



SEALING SOLUTIONS FOR THE HYDRAULICS INDUSTRY



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The information reproduced herein is based on laboratory tests and is not necessarily indicative of the performance of the end product. Complete testing and the performance of the end product are the user's responsibility.



COMPANY

The Freudenberg Group was founded in 1849 and is still owned by the approximately 300 descendants of the company founder. The resulting financial stability and social awareness are decisive success factors that create trust. Today, Freudenberg is a global, broadly diversified group of companies divided into Business Groups that operate in a wide variety of sectors. The company has always been considered an innovation and technology leader, from Vileda® brand household products to technically complex sealing solutions.

Freudenberg Sealing Technologies (FST) is the largest Business Group in the Freudenberg Group and is part of the Seals and Vibration Control Technology division. FST is a supplier, development and service partner for customers in a wide range of market segments, such as the automotive, civil aviation, mechanical engineering, shipbuilding, pharmaceutical, agricultural, construction machinery and food and beverage industries.

Starting with the Simmerring® developed by Freudenberg in 1929, FST now has a broad, continuously customer-oriented product portfolio of premium sealing technology for highly demanding applications – from tailor-made individual solutions to complete sealing packages. The company benefits from more than 170 years of engineering and materials experience in the research, development and introduction of innovative product and process solutions.

Freudenberg Sealing Technologies rounds off its portfolio with complementary industry-standard solutions from the Dichtomatik product brand. The two-brand strategy is part

of FST's comprehensive service portfolio and guarantees a full range of seals and product-related services. Dichtomatik products are manufactured by certified suppliers and are available in numerous seal forms and materials. They are suited for moderate operating conditions in static and dynamic applications and for fluid seals in a wide range of market segments. These include the hydraulics industry, the wind power plant industry, agricultural machinery and systems and components for general mechanical engineering. For more specific applications, e.g. in the food industry, Dichtomatik brand products are also available in certified materials.

Freudenberg Industrial Services offers technical services such as the preparation of drawings, radial force measurements, comprehensive quality and material documentation as well as material modifications and testing to ensure that all seals function reliably even in individual applications. Furthermore, local availability ensures short distances and fast response times to best serve customer needs.

FST SERVES THE ENTIRE SEALING MARKET AND THUS MEETS ALL MARKET REQUIREMENTS – QUICKLY, RELIABLY AND FROM A SINGLE SOURCE.

INDUSTRY-SPECIFIC AND CUSTOMIZED SERVICE CONCEPTS

ONLINE ORDERING PLATFORM EASY

The EASY online ordering platform enables easy order processing, as well as price, delivery time and stock queries around the clock. Besides detailed product information, installation space and cross-sectional drawings are available for download. The EASY Business Connector is used to transfer your orders directly to your SAP system. This ensures that you are always up to date on the status of your order. Register today if you do not yet have an EASY account.



APPLICATION KNOW-HOW

Dichtomatik products are also certified for special applications, e.g. in the food industry. This enables us to find the right solution for every application. To ensure that seals function reliably even in individual applications, our team of experts offers technical services such as drawing preparation, radial force measurements, comprehensive quality and material documentation as well as material modifications and testing. Customer-specific sealing solutions, kitting and single packaging are just some of the other services that can be offered (offerings vary by country).



LOGISTICAL SERVICES AND QUALITY STANDARDS

The 6,500 m² warehouse in Hamburg, which functions as a European logistics hub, has just one objective: delivering Dichtomatik's uniquely high number of warehoused items as quickly as possible to the locations they are needed at. In addition to the roughly 60,000 standard dimensions, around 15,000 customer-specific seals are available from stock. Additional warehouse locations around the world support the supply chain to ensure rapid availability for our customers.



Special logistics solutions, such as Kanban or vendor-managed inventory, quality testing and simplified customs processes due to certifications, simplify order processing. The location in Hamburg (incl. the warehouse) is certified according to DIN ISO 9001 and DIN ISO 14001, thus guaranteeing standardized processes in the quality and environmental management system. In addition, current processes are

analyzed and improved in regular Kaizen workshops. Furthermore, warehouse processes are supported by new technologies. For example, the forklifts have been converted into mobile workstations by using tablets and portable printers, and innovative glove scanners are used for scanning processes. Our other warehouses also meet the highest quality requirements and are part of regular certifications.

PRODUCT PORTFOLIO OF THE DICHTOMATIK BRAND

STATIC APPLICATIONS



The whole range of static seals – O-rings, cords, x-rings, cover seals, bolt seals, flange and profile seals, etc. is available in a large number of dimensions including metric, inch and other international standards. The variety of materials, also with application-specific certifications, leaves nothing to be desired.

ROTATING MOVEMENTS



Rotary shaft seals are available in the standard versions with and without protective lips and in the materials NBR and FKM. In addition to the standard designs, the product range also includes special designs of rotary shaft seals, axial seals, shaft sleeves and radial seals for rotary and swivel movements.

TRANSLATIONAL MOVEMENTS



Piston seals, rod seals, wipers, guide belts and rings for hydraulics are available from stock in countless standard dimensions in the materials including NBR, PTFE, TPU, hard fabric and NBR fabric-reinforced. Application-specific modifications of the design or material can also be realized.

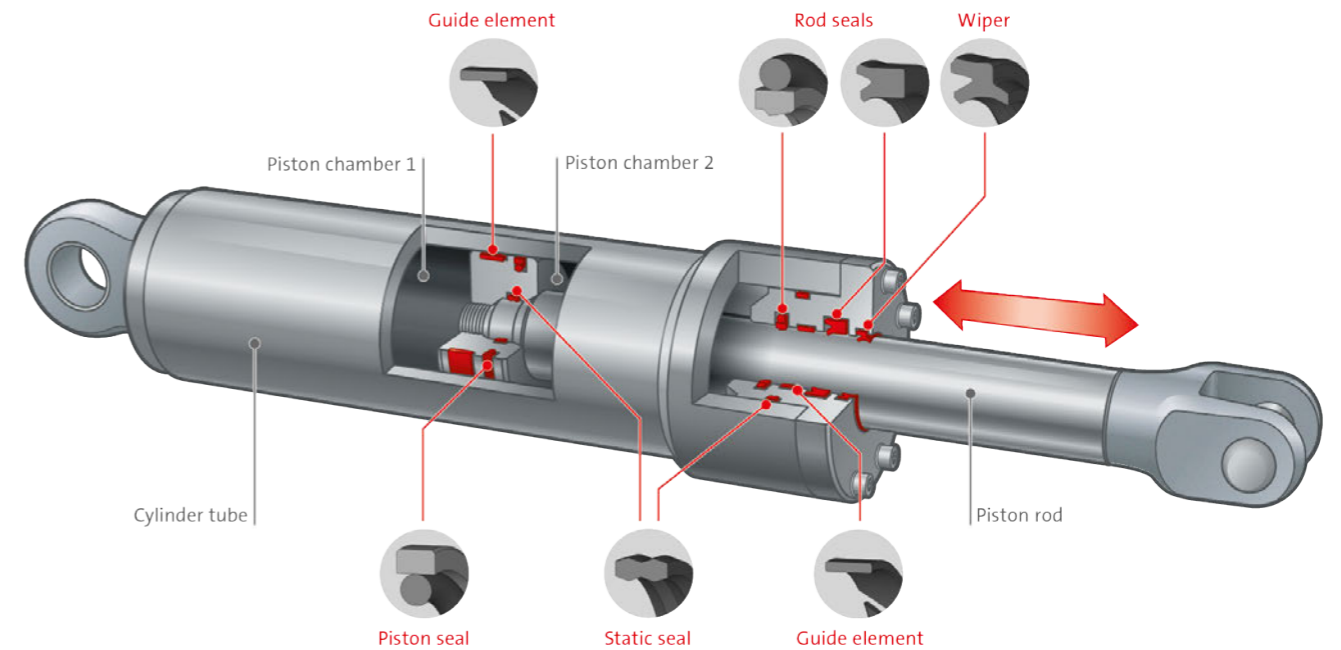
IMPORTANT NOTE

Dichtomatik products comply with the industrial standard. For this reason, they are not recommended for use in the automotive industry, especially in safety-relevant applications. An overview of complementary premium sealing solutions can be found at www.fst.com.





STRUCTURE AND SEALING COMPONENTS OF A HYDRAULIC CYLINDER



THE COMPONENTS USED IN HYDRAULICS INCLUDE

- Piston seals
- Piston rod seals/rod seals
- Wipers
- Guiding elements
- O-Rings

The requirements for the application are the decisive factor for selecting the seal profile and other seal components. Other factors to consider for a hydraulic seal to be effective include

- Functional reliability
- Easy assembly
- High durability
- Low friction
- Compatibility with the operating medium taking the operating temperatures into account

Piston seals

The function of the piston seal is to seal the piston against the cylinder barrel, thus allowing pressure to build up inside the piston chamber.

Rod seals

Rod seals have the task of sealing the retracting and extending piston rod to prevent the pressurized operating media from escaping from the cylinder.

Wipers

Wipers “wipe off” the dirt or foreign matter on the rod, thus preventing contamination from entering the hydraulic system.

Guide elements

Guide elements (guide bands and guide rings) are used to guide pistons and piston rods and avoid direct metal contact, which can be caused by transverse forces occurring.

POSSIBLE APPLICATIONS IN HYDRAULICS

- Construction machinery
- Agricultural machinery
- Mining machinery
- Mechanical and apparatus engineering

HYDRAULIC COMPONENTS

Sealing components for hydraulic applications are used to seal linear/reciprocating moving components. Sealing elements are selected according to the application at hand and its operating parameters, such as pressure, speed, hydraulic medium and operating temperature.

INTRODUCTION TO THE DESIGNATIONS

Designations of our hydraulic seals

Our nomenclature

N = U-Cup
 K = Piston seal
 S = Rod seal
 A = Wiper
 F = Guide elements

Types

Within the assemblies listed above, we distinguish between the following types:

Assembly	Type	Description
N		(N) U-Cup symmetrical
K	NA	(K) Piston Seal (N) U-Cup asymmetrical (A) Outer sealing
S	NI	(S) Rod Seal (N) U-Cup asymmetrical (I) Sealing inside
K	K	(K) Piston seal compact
K;S	POR	(K;SPOR) Pistons; Rod PTFE seal with an O-Ring preload element
K	PUOR	(KPUOR) Piston polyurethane seal with an O-Ring preload element
K;S	DS	(K;SDS) Pistons; Rods roof cuff set
A	E	(AE) Wiper single-acting
A	M	(AM) Wiper with a metal reinforcement (metal seat/metal-reinforced)
A	D	(AD) Wiper double acting
A	DM	(ADM) Wiper double-acting with a metal reinforcement (metal seat/metal-reinforced)
G	GS	(GS) Guide strip
F	RK	(FRK) Guide ring piston
F	RS	(FRS) Guide ring rod

DIMENSIONS

Rod seals, piston seals, wipers and guide elements are always defined according to the installation space dimension. This means that the size specifications of the seal correspond to the sizes of the installation space and that the installation space and not the seal is always measured.

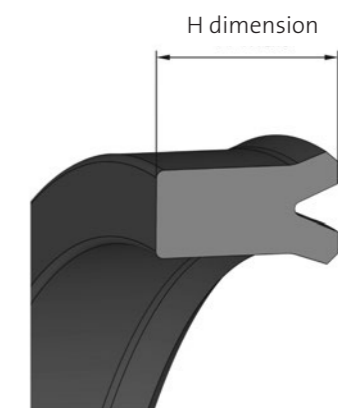
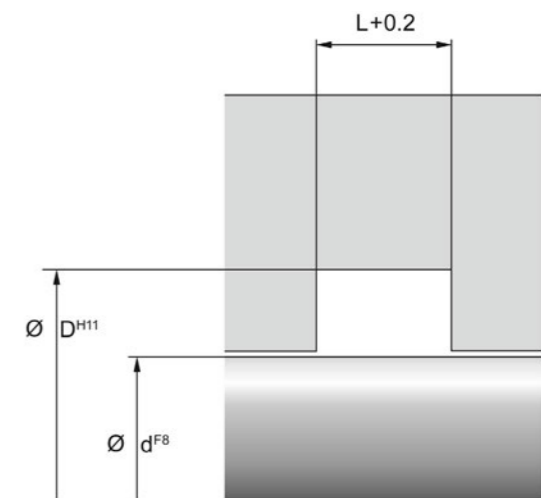
We also provide the H dimension (measured width of the seal) for many of our piston and rod seals.

For piston seals and piston guide rings, the outside diameter AD (cylinder barrel diameter) is always listed as the first dimension (reference dimension); the inside diameter ID (rod diameter) is always listed for rod seals, rod guide rings and wipers.

Examples:

KNA28:
 AD x ID x L 50 x 40 x 8 piston seal

SNI30:
 ID x AD x L 40 x 50 x 9 rod seal





SEALING FUNCTIONS

Hydraulic seals are manufactured with a so-called "profile preload" and radially compressed in the installation space. Hydraulic seals are therefore tight at rest due to the over-size and the resulting precompression **pv**. If the seal is then pressurized with the operating pressure **p**, this pressure is

added to the existing precompression pressure. The pressure at the sealing surface **pd** is therefore always greater than the pressure to be sealed:

$$pd = pv + p$$

THE SEALING MECHANISM OF ROD SEALS – DYNAMIC SEALING MECHANISM

The critical point of a hydraulic system is the rod seal. Leakage of hydraulic fluid from the cylinder would prevent trouble-free operation and lead to environmental damage, among other things.

The sealing mechanism between the dynamic sealing lip and the rod is based on the hydrodynamic processes in the sealing gap. When the sealing system starts to move, the liquid film is drawn off by the sealing lip. The resulting drag flow and hydrodynamic pressure buildup create the dynamic sealing gap. What remains is a thin lubricating film, the so-called residual oil film. This remaining but necessary liquid film, which is only a few μ thick, ensures low-friction operation and thus a long service life for the seal.

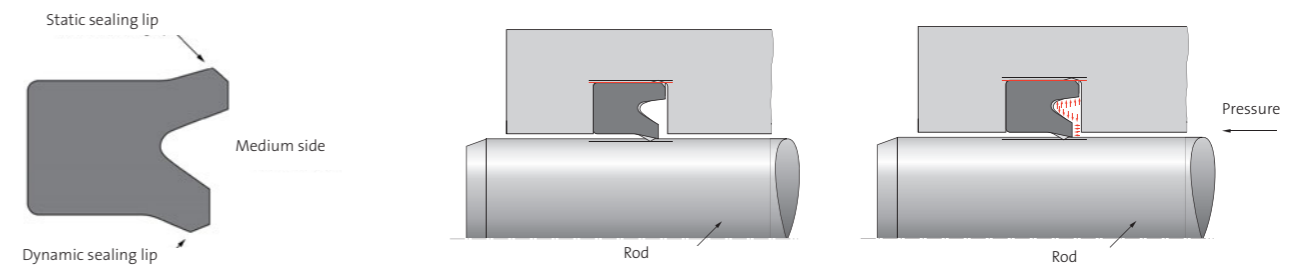
Experts speak of dynamic tightness when the oil film that has been dragged out is completely returned to the pressure chamber.

Rod seals

A rod seal must be both internally sealing (sealing to the rod) and externally sealing (on the outside diameter to the groove base, purely static) to prevent hydraulic fluid from escaping from the hydraulic system.

When arranging the rod seals, a distinction is usually made between a primary seal and a secondary seal. The primary seal's main task is to withstand the operating pressure, while the secondary seal, subjected to the lower interspace pressure (< 5 MPa), reduces the residual oil film to a minimum.

Example: U-Cups can only be pressurized on one side. As a rule, pressurization on one side is sufficient to meet the requirements of a rod seal.



Rod seal uninstalled

Static installation situation

- the static sealing lip seals towards the installation space
- the dynamic sealing lip also seals against the rod in the stationary state

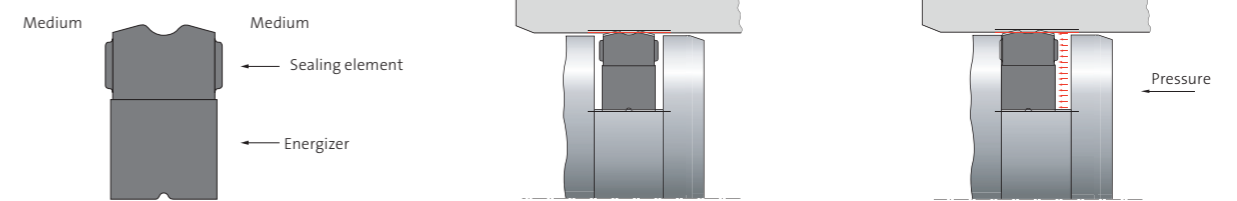
Dynamic installation situation

- the sealing effect is increased by means of pressurization
- both sealing lips are pressed "outwards"

THE SEALING MECHANISM OF PISTON SEALS – STATIC SEALING MECHANISM

A piston seal provides dynamic and static sealing on the outside to the cylinder wall and statically to the groove base in the inner diameter. If the piston seal is subjected to system pressure, the sealing effect will also increase and the dynamic sealing lip will be pressed against the cylinder wall.

The requirement for a piston seal is usually pressurization on both sides. Compact seals, here using the K84 as an example, can be pressurized on both sides. The pressure load is applied alternately from both sides.



Piston seal unassembled

Static installation situation

- the sealing element seals radially to the cylinder wall
- the contact pressure element creates the sealing effect and seals to the groove base

Dynamic installation situation

- pressure load compresses the seal according to the pressure direction
- the sealing effect increases



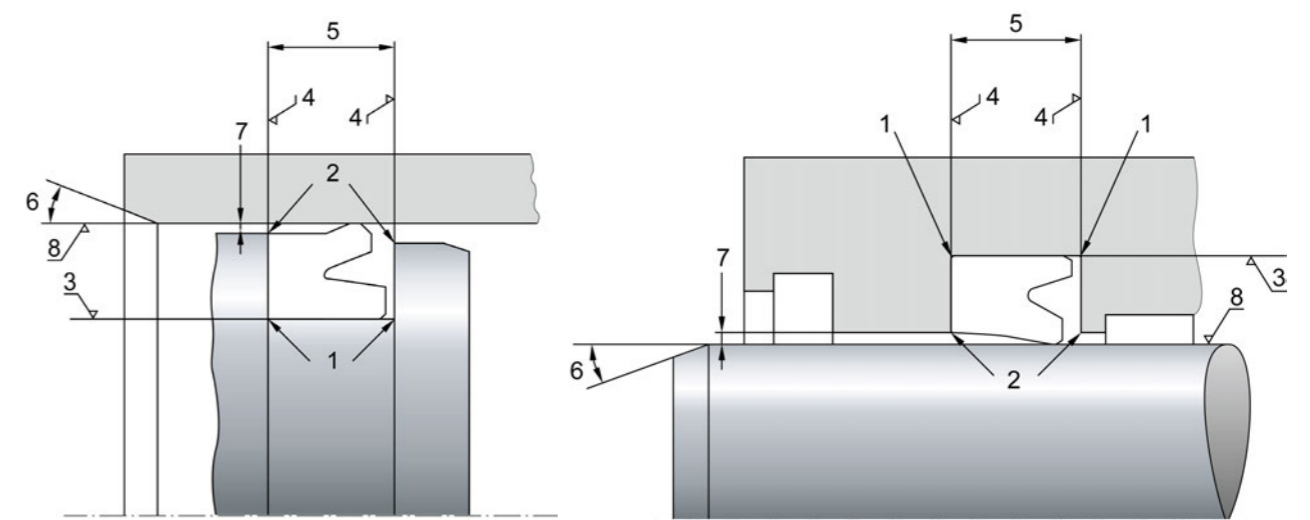
INSTALLATION SPACES AND CONSTRUCTIVE RECOMMENDATIONS

The parameters of installation spaces, e.g. dimensions, curves, tolerances, installation chamfers and surface finishes (surface roughness), are defined by the respective cylinder manufacturer. When replacing a seal, you must check whether the installation space has changed as a

result of operation. The required surface finishes in particular must be observed and compared with our specifications. Notches on the piston rod or traces of wear caused by abrasive substances must be assessed and, if necessary, repaired.

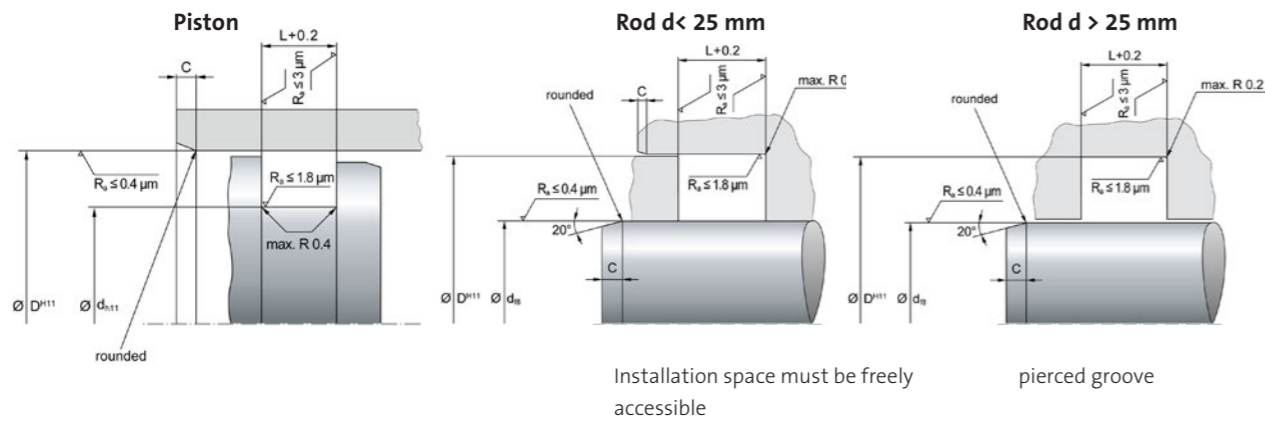
The following principles apply to the design of the installation space and should be strictly observed for trouble-free operation and a long service life of the seal:

- rounded corners in the groove base (1) ensure correct seating of hydraulic seals
- rounded groove flank transitions (2) reduce the risk of gap extrusion
- the surface finish of the groove base (3) and the groove flanks (4) ensure a good sealing function
- compliance with the tolerances for the groove width (5), the installation chamfer (6) and the correct dimensions of the sealing gap on the non-pressure side (7)
- the surface condition of the mating surfaces (8) is largely responsible for a stable sealing function

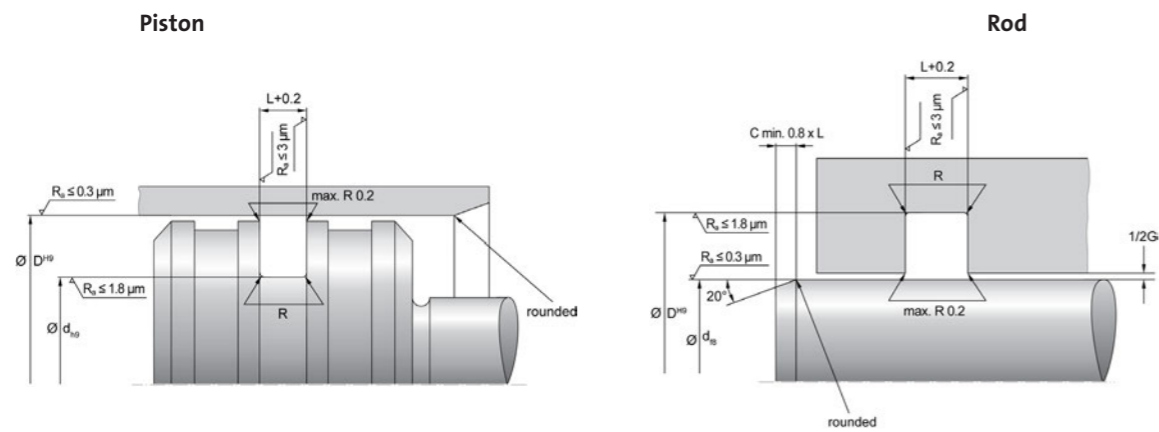


EXAMPLES FOR USE IN SPECIFIED INSTALLATION SPACES

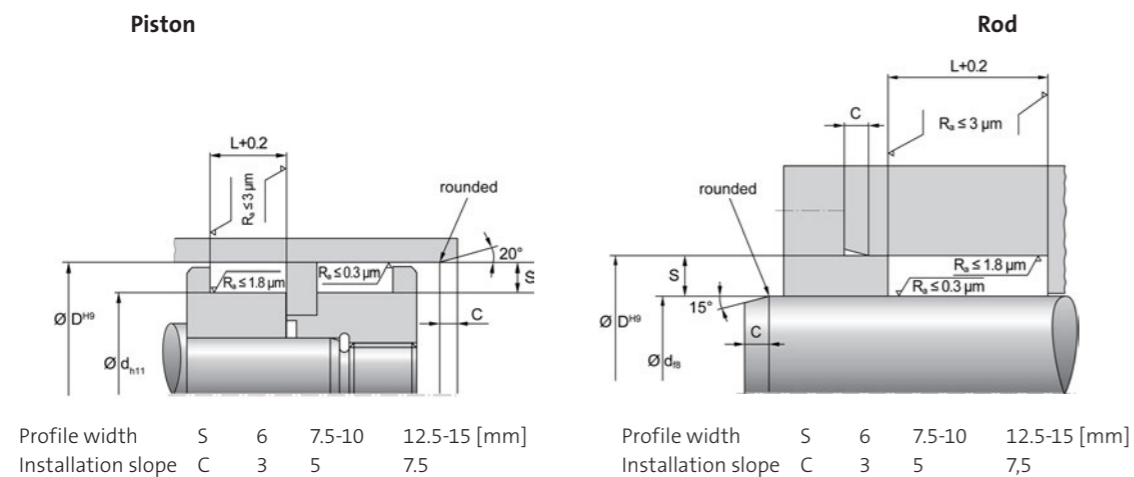
U-Cups type N, NA, NI



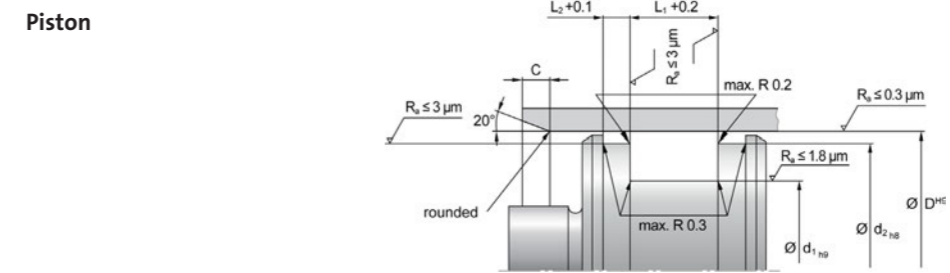
Type POR, PUOR



Roof collar sets type KDS 01, SDS 01

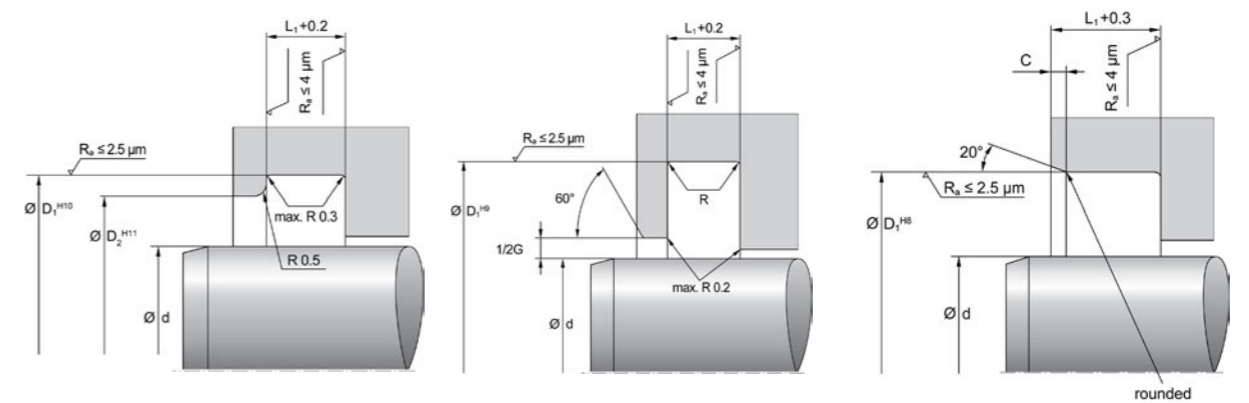


Compact seal type K



Wiper type AE, AD

Wiper type AM, ADM



The radius R for wiper designs AE40 and AE42 is selected as follows, depending on the height of the wiper:

H [mm] ≤ 12	16	18
R [mm] ≤ 1.0	1.5	3.0

For wiper types AE41, AE47, AD48 and AD51, the radius is always $R = 0.5$ regardless of the wiper height.

The AD60 and AD61 wipers require an axially accessible installation space with small diameters. With larger diameters, a closed installation space can be provided. Subsequent calibration is recommended. Please refer to the following table for dimension G and radius R:

L	3.7	5	6	8.4	11	14
G	1.5	1.5	1.5	2.0	2.0	2.5
R	0.4	0.8	1.0	1.2	1.5	2.0

When using double wipers, depending on the subsequent sealing arrangement, a relief hole may be required through which the retained oil is pumped back into the system.

The wiper can be easily installed axially if the proper installation chamfer C is available according to the following table.

H [mm]	C [mm]
≤ 4.5	0.6
5	0.6
6	0.8
7	0.8
8	1
9	1
10	1.4
12	1.8
14	2
16	2.4

Guide elements type GS, FRK, FRS



ASSEMBLY – WHAT NEEDS TO BE CONSIDERED

Even though the materials used for Dichtomatik brand hydraulic seals deliver excellent performance and are robust, special care is required during installation. Mechanical damage, especially to the sealing edge, can lead to leakage. In addition, each seal must be checked before installation for damage or aging that may have already occurred during transport or storage.

Instructions for mounting:

1. In the case of single-acting seals, the seal must be installed with the preload side facing the pressure side
2. Insertion chamfers are absolutely necessary on the cylinder barrel and piston rod. The chamfer should have an angle of 20°. The recommended length C depends on the profile width S. This profile width results from $S = (D-d)/2$

Profile width S [mm]	Length of the installation chamfer C [mm]
4	2
5	2.5
7.5	4
10	5
12.5	6.5
15	7.5
20	10
25	10

For the installation of wipers in open installation spaces, the following installation slopes C are recommended in relation to the installation space height H for trouble-free installation:

H [mm]	C [mm]
≤ 4.5	0.6
5	0.6
6	0.8
7	0.8
8	1
9	1
10	1.4
12	1.8
14	2
16	2.4

3. Edges must be free from burrs. Radii and chamfers must be manufactured according to the installation specifications
4. Dust, dirt and metal chips must be removed carefully
5. Thread tips, installation grooves for guide elements and rough surfaces etc. should be covered using a mounting cone, otherwise the seal runs the risk of being damaged
6. The cylinder barrel, piston rod and seal must be greased or oiled before assembly. Make sure that the seal is compatible with the medium (see resistance tool, QR code below)
7. Heating in oil or hot water to approx. +80 °C (please pay attention to resistance) makes materials more pliable and easier to expand for assembly. At a temperature of +80 °C to +120 °C, PTFE seals can be expanded much more easily in oil or hot water and then formed back (calibrated)
8. Any assembly tools used, such as expanding mandrels, assembly sleeves or calibration sleeves or calibration mandrels, should be made of soft material (e.g. POM) and be free from sharp edges
9. When mounting type N and NI rod seals in closed grooves, the minimum diameter d_{min} depends on the profile width S: $S=(D-d)/2$

S [mm]	4	5	6	7.5	10	12.5	15
d_{min}	25	30	40	50	80	100	120

For rod seals $d < 25$ mm, we recommend mounting in axially open installation spaces.

Standard dimensions of piston seals type N and NA can generally be mounted in closed or half-open installation spaces for sizes $d > 25$ mm using a snap-on assembly. Fabric-reinforced piston seals and roof collar sets can only be mounted in axially open installation spaces.

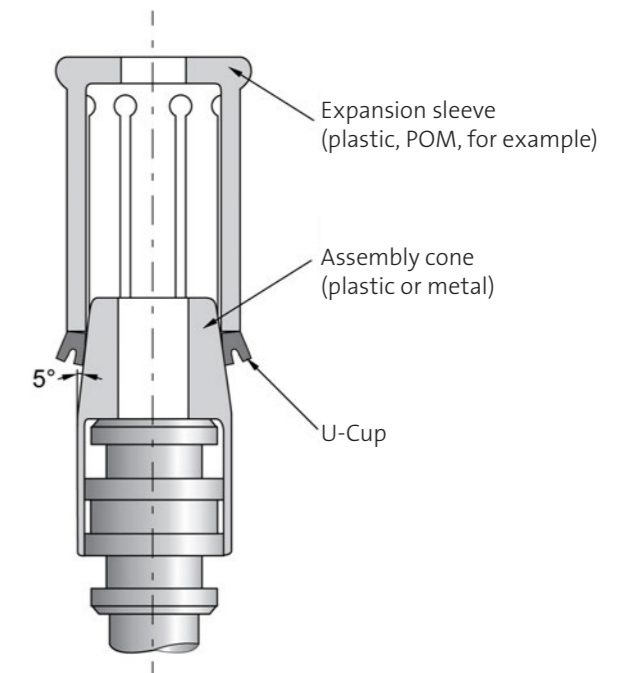
Use our resistance tools to find out the compatibility of chemicals and cleaning agents



APPLICATION OF ASSEMBLY TOOLS FOR U-CUPS

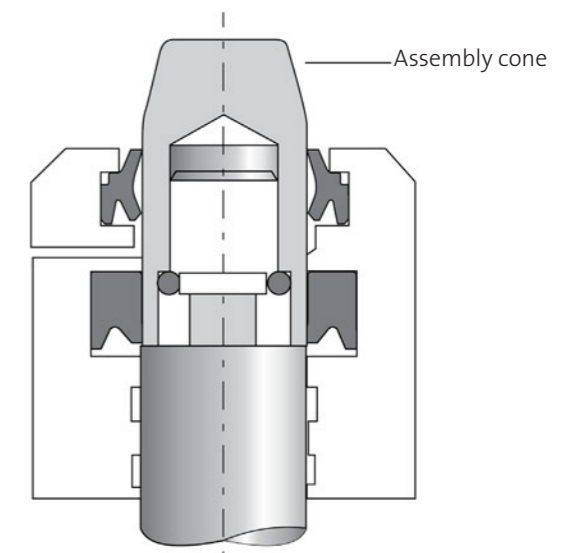
For easier assembly and to prevent damage to the seal during assembly, we recommend using assembly sleeves/assembly cones. The sleeve is pushed over the area to be covered.

Installation of a piston seal



The piston seal is then positioned over the cone in the installation space with the aid of an expanding sleeve.

Installation of a rod seal



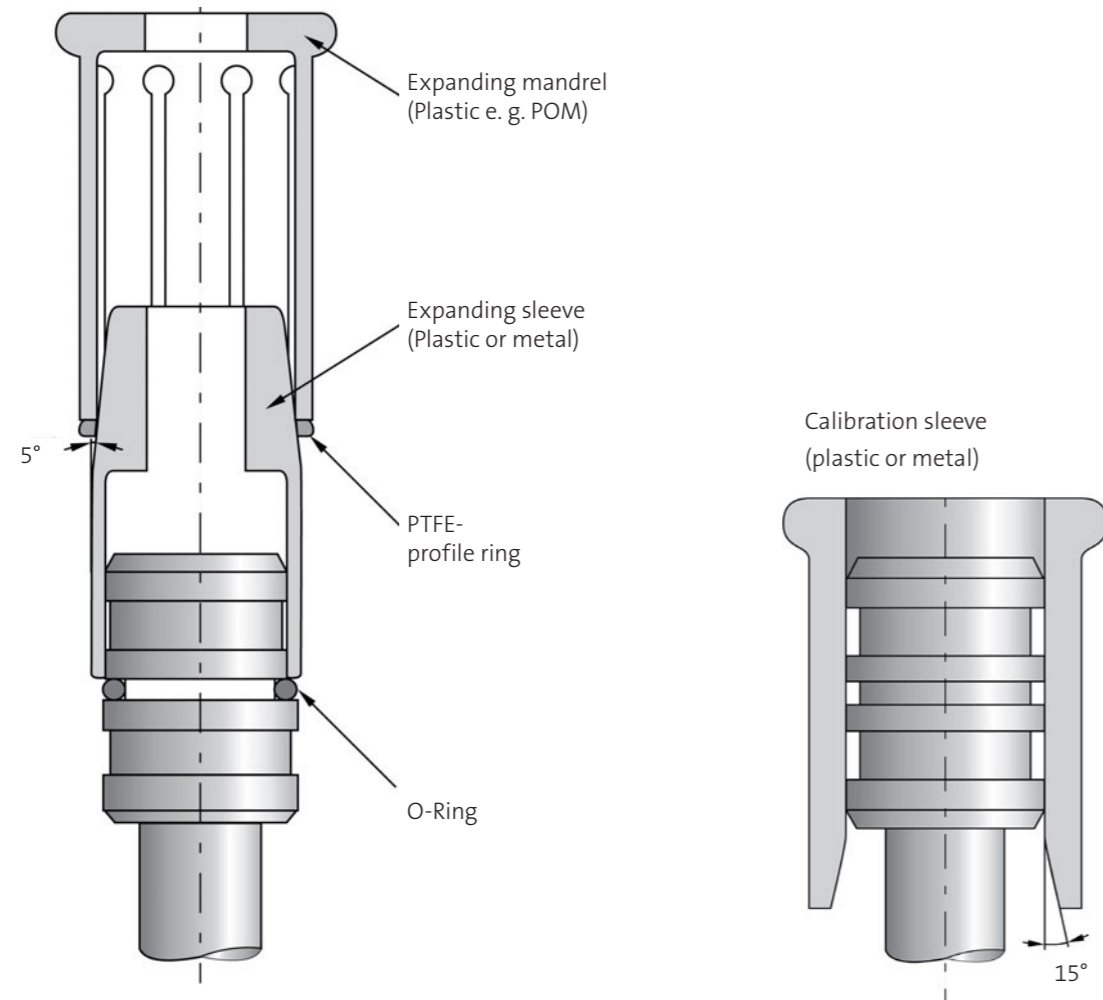
After installing the rod seal, the mounting sleeve prevents damage to the seal and wiper when inserting the rod.

SPECIAL FEATURES FOR THE MATERIAL PTFE

Since PTFE has virtually no elastic properties, PTFE-pre-loaded sealing elements (SPOR30, SPOR31, KPOR30, KPOR31) must be installed with particular care and then be calibrated. Observe the following installation instructions:

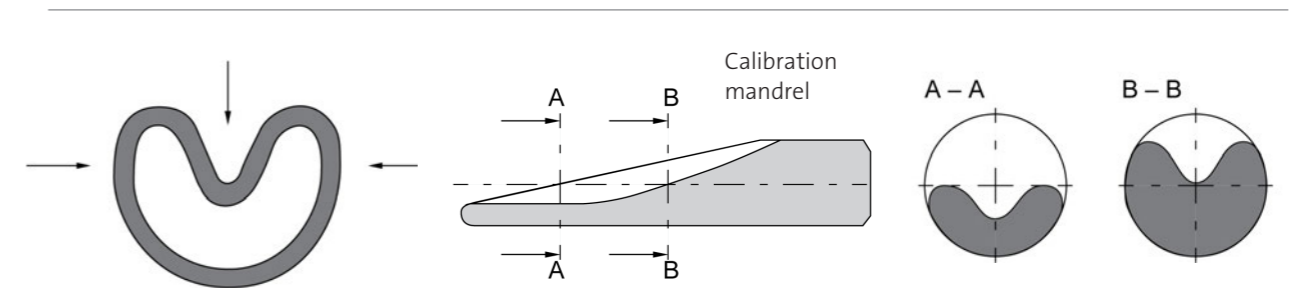
Installation of piston seals in an enclosed groove

Insert the O-Ring into the groove without torsion: We recommend the procedure already described for PTFE seals. In this case, the PTFE ring is pushed over a conical assembly aid with an expansion sleeve until it snaps into the groove to expand the ring. The deformation of the expanded PTFE ring is accelerated with a calibration sleeve or calibration pliers, the inside diameter of which corresponds to the cylinder barrel diameter.



Installation of rod seals in a closed groove

Insert the O-Ring into the groove without twisting: Press the PTFE ring together in a kidney shape. No sharp kinks may be created while doing so. Insert the compressed PTFE ring into the groove. Calibrate with a mandrel..



SMALLEST MOUNTABLE NOMINAL GASKET SIZES IN AXIALLY CLOSED INSTALLATION SPACES [MM]

Seal type	Series					
	000	001	002	003	004	005
SPOR30	>12	>16	>19	>38	>70	>200
SPOR31	>12	>16	>19	>38	>70	>200
KPOR30	>8	>15	>25	>40	>60	>133
KPOR31	>8	>15	>25	>40	>60	>133

SMALLEST MOUNTABLE NOMINAL GASKET SIZES IN SEMI-ENCLOSED INSTALLATION SPACES [MM]

Seal type	Series				
	000	001	002	003	004
SNI43	>20	>30	>35	>40	>45
KNA44	>11	>17,5	>20	>28	>45
Seg height of the semi-enclosed installation	0.4	0.6	0.7	0.8	0.9

Series depends on the L-dimension of the seal, please ask us for the series.



MATERIALS

Dichtomatik brand hydraulic seals are offered in elastomers, rubber-fabric materials, thermoplastic elastomers (TPEs), thermoplastics, and hard-fabric materials.

NBR – ACRYLONITRILE BUTADIENE RUBBER

NBR is widely used in the hydraulic industry due to its good mechanical properties and resistance to mineral oil-based lubricating oils and greases. The material shows good mechanical-technological parameters, e.g. high abrasion resistance, low gas permeability and good resistance to lubricating oils and greases based on mineral oil, hydraulic oils H, HL, HLP, flame-retardant pressure fluids HFA, HFB, HFC, aliphatic hydrocarbons, silicone oils and greases, water up to approx. +80 °C. NBR, on the other hand, is generally not resistant to aromatic and chlorinated hydrocarbons, fuels with a high aromatics content, polar solvents, glycol-based brake fluids and HFD flame-retardant pressure fluids. Ozone, weathering and aging resistance are low. However, this does not affect most hydraulic applications because the hydraulic seals are used in the hydraulic components.

TPU – THERMOPLASTIC POLYURETHANE

TPU materials belong to the group of thermoplastic elastomers (TPEs). The strength of TPUs lies in the combination of their good properties, both physical and chemical, as well as processing and economic. TPU materials stand out from classic elastomers due to their significantly higher mechanical strength. Other excellent material properties include high abrasion, wear and extrusion resistance, high compressive strength, high tear and tear propagation resistance, and very good resistance to aging and ozone. TPU is well suited for use in mineral oils and greases, hydraulic oils H, HL, HLP, silicone oils and greases, flame-retardant hydraulic fluids HFA and HFB and water up to +50 °C, as well as pure aliphatic hydrocarbons.

PTFE – POLYTETRAFLUOROETHYLENE

PTFE is a fluorinated plastic. PTFE has a wide range of positive properties that have become indispensable in sealing technology. It is characterized by its virtually universal chemical resistance, the wide temperature application range from -100 °C to +250 °C, an extremely low coefficient of friction and the resulting very good sliding properties, no stick-slip effect, special rigidity and the nearly unlimited resistance to ozone, weathering and aging. Virtually all known hydraulic media, lubricants, chemicals and solvents cannot harm PTFE. Disadvantages of PTFE are the tendency to cold flow or creep of the pure PTFE under pressure load.

HARD FABRIC MATERIALS

Hard fabric materials are manufactured from various fabric/resin combinations, such as synthetic fiber fabric + phenolic resin, cotton fabric + phenolic resin or polyester fabric + polyester resin. Hard fabric materials are selected for applications in hydraulics with high loads and transverse forces.

NBR F – RUBBER FABRIC MATERIALS








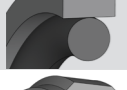







Cotton or synthetic fiber fabrics can be used as the basis for rubber fabric materials. As standard, Dichtomatik brand products are made of cotton fabric for hydraulic seals. They have high wear resistance, very good friction and sliding properties (due to the lubricant embedded in the fabric lubrication pockets), good low-temperature resistance, and high resistance to pressure and extrusion.

You can find further material information on our website















PROFILE OVERVIEW

PISTON SEALS

Profile	Type	Material	Hardness [Shore A]	Temperature [°C]	Sliding speed [m/s]	Pressure [MPa(bar)]
	KNA28	TPU	95	-40 to +100	≤ 0.5	40 (400)
	N25	TPU	95	-40 to +100	≤ 0.5	30 (300)
	KNA23	NBR	90	-30 to +100	≤ 0.5	16 (160)
	N21	NBR	90	-30 to +100	≤ 0.5	16 (160)
	N36	TPU	95	-40 to +100	≤ 0.5	40 (400)
	N05	NBR	80	-30 to +100	≤ 0.5	20 (200)
	KNA16	NBR	80	-30 to +100	≤ 0.5	50 (500)
	KPOR30	PTFE		-30 to +100	≤ 15	40(400)
	KPOR31	PTFE		-30 to +100	≤ 15	40 (400)
	KK03	NBR	80	-30 to +100	≤ 0.5	40 (400)
	KK22	NBR	90	-30 to +100	≤ 0.5	40 (400)
	KDS01	NBR F	90	-30 to +100	≤ 0.5	40 (400)
	KNA44	PTFE		-150 to +250	≤ 15	35 (350)
	K84	TPU	95	-30 to +100	≤ 0.5	40 (400)
	K70	TPU	95	-30 to +100	≤ 0.5	25 (250)



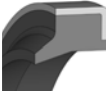











Note: The values listed here are maximum values. These may not all be reached at the same time.

ROD SEALS

Profile	Type	Material	Hardness [Shore A]	Temperature [°C]	Max. speed [m/s]	Max. pressure in [MPa(bar)]
	N21	NBR	90	-30 to +100	0.5	16 (160)
	SNI24	NBR	90	-30 to +100	0.5	16 (160)
	N05	NBR	80	-30 to +100	0.5	20 (200)
	SNI07	NBR	80	-30 to +100	0.5	40 (400)
	SDS01 3/2	NBR/NBR F *	90	-30 to +100	0.5	40 (400)
	N25	TPU	95	-40 to +100	0.5	30 (300)
	SNI30	TPU	95	-40 to +100	0.5	40 (400)
	SNI39	TPU	95	-40 to +100	0.5	40 (400)
	N36	TPU	95	-40 to +100	0.5	40 (400)
	S72	TPU	95	-30 to +100	0.5	40 (400)
	SNI35	TPU	95	-40 to +100	0.5	40 (400)
	SPOR30	PTFE-bronze		-30 to +100	15	40 (400)








* F: fabric (fabric-reinforced material)

WIPERS

Profile	Type	Material	Hardness [Shore A]	Temperature [°C]	Color	Sliding speed [m/s]	Single-acting	Double-acting
	AE40	NBR	90	-30 to +110	black	≤ 1	X	
	AE41	NBR	90	-30 to +110	black	≤ 1	X	
	AM43	NBR	90	-30 to +110	black	≤ 1	X	
	AM45	NBR	90	-30 to +110	black	≤ 1	X	
	AD51	NBR	90	-30 to +110	black	≤ 1		X
	AE42	TPU	90	-40 to +100	blue	≤ 2	X	
	AE47	TPU	90	-40 to +100	blue	≤ 2	X	
	AM44	TPU	95	-40 to +100	blue	≤ 2	X	
	AM54	TPU	95	-40 to +100	blue	≤ 1	X	
	AD48	TPU	95	-40 to +100	blue	≤ 1		X
	ADM55	TPU	95	-40 to +100	blue	≤ 1		X
	AD60	PTFE bronze		-30 to +100		≤ 15		X
	AD61	PTFE bronze		-30 to +100		≤ 15		X
	AE80	PTFE bronze		-30 to +100		≤ 15	X	

Note: The values listed here are maximum values. These may not all be reached at the same time.

GUIDE ELEMENTS, PISTONS AND RODS

Profile	Type	Material	Surface	Delivery condition	Sliding speed [m/s]	Dyn. surface pressure [N/mm ²]	Compressive strength [N/mm ²]	Temperature [°C]
	GS01	PTFE bronze filled	structured	Roll	≤ 15	≤ 15	≤ 25	-60 to +200
	GS10	PTFE bronze filled	smooth	Roll	≤ 15	≤ 15	≤ 25	-60 to +200
	FRK01	PTFE bronze filled	structured	Strips, cut 30°	≤ 15	≤ 15	≤ 25	-60 to +200
	FRS01	PTFE bronze filled	structured	Strips, cut 30°	≤ 15	≤ 15	≤ 25	-60 to +200
	GS05	Hard fabric with PTFE	smooth	Roll	≤ 1	≤ 100	≤ 350	-50 to +120
	FRK05	Hard fabric with PTFE	smooth	Ring, bevel cut 45°	≤ 1	≤ 100	≤ 350	-50 to +120
	FRS05	Hard fabric with PTFE	smooth	Ring, bevel cut 45°	≤ 1	≤ 100	≤ 350	-50 to +120

* F: fabric (fabric-reinforced material)

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