Rotary Shaft Seals with PTFE Sealing Lips

Rotary shaft seals with PTFE sealing lips are sealing elements – ready for assembly – which produce the desired sealing effect through radial contact pressure on the shaft. Sealing performance in the receiving hole is achieved by compression fit according to ISO 16589-1. Radial seals with PTFE sealing lips are ideally suited for sealing rotating shafts.

The requisite radial contact pressure is assured by selecting the suitable PTFE compound and sealing lip geometry as well as a special manufacturing process.

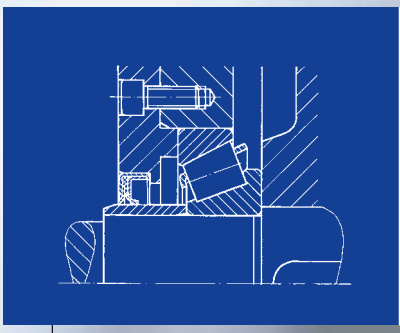
To cover a wide range of application requirements, standard ranges have been developed. Type HN 2580 is primarily used for pressureless service and/or with pressures slightly above atmospheric. Type HN 2390 is used with pressurized media.

Benefits

- Outstanding chemical resistance to corrosive media
- Suitable for applications with high thermal loads from –60 °C to +200 °C
- Suitable for use in low-lube and oil-free conditions
- Suitable even for use with unhardened shafts
- High wear resistance of the sealing lip compound
- Friction-optimized designs for minimum power loss
- Suitable for high peripheral speeds
- Low breakaway forces after prolonged down times (no stick-slip)
- Anti-adhesive behavior of the sealing lip
- Special types for the food processing and pharmaceutical industries available

Applications

Application Examples



Shaft seal in a spur gear type HN 2580.

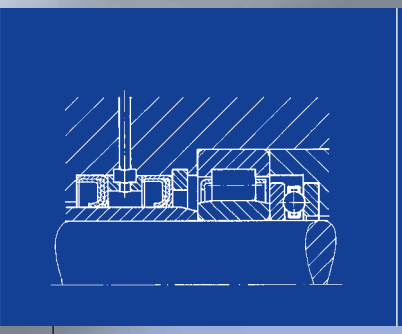
Fields of Application

Shaft seals with PTFE sealing lips are suitable for sealing applications involving the following media:

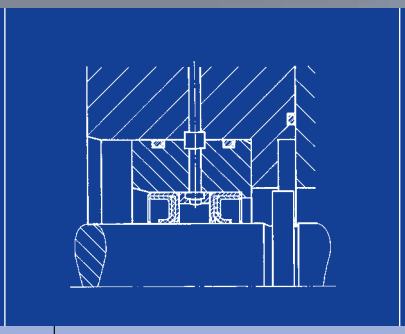
- Mineral-based and synthetic lubricants
- Pharmaceutical products and foodstuffs (FDA recommendations for certain PTFE compounds)
- Chemical waste water and wash water
- Corrosive, fluid and gaseous media
- Powders and granulates
- Coolant and lubricant fluids
- Water and steam
- Resins, glues and pastes
- Air/oxygen (BAM tests for certain PTFE compounds
- Heat transfer fluids (oils)

Typical Applications

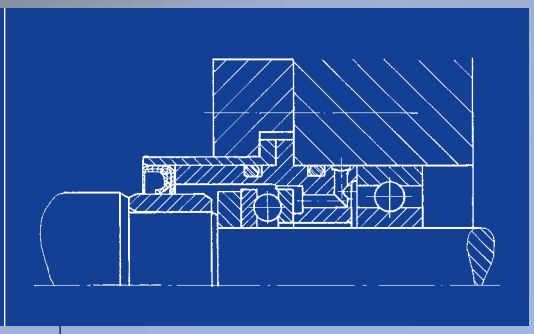
- Rotary compressors
- Screw-type compressors
- Transmissions/gearboxes
- Blower systems
- Mills/crushers/grinders
- Machine tools
- Stirring systems/agitators
- Pumps
- Handling systems
- Centrifuges/hydroextractors



Shaft seal in a rotary compressor with oil drainage, type HN 2390.

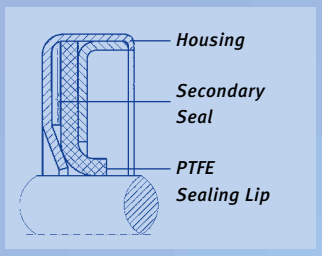


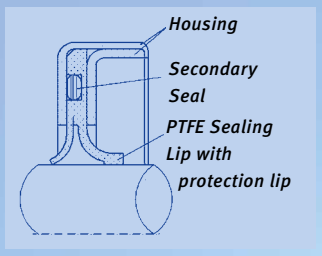
Shaft seal in a radial-flow fan with nitrogen scavenging, type HN 2390.



Shaft seal in a spindle boring head type HN 2390, friction-optimized.

Shaft Seal Design and Action Principle





Housing Materials

Standard:	1.4301/Aisi 304
Special versions:	1.4571/Aisi 316 Ti
	Free-cutting steel
	Mild steel (unalloyed sheet metal for deep drawing)
	Aluminum

Secondary Seal

The following materials are used for the secondary seal between the PTFE lip and the housing:

Standard:	FPM (–20 °C to +200 °C)
Special versions:	NBR (–30 °C to +110 °C)
	EPDM (–60 °C to +150 °C)
	PTFE/metal-special composite (–20 °C to +250 °C)

Sealing Lip

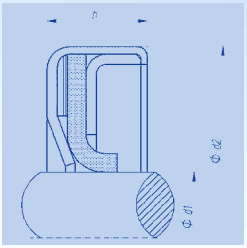
PTFE compound

Standard compound HS 21037 for type HN 2390

Standard compound HS 21059 for type HN 2580

Additional compound versions are available for special operating conditions. See compound table Pages 60 – 62.

Type HN 2390



Stock List

Designation example: rotary shaft seal with PTFE sealing lip for shaft diameter d_1 = 75, locating hole d_2 = 100 and width w = 10:

RWDR HN 2390 75 x 100 x 10

Standard

Thanks to its high wear and pressure resistance this standard design is suitable for a wide range of applications, such as pumps, blowers and compressors.

Sealing lip compound:

- PTFE compound HS 21037

Design features:

- Single lip
- Reinforced sealing lip
- Lip is effectively supported to resist deformation under pressure

Properties:

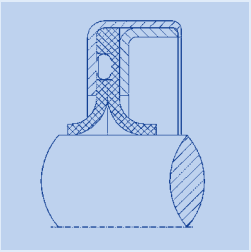
- Good sealing performance with pressurized media
- Suitable for both lubricated or oil-free service
- Suitable for unhardened shafts as well

Operating Limits[1]

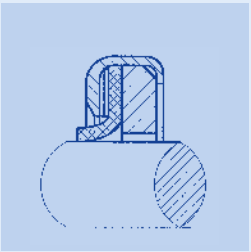
Max. peripheral speed	m/s	20
Temperature range	°C	–60 to +200
Max. pressure	bar	10
Vacuum	mbar	to 10^{-3}
Center offset	mm	≤ 0.1
Concentricity tolerance	mm	≤ 0.05

d_1 mm	*d_2 mm*	*b mm*	*Part-No.*
10	22	7	682.314
12	24	7	681.431
15	30	7	677.558
17	35	7	657.433
18	30	7	674.494
20	30	7	787.280
20	35	7	679.410
22	35	7	654.671
25	35	7	680.311
25	42	7	779.954
25	47	7	659.606
28	40	7	677.329
28	47	7	836.257
30	42	7	786.632
30	47	7	779.962
32	47	8	677.957
35	47	8	678.422
35	47	7	779.970
35	50	8	779.032
35	62	8	384.771
40	52	8	682.691
40	55	8	387.266
40	60	8	677.345
40	62	8	779.261
40	65	8	109.380
42	60	8	781.991
42	62	8	785.385
45	62	8	678.899
48	65	8	261.920
50	72	8	779.989
55	72	8	678.007
60	75	8	678.430
60	80	8	677.337
62	80	8	778.826
65	85	8	779.997
70	90	10	678.341
70	100	10	783.390
75	100	10	658.502
80	100	10	680.583
85	110	10	677.612
90	110	10	679.771
90	120	12	682.616
100	120	12	778.834
100	130	12	778.176
105	130	12	677.779
110	130	12	783.811
110	140	12	653.837
120	150	12	676.071

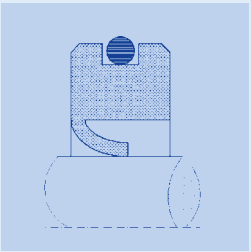
Other Special Versions Type HN 2390



Dual lip, counter-rotating, for separating two media, e.g. for centrifuges and decanters.



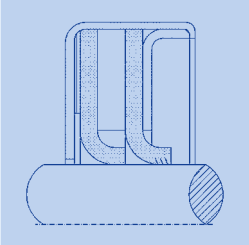
Sealing lip, negative. Small clearances, for food processing and medical technology, e.g. for mixers/blenders, meat processing machines and cutters.



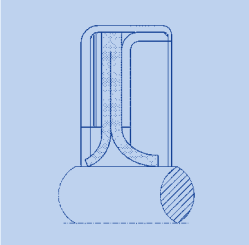
Shaft sealing ring without housing. Small and special dimensions/ geometries available.

Other Special Versions

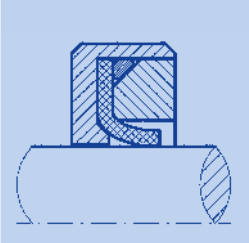
Type HN 2390



Dual lip, rotating in same direction, with or without hydrodynamic return feed spiral groove, good sealing performance, higher operational reliability, e.g. for pumps, screw-type and rotating compressors.

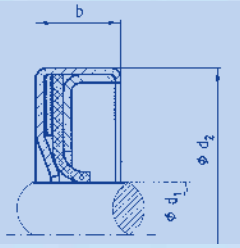


With protection sealing lip for use in dirty conditions, e.g. construction sites, and underfloor assemblies of screw and rotating compressors.



High-pressure version. Good pressure and temperature resistance, e.g. for machine tools and rotary transmissions.

Type HN 2390



Friction-Optimized Special Type

Vis-à-vis the standard version of type HN 2390 the friction-optimized special type has a significantly lower coefficient of friction.

Sealing lip compound:

- PTFE compound HS 21037

Design features:

- Sealing lip supported to resist pressure
- Low radial pre-loading of sealing lip

Properties:

- Suitable for non-hardened shafts as well
- Lower generation of frictional heat
- Suitable for high peripheral speeds
- Suitable for small assembly spaces
- Long service life

Operating Limits[1]

Max. peripheral speed	m/s	30
Temperature range	°C	–60 to +200
Max. pressure load	bar	3
Center offset	mm	≤ 0.1
Concentricity tolerance	mm	≤ 0.05

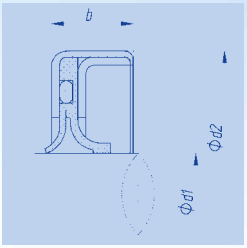
Stock List

Designation example: rotary shaft seal with PTFE sealing lip for shaft diameter d_1 = 70, locating hole d_2 = 78 and width w = 6:

RWDR HN 2390 Special Type, Friction-Optimized 70 x 78 x 6

d_1 mm	d_2 mm	w mm	Part-No.
8	18	5	779.210
10	22	7	781.703
12	22	7	681.741
20	28	5	786.357
20	30	5	786.322
22	30	5	781.681
22	35	7	786.888
25	32	5	682.713
30	37	5	682.721
30	40	5	781.711
30	45	7	681.776
35	45	5	781.738
37	47	5	780.375
40	47	5	682.438
40	50	5	780.383
45	55	5	780.367
50	60	5	675.280
50	62	6	780.146
55	63	6	682.748
55	80	8	782.858
60	80	8	205.840
65	75	6	841.110
65	85	8	677.574
70	78	6	682.756
80	100	10	922.692
100	120	10	786.152

Type HN 2580



Standard

Standard version for pressureless applications and/or pressures slightly above atmospheric. This version features a highly flexible sealing lip and an additional protective lip. Suitable applications include transmissions/gearboxes, machine tools and pumps.

Standard compound:

- PTFE-compound HS 21059

Design features:

- Single-part sealing and protective lip
- Sealing lip with wear protection
- Low radial pre-loading of sealing lip

Properties:

- Suitable for unhardened shafts as well
- High flexibility of the sealing lip
- Good friction behavior
- Pre-defined width of contact surface
- Suitable for oil-free and lubricated applications

Stock List

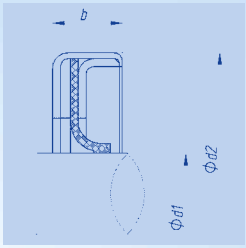
Designation example: rotary shaft seal with PTFE sealing lip for shaft diameter d_1 = 80, locating hole d_2 = 100 and width w = 10:

RWDR HN 2580 80 x 100 x 10

d_1 mm	d_2 mm	w mm	Part-No.
10	22	7	205.800
12	24	7	205.380
15	30	7	205.810
18	30	7	205.430
20	35	7	205.440
25	42	7	205.450
30	47	7	205.460
35	47	8	205.470
35	50	8	205.480
40	55	8	205.510
40	62	8	205.570
45	62	8	205.590
48	65	8	086.070
50	72	8	205.610
55	72	8	205.620
60	80	8	205.630
65	85	8	205.660
70	90	10	205.680
80	100	10	205.700
85	110	10	205.750
90	110	10	205.770
100	130	12	205.780
110	140	12	205.790

Operating Limits [1]

Max. peripheral speed	m/s	30
Temperature range	°C	–60 to +200
Max. pressure load	bar	0.5
Center offset	mm	≤ 0.2
Concentricity tolerance	mm	≤ 0.1



Special Type, Friction-Optimized

for low-pressure applications, e.g. centrifugal machines and blowers.

Standard compound:

- PTFE-compound HS 21059

Design features:

- Wear protection for prolonged service life
- Highly flexible sealing lip

Properties:

- Suitable for unhardened shafts as well
- Suitable for high peripheral speeds
- Low generation of frictional heat
- Suitable for small assembly spaces
- Long service life

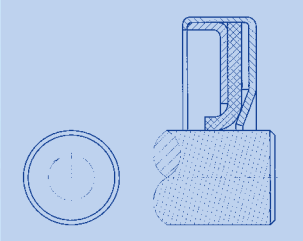
Operating Limits [1]

Max. peripheral speed	m/s	35
Temperature range	°C	–60 to +200
Max. pressure load	bar	0.5
Center offset	mm	≤ 0.2
Concentricity tolerance	mm	≤ 0.1

Hydrodynamic Return Feed Spiral Groove

In case of higher sealing performance requirements to be met by PTFE rotary shaft seals we recommend a spiral groove for hydrodynamic return feed either on the shaft surface or in the sealing lip. In this case, only one rotational direction of the shaft is permissible.

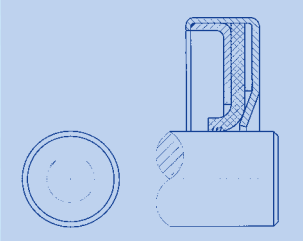
Return Feed Spiral Groove in the Shaft Surface/Protection Sleeve



The hydrodynamic return feed spiral groove should have the following characteristics:

- **Spiral angle to the plane surface: 5 – 10°**
- **Spiral groove depth: Rz 3 – 5 µm**
- **Spacing of the spiral groove must be uniform across the whole contacting surface, with individual grooves located close to each other**
- **Individual grooves in other angular directions should be avoided**

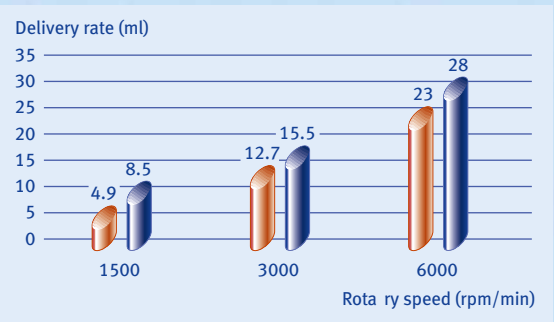
Return Feed Spiral Groove in the Sealing Lip



The hydrodynamic return feed spiral groove is worked into the PTFE sealing lip. To prevent dirt from being carried into the system and to optimize sealing performance a second sealing or dust lip should be used.

Return Feed Delivery Rates of Various Types of Spiral Grooves [2]

Oil seal (RWDR) dimensions:	65 x 85 x 8 mm
Sealing lip compound:	HS 21037
Sealing lip thickness:	1.0 mm
Oil level:	20 mm above bottom edge of shaft
Oil type:	SHELL MYRINA 15 W 20
Oil temperature:	80 °C
Operating period:	30 minutes



Spiral groove in sealing lip
Depth of spiral groove: 0.2 mm
Spiral groove ground into shaft protection sleeve, Rz = 3 µm, spiral angle 10°

Long-Term Wear in Dry-Running (Oil-Free) Conditions [2]

Test conditions:

Test atmosphere: air

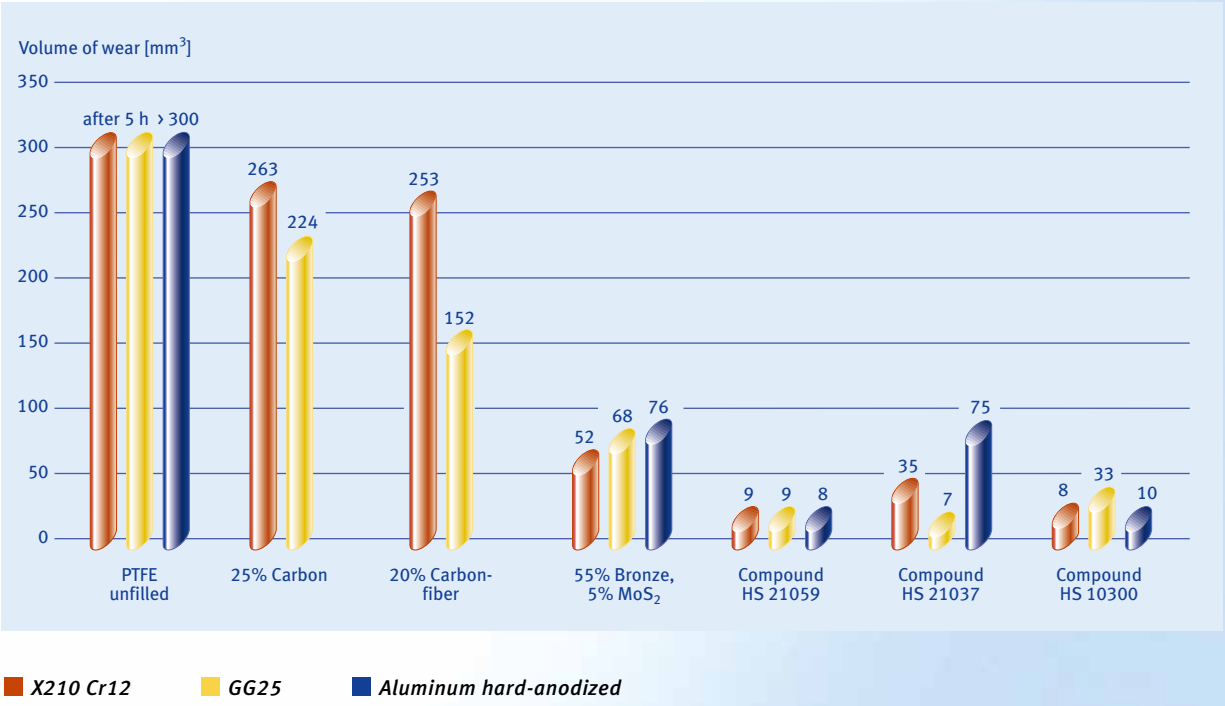
T = 100 °C

v = 4 m/s

p = 0.42 N/mm²

Rz = 2 µm

Test period: 100 h

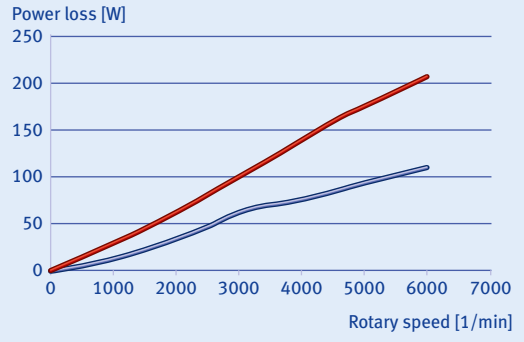


Power Losses and Friction Torques

Type HN 2390 standard and HN 2390 special, friction-optimized [2]

Test conditions:

Medium:	engine oil 15W-40
Oil level:	center of shaft
Oil temperature:	100 °C pressureless
Sealing lip compound:	HS 21037
Shaft diameter:	50 mm
Surface roughness of shaft:	Rz = 2 to 3 µm

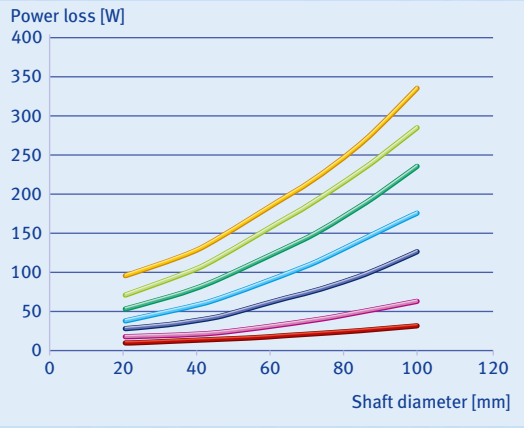


HN 2390 (friction-optimized) *HN 2390*

Type HN 2580 standard [2]

Test conditions:

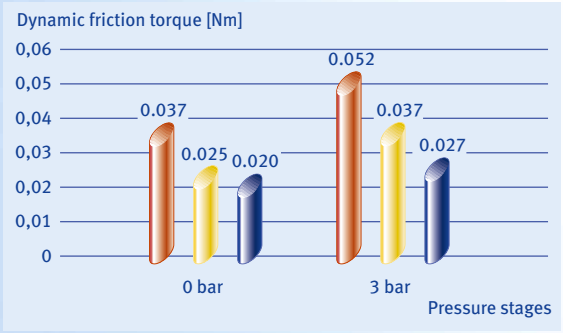
Medium:	engine oil 15W-40
Oil level:	center of shaft
Oil temperature:	100 °C pressureless
Sealing lip compound:	HS 21059
Surface roughness of shaft:	Rz = 2 to 3 µm



500 1/min *1000 1/min* *2000 1/min*
3000 1/min *4000 1/min* *5000 1/min*
6000 1/min

Dynamic friction torque [2]

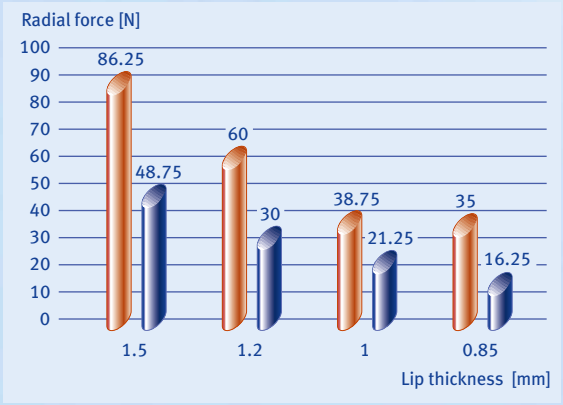
Type HN 2390 special, friction-optimized, Dimensions: 15 x 30 x 7, PTFE compound HS 21037, dry-running, n = 1500 min^{-1}.
Temperature = room temperature/self-heating



Lip thickness 1 mm
Lip thickness 0.7 mm
Lip thickness 0.5 mm

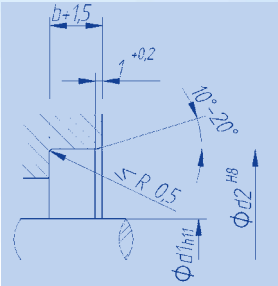
Radial force [2]

The radial force is determined according to the two-jaw measuring method. Measuring instrument according to DIN 3761. Shaft Ø 60 mm, Compound: HS 21037



HS 21037 (RT) *HS 21037 (100 °C)*

Engineering Design Instructions



Design of Locating Hole

Surface roughness:

Ra	≤ 1.6 µm
Rz	≤ 6.3 µm
Rmax	≤ 10 µm

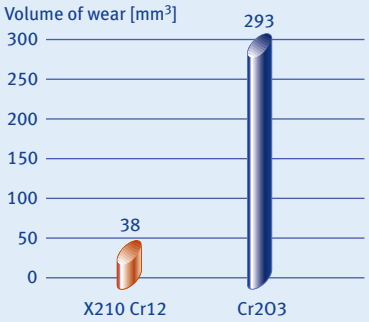
Contact Surface

PTFE shaft seals may be used on both hard and soft contact surfaces. Relevant criteria are the sealing lip compound, pressure conditions and peripheral speeds. Generally, hard contact surfaces are recommended.

Hardened steel is the most commonly used shaft material. Compared to other shaft materials and coatings, the use of hardened steel achieves very good service life of the sealing lip.

In case of soft shafts or special applications it is possible to coat the shaft. Due to the large number of coating methods and manufacturers of coating materials a general recommendation cannot be made. Cr_2O_3-coatings on high-grade/ stainless steel shafts, though, have been found to work well. However, the heat-insulating surface usually results in slightly higher wear of the sealing lip.

Wear test of compound HS 21037 on different contact surfaces [2]



Test conditions: p = 0.42 N/mm²
v = 4 m/s
T = 100 °C (Temperature contact surface)
Test atmosphere: air
Test period: 50 h

Hardness

The required hardness of the contact surface depends on a number of application parameters. For some applications with low demands on the shaft sealing ring (pressures slightly above atmospheric and low peripheral speeds) soft shafts may be suitable as well. This, however, also depends on the PTFE compound used. In case of more exacting requirements and pressurized applications, we recom-mend that the shaft has a hardness of ≥ 58 HRC.

Quality Condition of the Contact Surface

The quality/condition of the contact surface influences sealing performance (tightness) and service life of the shaft seal.

To achieve optimum sealing performance the surface roughness values recommended should be complied with to the extent possible. Machining grooves, scratches and cavities/piping have a negative impact on sealing performance. We recommend grinding the shaft in the recess of the sealing area. Another option is the application of a hydrodynamic return feed spiral groove.

Recommended surface roughness of the contact surface:

Ra	= 0.2 – 0.63 µm
Rz	= 1 – 3 µm
Rmax	= 1 – 4 µm

The material content M_r should be 50 – 75%, measured in a cut depth c = 25% of the Rz value based on a reference value of 5%.

In case of very hard surfaces, such as chromium oxide, roughness levels of Rz = 1 – 1.5 µm and Ra = 0.15 – 0.2 µm have been successfully used.

Fitting

Fitting Instructions

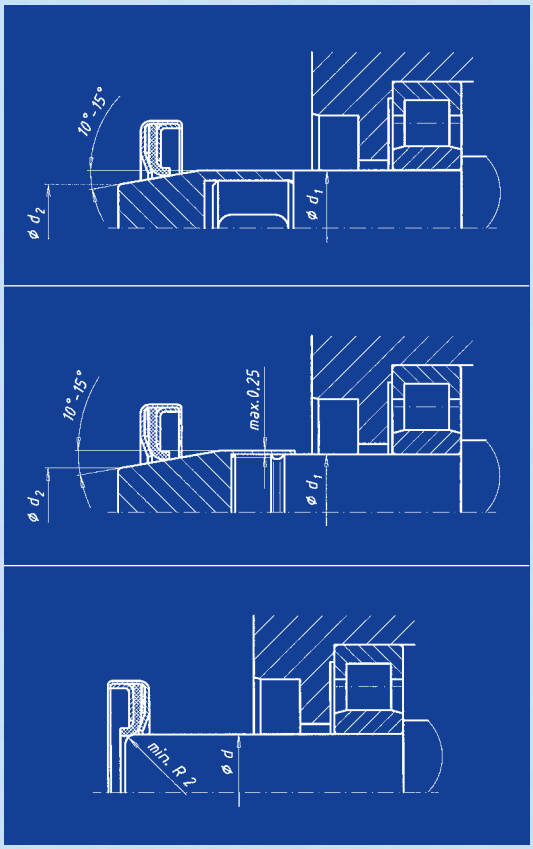
PTFE shaft seals are press-fitted into the receiving hole. We recommend that the sealing rings be glued into the receiving hole and/or use of a sealing/joining compound (e.g. Loctite 601, 641). In case of critical applications this prevents the risk of potential leakage occurring at the outer diameter.

Recommended Diameters of Lead-In Chamfers

Shaft-Ø d_1 [mm]	*Taper-Ø d_2 [mm]*
≤ 10	d_1 – 1.5
11 – 30	d_1 – 2
31 – 60	d_1 – 3
61 – 100	d_1 – 4
101 – 150	d_1 – 6
151 – 200	d_1 – 7

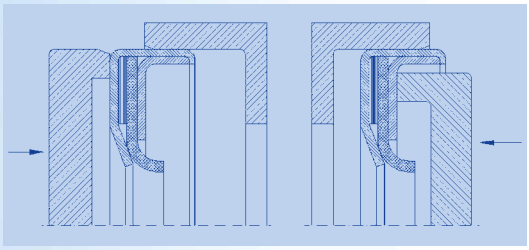
When fitting shaft seals absolute care must be taken to protect the PTFE sealing lip from damage. We recommend use of a conical fitting tool. When fitting the seal in the direction of the molded sealing lip a radius at the shaft may suffice in exceptional cases.

The surface of the fitting tool must be free from scoring. All edges must be rounded off, and sharp edge transitions avoided. When fitting across grooves or threads, the conical fitting tool must be used with a thin-walled extension. Temporary over-stretching of the PTFE lip during the assembly process is permissible.



Fitting Tools

To avoid deformations of the shaft seal, the seals must press-fitted as follows:



Additional Fitting Instructions

- Prior to starting the seal-fitting process, the sealing lip must be inspected for cleanliness and possible damage
- The sealing lips must not be deformed
- Seals may be fitted without lubrication. Other specifications may be coordinated with us

Storage Instructions

- Recommended storage temperature: –10° to +25 °C; humidity 40% to 70%
- Do not store in direct sunlight
- First-in-First-out storage system
- Protect seals from dirt and deformation

Take our plastics know-how to the test.

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