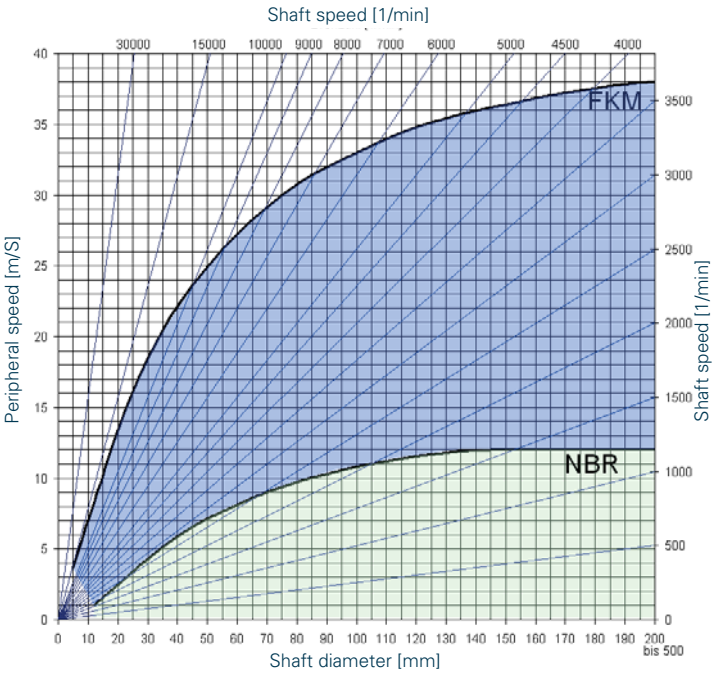
Operating parameters

Peripheral speed (rotational speed)

The figure to the right illustrates the permitted values for rotational speed or peripheral speed of the shaft for shaft seals as a function of material. The diagram is for no-pressure operation and favourable conditions with regard to lubrication and heat dissipation. With less favourable peripheral conditions, the permissible values are reduced correspondingly. For example, for grease lubrication the values can be assumed to be 50% lower.

The application of types with protective lips can cause friction-induced temperature increases. In this case the maximum peripheral speed must also be reduced.



Permissible peripheral speeds (rotational speeds) for no-pressure operation

How to use the diagram

With known shaft diameter and rotational speed:

You have to determine the point of intersection of the vertical line above the corresponding shaft diameter in [mm] at the base of the diagram with the appropriate diagonal rotational speed line starting from the right or upper edge of the diagram.

With established shaft diameter and peripheral speed:

You have to determine the point of intersection of the vertical line above the corresponding shaft diameter in [mm] at the base of the diagram with the appropriate horizontal line starting from the left edge of the diagram at the corresponding peripheral speed in [m/s].

If this intersection point lies below the NBR curve, a shaft seal in NBR can be used for this application. Should the intersection point lie above the NBR curve but below the FKM curve, a shaft seal made from FKM (VITON® ; Du Pont Dow trade name) can be used. NBR materials would be thermally overtaxed in this area due to the high speed.

In borderline cases all application parameters should be carefully considered and a higher quality material selected, if necessary. Should the resulting intersection point also lie above the FKM line, the application of standard shaft seals can no longer be recommended.

Please do not hesitate to contact us for further information and advice.

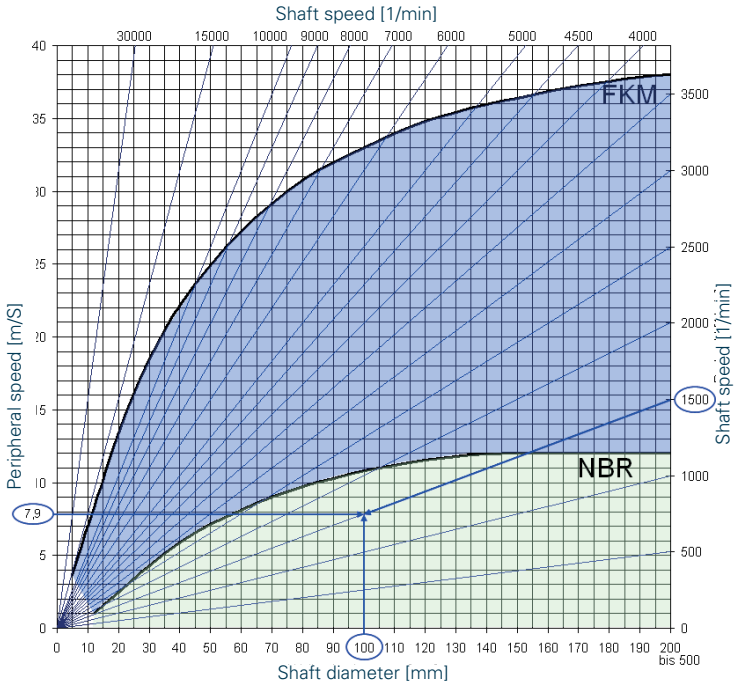
Example:

shaft diameter 100mm
rotational speed 1500 1/min
ð peripheral speed

$$v\,[m/s] = \frac{d\,[mm] * n\,[1/\min] * \pi}{60000}$$

v = peripheral speed
d = shaft diameter
n = rotational speed

$$ð \quad v = \frac{100 * 1500 * 3{,}1416}{60000} \approx 7{,}9\ \frac{m}{s}$$



Example, permissible peripheral speed (rotational speed) in no-pressure operation

Result:
The determined intersection point lies within the NBR area. With good lubrication and good heat dissipation a shaft seal made from NBR can be used.

Temperature

The temperature load to which the seal is subjected consists of the temperature of the medium, e.g. oil temperature and the excess temperature induced by the friction between the sealing edge and the shaft.

The temperature thus created in the sealing gap can reach up to 80°C in excess of the oil sump temperature depending on the peripheral speed, lubrication condition, medium, heat dissipation conditions, material of the shaft seal, surface finish of the shaft and the pressure load. An excess temperature of 30°C - 40°C can even occur in standard practice operational conditions.

The load caused by excess temperature must be considered in the selection of suitable material in accordance with the following table .

Material	Hardness [Shore A]	Colour	High temperature resistance [°C]	Low temperature resistance [°C]
NBR	70	black	+100	-40
FKM	80	brown	+150 continuous +200 max.	-30
HNBR	70	black	+125	-40
VMQ	80	red	+150 continuous +200 max.	-55
ACM	70	black	+150	-20

Should a thermal overload occur, it could result in premature failure of the seal due to excessive wear as well as hardening and cracking of the sealing lip.

Pressure

All standard shaft seals are designed for non-pressure operation.

Should excess pressure develop within the unit to be sealed during operation, it is advisable to ventilate the housing. Nevertheless, excess pressure of up to 0.05 MPa can be controlled by standard types. The maximum rotational speed is then reduced according to the following table:

Pressure difference maximum [MPa]	Shaft Maximum speeds [1/min]	at maximum peripheral speed [m/s]
0.05	up to 1000	2.8
0.035	up to 2000	3.15
0.02	up to 3000	5.6

Permitted rotational speed with pressurization acc. to DIN 3760

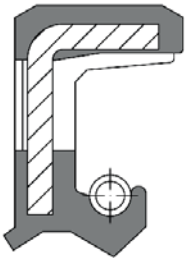
The pressing force of the sealing lip against the shaft increases as a result of the pressure build-up. The sealing lip is deformed and the contact width between the sealing lip and the shaft increases. This results in a sharp increase of the friction and the thermal load. This increased load must be taken into consideration when selecting the type and material of a seal. Premature failure of the seal due to wear or hardening would otherwise be the consequence. If the overload is too high, it can lead to lip inversion (a section of the sealing lip is turning outward towards the air side).

In pressurized systems, there is a danger of the shaft seal being pressed out of its fitting. For this reason, we recommend that axial protection is included in the design, e.g. a flange lid or a circlip.

Special types are available for sealing with excess pressure:

Our type OS-N21:

The sealing lip and the reinforcing ring of the OS-N21 are specially designed for pressure applications. The sealing lip is shorter and stiffer and does not allow excess increase of the contact pressure. The reinforcing ring is pulled down lower on the shaft diameter and can better support the sealing lip. The lower flexibility of the sealing lip requires lower tolerances with regard to the dynamic run-out and offset.



Type OS-N21

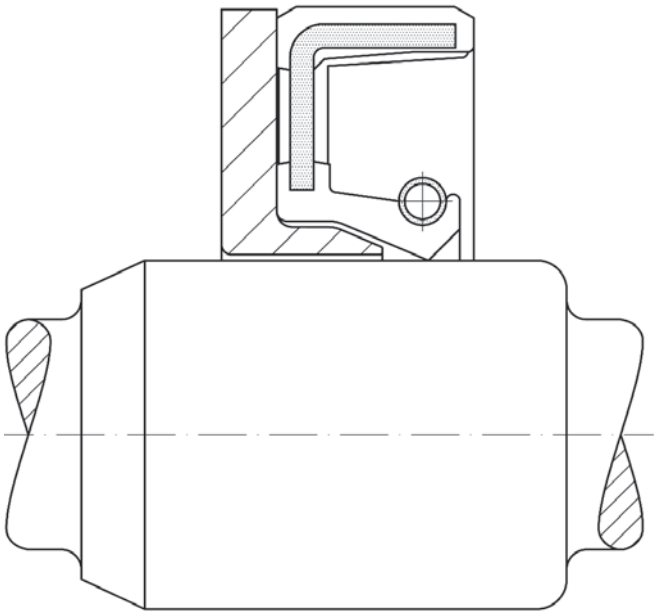
The application limits depend on the rotational speed and diameter of the shaft - see table:

Speed [1/min]	Shaft diameter [mm] 20	40	80
0	10	8.5	7
500	10	8.5	5
1000	5.5	4.5	3
2000	3	2.5	1.5
3000	2	1.5	0.3
4000	1.2	0.5	0
5000	0.7	0	-
6000	0	-	-

Maximum pressure [bar] for the OS-N21 type.
The figures apply for oil lubrication and favourable conditions with regard to heat dissipation.

Shaft seal + support ring

As an alternative to the OS-N21 type, a standard shaft seal (without protective lip) plus a separate support ring can be used. The permissible pressures for this option are lower than those for the OS-N21. Please contact us for the applicable support ring drawings.



Shaft seal with support ring

For pressures higher than the application limits of the OS-N21 further types are available, e.g. OS-N11. This can be used to seal pressures of up to 5 MPa (at a very low speed, e.g. slow swivelling movements).

Type OS-N11

Media to be sealed

The medium to be sealed combined with the expected temperature in the sealing area, has a decisive influence on the selection of the shaft seal and its material.

The shaft seal must be "resistant" to the medium used, which means the chemical influence on the sealing material should not negatively affect its characteristics to a considerable degree.

Elastomers can

- soften as a result of swelling, whereby the material absorbs some of the medium to be sealed
  or
- harden as a result of ageing processes, accelerated by high temperatures.

Evaluation of resistance can result from:

- 1. individual experience gained in comparable applications
- 2. Elastomer resistance lists (contact us, if necessary)
- 3. Information from the media producers (values gained by experience with standard elastomers)
- 4. laboratory tests with evaluation of characteristics of hardness, volume, tensile strength, ultimate elongation after storage of standardized test specimen in the medium
- 5. test rig testing under practical application conditions
- 6. practical tests under real conditions in machinery

In many cases, the evaluation of resistance is sufficiently accurate after the first 3 items.
With sensitive applications, unknown media, mixtures of different media and applications in which several parameters reach their permitted limits, resistance should be tested in advance (items 4 to 6).

Mineral-based lubricants

In the area of low additivated mineral oil based lubricants, our standard shaft seals made from NBR and FKM generally have good resistance. With special highly additivated lubricants, we recommend contact with the lubricant producer and, if necessary, testing.

Synthetic lubricants

The effect of synthetic lubricants on the sealing material depends mainly on the proportion of additive used in the lubricant. As positive as its effect on the characteristics of the lubricant is, its chemical influence on the seal can be just as negative. For this reason, we recommend testing of resistance where there is doubt.

Generally speaking, application of our standard shaft seals if NBR is possible with compatible, low additivated, synthetic lubricants and temperatures to approx. 60-80°C. At higher temperatures or higher additivated synthetic lubricants, FKM has proven to be the better material choice.

Aggressive media

Aggressive media require use of correspondingly more resistant sealing material or material combinations. Please consult the relevant resistance lists.
The products from our range which are most suitable in this case are:

OS-F10, OS-F11

Sealing lip material:	FKM
Spring material:	Stainless steel 1.4310
Reinforcing ring:	Fully-covered with elastomer (corrosion protected)

OS-PA30, OS-PA31, OS-PA32

Sealing lip material:	PTFE
Reinforcing ring:	Stainless steel 1.4571

OS-W50

Sealing lip material:	PTFE, static sealing by FKM O-ring
Spring material:	Stainless steel 1.4571

Highest permitted continuous temperatures for various media [°C]

Material	Mineral oils									Fire-resistant hydraulic fluids VDMA 24317 DIN 24320				Other media	
	Low temperature	High temperature (in air)	Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Hydraulic fluids acc. DIN 51524	Fuel oils EL and L	Greases	HFA Öl in Wasser Emulsionen	HFB	HFC	HFD	Water	Suds
NBR	-40	100	100	80	80	100	90	90	90	60	60	60	-	80	80
FKM	-30	200	150	150	140	150	130	100	150	●	●	-	150	80	80
NBR high-temperature grade	-30	120	120	100	100	110	100	90	100	60	60	60	-	80	80
NBR with high ACN content	-30	100	100	80	80	100	90	90	90	60	60	60	-	80	80
NBR low temperature grade	-50	90	90	70	70	80	80	●	80	●	●	●	-	●	●
NBR food grade	-40	100	100	80	80	100	90	90	90	60	60	60	-	80	80
NBR anti-friction	-40	100	100	80	80	100	90	90	90	60	60	60	-	80	80
HNBR	-40	150	110	90	90	110	100	90	100	60	60	60	-	90	90
Silicone VMQ	-55	200	130	130	-	-	-	-	-	●	●	●	-	●	●
ACM	-20	150	125	120	120	120	120	●	120	-	-	-	-	-	-
PTFE	-90	250	150	150	150	150	150	150	150	+	+	+	150	150	+

\+ resistant, application not customary
● limited resistance
\- not resistant