

Rotary shaft seals



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Description of standard shaft seal types (in accordance with DIN 3760)



A

Rubber covered O.D., metal insert, sealing lip with garter spring



AS

Rubber covered O.D., metal insert, sealing lip with garter spring and additional dust lip



B

Outer metal case, sealing lip with garter spring



BS

Outer metal case, sealing lip with garter spring and additional dust lip



C




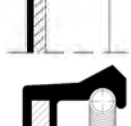

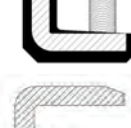



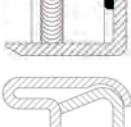


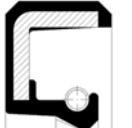

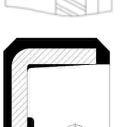

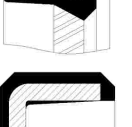





Outer metal case with reinforcing metal inner ring, sealing lip with garter spring



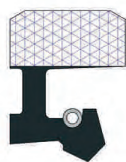
CS

Outer metal case with reinforcing metal inner ring, sealing lip with garter spring and additional dust lip

Additional types

| | | | | | |
|---|----------------|--|---|----------------------|---|
|  | A - P | Reinforced sealing lip for overpressure |  | A - EC | End covers |
|  | AS - P | Reinforced sealing lip for overpressure, with additional dust lip |  | A - TE | Rubber covered I.D. and sealing lip on O.D. |
|  | AS - PX | Reinforced sealing lip and special metal insert for overpressure, with additional dust lip |  | B - O | Outer metal case, sealing lip without spring |
|  | A - DUO | Twin sealing lip with two garter springs |  | B - TE | Inner metal case and sealing lip on O.D. |
|  | A - O | Sealing lip without spring |  | C - DUO | Outer metal case with reinforcing cap, twin sealing lip with two garter springs |
|  | A - FL | Different spring groove for a better spring retention |  | COMBI SEAL | Combination of a shaft seal and an additional seal in polyurethane against soiling in one housing |
|  | A - LD | Sealing lip with hydrodynamic ribs, left rotation |  | CASSETTE SEAL | Integrated sealing system: oil seal, wear sleeve and dust protection in one unit. |
|  | A - RD | Sealing lip with hydrodynamic ribs, right rotation |  | RADIASEAL | Rotary shaft seal with fabric reinforced outer diameter. See pag 18 |
|  | A - WD | Sealing lip with bidirectional hydrodynamic ribs |  | SPLITRING | Rotary shaft seal without metal insert, split. See pag 20 |
|  | A - X7 | Wavy rubber covered O.D., metal insert, sealing lip with garter spring |  | DINA Seal | Rotary shaft seal for needle bearing applications. See pag 21 |
|  | AS - X7 | Wavy rubber covered O.D., metal insert, sealing lip with garter spring and additional dust lip |  | C64D | Rotary shaft seal for heavy industry. See pag 22 |

Additional types



DX7

This seal is designed for use in presence of pressure, up to max 6 Bar. The radial force on the shaft caused by the fluid in pressure is reduced, and as a consequence there is a reduction of temperature. The absence of external metal avoids the possibility to damage the seal housing. This type of seal needs a retaining plate.



AX-7M

This seal is designed for use in presence of pressure, up to max 6 Bar. A metallic band is inserted in the back of the seal. It is assembled in open housings and does not need a retaining plate. This profile is flexible and easy to assemble, ensuring stability in the housing.



AX - 3M

This seal does not need the retaining plate. The rubber seal has a flexible metal band in its shoulder, which makes it resistant, elastic and easy to install. This seal can be assembled in open housings and has a better resistance for possible misalignments. The spring is protected.



AX - 3ML

Same profile as the AX-3M but this one has a rigid metal case inside the shoulder, instead of the flexible metal band.



DXVT

Produced with a high resistance rubberised fabric back, it allows a higher ring stiffness compared to normal seals. As an alternative solution to avoid shavings pollution in case of underdimensioned or reduced metallic parts.



C59D

Interchangeable with Garlock 59 seal, it is mostly used in steel mill plants or wherever a strong seal is necessary. This profile has a flexible rubber sealing lip and a metallic cage back with a finger-spring. The seal withstands a pressure of max 1 Bar.

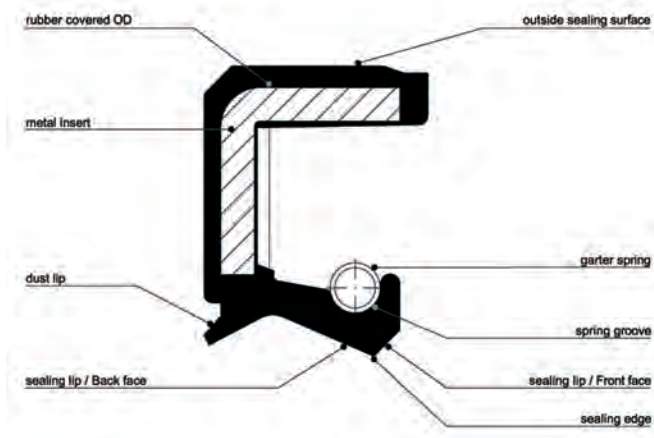


AX - GL

Originally designed to withstand large misalignments of some millimeters in static conditions, this seal can also be used for dynamic seal with limited radial speed. The profile has a metallic cage inside its shoulder, with a spring that ensures the constant load operation.

Technical Data

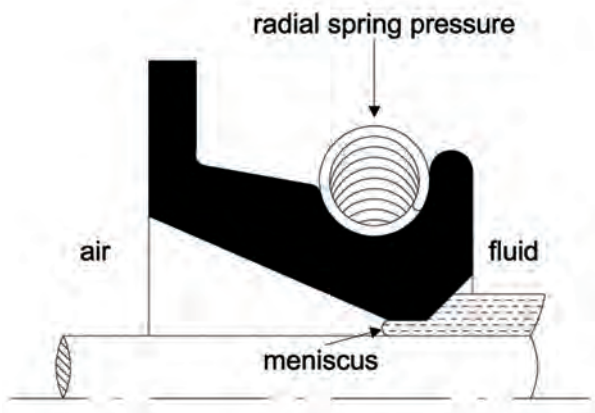
Description of rotary shaft seal



Working Principle

The area between the sealing edge and the shaft is the most important. The sealing effect is achieved by preloading the sealing lip, making its internal diameter slightly smaller than the shaft diameter. The garter spring ensures constant mechanical pressure and maintains the radial force to the shaft, flattening the sealing edge to a defined width. Sealing is provided by the surface tension of the hydrodynamic oil film between the seal flattened area and the shaft.

Oil thickness must be between 1 and 3 μm to avoid leakage. The meniscus acts as an interface between the outside air and the fluid. Any break in the meniscus will result in leakage. This can occur if the shaft contains scratches along the seal path.



Metal Case

The metal insert or case is used to give strength and rigidity to the seal. Normally it is made of cold rolled steel in accordance with DIN 1624.

To avoid rust or chemical attack, stainless steel can be used.

Chrome Nickel AISI 304 (DIN 1.4301 - V2A)

Chrome Nickel Molybdenum AISI 316 (DIN 1.4401 - V4A).

Garter spring

The garter spring maintains the radial force exerted by the sealing lip around the shaft surface. Normally produced in harmonic spring steel wire SAE 1074 (DIN 17223) or stainless steel wire Chrome Nickel AISI 302 (DIN 1.4300).

For special application also stainless steel springs in AISI 316 (DIN 1.4401 - V4A) are available. All our standard shaft seals produced in FPM compound are fitted with stainless steel springs in AISI 302.

Installation and operation

Shaft

The shaft hardness and surface finish are of primary importance for efficient sealing and for achieving a useful life. Basically the hardness should increase with increasing peripheral speed. According to DIN 3760 minimum hardness required is 45 HRC. At a peripheral speed of 4 m/s the hardness should be 55 HRC and at 10 m/s 60 HRC. Recommended hardness depth: 0.3 mm if shafts are not fully hardened.

Lubrication is also very important.

Surface finish as specified by DIN 3760 must be R_a 0.2 to 0.8 μm , R_z 1 to 5 μm , with R_{MAX} = 6.3 μm . Rougher surfaces generate higher friction, hence higher temperatures. Machining defects and scratches on the shaft must be avoided.

Even very small defects could be sufficient to increase the film thickness, eventually rupturing the meniscus and causing leakage. It is also important to avoid spiral grinding or marks, because they can cause a pumping effect and leakage.

Recommended machining tolerance is ISO h11 according to DIN 3760(see table below).

Table 1

| Shaft diameter | | Tolerance |
|----------------|----|--------------|
| from | to | h11 |
| 6 | 10 | 0 - 0,090 |
| 10 | 18 | 0 - 0,110 |
| 18 | 30 | 0 - 0,130 |
| 30 | 50 | 0 - 0,160 |
| 50 | 80 | 0 - 0,190 |

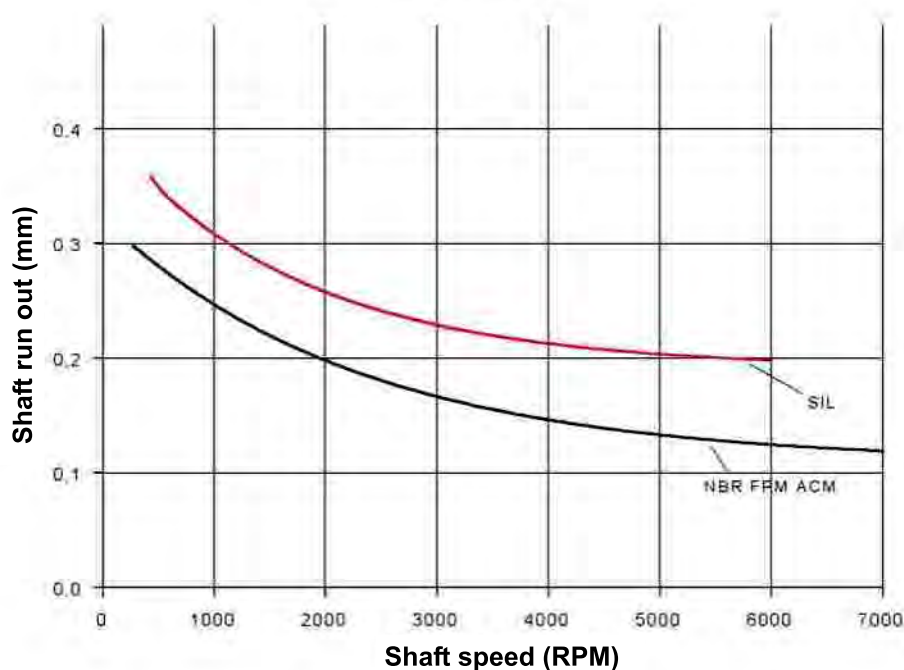
| Shaft diameter | | Tolerance |
|----------------|-----|--------------|
| from | to | h11 |
| 80 | 120 | 0 - 0,220 |
| 120 | 180 | 0 - 0,250 |
| 180 | 250 | 0 - 0,290 |
| 250 | 315 | 0 - 0,320 |
| 315 | 400 | 0 - 0,360 |

Installation and operation

The best working condition is to have a shaft rotating perfectly centered and concentric to the axis of the rotary shaft seal. Obviously this is not possible and inevitably some shaft run out is always present.

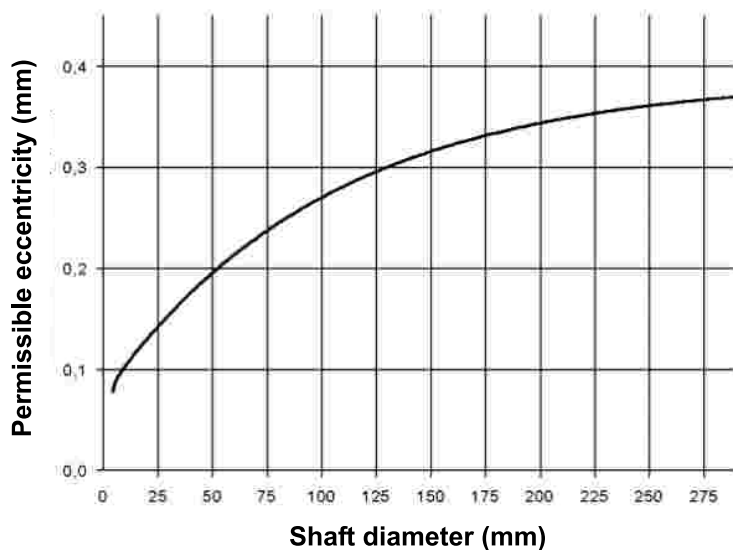
Therefore the sealing lip must compensate for it. The higher the rotation speed is, the smaller can be the permissible shaft run out which can be compensated by the sealing lip, because the inertia of the sealing lip prevents it from following the shaft movements. It is therefore advisable to install the seal immediately adjacent to the bearing and minimize bearing play.

Shaft run out



Eccentricity between shaft and housing bore centers must be avoided as much as possible so as to reduce unilateral load (wear) of the sealing lip.

Shaft eccentricity



Housing bore

A good press fit of the shaft seal onto the housing bore is vital. The result is a stable installation.

Recommended machining tolerances of the housing bore diameter for rotary shaft seals are ISO H8 according to DIN 3760(see table below).

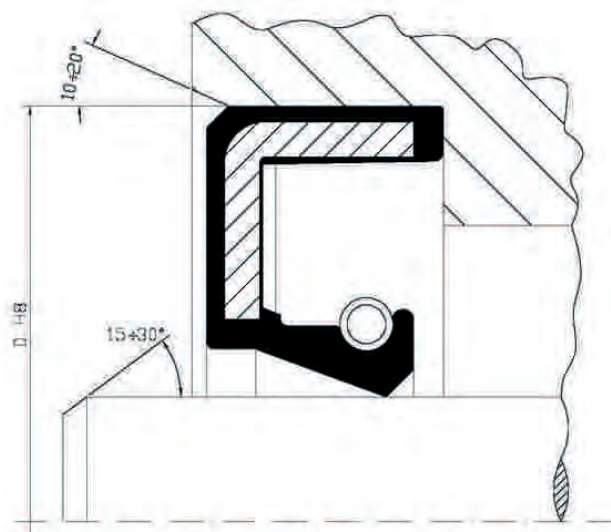
| Bore diameter | | Tolerance |
|---------------|----|--------------|
| from | to | h11 |
| 6 | 10 | 0 - 0,090 |
| 10 | 18 | 0 - 0,110 |
| 18 | 30 | 0 - 0,130 |
| 30 | 50 | 0 - 0,160 |
| 50 | 80 | 0 - 0,190 |

| Bore diameter | | Tolerance |
|---------------|----|--------------|
| from | to | h11 |
| 6 | 10 | 0 - 0,090 |
| 10 | 18 | 0 - 0,110 |
| 18 | 30 | 0 - 0,130 |
| 30 | 50 | 0 - 0,160 |
| 50 | 80 | 0 - 0,190 |

The maximum surface roughness of the housing according to DIN 3760 is: Ra 1.6 to 6.3 μm , Rz 10 to 20 μm , with $R_{\text{MAX}} = 25 \mu\text{m}$.

We recommend the use of a shoulder or a spacer ring against which the seal can be located. Should this not be possible one has to pay special attention that the seal is installed perpendicularly to the shaft axis.

To ease installation the entrance of the groove should have a chamfer inclined by $10^\circ - 20^\circ$ and a depth according to the ring thickness (see figure below). Also the mounting end of the shaft should have a chamfer inclined by $15^\circ - 30^\circ$, with rounded and polished edge.



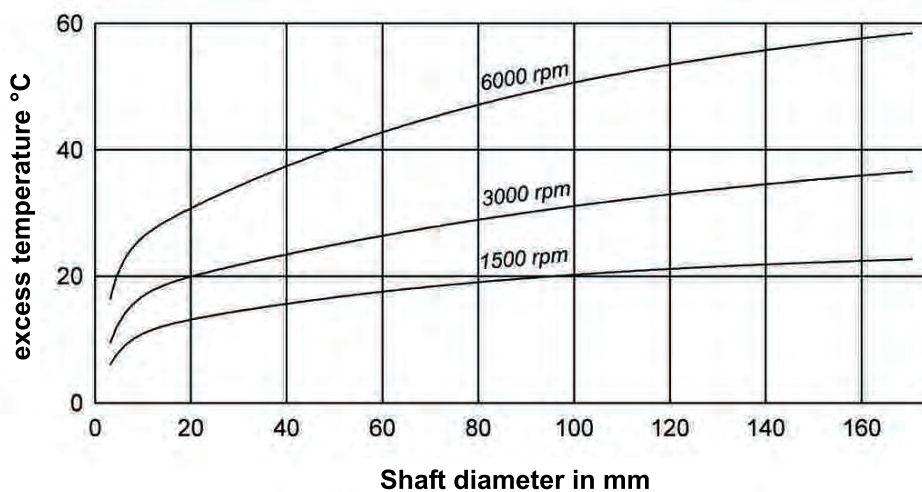
Lubrication

Lubrication is very important for a good function and life of the seal. The sealing lip does not actually run on the shaft directly, but on an oil film, called meniscus. The thickness of the meniscus is usually between 1 - 3 μm , but is affected by many factors such as oil viscosity, shaft surface finish and seal radial load.

The first few hours of operation is called the «bedding-in» time. This is necessary not only for the meniscus to form, but also for the sealing edge to flatten. During this time limited leakage is possible.

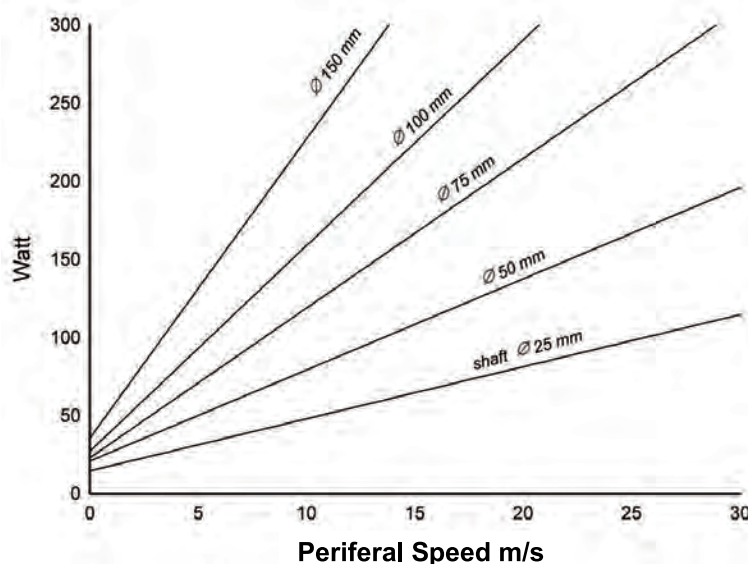
Adequate lubrication strongly reduces friction between sealing lip and shaft and also acts as a coolant to the generated heat. The lower the temperature can be kept, the longer will be the life expectancy of the seal. Should the fluid have poor lubricating capability (water and aqueous solutions), dust lip-type (AS, BS or CS) rotary lip seals must be used. In such a case make sure to fill the space between the two lips with grease. The friction heat also depends on the peripheral speed of the shaft.

Sealing lip frictional heat



Friction not only can be detrimental to the lip material, but also can cause a power loss which could be quite significant if low power is transmitted.

Frictional power loss



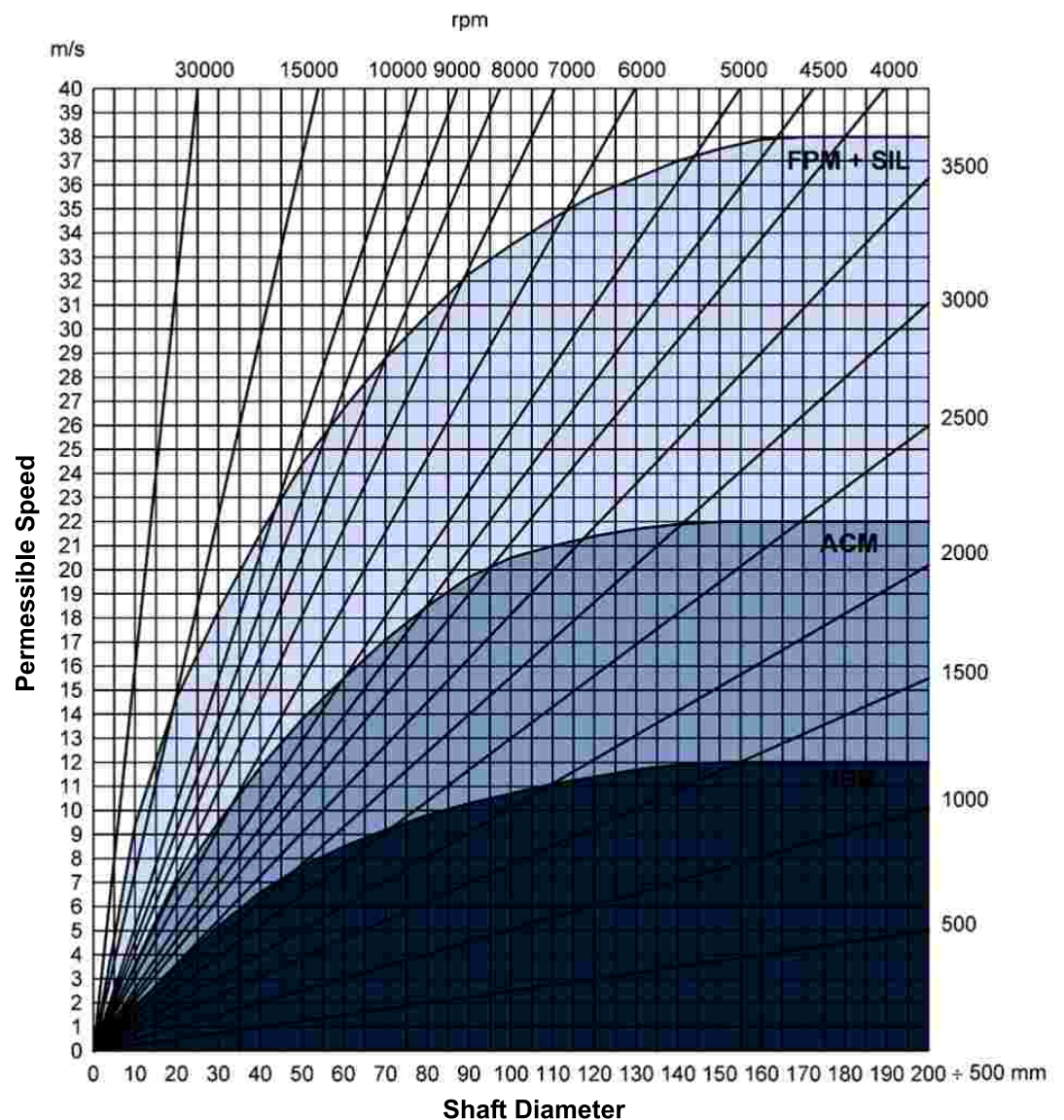
Temperature

The temperature on the sealing lip is the medium temperature increased by the temperature caused by frictional heat.

The higher the effective operating temperature is, the faster the ageing of the elastomer will be, thus affecting the performance of the sealing lip and the shaft.

Frictional heat depends on seal design and material, peripheral speed, sealing lip preloading spring force, shaft design and surface finish, lubrication, medium, etc.

Permissible speeds in pressure-free state to DIN 3760

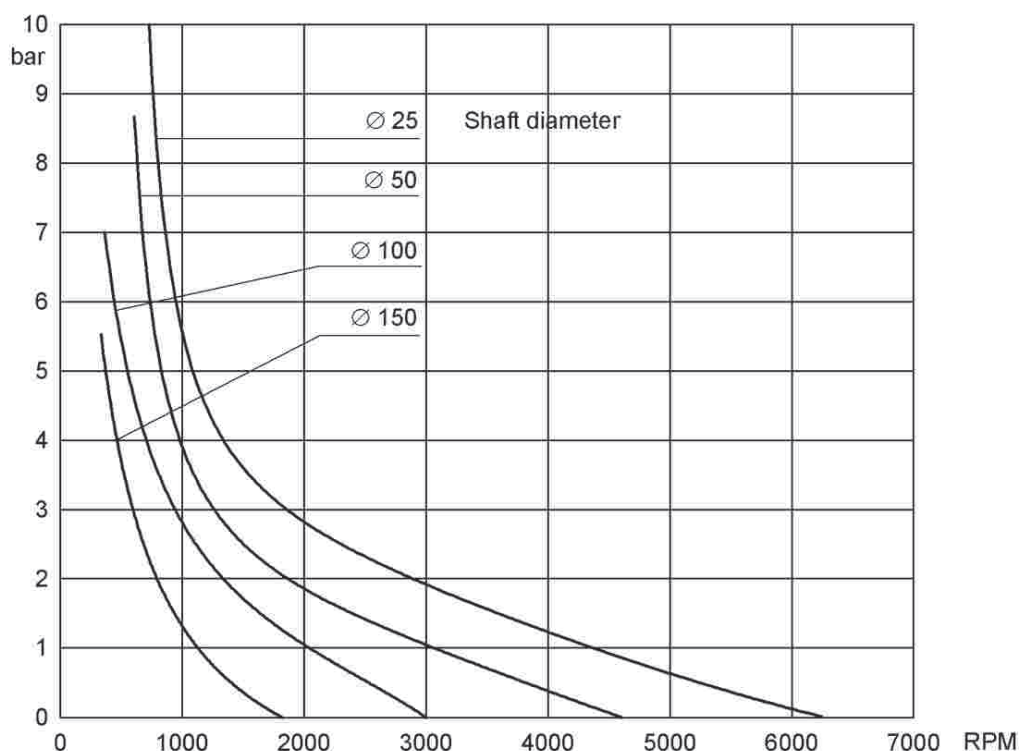


Pressure

In most applications there is no or little differential pressure. Where the rotary shaft seal is exposed to pressure, however, the sealing lip is pressed against the shaft, thus increasing temperature. In some cases the pressure can even cause overturning of the sealing lip.

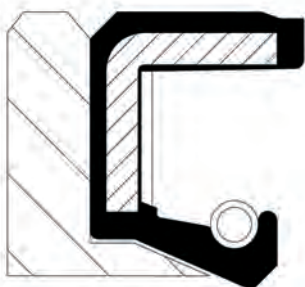
Over 0,2 bar at higher peripheral speeds or over 0,5 bar at low peripheral speeds back up rings or special designed rotary shaft seals with stronger sealing lip and supporting metal insert must be used. For the latter we refer to our P-types (e.g. AS-P). Nevertheless permissible overpressures with P-type shaft seals are limited (see diagram below).

Rotary shaft seals AS-P. Permissible Overpressure



On request we can supply shaft seals with special reinforced lip to withstand pressure over the indicated value.

If back up rings are installed, standard rotary shaft seals can be used. However, back up rings increase costs and often the necessary space for installation is not available. Sometimes the use of back up rings is even not possible, since it requires a very accurate fitting as well as very low eccentricity of the shaft.



Specially designed rotary shaft seals (P-types) are therefore preferred, even if more accurate fitting and lower eccentricity of the shaft than normal cases is required.



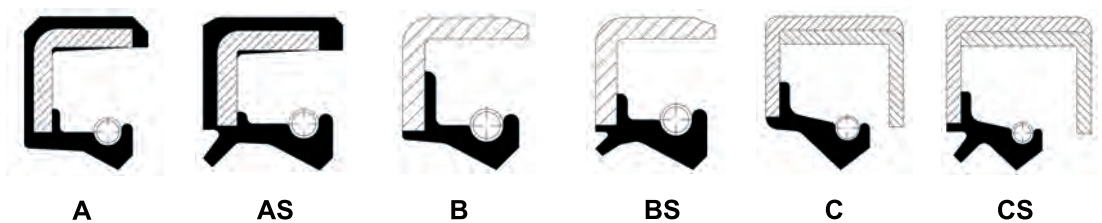
Production and Quality Assurance

Our rotary shaft seals are manufactured according to German Standard DIN 3760 and Quality assurance standards ISO 9001:2000.

All production phases are checked and all measurements are recorded and stored for eventual tracing.

Interference allowance and permissible eccentricity

In accordance with German Standard DIN 3760



| Seal outer diameter d_2 | Interference allowance (1) | | Tolerance on d_2 (2) |
|---------------------------|----------------------------|--------------------|---------------------------|
| | Types A, AS | Types B, BS, C, CS | Types A, AS, B, BS, C, CS |
| up to 50 | + 0,30 + 0,15 | + 0,20 + 0,10 | 0,25 |
| over 50 to 80 | + 0,35 + 0,20 | + 0,23 + 0,13 | 0,35 |
| over 80 to 120 | + 0,35 + 0,20 | + 0,25 + 0,15 | 0,50 |
| over 120 to 180 | + 0,45 + 0,25 | + 0,28 + 0,18 | 0,65 |
| over 180 to 300 | + 0,45 + 0,25 | + 0,30 + 0,20 | 0,80 |
| over 300 to 500 | + 0,55 + 0,30 | + 0,35 + 0,23 | 1,00 |

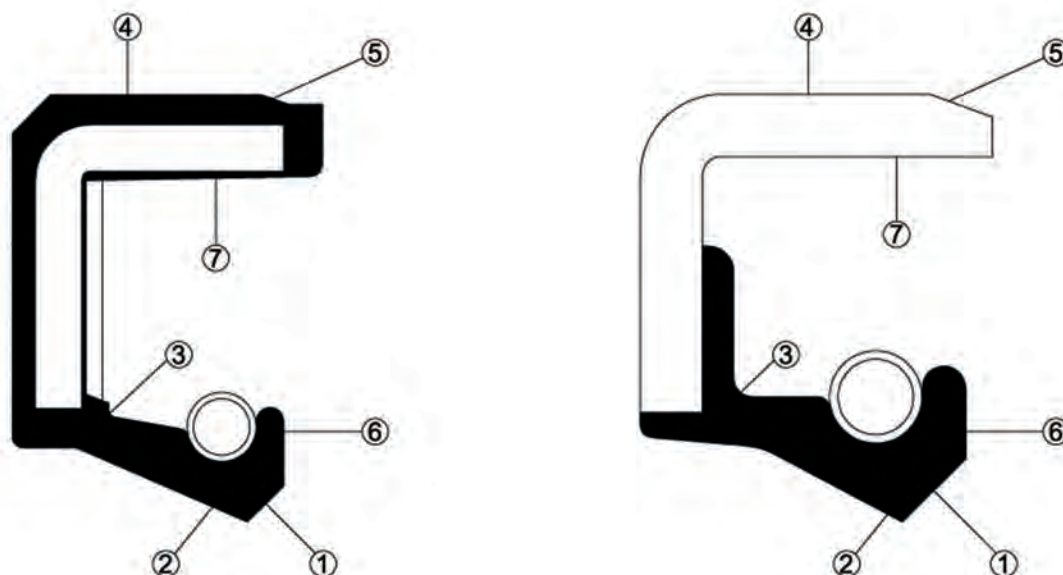
1)The average value for d_2 taken from a number of measurements shall not be greater than the value specified for d_2 plus the interference allowance.

2)The tolerance on d_2 (i.e. $d_{2max} - d_{2min}$) is to be determined by taking three or more measurements equally spaced around the circumference.

Production and Quality Assurance

Final Inspection Standard

In accordance with our Production Standard and DIN 3761 Part 4.



| | Zone | Not permitted | Permitted |
|-----|---|---|---|
| 1+2 | Contact band 1 = Front side 2 = Back side | Breaks in Sealing Edge | No fault permitted |
| 3 | Well of seal | Bond failures | |
| 4 | Seal O.D. | Faults which will affect the sealing on O.D. | Minor faults provided that at least 2/3 of the O.D. is unbroken at this point |
| 5 | Chamfer | Faults which will affect the installation of the seal | |
| 6 | Spring retention lip | Shortcomings could cause a break | Small shortages |
| 7 | Inside wall | Free burrs | Burrs permitted if bonded or secured to the inside wall |

The contact band width of the sealing lip is defined, according to DIN 3761 part 4, as follows:

| Shaft diameter | Front band width mm | Back band width mm |
|----------------|---------------------|--------------------|
| Up to 50 mm | 0.5 | 1,2 |
| 51 to 120 mm | 0,8 | 1,5 |
| over 121 mm | 1 | 2 |

Types for special applications

Radiaseal®

Radiaseal® is a rotary shaft seal with fabric reinforced outer diameter, rubber sealing lip and fitted with garter spring.

Radiaseal® has been designed for use as bearing seal for roll neck application of metal rolling mills, paper mills, heavy duty gear-boxes and for marine applications.

Radiaseal® has several advantages:

- 1 Accurate machining of housing bore is not essential.
- 2 Easy installation.
- 3 No corrosion problems.
- 4 Easy replacement.

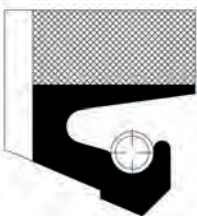
There are 4 different types of Radiaseal® in both endless or split version.



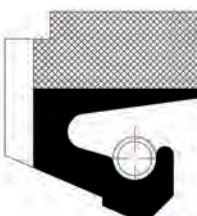
D5 Standard profile



D5S With additional dust lip



D6 With ports in the base, usually twin fitted back to back. An annular groove in the housing allows lubricant to pass around to the sealing lips.



D7 With annular groove in addition to ports, allowing lubricant to pass around to the sealing lips. Usually twin fitted back to back.

Standard Radiaseal® is produced in NBR elastomer. Upon request it is also available in FPM and with stainless spring AISI 302 (DIN 1.4300).

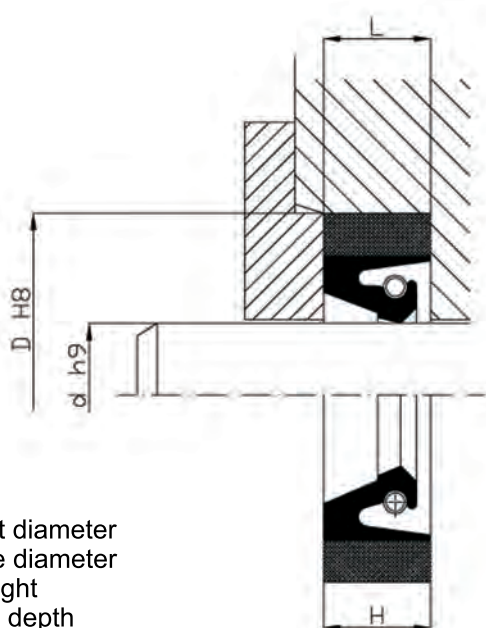
Types for special applications

Installation Instruction

Shaft tolerance ISO h9.
Surface finish roughness Rz 4 micron.
Hardness of the shaft surface 55 HRC or more.

Housing bore tolerance ISO H8.
Surface finish roughness Rz 16 micron.

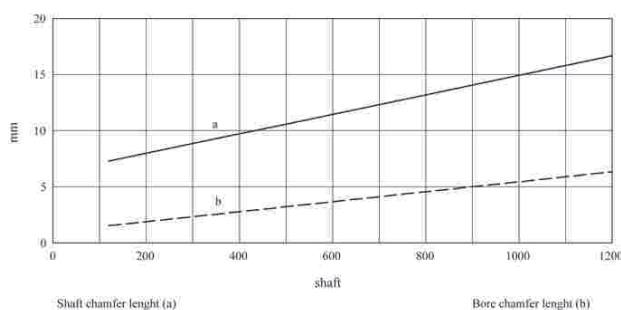
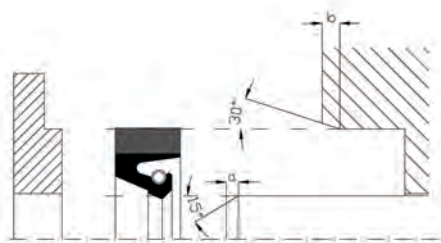
Radiaseal® is manufactured with oversized O.D. and the housing must be provided with retaining plate to give controlled axial compression to the seal, to correctly locate the seal in the housing, ensuring a good sealing on the O.D.



d = nominal shaft diameter
D = nominal bore diameter
H = shaftseal height
L = nominal bore depth

When fitting a split Radiaseal® to horizontal shafts, it should always be fitted with the split at the highest point of the shaft (i.e. remote from the oil).
Where two split Radiaseals® are fitted together, the splits should be staggered at 30° on each side of the top.

The bore entrance and the shaft should be provided with lead-in chamfer to facilitate proper entrance of the seal into the cavity and to avoid lip damage. Length and angle of the chamfers should be according to drawing and table below.



Types for special applications

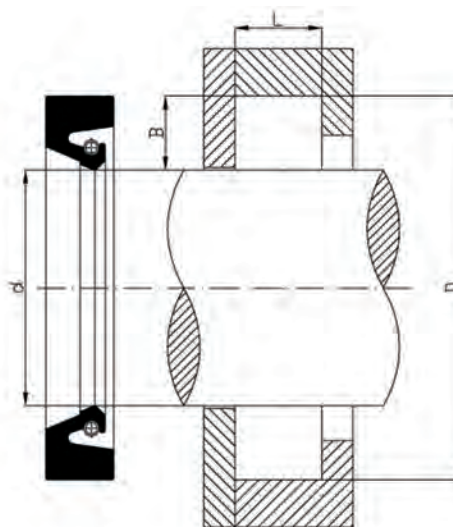
Splitring®

Splitring® is a rotary shaft seal made of only rubber, split, fitted with stainless steel coil garter spring AISI 302 (DIN 1.4300).

Splitring® is used where a standard integral hard shaft seal cannot be fitted due to the presence of flanges or supports.

Splitring® can be also used to avoid high down time costs.

They are produced in standard elastomer NBR.
FPM and SIL elastomers are available upon request.



Installation Instructions

Shaft tolerance ISO h9, surface finish max. roughness Rz 4 micron, hardness of the shaft sealing surface 55 HRC or more.

Housing bore according to table:

| Shaft Diam. d | Bore Diam. D Tolerance | Bore Depth L Tolerance |
|--------------------|------------------------|------------------------|
| Up to 140 mm | $\pm 0,12$ | $\pm 0,05$ |
| Over 140 up to 200 | $\pm 0,15$ | $\pm 0,07$ |
| Over 200 up to 300 | $\pm 0,15$ | $\pm 0,10$ |
| Over 300 up to 450 | $\pm 0,20$ | $\pm 0,12$ |
| Over 450 mm | $\pm 0,20$ | $\pm 0,15$ |

Splitring® should be fitted with the split at the highest point of the shaft and should not be used where static fluid level is higher than the lowest point of the seal.

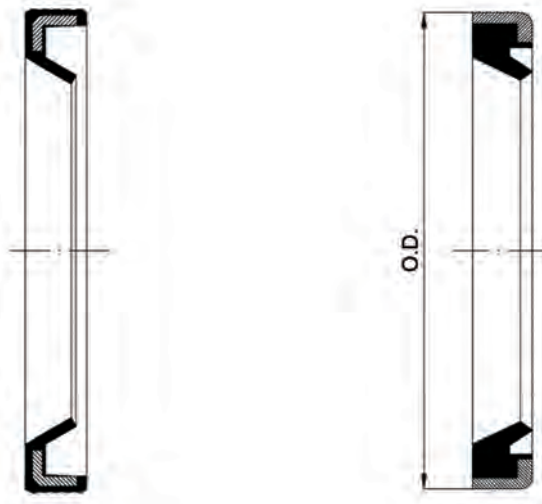
Clean the housing recess and remove all burrs and sharp edges.

Stretch the coil garter spring around the shaft and join it by screwing the conical end into the other and place the Splitring® around the shaft and stretch the spring into the groove on the sealing lip. Tight the Splitring® slightly against the shaft by pressing its outside diameter and insert the seal into the housing bore by starting near to the split and working around the entire periphery until the Splitring® has been entered into the housing. Then push the seal fully home. The housing must be provided with retaining plate to give axial compression to the seal.

Types for special applications

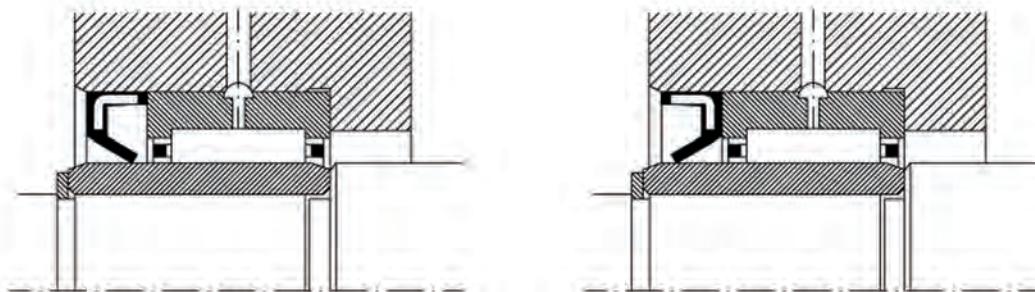
DINA Seal

This is a specially designed rotary shaft seal to be used for needle bearing applications. DINA Seal is reinforced with steel insert and has a single thin lip without spring that, together with minimal interference, has low frictional loss. In order to fit better into the bore, DINA Seal has a wavy rubber outer diameter. DINA Seal can also be supplied with metal O.D.



Standard DINA Seal materials are NBR elastomer and Carbon Steel insert. For special applications FPM and SIL elastomers and/or stainless steel insert are also available upon request.

DINA Seal can be used to prevent lubricant leakage if mounted with the front face near to the needle bearing, or to protect the bearing from dust and dirt if mounted with the back face near to it.

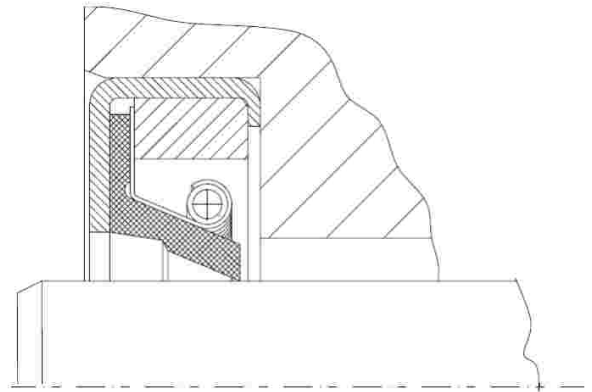


Types for special applications

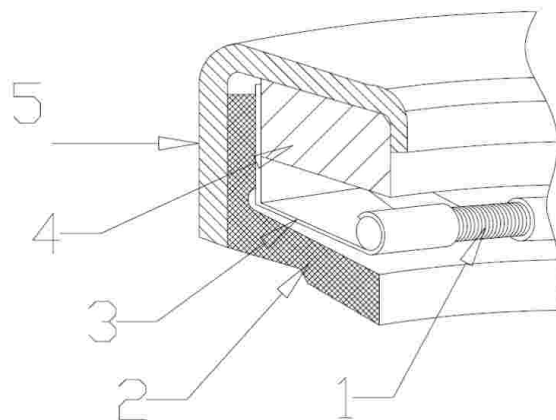
C64D

C64D shaft seal has been developed specifically for severe operating conditions in heavy industry.

The performance and the life of the seal in these conditions, involving important axial tolerances (shaft tolerances, shaft run out, non eccentricity and bearings clearance), are largely dependant upon the preload of the seal lip on the shaft. C64D shaft seal has a very flexible seal lip with a finger spring/garter spring combination that compensates shaft deviations without the need of changing the lip preload.



Seal construction



1 Garter spring

Material: AISI 302

To provide a regulated loading on the sealing lip and enable the sealing element to follow shaft deviations.

2 Sealing lip

Elastomer: FPM, NBR, SIL

3 Stainless steel spring carrier

Material: ACX 260 AISI 316L 2D

Designed to ensure the spring retention during the installation. If necessary to permit the removal and refitting of garter spring to provide a predetermined sealing lip preload which will permit the sealing element to follow shaft deflections.

4 Steel reinforcing ring

Material: Fe 37

To provide the required rigidity and to ensure an accurate installation of the seal in the groove.

5 Steel outer ring

Material: Fe-P04

| | FPM | SIL | NBR |
|---------------------------|------------|------------|------------|
| TEMPERATURE [°C] | -20 / +220 | -60 / +120 | -20 / +120 |
| Hardness [°ShA] | 75 | 70 | 75 |
| Max operating speed [m/s] | ≤35 | ≤25 | ≤25 |

Storage and Handling

Some storage precautions must be taken in order to avoid deterioration of the material. Rotary shaft seals should be stored in a dust free and dry atmosphere and they must be kept in their original wrapping which should only be opened just before installation. Samples should be repacked after inspection. Excessive humidity will deteriorate some elastomers as well as cause corrosive damage to metal casing and spring.

Do not drop rotary shaft seals on shelves or boxes, nor hang seals on hooks, wires or nails, since in either case the sealing lip can be damaged. Seals should be stored in a horizontal position.

Seals should be used on a first-in first-out basis to avoid ageing on the shelf. Avoid storage near sources of heat or near electrical equipments that may generate ozone. Also keep away from direct sun light.

Shaft seals interchange table

| Dichta types | A | AS | AS-P | A-O | A-DUO | B | BS | C | CS |
|---------------------|------|------|-------|-------|--------|------|-------|-------|--------|
| Simirit-Freudenberg | BA | BASL | BABSL | BAOF | BADUO | B1 | B1SL | B2 | B2SL |
| Goetze | 827N | 827S | 827SK | 827N0 | 827D | 822N | 822S | 824N | 824S |
| Kako | DG | DGS | DGSP | DE | DGD | DF | DFS | DFK | DFSK |
| Simmerwerke | A | ASL | | AOF | ADUO | B | BSL | C | CSL |
| Stefa | CB | CC | CF | CD | CK | BB | BC | DB | DC |
| Gaco | A | FA | | SA | DUPLEX | ABI | | | |
| Pioneer Weston | R21 | R23 | | R26 | R22 | R4 | R6 | R1 | |
| Paulstra | IE | IEL | | IO | IELR | EE | EEL | EEP | |
| Chicago Rawhide | | | | | | CRW1 | CRWA1 | CRWH1 | CRWHA1 |
| National | 35 | 32 | | | | 48 | 47 | 45 | 41 |
| NOK | SC | TC | TCN | VC | DC | SB | TB | SA | TA |

