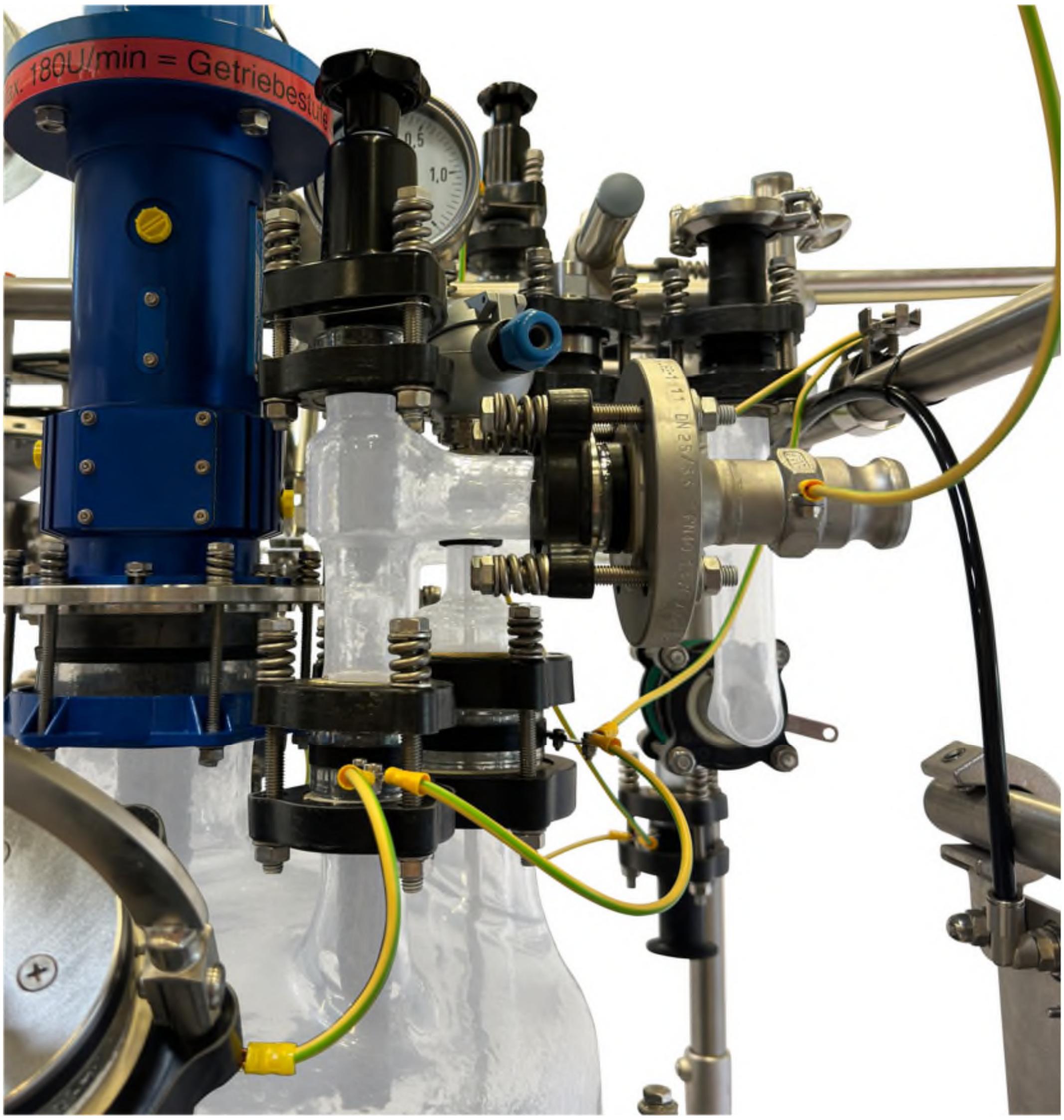
Explosion protection in glass plant construction



Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

Table of contents

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

1 The operation of glass systems in potentially explosive areas

Systems can often only be operated in potentially explosive atmospheres. These potentially explosive areas are possible both in the system (inner zone) and around the system (outer zone).

To ensure safe operation in these zones and the proper condition of the system, all potential ignition sources must be avoided. EU regulations require manufacturers to comply with the requirements of Directive 2014/34/EU, while operators must comply with the ATEX Operating Directive 1999/92/EC.

This ensures compliance with strict safety standards in potentially explosive environments.

1.1 Requirements for the manufacturer

The manufacturer produces the systems in accordance with the provisions of the Product Safety Act (ProdSG). In doing so, the manufacturer takes into account the ATEX zones inside and outside the system defined by the operator and equips the system in accordance with Directive 2014/34/EU. This process is documented in detail.

As the system is a process engineering system consisting of various individual devices, the system documentation goes beyond simply affixing the CE mark to the system's nameplate.

The individual devices in a glass installation that could potentially be electrical or mechanical ignition sources are certified in accordance with the requirements of Directive 2014/34/EU and bear the CE mark.

One example of this is our standard agitators, which are equipped with mechanical seals as well as temperature and pressure sensors. These devices are certified in accordance with Directive 2014/34/EU for equipment category 2 (Table 1) and explosion group IIC (Table 2) for indoor use.

Table 1: Device categories

Frequency of an explosive atmosphere	Zone classification according to 1999/92/EC (ATEX 137)	Safety level of the devices	Device category according to 2014/34/EU
Constantly, over longer periods of time	Zone 0	Very high	Category 1
Occasionally	Zone 1	High	Category 2
Rare, short-term	Zone 2	normal	Category 3

Table 2: Explosion groups:

Danger of an explosive zone	Group-determining gas-air mixture	Explosion group
High	Hydrogen	IIC
Medium	Ethylene	IIB
Low	Propane	IIA

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

1.2 Requirements for the operator

The operator must comply with the regulations of the German Ordinance on Industrial Safety and Health (BetrSichV). In addition, the rules of the Technical Guideline for Operational Safety 2153 (TRGS 727) must be observed when operating the system in ATEX zones to avoid ignition hazards due to electrostatic charges in accordance with the ATEX Operating Directive 1999/92/EC. The manufacturer prepares the equipment for the ATEX zones specified by the operator and provides the necessary equipment documentation for the explosion protection document. In this way, the operator can fulfill the requirements of the BetrSichV and ensure and document safe system operation.

2 Causes of ignition hazards in glass systems

The most common cause of electrostatic charging is contact charging. When two previously uncharged objects come into contact, a charge exchange takes place at their common interface. When the surfaces are subsequently separated, each surface carries a part of this charge, each with opposite polarity. Contact charging can occur at all interfaces between solid and/or liquid phases. Gases cannot be charged, but solid particles or liquid droplets contained in a gas flow can cause electrostatic charging (see TRGS 727) Electrostatic charging of liquids occurs mainly through contact charging. Examples of this are the flow of a liquid along a solid surface such as a pipe, pump or filter, as well as the stirring, shaking, spraying or atomizing of liquids. If the liquid contains additional phases, such as suspended solids or dispersed other liquids, the charge can be significantly increased as the interfaces increase. Normally, dangerous electrostatic charges only occur in liquids with low electrical conductivity (see TRGS 727).
High or dangerous charges can lead to electrostatic discharges or sparks that can ignite explosive atmospheres. For this reason, it is crucial to avoid dangerous charges in potentially explosive atmospheres
The operator should carry out a specific safety assessment. Normally, dangerous electrostatic charges only occur in liquids with low electrical conductivity. It is often possible to avoid charges by adding additives such as soluble salts to the fluids, which can sufficiently increase conductivity even at low concentrations in the ppm range. This helps to ensure safety and minimize potential hazards in potentially explosive atmospheres.

Table 3: Strong charge-generating processes:

Fast multiphase flow of liquids from a flow velocity of 1 m/s
Multiple rapid filling of containers from a flow velocity of 7 m/s
Liquid/liquid flows, flow of suspensions
Atomizing, spraying conductive liquids such as water
Conveying isolating suspensions or dusts
Stirring and mixing different liquids or liquids with solids

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3 Measures for charge-generating processes:

If charges arise due to frictional electricity, they can also be caused by induction in spatially distant conductive objects. To minimize such charges, certain countermeasures are required, such as earthing conductive materials and avoiding insulating materials. The extent of these measures depends on the frequency of charge-generating processes in and around the plant. The following equipment-related measures comply with the guidelines of TRGS 727 and are intended to prevent ignition hazards due to electrostatic charges under the given conditions. However, these measures are only necessary if, for example, inertization is not guaranteed in the equipment or a potentially ignitable mixture is present.

3.1 Potential equalization

If conductive components are earthed or dissipative components are connected to earth, they cannot become charged and therefore do not pose an ignition hazard. To ensure that currents of up to $^{10-4}$ A can be safely discharged in accordance with TRGS 727, a poorly conductive connection with a high resistance of ^{106} Ω is sufficient as earthing. This equipotential bonding in accordance with TRGS 727 differs from the earthing of electrical devices in accordance with DIN VDE 0100-200:2006-06, which must safely discharge significantly higher currents. We therefore use the term "equipotential bonding" instead of "earthing in accordance with TRGS 727". With equipotential bonding, either individual components or conductively connected components can be connected to earth together.

The equipotential bonding cable must be clearly marked with a yellow/green striped color.

3.2 Avoidance of insulating materials

Avoiding insulating materials is an important aspect of dealing with electrostatic charges and ensuring safety in areas where there is a risk of explosion or fire due to electrostatic discharge.

Insulating materials can maintain electrostatic charges as they do not conduct electrons and therefore cannot dissipate the charge. This can lead to dangerous voltages. To prevent this:

Use of conductive materials: Where possible and safe, conductive materials should be used. These can conduct electrons and contribute to the dissipation of charges.

Earthing and potential equalization: Conductive components **must** be connected to each other and to earth in order to safely dissipate the charges and ensure a uniform electrical potential.

Antistatic materials: If the use of insulating materials is unavoidable, antistatic coatings or materials should be considered. These can reduce electrostatic charges.

The exact implementation of these measures depends on the specific application and the hazards associated with electrostatic charges. A thorough hazard assessment and compliance with the relevant regulations, such as TRGS 727, are crucial to ensure safety

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.3 Measures for non-charge-generating processes

In the case of non-charge-generating processes in which no electrostatic charges occur or are to be expected, the measures required to prevent electrostatic charges and the associated hazards are limited. In such cases, for example, no equipotential bonding measures are necessary and the use of insulating materials is permissible if a dangerous charge in the interior and exterior of the system can be safely excluded or this has been proven by experimental tests.

3.4 Measures for highly charge-generating processes

For processes that generate a strong charge (see Table 3), special equipment measures are required to control electrostatic charges and minimize hazards. Regardless of the ATEX zone, it must be ensured that all conductive components and materials are connected to each other and to earth in order to ensure a uniform electrical potential and dissipate electrostatic charges. Non-conductive materials should generally be avoided and replaced with conductive, dissipative or dissipative-coated materials.

3.5 Measures for charge-generating processes

If charge-generating processes cannot be completely avoided and these processes are not classified as particularly charge-generating (see, for example, Table 1), equipment measures can be taken step by step to avoid dangerous electrostatic charges. In such situations, non-conductive material surfaces should only be present to a limited extent, and conductive or dissipative objects only need to be equipped with equipotential bonding above a certain capacity. The exact size of the permissible non-conductive material surfaces and the requirements for the equipotential bonding of conductive and dissipative objects depend on the ATEX zone and are specified in TRGS 727.

3.6 Equipotential bonding on glass systems

The outer surface of glass components and the flange connections have no direct contact with the flowing media in the system and can therefore only be charged by induction. The possible charging of a conductive object depends on its electrical capacity. Depending on the zone and the explosion group, different capacitances are permitted for which equipotential bonding can be dispensed with. TRGS 727, for example, specifies a guide value of 10 pF as the maximum permissible capacitance for zones 2, 1 IIA and 1 IIB and stipulates under these conditions that metal flanges with a nominal width of DN50 and above require equipotential bonding. The standard plastic clamp ring connections used by Pfaudler Normag Systems do not require equipotential bonding up to a nominal diameter of DN300. If metal flanges are installed, they must be provided with equipotential bonding in Zone 0 and Zone 1 IIC, regardless of their nominal diameter (see Table 4).

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

Table 4: Equipotential bonding on stainless steel connections (TRGS 727)

Zone	Explosion group	Stainless steel flange connections CS							
0	IIC								
	IIB								
	IIA								
1	IIC								
	IIB								
	IIA								
2	IIC								
	IIB								
	IIA								
Nominal diameter DN		15	25	40	50	80	100	200	300
		Capacitance C < 10pF < Capacitance C							

In order to take into account the large number of flange connections in a glass installation, an easy-to-install and safe potential equalization was implemented in the design of the flange connections. The flange connections made of corrosion-resistant stainless steel are connected electrically conductive one after the other after installation by attaching the clamp rings with an earthing clamp to the earthing holes (M5) provided. The earthing cable can then be connected continuously in series with these earthing clamps. The earthing clamps are corrosion-resistant and require special tools for disassembly. The equipotential bonding created in this way has a resistance of less than ^{106} Ω, which meets the requirements of TRGS 727. The interconnected components are connected to earth at suitable earthing points.

The advantage of equipotential bonding connected in series is that the entire equipotential bonding of all interconnected flanges is not interrupted if the clamp connection is released on just one flange.

All stainless steel flanges have an earthing hole and are therefore intended for potential equalization. This includes the flanges of bellows, valves, agitators, shell and tube heat exchangers, etc.

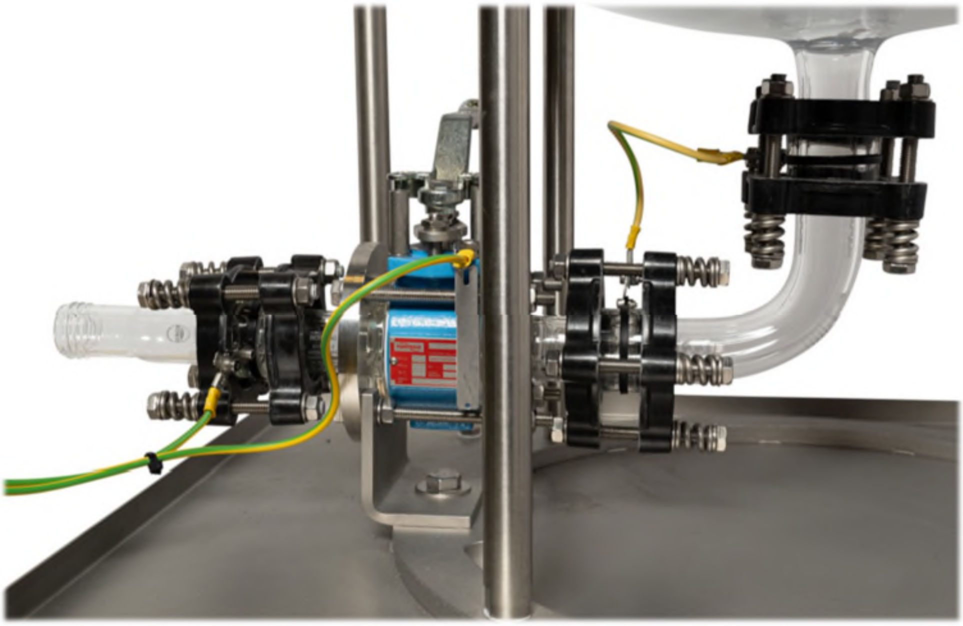


Fig.1: Equipotential bonding of the gaskets and metal flanges by firmly clamped cable

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7 Avoidance of insulating surfaces in glass systems

Avoiding insulating surfaces in glass installations is an important aspect of safety and control of electrostatic charges and potential hazards in industrial environments. Insulating surfaces can accumulate electrostatic charges and fail to dissipate them, leading to a risk of sparking and potentially explosive atmospheres. In glass installations, these insulating surfaces can be found on plastic components such as PTFE and, in certain circumstances, on external glass surfaces.

When selecting materials for components and surfaces in glass systems, conductive or dissipative materials, such as PTFE with conductive pigments, can be used. These materials can efficiently dissipate electrostatic charges

The outer glass surfaces can be made dissipative with a dissipative coating. However, in accordance with TRGS 727, the same measures must be taken inside glass installations as in other conductive facilities.

3.7.1 Dissipative coating for borosilicate glass

The borosilicate glass 3.3 used in glass apparatus is hydrophilic and has a surface resistance of approximately $10^{11}\ \Omega$ at 50 % relative humidity and 23 °C and is generally safe from dangerous charges caused by processes such as rubbing under these conditions. However, at a relative humidity of less than 50 % and temperatures above 50 °C, suitable measures must be taken to prevent dangerous charges if the glass system is to be operated in zone 0 or 1 IIC.

One such measure is the dissipative coating, for example, which has a surface resistance of less than $10^{8}\ \Omega$. This surface resistance is measured on each coated glass component in accordance with DIN VDE 0303-3:1983-05, and the admissibility is confirmed by a sticker on the coating indicating the date of the measurement. When installing the stainless steel clamp ring connection in all nominal sizes in the PF system on conductive coated components, a non-conductive rubber insert is used so as not to damage the coating. The same plastic insert can be used in the KF system. As the equipotential bonding is not carried out via the inserts and clamp rings, the conductive coating must therefore be connected to the equipotential bonding via conductive seals. It should be noted that this is done via the sealing collar, which means that a sealing collar must be in contact with every component with a conductive coating. Conductive double-collar gaskets ensure this in all cases and also offer the option of connecting several glass components together without having to connect each gasket individually to the equipotential bonding.

In addition to preventing potential ignition sources, the glass coating offers two important advantages: Firstly, it protects the glass surface from mechanical damage and secondly, it allows the system to be emptied of any residue in the event of glass breakage under certain circumstances. This dissipative coating, consisting mainly of polyurethane, is highly resistant to chemicals and weathering. The coating of a non-insulated glass component remains stable in the long term up to an operating temperature of 140°C.

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

Table 5: Selection diagram for dissipative coating

Zone	Explosion group	Glass surface
0 Exterior	IIC	
	IIB	
	IIA	
1 Exterior	IIC	
	IIB	
	IIA	
2 outside	IIC	
	IIB	
	IIA	
Nominal diameter DN		all

Dissipative coated glass	

Fig.2: Uncoated (front) and conductive coated glass (back)

Attention:
If a dissipative coating is required, a dissipative seal with earthing lug must be used regardless of the zone and explosion group, as the dissipative coating is connected to the equipotential bonding via this.

3.7.2 Dissipative PTFE components

If insulating plastics such as PTFE are used for individual components, there are specific specifications regarding the permissible surface size. According to TRGS 727, the largest projected surfaces adjacent to potentially explosive atmospheres (see Figure 5 and Figure 6) are decisive. These surfaces must not be larger than specified in Table 6.

PTFE components such as seals, bellows, agitators, valve bellows and others can be purchased in a dissipative version. These components have certificates that confirm both the discharge capability and the material properties in accordance with FDA regulations. In charge-generating processes that are not classified as particularly charge-generating, it is not always necessary to manufacture all PTFE components from dissipative material in accordance with section 3.4. Table 6 shows the maximum permissible surface area for non-conductive materials that are not expected to generate dangerous charges when used.

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

The projected surfaces for PTFE components are calculated in accordance with the guidelines of TRGS 727 for both outdoor and indoor areas. This is shown as an example in Figure 5 for the interior and in Figure 6 for the exterior. When deciding whether dissipative material is required, only the indoor area is taken into account for zone 0. Zone 0 in the outdoor area is not taken into account, as the devices used in glass installations covered by Directive 2014/34/EU are not certified for zone 0 in the outdoor area. For zones 1 and 2, the larger of the two areas is taken as the basis. The following selection diagrams show whether the use of dissipative PTFE is required or not, depending on the nominal width of a component and the associated ATEX zone or explosion group.

Table 6: Maximum permissible surfaces of insulating materials (TRGS 727)

Zone	Explosion group						
0 Inside	IIC		4				
	IIB				25		
	IIA					50	
1 Inside or outside	IIC			20			
	IIB						100
	IIA						100
2 Inside or outside	IIC						
	IIB						
	IIA						
Projected surface area cm²			4	20	25	50	100

Dissipative PTFE	

Table 6 shows that no dissipative PTFE is required in zone 2 inside/outside. The dissipative components are

characterized by the
They do not have insulating surfaces and are equipped with equipotential bonding just like conductive components. In contrast to the standard components with insulating PTFE, the metallic parts of the components equipped with conductive PTFE, such as bellows and intermediate plates, can become charged without any influence and therefore also require equipotential bonding
The most important components are presented below as examples. We will be happy to provide information on the other PTFE components on request.

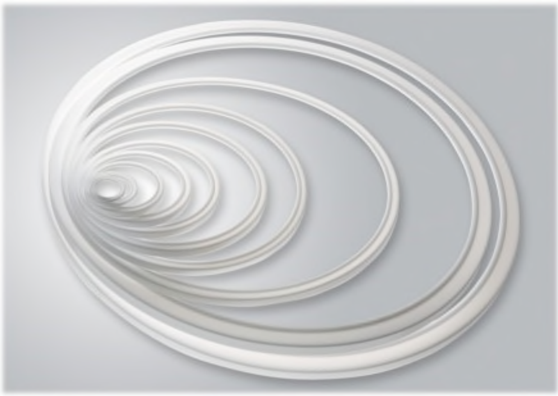
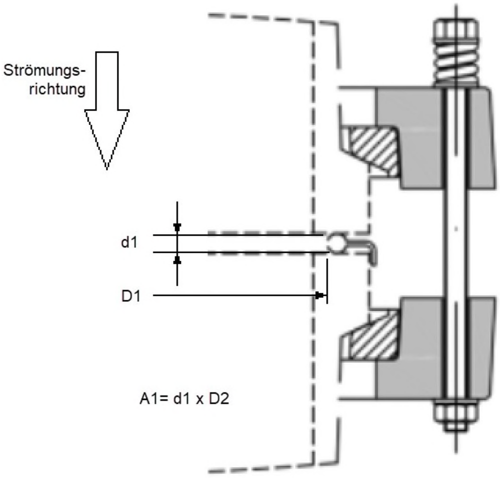


Fig.4: Flange shapes PF / KF system

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com



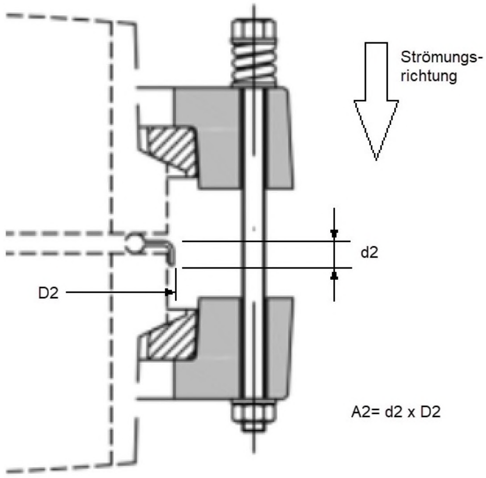


Fig.5: Projected surface insideFig. 6: Projected surface outside

The following diagrams show for the various seal types in the KF and PF system, from which nominal widths and for which zones they must be used in a dissipative design.

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.1 *Ring seal type CGR (KF + PF- system):*

The ring gasket (CGR-K) for the KF system can be used for ball and socket flange connections for all nominal sizes. The ring gaskets (CGR) are used for KF- Plan DN 200 and DN300. The ring gasket for the PF system (CGR-P) is used for the connection between PF flanges. For the classification in zone 1 and 2, the larger of the inner / outer projected surface was used. The dissipative PTFE gaskets are fitted with a tab so that they can be provided with equipotential bonding.

Table 7: Selection diagram for PTFE gaskets type CGR / CGR-M4

Zone	Explosion group	Ring seal - CGR								
0 Inside	IIC			40						
	IIB							150		
	IIA									400
1 Inside or outside	IIC			40		80				
	IIB									400
	IIA									400
2 Inside Or outside	IIC									
	IIB									
	IIA									
Nominal diameter DN		15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	
No conductive PTFE and no potential equalization	
Conductive PTFE with equipotential bonding (CGR with double collar, CGR-M3/M4)	

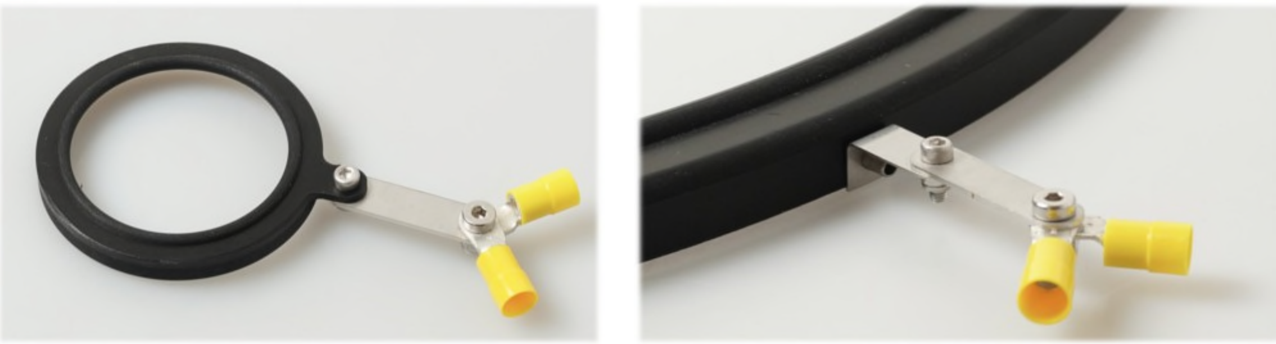


Fig.7+8: Ring seal with earthing lug

Fig.9: Joint seal with earthing lug

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.2 Articulated seals TYPE CGH (PF- system)

Articulated gaskets allow a flat flange connection in the PF system to be angled with minimal dead space. On the product side, they consist of a PTFE sleeve supported by three stainless steel rings. Equipotential bonding is achieved with a metal tab attached to the middle of the three stainless steel rings. Fig. 9

Table 8: Selection diagram for PTFE gaskets type CGH

Zone	Explosion group	Joint seal - CGH						
0 Inside	IIC	15						
	IIB				50			
	IIA						100	
1 Inside or Exterior	IIC				50			
	IIB						100	
	IIA						100	
2 Inside or outside	IIC							
	IIB							
	IIA							
	Nominal diameter DN	15	25	40	50	80	100	150

Conductive PTFE with potential equalization	
No conductive PTFE and no potential equalization	
Potential equalization and no dissipative PTFE	

3.7.2.3 Flat gaskets type CGF (KF + PF- system)

For the transition from glass flanges to plastic or PTFE-lined pipes, we recommend using a PTFE flat gasket in addition to the CGR ring gasket or CGC transition gasket. The flat gasket should prevent the ring gasket from pressing into the plastic or PTFE sealing surface. When used in combination with a CGR or CGC, the projected surface of the two gaskets in direct contact with each other must be considered.

Table 9: Selection diagram for PTFE gaskets type CGF

Zone	Explosion group	Flat gasket - CGF								
0 Inside	IIC				50					
	IIB								200	
	IIA									400
1 Inside Or Exterior	IIC							150		
	IIB									
	IIA									
2 Inside or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	
No conductive PTFE and no potential equalization	

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.4 Transition gaskets glass - enamel, type CGC

CGC type transition gaskets are used for the transition from glass to other materials, especially when a slightly different internal diameter or strongly rounded sealing surfaces, e.g. on glass-lined nozzles, need to be compensated for. The transition gaskets consist of a stainless steel ring, a graphite insert that compensates for slight unevenness and the PTFE sleeve with sealing beads on the product side.

Table 10: Selection diagram for PTFE gaskets type CGC

Zone	Explosion group	Transition gasket glass - enamel - CGC								
0 Inside	IIC		25							
	IIB					80				
	IIA							150		
1 Inside or outside	IIC					80				
	IIB									300
	IIA									300
2 Inside or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	(white)
Potential equalization and no dissipative PTFE	(grey)

3.7.2.5 Flat gaskets with steel core, type CGS

For the transition from PF glass flanges to pipelines with larger transition radii or slightly different diameters, we recommend using a PTFE-coated steel core gasket in addition to the CGR ring gasket. The steel core gasket enables the forces to be transmitted in accordance with the slightly different position of the gasket support diameters and also prevents the ring gasket from being pressed in during the transition to pipelines made of plastic or plastic lining. The steel core gasket is preferable to the CGC transition gasket for these applications in particular

Table 11: Selection diagram for PTFE gaskets type CGS

Zone	Explosion group	Flat gasket with steel core - CGS								
0 Inside	IIC			40						
	IIB						100			
	IIA								200	
1 Inside or outside	IIC						100			
	IIB									300
	IIA									300
2 Inside or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

Conductive PTFE with potential equalization	
No conductive PTFE and no potential equalization	
Potential equalization and no dissipative PTFE	

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.6 Flat gaskets for multiple opening, type CGP

The use of the chambered flat gasket type CGP.... is particularly recommended for applications that require regular opening and closing processes, e.g. for filter apparatuses The CGP gasket has a core made of stretched elastic PTFE.

Table12: Selection diagram for PTFE gaskets type CGP

Zone	Explosion group	Flat gasket for multiple opening CGP								
0 Inside	IIC		25							
	IIB								200	
	IIA									300
1 Inside or outside	IIC						100			
	IIB									
	IIA									
2 Inside Or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	

3.7.2.7 Transition gasket KF - PF, type CGE

Type CGE transition gaskets can be used for the transition from PF glass flanges to KF flanges in ball or cup design. The gasket is centered via a collar on the outer circumference of the glass tube end.

Table 13: Selection diagram for PTFE gaskets type CGE

Zone	Explosion group	Transition gaskets KF - PF CGE								
0 Inside	IIC		25							
	IIB					80				
	IIA							150		
1 Inside or outside	IIC			40						
	IIB							150		
	IIA							150		
2 Inside or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.8 GMP gaskets, type CGG

These GMP gaskets are used for applications where it is important to have flange connections with as little dead space as possible. The inside diameter of these gaskets is adapted to the inside diameter of the piping in order to keep the dead space gap as small as possible.

Table 14: Selection diagram for PTFE gaskets type CGG

Zone	Explosion group	GMP gaskets CGG								
0 Inside	IIC				50					
	IIB								200	
	IIA									400
1 Inside Or Exterior	IIC			40						
	IIB								200	
	IIA								200	
2 Inside or outside	IIC									
	IIB									
	IIA									
	Nominal diameter DN	15	25	40	50	80	100	150	200	≥300

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	(white)

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.9 Bellows - CBG, CBE, CBA

Bellows (Fig. 10) are used, for example, to compensate for temperature-related changes in the length of different materials within the system and thus avoid stresses in the glass. The bellows are made of PTFE and are connected to the piping via stainless steel flanges. As the projected surfaces perpendicular to the direction of flow are significantly larger than with the above-mentioned seals, the bellows are required from smaller nominal widths with dissipative PTFE. The same illustration applies to bellows with vacuum support. The bellows is connected directly to the metal flange, which in turn has contact with the stainless steel flange ring of the connection via the screws. Equipotential bonding is achieved in exactly the same way as with the stainless steel flange connection via the earthing terminals to which the continuous earthing cable is connected.

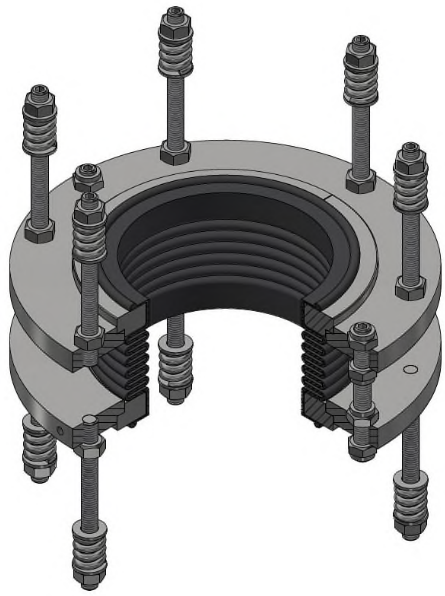


Fig. 10: Dischargeable bellows with earthing hole

Table 15: Selection diagram for conductive bellows

Zone	Explosion group	Bellows CBG CBE CBA						
0 Inside	IIC	KF+PF						
	IIB	(PF from DN25)						
	IIA		(PF from DN40)					
1 Inside or outside	IIC	KF+PF						
	IIB			(PF from DN50)				
	IIA			(PF from DN50)				
2 Inside or outside	IIC							
	IIB							
	IIA							
	Nominal diameter DN	15	25	40	50	80	100	≥100

Conductive PTFE with potential equalization	
No conductive PTFE and no potential equalization	
Potential equalization and no dissipative PTFE	

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.10 Discharge pipes - AIPP

With PTFE inlet pipes, the fluid to be introduced is fed into a vessel or reactor, for example, so that it does not run along the inner wall of the nozzle and the cap, but flows directly into the fluid in the container. The choice of PTFE for the inlet pipe is independent of the zone outside the container, as the main part of the inlet pipe is on the inside. As the projected surfaces perpendicular to the direction of flow are significantly larger than with the above-mentioned seals, the inlet pipes are required with dissipative PTFE even from small nominal diameters.

Equipotential bonding takes place via an earthing lug, just as with the seals. Table 16:

Selection diagram for conductive discharge pipes

Zone	Explosion group	AIPP inlet pipes - length 100/250 mm			
0 Inside	IIC				
	IIB				
	IIA				
1 Inside or Exterior	IIC				
	IIB				
	IIA				
2 Inside or outside	IIC				
	IIB				
	IIA				
Nominal		15	25	40	50

Conductive PTFE and potential equalization L=100 mm	
Conductive PTFE and potential equalization L=250 mm	
No conductive PTFE and no potential equalization	

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com

3.7.2.11 Valves

Type VS, VE and VOB bellows valves can be used both for shutting off and for coarse control. As the upper part of the valve is made of plastic and has no conductive connection to the valve bellows, a metal earthing lug is installed between the upper part and the valve bellows. The same continuous earthing cable is used here that is also connected to the earthing lugs of other conductive components. The choice of PTFE for the valve bellows is independent of the zone outside the apparatus, as the main part of the valve bellows is located in the glass housing and can therefore only be charged by frictional electricity in the apparatus. Table 17 shows the zones in the apparatus for which the valve bellows must be made of conductive PTFE.

Table 17: Selection diagram for dischargeable valve bellows

Zone	Explosion group						Valves VS, VE
0 Inside	IIC	15					
	IIB		25				
	IIA		25				
1 Inside	IIC	15					
	IIB			40			
	IIA			40			
2 Inside	IIC						
	IIB						
	IIA						
	Nominal diameter DN	15	25	40	50	80	100

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	(white)

Table 18: Selection diagram for conductive bellows VOB

Zone	Explosion group		VOB
0 Inside	IIC		
	IIB		
	IIA		
1 Inside	IIC		
	IIB		
	IIA		
2 Inside	IIC		
	IIB		
	IIA		
	Nominal diameter DN	40	50

Conductive PTFE with potential equalization	(blue)
No conductive PTFE and no potential equalization	(white)

Pfaudler Normag Systems GmbH
Auf dem Steine 4, 98693 Ilmenau
T: +49 3677 2079 0 | E: info@normag-glas.com | W: www.gmmpfaudler.com