FEP-/PFA-ENCAPSULATED O-RINGS

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SEALING TECHNOLOGIES

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FROM O-RING TO HIGH PERFORMANCE SEAL

FEP-/PFA-encapsulated O-rings consist of an elastomer core and a seamlessly closed casing of modified PTFE.

The elastomer core made of FKM (Viton) or VMQ (silicone) guarantees an even pretensioning at the sealing point. The seamless casing is composed of FEP (fluorinated ethylene propylene) or PFA (perfluoroalkoxy-copolymer). It ensures reliable sealing and high resistance to aggressive media. This produces performance similar to that of a PTFE material. Encapsulated O-rings are exclusively used in static applications since movement or abrasive media can destroy the casing.

For demanding applications involving aggressive media
There are numerous applications where the use of traditional elastomers is ruled out. Aggressive chemicals or extreme temperatures can destroy conventional O-rings. This ultimately leads to leakage.

FEP-/PFA-encapsulated O-rings can be used wherever an elastomer's chemical resistance is insufficient. Here FEP and PFA materials offer chemical resistance while the elastomer core provides elasticity. Seals made of PTFE are not an option in this case. The material does offer outstanding media resistance, but is not associated with elasticity.

When should encapsulated O-rings not be used?
- In dynamic applications
- In contact with abrasive media
- Under high pressure
- When the O-rings are highly elongated
- When there are high press-in forces in the housing

YOUR ADVANTAGES AT A GLANCE
- Very good resistance to nearly all media (exceptions are alkali metals and some fluorine compounds)
- Applications in broad range of temperatures
- Superbly suited for use in the food, chemical and pharmaceutical industries
- Low contamination
- Low permeation
- Low coefficient of friction prevents the stick-slip effect
- FDA-compliant
- Cost-effective, high-performance seal for many critical application areas

AVAILABILITY

Depending on the cross-section diameter, encapsulated O-rings have a lower limit to their inner diameter. If this is taken into account, practically any size can be manufactured.

Profiles and dimensions

The most used profile is the circular cross-section. Oval, rectangular and square profiles can be produced on request. Varying cross-sections are possible in both round and angular profiles. Since there are additional tooling costs for elaborate encapsulations, deviations involving small quantities are not always economical. Encapsulated O-rings can basically be offered in all the metric and imperial cross-section thicknesses.

Customer-specific solutions can also be realized without difficulty. Popular cross-section thicknesses in many dimensions can be delivered from inventory. This ensures the cost-effective and fast availability of what you need. The minimum manufacturing size of the inner diameter depends on the cross-section thickness of the O-ring. At a cross-section thickness of 1.5 mm, the smallest possible inner diameter works out to 5.3 mm. This is a special size for which a production period of 25 work days must be budgeted. Inner diameters of at least 16 mm at a cross-section thickness of 1.5 mm can be delivered as standard, mostly from inventory. The minimum dimensions are listed in the table on page 5.

There are no limits on the maximum size of the inner diameter. Since encapsulated O-rings are only slightly extendable and compressible, the installation space must be oriented to these characteristics when diameters are small.

Tolerances for inner diameters

Encapsulated O-rings cannot be produced with the same tolerances as conventional O-rings. They can deform due to the varying rigidity of the casing and the core due to temperature effects. But they are manufactured in such a way that they remain in compliance with DIN 7715M2F.

Materials

FKM or silicone is used as the material for the core of the encapsulated O-ring. EPDM is not recommended due to heat-related changes during the manufacturing process. FKM and silicone withstand these temperatures during production without a decline in performance.

FKM core – FKM (black) features very good rubber-elastic qualities. FKM has the capacity to re-assume its original form after its deformation thanks to its outstanding compression set.

Silicone core – The silicone core (mostly red) is considerably softer than an FKM core. In turn, it is more temperature-resistant. In addition to its superb thermal resistance, it has very good cold flexibility.

FEP encapsulation – FEP (fluorinated ethylene propylene) gives an O-ring its tremendous characteristics relating to its resistance to nearly all liquids, gases and chemicals. The exceptions are liquid alkali metals and some fluorine compounds.

PFA encapsulation – Perfluoroalkoxy copolymer (PFA) resembles FEP in its areas of application. It is distinguished by improved cold flow properties and optimized mechanical qualities at higher temperatures.

Approvals and compliance

- FDA-compliant
- USP Class VI
- EU Reg. 1935/2004
- 3-A® Sanitary Standards
- ADI-free

CHARACTERISTICS

FEP and PFA are very similar in their characteristics. PFA stands out for its greater thermal resistance at temperatures exceeding 200 °C.

Thanks to the opportunities for combining two encasing materials and two core materials, the best possible encapsulated ring can be selected for a particular application. The formation of the inner elastomer as a hollow core expands the range of applications to uses that require relatively low contact forces.

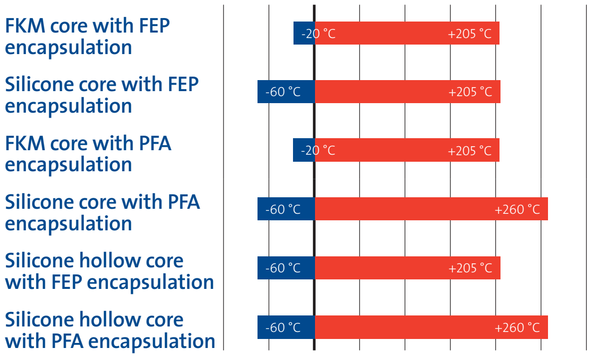
Advantages of FEP encapsulation

- High resistance to numerous chemicals
- High corrosion resistance
- Low compression set
- Low coefficient of friction

Advantages of PFA encapsulation

- All the benefits of FEP encapsulation
- Greater temperature resistance
- Greater mechanical strength
- Longer service life
- Greater cracking resistance

Application temperature range



Potential encapsulation structures

Solid core Hollow core

VERSION	CHARACTERISTICS	TEMPERATURE RANGE FOR USE	HARDNESS DATA
FKM core with FEP encapsulation	• Standard solution • Low compression set	-20 °C to +205 °C (-4 °F to +401 °F)	90 to 95 Shore A
Silicone core with FEP encapsulation	• Better low temperature behavior than FKM	-60 °C to +205 °C (-76 °F to +401 °F)	85 to 90 Shore A
FKM core with PFA encapsulation	• High abrasion resistance of the PFA encapsulation	-20 °C to +205 °C (-4 °F to +401 °F)	90 to 95 Shore A
Silicone core with PFA encapsulation	• Use in very wide temperature range, especially in extreme temperatures	-60 °C to +260 °C (-76 °F to +500 °F)	85 to 90 Shore A
Silicone hollow core with FEP encapsulation	• Low contact pressure • Use in sensitive equipment, such as glass	-60 °C to +205 °C (-76 °F to +401 °F)	75 to 80 Shore A
Silicone hollow core with PFA encapsulation	• Low contact forces • Use in sensitive equipment, such as glass • Use in expanded temperature range	-60 °C to +260 °C (-76 °F to +500 °F)	75 to 80 Shore A

DIMENSIONS

CROSS-SECTION (MM)	STANDARD PRODUCTION FEP/PFA		SPECIAL PRODUCTION FEP/PFA	
	MINIMUM ID VMQ / FKM (MM)	HOLLOW CORE VMQ (MM)	MINIMUM ID VMQ (MM)	MINIMUM ID FKM (MM)
1.50	16.00	–	5.30	6.07
1.60	16.00	–	6.07	6.07
1.78	16.00	20.35	6.07	6.07
1.80	16.00	20.35	6.07	6.07
2.00	16.00	28.00	6.07	6.07
2.40	16.00	28.00	7.59	9.20
2.50	16.00	30.00	7.59	9.20
2.62	18.00	29.83	7.59	9.20
3.00	22.00	30.00	9.20	10.00
3.15	22.00	30.00	9.20	10.00
3.50	24.00	31.34	9.20	12.30
3.53	24.00	31.34	9.20	12.30
3.80	32.00	35.00	18.00	18.00
4.00	32.00	40.00	18.00	18.00
4.30	35.00	42.00	18.00	20.00
4.50	37.00	45.00	18.00	20.00
4.75	37.00	50.00	18.00	20.00
5.00	37.00	60.00	18.00	20.00
5.33	37.00	62.87	20.00	20.00
5.50	48.00	65.00	20.00	20.00
5.70	52.00	70.00	20.00	27.00
6.00	53.00	80.00	20.00	27.00
6.30	55.00	90.00	27.00	35.00
6.50	55.00	126.00	36.00	37.46
6.99	60.00	126.37	36.00	37.46
7.00	60.00	126.37	36.00	37.46
7.50	75.00	140.00	50.80	60.00
8.00	85.00	150.00	50.80	60.00
8.40	105.00	155.00	50.80	73.00
9.00	110.00	160.00	50.80	73.00
9.50	110.00	162.00	50.80	73.00
10.00	125.00	170.00	57.00	74.00
11.00	135.00	180.00	70.00	102.00
12.00	145.00	190.00	70.00	102.00
12.70	170.00	200.00	70.00	102.00
14.00	250.00	280.00	130.00	130.00
15.00	280.00	300.00	150.00	177.80
16.00	280.00	–	150.00	177.80
18.00	340.00	–	150.00	177.80
19.00	340.00	–	203.20	203.20
20.00	370.00	–	203.20	203.20
25.40	–	–	228.60	–
31.75	–	–	400.00	–

INSTALLATION AND ASSEMBLY

Proper assembly is essential to achieve an extended service life for the seal. 90 % of seal malfunctions for encapsulated O-rings are related to installation errors or the defective design of the installation space.

Internal Sealing – The Housing Groove
- The seal must be deformed to fit into the housing
- To facilitate assembly, place the O-ring in hot water for 10 minutes and install it into the groove immediately thereafter
- To do this, push the forward edge of the ring out over the groove (Figure 1)
- Carefully position the rear edge of the ring into the groove
- Pull the front edge back until the ring snaps into the groove (Figure 2)
- The rod should be pushed in, provided that the ring is still warm and deformable
- Use of installation aids is an option

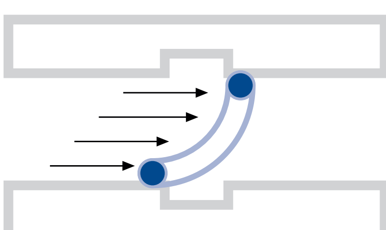


Figure 1

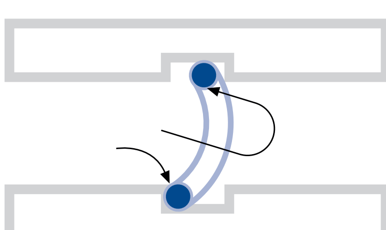


Figure 2

Outer Sealing – Groove on Shaft
- Use installation cone for assembly
- Place O-ring into hot water for 10 minutes
- Then, using the cone, press quickly and evenly until the ring snaps into the groove (Figure 3)
- If necessary, compress the ring to original dimensions using a second ring (applying pressure here)

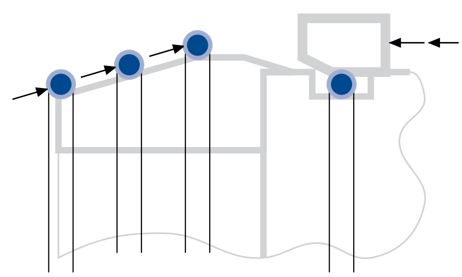


Figure 3

DESIGN INFORMATION	
Dimensions	• Cross-section thickness of 1.6 to 31.75 mm • Inner diameter of 16 to 400 mm • Special sizes on request
Roughness	• Not more than 50 µm on contact surface
Lead-in chamfer	• Angular position 30° to 40° • Length at least 50 % of cross-section thickness
Preparation	• Parts that come in contact with the seal during assembly and operation must be burr- and dirt-free • Edges must be rounded • Installation space should be axially accessible due to the ring's reduced extensibility and compressibility • Maximum caution through the use of clean, smooth and burr-free assembly pins or sleeves • Pay attention to return to former shape

COMPARABLE SEALING SOLUTIONS

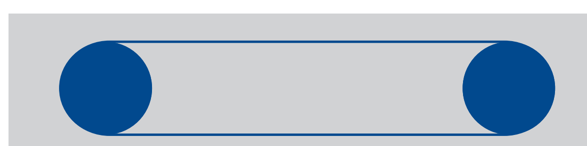
There are numerous high-performance sealing materials that are suited to applications in extreme media and temperatures. But if a number of influencing factors come together, they are no longer appropriate for the application – or are only partially appropriate for it. In the following, we look at various solutions and compare them to encapsulated O-rings from Freudenberg Sealing Technologies.

PTFE O-rings
Massive O-rings made of PTFE are universally chemical-resistant. Their disadvantage: Pure PTFE has a tendency to cold flow and thus cannot be used in applications that are continually under pressure.

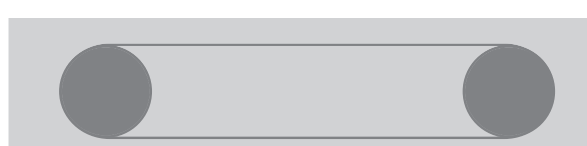
PTFE-encased O-rings
PTFE-encased O-rings display good stability in many chemicals. Since PTFE is a sintered powder and is not a melt material, O-rings cannot be seamlessly encapsulated in PTFE. Extremely high temperatures during the production process would destroy the elastomer. In contrast to FEP and PFA, it cannot be used to produce hose material. The construction of the PTFE casing thus holds out the risk that chemicals could penetrate to the core. This can lead to a seal's malfunction.

PTFE-coated O-rings
O-rings with an acrylic or latex PTFE dispersion have a very low coefficient of friction. The casing is abraded over time, however. As a result, PTFE-coated O-rings do not offer sufficient protection against aggressive chemicals.

Simriz® perfluoroelastomer O-rings
This high-performance elastomer combines elastomeric qualities with an extremely wide-ranging resistance to media and varying temperatures. The elasticity of pure elastomer far exceeds that of encapsulated rings. This greatly eases assembly and facilitates the design of the installation space.



Metallic O-rings
Metallic O-rings offer acceptable resistance to chemicals and very high compressive stability, but they are very inflexible and require pretensioning forces that are significantly greater than those for elastomer seals.



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