Engineering Parts and Tubings Made from PTFE.

Versatile Solutions Featuring Maximum Precision
Innovations from PTFE

With its seals and engineering design elements ElringKlinger has been one of the technology leaders in its field for over 50 years. We develop tailored solutions from PTFE, PTFE compounds and other high-performance plastics as well as composite parts combining PTFE with other plastics or metals for customers around the world. Our solutions meet the toughest demands to be found in the field – with economy and reliability guaranteed.

Top Performance and Functional Reliability

Engineering parts and tubings made from PTFE: the right choice when it comes to high thermal stress. In addition to their outstanding tribological properties, these compounds offer excellent chemical resistance to aggressive media. For applications in the food and pharmaceutical industry, our special compounds are used.

Quality and Environmental Policy

Top quality and an active commitment to environmental protection are key to ElringKlinger’s sustained success in the marketplace. That is why we are certified according to ISO/TS 16949 and DIN EN ISO 14001.

Technical Consulting Support

We will be pleased to support you in designing your engineering components. Please complete and return the technical questionnaire or contact us directly. Our application engineers will provide you with an installation/assembly proposal and/or a quotation as quickly as possible.
Properties of Fluoroplastics

PTFE is a linear polymer from carbon and fluorine with exceptional properties.

Nearly Universal Chemical Resistance
The extremely stable combination of fluorine and carbon atoms and the almost complete shielding of the carbon chain by the fluorine atoms give PTFE nearly universal chemical resistance. Only hydrocarbon combinations containing fluorine and melted alkali metals cause PTFE to swell or produce a limited chemical reaction on the surface. Even after prolonged storage, no water absorption can be noted. In extreme climatic conditions PTFE shows nearly unlimited weather resistance. Worthy of particular mention are PTFE’s good physiological properties.

High Thermal Stability
across a wide temperature range. PTFE can be used within a temperature range from –200°C to +300°C.

Good Sliding Properties
even in dry running conditions.

Friction Coefficient
Of all solids, PTFE has the lowest coefficients of friction. The static and dynamic coefficients of friction are nearly identical, which means that there is no stick-slip effect with PTFE even at very low sliding speeds.

Excellent Anti-Adhesive Properties
PTFE has very low adhesion. This is due to the strong bond between the carbon chain and the fluorine atoms and their low polarization capabilities.

PTFE is difficult to wet, but following a chemical pre-treatment it is suitable for glueing with good adhesive bonding.

Good Electric Properties
PTFE has outstanding electric insulation properties which are nearly constant across a wide temperature range. Added to this is a very low dielectric constant combined with a low dielectric loss factor.

High Reverse Bending Strength
PTFE Bellows

PTFE bellows are used as balancing elements between engineering parts. They are machined parts. Due to the different geometries of the folds highly flexible or pressure-resistant versions can be designed and manufactured. PTFE’s outstanding material properties allow bellows to be used increasingly in medical, food and general industrial applications.

Benefits

- Nearly universal chemical resistance
- FDA-conformable materials for food and pharmaceutical products
- Very good suitability for sterilization
- Anti-adhesive
- Wide temperature range from −60°C to +200°C
- Cost effective series production from in-house production of semi-finished goods to the final product
- High reverse bending strength
- Good dimensional stability
- Low tooling costs
- Freedom of design
### Fields of Application

- As compensation for expansion in pipe systems
- For shielding sterile areas
- For filling systems
- With aseptic valves
- With solenoid valves
- With metering devices
- With pumps and valves
Materials
- Typically, unfilled PTFE with FDA-conformance
- Modified PTFE with higher reverse bending strength
- Special versions with electrical conductivity
- With applications as metering, shut-off and sealing element the clamping flange, the sealing cone or the slide ring may be manufactured from a PTFE compound (e.g. glass fibers or ceramics)
- For information on materials with good reverse bending strength and low permeation, please see pages 26 – 27
- For your inquiry, please complete the technical questionnaire at the end of the catalog
PTFE Diaphragms

**Benefits**
- Good reverse bending strength
- Nearly universal chemical resistance
- Very good suitability for sterilization
- Temperature resistance –60°C to +200°C
- FDA-conformable materials
- Freedom of design
- Homogeneous structure

Diaphragms are hermetical seals between two spaces with media and pressures which, typically, differ from each other. Unlike piston and rod seals, there is no drag leakage at the contacting surfaces, and the requirements to be met in terms of tolerances and surfaces are lower.

Chemical resistance to aggressive media, flexibility and long service life are major requirements made on materials and the design of membranes. For perfect service, it is indispensable that diaphragms design and selection of the respective compound be adapted specifically to the particular application conditions.
Fields of Applications

- Metering devices for the pharmaceutical and food industries
- Pumps for the chemical industry
- Pumps for painting technology
- Pressure regulators
- Pharmaceutical valves

Diaphragm with metal core for painting pumps.

Diaphragm with grooves on the back for sterile valve with very smooth surfaces.
PTFE diaphragms are used in metering devices for the pharmaceutical and food industries as well as in pumps of the chemical industry and in painting technology.

Because of their outstanding physical and chemical properties PTFE diaphragms are being used in constantly increasing fields of application. The lift of the diaphragm is determined by its shape and design as well as the existing effective diameters.

To reduce the risk of damage, the sandwich diaphragm technology is primarily being used (principle of the double barrier, diaphragm technology with breakage sensor). This enables early detection of malfunctions for planned execution of timely repairs and appropriate corrective action which reduces production downtimes significantly. In addition, this helps prevent contamination of the media fluids to be pumped.

With multi-layered diaphragms and constant material thicknesses the actuating forces are considerably lower than those of single-layered diaphragms.

In addition to stamped diaphragms, machined diaphragms are increasingly being used. A major advantage over PTFE/elastomer composite diaphragms is the homogeneous structure and freedom of design offered by these diaphragms.

To increase service life, specially treated PTFE films and films made from modified PTFE are used.

For information on materials with good reverse bending strength and low permeation, see pages 26–27.

For your inquiry, please complete the technical questionnaire at the end of the catalog.
Versions

**Film Diaphragms**
- For large volumes
- For medium requirements regarding lift, service life, pressure
- More sophisticated design of clamping surfaces

**Flat Diaphragms**
- Only for very small lifts
- Lowest tooling and manufacturing costs
- Low assembly height

**Diaphragms with Stamped Contour**
- High performance capability
- Low restoring forces
- Multi-layered designs (for evacuation of leakage, higher pressure strength)

**Machined Diaphragms**
- For maximum requirements regarding lift, service life, pressure \( H_{\text{max}} \leq 0.30 \times \Theta_{\text{eff}} \)
- For specified installation spaces

**Versatile Design Options**
- No dead space in clamping areas
- Leakage evacuation with multi-layered designs
- Reinforcement grooves, beads, cuts to avoid radial creasing
- Sealing elements to close openings
- Core/disc design for mechanical articulation
Assembly and Design Instructions

In the clamping zone, the diaphragm is fastened between the housing flanges under sufficient pressure (thread-fastening, clamping). The diaphragm in this case acts like a static seal. Deformation damage caused by excessive clamping pressures must be avoided through flange stops and/or specified torque levels. Depending on the diaphragm material and diaphragm thickness, additional flat or profile seals may be used for sealing.

For mechanical articulation, the diaphragm is typically clamped between the supporting and the pressure disc. The individual components are joined by a threaded connection, riveting or vulkanized. When designing the support, it must be ensured that the surfaces contacting the diaphragm are burr-free and that there are sufficiently dimensioned transition radii.

General rule: \( R \geq 4 \cdot s \)

\( R = \text{radius}; \ s = \text{diaphragm thickness} \)

For perfect service, it is indispensable that diaphragm design and selection of the respective compound be adapted specifically to the particular application conditions.

We will be pleased to provide you with respective consulting support.

Dimensioning Legend for Engineering Drawings
- \( D, \ Ø \text{ outside} \)
- \( D_w, \ Ø \text{ eff} \)
- \( b \) (radial bead width)
- \( S \) (membrane thickness in the bead area)
- \( P \) (pressure)
- \( H_{\text{max}} \) (maximum lift)
- \( R \) (radii at the transition points)

Flat Diaphragms

Diaphragm with Bead

Other Clamping Options
ElringKlinger are masters in the art of making the best of plastics. We offer a wide range of materials that are optimally adapted to your needs. PTFE – the versatile high-performance plastic material – plays a superior role as the base material for new product ideas.

PTFE as an engineering design material or as a permanent composite with metals, elastomers and other plastics. Permanent strength even in extreme conditions.

But we also process other highly durable plastics such as:

- PE-UHMW (ultra-high molecular polyethylene)
- POM (polyoxymethylene)
- PA (polyamide)
- PEEK (polyetheretherketone)

One of the crucial prerequisites for the functional performance and quality of assembly components is accomplished professional processing: From single parts to cost efficient volume production.

We continuously improve our manufacturing processes and develop new methods for quality assurance.

Our experience in this specialty field and our specified, integrated quality management system ensure that ElringKlinger products and problem solutions fully meet the requirements of our customers.

The product and application examples below are provided to give design and development engineers ideas of what is possible. Trust us to be your partner when it comes to translating product ideas into optimum solutions with functional reliability assured. That is why: what you need you will get from ElringKlinger. Try us!

**Protective Covers**

are used in the food, chemical and pharmaceutical industries. This example shows a probe with a PTFE cover for protection from aggressive media, welded at the face side (photo, right). Another version: Temperature sensor with PTFE cover. Lining of electrical heating elements as protective sheathing in electroplating and microelectronics applications (photo, left).

**PTFE Blow Molded Tube**

to protect the feeder cable in the lambda sensor from dirt and bending.

**Trocar Tube**

used in endoscopic surgery. The device with a spiral-shaped PTFE tube enables the performance of surgical procedures with relatively low loss of blood.
Deep Drawing Parts

Typical Characteristics
- Low material consumption
- Allows complex geometries
- Parts have thin walls
- For cost-effective manufacturing of large-volume production
- Material properties can be influenced positively

Protective Cap for Steering Angle Sensors
- Protection of electronics
- Temperature stability up to +150°C
- Chemically resistant to aggressive oils and cold cleaners

Sliding Tiles for Dyeing Machines
- Good sliding properties
- Easy assembly and removal
- Cost-effective manufacture
- High chemical resistance
- Easy to clean (anti-adhesive)

Milled Parts

PTFE Agitator Blade with Sintered-in Magnets
for use in electroplating technology.
- Good chemical resistance

Pump Housing
for use in the chemical and semiconductor industries.
- Allows complex geometries
- Allows large dimensions
- Different manufacturing technologies available

Back Plates
in heat exchangers up to dimensions of 3000 x 1500 mm.

Ulbricht’s Spheres Made from Porous PTFE
for use in optical measuring systems.
For additional information on engineered porous PTFE parts such as filter elements, Lambert’s reflectors for projection screens, etc., please see our “Materials Catalog” as well as our “Light Flyer.”
Isostatically Compression-Molded Parts

Typical Characteristics
- Low material consumption
- Allows complex geometries

![Honeycomb](image1)  ![Extinguishing Nozzles](image2)

**Honeycomb**
for use in heat exchangers of power plants.
- Good chemical resistance

**Extinguishing Nozzles**
for use in high-voltage switches.
- Good electrical insulation
- High temperature resistance

Complete Solutions

![Double Piston Pump](image3)  ![Metering Piston with Injected Elastomer](image4)

**Double Piston Pump**
for use in home dialysis devices; consisting of a modified PE piston and rod seal as well as a POM housing. Complete assembly from a single source.

**Metering Piston with Injected Elastomer**
for use in the food and cosmetics industries.
Benefits

- Excellent anti-adhesive properties
- High temperature resistance
- Nearly universal chemical resistance
- Very good sliding properties
- Good wear resistance
- Adjustable thermal conductivity
- Adjustable electrical/dielectric conductivity

Application Examples

- Feed rolls and rollers
- Fuser rollers
- Pressure rolls and rollers
- Guide rolls and rollers

Manufacturing Process of PTFE Coatings

- Roller coatings with PTFE films
- Assembly of FEP-/PTFE shrink wraps

Rolls and Rollers with PTFE High-Performance Coating

The properties of PTFE can be influenced by processing methods and by adding fillers. Optimum adaptation to the respective application conditions is possible.

PTFE with Fillers

- Increased service life due to fillers
- Improved thermal conductivity due to fillers

Thermal Conductivity of Coatings for Fuser Rolls

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<tr>
<td>0.6205</td>
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<td>0.3313</td>
</tr>
</tbody>
</table>

PTFE unfilled (white)  PTFE/graphite (black)  PTFE/TP (brown)
Polyurethane-Coated Rolls and Rollers for Paper Feeding

Feeding Systems
Today two different technologies are used for feeding paper webs. We develop and manufacture both feeder rolls for paper with a so-called feeding perforation and newly developed feeding systems for tractor-less paper feeding.

Feeding Systems for Stacked Paper (PU-elastomer)

Benefits
- Long service life due to wear-resistant surface
- Quick and precise paper feeding due to high accuracies
- Good chemical resistance
- Low masses/weights
- Application-specific engineering design (surfaces, roller materials, dimensions)

Feeding Systems for Reel-Fed Paper (PU foam)

Benefits
- Reduction of paper costs by 30 – 50% by tractor-less paper feeding
- No disposal of edge trim needed
- Reliable feeding of light-weight papers
- Long service life due to wear-resistant surface
- Quick and precise paper feeding
- Good chemical resistance
- Low masses/weights
- Application-specific engineering design (surfaces, roller materials, dimensions)
Thermal Properties
Thermal loadability
• The thermal loadability of PTFE ranges from –260°C to +300°C (e.g. no brittling in boiling helium at –269°C)
• This temperature range is not achieved by any other commercially available plastic material. The permanent service temperatures, however, depend on the respective load and stress factors
• In concrete terms this means that PTFE in case of moderate mechanical stress can be used at temperatures ranging between –200°C to +260°C

Physiological Properties
• Unfilled PTFE is physiologically neutral
• PTFE conforms to the requirements of the U.S. Food & Drug Administration (FDA) and therefore can be used with components coming into contact with foodstuffs
• A very positive factor in this context is the material’s resistance to hot vapor which means that PTFE parts are very suitable for sterilization in medical or food applications
• Conformity certifications for various pigmented tubes are available
Thanks to its exceptional chemical, thermal and dielectric properties, PTFE ranks at the top of the list of fluoro-plastic materials. These properties enable manifold problem solutions in the chemical, electrical and medical sectors. Due to the stable combination of fluorine and carbon atoms and the nearly complete shielding of the carbon chain by the fluorine atoms PTFE has nearly universal chemical resistance. This property is attributable to the material’s molecular structure. The straight carbon chain is completely covered with a layer of fluorine atoms.

Chemical reactions between PTFE and other substances are limited to a few exceptions: alkali metals in melted or dissolved form attack the polymerizate, causing a brown discoloration. Also, elementary fluorine and chlorinetrifluoride effects PTFE at higher temperatures and pressures.

For some years, paste compounds have been used increasingly as well. The most common compounds are PTFE-carbon, PTFE-glass, PTFE-bronze and PTFE-graphite.

Pure-white material will continue to be used wherever the PTFE’s outstanding chemical and thermal resistance and adhesive properties are required. Glass-filled material is preferably used when wear resistance, which is required with industrial applications in particular, should be increased. Carbon and graphite improve the thermal conductivity of the tube in addition to some mechanical properties. By adding bronze as a filler the creep tendency of the base material can be reduced. A filler which has been gaining continuously increasing importance is bismuth-carbonate, which is primarily suitable for medical applications. This enables tubes used in endoscopic surgery to be made visible on respective fluoroscopic monitors during surgical procedures.

The aforementioned properties are key factors contributing to the continuously increasing utilization of PTFE tubings in the chemical, electrical and mechanical industries, but also in medical technology. Standard tube dimensions range from 0.3 x 0.8 mm to 24 x 26 mm and above.
Typical Application Examples

**Chemical Industry**
- For analytical and measuring equipment in chromatography and lab technology as well for lining measuring sensors in chemical process technology
- For transportation of food products, oils, resins and paints
- For transportation of aggressive media such as acids, alkaline solutions, gases and solvents

**Plant and Machinery, e.g. Painting Lines**
- In spray-painting lines in which pressure-proofed tubes and tubes are used

**Electrical Industry**
- Insulation of high voltage cables
- Lining of electrical heating elements as protective sheathing for electroplating and micro-electronics

**Medical Technology**
- Cannulas
- Catheters
- Pipettes
- Endoscopes

PTFE is physiologically harmless, non-toxic and can be used in medical applications. Even a respective pre-treatment of the surface using a plasma- or wet-chemical etching process will not substantially impair the tube properties. This special additional treatment is required whenever PTFE surfaces are supposed to be bonded with accessory parts, such as ceramic tips.

**Mechanical Applications**
The lower friction coefficient of PTFE enables bowden cables to be lined for example. In view of the high ambient temperatures in the engine compartment and due to stricter emission standards, automotive applications have been gaining increasing importance.

**Liquid Chromatography**
Ultra-pure PTFE tubes without aromates which interfere with analytical processes.

**Stock Dimensions of PTFE Tubings**
**Type HN 1331, Virginal PTFE,**
**Tolerance According to GKV Guideline**

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<thead>
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<th>ID mm x OD mm</th>
<th>Part No.</th>
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Tools are available for numerous additional dimensions. Please let us know your requirements.
Special Version for Medical Technology – Flexible Endoscopy

Color-Coded Tubes, with X-ray Contrast Capability

**Application**
- ERCP catheter, papillotomes in the field of polypectomy, lithoscopy or as a sclerosing needle
- UV-resistant
- Optimum visual detectability of intra-corporeal positioning
- Suitable for autoclaving and ETO sterilization
- High abrasion resistance

For X-ray applications, the PTFE matrix can be changed by means of contrast-capable additives, such as bismuth-carbonate, so as to ensure visual detectability of the tube.

**Bio-Compatibility**
In view of the stringent requirements, certain tube materials have been tested using the basic cytotoxicity test. Approval by a GLP-certified institute has been granted for:
- HS 10008
- HS 17006
- HS 11007
as well as for other ElringKlinger-specific material combinations.

Tube, 2 Lumens

**Application**
Fibrin-gluing-needler
- 1 lumen for glue
- 1 lumen for hardener (gluing of intra-corporeal “fissures”)

Catheter for gall stone extraction/surgery in the bile duct with X-ray marking if needed
- 1 channel has a dual function for a cutting wire/guiding wire
- 1 channel for contrast agent
- Stone-retrieving basket
- 1 channel for wire basket
- 1 channel for guiding wire

Tube, 3 Lumens

**Application**
Catheter for gall stone extraction/surgery in the bile duct with X-ray marking if needed. Optimized endoscopic solution compared to 2 lumens
- Each “extraction agent” has its own service channel

Tapered Tube

Particularly in bronchoscopy, tapered tubes are being used increasingly because they enable deeper penetration of damaged areas. This means that in case of severe stenosis, the passage of instruments in the respiratory tract is facilitated for more targeted treatment of tumors or lymphomas which may be present.
Special Solutions

**Tube Module**
for de-gassing of liquids in liquid chromatography equipment.

**PTFE Tubes as Continuous Material**
For custom cable packaging in the electrical engineering industry, PTFE tubes can also be manufactured cut to size according to customer specifications.

**Spiral Tubes**
for chemical process engineering.

**Profiles**
In different geometries and dimensions.

**Examples of Profile Cross-Sections**
Technical Details

Diameter and Wall Thickness Tolerances for Paste-Extruded PTFE Tubes, Type HN 1331

Smaller functional tolerances available after prior coordination.

### Inner Diameter (mm) Tolerance (mm)

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<thead>
<tr>
<th>Inner Diameter (mm)</th>
<th>Tolerance (mm)</th>
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<tr>
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<td>above 7 to 10</td>
<td>± 0.3</td>
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<td>above 10 to 15</td>
<td>± 0.35</td>
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<tr>
<td>above 15 to 20</td>
<td>± 0.4</td>
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### Wall Thickness (mm) Tolerance (mm)

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<th>Tolerance (mm)</th>
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<td>above 2.0 to 4.0</td>
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</tr>
<tr>
<td>above 4.0 to 6.0</td>
<td>± 0.5</td>
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Precision Tubes

In addition to the high-grade standard material, ElringKlinger offer even special versions for particular application. The diameter tolerance and material characteristic can be varied.

PTFE Compounds with Fillers

available on request.

Pigmentation Colors

<table>
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Pressure Resistance of PTFE Tubes

Pressurization Period: 1min

**Wall Thickness, 1 mm**

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**Wall Thickness 0.5 mm**

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<td>0</td>
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</tbody>
</table>

**Bursting pressure at 20°C**

**Service pressure at 20°C**

**Service pressure at 100°C**

In case of critical applications involving the PTFE tubes an additional pressure test up to 35 bar (depending on the particular dimensions) may be performed.

Minimum Bending Radii of PTFE Tubes at 23°C

<table>
<thead>
<tr>
<th>Bending radius [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
</tr>
<tr>
<td>180</td>
</tr>
<tr>
<td>160</td>
</tr>
<tr>
<td>140</td>
</tr>
<tr>
<td>120</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

**Wall thickness 0.5 mm**

**Wall thickness 1.0 mm**

**Wall thickness 1.5 mm**
New Materials and their Properties

In the past, with applications requiring the utilization of modified PTFE, certain limitations regarding reverse bending properties had to be accepted. Now ElringKlinger has managed to launch a new product on the market, HS 22121, which combines all the advantages of modified PTFE.

**Benefits**
- Higher permeation density
- Low cold flow
- Lower porosity
- Smoother surfaces
- Lower Stretch Void Index
- Weldability
- FDA-conformance

In certain aspects, the new material extent even significantly surpasses the excellent reverse bending properties of non-modified standard PTFE types. The combination of these properties was not possible in the past.

HS 22121 is equally suitable for use as a diaphragms or bellows.

In addition to the high reverse bending resistance, the material’s reduced cold flow improves the retention of the diaphragm and/or bellows in the clamping area; another plus in terms of sealing performance and service life.

The results of the reverse bending test were determined by bending a test rod with a 1-mm thickness at a frequency of 4 Hz without media contact by 180° respectively.

**Reverse Bending Test 180°**
SPI test rod, 1 mm thick, average value

In addition to the high reverse bending resistance, the material’s reduced cold flow improves the retention of the diaphragm and/or bellows in the clamping area; another plus in terms of sealing performance and service life.

**Cold Flow Benefits**
Measuring conditions: 15 N/mm², 100 hrs of pressure loading, 24 hrs of pressure relief, results in permanent deformation

<table>
<thead>
<tr>
<th>Deformation under load %</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard PTFE</th>
<th>HS 22121</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>
For long service life, bellows and/or diaphragms should be designed with thin walls. Consequently, it is all the more important that the material used have a high barrier effect with regard to permeation. This is the case with modified PTFE materials and applies to aggressive, gaseous chemicals such as SO₂, HCl or Cl₂, as well as to water. The latter poses a challenge for fluoropolymers particularly at high temperatures and/or in the vapor phase or in the form of aqueous, aggressive chemicals.

**Higher Barrier Effect of HS 22121**

a) Aggressive Media

Measuring method: According to DIN 53380, film thickness: 1 mm

<table>
<thead>
<tr>
<th></th>
<th>SO₂</th>
<th>Cl₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>mod. PTFE</td>
<td>210</td>
<td>170</td>
</tr>
<tr>
<td>Standard PTFE</td>
<td>640</td>
<td>320</td>
</tr>
</tbody>
</table>

b) Water and vapor

Medium: Water, measuring temperature:
23°C or 100°C, film thickness: 1 mm

<table>
<thead>
<tr>
<th></th>
<th>Water at 23°C</th>
<th>Water at 100°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>mod. PTFE</td>
<td>0.0166</td>
<td>0.02</td>
</tr>
<tr>
<td>Standard PTFE</td>
<td>3.4</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Further information about material you will find in our catalog “Compounds and Semi-Finished Products Made from PTFE”
### The Most Commonly Used Fillers and their Influences on Compound Properties

<table>
<thead>
<tr>
<th>PTFE-Type</th>
<th>Influence of Fillers</th>
<th>Filler Content in % of Weight</th>
<th>Limits of Use</th>
</tr>
</thead>
</table>
| PTFE filled with glass fibers | • higher pressure and wear resistance as well as better thermal conductivity  
• very good chemical resistance  
• good dielectric properties | up to 40% | resistant to organic solvents, non-resistant to alkaline solutions and acids |
| PTFE filled with carbon fibers | • very low deformation under load  
• good wear resistance, even in water  
• higher thermal conductivity and lower thermal expansion than glass fibers  
• very good chemical resistance | up to 25% | carbon fibers are chemically inert |
| PTFE filled with carbon | • high pressure resistance and hardness  
• good sliding properties and wear behavior  
• good thermal conductivity  
• good chemical resistance  
• low volume and surface resistivity  
• electrically conductive | up to 35%, also in combination with graphite | compound is brittle, filler may be attacked by oxidizing media |
| PTFE filled with graphite | • good lubricating effect  
• low friction coefficient  
• no static charging  
• good thermal conductivity  
• very good chemical resistance | typically up to 5%, in exceptional cases up to 15%, also in combination with glass fibers or carbon | high abrasion when used with hard metals, is attacked by oxidizing media |
| PTFE filled with molybdenum disulfite (MoS₂) | • good sliding properties and wear behavior  
• good no-lube operation in combination with bronze | up to 10%, also in combination with glass fibers or bronze | not resistant when used with hot, concentrated sulfuric acid |
| PTFE filled with bronze | • good sliding properties and wear behavior  
• low cold flow  
• good thermal conductivity  
• lower chemical resistance  
• high pressure resistance | up to 60%, also in combination with MoS₂, | may be attacked by acids and water |
| PTFE filled with organic fillers (high-performance thermoplastics) | • outstanding sliding properties and wear behavior  
• good chemical resistance  
• high pressure resistance in some cases  
• suitable for soft mating surfaces, e.g. aluminum  
• non-abrasive | up to 20%, may be higher in combination with different fillers | depending on the respective filler |

(1) **Limit Values:**
Limit values have been compiled with great care based on years of experience. Values, however, will not be deemed binding and are provided without guarantee. Please note that the desired function is only assured when considering the specific conditions of a particular application. In any event, we recommend prior sampling and testing. Our development team will be happy to assist you with requisite expertise and in-house test rigs.

(2) **Diagrams:**
The information provided in these diagrams is based on comparative values determined by ElringKlinger. These values have been obtained under specifically defined conditions and may not be transferred exactly to other applications. The diagrams, however, allow you to draw a basic comparison between our seal designs and compounds.
Technical Questionnaire
Diaphragms/Bellows
Please complete and return by fax to:
+49 7142 583-200

1.1. Pressure Conditions, Diaphragm
   Pressure (bar): __________________________
   Differential pressure (bar): __________________________

1.2. Pressure Conditions, Bellows
   Pressure interior (bar): __________________________
   Pressure exterior (bar): __________________________

2. Operating Conditions
   Permanent temperature (°C): __________________________
   Peak temperature (°C): __________________________
   Frequency/# of strokes/lifts: __________________________
   Medium: __________________________
   Stroke/lift (mm): __________________________
   Diaphragm feeding volume (cm³): __________________________
   Required service life: __________________________
   Application: __________________________

3.1. Dimensions, Diaphragm
   Clamping dimensions D (mm): __________________________
   Type of retention/fixing: __________________________

3.2. Dimensions, Bellows
   Inner Ø (mm): __________________________
   Outer Ø (mm): __________________________
   Length min/max (mm): __________________________

4. Special Needs/Design

5. Requirement
   Once-off (pieces): __________________________
   Monthly (pieces): __________________________
   Anually (pieces): __________________________

Company (Address)

Contact person __________________________
Phone __________________________
Fax __________________________
E-Mail __________________________
Take our plastics know-how to the test.