Pneumatics

Technical Principles

Products

Pneumatics

With approx. 500 different dimensions, Simrit has a comprehensive range of rod and piston seals, wipers and guides for pneumatics.
A comprehensive, cost-effective, complete program of standard products in a variety of different mixtures for diverse applications is available to the customer. In addition, we also gladly develop individual solutions for our customers.
Simrit is with you as partner from the product design, to the selection of materials, to the individual product manufacture.

Requirements

- Seals for small forces and fast movements
- Medium: Compressed gases and air
- Only minimal spare parts requirement
- Most frequent application area: Automation industry
- Large amounts
- Few standard dimensions
- Strong innovation and great creativity from Simrit is in demand.

Features

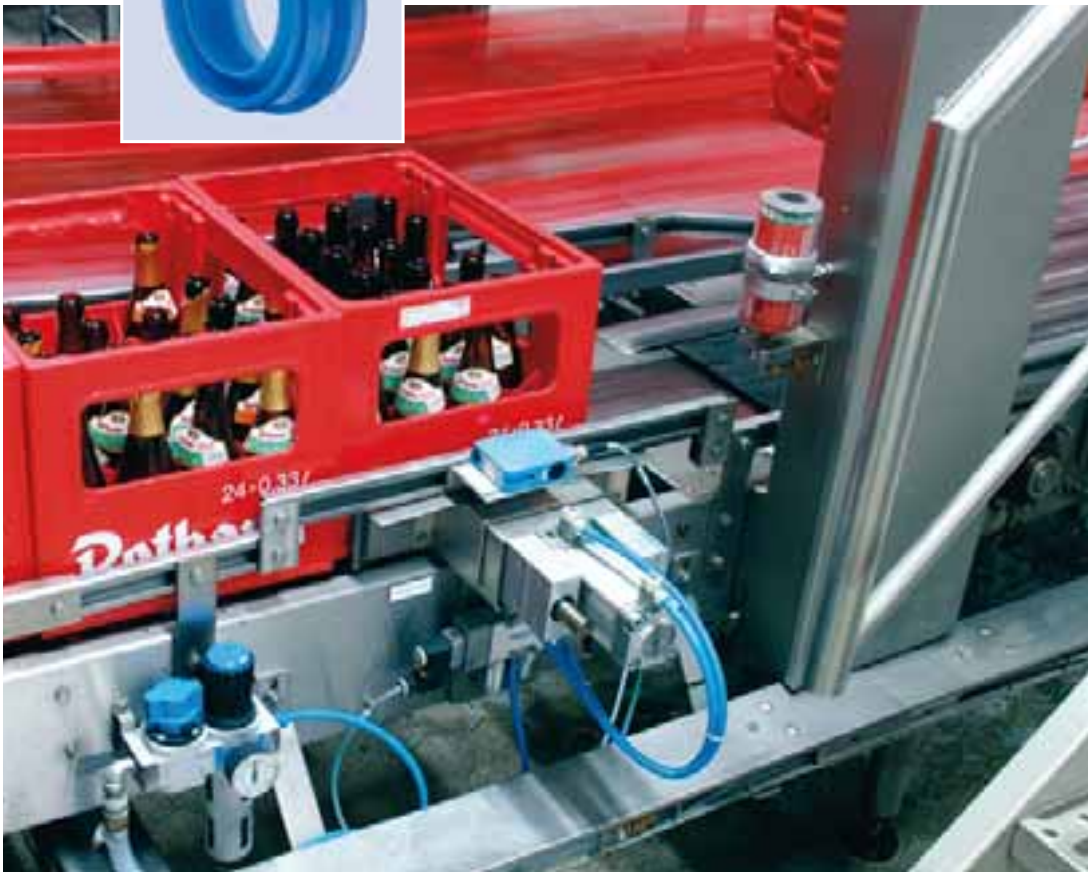
- Broad selection of dimensions in the diameter range from 1 mm to 500 mm
- Application-specific material matching depending on the application
- Application possibilities within a wide temperature range from −40°C to +200°C
- Cost-effective manufacturing procedures geared to application and amounts.

Application range

Merkel Pneumatic seals are used in pneumatic cylinders as well as for the pneumatic control and regulation of valves. In addition, Simrit also offers solutions for the sealing of rod-less cylinders with polyurethane sealing strips.

Application areas are:

- General mechanical engineering
- Automation engineering
- Foodstuffs and packaging industry
- Materials handling
- Individual customer solutions for special applications e.g. for hand-guided power tools.



Use of Pneumatic Seals

Pneumatics, a subgroup of fluid power technology, is the study of the behaviour of gases. Today the term "pneumatics", derived from the Greek "pneuma" primarily refers to the transport of energy by compressed air.

Pneumatic drives and controls, increasingly used for mechanisation and automation of production processes, consist primarily of valves and cylinders.
Pneumatic devices require sealing of volumes of air subject to pressure for their function. The pneumatic seals used for this purpose can be classified into cylinder and valve seals (→ Fig. 2). There is no point to making a more detailed classification for valve seals similar to that used for cylinder seals. Valve seals are special seals designed for the different valve designs of individual manufacturers.

Application examples

The starting point for the design of a pneumatic drive is the cylinder. The most frequently used cylinders for the creation of a straight-lined movement are shown in → Fig. 1 and → Figs. 3 to 5.

A simple cylinder design is shown in → Fig. 1. A combination element is fitted to the rod. It combines the functions of sealing and wiping away dirt. A complete piston with injection-moulded guides and snap-on, double-acting seal (Merkel Complete Piston Pneuko G) is screwed to the end of the rod. The complete piston has a square elastomer ring for static sealing between piston and rod. The end stop of the piston at the final positions is damped by elastomer discs. In some cases, particularly with small cylinders, complete pistons with vulcanised damping bars (Merkel Complete Piston NADUOP) are used instead of the elastomer discs.

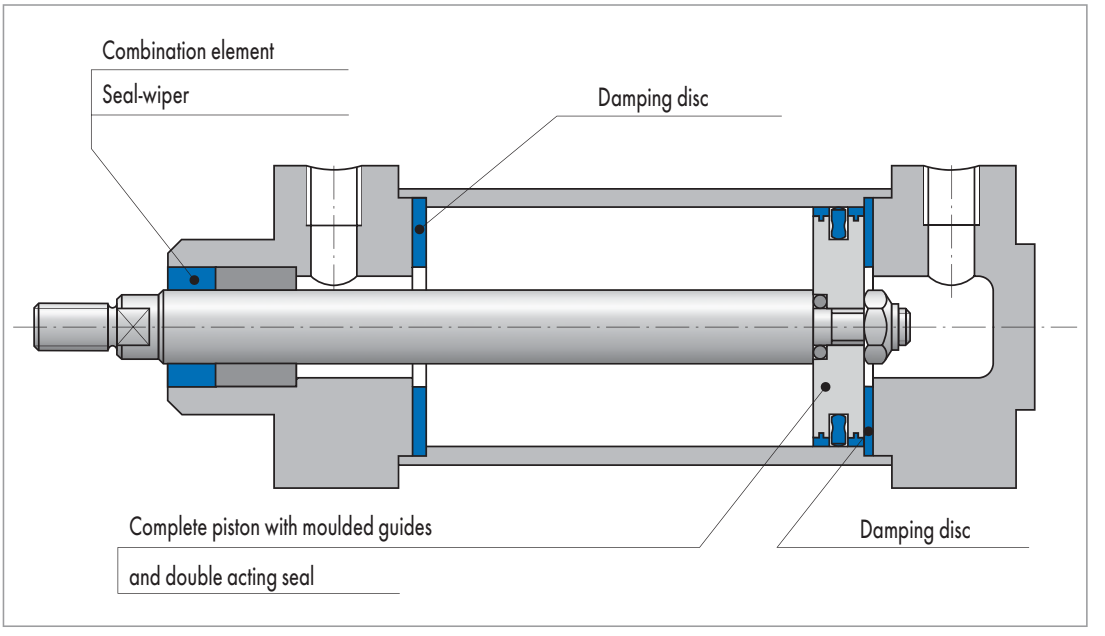


Fig. 1 Pneumatic cylinder I

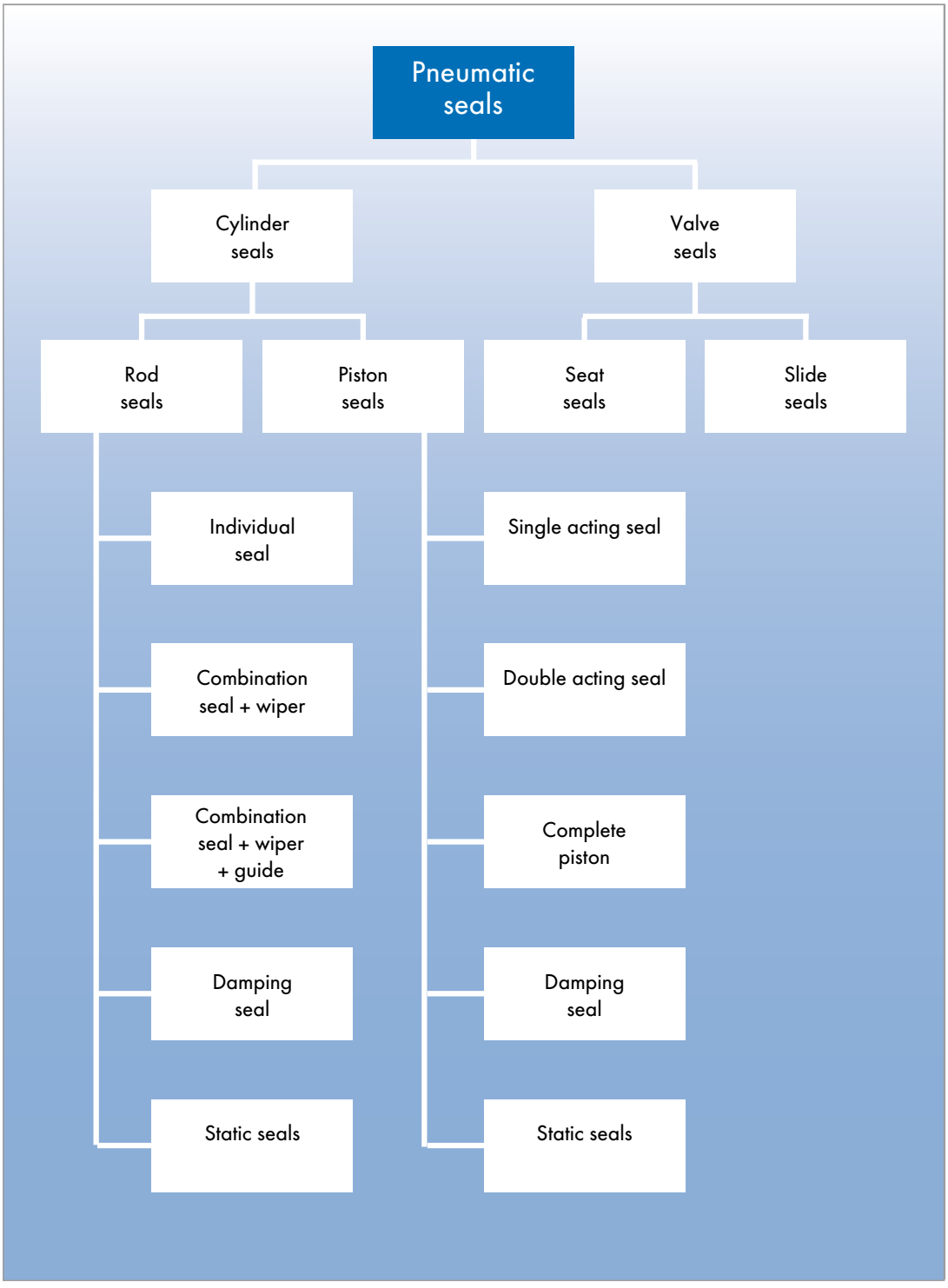


Fig. 2 Categorisation of pneumatic seals

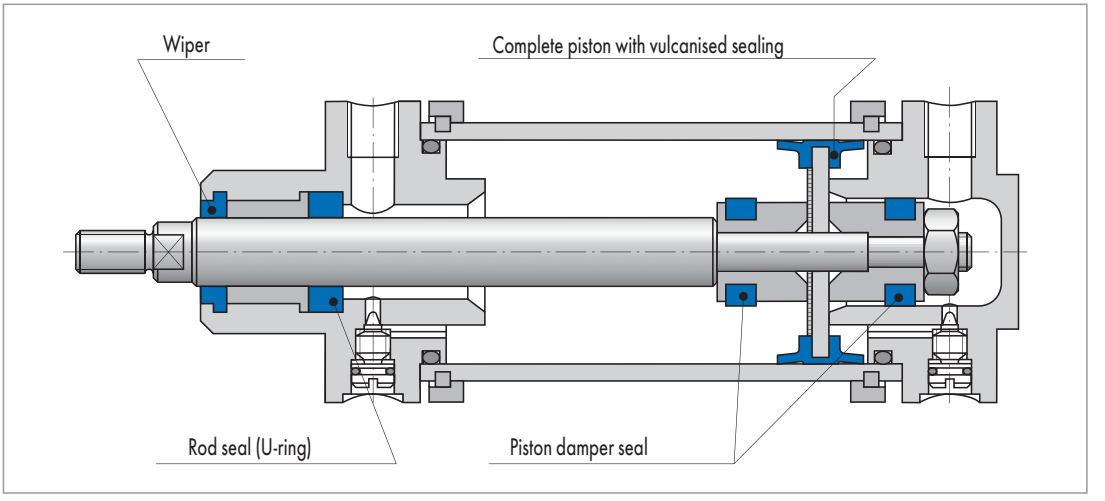


Fig. 3 Pneumatic cylinder II

→ Fig. 3 shows a cylinder design with adjustable damping. Piston damping seals are installed on both sides of the double-lip seal (Merkel Complete Piston TDUOP), which acts as a complete piston. When the damper seals are retracted into the damping cylinder the pressure created is relieved by an adjustable throttle valve. The kinetic energy of the piston, rod and the external mass is absorbed over a few millimetres without a hard end stop.

The double-lip seal can also be used for positioning when using aluminium, brass or plastic cylinder bores. Sensors attached to the exterior of the cylinder are activated by the steel washer of the double-lip seal and control the directional control valve by an electrical circuit.

The functions of sealing, guiding and wiping away dirt are distributed over three separate components in these cylinders. The brass rod guide ring is installed between the seal and the wiper.
A standard cylinder design is shown → Fig. 4. The rod is guided in a bronze, plastic or brass bush and is fitted with a combined wiper and rod seal (Merkel Combination Seal AUNIPSL). The piston is sealed using two pneumatic U-rings (Merkel U-Ring NAP 300, Merkel U-Ring NAP 310). A separate guide is installed between the U-rings.

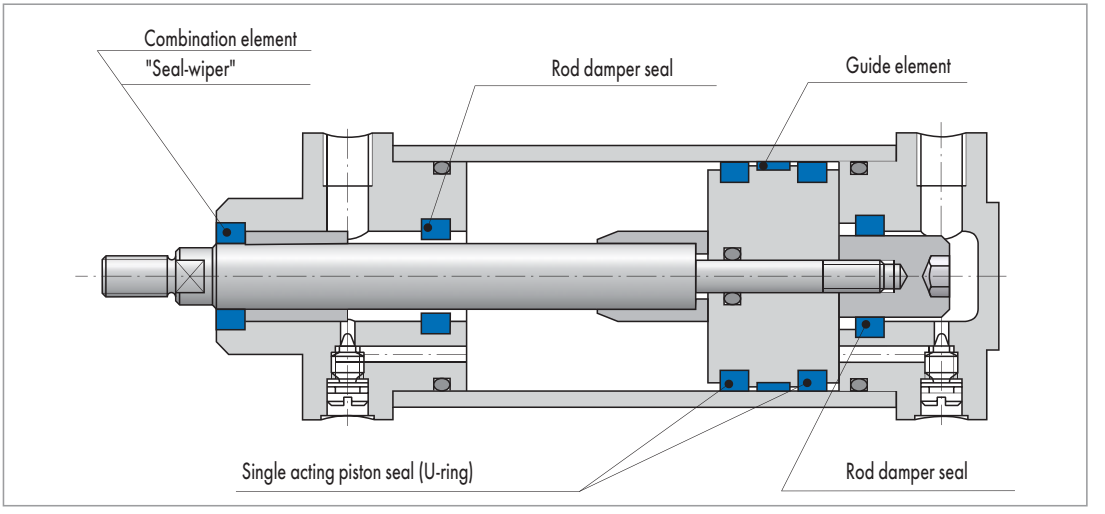


Fig. 4 Pneumatic cylinder III

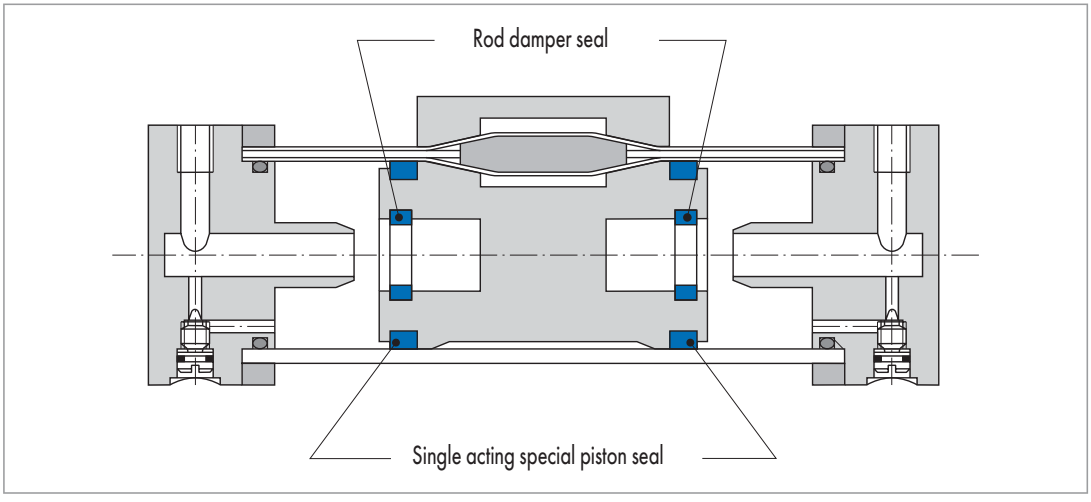


Fig. 5 Pneumatic cylinder without piston rod

This has either a guide belt of PTFE or injection-moulded guide rings.

An alternative is pistons of plastic, which do not have the separate guide element. The pistons have a ring magnet inserted in them for positioning such cylinders.

Damping at the end positions is achieved using the same principle as shown in → Fig. 3. In contrast to the cylinder shown in → Fig. 3, rod damper seals (Merkel Damper Seal DIP, Merkel Damper Seal AUDIP) → Fig. 4 are used instead of piston damper seals. The static sealing between cylinder bore and cylinder floor cover as well as between piston and piston rod is handled by O-rings.

The rod seal is not needed in the rod-less cylinder shown in → Fig. 5. Damping at the end positions is achieved in the same way as in → Fig. 4. The longitudinal slit in the cylinder barrel is sealed with two steel strips that are held in position by a permanent magnet. Alternative designs use special belts of polyurethane, which are snap-fitted into longitudinal grooves in the cylinder bore. The geometry of the sealing surface is distorted in the area of the inside sealing belt. This is why special seals have been developed for sealing the piston.

In addition to the piston cylinders described above there are diaphragm cylinders for very small linear movements. Here the function of the piston is carried out by a diaphragm of elastomer or plastic material.

Rotating cylinders are used to generated a limited rotary movement. They are designed as double-acting piston cylinders, where the piston rod is driven by a gear on a tooth profile, or a rotary blade cylinder.

The dynamic sealing of rotary blade cylinders is not simple because of the complex geometry and requires special designed for the seals.

From the wide variety of valve seals available, a few examples have been chosen and are shown in→ Fig. 6, to Fig. 8. The diagrams of the valves are greatly simplified to show the mode of operation and the task of the valve seals clearly.

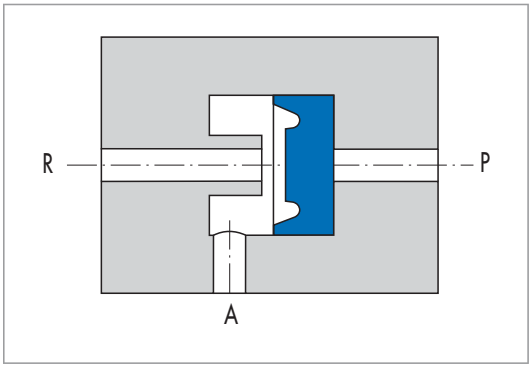


Fig. 6 Pneumatic quick-venting valve

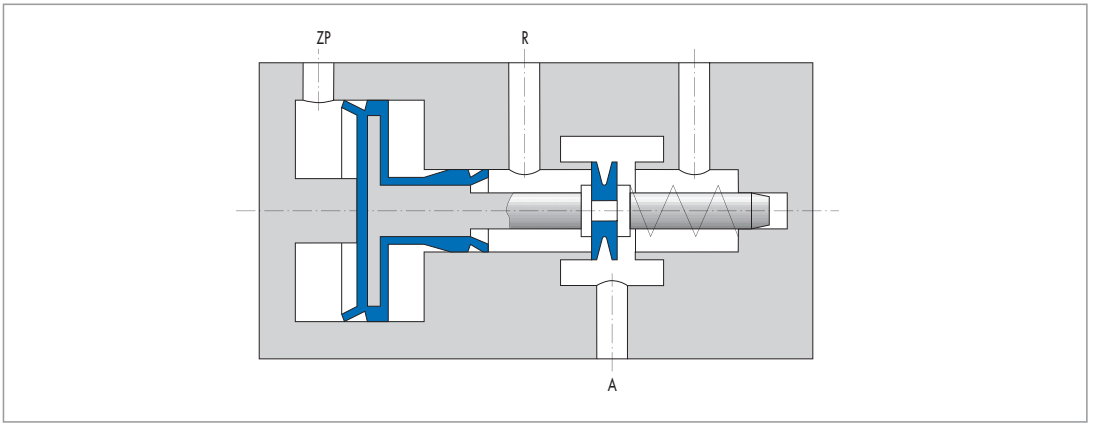


Fig. 7 Pneumatic 3/2-way valve

The quick-venting valve shown in → Fig. 6 is used to increase the piston speed in cylinders. The decisive factor for its operation is the cup-like design of the seal and the elastic sealing material. When pressure is applied at port P the seal covers vent R and releases the path to A via the flexible lips. If there is no pressure at P, and the air is returning from the cylinder via A, the seal closes port P, and the air can flow freely over the short distance outside via R.

The 3/2-way valve shown in → Fig. 7 has 2 double-acting sealing components, a differential piston and a U-ring. The differential piston consists of a basic plastic body, which is surrounded by an elastomeric material or is a fully polyurethane component. The action threshold is favourably influenced by appropriate design of the sealing lips and the use of a low-friction elastomer material. The U-ring with its dynamic loading requires an elastic material with very high mechanical strength and very good wear properties. Special polyurethane materials that meet these requirements are used.

An important factor in the operation of the 5/2-way valve in → Fig. 8 is the snap-on diaphragms at the left and right end of the valve rod. The design of the diaphragms in connection with highly dynamically loaded polyurethane material ensures that this valve operates correctly. The valve is actuated alternately by the pressure applied at ports Y and Z and retained the position until the next impulse is applied. The fluid can flow from P to A or from P to B with the seal in the centre of the control piston.

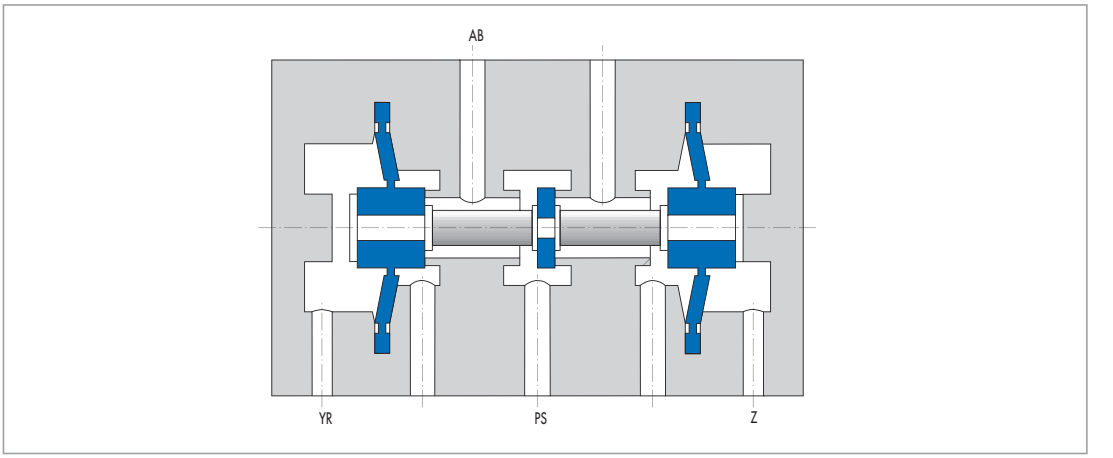


Fig. 8 Pneumatic 5/2-way valve

Sealing Mechanism and Influencing Quantities

Whether it is drive applications, control or regulation: air plays a major role in engineering! Pressure and suction air in pistons can move, lift and retract workpieces and tools as well as use valves to control start, stop, direction, pressure and flow. It is now wonder that pneumatics is at home in handling and automation technology.

There are three major requirements for pneumatic seals:
- High sealing effect
- Low friction
- Long service life.

The sealing effect at rest without pressure is guaranteed with elastic seals because of the radial pressure resulting from the overdimensioning. The sealing pressure is superimposed on the basic compression. This means that the compression between the seal and the mating surface is always greater than the sealing pressure. This effect, known as "automatic sealing effect" is shown in → Fig. 9 using an O-ring as an example.

To reduce friction and wear a lubricant is frequently used, which must be able to withstand very different conditions: ambient temperature, sliding speed, normal forces etc. – a complex tribological system with high demands on the manufacturer of pneumatic drives.

The results of cooperation with well-known manufacturers of pneumatic components and university research establishments are seal and lubricant combinations that are the optimum solutions for a wide variety of applications for pneumatic systems.

Formation of lubricant films and sealing lip geometry

It is well known that friction and wear between two bodies sliding over each other can be minimised if the two friction surfaces are completely separated by a layer of lubricant.
In the case of elastic seals the formation of the lubricating film between the seal and sliding surface depends primarily on the following:
- The sliding speed
- The dynamic viscosity of the lubricant
- The pressure curve in the lubricating gap.

The sliding speed and viscosity of the lubricant are mostly preset, so the formation of the lubricating film can only be influenced by the pressure curve in the lubricating gap. The pressure curve in the lubricating gap during movement and the static pressure distribution between the seal and the mating surface are virtually identical for elastic seals. The pressure distribution can be influenced by the geometric design of the sealing lip.
The majority of pneumatic seals are lubricated for life when mounting. Therefore, the sealing lips of the pneumatic seal must be designed so the lubricating film, which is applied once, is retained for the entire service life.
To ensure this maximum cleanliness is essential before greasing and commissioning: the system must be completely free from machining residue and old lubricants as well as any other contaminants. This is the only way that both the seals and the mating surfaces can be adequately lubricated. This ensures a uniform coating of lubricant over the friction pair.

Tip for greasing cylinder contact surfaces:
Application of lubricants with fitted round brushes or automatic greasing by lubrication pistons are two proven methods. It is important to move the working piston throughout the complete stroke several times after fitting – this distributes the lubricant and also coats the seal with lubricant adequately with only one-sided greasing.

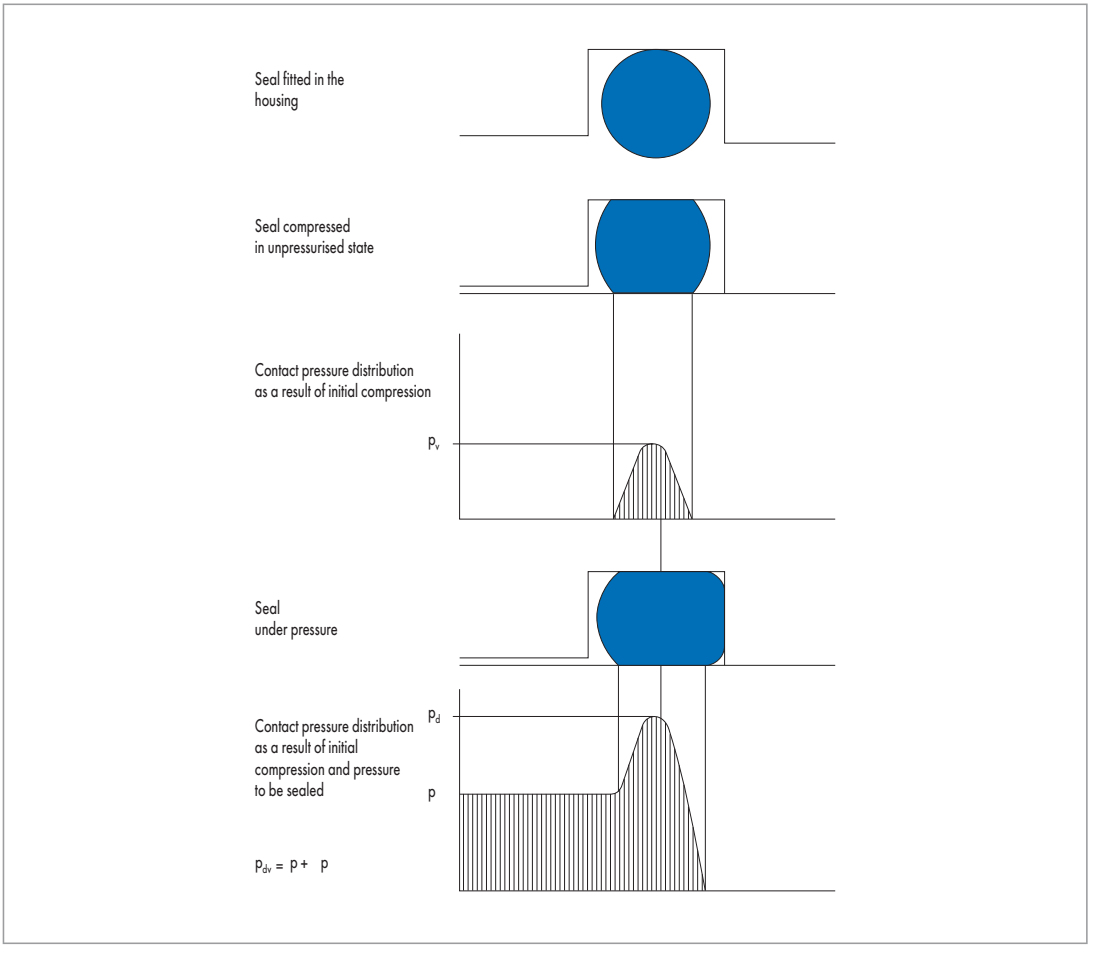


Fig. 9 Automatic sealing effect with elastic seals

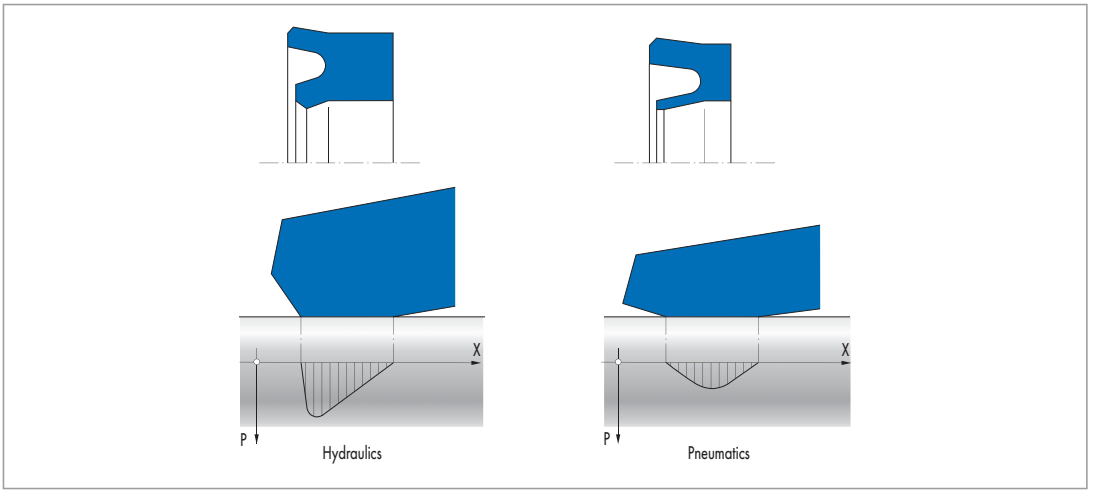


Fig. 10 Different lip geometry and pressure distribution with hydraulics and pneumatics

Tip for greasing valves:

The procedure is similar to that with cylinders. Depending on the size and circumference excess greasing of the piston seal also ensures an even coating of lubrication on the mating surface after several strokes.

In contrast to that hydraulic seals are intended to spread the medium as much as possible. Pneumatic seals therefore have a very different lip geometry from that of hydraulic seals (→ Fig. 10).

The typical pneumatics sealing lip is relatively long compared to the thickness. In combination with the very blunt, angled sealing edge there is a small, equally large angle between the sealing lip and the mating surface when it is pressed to the sliding surface. The resulting symmetrical pressure distribution has a favourable effect on the retention of the lubricating film and thus on the friction and wear.

Sealing system

Tribological view of the sealing system

Friction and service life are interrelated in the operation of a sealing system. The interaction depends on operating parameters (temperature, pressure and speed) as well as the fitting characteristics, the seal geometry, the seal material, the surface design and the lubricant (→ Fig. 11).
The friction describes the proportion of energy lost as a result of the physical energy transfer. With a linear movement it represents the movement resistances in the form of a friction force.

This consists of the interplay between the friction pairs and the resistance of the materials against deformation during a movement or the possibility of a movement.

- Adhesive proportion of friction

The surface activity and polarity of the friction pair tends to pull them apart and thus generate a resistance that corresponds to the adhesive proportion of the friction (→ Fig. 11.).

- Deformation of proportion of friction

Macro and microgeometric attachments cause plastic and/or elastic deformation of the friction pairs. The surfaces of two friction pairs always have some irregularities as a result of manufacturing processes that obstruct one another during a relative movement.

- Internal proportion of friction

Internal friction is the energy losses in the form of heat that occur when a material is deformed (hysteresis, damping).

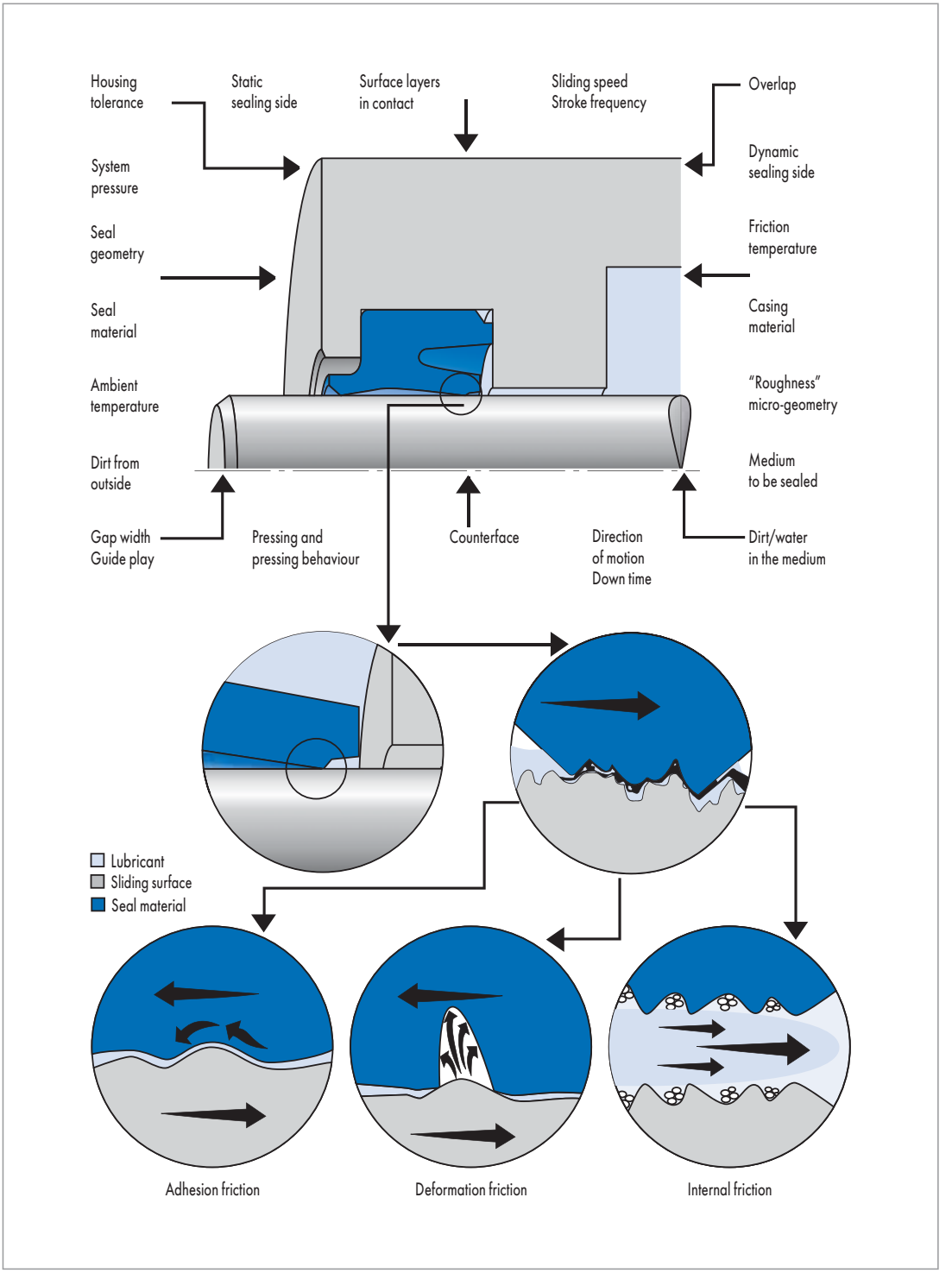


Fig. 11 Basic influences on the tribosystem

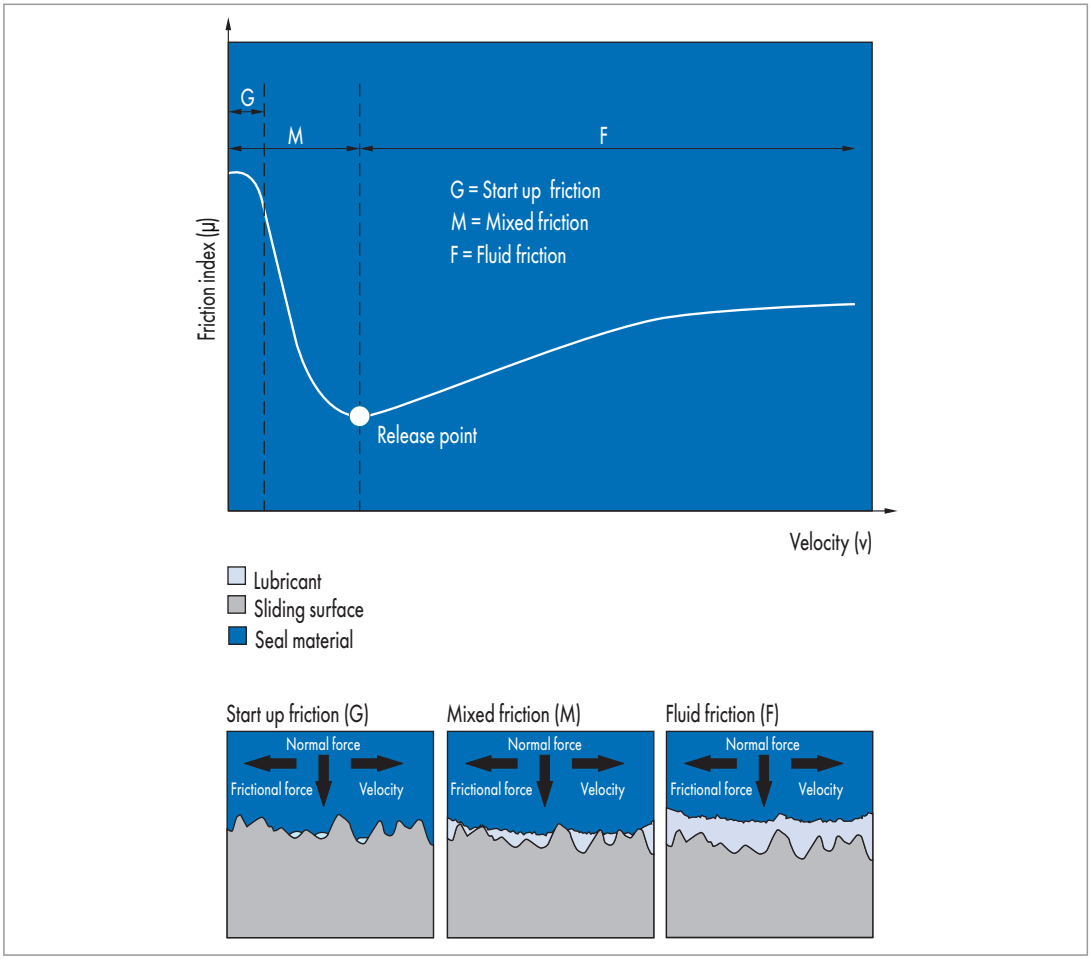


Fig. 12 Stribeck graph describes the dependency of the friction force on the speed

Dominant friction states

Different friction states are generated by factors such as the sliding speed of the friction pairs together.
The Stribeck graph shows the friction force depending on the speed. The friction states shown in → Fig. 12 are generated depending on the sliding speed:

- Boundary friction

When a movement is imminent the friction pair adheres together by micro interlocking resulting from adhesive friction. The internal friction also acts as a resistance force to displacement of the micro interlocking. The friction pair has no movement relative to each other.

- Mixed friction

In this case a relative movement takes place, which is prevented primarily by the proportion of micro interlocking and adhesive friction as well as internal friction. The friction force overall is generally less than that with boundary friction, because the penetration of the interlocking is significantly less and the lubrication component of the lubricant comes into effect.

The higher the speed the less possibility there is of the surface irregularities adhering together, therefor the friction is reduced.

■ Fluid friction

At sufficiently high sliding speed the viscosity of the lubricant forms a pressure between the friction pair, which completely separates the contact surfaces (grease-planing). The friction is primarily influenced by operating parameters (pressure, temperature, speed) and by internal friction components
of the lubricant.

Housing and surface characteristics

The housing for pneumatic seals should be designed so the seal can be easily installed and provides an optimum sealing effect during operation.

Individual seals must not have any guidance functions; combination components form an exception. During the use of individual sealing components the guides should be designed in the fit pair H9/f8, unless separate guide elements (guide belt of PTFE or guide rings of plastic) are used (→ Fig. 16).

The surface characteristics of the groove base and the dynamic mating running surface have a great influence on the operation and service life of the sealing component. The surface roughness R_{max} is the most important quantity for the specification of the surface quality as per DIN ISO 4287 (→ Fig. 17). In addition, the profile support component t_p should be as high as possible (50% up to 70%). Instead of the explicit value of t_p the quotient from the individual measured values depth of surface smoothness R_p and the measured surface roughness R_z should be used to evaluate the dynamic mating surface. Profiles with R_p/R_z <0,5 (closed profiles) are favourable with reference to the wear and service life of elastomer seals. In contrast open profiles with R_p/R_z >0,5 result in premature wear of seals.

These recommendations are intended to present an ideal surface for seal running surfaces (→ Fig. 13).

A surface structure that is too "smooth" (→ Fig. 14) has only very small surface indentations in which the lubricant can be deposited. The result is that the lubricant is wiped away by the sealing lip because the shape-associated residues is too small and the remaining lubricating film is not sufficient. The wear of the sealing lip and the mating surface is greatly increased.

A surface that is too rough (→Fig. 15) has a primarily negative effect on the surface of the sealing lip, because the back and forth movement affects it more.

Both surfaces – too rough or too smooth – cause a reduced running performance (leakage) and higher friction (wear).

Schematic views of surfaces

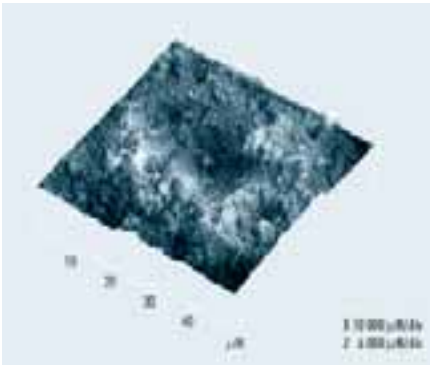


Fig. 13 Ideal surface structure

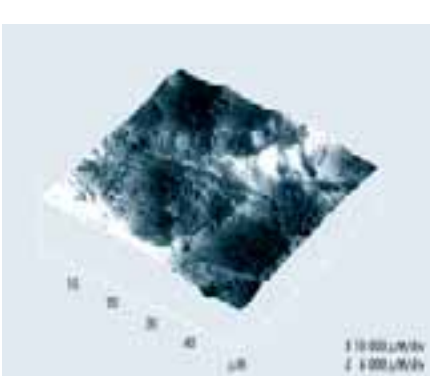


Fig. 14 Too smooth surface structure

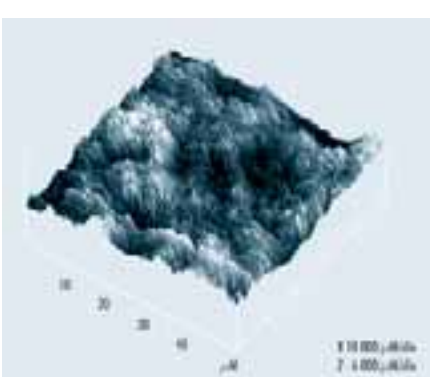


Fig. 15 Too rough surface structure

→ Tbl. 1 shows a table with the most important information on the design of the sealing point.

1. Cylinder bore	
Material:	St, Ms, Al, GFK
Tolerance:	H 11 / H 12
Surface:	R_{max} ≤4 µm,
	R_p/R_z <0,5
	t_p (25% R_{max}) = 50 ... 70%
Machining method:	Honing, drawing, roller burnishing. No additional chemical treatment permissible. Al tubes must be hard-anodised.
2. Rods	
Material:	St
Tolerance:	f 8
Surface:	R_{max} ≤4 µm,
	R_p/R_z <0,5
	t_p (25% R_{max}) = 50 ... 70%
Machining method:	Grinding, roller burnishing (rolling). The hardness of the running surface should be 55 HRC up to 60 HRC. Hard-chromed surfaces (coating thickness 30 µm) must be reworked to the required surface quality.
3. Housings	
Material:	St, Ms, Al, plastic
Tolerance:	Seals: see detailed descriptions.
	Rod guide: H−8
	Piston guide: h8
Surface:	R_{max} ≤10 µm
	R_p/R_z <0,5
	t_p (25% R_{max}) = 50 ... 70%
Machining method:	Turning, grinding.

Tbl. 1 Surface roughness and machining methods

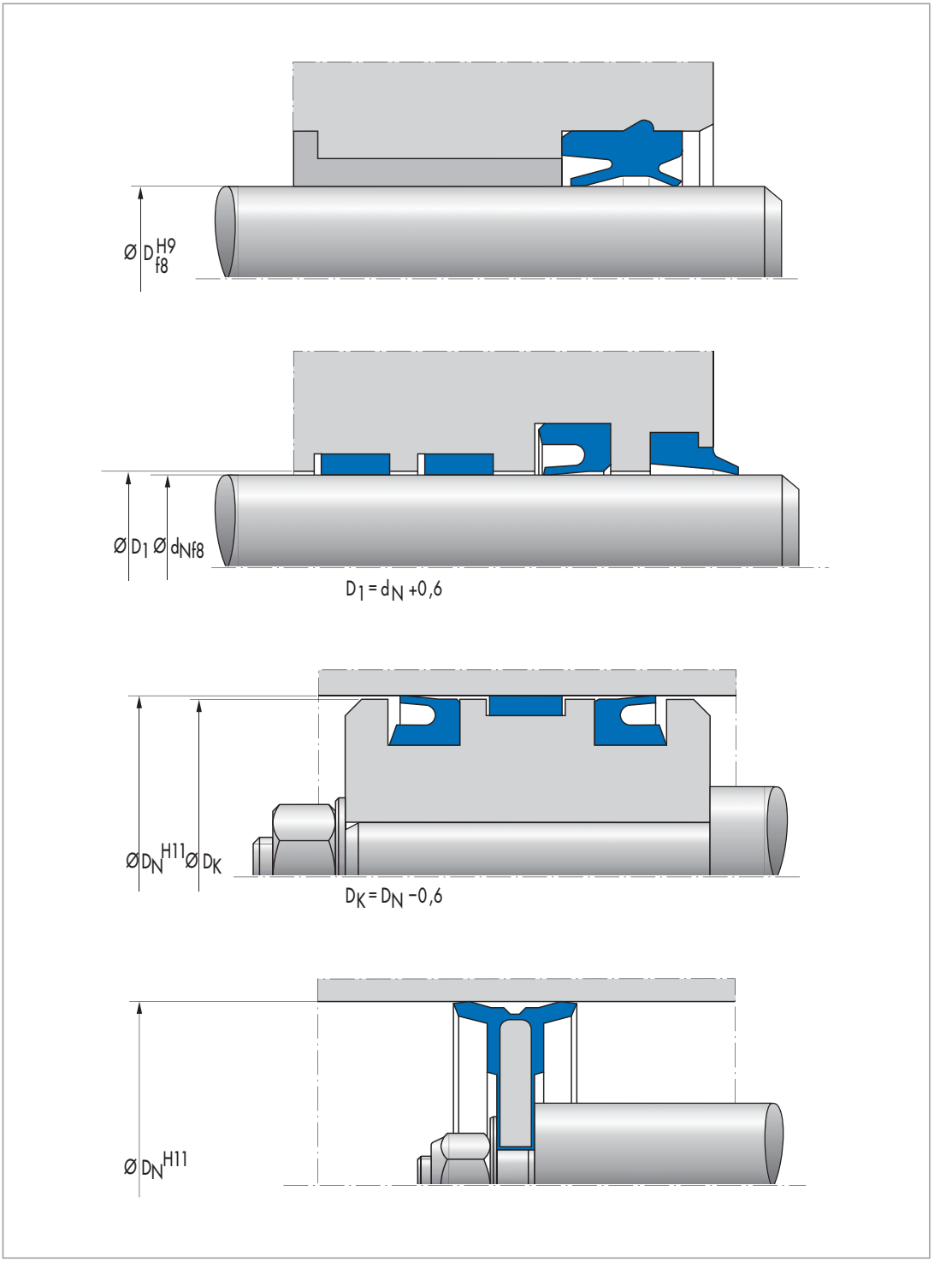
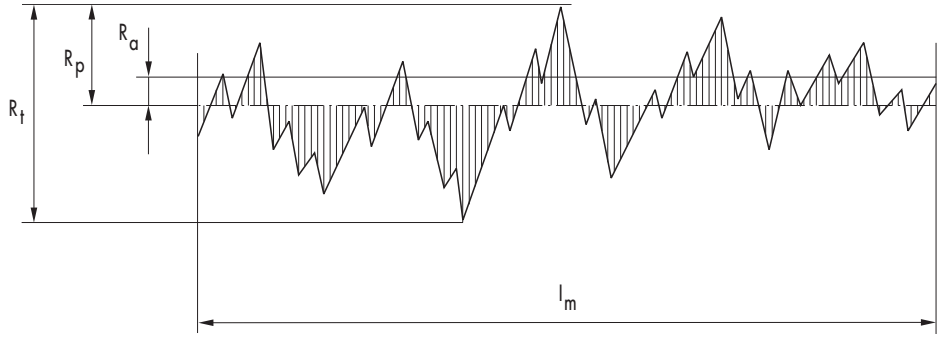
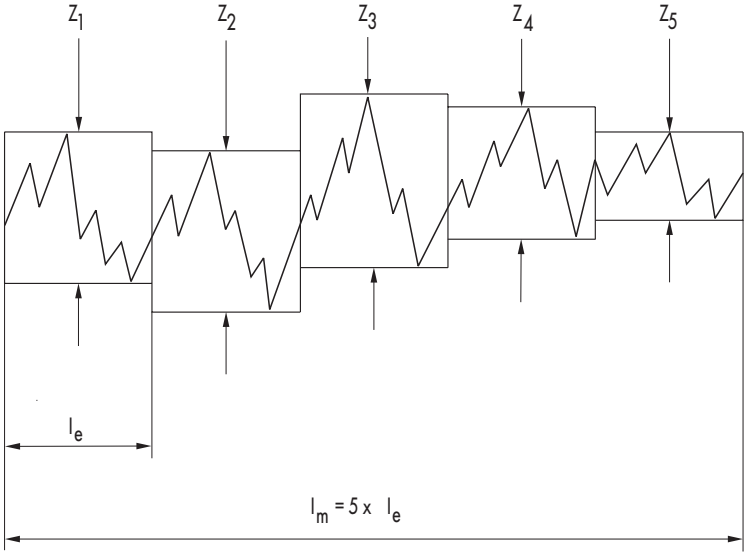


Fig. 16 Fitting and tolerances for seals and guides



R_t ... Peak-to-valley height
R_p ... Smoothing depth
R_a ... Arithmetic mean roughness



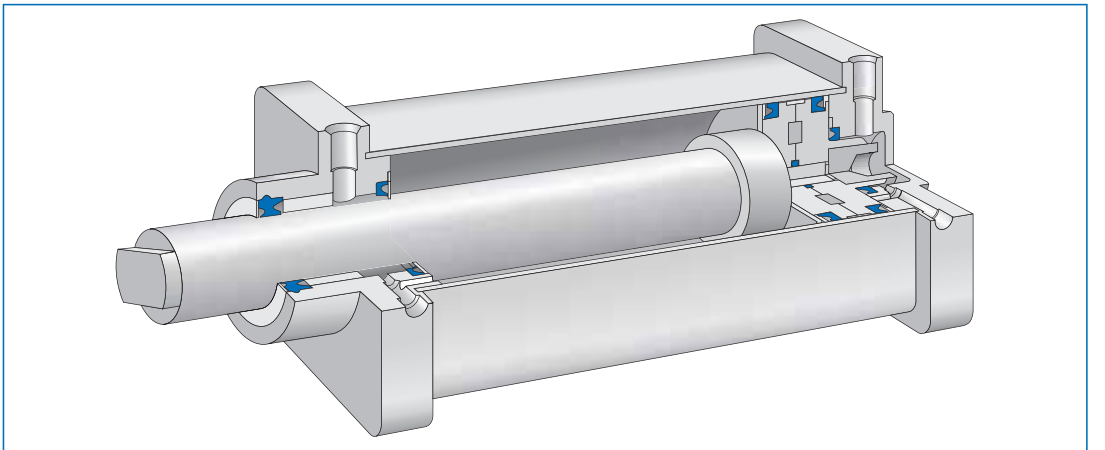
R_z ..... Peak-to-valley height determined

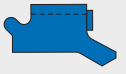
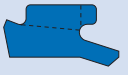
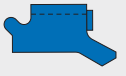
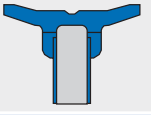
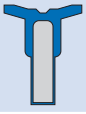
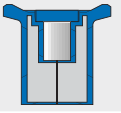
$$R_z = \frac{1}{5}(Z_1 + Z_2 + Z_3 + Z_4 + Z_5)$$

R_{max} .... Maximum peak-to-valley height
(here $R_{max} = Z_3$)

Fig. 17 Roughness terms

Seals and lubricants for ISO cylinders



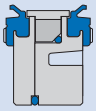
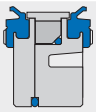
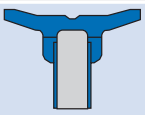
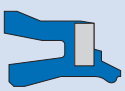
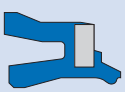
Lubricant [a]	Seal profile	Type [c]	Material	Pressure max (MPa)	Temperature (°C)
Klübersynth AR 34-402		Damper Seal DIP	90 NBR 108	1,6	−30 ... +100
POLYLUB GLY 151		Damper Seal AUDIP	94 AU 925	2,5	−30 ... +90
BARRIERTA L 55/1 [b]		Damper Seal DIP	75 FKM 595	1,6	−5 ... +150
Klübersynth AR 34-402		U-Ring NAPN	80 NBR 186349	1,0	−20 ... +100 (for FKM −5 ... +150)
Klübersynth AR 34-402		Complete Piston with venting passages T DUO P	72 NBR 708	1,2	−20 ... +100
Klübersynth AR 34-402		Complete Piston T DUO P	72 NBR 708	1,2	−20 ... +100
Klübersynth AR 34-402		Complete Piston with magnet and guide belt T DUO PM	72 NBR 708	1,2	−20 ... +80

Tbl. 2

[a] Application in food industry: Klübersynth UH1 14-151/PARALIQ GTE 703 – approved by USDA (United States Department of Agriculture) H1

[b] High temperature application

[c] Operating conditions and fitting information → see product description.

Lubricant [a]	Seal profile	Type [c]	Material	Pressure max (MPa)	Temperature (°C)
Klübersynth AR 34-402		U-Ring NAP 210	80 NBR 99079	1,2	−25 ... +100
POLYLUB GLY 151		Complete Piston Pneuko M	80 AU 21000	1,2	−25 ... +80
POLYLUB GLY 151		U-Ring NAP 310	80 AU 20994	1,2	−35 ... +80
BARRIERTA L 55/1 [b]		U-Ring NAPN	75 FKM 230553	1,0	−5 ... +150
BARRIERTA L 55/1 [b]		Complete Piston Pneuko M	75 FKM 181327	1,2	−5 ... +150
BARRIERTA L 55/1 [b]		Complete Piston with venting passages T DUO P	75 FKM 595	1,2	−5 ... +150
BARRIERTA L 55/1 [b]		Complete Piston T DUO P	75 FKM 595	1,2	−5 ... +150
BARRIERTA L 55/1 [b]		U-Ring NAP 210	75 FKM 99104	1,2	−5 ... +200
POLYLUB GLY 151		U-Ring NAP 300	80 AU 941	1,2	−35 ... +80
Klübersynth AR 34-402		Combination Seal NIPSL	72 NBR 708	1,2	−20 ... +100
POLYLUB GLY 151		Combination Seal AUNIPSL	94 AU 925	1,2	−30 ... +90
BARRIERTA L 55/1 [b]		Combination Seal NIPSL	75 FKM 595	1,2	−5 ... +150

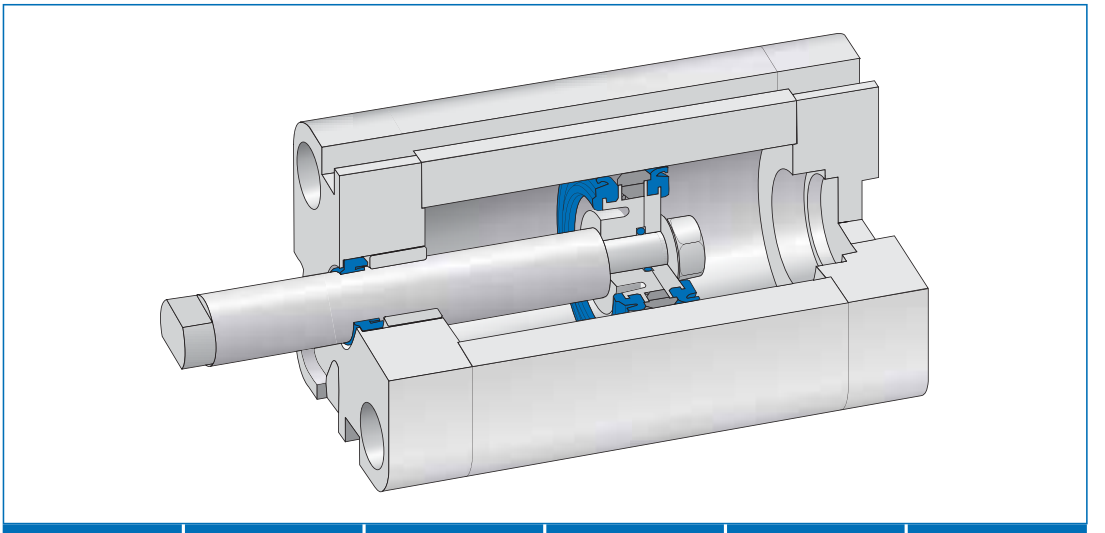
Tbl. 2

[a] Application in food industry: Klübersynth UH1 14-151/PARALIQ GTE 703 – approved by USDA (United States Department of Agriculture) H1

[b] High temperature application

[c] Operating conditions and fitting information → see product description.

Seals and lubricants for short stroke and compact cylinders



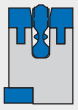
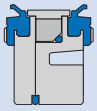
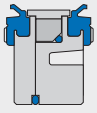
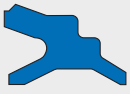
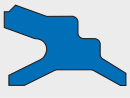
Lubricant [a]	Seal profile	Type [c]	Material	Pressure max (MPa)	Temperature (°C)
Klübersynth AR 34-402		Compact Seal Airzet PK	80 NBR 186349	1,2	−20 ... +100
Klübersynth AR 34-402		Compact Seal KDN	72 NBR 708	1,0	−20 ... +100
Klübersynth AR 34-402		Complete Piston NADUOP	72 NBR 708	1,0	−20 ... +100
BARRIERTA L 55/1 [b]		U-Ring NAP 210	75 FKM 99104	1,2	−5 ... +200
Klübersynth AR 34-402		U-Ring NAP 210	80 NBR 99079	1,2	−25 ... +100
POLYLUB GLY 151		U-Ring NAP 310	80 AU 20994	1,2	−35 ... +80

Tbl. 3

[a] Application in food industry: Klübersynth UH1 14-151/PARALIQ GTE 703 – approved by USDA (United States Department of Agriculture) H1

[b] High temperature application

[c] Operating conditions and fitting information → see product description.

Lubricant [a]	Seal profile	Type [c]	Material	Pressure max (MPa)	Temperature (°C)
Klübersynth AR 34-402		Complete Piston Pneuko G	72 NBR 708	1,0	−20 ... +100
POLYLUB GLY 151		Complete Piston Pneuko M	80 AU 21000	1,2	−25 ... +80
BARRIERTA L 55/1 [b]		Complete Piston Pneuko M	75 FKM 181327	1,2	−5 ... +150
Klübersynth AR 34-402		Compact Seal Airzet PR	80 NBR 186349	1,2	−20 ... +100
Klübersynth AR 34-402		Combination Seal NIPSL 200	80 NBR 4005	1,0	−20 ... +100
BARRIERTA L 55/1 [b]		Combination Seal NIPSL 210	75 FKM 181327	1,0	−5 ... +150
POLYLUB GLY 151		Combination Seal NIPSL 300	85 AU 20991	1,0	−30 ... +90
POLYLUB GLY 151		Combination Seal NIPSL 310	85 AU 20991	1,0	−30 ... +80
POLYLUB GLY 151		Combination Seal NIPSL 320	94 AU 925	1,2	−30 ... +90
Klübersynth AR 34-402		Combination Seal NIPSL SF	90 NBR 108	1,0	−20 ... +100
BARRIERTA L 55/1 [b]		Combination Seal NIPSL SF	75 FKM 595	1,0	−5 ... +150

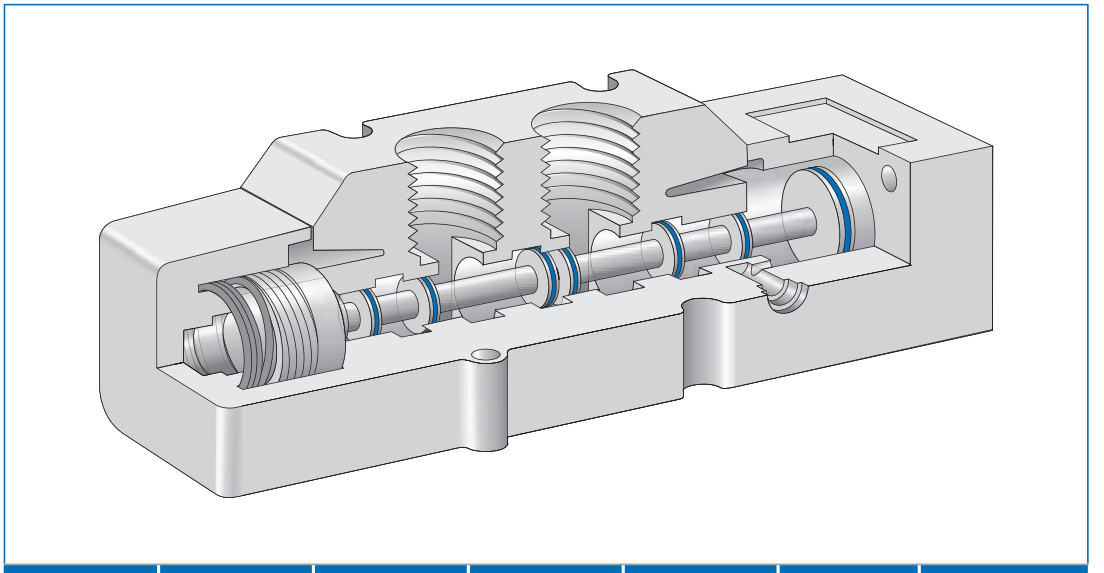
Tbl. 3

[a] Application in food industry: Klübersynth UH1 14-151/PARALIQ GTE 703 – approved by USDA (United States Department of Agriculture) H1

[b] High temperature application

[c] Operating conditions and fitting information → see product description.

Seals and lubricants for valves



Valve type	Lubricant	Seal profile [a]	Type	Material	Pressure max (MPa)	Temperature (°C)
Directional Control Valve	PETAMO GHY 133 N UNISILKON L 641		special shapes	80 NBR 186349	1,2	−30 ... +100
Directional Control Valve	PETAMO GHY 133 N UNISILKON L 641		special shapes	80 HNBR 181572	1,2	−15 ... +120
Directional Control Valve	PETAMO GHY 133 N UNISILKON L 641		special shapes	AU [a]	1,2	−35 ... +80
Directional Control Valve	PETAMO GHY 133 N UNISILKON L 641		NAP 310	AU [a]	1,2	−35 ... +80
Directional Control Valv	PETAMO GHY 133 N UNISILKON L 641		KDN NAP 210 Airzet	NBR [a]	1,2	−30 ... +100
Seat Valve	PETAMO GHY 133 N UNISILKON L 641		special shapes	AU [a]	1,2	−35 ... +80

Tbl. 4

[a] on enquiry

Product data

Lubricants	Base oil/ oil thickener	Operational temperature range [a] [°C] approxi-mately	Density at 20 °C DIN 51 757 [g/cm³] approxi-mately	Base oil viscosity DIN 51 562 T1 [mm²/s] at approximately		Walk pen-etration DIN ISO 21 37 [0,1 mm]	Consistency NLGI class DIN 51 818	Miscellaneous instructions
				40 °C	100 °C			
Lubrication of pneumatic cylinders								
Klübersynth AR 34-402	Synth. hydro-carbon oil/special calcium soap	−30 ... +130	0,90	400	40	265 ... 295	2	Adhering lubricating grease for high piston speed ranges; reduced stick-slip tendency at very low piston speeds; low breakaway force even after extended downtime
POLYLUB GLY 151	Mineral oil/ synth. hydro-carbon oil/ Li special soap	−50 ... +130	0,85	150	18,5	310 ... 340	1	Light-running grease; also preferred for applications at low temperatures
BARRIERTA L 55/1	PFPE/PTFE	−40 ... +260	1,95	415	40	310 ... 340	1	Adhering lubricating grease for high-temperature applications; very good resistance to most chemicals; good compat-ibility with most elastomers and plastics
Klüber-synth UH1 14-151	Synth. hy-dro-carbon oil/Al com-plex soap	−40 ... +120	0,92	150	22	310 ... 340	1	Approved by USDA H1, and designed for applications in the food industry; good water resistance and good corrosion protection
PARALIQ GTE 703	Silicone oil/PTFE	−50 ... +150	1,31	1000	360	220 ... 250	3	Approved by USDA H1, and designed for applications in the food industry; wide temperature range; resistant to hot and cold water and also compatible with EPDM
PETAMO GHY 133N	Mineral oil/ synth hydro-carbon oil/ polyurea	−30 ... +160	0,88	150	18	265 ... 295	2	Adhering lubricating grease for a wide temperature range; reduced adhesion and movement friction; good wear resistance; good corrosion protection effect
UNI-SILKON L 641	Silicone oil/PTFE	−40 ... +160	1,25	75000	30000	300 ... 320	–	Approved by USDA H1; adhering lubricating grease; particularly for applications with high switching frequen-cies and high air flow as well as at low temperatures

Tbl. 5

[a] Operating temperature data are recommended values oriented to lubricant structure, the specified use and the application technology. Lubricants change consistency depending on the type of mechanical-dynamic loading with the temperature, pressure and time, apparent viscosity and viscosity. The change in the characteristics of the product may influence the function of components.

Compressed air

Depending on the application various compressed-air classes are recommended in PNEUROP Guideline 6611. The criteria

- particle size
- pressure dew-point
- oil content

are listed in PNEUROP 6611 tables in which the quality classes are specified.

The most general distinction of prepared and unprepared compressed air. Unprepared air is compressed with oil-lubricated compressors and only coarsely filtered. It still contains fine dirt particles, water and oil.

To prevent premature wear of valves, cylinders and seals, particles larger than 40 µm should be removed by appropriate filters.
Prepared air is prefiltered after compression, dehydrated by cold dryers (pressure dew-point +2°C) and then cleaned in very fine filters. This air quality is frequently referred to as "dried and de-oiled compressed air".
For particularly critical applications the air can be dried in an absorption dryer (pressure dew-point −40 °C up to −60 °C) after the fine filtering. Under extreme operating conditions "dried and de-oiled compressed air" is recommended for the pneumatic components. In these cases a compressed air oiler is installed immediately before the consumer. With the frequently encountered dried and de-oiled compressed air the service life of the pneumatic seals depends greatly on the one-time initial lubrication. The lubricants must adhere well to the metal and elastomer surfaces. They must be compatible with the sealing material, have high resistance to ageing, good corrosion protection, a consistency suitable for smooth running and be suitable for use in the required temperature range.

If oiled compressed air is used, the compatibility between the lubricant and the oil is important with reference to maintaining a stable lubricating film.

Fitting of Pneumatic Seals

Before fitting of sealing components the complete system must be cleaned of machining residue, chips, dirt and other particles. Seals must not be pulled over sharp edges, threads, feather key grooves or similar during fitting. Cover these parts before fitting (→ Fig. 19).

Sharp edges must be de-burred or chamfered or smoothed off. Never use sharp-edged tools.
The seal, piston rod and cylinder bore must be oiled or greased before fitting.

Insertion chamfers on rods and pipes

Cylinder bores and piston rods must be chamfered to prevent damage to the sealing components during fitting. The length of the chamfer depends on the nominal diameter.
The dimensions are shown in → Tbl. 6. The edge at the transition from the chamfer to the sliding surface must be rounded and polished.

Length Z (chamfer)	Nominal diameter
2	<20
3	0 ... 49
4	50 ... 99
5	100 ... 159
6	160 ... 249
7	250 ... 400
8	>400

Tbl. 6

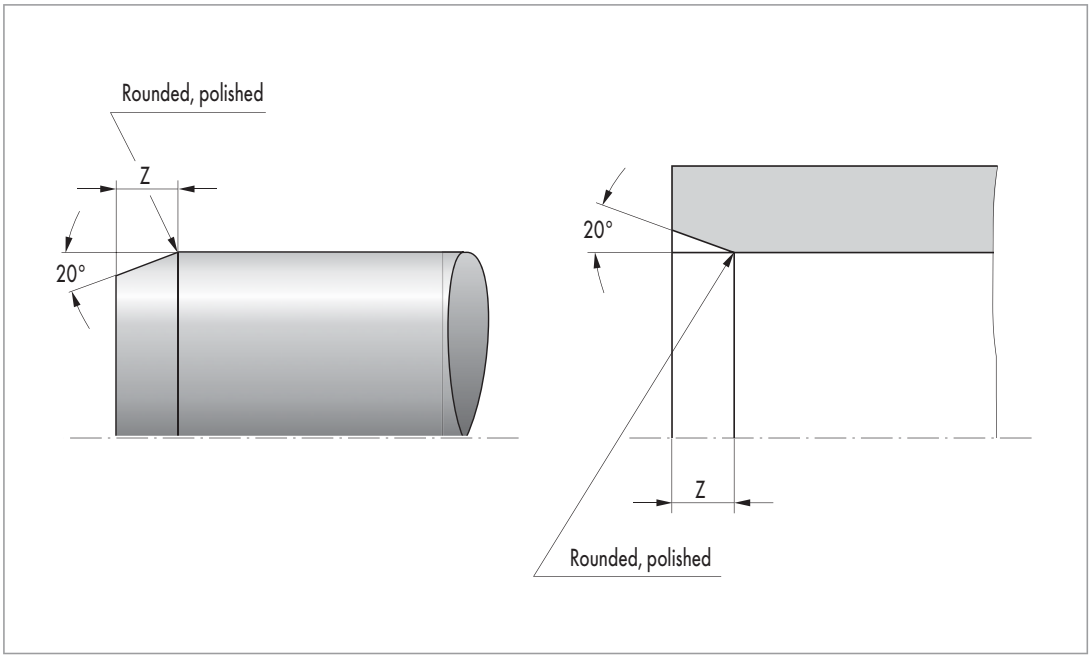


Fig. 18 Chamfering rods and pipes

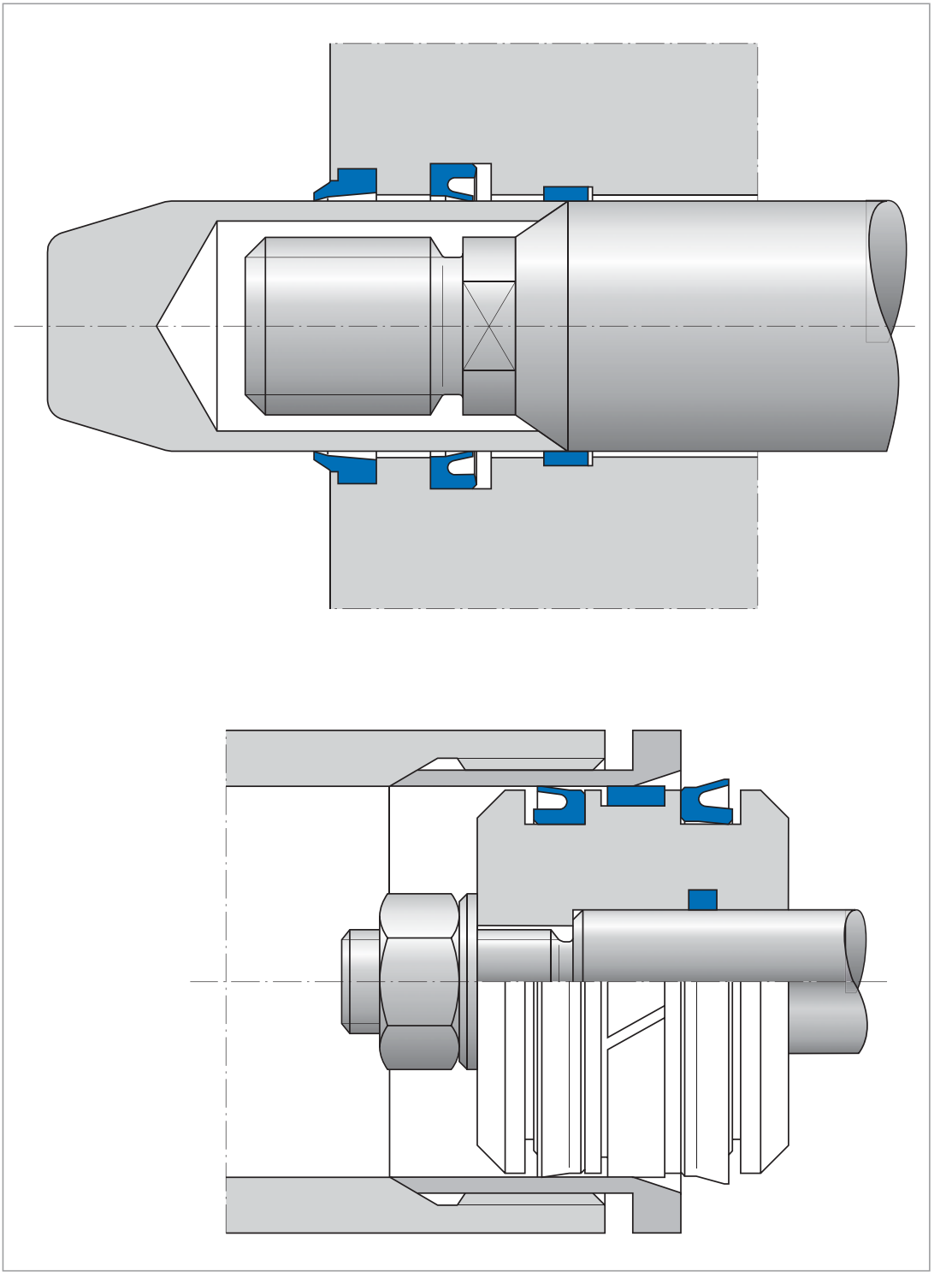


Fig. 19 Covering threads when mounting seals

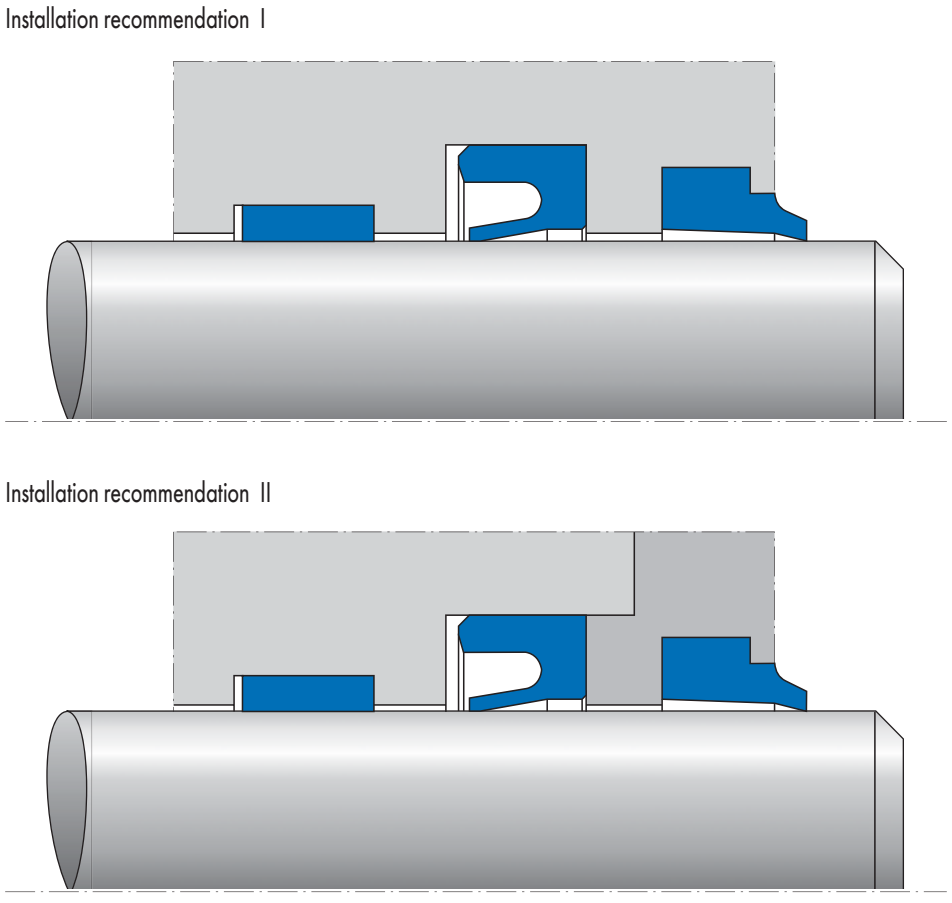


Fig. 20 Fitting types of rod seals

Fitting of pneumatic seals

When mounting individual sealing components two types of fitting are possible (→ Fig. 20):

- Snap-in fitting in an undivided housing (recommendation I)
- Fitting in a divided housing (recommendation II).

All edges around the seal housing must be carefully de-burred and rounded.

The individual sealing components can generally be installed by hand without equipment (snap-in fitting).

Fitting can be simplified by using suitable fitting tools (→ Fig. 21 and → Fig. 22). When using the two-component fitting tool II the seal is pushed through the tapered mounting sleeve with the mandrel and it snaps into the grooves (→ Fig. 23).
Another option is to use a suitable fitting tool (→ Fig. 24). In this regard the seal is initially positioned by hand in the groove and then pushed with a rod until is snaps into the groove.

Fig. 21 Fitting tool for rod seals

Fig. 22 Fitting tool for rod seals

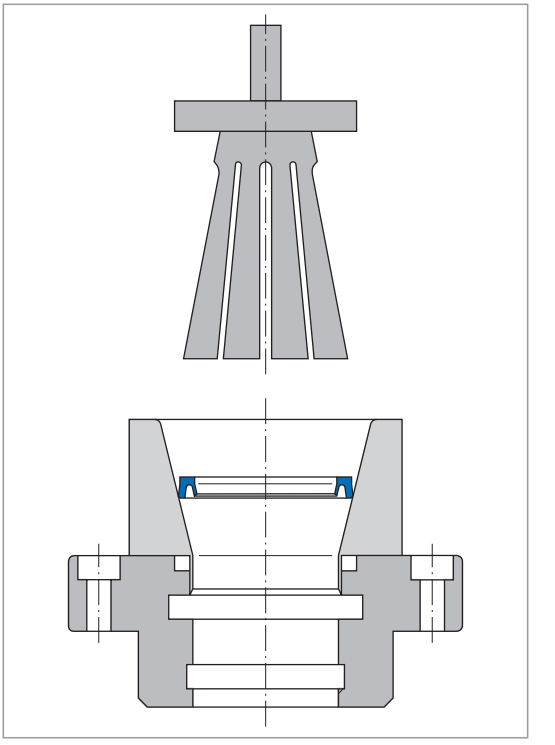


Fig. 23 Fitting of rod seals

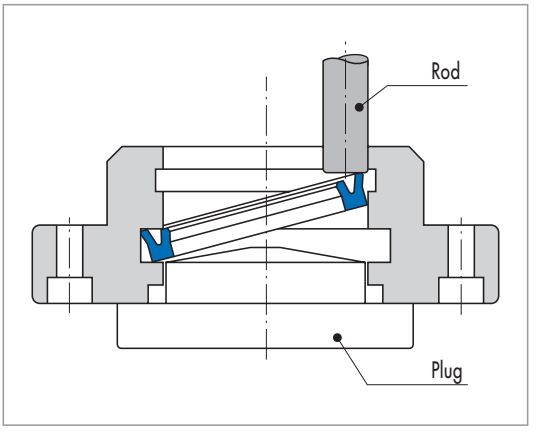


Fig. 24 Fitting aid for rod seals

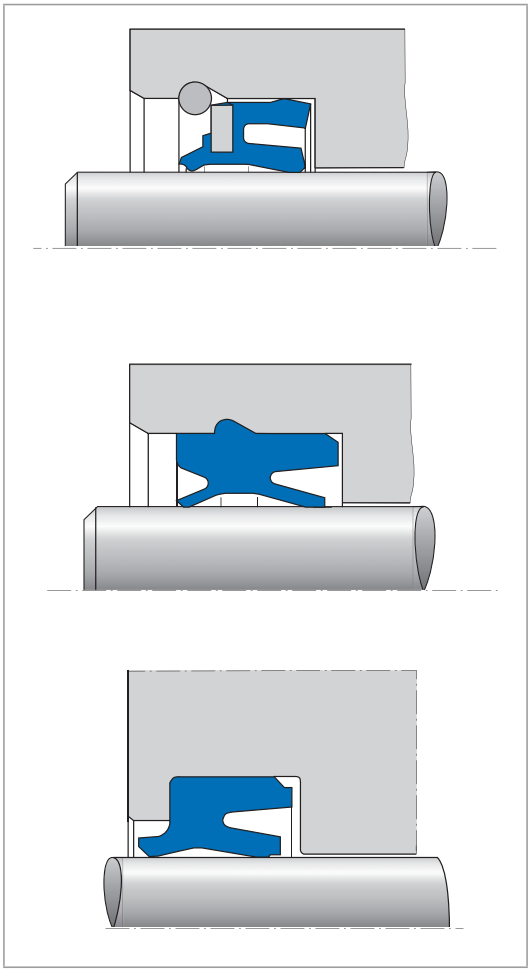


Fig. 25 Fitting of combination components

Fig. 26 Snap-in fitting of a piston seal

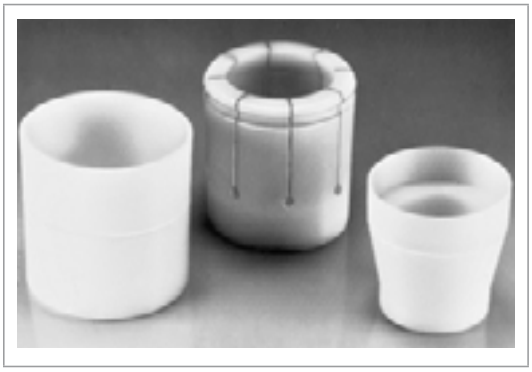


Fig. 27 Fitting tool for piston seals

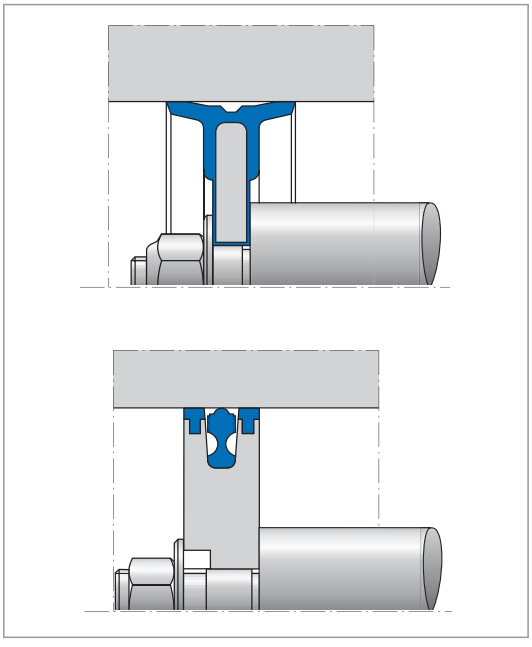


Fig. 28 Assembly of pneumatic complete pistons

Combination components (AUNIPSL, NIPSL), which in some cases contain metal reinforcements or plastic support components, are always installed in axially accessible grooves (→ Fig. 25). They can be installed without equipment and fitting can be automated for production lines.

Pneumatic complete pistons (TDUOP, Pneuko M) are positioned on a piston rod and fastened with hex nuts (→ Fig. 28). An additional lock on the threaded connection using a self-locking nut or an adhesive is recommended.

Products

Rod Seals

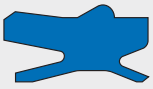
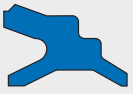
Damper Seals

Piston Seals

Guides

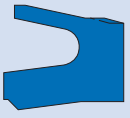
Pre-Selection Pneumatics

Note:
The information on minimum operating temperatures is to be considered genaral, as alongside the material, the type of seal, the housing and the operating conditions can also affect the function. The maximum operating temperatures can be exceeded, in this case a reduction in the service life of the seals can be expected.
The effect of media (e.g. unsuitable lubricants) can reduce the operating temperature limits..

Type	Material	Hardness Shore A	Pressurised area in MPa (bar)	Temperature range in °C [2]	Speed in m/s
Rod Seals					
Merkel Combination Seal AU NIPSL 	AU	94	≤1,2 (12)	−30 ... +90	≤1
Merkel Combination Seal NIPSL 	NBR	90	≤1,2 (12)	−20 ... +100	≤1
	FKM [1]			−5 ... +150	
Merkel Combination Seal NIPSL 200 	NBR	80	≤1,0 (10)	−20 ... +100	≤1
Merkel Combination Seal NIPSL 210 	FKM	75	≤1,0 (10)	−5 ... +150	≤1
Merkel Combination Seal NIPSL 300 	AU	90	≤1,0 (10)	−30 ... +90	≤1
Merkel Combination Seal NIPSL 310 	AU	85	≤1,0 (10)	−30 ... +80	≤1

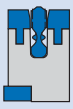
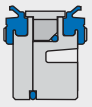
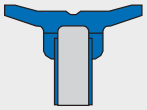
[1] On request

[2] Usual temperature range for pneumatic cylinders: −20 ... +80 °C

Type	Material	Hardness Shore A	Pressurised area in MPa (bar)	Temperature range in °C [2]	Speed in m/s
Merkel Combination Seal NIPSL 320 	AU	94	≤1,2 (12)	−30 ... −90	≤1
Merkel Combination Seal NIPSL SF 	NBR	80	≤1,0 (10)	−20 ... +100	≤1
	FKM [1]			−5 ... +150	
Merkel Combination Seal Airzet PR 	NBR	80	≤1,2 (12)	−30 ... +100	≤1
	FKM	75		−5 ... +150	
Piston Seals					
Merkel U-Ring NAP 210 	FKM [1]	75	≤1,2 (12)	−5 ... +200	≤1
	NBR	80		−25 ... +100	
Merkel U-Ring NAP 300 	AU	80	≤1,2 (12)	−35 ... +80	≤1
Merkel U-Ring NAP 310 	AU	80	≤1,2 (12)	−35 ... +80	≤1
Merkel U-Ring NAPN 	NBR	80	≤1 (10)	−20 ... +100	≤1
	FKM [1]			−5 ... +150	

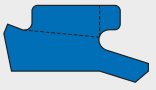
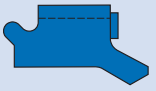
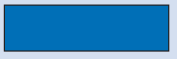
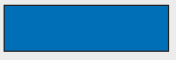
[1] On request

[2] Usual temperature range for pneumatic cylinders: −20 ... +80 °C

Type	Material	Hardness Shore A	Pressurised area in MPa (bar)	Temperature range in °C [2]	Speed in m/s
Merkel Compact Seal Airzet PK 	NBR	80	≤1,2 (12)	−20 ... +100	≤1
	FKM	75		−5 ... +150	
Merkel Compact Seal KDN 	NBR	72	≤1,2 (12)	−20 ... +100	≤1
Merkel Complete Piston NADUOP 	NBR	72	≤1 (10)	−20 ... +100	≤1
Merkel Complete Piston Pneuko G 	NBR + PA	72	≤1 (10)	−20 ... +100	≤1
Merkel Complete Piston Pneuko M 210 / Pneuko M 310 	FKM	75	≤1,2 (12)	−5 ... +150	≤1
	AU	80		−25 ... +80	
Merkel Complete Piston TDUOP 	NBR	72	≤1,2 (12)	−20 ... +100	≤1
	FKM [1]			−5 ... +150	
Merkel Complete Piston TDUOP with Venting Passages 	NBR	72	≤1,2 (12)	−20 ... +100	≤1

[1] On request

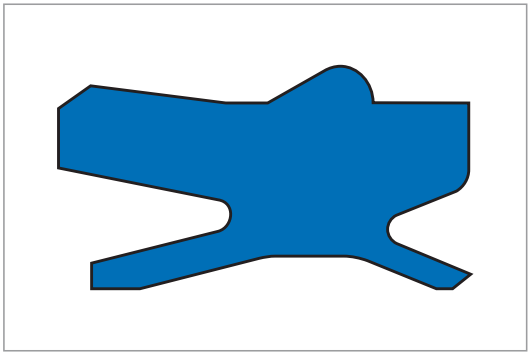
[2] Usual temperature range for pneumatic cylinders: −20 ... +80 °C

Type	Material	Hardness Shore A	Pressurised area in MPa (bar)	Temperature range in °C [2]	Speed in m/s
Merkel Complete Piston TDUOP M 	NBR	72	≤1,2 (12)	−20 ... +80	≤1
Damper Seals					
Merkel Damper Seal AU DIP 	AU	94	≤2,5 (25)	−30 ... +90	≤1
Merkel Damper Seal DIP 	NBR	90	≤1,6 (16)	−30 ... +100	≤1
	FKM [1]			−5 ... +150	
Guides					
Merkel Guide Ring EKF 	PA	–	–	−30 ... +100	≤1
Merkel Guide Strip KF 	PTFE	–	–	−40 ... +200	≤1
Merkel Guide Strip SF 	PTFE	–	–	−40 ... +200	≤1

[1] On request

[2] Usual temperature range for pneumatic cylinders: −20 ... +80 °C

Merkel Combination Seal AU NIPSL



Merkel Combination Seal AU NIPSL

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The component needs no additional element (circlip) for axial fixing within the housing
- Long service life
- Robust design.

Application

Rod seal e.g. for ISO cylinders.

Product description

Merkel combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Material

Material	Code	Hardness
High performance polyurethane	94 AU 925	94 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−30 ... +90 °C
Running speed v	≤1 m/s

Design notes

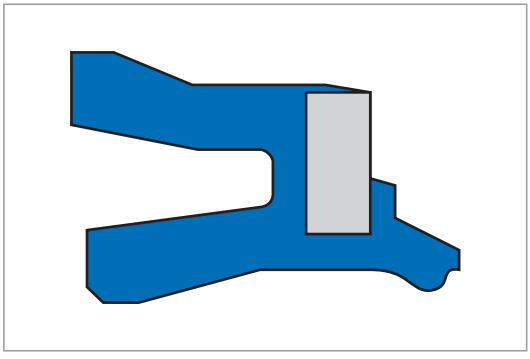
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal AU NIPSL is ressed into the housing from outside. The bead on the outside diameter snaps into the circlip groove and fixes the seal in the housing.

Merkel Combination Seal NIPSL



Merkel Combination Seal NIPSL

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards.
- The component can be replaced from the outside (without dismantling the equipment)
- Broad supply range.

Application

Rod seal for pneumatic cylinders.

Product description

Combination wiper seal with metal reinforcement and special pneumatic sealing edge.

Material

Material	Code	Hardness	Base plate
Acrylonitrile-butadiene rubber	72 NBR 708	72 Shore A	mild steel according to DIN 1624

FKM on enquiry.

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

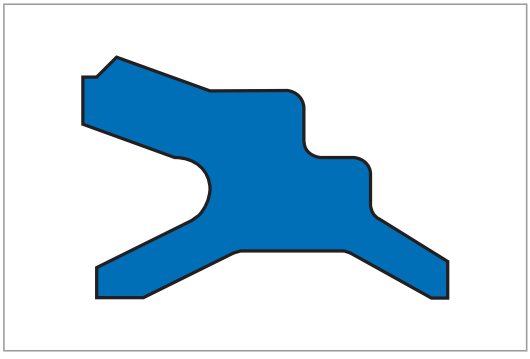
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL is pressed into the housing from outside. The back is supported by a circlip (DIN 7993). To remove the seal, it is advisable to provide an axial cut-out in the ring groove that allows the circlip to be easily removed.

Merkel Combination Seal NIPSL 200



Merkel Combination Seal NIPSL 200

Product description

Combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film.

Application

Small cylinders.

Material

Material	Code	Hardness
NBR rubber	80 NBR 4005	80 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

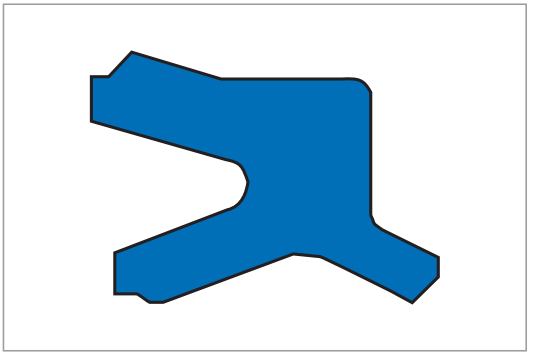
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL 200 for small cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Combination Seal NIPSL 210



Merkel Combination Seal NIPSL 210

Design note

Compact combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Suitable for high-temperature applications.

Application

Small cylinders, compact cylinders. Small cylinders, compact cylinders.

Material

Material	Code	Hardness
FKM rubber	75 FKM 181327	75 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−5 ... +150 °C
Running speed v	≤1 m/s

Design note

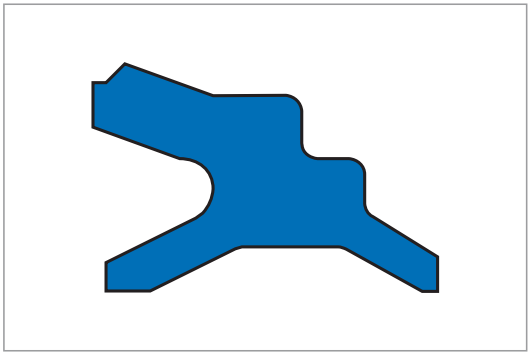
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	–
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL 210 for small cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Combination Seal NIPSL 300



Merkel Combination Seal NIPSL 300

Product description

Combination wiper seal without metal reinforcement with special pneumatic sealing edge (previous code: AUNIPSL SF).

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Material with high wear resistance.

Application

Small cylinders.

Material

Material	Code	Hardness
High performance polyurethane	85 AU 20991	85 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−30 ... +90 °C
Running speed v	≤1 m/s

Design notes

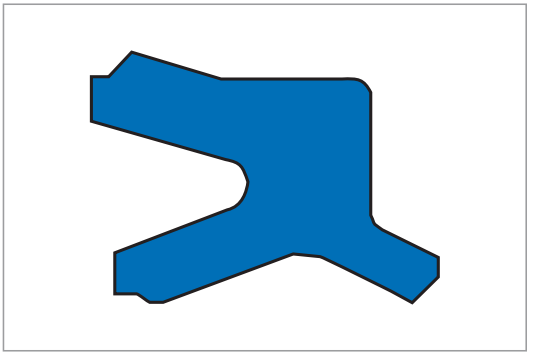
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL 300 for small cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Combination Seal NIPSL 310



Merkel Combination Seal NIPSL 310

Product description

Compact combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Material with high wear resistance.

Application

Small cylinders, compact cylinders.

Material

Material	Code	Hardness
High performance polyurethane	85 AU 20991	85 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−30 ... +80 °C
Running speed v	≤1 m/s

Design notes

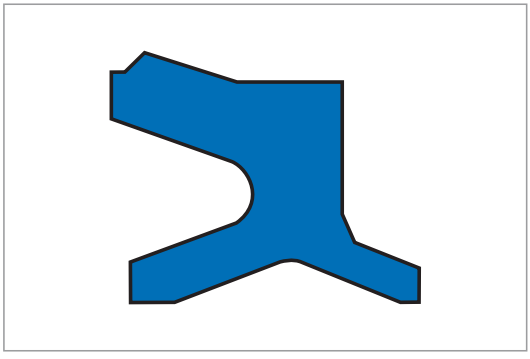
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	–
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL 310 for small cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Combination Seal NIPSL 320



Merkel Combination Seal NIPSL 320

Product description

Combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Material with high wear resistance.

Application

Small cylinders, compact cylinders.

Material

Material	Code	Hardness
High performance polyurethane	94 AU 925	94 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	–30 °C ... +90 °C
Running speed v	≤1 m/s

Design notes

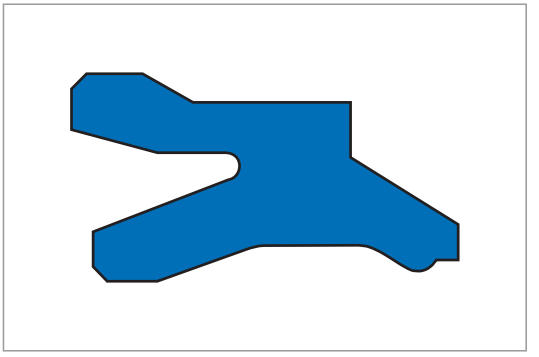
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	–
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL 320 for small cylinders and compact cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Combination Seal NIPSL SF



Merkel Combination Seal NIPSL SF

Product description

Combination wiper seal without metal reinforcement with special pneumatic sealing edge.

Product advantages

- Combination seal with minimal space requirements, which seals inwards and wipes outwards
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Optimal material for high loads.

Application

Small cylinders.

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	90 NBR 108	90 Shore A

FKM on enquiry.

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

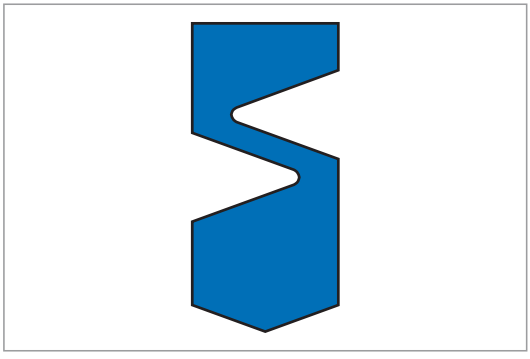
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Combination Seal NIPSL SF for small cylinders can be snapped by hand into the housing grooves provided, with the piston rod removed.

Merkel Compact Seal Airzet PR



Merkel Compact Seal Airzet PR

Product description

Merkel Compact Seal can be pressurised on both sides with grooves on the front side for pressure activation.

Product advantages

- The compact design permits short cylinder cover designs
- The rounded sealing profile and the flexible centre part give good tightness with low friction and maintain an effective lubricating film
- Widely proven design
- Large supply range available
- Very good tribological properties (wear, friction and long service life).

Application

- Short cylinders
- Short solution for cylinders (short stroke) and valves for high-temperature applications (only FKM).

Material

Material	Code	Hardness
NBR rubber	80 NBR 186349	80 Shore A
Fluoro elastomer	75 FKM 230553	75 Shore A

Operating conditions

Material	NBR	FKM
Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)	
Operating pressure p	≤1,2 MPa (12 bar)	
Temperature T	−20 ... +100 °C	−5 ... +150 °C
Running speed v	≤1 m/s	

Design notes

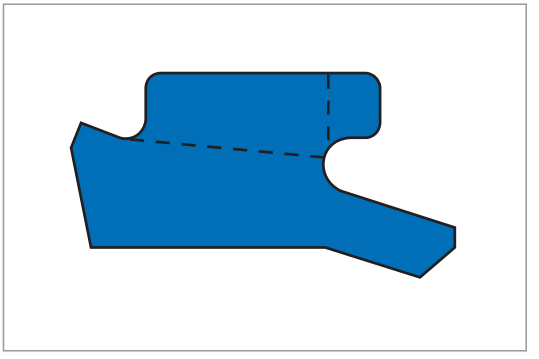
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Compact Seal Airzet PR is snapped over the de-burred housing edge into the housing groove. An axiallyaccessible housing is required for rod diameters less than 15 mm.

Merkel Damper Seal AU DIP



Merkel Damper Seal AU DIP

Product description

Merkel Damper Seal AU DIP with spacer lug and flow passages. Integrated non-return valve function due to axial seal, spacer lugs and flow passages.

Product advantages

- Constant, reliable damping function due to automatic centring.

Application

Damping element e.g. for ISO cylinders.

Material

Material	Code	Hardness
High performance polyurethane	90 AU 924 all Ø ≤10 94 AU 925 Ø >10	90 Shore A 94 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤2,5 MPa (25 bar)
Temperature T	−30 ... +90 °C
Running speed v	≤1 m/s

Design notes

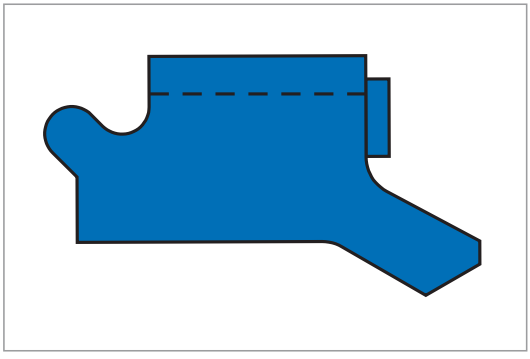
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Merkel damper seals can be snapped by hand into the housing grooves provided.

Merkel Damper Seal DIP



Merkel Damper Seal DIP

Product description

Merkel Damper Seal DIP with spacer lug and flow passages.

Product advantages

- Integrated non-return valve function through axial seal, spacer lugs and flow passages
- Constant, reliable damping function due to automatic centring.

Application

Damper seal e.g. for ISO cylinders.

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	90 NBR 109	90 Shore A

FKM on enquiry.

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,6 MPa (16 bar)
Temperature T	−30 ... +100 °C
Running speed v	≤1 m/s

Design notes

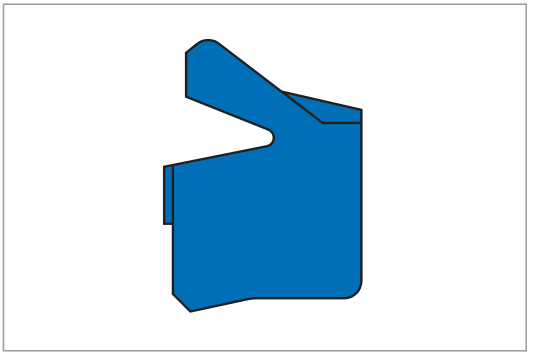
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Merkel damper seals can be snapped by hand into the housing grooves provided.

Merkel U-Ring NAP 210



Merkel U-Ring NAP 210

Product description

Compact Merkel U-ring with asymmetrical profile and special pneumatic sealing edge on the dynamic sealing lip.

Product advantages

- The asymmetrical profile with the longer and thicker static sealing lip ensures secure seating in the bottom of the groove
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Large range
- Minimal axial space requirements
- Integrated pressure relief to prevent an intermediate pressure build-up.

Application

- Piston seal for pneumatic cylinders
- Piston seal for high-temperature cylinders (only FKM).

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	80 NBR 99079	80 Shore A
Fluoro elastomer	75 FKM 99104	75 Shore A

Operating conditions

Material	NBR	FKM
Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)	
Operating pressure p	≤1,2 MPa (12 bar)	
Temperature T	−25 ... +100 °C	−5 ... +200 °C
Running speed v	≤1 m/s	

Design notes

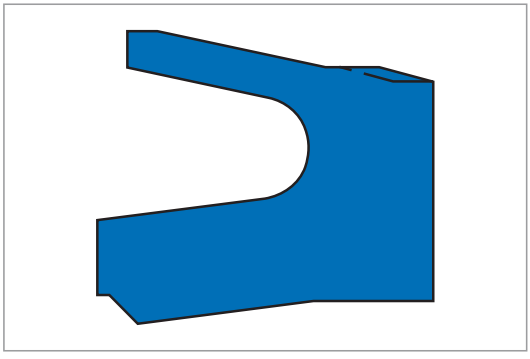
Surfaces

Surface roughness	R_{max}	R_p/R_z
Rod/cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Pneumatic U-rings can be snapped by hand into the housing grooves provided.

Merkel U-Ring NAP 300



Merkel U-Ring NAP 300

Product description

Merkel U-ring with asymmetrical profile and special pneumatic sealing edge on the dynamic sealing lip.

Product advantages

- The asymmetrical profile with the longer and thicker static sealing lip ensures secure seating in the bottom of the groove
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Material with high wear resistance
- Good low temperature properties.

Application

Piston seal e.g. for ISO pneumatic cylinders.

Material

Material	Code	Hardness
High performance polyurethane	80 AU 941	80 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−35 ... +80 °C
Running speed v	≤1 m/s

Design notes

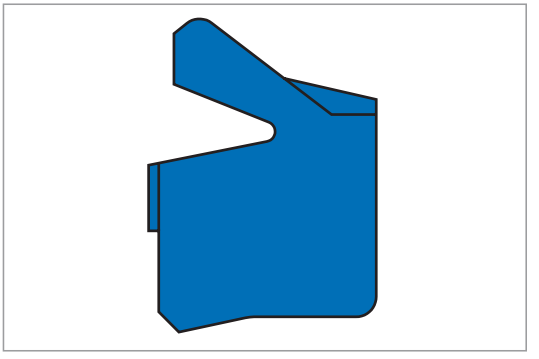
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Pneumatic U-rings can be snapped by hand into the housing grooves provided.

Merkel U-Ring NAP 310



Merkel U-Ring NAP 310

Product description

Compact Merkel U-ring with asymmetrical profile and special pneumatic sealing edge on the dynamic sealing lip.

Product advantages

- The asymmetrical profile with the longer and thicker static sealing lip ensures secure seating in the bottom of the groove
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Material with high wear resistance
- Good low temperature properties.

Application

Piston seal e.g. for ISO pneumatic cylinders.

Material

Material	Code	Hardness
High performance polyurethane	80 AU 20994	80 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−35 ... +80 °C
Running speed v	≤1 m/s

Design notes

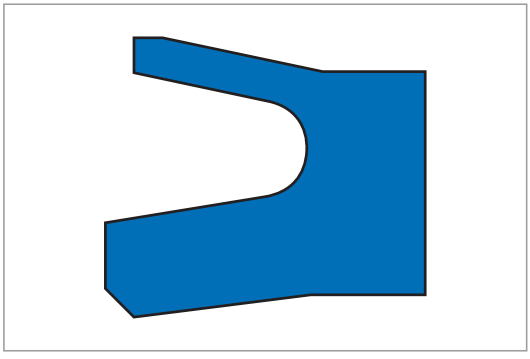
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Pneumatic U-rings can be snapped by hand into the housing grooves provided..

Merkel U-Ring NAPN



Merkel U-Ring NAPN

Product description

Merkel U-ring with asymmetrical profile and special pneumatic sealing edge on the dynamic sealing lip.

Product advantages

- The asymmetrical profile with the longer and thicker static sealing lip ensures secure seating in the bottom of the groove
- The special pneumatic sealing edge gives very good tightness with low friction and maintains an effective lubricating film
- Widely proven design
- Large supply range available
- Very good tribological properties (wear, friction and long service life).

Application

Piston seal e.g. in the ISO cylinder (only FKM: for high-temperature applications).

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	80 NBR 186349	80 Shore A
Fluoro elastomer	75 FKM 230553	75 Shore A

Operating conditions

Material	NBR	FKM
Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)	
Operating pressure p	≤1 MPa (10 bar)	
Temperature T	−20 ... +100 °C	−5 ... +150 °C
Running speed v	≤1 m/s	

Design notes

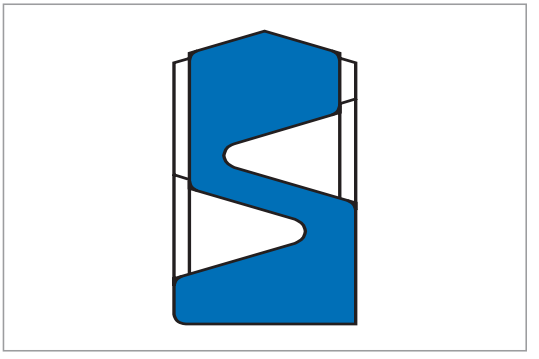
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. Pneumatic U-rings can be snapped by hand into the housing grooves provided.

Merkel Compact Seal Airzet PK



Merkel Compact Seal Airzet PK

Product description

Merkel Compact Seal Airzet PK can be pressurised on both sides with grooves on the front side for pressure activation.

Product advantages

- The compact design permits short piston designs
- The rounded sealing profile and the flexible centre part give good tightness with low friction and maintain an effective lubricating film
- Widely proven design
- Large supply range available
- Very good tribological properties (wear, friction and long service life).

Application

- Short-stroke cylinders
- Valves and cylinders, especially short-stroke cylinders for high-temperature applications (only FKM).

Material

Material	Code	Hardness
NBR rubber	80 NBR 186349	80 Shore A
Fluoro elastomer	75 FKM 230553	75 Shore A

Operating conditions

Material	NBR	FKM
Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)	
Operating pressure p	≤1,2 MPa (12 bar)	
Temperature T	−20 ... +100 °C	−5 ... +150 °C
Running speed v	≤1 m/s	

Design notes

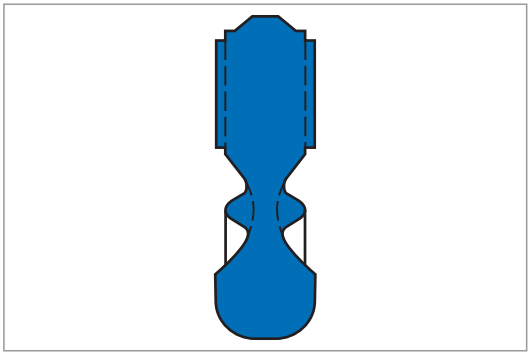
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel compact seal Airzet PK is snapped over the de-burred housing edge into the housing groove.

Merkel Compact Seal KDN



Merkel Compact Seal KDN

Product description

- Merkel Compact Seal can be pressurised on both sides with grooves on the front side for pressure activation.

Product advantages

- The compact design permits short piston designs
- The rounded sealing profile and the flexible centre part give good tightness with low friction and maintain an effective lubricating film.

Application

Short-stroke cylinders.

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	72 NBR 708	72 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

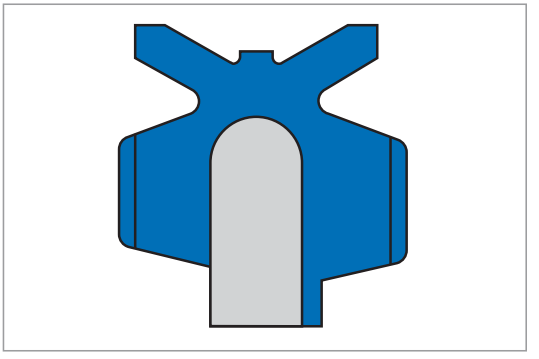
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	
Groove base	≤10 µm	<0,5

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal.Merkel Compact Seal KDN is snapped over the de-burred housing edge into the housing groove.

Merkel Complete Piston NADUOP



Merkel Complete Piston NADUOP

Product description

Short Merkel complete piston with steel base plate, vulcanised buffers and sealing lips with special pneumatic sealing edges. Ready to install Merkel complete piston with integrated guide that can be pressurised on both sides.

Product advantages

- Vulcanised buffers for end-position damping of piston in the cylinder
- Radial venting passages for reliable pressure application at the end of the stroke.

Application

Pneumatic cylinders.

Material

Material	Code	Hardness	Base plate
Acrylonitrile-butadiene rubber	72 NBR 708	72 Shore A	mild steel according to DIN 1624

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

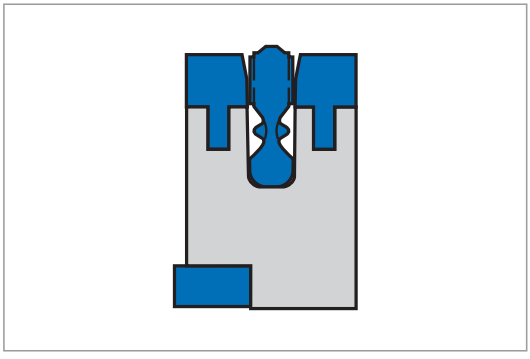
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston NADUOP is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Complete Piston Pneuko G



Merkel Complete Piston Pneuko G

Product description

Merkel complete piston with light alloy/polyamide body, snap-action seal and integrated guide.

Product advantages

- Ready to fit Merkel complete piston with very low height to which pressure can be applied on both sides
- Easily fastened to the piston rod
- Integrated static seal on the inside diameter.

Application

Pneumatic cylinder without request, frequent special cylinder.

Material

Material	Acrylonitrile-butadiene rubber
Code	72 NBR 708
Hardness	72 Shore A
Base plate	Al (POM 20 for Ø ≤25)
Guide	PA 4601 (POM for Ø ≥25)
Static seal	72 NBR 872

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1 MPa (10 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

Careful fitting is a prerequisite for the correct function of the seal. The complete piston is fitted to shouldered end of the piston rod and fastened with washers (up to and including Ø 25 DIN 125 ≥ Ø 25 DIN 1440) and a nut. The threaded fitting is to be protected against loosening.

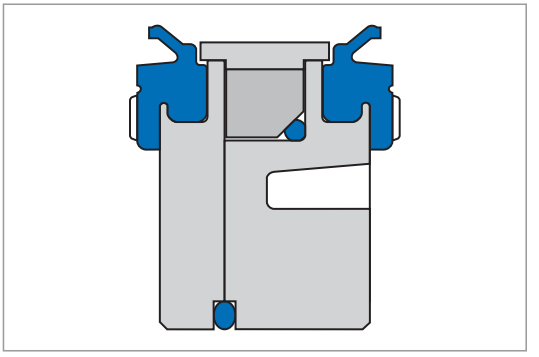
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	

Fitting & installation

Prior to installation in the cylinder, grease all cylinder contact surfaces evenly. Do not introduce any grease into the piston groove.

Merkel Complete Piston Pneuko M 210



Merkel Complete Piston Pneuko M 210

Product description

The compact, short, Merkel complete pneumatic piston Pneuko M consists of an aluminium body, guide strip, a magnet and the sealing body with a special sealing edge on the sealing lip and integrated buffers made of very wear resistant fluoro elastomer FKM for special applications.

Product advantages

- Long service life
- Low start friction due to optimised sealing lip geometry and additional venting passages
- Constant good sealing behaviour over a wide pressure range (to 1,2 MPa)
- Running properties without tendency to tilt due to a guide strip optimised for the application
- Aluminium body brings weight saving and permits high energy absorption
- Easily fastened to the piston rod
- Integrated static seal
- Supplied suitable for storage and fitting in deep-drawn inserts
- Simple provisioning
- Integrated magnet for a position check using a sensor.

Application

Broad range of uses, only one piston for short stroke cylinders, compact cylinders, round cylinders and ISO cylinders.

Material

Material	Code	Hardness
Fluoro elastomer	75 FKM 181327	70 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−5 ... +150 °C
Running speed v	≤1 m/s

Design notes

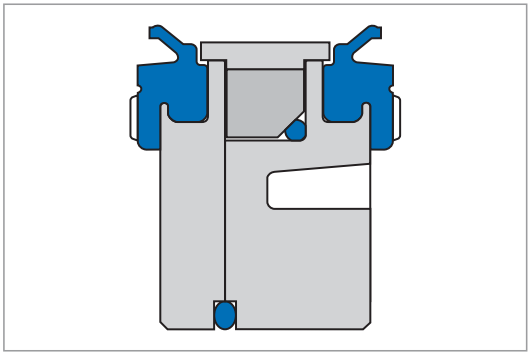
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston Pneuko M 210 is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Complete Piston Pneuko M 310



Merkel Complete Piston Pneuko M 310

Product description

The compact, short, Merkel complete pneumatic piston Pneuko M consists of an aluminium body, guide strip, a magnet and the sealing body with a special sealing edge on the sealing lip and integrated buffers made of very wear resistant polyurethane.

Product advantages

- Long service life
- Low start friction due to optimised sealing lip geometry and additional venting passages

Constant good sealing behaviour over a wide pressure range (to 1,2 MPa)

- Running properties without tendency to tilt due to a guide strip optimised for the application
- Aluminium body brings weight saving and permits high energy absorption
- Easily fastened to the piston rod
- Integrated static seal
- Supplied suitable for storage and fitting in deep-drawn inserts
- Simple provisioning
- Integrated magnet for a position check using a sensor.

Application

Broad range of uses, only one piston for short stroke cylinders, compact cylinders, round cylinders and ISO cylinders.

Material

Material	Code	Hardness
High performance polyurethane	80 AU 21000	80 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−25 ... +80 °C
Running speed v	≤1 m/s

Design notes

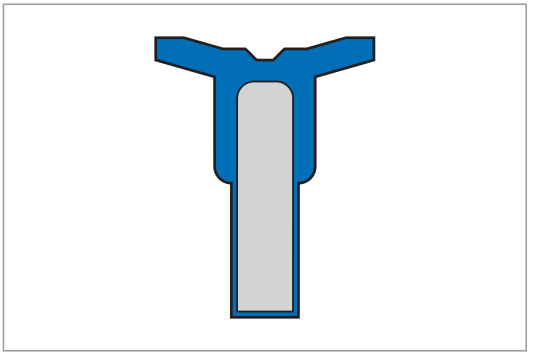
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston Pneuko M 310 is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Complete Piston TDUOP



Merkel Complete Piston TDUOP

Product description

Merkel complete piston with steel base plate and vulcanised sealing lips with special pneumatic sealing edges.

Product advantages

- Ready to fit complete piston to which pressure can be applied on both sides with integrated guide
- Easily fastened to the piston rod without additional sealing components
- Long service life
- Constant good sealing behaviour over a wide pressure range (to 1,2 MPa)
- Simple provisioning.

Application

Pneumatic cylinder without request.

Material

Material	Code	Hardness	Base plate
NBR rubber	72 NBR 708	72 Shore A	mild steel according to DIN 1624

FKM on enquiry.

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

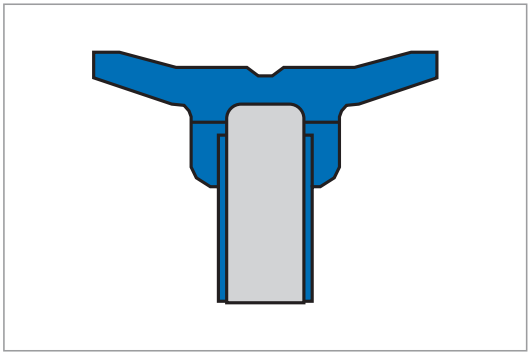
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 70%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston TDUOP is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Complete Piston TDUOP with Venting Passages



Merkel Complete Piston TDUOP with Venting Passages

Product description

- Merkel complete piston with steel base plate and vulcanised sealing lips with special pneumatic sealing edges
- Ready to fit complete piston to which pressure can be applied on both sides with integrated guide
- Easily fastened to the piston rod without additional sealing components
- The design with radial venting passages on the front sides facilitates reliable pressure application at the end of the stroke.

Product advantages

- Long service life
- Low start friction due to optimised sealing lip geometry and supported by additional venting passages
- Constant good sealing behaviour over a wide pressure range (to 1,2 MPa)
- Easily fastened to the piston rod
- Simple provisioning.

Application

Pneumatic cylinder without request.

Material

Material	Code	Hardness	Base plate
NBR rubber	72 NBR 708	72 Shore A	mild steel according to DIN 1624

FKM on enquiry.

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−20 ... +100 °C
Running speed v	≤1 m/s

Design notes

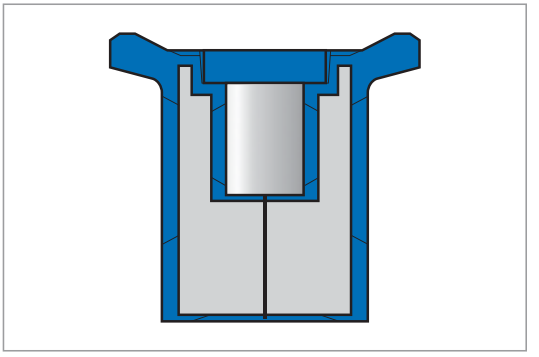
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston TDUOP with Venting Passages is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Complete Piston TDUOP M



Merkel Complete Piston TDUOP M

Product description

The compact, short, Merkel Complete Piston TDUOP M consists of an aluminium body, a guide strip, a magnet and a sealing element with a special sealing edge on the sealing lip.

Product advantages

- Broad range of uses, only one complete piston for round cylinders and ISO cylinders
- Long service life
- Low start friction due to optimised sealing lip geometry
- Constant good sealing behaviour over a wide pressure range (to 1,2 MPa)
- Running properties without tendency to tilt due to a guide strip optimised for the application
- Aluminium body brings weight saving and permits high energy absorption
- Easily fastened to the piston rod
- Integrated static seal
- Supplied suitable for storage and fitting in deep-drawn inserts
- Simple provisioning
- Integrated magnet for a position check using a sensor.

Application

Pneumatic cylinder with request.

Material

Material	Code	Hardness
Acrylonitrile-butadiene rubber	72 NBR 708	72 Shore A

Operating conditions

Medium	Prepared, dried and de-oiled compressed air (after greasing for fitting)
Operating pressure p	≤1,2 MPa (12 bar)
Temperature T	−20 ... +80 °C
Running speed v	≤1 m/s

Design notes

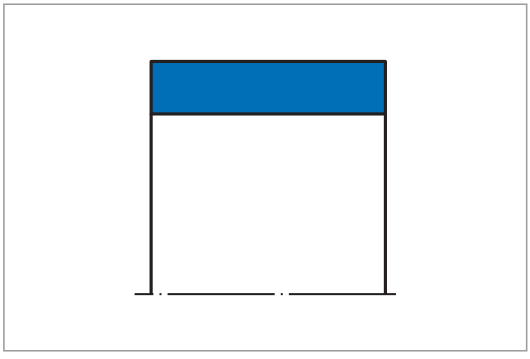
Surfaces

Surface roughness	R_{max}	R_p/R_z
Cylinder barrel	≤4 µm	<0,5
	tp (25% R_{max}) = 50 ... 75%	

Fitting & installation

Careful fitting is a prerequisite for the correct function of the seal. The Merkel Complete Piston TDUOP M is fitted to shouldered end of the piston rod and fastened with washers and a nut. The threaded fitting is to be protected against loosening.

Merkel Guide Strip SF



Merkel Guide Strip SF

Product description

Non-metallic Merkel Guide Strip SF, available ready to fit cut to size or by the metre.

Product advantages

As a non-metallic guide element for rods, also for standardised housings according to ISO 10766

- Low friction, free of stick-slip.

Application

Control and regulation equipment, handling equipment, injection moulding machines.

Material

Material	Code
PTFE bronze compound	PTFE B500

Operating conditions

Material	PTFE B500
	Temperature range in °C
Hydraulic oils HL, HLP	−40 ... +200
HFA fluids	–
HFB fluids	–
HFC fluids	–
HFD fluids	−40 ... +200
Water	–
HETG (rapeseed oil)	−40 ... +80
HEES (synthetic esters)	−40 ... +100
HEPG (glycol)	−40 ... +80
Mineral greases	−40 ... +200

Surface quality

Surface roughness	R_a	R_{max}
Sliding surface	0,05 ... 0,3 µm	≤2,5 µm
Groove base	≤2 µm	≤10,0 µm
Side of groove	≤3 µm	≤15,0 µm

Percentage contact area M_r >50% to max. 90% at cutting depth c = Rz/2 and reference line C ref = 0%..

Design notes

Please observe our general design notes.

Calculating straight length L2

L2	Production tolerances
>20 ... 80	... 0,5
>80 ... 250	... 1,0
>250 ... 500	... 1,5
>500 ... 1000	... 2,0
>1000 ... 2000	... 3,0
>2000 ... 4000	... 4,0

Tolerance recommendation

D_1
H8

The tolerance definition for the dimensions D and d_F must be viewed in connection with the seal used. The diameter d_1 specified in the table of dimensions is to is to be viewed exclusively in relation to the guide ring. The corresponding diameter of an adjacent seal housing should be tailored to the sealing component.

Manufacturing tolerance

Production tolerance profile thickness S
–0,05

Surface load

p <15 N/mm² up to 20 °C
p <7,5 N/mm² up to 80 °C
p <5 N/mm² up to 120 °C

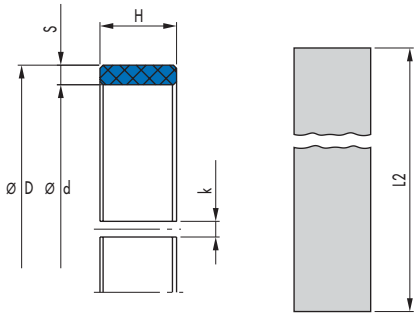
For running speed, see sealing system.

Cutting rolls to size

The following dimensions are available from stock by the metre. The straight length L2 of blanks is to be determined using the formula. The gap k produced after fitting is necessary due to thermal expansion. We recommend a straight cut on the strips. In the event of butt joints the tips may be damaged and break-off. Our cutter (Article No. 507228) facilitates time-saving and accurate cutting to size.

Calculation of the straight length L2 for rods:

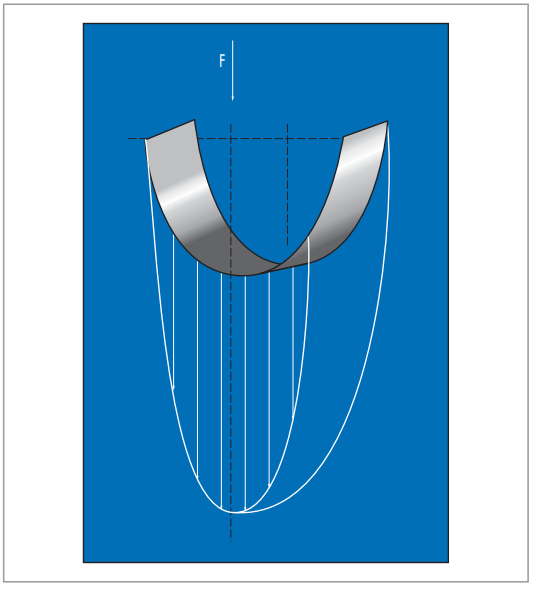
L2 = (d + S) x 3,11 − 0,5

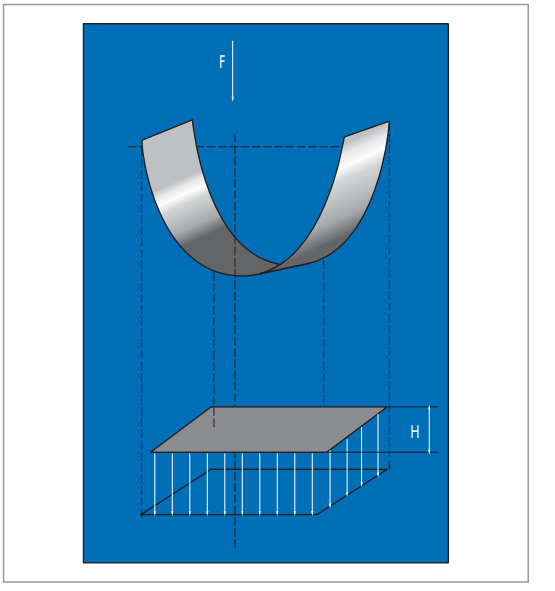


Groove length L	Profile thickness S	Article No.
8	2,5	24226174
9,7	2,5	24102775
10	2,5	24102563
12	2,5	24099191
15	2,5	24102564
20	2,5	24076217
25	2,5	24107955
15	4,0	24160019
20	4,0	24238052
25	4,0	24148093

Surface force

The pressure distribution on the guide rings is non-linear. The non-linear pressure curve over the contact range was taken into account when calculating the permissible specific surface pressure. The permissible load on the guide strip is calculated by multiplying the projected surface with the permissible specific surface pressure. However, the figure for the permissible specific surface pressure takes into account the possible angular offset of the rods when the recommended guide elements are used.

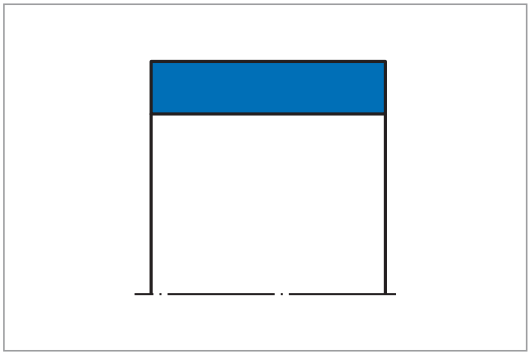




F = P x A
H = F / (d x P)

H = guide strip width [mm]
F = radial loading [N]
A = projected area [mm²]
P = perm. compression per unit area [N/mm²]
d = rod diameter with rod guidance;
piston diameter with piston guidance [mm].

Merkel Guide Ring EKF



Merkel Guide Ring EKF

Product description

Slit, non-metallic Merkel Guide Ring EKF.

Product advantages

Non-metallic guide element for pistons.

Application

Standard cylinders, mobile hydraulics, injection moulding machines.

Material

Material	Code
Polyamide	PA 4201

Operating conditions

Material	PA 4201
	Temperature range in °C
Hydraulic oils HL, HLP	−30 ... +100
HFA fluids	+5 ... +50
HFB fluids	+5 ... +50
HFC fluids	−30 ... +50
HFD fluids	–
Water	+5 ... +50
HETG (rapeseed oil)	−30 ... +60
HEES (synthetic ester)	−30 ... +80
HEPG (glycol)	−30 ... +50
Mineral greases	−30 ... +100
Running speed v in m/s	1
Loading (permitted specific surface pressure*)	≤25 N/mm² at 20 °C ≤15 N/mm² at 100 °C

* For the simple determination of the loading, a constant surface pressure is calculated using the projected area (D x H). The actual surface pressure is clearly greater in the centre of the surface than the calculated surface pressure. This is taken into account in the value for the permissible specific surface pressure.

Surface quality

Surface roughness	R_a	R_{max}
Sliding surface	0,05 ... 0,3 µm	≤2,5 µm
Groove base	≤2 µm	≤10,0 µm
Groove flanks	≤3 µm	≤15,0 µm

Percentage contact area M_r >50% to max. 90% at cutting depth c = Rz/2 and reference line C ref = 0%.

Design notes

Please observe our general design notes.

Tolerance recommendation

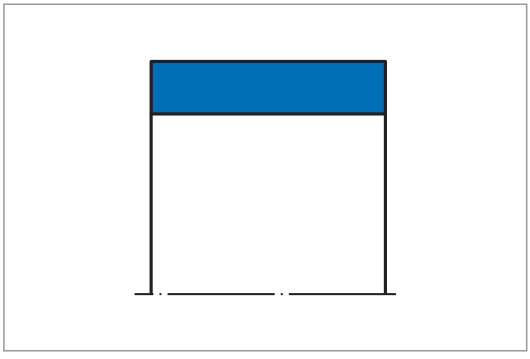
D_1	d_F	d_{F1}
H8	h8	h9

The tolerances give are recommended values. The usage of the guide and tolerance definition are to be considered in connection with the seal employed. The diameter d_{F1} given in the table of dimensions is to be considered exclusively in relation to the guide ring. The corresponding diameter for the adjacent seal housing is to be matched to the sealing component.

Fitting & installation

Merkel Guide Ring EKF can be easily snapped into the housing groove. Careful fitting is a prerequisite for correct function.

Merkel Guide Strip KF



Merkel Guide Strip KF

Product description

Non-metallic Merkel Guide Strip KF, available ready to fit cut to size or by the metre.

Product advantages

Non-metallic guide element for pistons, also for standardised housings as per ISO 10766

- Low friction, free of stick-slip.

Application

Injection moulding machines, control and regulation equipment, handling equipment.

Material

Material	Code
PTFE bronze compound	PTFE B500

Operating conditions

Material	PTFE B500
	Temperature range in °C
Hydraulic oils HL, HLP	−40 ... +200
HFA fluids	–
HFB fluids	–
HFC fluids	–
HFD fluids	−40 ... +200
Water	–
HETG (rapeseed oil)	−40 ... +80
HEES (synthetic esters)	−40 ... +100
HEPG (glycol)	−40 ... +80
Mineral greases	−40 ... +200

Surface quality

Surface roughness	R_a	R_{max}
Sliding surface	0,05 ... 0,3 µm	≤2,5 µm
Groove base	≤2 µm	≤10,0 µm
Groove flanks	≤3 µm	≤15,0 µm

Percentage contact area M_r >50% to max. 90% at cutting depth c = Rz/2 and reference line C ref = 0%.

Design notes

Please observe our general design notes.

Calculating straight length L2

L2	Production tolerances
>20 ... 80	... 0,5
>80 ... 250	... 1,0
>250 ... 500	... 1,5
>500 ... 1000	... 2,0
>1000 ... 2000	... 3,0
>2000 ... 4000	... 4,0

Tolerance recommendation

d_1
h8

The tolerance definition for the dimensions D and d_F must be viewed in connection with the seal used. The diameter D_1 specified in the table of dimensions is to is to be viewed exclusively in relation to the guide ring. The corresponding diameter of an adjoining seal housing should be tailored to the sealing component.

Manufacturing tolerance

Production tolerance profile thickness S
–0,05

Surface load

p <15 N/mm² up to 20 °C
p <7,5 N/mm² up to 80 °C
p <5 N/mm² up to 120 °C

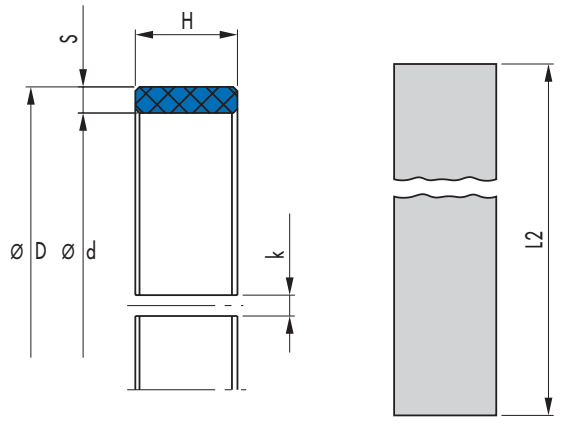
For running speed, see sealing system.

Cutting rolls to size

The following dimensions are available from stock by the metre. The straight length L2 of blanks is to be determined using the formula. The gap k produced after fitting is necessary due to thermal expansion. We recommend a straight cut on the strips. On impact at an angle the tips may be damaged and break-off. Our cutter (Article No. 507228) facilitates time-saving and accurate cutting to size.

Calculating stretched length L2 for rods:

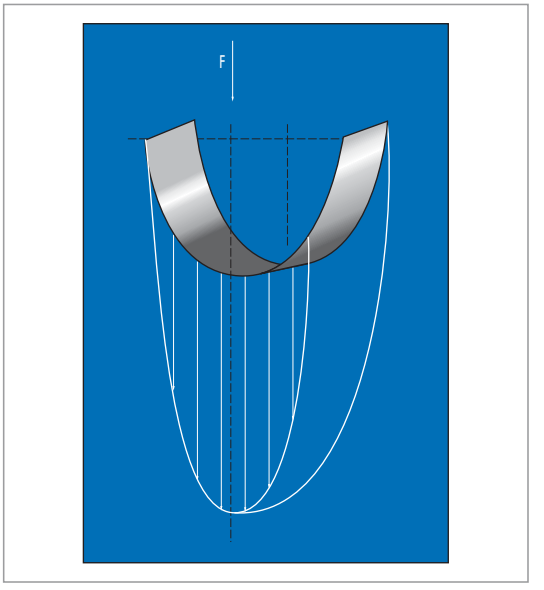
L2 = (D – S) x 3,11 – 0,5

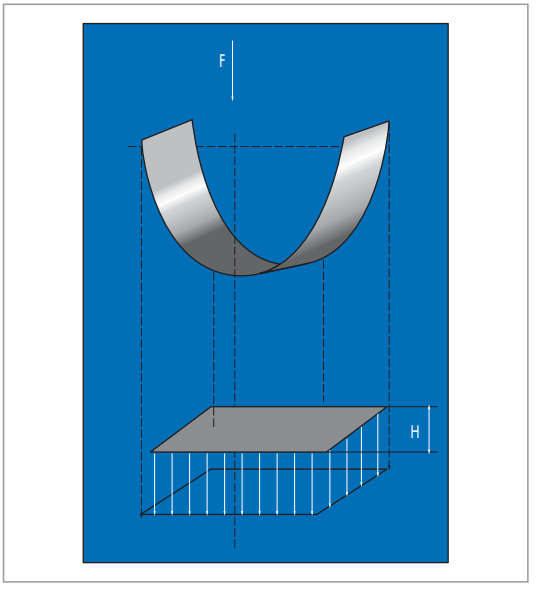


Groove length L	Profile thickness S	Article No.
8	2,5	24226174
9,7	2,5	24102775
10	2,5	24102563
12	2,5	24099191
15	2,5	24102564
20	2,5	24076217
25	2,5	24107955
15	4,0	24160019
20	4,0	24238052
25	4,0	24148093

Surface force

The pressure distribution on the guide rings is non-linear. The non-linear pressure curve over the contact range was taken into account when calculating the permissible specific surface pressure. The permissible load on the guide strip is calculated by multiplying the projected area with the permissible specific surface pressure. However, the figure for the permissible specific surface pressure takes into account the possible angular offset of the piston when the recommended guide elements are used.





F = P x A
H = F / (d x P)

H = guide strip width [mm]
F = radial loading [N]
A = projected area [mm²]
P = perm. compression per unit area [N/mm²]
d = rod diameter with rod guidance;
piston diameter with piston guidance [mm].