HANSA-FLEX

TECHNICAL INFORMATION
SEALING TECHNOLOGY

REV. A / 11 / 2024

Technical information Sealing technology

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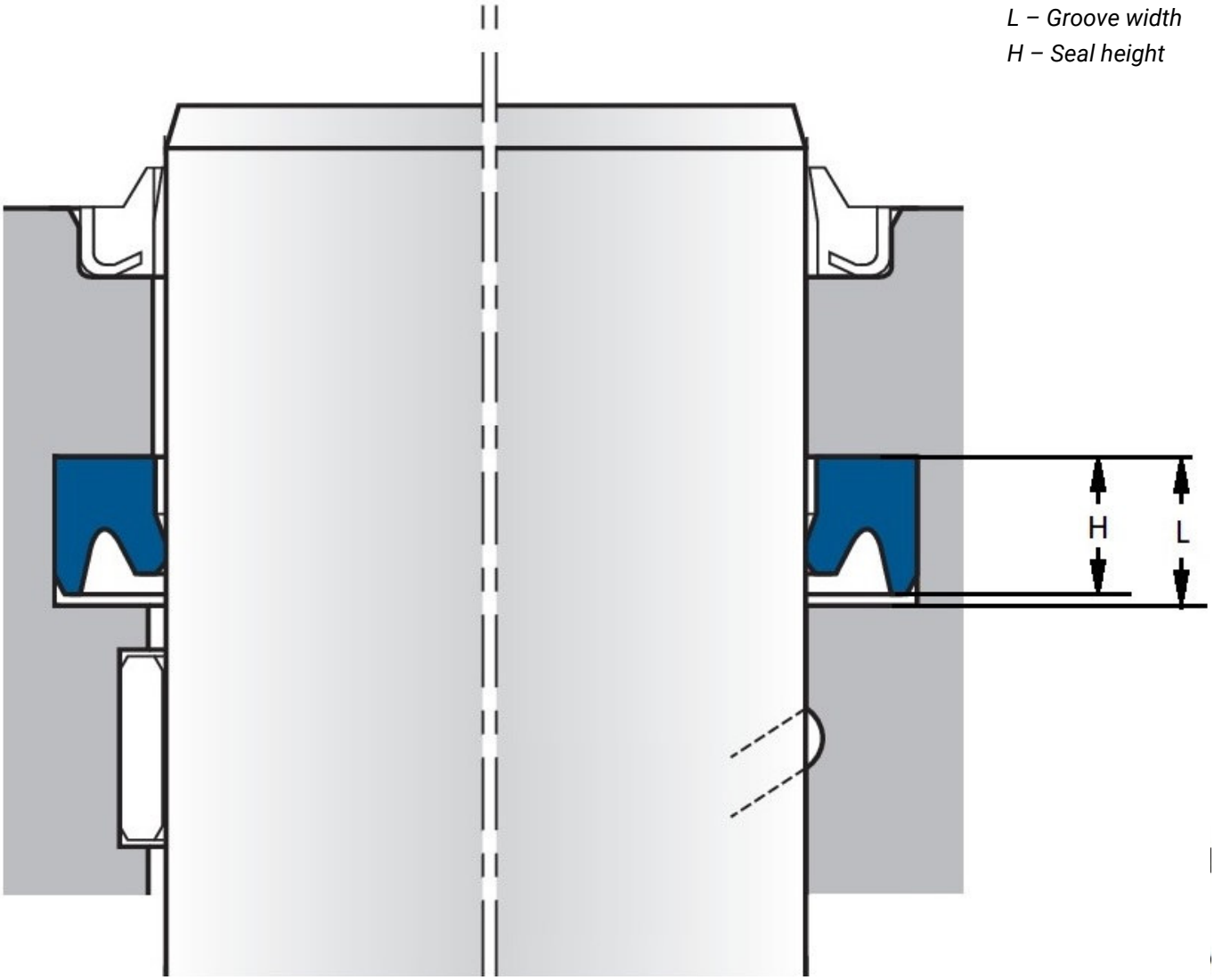
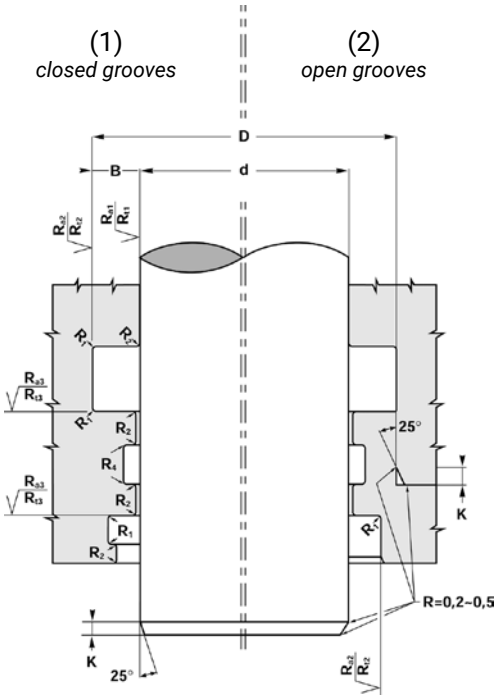
Difference: Groove width “NB” & seal height “DH”

L – Groove width
H – Seal height



1. Installation instructions

1.1 Rod seals and wipers



Surface quality
The roughness values stated in table 1.1 must be observed in both the R_a and R_t areas.

Open or closed grooves
Table 1.2 can be used to establish whether a seal can be fitted in closed grooves (1). In the case of a specific cross-section B, we recommend fitting in open grooves (2) if the diameter of the rod is less than the minimum diameter (d_{min}).

Chamfers
Table 1.3 lists the chamfer lengths K to be observed.

Roundings
Sharp edges must be avoided. Table 1.4 lists the radii to be observed.

Table 1.1

R_{a1}	R_{t1}	R_{a2}	R_{t2}	R_{a3}	R_{t3}
≤ 0.3 µm	≤ 3 µm	≤ 1.8 µm	≤ 10 µm	≤ 3 µm	≤ 16 µm

Table 1.2

B (mm)	4	5	6	7.5	10	12.5	15
d_{min} (mm)	30	40	50	65	80	150	200

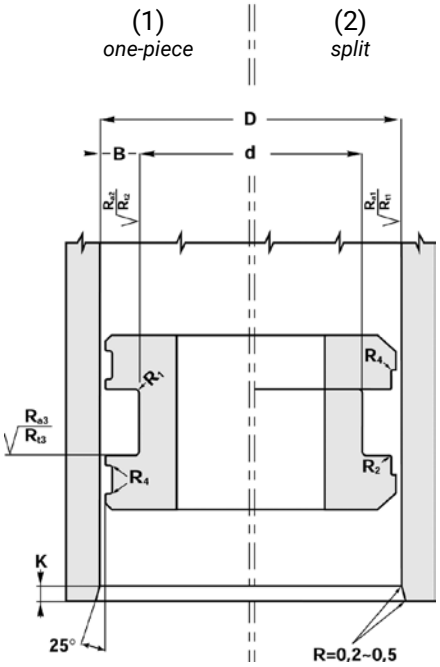
Table 1.3

K (mm) = 0.6 B

Table 1.4

B (mm)	R_t (mm)	R_2 (mm)	R_4 (mm)
≤ 7.5	≤ 0.3	0.2	≤ 0.2
> 7.5	≤ 0.6	0.4	

1.2 Piston seals and guide rings



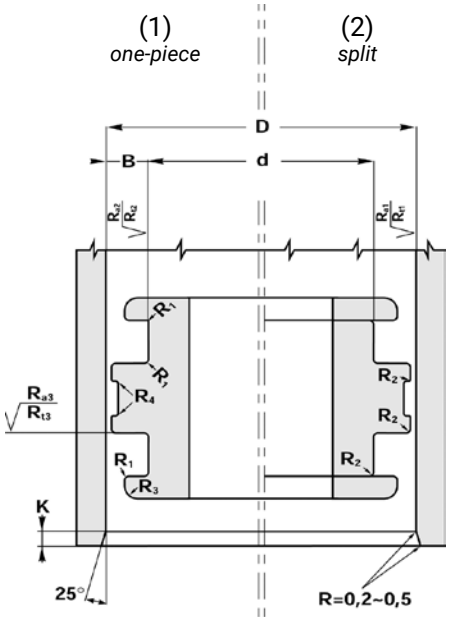
Surface quality
The roughness values stated in Table 1.1 must be observed in both the Ra and Rt areas.

Single or multipart pistons
Please refer to the “Installation” instructions in this catalogue for each seal profile and each individual seal.

Chamfers
Table 1.3 lists the chamfer lengths K to be observed.

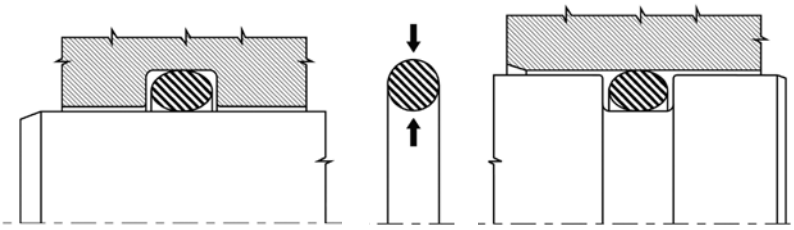
Roundings
Sharp edges must be avoided. Table 1.5 lists the radii to be observed.

Table 1.5				
B (mm)	**R1 (mm)**	**R2 (mm)**	**R3 (mm)**	**R4 (mm)**
≤ 7.5	≤ 0.3	0.2	≤ 2	≤ 0.2
> 7.5	≤ 0.6	0.4	≤ 4	



1.3 Static seals - Radial installation

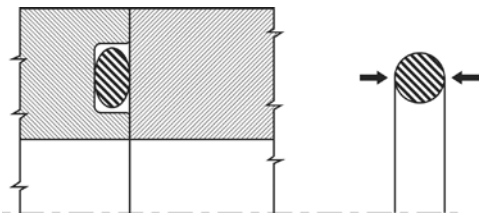
The static seal is squeezed between its external and internal diameters.



Installation in internal groove *Installation in external groove*

1.4 Static seals - Axial installation

The static seal is squeezed between its two side faces.



2. Correct installation

Hydraulic seals can be damaged if they are not correctly installed. This can result in many problems, which can be avoided by observing the following guidelines:

- Check that the groove diameters, tolerances, surface qualities and chamfers are based on the values given in this catalogue.
- Ensure that the seal does not come in contact with sharp edges, bored holes or threads during assembly.
- All metal parts must be absolutely clean and free of swarf, weld splatter and defects.
- All seals must be lubricated before assembly with the same liquid or a liquid compatible with that which will be used in the hydraulic system.
- Do not use sharp-edged tools for installation. Do not allow seals to be deformed for a prolonged period.
- Ensure the seal is correctly oriented with respect to the direction of fluid pressure. The same applies to all the other parts.

3. Table of international corrosion-resistant steel grades and their equivalents

	Germany		*Steel micro-structure*	*Tensile strength*	*Breaking elon-gation*	USA	France	UK	Italy	Sweden	Japan
Wk.No.	DIN	Type									
1.4113	X 6 CrMo 17-1	F1	*ferritic*	*450/630*	*18*	434	-	434 S 17	X 8 CrMo 17	-	SUS 434
1.4016	X 8 Cr 17	F1	*ferritic*	*450/630*	*20*	430	Z 8 C 17	430 S 17	X 8 Cr 17	2320	SUS 430
1.4006	X 10 Cr 13	C1	*martensitic*	*730*	*20*	410	Z 10 C 13	410 C 21	X 10 Cr 13	2302	SUS 410
1.4021	X 20 Cr 13	C1	*martensitic*	*800/950*	*12*	420	Z 20 C 13	420 S 37	X 20 Cr 13	2303	SUS 420 J1
1.4028	X 30 Cr 13	C1	*martensitic*	*850/1000*	*10*	420 F	Z 30 C 13	420 S 45	X 30 Cr 13	2304	SUS 420 J2
1.4057	X17 CrNi 16-2	C3	*martensitic*	*800/950*	*12*	431	Z 15 CN 10-02	431 S 31	X 16 CrNi 16	-	SUS 431
1.4125	X 105 CrMo 17	C3	*martensitic*	*-*	*-*	440 C	Z 100 CD 17	-	-	-	SUS 440 C
1.4305	X 8 CrNi 18-9	A1	*austenitic*	*500/700*	*35*	303	Z 8 CNF 18-09	303 S 22	X 10 CrNiS 18 09	2346	SUS 303
1.4301	X 5 CrNi 18-10	A2	*austenitic*	*540/750*	*45*	304	Z 6 CN 18-09	304 S 17	X 5 CrNi 18 10	2332	SUS 304
1.4303	X 4 CrNi 18-12	A2	*austenitic*	*500/650*	*45*	305	Z 5 CN 18-11	305 S 19	X 7 CrNi 18 10	-	SUS 305
1.4306	X 2 CrNi 19-11	A2	*austenitic*	*520/670*	*45*	304 L	Z 2 CN 18-10	304 S 11	X 2 CrNi 18 11	2352	SUS 304 L
1.4541	X CrNiTi 18-10	A2	*austenitic*	*520/720*	*40*	321	Z 6 CNT 18-10	321 S 31	X 6 CrNiTi 18 11	2337	SUS 321
1.4550	X 6 CrNiNb 18-10	A2	*austenitic*	*520/720*	*40*	347	Z 6 CNNb 18-10	347 S 20	X 6 CrNiNb 18 11	2338	SUS 347
1.4401	X 5 CrNiMo 17-12-2	A4	*austenitic*	*530/680*	*40*	316	Z 7 CND 17-11-02	316 S 17	X 5 CrNi Mo 17 12	2347	SUS 316
1.4404	X 2 CrNiMo 17-12-2	A4	*austenitic*	*530/680*	*40*	316 L	Z 3 CND 17-11-02	316 S 11	X 2 CrNi Mo 17 12	2348	SUS 316 L
1.4435	X 2 CrNiMo 18-14-3	A4	*austenitic*	*500/700*	*40*	316 L	Z 3 CND 17-11-03	316 S 14	X 2 CrNi Mo 17 13	2353	SUS 316 L
1.4436	X 3 CrNi Mo 17-13-3	A4	*austenitic*	*550/700*	*40*	316	Z 6 CND 18-12-03	316 S 19	X 5 CrNi Mo 17 13	2343	SUS 316
1.4438	X 2 CrNiMo 18-15-4	A4	*austenitic*	*550/700*	*40*	317 L	Z 2 CND 19-15-04	317 S 12	X 5 CrNi Mo 17 13	2343	SUS 316
1.4539	X 1 NiCr-MoCuN 25-20-5	A4	*austenitic*	*530/730*	*35*	904 L	Z 2 NCDU 25-20	-	-	2562	-
1.4571	X 6 Cr NiMoTi 17-12-22	A4	*austenitic*	*450/690*	*40*	316 Ti	Z 6 CNDT 17-12	320 S 18	X 6 CrNi MoTi 17 12	2350	SUS 316 Ti
1.4580	X 6 CrNiMoNb 17-12-2	A4	*austenitic*	*450/690*	*40*	316 Cb	Z 6 CNDNb 17-12	318 S 17	X 6 CrNi MoNb 17 12	-	-

4. Storage conditions for elastomers

- Max. 25 °C
- Keep away from sources of direct heat
- Keep out of direct sunlight
- Install low-UV lighting
- Max. air humidity 60 % prevent condensation occurring
- Keep away from ionizing radiation and the effects of ozone, for example produced by welding work
- Store in a PE bag or the original packaging
- Do not store hung up on a hook or similar

Shelf lives of elastomers		
Material	**Initial storage**	**Extension storage**
Polyurethane, SBR	5 years	2 years
NBR, HNBR	7 years	3 years
FPM, FFKM, EPDM, VMQ	10 years	5 years

INSPECT AFTER THE INITIAL PERIOD OF STORAGE

Visual inspection:

- Deformation, cuts, surface cracks (use a 10 x magnifying glass)
- Hardening, softening, discolouration, contamination
- Permanent deformations, creases, flat areas

5. Tolerances and fits

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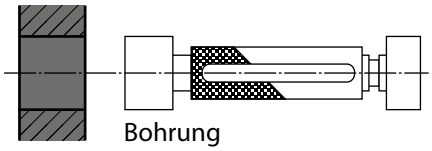
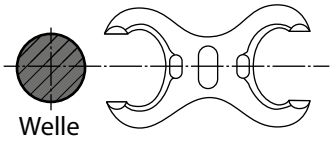




standard is **DIN 7161**.

The ISO system for tolerances and fits relates to all linear parameters such as external dimensions, internal dimensions, diameters, lengths, widths, heights and thicknesses.

A reference temperature 20 °C applies to all the dimensions defined in this system. Tables 5.1, 5.2 and 5.3 contain a selection of tolerances that are used successfully in the field of tool and mould making; these tolerances are used in our technical documents to precisely describe our products. These tolerances can also be used to advantage in other areas.

TOLERANCES FOR INTERNAL DIMENSIONS (HOLES)

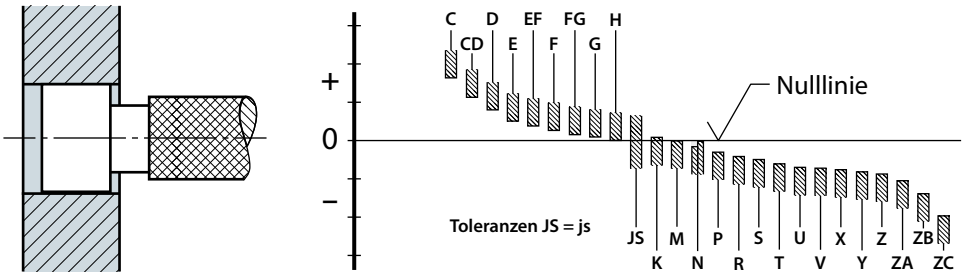


Table 5.1 - Extract from DIN 7161, allowances in µm (0.001 mm)

Nominal size range (mm)	Symbol	F 6	F 7	F 8	G 6	G 7	H 5	H 6	H 7	H 8	H 9	H 10	H 11	H 12	H 13	K 6	K 7	K 8	JS
	From / to																		
	3	+12 +6	+16 +6	+20 +6	+8 +2	+12 +2	+4 0	+6 0	+10 0	+14 0	+25 0	+40 0	+60 0	+100 0	+104 0	0 -6	0 -10	0 -14	Dimensions for "JS" and "js" are identical – for values see Tables 2 and 2.1
	3 - 6	+18 +10	+22 +10	+28 +10	+12 +4	+16 +14	+5 0	+8 0	+12 0	18 0	+30 0	+48 0	+75 0	+120 0	+180 0	+2 -6	+3 -9	+5 -13	
	6 - 10	+22 +13	+28 +13	+35 +13	+14 +5	+20 +5	+6 0	+9 0	+15 0	+22 0	+36 0	+58 0	+90 0	+150 0	+220 0	+2 -7	+5 -10	+6 -16	
	10 - 18	+27 +16	+34 +16	+43 +16	+17 +6	+24 +6	+8 0	+11 0	+18 0	+27 0	+43 0	+70 0	+110 0	+180 0	+270 0	+2 -9	+6 -12	+8 -19	
	18 - 30	+33 +20	+41 +20	+53 +20	+20 +7	+28 +7	+9 0	+13 0	+21 0	+33 0	+52 0	+84 0	+130 0	+210 0	+330 0	+2 -11	+6 -15	+10 -23	
	30 - 50	+41 +25	+50 +25	+64 +25	+25 +9	+34 +9	+11 0	+16 0	+25 0	+39 0	+62 0	+100 0	+160 0	+250 0	+390 0	+3 -13	+7 -18	+12 -27	
	50 - 80	+49 +30	+60 +30	+76 +30	+29 +10	+40 +10	+13 10	+19 0	+30 0	+46 0	+74 0	+120 0	+190 0	+300 0	+460 0	+4 -15	+9 -21	+14 -32	
	80 - 120	+58 +36	+71 +36	+90 +36	+34 +12	+47 +12	+15 0	+22 0	+35 0	+54 0	+87 0	+140 0	+220 0	+350 0	+540 0	+4 -18	+10 -25	+16 -38	
	120 - 180	+68 +43	+83 +43	+106 +43	+39 +14	+54 +14	+18 0	+25 0	+40 0	+63 0	+100 0	+160 0	+250 0	+400 0	+630 0	+4 -21	+12 -28	+20 -43	
	180 - 250	+79 +50	+96 +50	+122 +50	+44 +15	+61 +15	+20 0	+29 0	+46 0	+72 0	+115 0	+185 0	+290 0	+460 0	+720 0	+5 -24	+13 -33	+22 -50	
	250 - 315	+88 +56	+108 +56	+137 +56	+49 +17	+69 +17	+23 0	+32 0	+52 0	+81 0	+130 0	+210 0	+320 0	+520 0	+810 0	+5 -27	+16 -36	+25 -56	
	315 - 400	+98 +62	+119 +62	+151 +62	+54 +18	+75 +18	+25 0	+36 0	+57 0	+89 0	+140 0	+230 0	+360 0	+570 0	+890 0	+7 -29	+17 -40	+28 -61	
	400 - 500	+108 +68	+131 +68	+165 +68	+60 +20	+83 +20	+27 0	+40 0	+63 0	+97 0	+155 0	+250 0	+400 0	+630 0	+970 0	+8 -32	+18 -45	+29 -68	

TOLERANCES FOR EXTERNAL DIMENSIONS (SHAFTS)

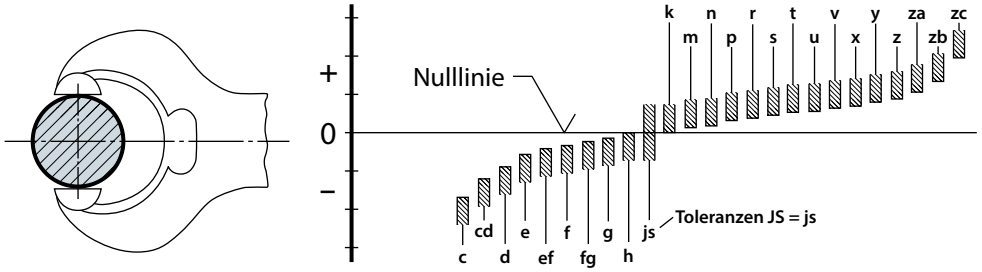


Table 5.2 – Extract from DIN 7160, allowances in µm (0.001 mm)

Nominal size range (mm)	Symbol	E 6	E 7	E 8	F 6	F 7	F 8	G 5	G 6	G 7	H 4	H 5	H 6	H 7	H 8	H 9	H 10	H 11	JS 6
	From / to																		
	3	-14 -20	-14 -24	-14 -28	-6 -12	-6 -16	-6 -20	-2 -6	-2 -8	-2 -12	0 -3	0 -4	0 -6	0 -10	0 -14	0 -25	0 -40	0 -60	+3 -3
	3 - 6	-20 -28	-20 -32	-20 -38	-10 -18	-10 -22	-10 -28	-4 -9	-4 -12	-4 -16	0 -4	0 -5	0 -8	0 -12	0 -18	0 -30	0 -48	0 -78	+4 -4
	6 - 10	-25 -34	-25 -40	-25 -47	-13 -27	-13 -28	-13 -35	-5 -11	-5 -14	-5 -20	0 -4	0 -6	0 -9	0 -15	0 -22	0 -36	0 -58	0 -90	+4.5 -4.5
	10 - 18	-32 -43	-32 -50	-32 -59	-16 -27	-16 -34	-16 -43	-6 -14	-6 -17	-6 -24	0 -5	0 -8	0 -11	0 -18	0 -27	0 -43	0 -70	0 -110	+5.5 -5.5
	18 - 30	-40 -53	-40 -61	-40 -73	-20 -33	-20 -41	-20 -53	-7 -16	-7 -20	-7 -28	0 -6	0 -9	0 -13	0 -21	0 -33	0 -52	0 -84	0 -130	+6.5 -6.5
	30 - 50	-50 -66	-50 -75	-50 -89	-25 -41	-25 -50	-25 -64	-9 -20	-9 -25	-9 -34	0 -7	0 -11	0 -16	0 -25	0 -39	0 -62	0 -100	0 -160	+8 -8
	50 - 80	-60 -79	-60 -90	-60 -106	-30 -49	-30 -60	-30 -76	-10 -23	-10 -29	-10 -40	0 -8	0 -13	0 -19	0 -30	0 -46	0 -74	0 -120	0 -190	+9.5 -9.5
	80 - 120	-72 -94	-72 -107	-72 -126	-36 -58	-36 -71	-36 -90	-12 -27	-12 -34	-12 -47	0 -10	0 -15	0 -22	0 -35	0 -54	0 -87	0 -140	0 -220	+11 -11
	120 - 180	-85 -110	-85 -125	-85 -148	-43 -68	-43 -83	-43 -106	-14 -32	-14 -39	-14 -54	0 -12	0 -18	0 -25	0 -40	0 -63	0 -100	0 -160	0 -250	+12.5 -12.5
	180 - 250	-100 -129	-100 -146	-100 -172	-50 -79	-50 -96	-50 -122	-15 -35	-15 -44	-15 -61	0 -14	0 -20	0 -29	0 -46	0 -72	0 -115	0 -185	0 -290	+14.5 -14.5
	250 - 315	-110 -142	-110 -162	-110 -191	-56 -88	-56 -108	-56 -137	-17 -40	-17 -49	-17 -69	0 -16	0 -23	0 -32	0 -52	0 -81	0 -130	0 -210	0 -320	+16 -16
	315 - 400	-125 -161	-125 -182	-125 -214	-62 -98	-62 -119	-62 -151	-18 -43	-18 -54	-18 -75	0 -18	0 -25	0 -36	0 -57	0 -89	0 -140	0 -230	0 -360	+18 -18
	400 - 500	-135 -175	-135 -198	-135 -232	-68 -108	-68 -131	-68 -165	-20 -47	-20 -60	-20 -83	0 -20	0 -27	0 -40	0 -63	0 -97	0 -155	0 -250	0 -400	+20 -20

Table 5.3

Nominal size range (mm)	Symbol	JS 7	JS 8	JS 9	JS 10	JS 11	JS 12	JS 13	JS 14	JS 15	JS 16	JS 17	JS 18	K 6	K 7	K 8	M 5	M 6	M 7
	From / to																		
	3	+5 -5	+7 -7	+12.5 -12.5	+20 -20	+30 -30	+50 -50	+70 -70	+125 -125	+200 -200	+300 -300	_	_	+6 0	+10 0	+14 0	+6 +2	+8 +2	_
	3 – 6	+6 -6	+9 -9	+15 -15	+24 -24	+37.5 -37.5	+60 -60	+90 -90	+150 -150	+240 -240	+375 -375	_	_	+9 -1	+13 -1	+18 -1	+9 +4	+12 +4	+16 +4
	6 – 10	+7.5 -7.5	+11 -11	+18 -18	+29 -29	+45 -45	+75 -75	+110 -110	+180 -180	+290 -290	+450 -450	+750 -750	_	+10 +1	+16 +1	+22 0	+12 +6	+15 +16	+21 +6
	10 – 18	+9 -9	+13.5 -13.5	+21.5 -21.5	+35 -35	+55 -55	+90 -90	+135 -135	+215 -215	+350 -350	+550 -550	+900 -900	+1350 -1350	+12 +1	+19 +1	+27 0	+12 +7	+18 +7	+25 +7
	18 – 30	+10.5 -10.5	+16.5 -16.5	+26 -26	+42 -42	+65 -65	+105 -105	+165 -165	+260 -260	+420 -420	+650 -650	+1050 -1050	+1650 -1650	+15 +2	+23 +2	+33 0	+17 +8	+21 +8	+29 +8
	30 – 50	+12.5 -12.5	+19.5 -19.5	+31 -31	+50 -50	+80 -80	+125 -125	+195 -195	+310 -310	+500 -500	+800 -800	+1250 -1250	+1950 -1950	+18 +2	+27 +2	+39 0	+20 +9	+25 +9	+34 +9
	50 – 80	+15 -15	+23 -23	+37 -37	+60 -60	+95 -95	+150 -150	+230 -230	+370 -370	+600 -600	+950 -950	+1500 -1500	+2300 -2300	+21 +2	+32 +2	+46 0	+24 +11	+30 -11	+41 +11
	80 – 120	+17.5 -17.5	+27 -27	+43.5 -43.5	+70 -70	+110 -110	+175 -175	+270 -270	+435 -435	+700 -700	+1100 -1100	+1750 -1750	+2700 -2700	+25 +3	+38 +3	+54 0	+28 +13	+35 +13	+48 +13
	120 – 180	+20 -20	+31.5 -31.5	+50 -50	+80 -80	+125 -125	+200 -200	+315 -315	+500 -500	+800 -800	+1250 -1250	+2000 -2000	+3150 -3150	+28 +3	+43 +3	+63 0	+33 +15	+40 +15	+55 +15
	180 – 250	+23 -23	+36 -36	+57.5 -57.5	+92.5 -92.5	+145 -145	+230 -230	+360 -360	+575 -575	+925 -925	+1450 -1450	+2300 -2300	+3600 -3600	+33 +4	+50 +4	+72 0	+37 +17	+46 +17	+63 +17
	250 – 315	+26 -26	+40.5 -40.5	+65 -65	+105 -105	+160 -160	+260 -260	+405 -405	+650 -650	+1050 -1050	+1600 -1600	+2600 -2600	+4500 -4500	+36 +4	+56 +4	+81 0	+43 +20	+52 +20	+72 +20
	315 – 400	+28.5 -28.8	+44.5 -44.8	+70 -70	+115 -115	+180 -180	+285 -285	+445 -445	+700 -700	+1150 -1150	+1800 -1800	+2850 -2850	+4450 -4450	+40 +4	+61 +4	+89 0	+46 +21	+57 +21	+78 +21
	400 – 500	+31.5 -31.5	+48.5 -48.5	+77.5 -77.5	+125 -125	+200 -200	+315 -315	+485 -485	+775 -775	+1250 -1250	+2000 -2000	+3150 -3150	+4850 -4850	+45 +5	+68 +5	+97 0	+50 +23	+63 +23	+86 +23

6. Surface quality parameters for seal housings

Surface	Roughness Rt	Roughness Ra	Material ratio Rmr
Counter surface	≤ 3 µm	0.05 ≥ optimum value 0.2 ≤ 0.3 µm	50 % < optimum value 80 % ≤ 90 %
Groove bottom	≤ 10 µm	≤ 1.8 µm	
Groove sides	≤ 16 µm	≤ 3 µm	

7. Abbreviations used for materials in HF seals

Material	Abbreviations	Tolerance
NBR Shore A 65	N65	± 5 Shore
NBR Shore A 70	N70	± 5 Shore
NBR Shore A 80	N80	± 5 Shore
NBR Shore A 90	N90	± 5 Shore
FPM Shore A 75	V75	± 5 Shore
FPM Shore A 80	V80	± 5 Shore
FPM Shore A 90	V90	± 5 Shore
EPDM Shore A70 sulphur crosslinked	E70S	± 5 Shore
EPDM Shore A70 peroxide crosslinked	E70P	± 5 Shore
MVQ Shore 40	S40	± 5 Shore
MVQ Shore 70	S70	± 5 Shore
FEP/MVQ	F-S	
FFKM Shore A 80	K80	± 5 Shore
NBR cotton fabric	NBR-C	
FPM cotton fabric	FPM-C	
FPM aramid fabric	FPM-K	
Phenol resin/fabric	PH/GEW	
Graphite/split sheet metal	GRSP	
Graphite/smooth sheet metal	GRGL	
Klinger graphite Topgraph	TGR	
Klinger C4400	C4400	
PTFE/pure	PT	
PTFE/glass	PT/GL	
PTFE/bronze	PTBR	
PTFE/glass/MoS2	PT/GM	
PTFE/carbon	PT/K	
Soft iron	WE	
Stainless steel 1.4571	INOX	
Polyurethane	PUR	
Polyurethane, hydrolysis-resistant	H-PU	
Polyamide	PA	
Polyoxymethylene	POM	
Ultra high density polyethylene	UHMW-PE	

8. Bushes

8.1 General

Technical data

To make things clearer, we would like to define in advance some important technical data used repeatedly in this document. For this purpose, we shall consider a bush with an internal diameter “d” and a width “L”.

Specific bearing load = p (N/mm²)

For a vertically applied load “F” (N):

$$p = \frac{F}{d \cdot L}$$

Sliding speed = v (m/s)

In the case of rotation: for a rotation speed “n” (min^{-1}):

$$v = \frac{d \cdot \pi \cdot n}{60 \cdot 10^3}$$

In the case of oscillatory motion: where “n” is the frequency of the oscillatory motion (min^{-1}) and “μ” is the amplitude of the motion expressed in degrees:

$$v = \frac{d \cdot \pi}{60 \cdot 10^3} \cdot \frac{2\mu \cdot n}{360}$$

pv value = p x v (N/mm² x m/s)

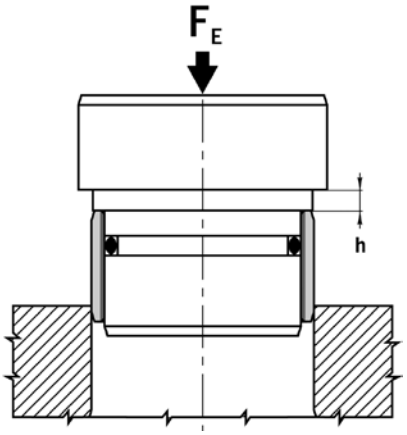


Figure 8.1

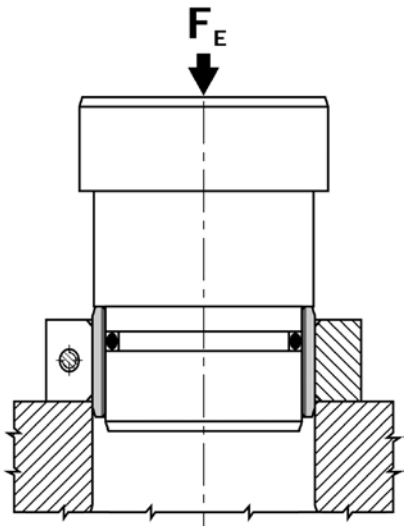


Figure 8.2

Calculation of the service life

The service life of a bush depends on the specific bearing load, sliding speed, operating temperature and the shaft material (surface quality and hardness). On request, we can calculate a service life for you, but this can be no more than a guide.

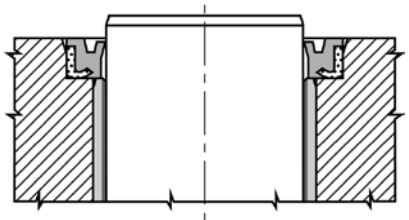


Figure 8.3

Installing the bushes

Use the basic arrangement shown in Figure 8.1 to install bushes with an external diameter of up to 50 mm. By machining the bearing surface at a specific height h, the bush can be pressed an exact depth h into the hole.

Use an auxiliary ring as shown in Figure 8.2 to fit bushes with an external diameter greater than 50 mm. On request, we can calculate the press-in force FE for you.

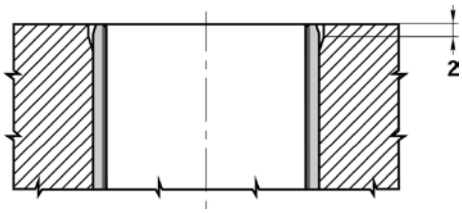


Figure 8.4

Installation principle

We recommend protecting the bushes against dirt by using type SWP seal ends or shaft seal rings (Fig. 8.3). Finally, chamfers should preferably be machined in order to prevent stress concentrations at the edges of the bushes (Fig. 8.4), or the bushes should project above the surrounding material (Fig. 8.5).

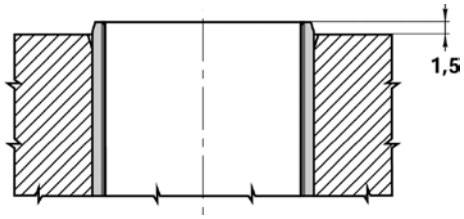


Figure 8.5

8.2 Maintenance-free bushes type BK-1

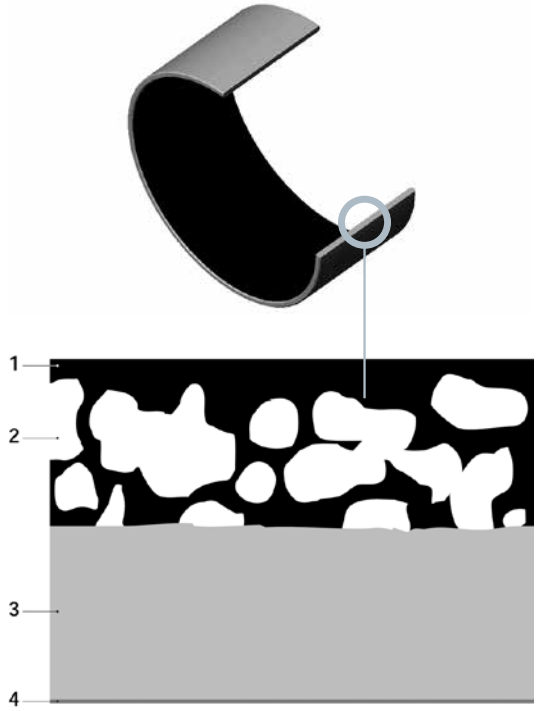


Table 8.6

Coefficient of friction	P N/mm²	v m/s
0.025	250-140	<0.001
0.04-0.07	140-60	0.001-0.005
0.07-0.1	60-10	0.005-0.05
0.1-0.15	10-1	0.05-0.5
0.15-0.2	<1	0.5-2

1 – PTFE-lead mixture: 0.01 – 0.05 mm

2 – Bronze coating: 0.20 – 0.35 mm

3 – Steel backing

4 – Surface protection: ~0.002 mm

Construction

The BK-1 bush consists of a porous bronze coating (2) sinter-fused onto a steel backing (3). A PTFE-lead mixture (1) is then rolled into the bronze coating. The steel backing is protected against corrosion by external tin- or copper-plating (4).

Properties

The BK-1 bush has many advantages:

- Suitable for dry running and maintenance-free
- Noise and vibration absorption
- Hydrodynamic operation possible
- High permissible load
- Good chemical resistance
- Good friction characteristics
- No stick-slip
- Wide temperature range
- High slide speed
- No water absorption
- Low play during operation
- Extremely space-saving

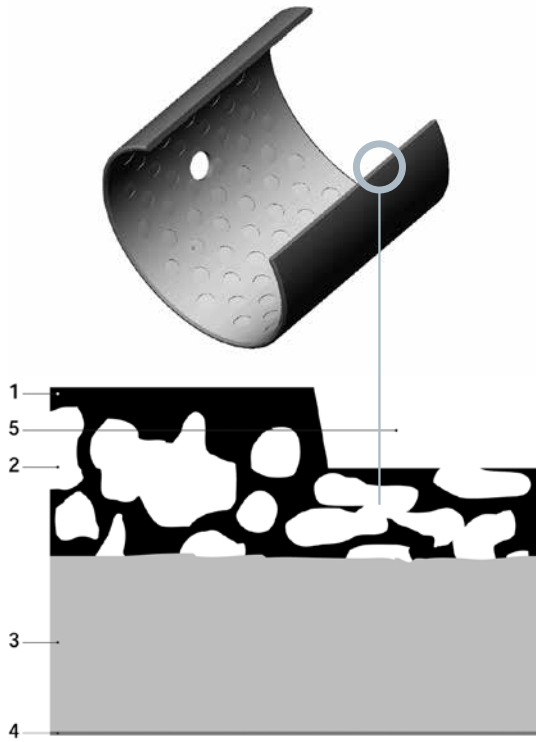
Areas of application

BK-1 bushes are suitable for translatory, rotary and oscillatory motions.

Application examples:

- Rod guide for pneumatic and hydraulic cylinders
- Attachment eyes for pneumatic and hydraulic cylinders
- Conveyor-belt systems, textile machinery, automobiles, ...

8.3 Relubricatable bushes type BK-2



1 – Acetal resin: 0.30 – 0.50 mm
2 – Bronze coating: 0.20 – 0.35 mm
3 – Steel backing
4 – Surface protection: ~0.002 mm
5 – Lubrication pockets

Construction

The BK-2 bush consists of a porous bronze coating (2) sinter-fused onto a steel backing (3). An acetal resin POM (1) is then rolled into the bronze coating. The steel backing is protected against corrosion by external tin- or copper-plating (4). Finally the lubrication pockets (5) are stamped into the slide coating.

Properties

The BK-2 bush has many advantages:

- Maintenance-free operation
- Noise and vibration absorption
- Relubricatable
- Hydrodynamic operation possible
- High permissible load
- Good friction characteristics
- High slide speed
- No water absorption
- Can be used where oil film formation is difficult
- Low play during operation
- Extremely space-saving

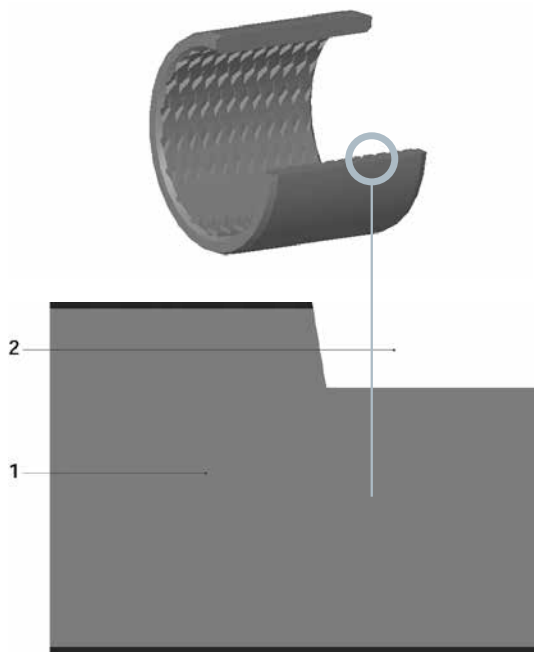
Areas of application

BK-2 bushes are suitable for rotary and oscillatory movements. Initial lubrication with grease is advisable, and continual lubrication substantially lengthens the service life of the slide bearing.

Application examples:

- Attachment eyes of pneumatic and hydraulic cylinders
- Agricultural equipment
- Material handling equipment
- Construction machinery, ...

8.4 Bronze bushes type BK090



1 – Bronze

2 – Lubrication pockets

Construction

The BK090 bush is made entirely out of CuSn8 bronze and manufactured from calibrated rolled strips. The entire sliding surface is covered with diamond-shaped lubrication pockets. Lubricant is introduced into these pockets, which then function as reservoirs, releasing the lubricant progressively during operation. Drill holes to allow relubrication.

Properties

The BK090 bush has many advantages:

- Maintenance-free operation
- Relubricatable
- Suitable for dirty conditions
- Shock and vibration resistant
- High permissible load
- Good friction characteristics
- No water absorption
- Low play during operation
- Extremely space-saving

Areas of application

BK090 bushes are suitable for rotary and oscillatory movements. Initial lubrication with grease is advisable, and continual lubrication substantially lengthens the service life of the slide bearing.

Application examples:

- Attachment eyes for hydraulic cylinders
- Forestry machinery
- Agricultural equipment
- Conveyors and elevators
- Construction machinery, ...

9. O-rings

9.1 Description of O-rings

O-rings are ring-shaped seals with a round cross-section (a torus) defined by the inside diameter (D) and the cross-sectional diameter (d). It is the most common seal type for hydraulic and pneumatic applications.

O-rings have the following advantages:

- The groove is simple and easy to machine
- Large choice of compounds: NBR, FPM, EPDM, silicone, PTFE, PUR, ...
- Easy to install due to its symmetry
- Attractive price thanks to new production techniques
- Extremely wide variety of applications:
- static, dynamic (both linear and rotary), ...
- Compact design

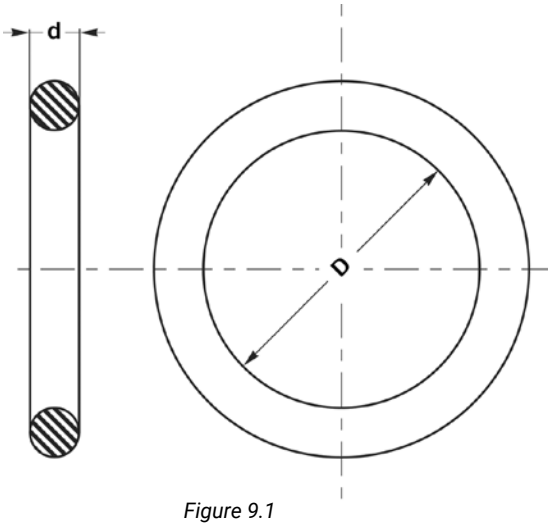


Figure 9.1

9.2 Principle of O-rings

The functional principle is summarised in Figure 9.2:

- The O-ring is installed in a groove with a depth g smaller than the diameter d of the cross-section (Fig. 9.2).
- After installation, the O-ring seal is squeezed and this creates a pressing action (Fig. 9.3).
- The media exerts pressure on the O-ring and intensifies the initial pressing action (Fig. 9.4).

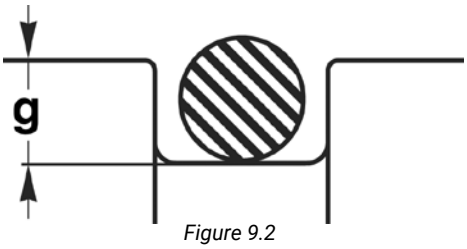


Figure 9.2

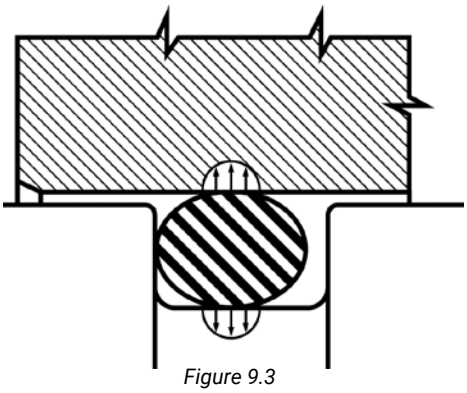


Figure 9.3

The initial precompression (Fig. 9.3) is very important to the way the O-ring works. Depending on the application and material, the compression of the elastomer will change as follows:

- From 3 to 20 % dynamic seal (pneumatic and hydraulic). In this catalogue, the initial pressure used for a static seal fluctuates between 12 and 14 %.
- From 15 to 30 % static seal. In this catalogue, the initial pressure used for a static seal fluctuates between 17 and 27 %.

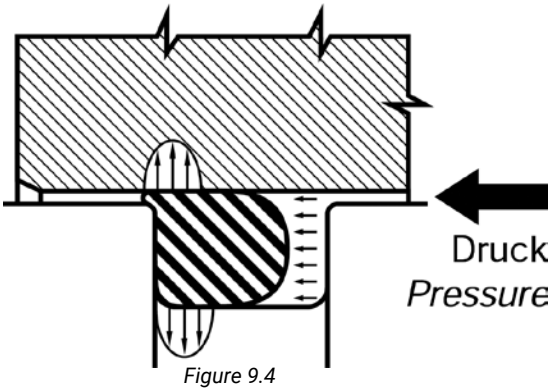


Figure 9.4

9.3 Technical features of O-rings

Static working pressure

- Up to 150 bar for NBR 70 shore A without support ring
- Up to 500 bar for NBR 70 shore A with support ring

Linear speed
Up to 0.5 m/s

Speed with rotational movements
Up to 2 m/s

C.S.: compression set
Compression set is a very important property because it expresses the time-related elasticity of the elastomer used.

Figures 9.5, 9.6 and 9.7 show an O-ring with cross-sectional diameter (d), compressed with a force (F) resulting in a value (C) for a specified time and temperature.

The value R is measured after the specified time has elapsed following the removal of force F:

$$\text{C.S. (\%)} = \frac{d - R}{d - C} \cdot 100$$

A completely elastic material has a C.S. of 0 %, while a completely inelastic material has a C.S. of 100 %.

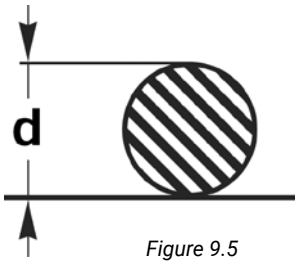


Figure 9.5

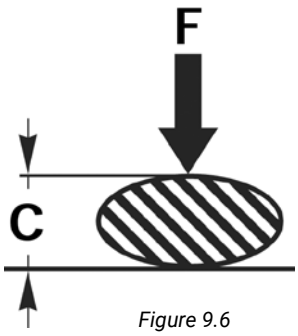


Figure 9.6

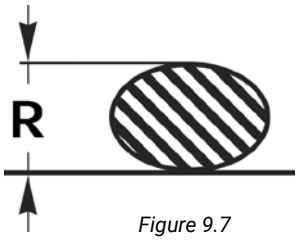


Figure 9.7

9.4 Permissible clearance gap of O-rings

The highest permissible clearance gap **e** can be determined from the chart in Figure 9.8 a. The clearance gap must be less than the value read from axis to the left of the relevant curve and depends on the pressure used.

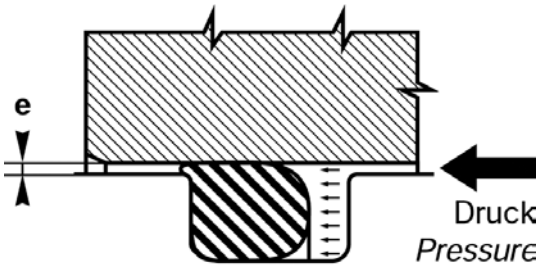


Figure 9.8 b

Chart for the design of static O-ring seals

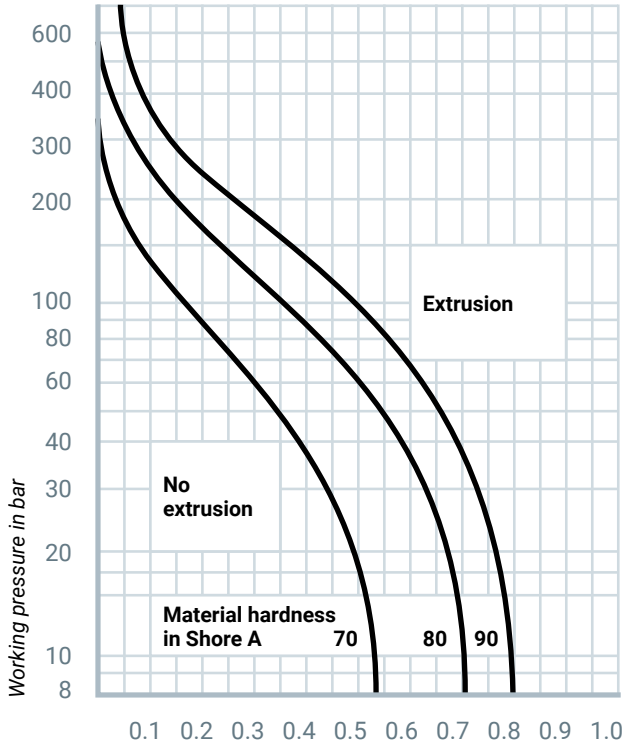


Figure 9.8 a

9.5 Dimensional tolerances for O-rings in accordance with ISO 3601-1: Class B

The tolerances for the cord diameters d_2 are shown in Table 9.9. The tolerances for the internal diameter d_1 are calculated **in accordance with ISO 3601-1: Class B** using the following formula:

$d_1 = (d_1^{0.95} \cdot 0.009) + 0.11$ [mm]

This formula is for use only with metric dimensions. The tolerances for internal diameters d_1 up to 600 mm are listed in Table 9.10.

Table 9.10

Internal diameter d_1 (mm)	Tolerances ±
$d_1 \leq 1.71$	0.12
$1.71 < d_1 \leq 2.93$	0.13
$2.93 < d_1 \leq 4.17$	0.14
$4.17 < d_1 \leq 5.44$	0.15
$5.44 < d_1 \leq 6.72$	0.16
$6.72 < d_1 \leq 8.01$	0.17
$8.01 < d_1 \leq 9.31$	0.18
$9.31 < d_1 \leq 10.62$	0.19
$10.62 < d_1 \leq 11.94$	0.20
$11.94 < d_1 \leq 13.27$	0.21
$13.27 < d_1 \leq 14.61$	0.22
$14.61 < d_1 \leq 15.95$	0.23
$15.95 < d_1 \leq 17.29$	0.24
$17.29 < d_1 \leq 18.64$	0.25
$18.64 < d_1 \leq 20.00$	0.26
$20.00 < d_1 \leq 21.36$	0.27
$21.36 < d_1 \leq 22.73$	0.28
$22.73 < d_1 \leq 24.10$	0.29
$24.10 < d_1 \leq 25.47$	0.30
$25.47 < d_1 \leq 26.85$	0.31
$26.85 < d_1 \leq 28.23$	0.32
$28.23 < d_1 \leq 29.61$	0.33
$29.61 < d_1 \leq 31.00$	0.34
$31.00 < d_1 \leq 32.39$	0.35
$32.39 < d_1 \leq 33.78$	0.36
$33.78 < d_1 \leq 35.18$	0.37
$35.18 < d_1 \leq 36.58$	0.38
$36.58 < d_1 \leq 37.98$	0.39
$37.98 < d_1 \leq 39.38$	0.40
$39.38 < d_1 \leq 40.79$	0.41
$40.79 < d_1 \leq 42.20$	0.42
$42.20 < d_1 \leq 43.61$	0.43

Table 9.10

Internal diameter d_1 (mm)	Tolerances ±
$43.61 < d_1 \leq 45.02$	0.44
$45.02 < d_1 \leq 46.44$	0.45
$46.44 < d_1 \leq 47.86$	0.46
$47.86 < d_1 \leq 49.28$	0.47
$49.28 < d_1 \leq 50.70$	0.48
$50.70 < d_1 \leq 52.12$	0.49
$52.12 < d_1 \leq 53.55$	0.50
$53.55 < d_1 \leq 54.98$	0.51
$54.98 < d_1 \leq 56.41$	0.52
$56.41 < d_1 \leq 57.84$	0.53
$57.84 < d_1 \leq 59.27$	0.54
$59.27 < d_1 \leq 60.71$	0.55
$60.71 < d_1 \leq 62.14$	0.56
$62.14 < d_1 \leq 63.58$	0.57
$63.58 < d_1 \leq 65.02$	0.58
$65.02 < d_1 \leq 66.47$	0.59
$66.47 < d_1 \leq 67.91$	0.60
$67.91 < d_1 \leq 69.35$	0.61
$69.35 < d_1 \leq 70.80$	0.62
$70.80 < d_1 \leq 72.25$	0.63
$72.25 < d_1 \leq 73.70$	0.64
$73.70 < d_1 \leq 75.15$	0.65
$75.15 < d_1 \leq 76.60$	0.66
$76.60 < d_1 \leq 78.05$	0.67
$78.05 < d_1 \leq 79.51$	0.68
$79.51 < d_1 \leq 80.97$	0.69
$80.97 < d_1 \leq 82.42$	0.70
$82.42 < d_1 \leq 83.88$	0.71
$83.88 < d_1 \leq 85.34$	0.72
$85.34 < d_1 \leq 86.80$	0.73
$86.80 < d_1 \leq 88.27$	0.74
$88.27 < d_1 \leq 89.73$	0.75
$89.73 < d_1 \leq 91.20$	0.76
$91.20 < d_1 \leq 92.66$	0.77
$92.66 < d_1 \leq 94.13$	0.78
$94.13 < d_1 \leq 95.60$	0.79
$95.60 < d_1 \leq 97.07$	0.80
$97.07 < d_1 \leq 98.54$	0.81
$98.54 < d_1 \leq 100.01$	0.82
$100.01 < d_1 \leq 101.48$	0.83
$101.48 < d_1 \leq 102.96$	0.84
$102.96 < d_1 \leq 104.43$	0.85
$104.43 < d_1 \leq 105.91$	0.86
$105.91 < d_1 \leq 107.39$	0.87

Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
107.39 < d_1 ≤ 108.86	0.88
108.86 < d_1 ≤ 110.34	0.89
110.34 < d_1 ≤ 111.82	0.90
111.82 < d_1 ≤ 113.30	0.91
113.30 < d_1 ≤ 114.79	0.92
114.79 < d_1 ≤ 116.27	0.93
116.27 < d_1 ≤ 117.75	0.94
117.75 < d_1 ≤ 119.24	0.95
119.24 < d_1 ≤ 120.72	0.96
120.72 < d_1 ≤ 122.21	0.97
122.21 < d_1 ≤ 123.70	0.98
123.70 < d_1 ≤ 125.19	0.99
125.19 < d_1 ≤ 126.68	1.00
126.68 < d_1 ≤ 128.17	1.01
128.17 < d_1 ≤ 129.66	1.02
129.66 < d_1 ≤ 131.15	1.03
131.15 < d_1 ≤ 132.64	1.04
132.64 < d_1 ≤ 134.14	1.05
134.14 < d_1 ≤ 135.63	1.06
135.63 < d_1 ≤ 137.13	1.07
137.13 < d_1 ≤ 138.62	1.08
138.62 < d_1 ≤ 140.12	1.09
140.12 < d_1 ≤ 141.62	1.10
141.62 < d_1 ≤ 143.12	1.11
143.12 < d_1 ≤ 144.62	1.12
144.62 < d_1 ≤ 146.12	1.13
146.12 < d_1 ≤ 147.62	1.14
147.62 < d_1 ≤ 149.12	1.15
149.12 < d_1 ≤ 150.62	1.16
150.62 < d_1 ≤ 152.13	1.17
152.13 < d_1 ≤ 153.63	1.18
153.63 < d_1 ≤ 155.13	1.19
155.13 < d_1 ≤ 156.64	1.20
156.64 < d_1 ≤ 158.15	1.21
158.15 < d_1 ≤ 159.65	1.22
159.65 < d_1 ≤ 161.16	1.23
161.16 < d_1 ≤ 162.67	1.24
162.67 < d_1 ≤ 164.18	1.25
164.18 < d_1 ≤ 165.69	1.26
165.69 < d_1 ≤ 167.20	1.27
167.20 < d_1 ≤ 168.71	1.28
168.71 < d_1 ≤ 170.22	1.29
170.22 < d_1 ≤ 171.73	1.30
171.73 < d_1 ≤ 173.25	1.31
173.25 < d_1 ≤ 174.76	1.32
174.76 < d_1 ≤ 176.28	1.33

Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
176.28 < d_1 ≤ 177.79	1.34
177.79 < d_1 ≤ 179.31	1.35
179.31 < d_1 ≤ 180.82	1.36
180.82 < d_1 ≤ 182.34	1.37
182.34 < d_1 ≤ 183.86	1.38
183.86 < d_1 ≤ 185.38	1.39
185.38 < d_1 ≤ 186.89	1.40
186.89 < d_1 ≤ 188.41	1.41
188.41 < d_1 ≤ 189.93	1.42
189.93 < d_1 ≤ 191.45	1.43
191.45 < d_1 ≤ 192.98	1.44
192.98 < d_1 ≤ 194.50	1.45
194.50 < d_1 ≤ 196.02	1.46
196.02 < d_1 ≤ 197.54	1.47
197.54 < d_1 ≤ 199.07	1.48
199.07 < d_1 ≤ 200.59	1.49
200.59 < d_1 ≤ 202.12	1.50
202.12 < d_1 ≤ 203.64	1.51
203.64 < d_1 ≤ 205.17	1.52
205.17 < d_1 ≤ 206.69	1.53
206.69 < d_1 ≤ 208.22	1.54
208.22 < d_1 ≤ 209.75	1.55
209.75 < d_1 ≤ 211.28	1.56
211.28 < d_1 ≤ 212.81	1.57
212.81 < d_1 ≤ 214.34	1.58
214.34 < d_1 ≤ 215.87	1.59
215.87 < d_1 ≤ 217.40	1.60
217.40 < d_1 ≤ 218.93	1.61
218.93 < d_1 ≤ 220.46	1.62
220.46 < d_1 ≤ 221.99	1.63
221.99 < d_1 ≤ 223.52	1.64
223.52 < d_1 ≤ 225.06	1.65
225.06 < d_1 ≤ 226.59	1.66
226.59 < d_1 ≤ 228.12	1.67
228.12 < d_1 ≤ 229.66	1.68
229.66 < d_1 ≤ 231.19	1.69
231.19 < d_1 ≤ 232.73	1.70
232.73 < d_1 ≤ 234.27	1.71
234.27 < d_1 ≤ 235.80	1.72
235.80 < d_1 ≤ 237.34	1.73
237.34 < d_1 ≤ 238.88	1.74
238.88 < d_1 ≤ 240.42	1.75
240.42 < d_1 ≤ 241.95	1.76
241.95 < d_1 ≤ 243.49	1.77
243.49 < d_1 ≤ 245.03	1.78
245.03 < d_1 ≤ 246.57	1.79

Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
246.57 < d_1 ≤ 248.11	1.80
248.11 < d_1 ≤ 249.66	1.81
249.66 < d_1 ≤ 251.20	1.82
251.20 < d_1 ≤ 252.74	1.83
252.74 < d_1 ≤ 254.28	1.84
254.28 < d_1 ≤ 255.82	1.85
255.82 < d_1 ≤ 257.37	1.86
257.37 < d_1 ≤ 258.91	1.87
258.91 < d_1 ≤ 260.46	1.88
260.46 < d_1 ≤ 262.00	1.89
262.00 < d_1 ≤ 263.55	1.90
263.55 < d_1 ≤ 265.09	1.91
265.09 < d_1 ≤ 266.64	1.92
266.64 < d_1 ≤ 268.18	1.93
268.18 < d_1 ≤ 269.73	1.94
269.73 < d_1 ≤ 271.28	1.95
271.28 < d_1 ≤ 272.83	1.96
272.83 < d_1 ≤ 274.38	1.97
274.38 < d_1 ≤ 275.92	1.98
275.92 < d_1 ≤ 277.47	1.99
277.47 < d_1 ≤ 279.02	2.00
279.02 < d_1 ≤ 280.57	2.01
280.57 < d_1 ≤ 282.12	2.02
282.12 < d_1 ≤ 283.68	2.03
283.68 < d_1 ≤ 285.23	2.04
285.23 < d_1 ≤ 286.78	2.05
286.78 < d_1 ≤ 288.33	2.06
288.33 < d_1 ≤ 289.88	2.07
289.88 < d_1 ≤ 291.44	2.08
291.44 < d_1 ≤ 292.99	2.09
292.99 < d_1 ≤ 294.54	2.10
294.54 < d_1 ≤ 296.10	2.11
296.10 < d_1 ≤ 297.65	2.12
297.65 < d_1 ≤ 299.21	2.13
299.21 < d_1 ≤ 300.76	2.14
300.76 < d_1 ≤ 302.32	2.15
302.32 < d_1 ≤ 303.88	2.16
303.88 < d_1 ≤ 305.43	2.17
305.43 < d_1 ≤ 306.99	2.18
306.99 < d_1 ≤ 308.55	2.19
308.55 < d_1 ≤ 310.11	2.20
310.11 < d_1 ≤ 311.66	2.21
311.66 < d_1 ≤ 313.22	2.22
313.22 < d_1 ≤ 314.78	2.23
314.78 < d_1 ≤ 316.34	2.24
316.34 < d_1 ≤ 317.90	2.25

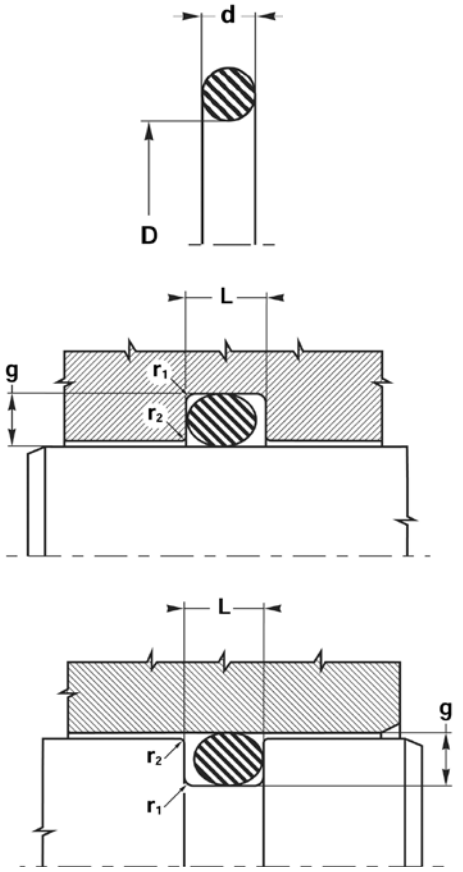
Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
317.90 < d_1 ≤ 319.46	2.26
319.46 < d_1 ≤ 321.02	2.27
321.02 < d_1 ≤ 322.58	2.28
322.58 < d_1 ≤ 324.15	2.29
324.15 < d_1 ≤ 325.71	2.30
325.71 < d_1 ≤ 327.27	2.31
327.27 < d_1 ≤ 328.83	2.32
328.83 < d_1 ≤ 330.39	2.33
330.39 < d_1 ≤ 331.96	2.34
331.96 < d_1 ≤ 333.52	2.35
333.52 < d_1 ≤ 335.09	2.36
335.09 < d_1 ≤ 336.65	2.37
336.65 < d_1 ≤ 338.21	2.38
338.21 < d_1 ≤ 339.78	2.39
339.78 < d_1 ≤ 341.35	2.40
341.35 < d_1 ≤ 342.91	2.41
342.91 < d_1 ≤ 344.48	2.42
344.48 < d_1 ≤ 346.04	2.43
346.04 < d_1 ≤ 347.61	2.44
347.61 < d_1 ≤ 349.18	2.45
349.18 < d_1 ≤ 350.75	2.46
350.75 < d_1 ≤ 352.31	2.47
352.31 < d_1 ≤ 353.88	2.48
353.88 < d_1 ≤ 355.45	2.49
355.45 < d_1 ≤ 357.02	2.50
357.02 < d_1 ≤ 358.59	2.51
358.59 < d_1 ≤ 360.16	2.52
360.16 < d_1 ≤ 361.73	2.53
361.73 < d_1 ≤ 363.30	2.54
363.30 < d_1 ≤ 364.87	2.55
364.87 < d_1 ≤ 366.44	2.56
366.44 < d_1 ≤ 368.01	2.57
368.01 < d_1 ≤ 369.58	2.58
369.58 < d_1 ≤ 371.16	2.59
371.16 < d_1 ≤ 372.73	2.60
372.73 < d_1 ≤ 374.30	2.61
374.30 < d_1 ≤ 375.87	2.62
375.87 < d_1 ≤ 377.45	2.63
377.45 < d_1 ≤ 379.02	2.64
379.02 < d_1 ≤ 380.59	2.65
380.59 < d_1 ≤ 382.17	2.66
382.17 < d_1 ≤ 383.74	2.67
383.74 < d_1 ≤ 385.32	2.68
385.32 < d_1 ≤ 386.89	2.69
386.89 < d_1 ≤ 388.47	2.70
388.47 < d_1 ≤ 390.05	2.71

Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
390.05 < d_1 ≤ 391.62	2.72
391.62 < d_1 ≤ 393.20	2.73
393.20 < d_1 ≤ 394.78	2.74
394.78 < d_1 ≤ 396.35	2.75
396.35 < d_1 ≤ 397.93	2.76
397.93 < d_1 ≤ 399.51	2.77
399.51 < d_1 ≤ 401.09	2.78
401.09 < d_1 ≤ 402.66	2.79
402.66 < d_1 ≤ 404.24	2.80
404.24 < d_1 ≤ 405.82	2.81
405.82 < d_1 ≤ 407.40	2.82
407.40 < d_1 ≤ 408.98	2.83
408.98 < d_1 ≤ 410.56	2.84
410.56 < d_1 ≤ 412.14	2.85
412.14 < d_1 ≤ 413.72	2.86
413.72 < d_1 ≤ 415.30	2.87
415.30 < d_1 ≤ 416.89	2.88
416.89 < d_1 ≤ 418.47	2.89
418.47 < d_1 ≤ 420.05	2.90
420.05 < d_1 ≤ 421.63	2.91
421.63 < d_1 ≤ 423.21	2.92
423.21 < d_1 ≤ 424.80	2.93
424.80 < d_1 ≤ 426.38	2.94
426.38 < d_1 ≤ 427.96	2.95
427.96 < d_1 ≤ 429.55	2.96
429.55 < d_1 ≤ 431.13	2.97
431.13 < d_1 ≤ 432.71	2.98
432.71 < d_1 ≤ 434.30	2.99
434.30 < d_1 ≤ 435.88	3.00
435.88 < d_1 ≤ 437.47	3.01
437.47 < d_1 ≤ 439.05	3.02
439.05 < d_1 ≤ 440.64	3.03
440.64 < d_1 ≤ 442.22	3.04
442.22 < d_1 ≤ 443.81	3.05
443.81 < d_1 ≤ 445.40	3.06
445.40 < d_1 ≤ 446.98	3.07
446.98 < d_1 ≤ 448.57	3.08
448.57 < d_1 ≤ 450.16	3.09
450.16 < d_1 ≤ 451.75	3.10
451.75 < d_1 ≤ 453.33	3.11
453.33 < d_1 ≤ 454.92	3.12
454.92 < d_1 ≤ 456.51	3.13
456.51 < d_1 ≤ 458.10	3.14
458.10 < d_1 ≤ 459.69	3.15
459.69 < d_1 ≤ 461.28	3.16
461.28 < d_1 ≤ 462.87	3.17

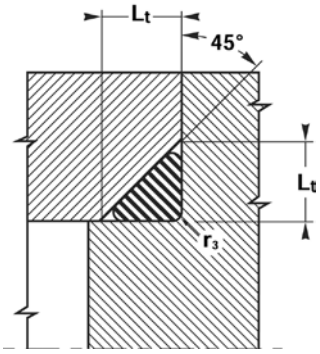
Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
462.87 < d_1 ≤ 464.46	3.18
464.46 < d_1 ≤ 466.05	3.19
466.05 < d_1 ≤ 467.64	3.20
467.64 < d_1 ≤ 469.23	3.21
469.23 < d_1 ≤ 470.82	3.22
470.82 < d_1 ≤ 472.41	3.23
472.41 < d_1 ≤ 474.00	3.24
474.00 < d_1 ≤ 475.59	3.25
475.59 < d_1 ≤ 477.19	3.26
477.19 < d_1 ≤ 478.78	3.27
478.78 < d_1 ≤ 480.37	3.28
480.37 < d_1 ≤ 481.96	3.29
481.96 < d_1 ≤ 483.56	3.30
483.56 < d_1 ≤ 485.15	3.31
485.15 < d_1 ≤ 486.74	3.32
486.74 < d_1 ≤ 488.34	3.33
488.34 < d_1 ≤ 489.93	3.34
489.93 < d_1 ≤ 491.52	3.35
491.52 < d_1 ≤ 493.12	3.36
493.12 < d_1 ≤ 494.71	3.37
494.71 < d_1 ≤ 496.31	3.38
496.31 < d_1 ≤ 497.90	3.39
497.90 < d_1 ≤ 499.50	3.40
499.50 < d_1 ≤ 501.10	3.41
501.10 < d_1 ≤ 502.69	3.42
502.69 < d_1 ≤ 504.29	3.43
504.29 < d_1 ≤ 505.89	3.44
505.89 < d_1 ≤ 507.48	3.45
507.48 < d_1 ≤ 509.08	3.46
509.08 < d_1 ≤ 510.68	3.47
510.68 < d_1 ≤ 512.27	3.48
512.27 < d_1 ≤ 513.87	3.49
513.87 < d_1 ≤ 515.47	3.50
515.47 < d_1 ≤ 517.07	3.51
517.07 < d_1 ≤ 518.67	3.52
518.67 < d_1 ≤ 520.27	3.53
520.27 < d_1 ≤ 521.87	3.54
521.87 < d_1 ≤ 523.46	3.55
523.46 < d_1 ≤ 525.06	3.56
525.06 < d_1 ≤ 526.66	3.57
526.66 < d_1 ≤ 528.26	3.58
528.26 < d_1 ≤ 529.86	3.59
529.86 < d_1 ≤ 531.46	3.60
531.46 < d_1 ≤ 533.07	3.61
533.07 < d_1 ≤ 534.67	3.62
534.67 < d_1 ≤ 536.27	3.63

Table 9.10	
Internal diameter d_1 (mm)	**Tolerances ±**
536.27 < d_1 ≤ 537.87	3.64
537.87 < d_1 ≤ 539.47	3.65
539.47 < d_1 ≤ 541.07	3.66
541.07 < d_1 ≤ 542.68	3.67
542.68 < d_1 ≤ 544.28	3.68
544.28 < d_1 ≤ 545.88	3.69
545.88 < d_1 ≤ 547.48	3.70
547.48 < d_1 ≤ 549.09	3.71
549.09 < d_1 ≤ 550.69	3.72
550.69 < d_1 ≤ 552.29	3.73
552.29 < d_1 ≤ 553.90	3.74
553.90 < d_1 ≤ 555.50	3.75
555.50 < d_1 ≤ 557.11	3.76
557.11 < d_1 ≤ 558.71	3.77
558.71 < d_1 ≤ 560.32	3.78
560.32 < d_1 ≤ 561.92	3.79
561.92 < d_1 ≤ 563.53	3.80
563.53 < d_1 ≤ 565.13	3.81
565.13 < d_1 ≤ 566.74	3.82
566.74 < d_1 ≤ 568.34	3.83
568.34 < d_1 ≤ 569.95	3.84
569.95 < d_1 ≤ 571.56	3.85
571.56 < d_1 ≤ 573.16	3.86
573.16 < d_1 ≤ 574.77	3.87
574.77 < d_1 ≤ 576.38	3.88
576.38 < d_1 ≤ 577.98	3.89
577.98 < d_1 ≤ 579.59	3.90
579.59 < d_1 ≤ 581.20	3.91
581.20 < d_1 ≤ 582.81	3.92
582.81 < d_1 ≤ 584.42	3.93
584.42 < d_1 ≤ 586.02	3.94
586.02 < d_1 ≤ 587.63	3.95
587.63 < d_1 ≤ 589.24	3.96
589.24 < d_1 ≤ 590.85	3.97
590.85 < d_1 ≤ 592.46	3.98
592.46 < d_1 ≤ 594.07	3.99
594.07 < d_1 ≤ 595.68	4.00
595.68 < d_1 ≤ 597.29	4.01
597.29 < d_1 ≤ 598.90	4.02
598.90 < d_1 ≤ 600.00	4.03
d_1 > 600	using a formula

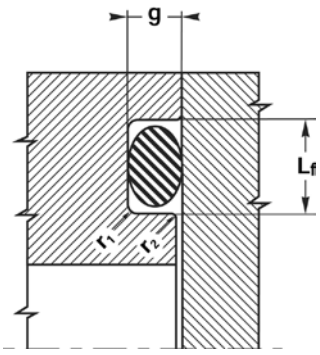
9.6 Static seal of O-rings



Radial pressing action



Three-sided pressing action



Axial pressing action

Table 9.11
Calculation of grooves and static seal in accordance with DIN 3601-2/Part 5 (ISO standard in bold)

d O-ring		g 0 / +0.0	L 0 / +0.20	Lf 0 / +0.20	Lt	tol. Lt	r1	r2	r3
1.00	1.02	0.70	1.40	1.40	1.35	0 / +0.10	0.20	0.10	0.20
1.50	1.52	1.10	2.00	2.10	2.00	0 / +0.10	0.20	0.10	0.20
1.60	1.63	1.20	2.10	2.20	2.15	0 / +0.10	0.30	0.10	0.30
1.78	**1.80**	**1.30**	**2.40**	**2.60**	**2.40**	**0 / +0.10**	**0.40**	**0.10**	**0.30**
1.90		1.40	2.60	2.70	2.55	0 / +0.10	0.40	0.10	0.40
2.00	1.98	1.50	2.70	2.80	2.70	0 / +0.10	0.40	0.10	0.40
2.40		1.80	3.20	3.30	3.20	0 / +0.15	0.50	0.10	0.40
2.50		1.85	3.30	3.40	3.40	0 / +0.15	0.50	0.10	0.60
2.62	**2.65**	**2.00**	**3.60**	**3.80**	**3.50**	**0 / +0.15**	**0.60**	**0.10**	**0.60**
2.70		2.05	3.60	3.80	3.65	0 / +0.15	0.60	0.10	0.60
3.00		2.30	4.00	4.00	4.00	0 / +0.20	0.60	0.15	0.60
3.10		2.40	4.10	4.10	4.10	0 / +0.20	0.60	0.15	0.60
3.50		2.65	4.60	4.70	4.70	0 / +0.20	0.60	0.15	0.90
3.53	**3.55**	**2.70**	**4.80**	**5.00**	**4.80**	**0 / +0.20**	**0.80**	**0.15**	**0.90**

Table 9.11
Calculation of grooves and static seal in accordance with DIN 3601-2/Part 5 (ISO standard in bold)

d O-ring		g 0 / +0.0	L 0 / +0.20	Lf 0 / +0.20	Lt	tol. Lt	r1	r2	r3
3.60		2.80	4.80	5.10	4.90	0 / +0.20	0.80	0.15	0.90
4.00		3.10	5.20	5.30	5.40	0 / +0.20	0.80	0.15	1.20
4.50		3.50	5.80	5.90	6.10	0 / +0.20	0.80	0.15	1.20
5.00		4.00	6.60	6.70	6.70	0 / +0.25	0.80	0.15	1.20
5.33	**5.33**	**4.30**	**7.10**	**7.30**	**7.10**	**0 / +0.25**	**1.20**	**0.20**	**1.50**
5.50		4.50	7.10	7.30	7.40	0 / +0.25	1.20	0.20	1.50
5.70		4.60	7.20	7.40	7.60	0 / +0.25	1.20	0.20	1.50
6.00		4.90	7.40	7.60	8.00	0 / +0.30	1.20	0.20	1.50
7.00	**6.99**	**5.80**	**9.50**	**9.70**	**9.40**	**0 / +0.30**	**1.50**	**0.20**	**2.00**
8.00		6.70	9.80	10.00	10.80	0 / +0.30	1.50	0.20	2.00
8.40		7.10	10.00	10.30	11.30	0 / +0.30	1.50	0.20	2.00

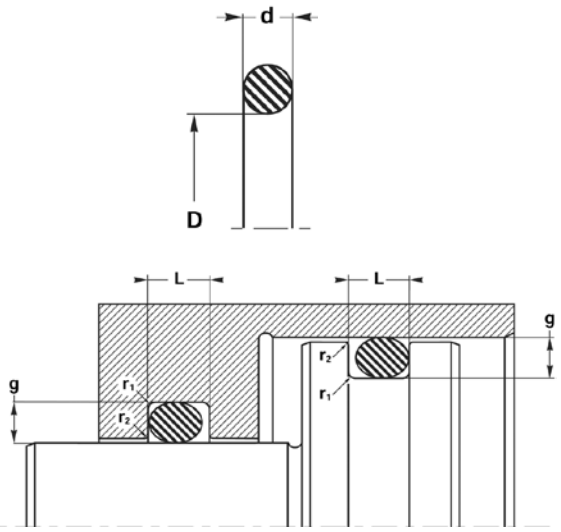
9.7 Dynamic seal for pneumatic cylinders

Table 9.12
(ISO standard in bold)

d		g	L	r1	r2
1.00	1.02	0.95	1.30	0.20	0.10
1.50	1.52	1.35	1.90	0.20	0.10
1.60	1.63	1.45	2.00	0.30	0.10
1.78	**1.80**	**1.55**	**2.30**	**0.30**	**0.10**
1.90		1.75	2.40	0.40	0.10
2.00	1.98	1.80	2.50	0.40	0.10
2.40		2.15	2.90	0.50	0.10
2.50		2.25	3.00	0.50	0.10
2.62	**2.65**	**2.35**	**3.10**	**0.60**	**0.10**
2.70		2.45	3.30	0.60	0.10
3.00		2.75	3.60	0.60	0.15
3.10		2.85	3.70	0.60	0.15
3.50		3.25	4.20	0.60	0.15
3.53	**3.55**	**3.25**	**4.20**	**0.80**	**0.15**
3.60		3.35	4.30	0.80	0.15
4.00		3.70	4.80	0.80	0.15
4.50		4.20	5.40	0.80	0.15
5.00		4.65	6.00	0.80	0.15
5.34	**5.30**	**4.95**	**6.40**	**1.20**	**0.20**
5.50		5.15	6.60	1.20	0.20
5.70		5.35	6.90	1.20	0.20

Table 9.12
(ISO standard in bold)

d		g	L	r1	r2
6.00		5.65	7.20	1.20	0.20
7.00	**6.99**	**6.60**	**8.40**	**1.50**	**0.20**
8.00		7.60	9.60	1.50	0.20
8.40		7.90	10.10	1.50	0.20



We recommend that the surface finishes, chamfers and radii shown are observed (see 9.9 Installation instructions for O-rings).

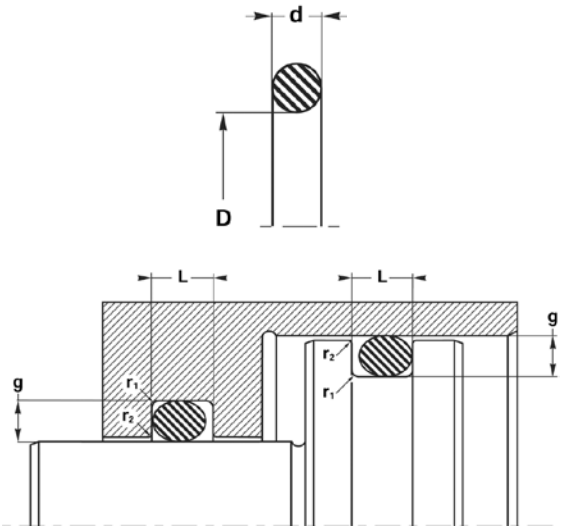
9.8 Dynamic seal for hydraulic cylinders

Table 9.13
(ISO standard in bold)

d		g	L	r1	r2
1.00	1.02	0.90	1.40	0.20	0.10
1.50	1.52	1.25	2.00	0.20	0.10
1.60	1.63	1.30	2.10	0.30	0.10
1.78	**1.80**	**1.55**	**2.40**	**0.40**	**0.10**
1.90		1.55	2.60	0.40	0.10
2.00	1.98	1.65	2.70	0.40	0.10
2.40		2.05	3.20	0.50	0.10
2.50		2.15	3.30	0.50	0.10
2.62	**2.65**	**2.25**	**3.60**	**0.60**	**0.10**
2.70		2.30	3.60	0.60	0.10
3.00		2.60	4.00	0.60	0.15
3.10		2.70	4.10	0.60	0.15
3.50		3.05	4.60	0.60	0.15
3.53	**3.55**	**3.10**	**4.80**	**0.80**	**0.15**
3.60		3.15	4.80	0.80	0.15
4.00		3.50	5.20	0.80	0.15
4.50		4.00	5.80	0.80	0.15
5.00		4.40	6.60	0.80	0.15
5.34	**5.30**	**4.70**	**7.10**	**1.20**	**0.20**
5.50		4.80	7.10	1.20	0.20

Table 9.13
(ISO standard in bold)

d		g	L	r1	r2
5.70		5.00	7.20	1.20	0.20
6.00		5.30	7.40	1.20	0.20
7.00	**6.99**	**6.10**	**9.50**	**1.50**	**0.20**
8.00		7.10	9.80	1.50	0.20
8.40		7.50	10.00	1.50	0.20



We recommend that the surface finishes, chamfers and radii shown are observed (see 9.9 Installation instructions for O-rings).

9.9 Installation instructions for O-rings

Installation and clearance gap
We give advice on the tolerances H7 / f6 for installation. The highest permissible clearance gap **e** can be determined from the chart in Figure 9.8 a and 9.4 “Permissible clearance gap of O-rings”. The clearance gap **e** must be less than the value read from axis to the left of the relevant curve and depends on the pressure used.

Surface quality
The roughness values stated in Table 9.15 must be observed in both the R_a and R_t areas.

Chamfers
Table 9.14 lists the chamfer lengths (K) to be observed.

Roundings
Sharp edges must be avoided. The radii to be observed are shown on the following pages.

Radial installation

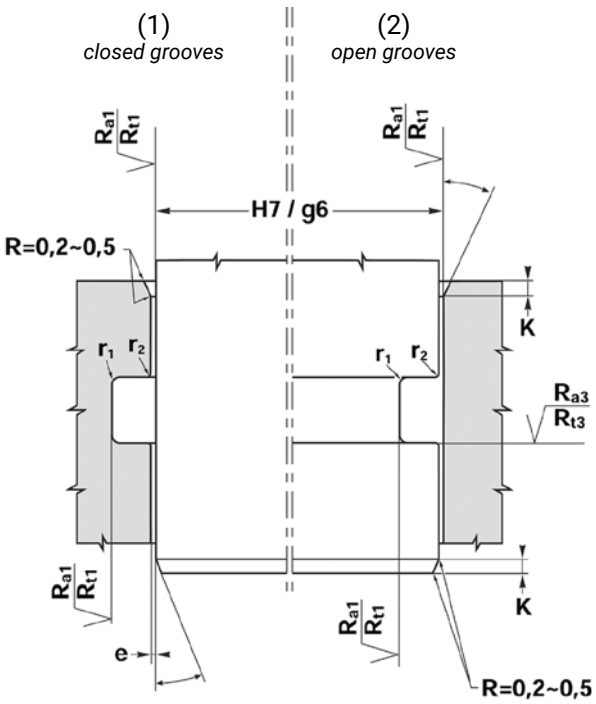


Table 9.14		
d O-ring	**– – – – – – – K (mm) – – – – – – –**	
	α = 20°	**α = 30°**
≤ 1.78	2.0	1.5
≤ 2.65	2.5	2.0
≤ 3.55	3.0	2.5
≤ 5.34	4.0	3.5
≤ 7.00	5.0	4.0
≤ 8.40	5.5	4.5

Axial installation

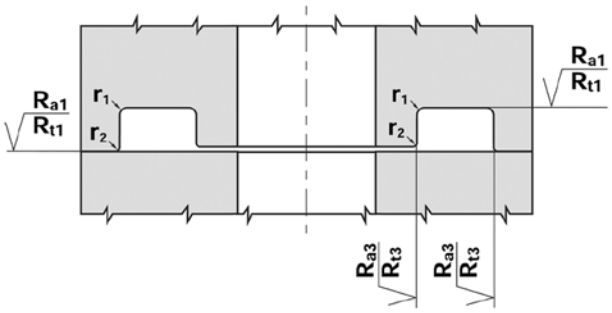


Table 9.15			
R_{a1}	R_{t1}	R_{a3}	R_{t3}
≤ 0.8 µm	≤ 4 µm	≤ 3 µm	≤ 16 µm

10. Support rings

10.1 Extrusion

Extrusion problems occur when the **clearance gap e** between the parts in relation to the pressure deforming the O-ring is too large. The O-ring becomes gradually worn at the edges and wears out completely over time (Fig. 10.1).

The groove is widened by the value **E (thickness of the support ring)**. This support ring is installed on the side facing the direction of pressure. This supports the O-ring and solves extrusion problem (Fig. 10.2).

Support rings are used similarly for double-acting sealing systems. In this case, two support rings are required (Fig. 10.3).

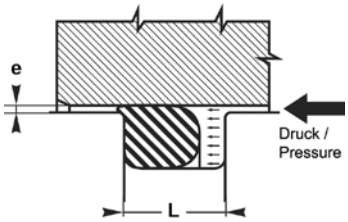


Figure 10.1

10.2 Profiles and materials

We recommend solid support rings for internal and external grooves. PTFE must be used in applications with high temperatures and special fluids. For external grooves, the support rings have to be cut through to allow installation.

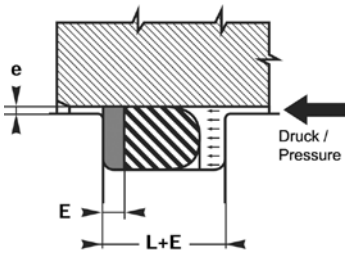


Figure 10.2

10.3 Further information

Although a support ring is a very simple product, its choice and dimensions can be very complex, as we will demonstrate below.

A The problem of **replacing existing parts**: there is an enormous difference in the depth of the grooves used on the market. The initial compression can vary between 10 and 30 %.

Example: our standard rings BU and PBK. For an O-ring d=2.62 mm, the section of the ring will be 2.25 mm for the PBK and 2.18 mm for the BU. Therefore the determination of the dimensions of the existing pieces must be done very carefully, **because any dimension is possible; every manufacturer uses different standards**.

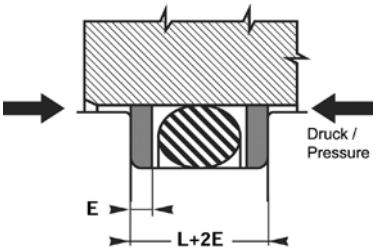


Figure 10.3

Incorrectly determined ring dimensions can have disastrous consequences. If the ring is a poor fit for the groove, it can cause the following problems:

- If the cross-section of the ring is too large, installation will be difficult, if not impossible, and the ring will inevitably wear out (see Fig. 10.4).

- On the other hand, if the cross-section is too small, there is no point in installing it: the extrusion problem is as bad as ever, as can be seen in Figure 10.5.

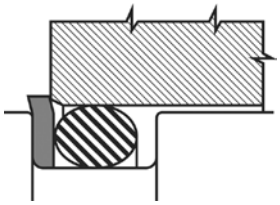


Figure 10.4

B With respect to the **new versions**, the seal manufacturers' standard ranges are very often limited. The same ring is used for static and dynamic sealing.

Example: our PBK rings are often used for static sealing. However, they are more suitable for dynamic applications (see Table 9.13 in "9.8 Dynamic seal for hydraulic cylinders"). PBK rings are used in static applications mainly on the grounds of economy. However this conflicts with the groove depth we recommend in "9.9 Installation instructions for O-rings". For dimensions corresponding to those in Table 9.14, we recommend a DST 108 in H-PU.

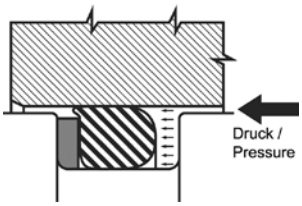


Figure 10.5

Selecting a support ring for a new design is completely different to selecting one as a replacement.

11. Flat seals

11.1 Flat seals in accordance with EN1514-1 (DIN 2690, 2691, 2692)

Standard		DIN EN 1514						DIN EN 1514-1		DIN EN 1514-1	
Flange shape		A-B smooth seal surface without/with sealing lip						C-D tongue/groove		E-F projection/recess	
Nominal pressure		PN 2.5	PN 6	PN 10	PN 16	PN 25	PN 40	PN 10-160		PN 10-100	
DN mm	d1 mm	d2 mm	d2 mm	d2 mm	d2 mm	d2 mm	d2 mm	d1 mm	d2 mm	d1 mm	d2 mm
4	6	–	–	–	–	30	–	20	30	–	–
6	10	28	28	38	38	38	38	20	30	–	–
8	14	33	33	43	43	43	43	22	32	–	–
10	18	38	38	45	45	45	45	24	34	18	34
15	22	43	43	50	50	50	50	29	39	22	39
20	28	53	53	60	60	60	60	36	50	28	50
25	35	63	63	70	70	70	70	43	57	35	57
32	43	75	75	82	82	82	82	51	65	43	65
40	49	85	85	92	92	92	92	61	75	49	75
50	61	95	95	107	107	107	107	73	87	61	87
60	–	–	–	–	–	–	–	–	–	–	–
65	77	115	115	127	127	127	127	95	109	77	109
80	90	132	132	142	142	142	142	106	120	90	120
100	115	152	152	162	162	168	168	129	149	115	149
125	141	182	182	192	192	195	195	155	175	141	175
150	169	207	207	218	218	225	225	183	203	169	203
(175)	195	237	237	248	248	255	267	213	233	195	233
200	220	262	262	273	273	285	292	239	259	220	259
250	274	318	318	328	330	342	353	292	312	274	312
300	325	373	373	378	385	402	418	343	363	325	363
350	368	423	423	438	445	458	475	395	421	368	421
400	420	473	473	490	497	515	547	447	473	420	473
(450)	470	528	528	540	557	565	572	–	–	–	–
500	520	578	578	595	618	625	628	549	575	520	575
600	620	680	680	695	735	730	745	649	675	620	675
700	720	785	785	810	805	830	850	751	777	720	777
800	820	890	890	915	910	940	970	856	882	820	882
900	920	990	990	1015	1010	1040	1080	961	987	920	987
1000	1020	1090	1090	1120	1125	1150	1190	1062	1092	1020	1091
1100	–	–	–	–	–	–	–				
1200	1220	1290	1305	1340	1340	1360	1395				
1400	1420	1490	1520	1545	1540	1575	1615				
1500	–	–	–	–	–	–	–				

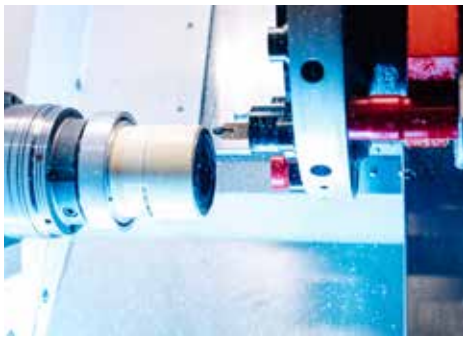
Standard		DIN EN 1514						DIN EN 1514-1		DIN EN 1514-1	
Flange shape		A-B smooth seal surface without/with sealing lip						C-D tongue/groove		E-F projection/recess	
Nominal pressure		PN 2.5	PN 6	PN 10	PN 16	PN 25	PN 40	PN 10-160		PN 10-100	
DN mm	d1 mm	d2 mm	d2 mm	d2 mm	d2 mm	d2 mm	d2 mm	d1 mm	d2 mm	d1 mm	d2 mm
1600	1620	1700	1720	1770	1760	1795	1830				
1800	1820	1900	1930	1970	1960	2000					
2000	2020	2100	2138	2182	2168	2230					
2200	2220	2307	2384	2384							
2400	2420	2507	2558	2594							
2600	2620	2707	2762	2794							
2800	2820	2924	2972	3014							
3000	3020	3124	3172	3228							
3200	3220	3324	3382								
3400	3420	3524	3592								
3600	3620	3734	3804								
3800	3820	3931									
4000	4020	4131									
Flange standard:		DIN 2630	DIN 2631	DIN 2632	DIN 2633	DIN 2634	DIN 2635	DIN 2512	DIN 2512	DIN 2513	DIN 2513

11.2 Dimensions and tolerances for sealing plates, cut plates and punched articles

Tolerances for plates, cut plates and punched articles in accordance with DIN 7715 Part 5			
	Class P1	Class P2	Class P3
Nominal size	Tolerances in mm	Tolerances in mm	Tolerances in mm
0.0 – 1.6	± 0.20	± 0.20	± 0.40
> 1.6 – 4.0	± 0.20	± 0.30	± 0.40
> 4.0 – 6.3	± 0.20	± 0.40	± 0.50
> 6.3 – 10.0	± 0.30	± 0.50	± 0.60
> 10.0 – 25.0	± 0.30	± 0.60	± 0.80
> 25.0 – 40.0	± 0.40	± 0.80	± 1.00
> 40.0 – 63.0	± 0.50	± 1.00	± 1.50
> 63.0 – 100.0	± 0.60	± 1.20	± 2.00
> 100.0 – 160.0	± 0.80	± 1.40	± 2.50
> 160.0 – 250.0	± 1.00	± 1.60	± 3.00
> 250.0 – 400.0	± 1.60	± 2.50	± 5.00
	Tolerances in %	Tolerances in %	Tolerances in %
> 400.0	± 0.50	± 0.80	± 1.50

Abbreviations used for materials in HANSA-FLEX articles	
Material	**Abbreviations**
Graphite/split sheet metal	GRSP
Graphite/smooth sheet metal	GRGL
Klinger graphite Topgraph	TGR
Klinger C4400	C4400
PTFE/pure	PT
PTFE/glass	PT / GL
PTFE/glass/MoS2	PT / GM
PTFE/carbon	PT / K
Soft iron	WE
Stainless steel 1.4571	INOX

12. On-demand seal production



The HANSA-FLEX seal production centre

With two CNC manufacturing facilities we are able to produce precision seals and special turned parts immediately in plastic or aluminium from 5 – 700 mm using computer-assisted manufacturing techniques. We store thousands of seals as datasets in the production centre's computer ready for just-in-time manufacture of seals from 5 – 700 mm directly to order. We offer the prompt supply of almost any seal, whether standard or special profile.

The advantages of seal production

All seals and special turned parts can be supplied as customised or standard parts, individually or mass produced, with the highest level of precision. Our production software has over one hundred pre-programmed standard profiles. Hence, we are capable of adapting to the specific needs of our customers.

Furthermore, we maintain a standard seal stock with over 11,000 different seal types and dimensions ready and waiting for our customers.

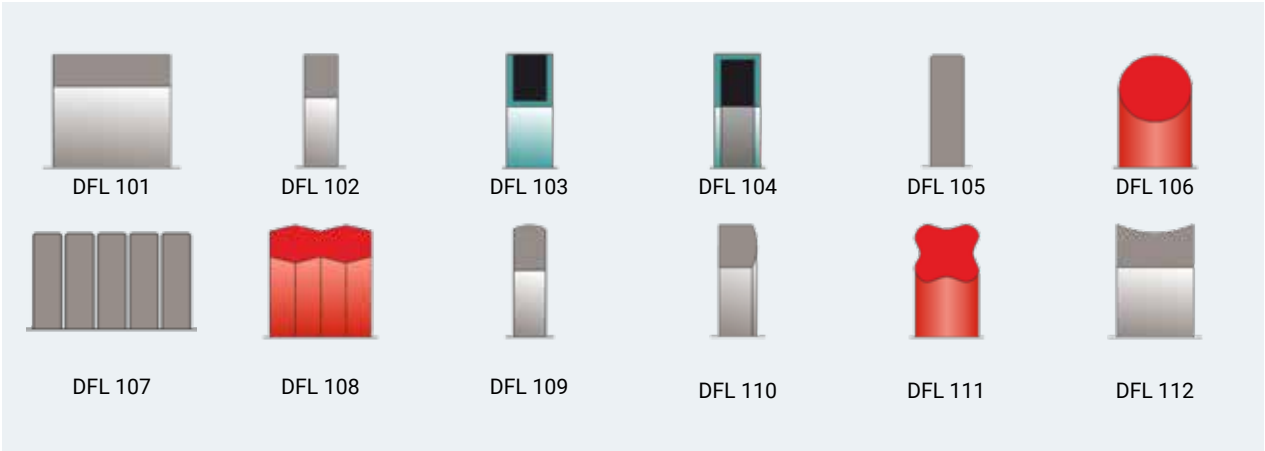
13. Seal profiles

Support rings

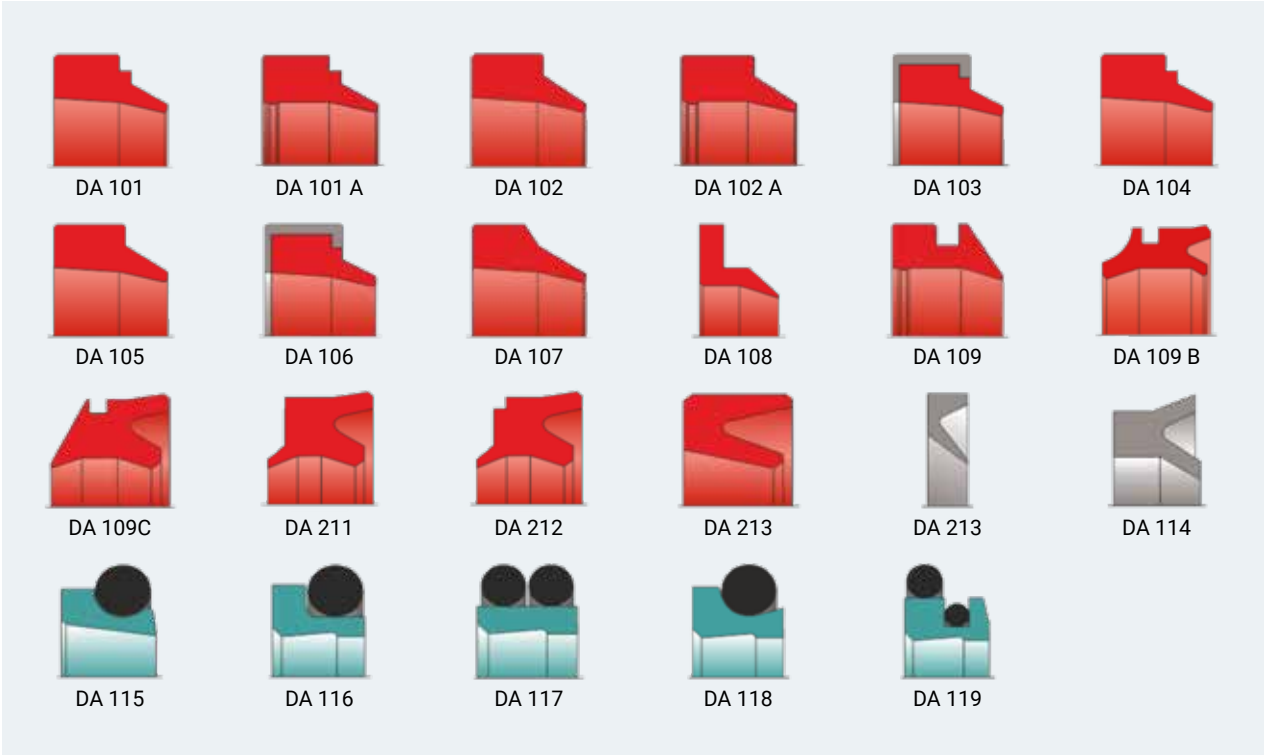
Piston seals

Important information: *Profiles DK 105 – Pneumatic*

Flat seals



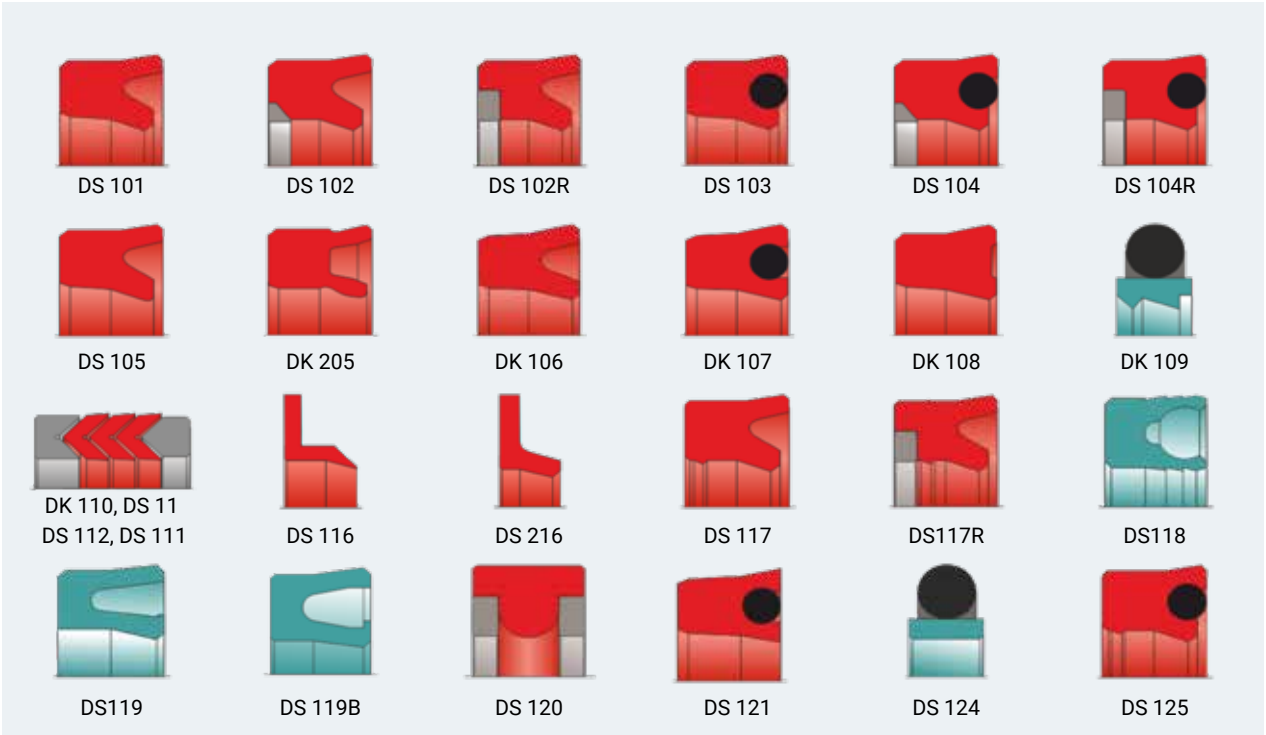
Wipers

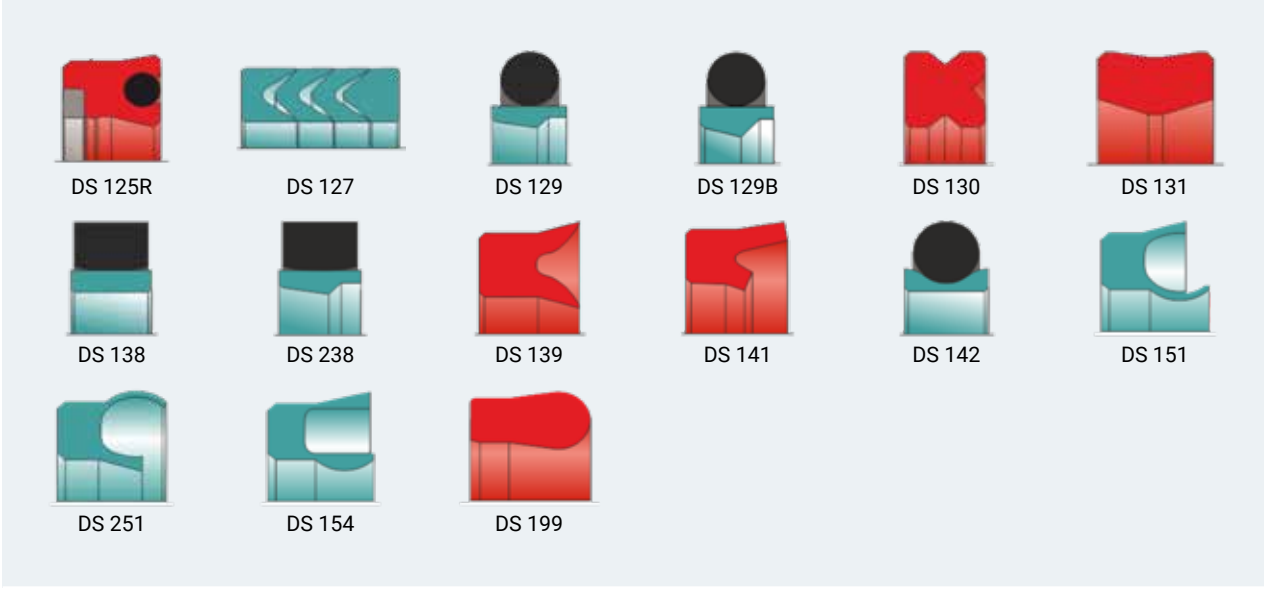


Important information:
Profiles DA 103, DA 106, DA 114 – not snap-in wiper / Profiles DA 104, DA 105, DA 106 – pneumatic

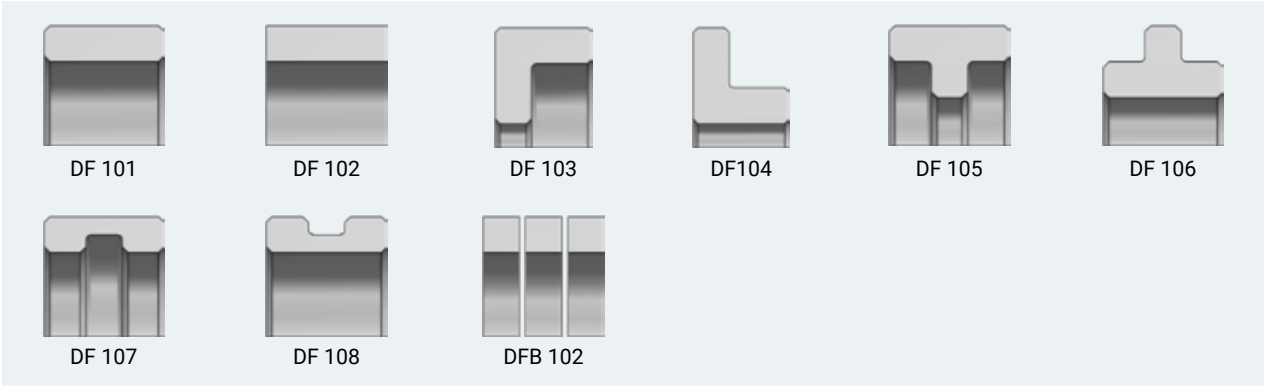
Rotary seals

Rod seals





Guide rings



Should you have special requirements, e.g. pressure, temperature, velocity, medium, please contact our Sealing Technology Department. We would be pleased to optimise design and materials to suit your particular application.

All materials available for seal manufacture:

DMH HPU 55D	DMH C-HPU 72D	DMH SL-PU 96A	DMH NBR white
DMH C-HPU 96A	DMH LT-PU 95A	DMH PU 93A	DMH T-NBR 85
DMH C-HPU 57D	DMH LT-PU plus 96A	DMH NBR	DMH H-NBR

14. Material datasheet

Material			CH-PU	H-PU	H-PU D55	NBR	H-NBR	T-NBR	EPDM	VMQ	FPM	PTFE	PTFE	PTFE	POM	PA
												Virgin	Glass/ MoS2	Bronze		
Colour			Red	Red	Red	Black	Green	Black	Black	Blue	Brown	White	Grey	Brown	White	Natural
Properties																
Hardness	DIN ISO 48-4 ISO 84-5	Shore A	95	95	97	85	85	80	85	85	85					
Hardness	DIN ISO 48-4 ISO 84-5	Shore D	48	48	55							55	63	69	85	85
Tensile strength	DIN 53504 DIN ISO EN 525	N/mm²	50	55	55	17	20	14	12	7.5	10	27	15	14	70	80
Breaking elongation	DIN 53504 DIN ISO EN 525	%	450	350	330	150	200	160	80	130	200	350	280	170	40	40
100 % modulus	DIN 53504	N/mm²	14	16	18	11	10	9		6.5	8					
300 % modulus	DIN 53504	N/mm²	28	35	39											
Rebound resilience	DIN 53512	%	35	35		20	26	50	37	35	7					
Tear strength	DIN ISO 34-1 DIN ISO 34-1	N/mm	140	100	100	9	6	5	9	12	6					
Density	DIN EN ISO 1183	g/cm³	1.2	1.2	1.22	1.32	1.32	1.28	1.23	1.6	2.51	2.16	2.3	3.2	1.41	1.13
Abrasion	DIN ISO 4649	mm³	24	18		130	130		140		200					
Compression set	DIN ISO 815-1 DIN ISO 815-2 DIN ISO 815	%	27	24	27	6	12	6	5	8	7					
70° / 24 h 20 % Defo.																
Compression set	DIN ISO 815-1 DIN ISO 815-2 DIN ISO 815	%	35	33	35	5	14	9	7	9	8					
100° / 24 h 20 % Defo.																
Compression set	DIN ISO 815-1 DIN ISO 815-2 DIN ISO 815	%					22									
150° / 24 h 20 % Defo.																
Compression set	DIN ISO 815-1 DIN ISO 815-2 DIN ISO 815	%								35	9					
175° / 24 h 20 % Defo.																
Min. temperature		°C	-35	-25	-20	-35	-20	-46	-45	-60	-20	-200	-200	-200	-45	-40
Max. temperature		°C	110	110	110	120	150	100	150	220	200	260	260	260	100	110
Temp. max water/steam		°C		80	80		120		150	120	150					
Temp. max. hot air		°C					180 short		180 short	300 short	300 short					
Modulus of elasticity	DIN EN ISO 178 DIN EN ISO 527 DIN EN ISO 604	N/mm²										540	1320	1375	3000	3000
Approval for food use												–			–	
Special manufacture with approval for food use			–	–					–	–	–					

DMH MVQ white FDA	PTFE virgin	PTFE D08	PTFE Ekonol
DMH POM	PTFE D05	PTFE 25% glass	PTFE Cond
DMH PA	PTFE TFM	PTFE II	PTFE Carbon
DMH UHMW-PE	PTFE I	PTFE D46	PTFE E-Carbon
DMH ALU	PTFE D05 glass	PTFE PEEK	PTFE Graphite)

The test results are average results measured from test specimens and cannot be transferred to seal applications. The Sealing Technology Department is not liable for products manufactured from our raw material.

Flat seals – Graphite without glue - (graphite / perforated sheet)

Material profile
Made of expanded graphite reinforced with perforated stainless steel SUS316 (0.10 mm thick), used as seal material.

Typical use
High thermal and mechanical loads, frequently changing loads; saturated steam, superheated steam, oil as heat carrier.

Properties	Standard	Unit	Values		
Thickness		mm	**1.0**	**2.0**	**3.0**
Density (graphite)		g/cm³	1.0	1.0	1.0
Compressibility	**ASTM F36/A**	%	35-50	35-50	35-50
Recovery	**ASTM F36/A**	%	10-20	10-20	10-20
Leakage rate	**DIN 3535**	ml/min	**≤** 1.0	**≤** 1.0	**≤** 1.0
Temperature					
Max. temperature inert atmosphere		°C	2500	2500	2500
Continuous work temp. (with oxidation)		°C	250	250	250
Short-term work temp. (inert atmosphere)		°C	550	550	550
Fluid resistance	**ASTM F146**				
ASTM 3 oil 150 °C, 5 h					
Weight increase		%	< 15	< 15	< 15
Thickness increase		%	**≤** 6	**≤** 6	**≤** 6
LLC50% 100 °C, 22 h					
Weight increase		%	<15	<15	15
Thickness increase		%	**≤** 6	**≤** 6	**≤** 6
Sulphur content	**ASTM C816**	ppm	≈ 1300	≈ 1300	≈ 1300
Leachable chloride content	**ASTM F1277**	ppm	**≤** 50	**≤** 50	**≤** 50
Carbon content	**JB/T 914**	%	≥ 98.5	≥ 98.5	≥ 98.5
Fluoride content		ppm	**≤** 30	**≤** 30	**≤** 30

15. Disposal of seals

- Observe the requirements of DGUV Rule 113-020 (on the handling of hydraulic fluids) when replacing seals
- Observe the material safety datasheets
- Flange seals containing asbestos to waste disposal / landfill sites
- Observe the requirements for oil-contaminated operating materials
- Observe local regulations (e.g. oil-contaminated special wastes)
- Clean then, if appropriate, dispose with non-recyclable waste