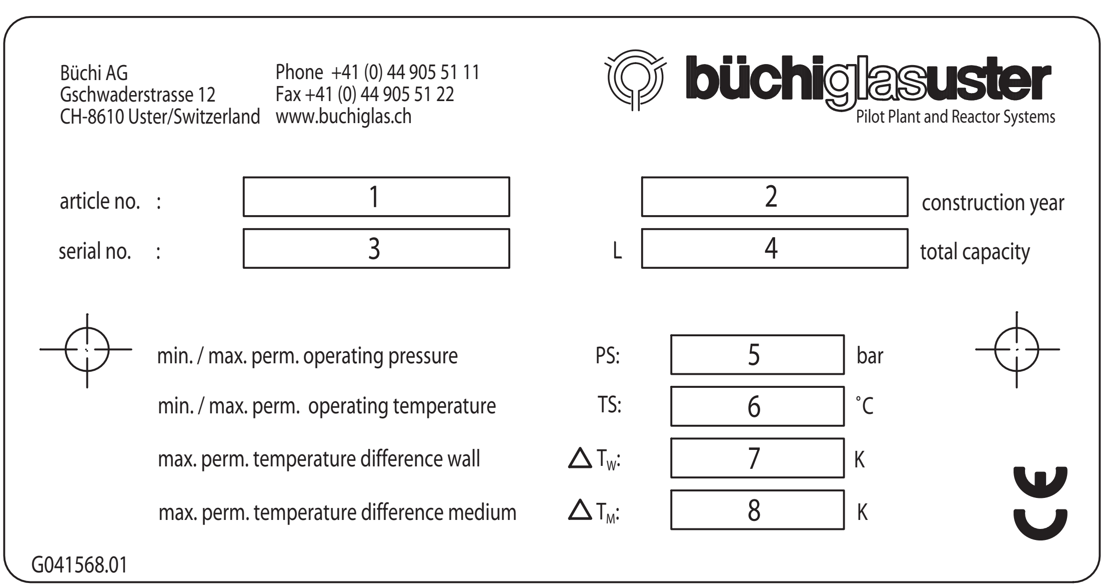
Technical information about special glassware components is provided in separate documents that are delivered with the components.

### Identification of equipment consisting of standard glassware components according to Catalogue 8801

Equipment configured with standard glassware components is shipped with pertinent drawings and parts lists. Such equipment is identified with rating plates as shown here. The parts list mention each component with their respective part number. The part number cross-references the technical information contained in Catalogue 8801.

**To avoid mistakes and to expedite the shipment, spare parts should always be ordered with the part numbers indicated on the parts list.**

The permissible service conditions of a configuration always result from the weakest glass component.




**"Permissible temperature difference" means "wall temperature difference $T_w$" from the section entitled "Permissible operating temperature"**

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# Prevention of excessive positive pressure, permissible service pressure

Plant sections or individual glassware components must be protected with safety devices if it is conceivable that the positive pressure will exceed the permissible operating pressure.
A glassware component can be exposed to an impermissibly high positive pressure mainly as a result of:

- Heat input from the outside, for example with a heating jacket
- Generation of heat by chemical or physical processes
- Generation of gases by chemical or physical processes
- Infeed of gases, including inert gases, at excessive pressure levels

If more than one glassware component in a plant can be conceivably exposed to an impermissibly high positive pressure, one safety device is sufficient provided the respective glassware components are interconnected. However, if these glassware components are isolated with valves, separate precautions must be taken for each glassware component which can be exposed to positive pressure.

**Typical applications include:**

- Reactor vessels
- Evaporators
- Stirrer vessels
- Filters
- Inert gas to glass vessels: use a pressure limiting device in the inert gas feed line or install a safety device

If the reactor vessel can be isolated from the other glassware with valves, safety devices need to be provided for the reactor and for the glassware.

Pursuant to Directive 97/23/EU of the European Parliament and of the Council, the so-called "Pressure Equipment Directive (PED)", as well as pursuant to EN 1595, no officially tested safety devices are required for operating pressures of 0.5 bar and smaller, or for piping with nominal diameters of DN25 and smaller. In general, rupture discs are recommended due to their low response pressure, cost, and size.
The büchiglasuster product line contains a range of rupture discs: they are presented in the "Valves" section.
**The response pressure of the safety device must not be higher than the operating pressure.** However, many safety devices have a tolerance range of generally about 10%. To prevent the inadvertent response of the safety device, the permissible service pressure should be reduced by at least the respective tolerance. Typical calculation:

- Permissible operating pressure +0.5 bar
- Rated response pressure of the rupture disc +0.5 bar ± 0.05 bar (10%)
- Determination of permissible service pressure max. +0.45 bar, i.e. + 0.4 bar

It is recommendable to monitor the pressure and if applicable the temperature (pressure gauge, pressure transmitters, resistance thermometers, etc.) of every glassware component which is potentially exposed to an impermissibly high positive pressure.

# Protection against collision damage

The danger of glass plant damage is particularly acute in work areas and traffic zones. It may be necessary to introduce safety precautions such as polycarbonate shields or wire mesh protection. Countermeasures must also be taken if electrostatic charges can build up.

The büchiglasuster armour coating can also prevent scratches or minor nicks.

It is recommendable that such shields and wire mesh protectors be crafted by the customer's personnel on site:

- Precise design of protection can be optimised after the glass plant has been configured
- No planning expenditure is incurred
- Low costs
- Modifications and replacement are fast and simple

# PTFE seal material


Glassware components can only be interconnected with soft seals. For this reason, and because the seal is in contact with the medium, only pure PTFE (Teflon®) seals should be used. Seals for "büchiflex" connections as well as all other seals which connect two glassware components are made exclusively of pure PTFE.

Sheath gaskets consist of a soft liner with a PTFE sheath. PTFE is resistant to practically all media. Only very few exceptions are known. Despite the low permeation of PTFE, the area in contact with the medium is minimised.

It is used mainly as a seal material; other applications include:

- Bellows in seat valves
- Compensators, bellows
- End plates in tubular heat exchangers
- Ring gaskets in ball valves
- Customised connecting flanges, etc.

In terms of quality, all of the PTFE outsourced by büchiglasuster complies with FDA regulations as well as all pertinent pharmaceutical and food industry provisions.

# Apparatus in hazardous locations

All areas, because of the local and operational conditions, in which potentially explosive atmospheres may occur in hazardous quantity are potentially explosive areas. According to the probability, in terms of time and location, of the presence of potentially explosive atmospheres, potential explosive areas are divided into Zones which allow differentiated evaluation of the explosion hazard.

Many processes in the chemical industry require the classification of the inside of the plant in Zone 0 respectively 1 and the immediate surroundings in Zone 1 respectively 2. The designation of Zones and of temperature class (e.g. T3, T4) must be determined by the end user, according to EU Directive 1999/92/EG.

The selection of the equipment for a given Zone is very important and is governed by EU Directive 94/9/EG. As a result, all mechanical and electrical explosion proof equipment has additional identification explaining, the Zone in which it may be operated.

- only equipment rated for Category 1 G must be installed in Zone 0.
- only equipment rated for Category 1 G or G2 must be installed in Zone 1.
- Category 2 equipment intended for installation in Zone 0 must comply with isolation requirements.

The introduction of EU Directive 94/9/EG in July 2003 and its application require that compliance with all relevant standards pertaining to the configuration and operation of explosion proof equipment must be documented in the declaration of conformity of the respective equipment.
Extensive knowledge is required for the appraisal of the possible causes of the formation of explosive atmospheres and of countermeasures. In-depth knowledge of the specifications as well as familiarity with the deployment of electrical equipment and its integration in systems is mandatory.

If you have questions regarding this subject please contact our engineers for further information.

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# Potential equalisation, grounding of glass components

Electrostatic charges can occur in many different industrial processes and are often the cause of fire and explosions. Therefore, special attention is required when commissioning and operating glassware components and plants made of glass to prevent electrostatic charges. This fact must be taken into consideration at the safety engineering level. According to Directive 94/9/EU (ATEX 95) electrostatic charges which could lead to dangerous discharges must be prevented with suitable measures.

Most European countries have issued national guidelines and regulations with respect to such measures (see box).
The decision as to potential equalisation measures depends mainly on the fluids, vapors and gases used in the plant and on the subdivision into Zones. For this reason, the decision must be made by the enduser.
Important information is provided in CENELEC Reports R044-001, and BGR132 and should be taken into consideration.

- CENELEC, European Committee for Electrotechnical Standardisation, R044-001, Europe
- Hauptverband der gewerblichen Berufsgenossenschaften Fachausschuss “Chemie” BGR 132, Germany
- ESCIS, Schriftenreihe Sicherheit, Heft 2, Statische Elektrizität, Regeln für die betriebliche Sicherheit, Switzerland

For the majority of processes and applications the area around glass components and glass plants is defined as Zone 1 or 2. For these glass components and plants, from catalog 8801, in which fluids with low or moderate conductivity are used, the following must be considered:

- In processes involving Explosion Group IIC in Zone 1, all connection flanges, valves and sensors installed on glassware must be grounded.
- In processes involving Explosion Group IIA and IIB in Zone 1, or Explosion Group IIC in Zone 2 it is usually only necessary to ground pumps, filters and inlet pipes up to size DN50 where significant charges may occur.
- Flanges and other conductors installed on glassware components or glass piping with a nominal diameter greater than DN50 must always be grounded.
- Conductive plant components (reactor bottoms, coverplates, control panels, scaffoldings, etc.) must always be grounded.
- Glassware components or plants consisting of glassware with Glassprotect-P coating installed in hazardous areas must always be grounded.

In grounding arrangements, the resistance between a measuring electrode and ground must be smaller than $10^6\,\Omega$. Ground wiring must be carried out by qualified personell provided by the end user.
All büchiglasuster components are equipped with grounding connections so that grounding is possible according to applicable guidelines.
Further technical information regarding electrostatic charges and grounding arrangements for glassware components and plants is available from büchiglasuster.
If you have questions regarding this subject please contact our engineers for further information.

# Coated Glass

Büchiglasuster offers 2 different types of transparent Glass coatings for all glass components, both of them providing efficient protection of the glass and of the operator in case of inappropriate impact. It is used to protect the environment and operator as well as the user of a reaction system of possible complete loss of the product due to leakage.

## The protection offered by «Glassprotect-P»

The risk of glass breakage of correctly installed equipment using the «büchiflex» system is minimal. However, impact, rough handling or unskilled installation can cause damage. Generally speaking, coated glass is less sensitive to impact because «Glassprotect-P» forms an effective cushion. But if for some reason glass breakage occurs the coating provides effective protection from glass slivers. Tests and practical experience shows that the coating is capable of holding a fractured glass pipe together even when pressurized. Therefore a production run can be continued safely to the end.

**Summary of the protection effects**

| | |
|---|---|
| Surface protection: | increase of impact protection by shock absorbing external coating |
| Shatter protection: | avoidance of shattered glass pieces by well clinging coating with large elasticity |
| Drain off protection: | Damaged glass parts are held together, depending on the severity of the impact and the pressure applied, allowing a controlled draining. Leakage is greatly reduced, but still possible. |
| In general: | The coating of glass components does not increase the allowable operating pressure or the thermal shock temperature, but the allowable operation temperature is influenced, depending on the type of coating. |

## Coating types

### Glassprotect-P

Transparent antistatic glass coating for installations in hazardous areas. Resistance on the surface <109Ω. These components must always be electrically earthed, regardless of explosion zone and gas class.

**This type of coating is delivered, if coated glass pieces are ordered with the predefined codes according to this glass catalogue.**

*Technical description*

| | |
|---|---|
| Composition | Polyurethane Based |
| Permitted operation temperature | –40/+100°C<br>short-term up to +120°C |
| Characteristics | The long-term antistatic discharge capability complies with ATEX guideline 94/9/EG for use in hazardous area. |
| Transparency | very good |
| Stability | Good/fair chemical resistance against oils, fats, benzenes and numerous solvents as well as against water and weak bases |
| Cleaning | with water and commercially available detergents |

### Glassprotect-ECTFE

Transparent, not antistatic glass coating. The applied fluor based material features excellent chemical resistance and an extended operation temperature range compared to the Glassprotect-P coating.

*Technical description*

| | |
|---|---|
| Composition | Fluor based plastic material |
| Permitted operation temperature | –60/+150°C<br>short-term up to +200°C |
| Characteristics | No antistatic discharge capability, does not comply with ATEX guideline 94/9/EG. |
| Transparency | very good |
| Stability | similar to PTFE<br>Excellent chemical resistance against oils, fats, benzenes and numerous solvents as well as against water and weak bases |
| Cleaning | with water and commercially available detergents |

In case of questions, please feel free to contact our sales engineers.

# Assembly and commissioning

The "büchiflex" tube connection greatly simplifies assembly. For this reason, even unskilled individuals can configure glass plant. Needless to say, support is always available from büchiglasuster.

büchiglasuster also provides personnel for the assembly of glassware configurations. The company's experienced, thoroughly trained glass assemblers guarantee the fast and professional installation of all of our glassware products.

As a rule, a plant is tested for tightness with a vacuum test after assembly. A separate data sheet listing the key assembly steps is available on request.

**Max. screw tightening torque* in Nm for glass connection systems**

| DN | "büchiflex" tube connection | KF plane joint connection | as per DIN/ISO 3587 |
|---|---|---|---|
| 15 | 2.0 | 1.0 | – |
| 25 | 2.0 | 2.5 | 1.5 |
| 40 | 2.5 | 4.5 | 1.5 |
| 50 | 2.5 | 4.5 | 1.5 |
| 70 | 3.0 | – | – |
| 80 | – | 4.5 | 2.0 |
| 100 | 3.0 | 6.0 | 2.0 |
| 150 | 4.0 | 6.0 | 2.0 |
| 200 | – | 6.0 | – |
| 300 | – | 6.0 | – |
| 400 | – | 9.0 | – |
| 450 | – | 9.0 | – |
| 600 | – | 15.0 | – |

*** The indicated screw tightening torques apply to the maximum operating pressure and can be reduced if the actual pressure levels are lower.**

# Operation and maintenance

The top priority in the operation of glassware components and of plant consisting of glassware components is to maintain the permissible service conditions as outlined in this section. In general, persons who move about in hazard zones must wear safety goggles. Further information is available on request.

Repairs as well as the replacement of glassware components, seals and scaffolding parts should be performed exclusively with original parts.

Glassware components and plant manufactured by büchiglasuster have a very long service life, generally of several decades. Corrosion of glass surfaces may reduce the surface tension of the respective components and reduce the permissible operating pressure. The glassware component must be replaced if it exhibits noticeable white clouding or perceptible roughness of the surface.

Whenever glass connections are dismantled, it is recommendable to use new seals when reassembling them. Teflon bellows should also be replaced if they exhibit significant wear (seat surface erosion, cracking). Further information is available on request.

# GMP-compliant systems

The systematic use of the right materials for the design of systems pursuant to GMP guarantees compliance with the guidelines. This applies specifically to borosilicate glass 3.3 due to its properties which are appreciated in pharmaceutical applications.
In combination with FDA approved materials such as glass lined steel (reactors) and PTFE/PFA (gaskets, bellows, liners) borosilicate glass reduces the incidence of baked on product to wetted surfaces. A plant with minimal dead volumes to assure complete drainability as well as simple and effective cleanability is achieved by the design of components, their configuration and the selection of suitable valves and fittings.
Proper selection, optimal arrangement and correct application of glassware components and instrumentation help assure compliance with guidelines. Suitable scaffoldings made of stainless steel are available for systems installed in clean room environments.
Requirements regarding process, draining, cleaning and documentation (validation) are best discussed with büchiglasuster during the planning stage.

If you have questions regarding this subject please contact our engineers for further information.

**Specific notes:**

- The use of "büchiflex" connections eliminates the need for bellows or compensators.
- Reduce the number of connections, especially horizontal ones by using special glass components.
- Only use "büchiflex" GMP-Sealing rings in horizontal lines.
- Install piping with a gradient of at least 3°.
- Make sure bellow valves and ball valves are installed correctly.
- Dismantle components for cleaning if they are not suitable for CIP.
- If possible, use CIP spray balls.
- Scaffolding entirely made of stainless steel 316/1.4404.
- Minimize the diversity of materials used.

# Connection systems, grinding types and dimensions

### "büchiflex" ball and socket DN15–150
### Code No. 1+2

| DN | a1 (mm) | a2 (mm) | b (mm) | c (mm) | e (mm) |
|---|---|---|---|---|---|
| 15 | 28.1 | 28.575 | 20+0.4 | 3.0+0.3 | 37 |
| 25 | 39.2 | 39.688 | 34+0.5 | 4.0+0.4 | 50 |
| 40 | 59.6 | 60.325 | 50+0.8 | 4.5+0.4 | 70 |
| 50 | 69.4 | 70.000 | 59+0.8 | 4.5+0.4 | 85 |
| 70 | 89.4 | 90.000 | 80+1.5 | 5.0+0.5 | 107 |
| 100 | 119.2 | 120.000 | 110+1.8 | 7.0+0.8 | 136 |
| 150 | 179.0 | 180.000 | 165+2.0 | 7.0+1.0 | 200 |

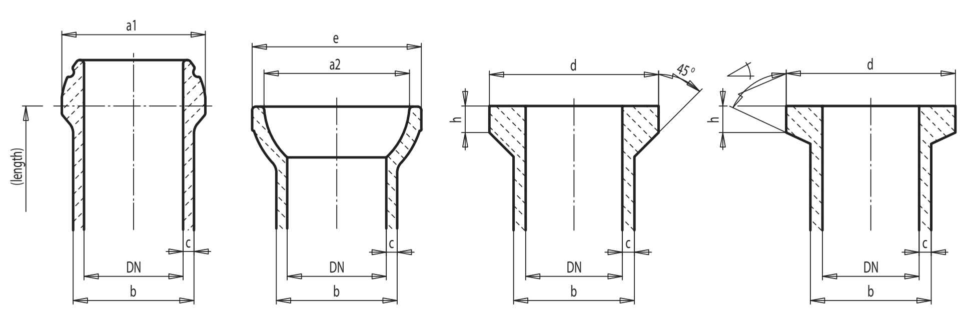
(Simax)

### büchiglasuster plane joint DN15–200
### Code No. 3

| DN | d (mm) | b (mm) | c (mm) | h (mm) |
|---|---|---|---|---|
| 15 | 30 | 20+0.4 | 3.0+0.3 | 5 |
| 25 | 45 | 34+0.5 | 4.0+0.4 | 7 |
| 32 | 60 | 41+1.0 | 4.5+0.5 | 10 |
| 40 | 70 | 50+0.8 | 4.5+0.4 | 11 |
| 50 | 80 | 59+0.8 | 4.5+0.4 | 12 |
| 60 | 90 | 70+1.2 | 4.2+0.4 | 12 |
| 70 | 100 | 80+1.5 | 5.0+0.5 | 13 |
| 80 | 110 | 90+1.5 | 5.0+0.5 | 13 |
| 100 | 135 | 110+1.8 | 7.0+0.8 | 14 |
| 115 | 150 | 130+1.8 | 7.0+0.9 | 15 |
| 125 | 160 | 140+2.0 | 7.0+0.9 | 15 |
| 150 | 190 | 165+2.0 | 7.0+1.0 | 16 |
| 200 | 250 | 215+2.6 | 7.0+1.1 | 16 |

### KF plane joint DN200–600
### Code No. 4

| DN | d (mm) | b (mm) | c (mm) | ∢ | h (mm) |
|---|---|---|---|---|---|
| 200 | 233 | 215 | 7.0 | 65° | 24 |
| 300 | 338 | 315 | 7.0 | 65° | 24 |
| 400 | 465 | 415 | 7.5 | 65° | 23 |
| 450 | 526 | 465 | 7.5 | 65° | 26 |
| 600 | 684 | 620 | 10.0 | 65° | 30 |




"büchiflex" ball — Code No. 1
"büchiflex" socket — Code No. 2
"büchiflex" plane joint — Code No. 3
KF plane joint — Code No. 4


ENGLISH

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