When sealing demands high performance.

Seals and sealing elements made from PTFE and PTFE compounds.
Radial shaft sealing rings have been successfully used for sealing rotating shafts for more than fifty years. Starting from seals with leather sleeves, ongoing development led to today’s shaft sealing ring designs with optimised profiles and sealing materials. The standard versions with NBR, HNBR and FPM elastomers, however, are not always suited to coping with the sometimes extreme operating conditions encountered today. For extreme operating conditions such as
- high and low temperatures
- insufficient lubrication or dry running
- aggressive chemical media
- high pressures
- applications in the food & beverage and pharmaceutical industries
- high circumferential speeds
  
  the Tecoflon ring extends the range of application of the standard versions through the use of PTFE and special PTFE compounds.

Figures 1, 2 and 3 show examples of the design of the individual components of various Tecoflon rings:
- Type 100/OR, Type 431 and Type 410/OR/STR.

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Properties of PTFE (polytetrafluorethylene) and PTFE compounds

PTFE is a thermoplastic polymer of tetrafluorethylene. Apart from its favourable sliding and wear properties, the advantages of this high-quality product are not so much mechanical but lie rather in its thermal, electrical and chemical properties. Its characteristic features include:

- almost universal resistance to chemicals
- insolvability in almost all well-known solvents below 300 °C
- high thermal stability, usable continuously within a range from ~270 °C to ~260 °C
- low adhesivity, low coefficient of friction
- excellent electrical properties
- resistance to stress cracking and atmospheric influences
- only limited usability for load-bearing parts because of the low modulus of elasticity

This set of properties can be modified in a variety of ways by forming compounds with additives that add strength or reduce wear.

Structure and general characteristics

PTFE is an almost unbranched polymer with a linear structure. It is this compact make-up that leads to the unusually high chemical and thermal stability. On the other hand, the low intermolecular forces in PTFE result in lower mechanical strength and rigidity. A high crystallinity and the small low-molecular forces make PTFE resistant to almost all solvents.

Fillers

The properties of pure PTFE are optimised to suit the particular application through the use of fillers, which mostly account for a proportion of between 5 and 40%. Of the wide variety of fillers available, the following have proved to be particularly useful:

- Graphite: Improvement of sliding properties. Low abrasion against soft, metallic countersurfaces. Improvement of thermal conductivity.
- Glass: Greater compressive strength and wear resistance. Readjustment of cold flow.
- Coal/ coke: Increase in thermal conductivity, compressive strength and wear resistance. Electrically conductive with a high proportion of filler. Good dry running characteristics.
- Bronze: Very good compressive strength and wear resistance. Increase in thermal conductivity. Often a favoured choice in hydraulic applications.
- Stainless steel: Improvement of thermal conductivity. Reduction of cold flow.

Thermal properties

The thermal stability of PTFE is unsurpassed by any other commercially available plastic. No noticeable degradation occurs until temperatures reach > +350 °C. The upper temperature for continuous operation is +260 °C, which means that PTFE spans an application range from ~200 °C to +260 °C. PTFE still exhibits a certain elasticity at ~200 °C. The material can therefore also be used for seals and components with liquefied gases.

Electrical properties

The electrical insulation characteristics are extraordinarily good. They are almost entirely independent of frequency, temperature and ambient conditions.

Eigenschaften von PTFE (Polytetrafluorethylen) und PTFE-Compounds

Mechanical properties

Above 19 °C, PTFE undergoes a transformation of the crystalline structure. The triclinic packing changes to a more or less ordered hexagonal packing. This results in an increase in volume of about 1%. Above a certain loading, the material is deformed by creep or cold flow if parts are made of pure PTFE.

Moulding materials made of PTFE exhibit high viscosity, which applies even at temperatures as low as ~200 °C.

Of all solid materials, PTFE has the lowest coefficient of friction – which is another consequence of the low intermolecular forces. As the dynamic and static coefficient of friction are the same, no stick-slip occurs. The favourable sliding properties are retained both at low temperatures (below 0 °C) and at high temperatures. The coefficients of friction of the filled compounds are usually lower than those of unfilled PTFE. Generally, the coefficient of friction can be expected to be between $\mu = 0.1$ and 0.25.

Moulded PTFE parts are not manufactured by melting but by means of a sintering process. This, and the weak intermolecular forces, explains the low abrasion resistance of PTFE. In contrast, abrasion is significantly lower with PTFE compounds.

Chemical properties

The chemical stability exceeds that of any other elastomers or other thermoplastics. This provides good resistance to swelling in almost all media. Only liquid alkali metals and some fluorine compounds affect the PTFE material at relatively high temperatures and pressures. PTFE is characterised by high resistance to ultraviolet radiation and weathering, and can be recommended without reservation for outdoor use. Furthermore, the relatively loose microstructure (somewhat larger than PVC, for example) leads to low permeability for gases and vapours.

Health assessment

There are no concerns regarding the use of PTFE in respect of German food law. Thermal degradation begins at temperatures above 200 °C. In its non-compounded form, PTFE is physiologically inert. Long-term feeding trials have shown no effects on animals. The PTFE material does not cause any skin irritation, and is very well tolerated when implanted in living tissue.

PTFE products also meet all requirements for application in the food sector.

Pure PTFE satisfies the requirements of the U.S. Food and Drug Administration (FDA, Title 21: Code of Federal Regulations, §177.350) and the regulations of the German Federal Health Office BGA (160th Report).
Particular features of Tecoflon rings

Tecoflon rings
Radial shaft sealing rings made of PTFE compounds

Advantages and application limits:
- high chemical and thermal stability from –70 °C to +260 °C
- can be used in starved lubrication conditions and for dry running
- circumferential speeds of up to 30 m/s
- special materials can be used in the pharmaceutical and food & beverage industries
- high wear resistance of the seal material
- low friction and low breakaway torque following lengthy stationary periods
- anti-adhesive seal material
- can be used on non-hardened shafts, depending on material
- installation spaces can be designed as required, according to DIN 3760 or customer specifications

Areas of application
Sealing for a wide variety of media, for example:
- aggressive and corrosive chemicals in both the liquid and gaseous state
- granulates, powders and liquids in the food & beverage and pharmaceutical sectors
- mineral and synthetic greases and oils
- lubricating and cooling liquids
- bulk goods for the building materials industry
- water and steam
- resins and paste-like masses

Examples of applications
- Machine tools
- Beverage bottling plants
- Bakery machinery
- Butchery machinery
- Mills
- Fans
- Compressors
- Stirrers
- Conveying and dosing systems
- Gear
- Rotary feedthroughs
- Centrifuges

Note: these limit values depend on the material combination, the type of seal and the operating conditions.

Pressure as a function of speed

Example: Type 410 Tecoflon ring
at an operating temperature of 50 °C

at a speed of
1 m/s withstands pressure up to approx. 1.0 MPa
5 m/s withstands pressure up to approx. 0.5 MPa
10 m/s withstands pressure up to approx. 0.3 MPa
15 m/s withstands pressure up to approx. 0.2 MPa
20 m/s withstands pressure up to approx. 0.1 MPa

Pressure as a function of temperature

Example: Type 410 Tecoflon ring
at a speed of 1 m/s

at a temperature of
up to +50 °C withstands pressure up to approx. 1.0 MPa
up to +100 °C withstands pressure up to approx. 0.6 MPa
up to +150 °C withstands pressure up to approx. 0.4 MPa
up to +200 °C withstands pressure up to approx. 0.2 MPa
**Bauformen**

**Type 100**
Spring-supported outer jacket. Sealing lip with garter spring to accommodate radial shaft run-out.

**Type 100/OR**
Design as for Type 100, but with an O-ring for additional sealing at the outer diameter.

**Type 110/OR**
With additional dust lip, otherwise identical to Type 100/OR.

**Type 411**
No dead space, for medical and food & beverage technology.

**Type 421/i**
Sealing lip arrangement as for Type 421, but with internal sealing lips that do not project beyond the width of the seal.

**Type 420**
With two sealing lips, therefore greater operational reliability and improved sealing function.

**Type 420/OR**
Design as for Type 420, but with an O-ring for better sealing at the outer diameter.

**Type 430**
With three sealing lips for extreme conditions, e.g. for solids mixers and sludge pumps.

**Type 430/OR**
Design as for Type 430, but with additional O-rings for better sealing at the outer diameter.

**Type 431**
With three sealing lips, e.g. for sealing a screw conveyor bearing. One sealing lip faces the bearing and two sealing lips face the abrasive medium to be transported, thus giving greater operational reliability and improved sealing function.

**Type 431/OR/STR**
With closed metallic support ring, thus allowing installation in open bore holes without additional axial securing.

**Type 432**
With air-barrier hole.

**Type 432/SP**
With air-barrier hole and internal sealing lips that do not project beyond the width of the seal.

**Type 433**
Type 420 With two sealing lips, therefore greater operational reliability and improved sealing function.

**Type 433/SP**
With air-barrier hole.

**Type 442/SP/i**
With air-barrier hole and internal sealing lips that do not project beyond the width of the seal.

**Type 442/SP/STR**
No dead space, for use in medical and food & beverage technology.

**Other possible designs**

**Type 422**
No dead space, for medical and food & beverage technology.

**Type 421**
Inversely arranged sealing lips. For separation of two media, e.g. for decanters and centrifuges.

**Type 432/SP**
With air-barrier hole.

**Type 411/OR/STR**
No dead space, for use in medical and food & beverage technology.
Mounting dimensions (special dimensions on request)

Type 100

Type 431/OR

Mounting dimensions (special dimensions on request)

Type series 100, 100/OR, 110

<table>
<thead>
<tr>
<th>Shaft ø d</th>
<th>ø D</th>
<th>Housing/seal</th>
<th>Mounting chamfer</th>
</tr>
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<tbody>
<tr>
<td>over</td>
<td>up to</td>
<td>100 A</td>
<td>100/B</td>
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<tr>
<td>10</td>
<td>25</td>
<td>6</td>
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<td>41</td>
<td>120</td>
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<tr>
<td>241</td>
<td>500</td>
<td>20</td>
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Type series 400 and 400/i

<table>
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<th>ø D</th>
<th>Housing/seal</th>
<th>Mounting chamfer</th>
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<tbody>
<tr>
<td>over</td>
<td>up to</td>
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<td>410/B</td>
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<td>10</td>
<td>25</td>
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<td>26</td>
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<tr>
<td>241</td>
<td>500</td>
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Type series 400/OR and 400/OR/i

<table>
<thead>
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<td>241</td>
<td>500</td>
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Type series 410/OR and 410/OR/i

<table>
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<th>Shaft ø d</th>
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<td>241</td>
<td>500</td>
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For all other dimensions see table for type series 400

Type series 410/OR/STR and 411/OR/STR

<table>
<thead>
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<th>Shaft ø d</th>
<th>ø D</th>
<th>Housing/seal</th>
<th>Mounting chamfer</th>
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øD = ød + 2 x A
**Design notes**

**Mounting hole**
The seal chambers must be accessible from the axial direction.
The hole must be closed by appropriate means to prevent the seal from becoming displaced.

Surface roughness
Ra ≤ 1.6 µm
Rz ≤ 6.3 µm

In the presence of high pressures and/or abrasive media and at circumferential speeds of over 4m/s we recommend a hardness H > 55 HRC.

**Shaft characteristics**

- Surface properties
  - Hardness 45 bis 65 HRC
  - Ra = 0.2 bis 0.8 µm
  - Rz = 1 bis 4 µm

- Dry running and vacuum
  - Ra = 0.2 bis 0.4 µm
  - Rz = 1 bis 2 µm

- Plunge ground

**Notes on fitting**

If the design of the equipment does not allow the provision of a suitable mounting chamfer on the shaft, or if the PTFE sealing lip has to be fitted via fitting key grooves or O-ring grooves, an assembly sleeve must be used to protect the sealing lip.

All the edges of the assembly sleeve must be rounded off; there must be no sharp-edged transitions. The surface of the assembly sleeve should have no score marks. The installation spaces should be cleaned before the seal is fitted, and the seal itself should be checked for damage. We will be pleased to manufacture appropriate assembly sleeves on request.

<table>
<thead>
<tr>
<th>Shaft dia. d (mm)</th>
<th>Assembly sleeve diameter d1 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 25</td>
<td>d1 = ød - 2.5</td>
</tr>
<tr>
<td>26–40</td>
<td>d1 = ød - 3.0</td>
</tr>
<tr>
<td>41–120</td>
<td>d1 = ød - 4.0</td>
</tr>
<tr>
<td>121–260</td>
<td>d1 = ød - 5.0</td>
</tr>
<tr>
<td>261–500</td>
<td>d1 = ød - 6.0</td>
</tr>
<tr>
<td>501–900</td>
<td>d1 = ød - 8.0</td>
</tr>
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The Künemund Group |

Eleven individual companies – one strong network, one strong group | 15

Dr Kai Dürr, Managing Director, Künemund GmbH & Co. KG

We not only supply you with products, but also solutions. Because we are not just distributors but also manufacturers.

Künemund Dichtungstechnik GmbH is a Künemund Group company. This strong alliance of consolidated companies unites professionals specialising in consultancy and sales with skilled experts in the production of roller bearings, seals and linear technology.

Further added value

- **Group know-how:**
  there is a constant exchange of knowledge taking place within the Group. This ensures that we are familiar with all products across the board and that our know-how is completely up to date.
- **Commercial competence:**
  at each of our six trading enterprises you have access to the entire range of products supplied by the Künemund Group – roller bearings, seals and linear technology.
- **Flexible sales:**
  our professional field staff will be happy to visit you to offer advice.
- **Fast order processing**
  six distribution centres and our own production facilities ensure high levels of product availability.
- **Full-range supplier:**
  we supply products from top manufacturers such as FEDERAL MOGUL, GMN, GRW, Schaeffler, Timken etc.
- **Merchandise management competence:**
  RZ Hohlräder GmbH takes care of reliable provision of all IT solutions within the Künemund Group.

A strong network: Künemund Group’s manufacturing and trading companies are situated in various locations across Germany.

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2. Compound GmbH Hochtemperatur Wälzlager, 77694 Kehl am Rhein
3. Künemund Düsseldorf GmbH, 40589 Düsseldorf
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