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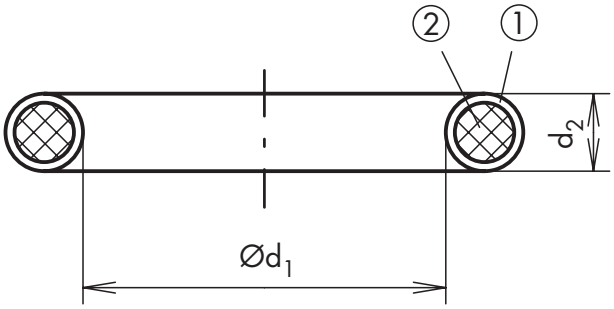
FEP-O-SEAL® O-Rings
Technical Brochure

FEP-O-SEAL® O-Rings

General Notes

These seals ideally combine the elastic characteristics of elastomer O-Rings and the chemical resistance of FEP or PFA.
FEP-O-SEAL® O-Rings consist of two components: a seamless covering of FEP or PFA (1) and an elastomer core (2) that guarantees dimensional stability.
There are numerous applications where the use of traditional elastomers causes failure. Aggressive chemicals or extreme temperatures can destroy conventional elastomer O-Rings which can ultimately lead to leakage.



Advantages of FEP-O-SEAL® O-Rings

- extremely high chemical resistance against most liquids and chemicals
- great range of possible operating temperatures from -60°C up to +250°C (depending on the core material)
- good resistance to pressure, compression and deformation
- low steam permeability and minimum water absorption combined with low cold flow compared to PTFE
- durability and reliable service
- saving in maintenance costs
- compatibility with foodstuffs
- non-adhesive smooth surface

Fields of use

FEP-O-SEAL® O-Rings are used in a wide variety of applications in many industry sectors, but in particular, where ordinary elastomers fail due to aggressive fluids.

- chemical industry
- petrochemical industry
- foodstuffs industry
- medical engineering
- photographic chemicals
- pharmaceuticals
- vacuum technology
- valves
- refrigeration
- mechanical seals
- filtration

Design notes

It should be noted, that FEP-O-SEAL®, like all other elastomer O-Rings, are subject to compression set caused by stress and associated material fatigue. FEP-O-SEAL® rings with a small cross sectional diameter have a relatively high compression set. For these reasons, it is important to always use the FEP-O-SEAL® ring with the largest possible cross sectional diameter. We recommend FEP-O-SEAL® primarily for static applications, either axial or radial. For dynamic seals e.g. valve spindles and slip ring seals, FEP-O-SEAL® should only be used if "p – v values" are low and only after preliminary testing.

Materials

VMQ Core	is well matched for applications that demand lighter compressive forces and higher temperatures.
FKM Core	is a fluoroelastomer compound with exceptional mechanical properties. The FKM elastomer gives the O-ring a faster recovery rate.
CRYOLOX	Core stainless steel components are ideal in services such as flowing liquid oxygen and hydrogen with extremely low cryogenic temperatures.
FEP encapsulation	(fluorinated ethylene propylene) gives the O-Ring its strong characteristics relating to its resistance to nearly all chemicals, liquids and gases.
PFA encapsulation	(perfluoroalkoxy copolymer) is similar to FEP but with improved cold flow properties and optimized mechanical qualities at higher temperatures.

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Materials of FEP-O-SEAL® and approvals

Material	Hardness Shore A	Operating Temperature in °C	FDA	EC 1935/2004	3A Sanitary	USP VI (121°C)	RoHS/REACH	ADI free
VMQ	70	-60°C to 250°C	•				•	•
FKM	75	-20°C to 150°C					•	•
FEP	-	-250°C to 200°C	•	•	•	•	•	•
PFA	-	-250°C to 250°C	•	•	•		•	•
Cryolox	-	-250°C to 250°C	•	•	•		•	•

Hardness of FEP-O-SEAL®

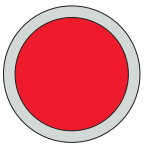
With VMQ solid core approx. 85 – 90 Shore A
With VMQ hollow core approx. 75 – 80 Shore A
With FKM solid core approx. 90 – 95 Shore A

These values are just indications and not quality relevant.

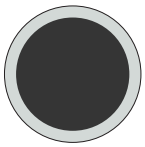
Version of FEP-O-SEAL®

Version	VMQ	FKM	Cryolox Stainless Spring
Solid core	•	•	
Hollow core	•		
FEP	•	•	•
PFA	•	•	•

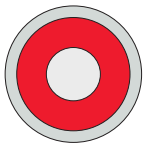
Special materials on request



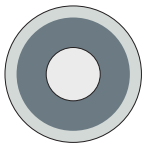
VMQ



FKM



VMQ
Hollow Core



Cryolox
Stainless spring

Thickness of FEP / PFA covering

Cross Section (d2) in mm	Thickness of sheath in mm
1,78 – 2,00	0.28
2,40 – 3,00	0.30
3,50 – 4,00	0.33
4,50 – 6,00	0.43
6.50 – 12,00	0.76
on hollow elastomer core, all cross-sectional diameters	Like solid core

Tolerances on small internal diameter

Cross Section (d2)	Diameter (d1)	Inner Diameter (d1)	Inner Diameter (d1)
mm	mm		
1.78	5.31 - 10.16 +/-0.38	10.17 - 25.37 +/-0.31	25.40 - 50.78 +/-0.38
2.00	5.99 - 11.43 +/-0.38	11.46 - 25.37 +/-0.31	25.40 - 50.78 +/-0.38
2.50	5.99 - 11.43 +/-0.38	11.46 - 25.37 +/-0.31	25.40 - 50.78 +/-0.38
2.62	5.99 - 11.43 +/-0.38	11.46 - 25.37 +/-0.31	25.40 - 50.78 +/-0.38
3.00	8.89 - 13.97 +/-0.38	14.00 - 25.37 +/-0.31	25.40 - 50.78 +/-0.38
3.53	12.07 - 19.69 +/-0.46	16.55 - 25.37 +/-0.38	25.40 - 50.78 +/-0.38
4.00	15.47 - 25.37 +/-0.51		25.40 - 50.78 +/-0.46
4.50	18.03 - 25.37 +/-0.56		25.40 - 50.78 +/-0.46
5.00	19.05 - 25.37 +/-0.56		25.40 - 50.78 +/-0.46
5.34	21.59 - 50.78 +/-0.56		
5.50	22.89 - 50.78 +/-0.56		
6.00	27.94 - 50.78 +/-0.56		
6.99	40.00 - 50.78 +/-0.76		

Tolerances on big internal diameter

Inner diameter (d1) mm for cross section (d2) up to 7mm	Tolerance mm
50.80 - 101.57	+/- 0.51
101.60 -177.77	+/- 0.64
177.80 - 253.97	+/- 0.76
254.00 - 380.97	+/- 0.89
381.00 - 507.97	+/- 1.02
508.00 - 660.37	+/- 1.14
bigger cross section and diameter on request	on request

Tolerances for Cryolox + 0,13 to the above mentioned

Gap-Extrusion

The FEP sleeve of FEP-O-SEAL® is very sensible to extrude at pressures above 50 bar (with hollow core type on up to 50 bar). At these higher pressures, back-up rings must be provided. The permissible clearance on the side away from the pressure is given in the table below.

Permissible diametral clearances for FEP-O-SEAL® O-Rings

Pressure	Diametral clearance S by cross section d2 (mm)								
	≤ 1,8	> 1,8 - ≤ 2,2	> 2,2 - ≤2,7	> 2,7 - ≤ 3,2	> 3,2 - ≤ 3,7	> 3,7 - ≤ 4,2	> 4,2 - ≤ 5,0	> 5,0 - ≤ 6,0	> 6,0 - ≤ 8,4
bar	mm	mm	mm	mm	mm	mm	mm	mm	mm
Hardness of O-Ring material: 70 ± 5 Sh A									
< 50	0,12	0,13	0,17	0,18	0,19	0,20	0,22	0,23	0,26
< 100	0,05	0,07	0,09	0,10	0,11	0,12	0,13	0,14	0,16
< 150	0,02	0,03	0,04	0,05	0,06	0,07	0,08	0,09	0.10
Hardness of O-Ring material 80 ± 5 Sh A									
< 50	0,17	0,18	0,22	0,23	0,26	0,27	0,30	0,31	0,36
< 100	0,10	0,11	0,13	0,14	0,15	0,16	0,18	0,19	0,22
< 150	0,05	0,06	0,07	0,08	0,09	0,10	0,12	0,13	0,13
< 200	0,02	0,02	0,04	0,04	0,05	0,07	0,08	0,08	0,08
Hardness of O-Ring material 90 ± 5 Sh A									
< 50	0,22	0,23	0,28	0,30	0,35	0,35	0,38	0,40	0,45
< 100	0,15	0,16	0,18	0,19	0,22	0,23	0,25	0,26	0,32
< 150	0,08	0,10	0,12	0,13	0,15	0,16	0,18	0,18	0,22
< 200	0,05	0,06	0,09	0,10	0,11	0,12	0,14	0,14	0,17
< 250	0,02	0,03	0,07	0,08	0,09	0,10	0,11	0,11	0,13
< 300	-	-	0,05	0,05	0,06	0,07	0,08	0,08	0,10
< 350	-	-	0,03	0,03	0,05	0,06	0,07	0,07	0,08

Tolerances and groove design chart

Cross Section	Tolerances	Groove Depth	Groove Width	Minimal ID	Maximal OD
d2				d1	
1.78	+/-0.13	1.30	2.46	5.30	150.00
2.00	+/-0.13	1.50	2.70	6.00	175.00
2.50	+/-0.13	1.90	3.30	6.00	265.00
2.62	+/-0.13	2.00	3.50	6.00	UNLIMITED
3.00	+/-0.13	2.30	4.00	12.10	UNLIMITED
3.50	+/-0.15	2.75	4.50	10.70	UNLIMITED
3.53	+/-0.15	2.77	4.50	10.70	UNLIMITED
4.00	+/-0.15	3.15	5.00	15.50	UNLIMITED
4.50	+/-0.15	3.60	5.70	19.10	UNLIMITED
5.00	+/-0.20	4.00	6.50	19.10	UNLIMITED
5.34	+/-0.20	4.30	7.00	23.20	UNLIMITED
6.00	+/-0.25	4.95	7.80	38.10	UNLIMITED
6.99	+/-0.25	5.85	9.50	38.10	UNLIMITED
8.00	+/-0.38	6.75	10.40	63.50	UNLIMITED
8.40	+/-0.38	7.20	11.00	70.00	UNLIMITED
10.00	+/-0.38	8.95	12.50	89.00	UNLIMITED
12.00	+/-0.38	10.60	15.60	127.00	UNLIMITED

Normally the groove dimensions of elstomer O-Rings are also valid for FEP-O-SEAL®.

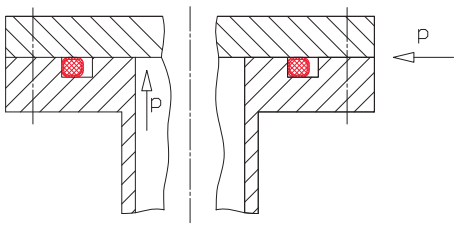
Mounting FEP-O-SEAL® O-Rings

FEP-O-SEAL® O-Rings are preferably used as static seals (axial or radial), e.g. for flanges, covers, shafts, pistons, spindles etc. The surface finish of the contact faces and the groove should be as follows:

Surface	Rugosity			Rugosity class
	Ra	Rt	Rz	
contact surface	0,2 µm	2,0 µm	0,8 µm	N4
base of groove	1,6 µm	16,0 µm	6,3 µm	N7
sides of groove	2,5 µm	19,0 µm	10,0 µm	N7/N8

Assembly

In the case of flange or cover seals where the groove is axially accessible, there is no need for any special precautions. If the pressure is exerted from inside, the FEP-O-SEAL® should be in contact with the outer diameter of the groove and vice versa, if pressure is exerted from outside, the O-Ring must be in contact with the inner diameter of the groove.



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If shafts or pistons are sealed radially, grooves that can be accessed axially should be provided wherever possible.
If grooves are not accessible axially, the following mounting instructions should be observed:

1. In the FEP-O-SEAL® O-Ring mounting area there must be no sharp-edged transitions, ridges, machining lines, threads, through holes etc. The slightest damage to the FEP covering causes loss of seal.

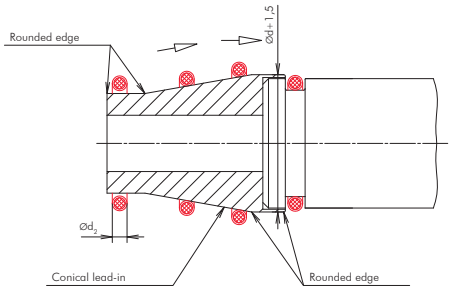
2. If possible, grease the surface.

3. The FEP-O-SEAL® O-Ring can be made to bend and stretch more easily if it is briefly dipped in boiling water (+80°C). This softens the FEP covering and facilitates mounting.

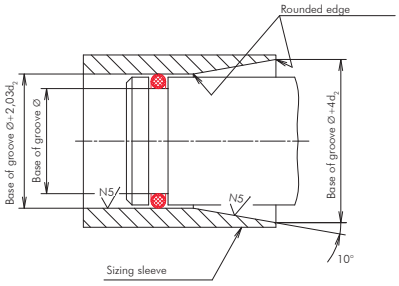
4. Under no circumstances use force to mount FEP-O-SEAL® in the groove, e.g. bending FEP coverings with kinks do not provide a tight seal.

5. Keep all dirt away from the groove and sealing location and remove any dirt that is present.

6. If the FEP-O-SEAL® O-Ring has to be stretched to fit over a shaft or piston, a conical lead in is advisable. The lead in diameter should be 1,00 mm less than the inner diameter of the O-Ring. It should not extend more than 1,5 mm beyond the shaft end. The ideal slope of the lead in is 10°.

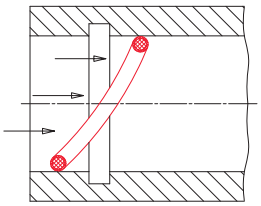


7. After mounting, the FEP-O-SEAL® should be resized to enable better recovery after stretching.



If an FEP-O-SEAL® O-Ring has to be squeezed into a hole, the smaller the hole diameter, the more difficult this becomes. To avoid bending the FEP covering, the O-Ring is to be mounted as follows:

O-Ring in front of groove: The FEP-O-SEAL® is laid in an angle. The lower half of the circumference is in front of the groove and the upper half is behind it.



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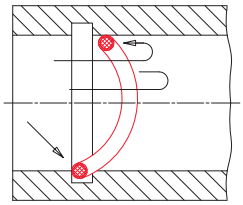
O-Ring half in the groove: The lower half of the circumference is engaged in the groove. The upper half is pulled back.



O-Ring in the groove: The upper half of the circumference is also engaged in the groove. The entire circumference of the FEP-O-SEAL® is in the groove. After mounting, recovery can be accelerated by warming.