Sealing Solution Handbook for the Food and Beverage Industry

An Overview of Technologies, Materials, Products and Applications

Freudenberg
Process Seals

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Freudenberg Process Seals – Leading Sealing Know-how for Process Engineering

As a member of the international Freudenberg Group, Freudenberg Process Seals combines over 160 years of technological expertise with the know-how of the market specialist for process engineering applications.

A sealing solution can ever only be as good as its developer's understanding of the planned application. That understanding in turn is based on seal engineering expertise on the one hand, and on well-founded knowledge of the available technologies and processes on the application market on the other. Thinking one step ahead, the respective market mechanisms connected to availability, process costs and logistics should also be taken into consideration, so as to ensure that market-specific sealing solutions can be provided not only highly reliably, but also economically and tailored to customer-specific needs.

Freudenberg Process Seals is a market specialist. Our exclusive focus is on developing solutions for the process industries; as such, as a member of the Freudenberg Group we have tailored this family-run technological concern's more than 160 years of sealing expertise to the specific demands of the food and beverage, pharmaceutical and chemical industries. Our specialists are extremely familiar with the application fields in these markets, allowing them to precisely meet your needs not only in terms of materials and product development, but also with regard to logistics concepts and services – quickly, professionally, and customer-oriented.

Materials – The basis of our success

No other company can claim as much materials expertise for elastomer sealing solutions as Freudenberg – an unbeatable advantage we can offer our process engineering customers, and the foundation of our extraordinary product innovations and developmental partnerships. This is essential, as especially when it comes to highly sensitive applications in the food and beverage industry, or to the aggressive media and extreme temperature ranges in chemical and pharmaceutical applications, tailor-made materials of the highest quality are the decisive prerequisite for dependable and lasting sealing solutions.

Market-specific technologies and services

Optimizing processes, ensuring smoothly running production, and reducing costs – our innovative sealing technologies and services offer added values far beyond reliable seals. Whether in developing new sealing geometries for high-hygiene applications, CIP / SIP testing facilities for performance prognoses, or Process^{Plus} services for economical C-parts management and Total Sealing – Freudenberg Process Seals has consistently oriented its service spectrum on the complex and demanding requirements of the process industries, making us a partner you can depend on for all levels of sealing technologies support.

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Process^{Plus} – Our Service Package for Comprehensive Seal Management

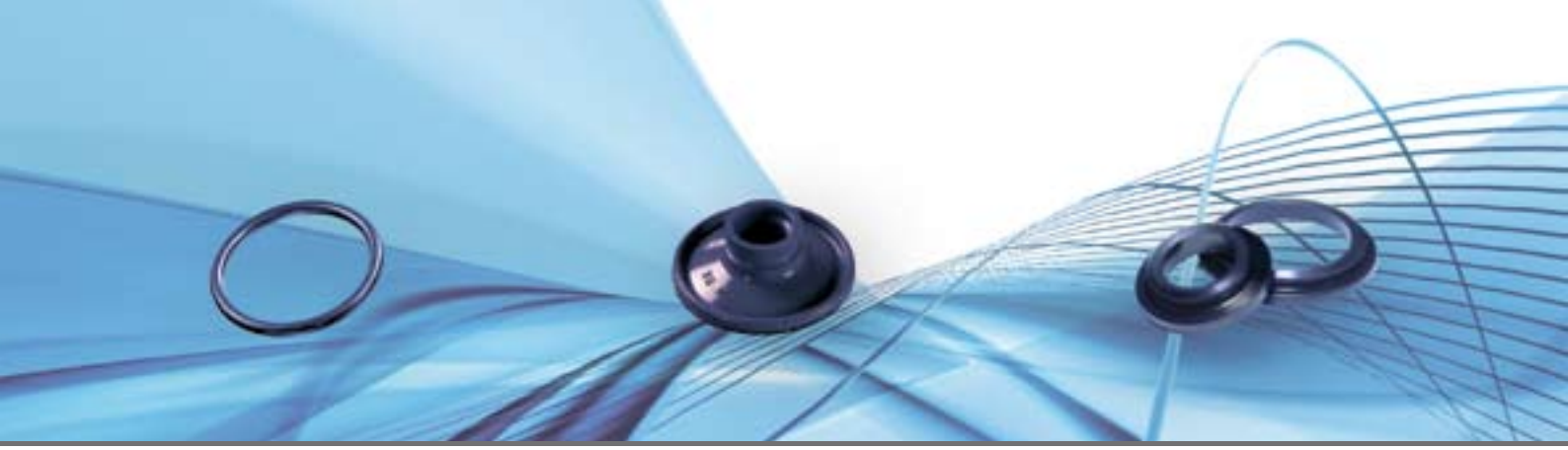
Especially in the process industries, the interplay of functional reliability, customer-specific design and economical supply is an essential precondition for efficient seal management. With Process^{Plus}, Freudenberg Process Seals meets these requirements using a market-specific approach.

The requirements for seals in the process industries are fundamentally different from those of other industries – both technologically and logistically. For example, whereas in the automotive industry large quantities of seals are needed for a limited application range, the diverse application ranges and specific requirements of the process industries call for an extremely broad palette of articles, at times in extremely small batch sizes that need to be supplied as economically as possible. At the same time, maximum quality and functional reliability have to be ensured in order to protect the seals from the influences of aggressive media and extreme temperature ranges, and to prevent their contamination. With Process^{Plus}, Freudenberg Process Seals has developed a service package unique on the market in order to fulfill these parameters, which goes far beyond conventional services and allows extremely efficient seal management.

Technological services

Approvals, resistance ratings, CIP / SIP cleaning processes, Hygienic Design – the list of requirements for the process industries is a long and above all demanding one.

In ensuring these requirements are met, Process^{Plus} offers the ideal infrastructure for orienting sealing technologies on customers' individual needs. Our range of services includes application consulting by certified market specialists; customer-specific materials development in cooperation with the international R&D centers of the Freudenberg Group; advanced testing and analysis facilities for reliable functional prognoses prior to serial production, training, and sensible building blocks for your quality management, such as our safe® product labeling technology.



The technological services comprising Process[Plus] are linked in an interdisciplinary manner, allowing us to not only provide you with the optimal material for your specific needs, but also to design it so that you can economically cover as many applications as possible; ideally all seals produced by the same machine can also be produced from the same material.

Logistics services with added value

More so than in other markets, in the process industries the discrepancy between the commercial aspect of seals as C-parts and their actual function as A-parts is a prominent one. In order to find a successful common denominator for both requirements, Process[Plus] offers forward-thinking solutions for efficient C-parts management. We optimize process costs for you, determine potentials for reducing inventory and storage costs, and provide valuable logistics support, from customer-specific packaging and the development of Kanban Systems, to the implementation of consignment stock and bin storage concepts, allowing you to rest assured that, even with a broad range of products and relatively low batch sizes, you can implement your sealing solution quickly, economically, and tailored to your application.

Process[Plus] at a glance

- Market-specific application consulting
- Individualized materials development
- Innovative testing and analysis facilities
- Reliable durability and resistance prognoses prior to serial production
- Lip and housing design
- Training
- Economical materials reduction
- Efficient C-parts management
- Process cost analysis
- Reducing inventory and storage costs
- Support for Kanban Systems
- Support for consignment stock and bin storage concepts

Safe® Product Labeling Technology

Thanks to its identifiability and traceability, safe® – secure adaptive freudenberg encryption – offers ultimate application security and intellectual property protection for the process industries.

The food and beverage and pharmaceutical industries' requirements for sealing components are characterized by high demands with regard to material purity, reliable chemical and temperature resistance, and diverse approval specifications. And only specially designed, quality products meet these requirements, guaranteeing smooth production processes. Safe® – the new product labeling technology from Freudenberg – allows you to rest assured that you are using original quality sealing solutions tailored to your specifications, to avoid using non-verifiable look-alikes, and to guarantee the seamless traceability of the component used.

This is How We Make Your Seal Unique

The innovative product labeling technology safe® marks sealing components with an unforgeable, patented laser label (patent pending) with a 24-digit code. The information it contains on the product's article, batch and serial numbers, the manufacturing date as well as client-specific information regarding the application and approval can be accessed easily and reliably using a reading device, our security software and a standard laptop. A unique benefit: thanks to the high degree of code redundancy, safe® product labels can still be decoded even if up to 60% of the label have been destroyed. Furthermore, their topography makes them extraordinarily resistant to mechanical and chemical damage.

Especially for the food and beverage and pharmaceutical industries, safe® offers a considerable additional benefit by minimizing the risk of process disruptions being caused by the seal. Material mix-ups can be prevented and documentation requirements can be complied with much more easily, allowing you to uphold your guarantee promises and avoid unjustified warranty claims. Further, Freudenberg has also consistently borne in mind the industry's requirements for contamination-free components in the labeling process.

FDA-compliant and Hygienic Labeling Technology

By integrating the code's laser label into the sealing material, Freudenberg precludes the need to add labeling substances or components, guaranteeing the material's continued FDA compliance. Furthermore, the laser label's code depth is absolutely harmless for hygienic applications. To prove this, Freudenberg extensively tested labeled seals according to the EHEDG standards. The result shows that the code structure does not affect the cleanability and, therefore, the danger of bacterial contamination at e.g. bottling plants does not increase.

A Broad Field of Application for Many Different Elastomer Seals

Safe® can easily be applied for most of Freudenberg Process Seals' elastomer seals. Therefore, one of the most innovative product labeling technologies will be available to you for many different applications to ensure the highest security and quality. There may be coding limitations for extremely small components or those with surfaces that are extremely rough or uneven. For such applications, we would be glad to conduct individual tests to find the right individual solution for you.

Safe® – An Overview of Your Added Value

- Unique labeling system for fast, easy and economical identification and traceability
- Unforgeable technology to prevent product copying
- Traceability of article, batch and serial numbers, the manufacturing date and specifications for the material, measurements and design
- Readable even if the code is damaged
- Avoids product mix-ups and ensures smoothly running product applications
- Allows you to keep guarantee promises and to avoid unjustified warranty claims
- FDA-compliant and EHEDG-approved labeling technology

Test Plant for Sealing Systems in the Process Industries

The new test plant from Freudenberg Process Seals offers you new validation options to perfectly match sealing solutions to your individual CIP / SIP processes.

In the food and beverage industry, CIP / SIP and hot steam cleaning processes are an essential element of the production process. The cleaning media and heat used in these methods put considerable strains on seals for butterfly valves – which can be a neuralgic weak spot for smoothly running production if the wrong choice of seal material or design is used.

Our test plant allows you to perform conclusive seal tests in all conventional CIP / SIP media, steam and hot water sterilization of your specific media application under actual operating conditions. As such, from O-rings to seals for butterfly valves, you can make proven functional evaluations as regards the optimal sealing solution prior to serial production: a proactive development partnership that considerably decreases the likelihood of seal failure and similarly increases the efficiency of your valves and systems.

CIP / SIP Processes Under Authentic Operating Conditions: Test Plant Design

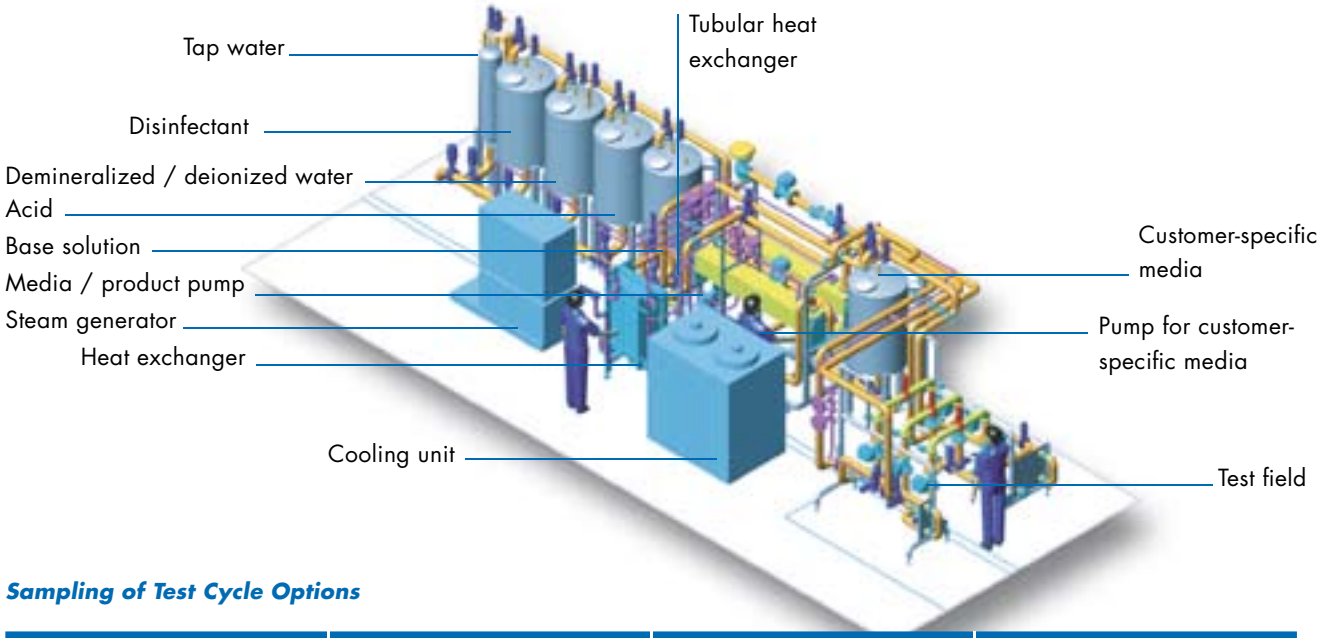
The test plant is designed as a multiple-container CIP system, allowing testing of various cleaning processes involving acids, caustic solutions and disinfectants. The heart of the system consists of 3 testing tracks, on which 3 valves can be simultaneously or sequentially tested, with operating parameters such as torque being recorded online. For simulations requiring controlled contamination of the valves, an additional container can be filled with the medium of your choice. So as to create completely authentic testing conditions, we can easily make any customer-specific adaptations to the fittings and components you may need.

With this test plant, you will receive decisive test results on seal service life and durability, as well as on any design optimizations that may be necessary: valuable information in selecting the ideal materials and design from the outset.

Testing Methods and Options

- Seal testing involving caustic solutions, acids and disinfectants
- Introduction of separate media to test valve and seal contamination
- Testing of critical applications involving steam, coolants and high-pressure air
- Testing of all elastomeric seals such as O-rings, diaphragms, seals for butterfly valves, cam-profile gaskets, and molded parts
- Testing of seals in pumps and measuring devices
- Conducting damage analyses

Technical Design of the Test Plant



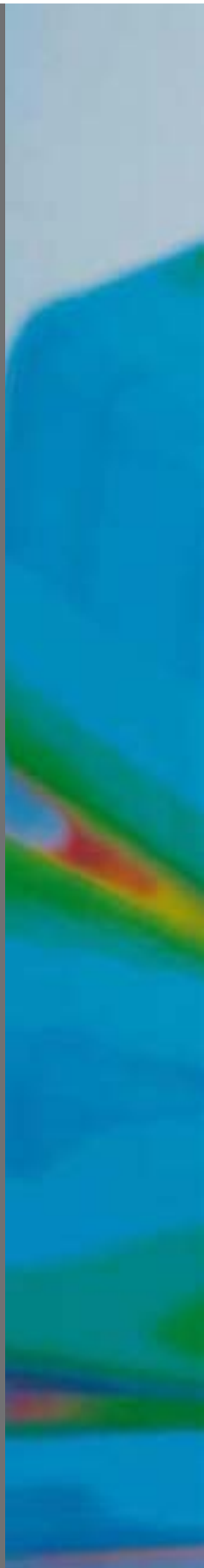
Sampling of Test Cycle Options

CIP / SIP Media	Concentration Range	Duration of Exposure	Temperature Range
Acidic cleaning agents, e.g. HNO_3	0,5 – 3%	20 – 30 minutes	30 – 80 °C
Caustic cleaning agents, e.g. NaOH-based	2 – 3%	20 – 120 minutes	30 – 80 °C
Disinfectants, e.g. H_2O_2-based	0,3 – 1%	30 – 60 minutes	25 °C
Acidic disinfectants, e.g. H_2O_2 + HNO_3-based	0,5 – 1%	20 minutes	25 °C
Caustic disinfectants, e.g. H_2O_2 + NaOH-based	0,5% H_2O_2 1 – 2% NaOH	30 minutes	80 °C
Steam sterilization		20 – 45 minutes	120 – 140 °C
Hot water sterilization		20 – 45 minutes	120 – 140 °C

Your Advantages at a Glance

- Illustrates your individual CIP / SIP processes under authentic operating conditions
- Conclusive prognoses on the durability and functional reliability of sealing materials and designs
- Ensures the correct choice of seal prior to serial use
- High functional reliability throughout the entire product lifecycle
- More efficient production processes
- Avoids expensive and time-consuming field tests

Technical Criteria for the Use of Seals in the Food and Beverage Industry



Essential Materials Testing
Hardness / Volume Change / Compression Set

A material's hardness rating, compression set and degree of volume change are essential parameters that influence both the sealing function and the longevity of a sealing solution, making exact prognoses on materials behavior indispensable. To ensure the accuracy of these prognoses, Freudenberg Process Seals utilizes a variety of testing procedures and methods.

Hardness Tests

One of the most important parameters in rubber technology is the hardness rating. For all Freudenberg Process Seals materials, this rating number is listed directly before the name of the base elastomer in the material name (e.g.: 70 EPDM 291). Hardness is measured using various standardized procedures. All procedures measure how far a given test object penetrates the rubber under a predetermined amount of force.

Shore A in Compliance with DIN 53 505

This procedure was developed by Albert F. Shore in the 1920s and remains the most common method for testing hardness in elastomers.

The surfaces of the test object must be level and coplanar. The measurement is taken after 30 seconds holding time. As such, the Shore A testing method is predominantly used in materials development and for the approval of mixed materials. Shore A can only be used with molded parts if the latter are suitably thick and have level contact surfaces for measurement. Shore A is applicable for hardness ratings of 10 to 90. For ratings beyond 90, the Shore D method must be used. For elastomers, however, Shore D is not necessary.

IRHD in Compliance with DIN ISO 48

The IRHD (International Rubber Hardness Degree) in compliance with DIN ISO 48 is used for hardness testing on seals. This standard describes 4 methods: N (normal for hardnesses of 30 to 95 IRHD), H (for the testing of higher hardnesses, between 85 and 100), L (for the range 10 to 35 IRHD) and M (Micro-hardness ratings for the testing of smaller or more delicate samples). In seal engineering, methods N and M are predominantly used.
The micro-hardness ratings for molded parts / seals are not directly analogous to the IRHD ratings, method N and the Shore A ratings for test plates.

Measuring Volume Change

Seals come into contact with a broad variety of media – primarily fluids and gases. These media affect elastomer materials in a number of ways.

A key distinction is made between chemically active and physically active media. Chemically active media react with the elastomer compounds and irreversibly change their characteristics, e.g. by splitting the bonds between the molecular chains (= softening and loss of elasticity) or by forming additional bonds (= hardening the material). Certain media even attack and destroy the molecular chains in elastomers. Physically active media simultaneously trigger two processes:
a. An absorption of the medium on the part of the elastomer and
b. An extraction of soluble components (e.g. softening agents) from the elastomer.

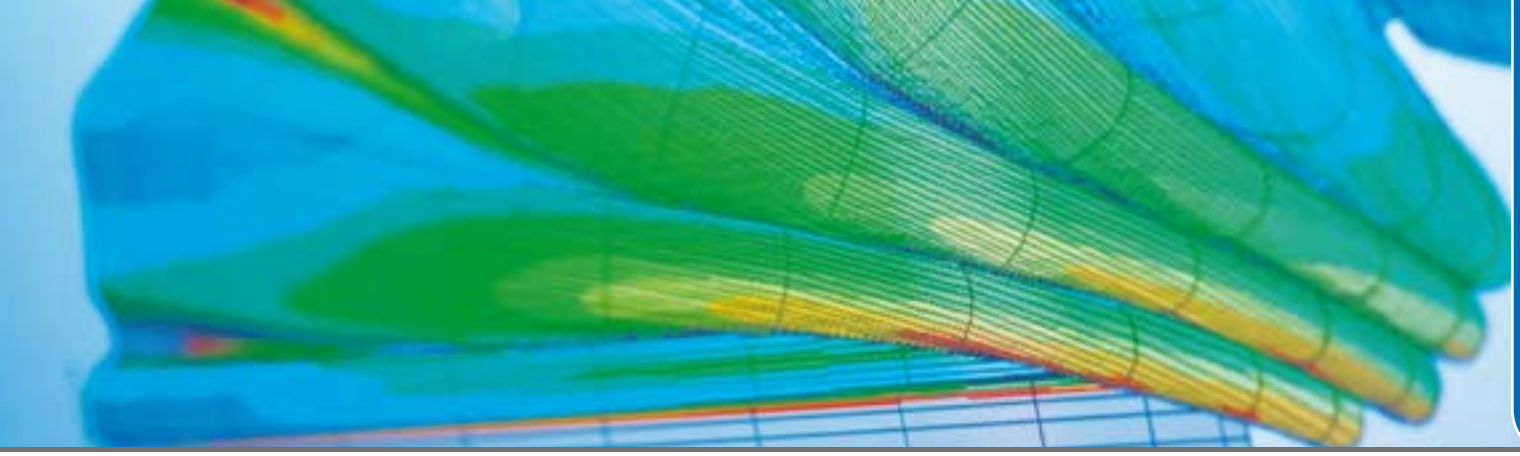
These processes can be recorded by measuring the resultant volume change: swelling when **a.** is greater than **b.** or shrinking when **b.** is greater than **a.**

As a rule, these processes are reversible.

The degree of volume change depends on the following factors:
- The type of influencing medium
- The material composition of the elastomer compound
- Temperature
- Geometric form (thickness) of the seal
- The amount of tension on the seal (the effect is greater on stretched parts, lesser on compressed ones)

Due to the elastomers' cross-linked structure, the degree of volume change is limited, i.e., it reaches a maximum, after which there is no further change.

Any volume change, whether swelling or shrinking, also causes changes in the elastomer's physical characteristics, such as its hardness, elasticity, tensile perform-



ance, elongation at break and behavior at different temperatures. Accordingly, measuring the volume change after a predetermined exposure period (for a given time, at a given temperature) provides an essential parameter for determining and assessing the durability of elastomer compounds in the media they will be exposed to in actual operation.

Note: In the food and beverage industry, not only the production media (e.g. beer, mineral water, milk products, etc.) but also the cleaning and sterilization media used in the production process have to be tested for their compatibility with the sealing material.

Testing Procedure in Compliance with DIN ISO 1817

The volume of the test object (the seal or a part of it) is determined. The test object is exposed to the medium, either according to the requirements set out by the standard or those requested by the customer. At the end of the exposure period (and after the object has cooled), the volume is measured again. The result is expressed as a change from the original in %.

Measuring Compression Set / Elasticity

The compression set is an important characteristic in determining the performance of a sealing material. It describes the material's ability to exert sufficient restoring force on the contact surfaces to ensure a reliable seal, even after a considerable operating time in contact with the respective medium. Further, the compression set provides valuable information on a material's vulcanization behavior. It should be kept in mind that the compression set does not represent an absolute value, but should be considered in comparison to the material's initial or desired values.

The compression set is determined in compliance with DIN ISO 815 as follows:

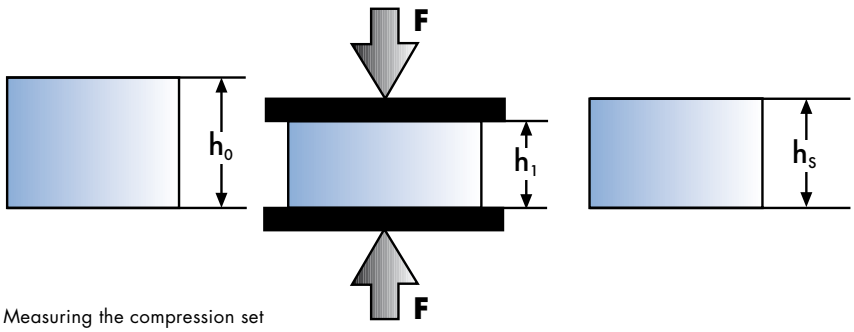
1. h0 = The thickness of the test object, which should have coplanar surfaces, is measured. The compression set testing can be conducted no sooner than 16 hours after the vulcanization of the test object.
2. h1 = The sample is compressed between two sheets of metal to a predetermined degree (normally 25%).
3. The compressed sample, which remains in the compression device, is then air-stored (or as an exception to the rule stored in a medium) for a predetermined time and at a predetermined temperature. Standard testing times are 24h, 72h, 168h or a multiple of 168h.
4. At the end of the testing time, the sample is immediately removed from the compression device.
5. hs = 30 minutes after the sample is removed from the device, its thickness is measured again.

The compression set is determined using the formula:
C[%] = (h0 - hs) / (h0 - h1) x 100%

Please note:

Compression sets can only be compared with one another if the following parameters are identical:

- Compression (standard: 25%)
- Duration of compression (standard: 24 or 72 hours)
- Temperature during compression (depends on the elastomer being tested)
- Medium in which the elastomer is tested (standard: air)
- Form of the test object



Measuring the compression set

Essential Materials Testing
Density / Tensile Test / Tear Resistance

Measuring Density

The density of vulcanized rubber is a specific value. A simple, quick measurement of the density allows initial conclusions to be made about the compound used. In the manufacture of elastomer compounds, the density measurement serves as an indicator of whether the material components have been correctly mixed. Further, when analyzing unknown compounds the density test is the first test performed, in order to reduce the number of potential compounds.

As a rule, density is measured using the buoyancy method. According to Archimedes' principle, when a body is immersed in a liquid, it generates a buoyancy force. This force consists of the difference between the body's normal weight and its weight in the liquid. Yet the buoyancy force is simultaneously also the weight of the volume of fluid displaced by the body. This in turn allows us to derive the volume of the test object regardless of its geometric shape. Using this volume and the object's normal weight, we can calculate its specific weight:
$\rho = [GL / (GL - GF)]^* \rho F$
(ρF = specific weight of water ~ 1).

Tensile Tests

Tensile tests are used to determine the tensile strength, ultimate elongation or elongation at break, and elongation values of elastomer materials. The test objects used are normally either standardized dumbbells or standardized rings with square cross-sections. Excepting O-rings, as a rule tensile tests cannot be performed on molded seals, as the seal's form can greatly influence the test results.

In every tensile test, 3 values are determined:

The tensile strength (sR) is the force FR produced in the tearing moment in relation to the initial diameter (A0) of the test object prior to testing:
$sR = FR/A0 * [N/mm^2]$.

The modulus at 100% elongation (sx) is defined as the amount of force (Fx) needed for a certain degree of elongation (ex) (as a rule 100%) in relation to the initial cross-section (A0):
$Sx = Fx /A0 * [N/mm^2]$
* For standardized dumbbells, A0 is the width x the thickness in the narrow part of the rod. When testing rings, A0 = 2 x the ring cross-section.

The elongation at break (or ultimate elongation) (eR) is the relation in percent of the elongation reached at the moment the material breaks or tears (LR – L0) to the sample's initial length (L0):
$eR = [(LR - L0)/L0] * 100 [\%]$.

The three parameters tensile strength, modulus at 100% elongation, and elongation at break are provided on Freudenberg Process Seals' information sheets for all materials. These parameters are influenced by the degree of vulcanization, the specific compound mixture, filler materials (carbon black, softening agents, anti-aging chemicals, etc.), storage conditions and product age.

Tear Resistance

Tear resistance reflects elastomer materials' tear performance in response to cuts or cracks. The most common method for determining tear resistance is the strip test in accordance with DIN ISO 34-1 (DIN 53 507). Here a lengthwise incision is made in the strip of the material to be tested, and the two half-strips are fastened to a pulling machine and pulled apart. This determines the force (FR) the sample exerts to resist tearing in relation to the sample's thickness. A further testing method is the angle test piece method in accordance with DIN ISO 34-1 (DIN 53 515): Here an incision is made in an angled ("bent") sample manufactured in a form, and the sample is similarly pulled apart using a pulling machine. The measured values need not correlate with the elongation values arrived at in the tensile test. As tear resistance values depend heavily on the specific testing conditions, and especially on the shape of the sample, it is essential that the testing method and sample shape used are always included when listing the testing results.

Storage Conditions

Rubber articles are subject to aging. Modern elastomer materials are more stable and have extremely long service lives, due both to the base rubber used and the further components mixed with it. Nonetheless, certain rules should be observed in the storage of rubber products.

The aging process is predominantly dependent on the following factors:

- Temperature
- Heat
- Sunlight
- Moisture
- Relative humidity < 65%
- Ozone and ionizing radiation
- Tensile stress on the component

As such, we can derive the following rules for storing elastomer seals:

- The storage temperature must remain below 25 °C
- There should be no direct heat sources in the storage area
- The seals should not be exposed to direct sunlight
- The seals must be protected from the effects of ozone and ionizing radiation
- The seals must be stored so as to avoid their being under tensile stress

Group	Materials	Shelf Life (in years)	Extension (in years)
1	NR, AU, EU, SBR	5	2
2	NBR, HNBR, ACM, AEM, XNBR, ECO, CIIR, CR, IIR	7	3
3	FKM, VMQ, EPDM, FVMQ, PVMQ, FFKM, Fluoroprene® XP, CSM	10	5

So as to fulfill these requirements, elastomer products should be packaged as follows:
All materials used for storage containers, to cover or to wrap the seals should be free of substances that can deteriorate or break down elastomers. Suitable packing materials include e.g. PE-coated paper, aluminum foil or non-transparent PE (min. 0.075 mm thick).

ISO 2230 provides guidelines for the storage and for determining the shelf life of vulcanized rubber products. This standard classifies elastomer products into three groups, with different shelf lives.

It is possible to receive extensions on the projected shelf life, but only after consultation with Freudenberg Process Seals. The following tests have been laid out by Freudenberg's Materials Development division for assessing elastomer parts after the expiration of their initial shelf life:

1. **Testing in accordance with the respective product specifications**
   If the product specifications make no mention of such testing, the following procedures should be used:

1.1. Visual inspection

Every part or component in a representative sample is to be checked for the following changes:

- permanent deformations, e.g. folds, wrinkles or flattened areas
- mechanical damage, e.g. cuts, cracks, worn or dissolved areas
- surface crack formation, visible under 10-power magnification
- changes to the surface, e.g. stiffening, softness, stickiness, discoloration or dirtiness

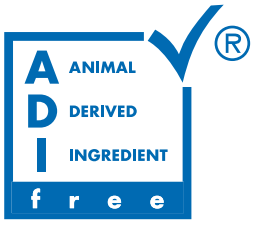
A list of key characteristics tested is to be made for the stored parts or components; it must include the following:

a) the quantity stored for each part or component, the date of their initial packaging, the date of their being placed in storage
b) the date(s) of each consecutive repacking
c) the manufacturer's lot number, and the number of parts or components that is a representative sample of the whole.

Approvals, Tests and Conformities

The requirements of the food and beverage and pharmaceutical industries start with those for materials.

As a rule, all materials must satisfy the requirements of the Food and Drug Administration (FDA). There are however also further requirements with regard to e.g. drinking water applications or the processing of perishable foodstuffs. The following table offers an overview of several such guidelines.



	Approvals	Name of the Organization	Legal Basis
Drinking Water Industry	W270	DVGW – Deutscher Verein des Gas- und Wasserfaches e.V. (German Technical and Scientific Association for Gas and Water)	Recommendation
	KTW – Kunststoffe im Trinkwasser (Plastics in Drinking Water)	BfR – Bundesamt für Risikobewertung (Federal Office for Risk Assessment)	LFGB – Lebensmittel- und Futtermittelgesetzbuch (legislation on foodstuffs and feeds) (§ 2 Section 6 Line 1 Nr. 1)
	ACS – Accreditation de conformité sanitaire (Accreditation of Hygienic Conformity)	ACS – Accreditation de conformité sanitaire (Accreditation of Hygienic Conformity)	AFNOR – Association française de normalisation XO P41-250 Parts 1 – 3 (French Association of Standardization)
	WRAS – Water Regulations Advisory Scheme	WRAS – Water Regulations Advisory Scheme	BSI 6920 and BS 2494
	Ö Norm	ÖVGW – Österreichischer Verein des Gas- und Wasserfaches (Austrian Gas and Water Union)	Ö Norm B5014/ Section 1
	KIWA	Ministerial Expert Committee + Toxicity Sub-Committee	Directive Doc. 94-01
	ETA-DK (Danish Board of European Technical Approvals)	DEPA and DTC	NKB rules + DS/EN standards
	NSF 61	National Sanitation Foundation	NSF Standard 61
	AS/NZS 4020:2005	AWQC – Australien Water Quality Criteria	AS/NZS 4020:2005
Food and Beverage Industry	EU Directive 1935/2004	European Parliament	EU Directive 1935/2004
	BfR Recommendation 21 for Rubbers	Bundesamt für Risikobewertung (Federal Office for Risk Assessment)	LFBG – Lebensmittel- und Futtermittelgesetzbuch (legislation on foodstuffs and feeds)
	BfR Recommendation 15 for Silicone Materials	Bundesamt für Risikobewertung (Federal Office for Risk Assessment)	LFBG – Lebensmittel- und Futtermittelgesetzbuch (legislation on foodstuffs and feeds)
	FDA Conformity	Food and Drug Administration	FDA 21. CFR 177.2600 (Elastomers)/ FDA 21. CFR 177.2400 (Perfluoroelastomers)/ FDA 21. CFR 177.1500 (Plastics)
	NSF 51	National Sanitation Foundation	FDA 21. CFR 177.2600 (Elastomers)/ FDA 21. CFR 177.2400 (Perfluoroelastomers)/ FDA 21. CFR 177.1500 (Plastics)
	3-A® Sanitary Standard	3-A®	
	ADI free® – Animal derived ingredient free		EMEA/410/01 rev. 2
Pharmaceutical Industry	USP Class VI	United States Pharmacopeia	

Geographic Scope	Testing Institute	What is Tested	Duration of Validity	Testing Criteria
Germany	DVGW-certified Laboratories	Material	5 Years	Microbiological Examination
Germany	DVGW-certified Laboratories	Material and Product	5 Years	BfR White List (i.e., BfR Recommendation 15, Cat. 4) - Chlorine Demand - TOC Level - Migration Tests
France	CRECEP – Paris LHRSP – Nancy IP – Lille	Material and Product	5 Years	- White List - Material Composition - Cytotoxicity - TOC Level
Great Britain	WRAS-certified Laboratories	Material and Product	5 Years	- Material Composition - Manufacture - Cytotoxicity - Migration Tests
Austria (also accepts the KTW test)	ÖVGW-certified Laboratories	Material and Product	5 Years	- White List - Material Composition - Chlorine Demand - TOC Level - Migration Tests
Netherlands	KIWA	Material and Product	5 Years	- Material Composition - Manufacture - Toxicity Tests - Migration Tests - Microbiological Examination
Denmark (also accepts the KTW test)	Certified Laboratories	Material and Product	5 Years	- White List - Material Composition - Manufacture - TOC Level - Migration Tests
USA	NSF-certified Laboratories	Material and Product	5 Years with Annual Audit	- Material Composition - Testing the Groups - Toxicity Tests - Microbiological Examination
Australia	AWQC-certified Laboratories	Material and Product	5 Years	- Microbiological Examination - Manufacture - Toxicity Tests - Migration Tests
Europe	Any Accredited Testing Laboratory	Material	Unlimited	- FDA Conformity - BfR Recommendation 21, Cat. 4 - ADI Free®
Germany	Any Accredited Testing Laboratory	Material	Unlimited	- BfR White List - Migration Tests (categorized by contact duration)
Germany	Any Accredited Testing Laboratory	Material	Unlimited	- BfR White List - Migration Tests (categorized by contact duration)
USA (is also accepted in Europe)	Any Accredited Testing Laboratory	Material	Unlimited	- FDA White List - Migration Tests
USA	NSF-certified Laboratories	Material	5 Years with Annual Audit	- FDA White List - Migration Tests
USA (is also accepted in Europe)	Any Accredited Testing Laboratory	Material	Unlimited	Durability Tests in Predetermined Media Classification Using Fixed Limits
Worldwide		Material	Unlimited	
USA (is also accepted in Europe)	Licensed Laboratories	Material	Unlimited	Testing Compatibility with Living Organisms

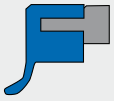
Hygienic DesigN

Choosing the right material in light of the intended operating conditions, the degree of purity needed, and conformity issues is only the first step in fulfilling industrial requirements.

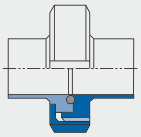
For all those operating production facilities, it is of paramount importance that they observe all regulations designed to promote public health. Every food, pharmaceutical and cosmetic product must ultimately be cleanly produced, and in such manner that it can by no means endanger the health of consumers.

A facility constructed according to the principles of Hygienic Design is characterized by a high degree of cleanability, which precludes its being contaminated by micro-organisms. As automated CIP and SIP (Cleaning In Place / Sterilization In Place) cleaning processes are increasingly used, fewer facilities have to be dismantled for cleaning, which in turn does away with the opportunity for visual inspection. As such, when mechanical cleaning processes are used, it is essential that these processes can be relied upon, and that there are no dead spaces where product residue can build up and later microorganisms can breed. This means that square grooves that are approx. 80% filled by their seals are not acceptable. Hygienically designed grooves are tighter, making the amount of space where product material could escape the seal correspondingly small.

Standardized Connections



HTS II 9539 VL
Dead space-free version with protruding sealing lips for Hygienic Design applications



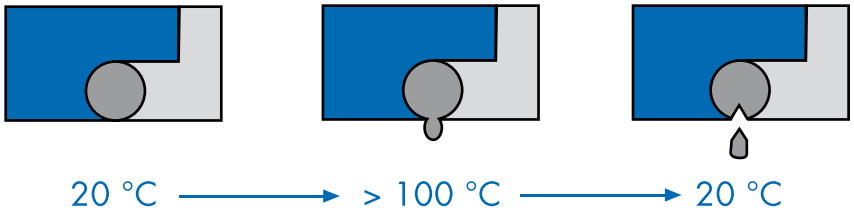
DIN 11864
Aseptic O-ring union
Metallic stop, non-shrinking, aseptic and hygienic connection

But elastomers and steel display different behavior as regards their manufacture and temperature. There are considerably higher tolerances in the manufacture of elastomers, as a result of which in extreme cases, the seal may already "overflow" its groove on the day of its installation. It must also be kept in mind that, when compared to steel, elastomers are 15 times as susceptible to thermal expansion. Elastomers are incompressible and therefore require room for expansion. If an elastomer seal is installed in an overly tight space, extreme tension can be produced when it cools, resulting in material shearing.

The preclusion of dead spaces is also a priority in dynamic sealing solutions such as rotary shaft seals. Whereas normal rotary shaft seals are extremely difficult to clean, the dead space-free HTS II 9539 with elongated PTFE sealing lips is practically impossible to contaminate and can be cleaned very easily.

The EHEDG (European Hygienic Engineering and Design Group) is a consortium of equipment manufacturers, representatives of the food and beverage industry, research institutions and public health authorities. Freudenberg Process Seals is a member of the EHEDG and is actively involved in promoting the standards of Hygienic Design, e.g. through its involvement in the creation of guidelines.

Effects of Heat on O-ring Seals



Expansion of elastomers: 15 x greater than that of stainless steel

Materials Requirements

For a number of reasons, the demands placed on seals by the food and beverage industry continue to grow. For example, production facilities are now cleaned using acids and bases. Further, so as to reduce cleaning times, both the chemical concentrations and temperatures have also been increased. Whereas the longevity of foodstuffs was once ensured using preservatives, today it is optimized through sterile production. As a result, seals used in these production facilities must also be resistant to sterilizing agents such as peracetic acid, and to steam. A further aspect to be considered is that today's facilities are multi-purpose: whereas dairy processing plants once produced only dairy products, today any number of mixed drinks also belong to the production portfolio; these other products place different sets of demands on the seals, making a universal sealing material increasingly necessary.

Requirements Profile Sealing Material	
Suitable for Contact with Foodstuffs	FDA-compliant; conforms to EG 1935/2004 ADI Free® 3-A®-certified (Use in the dairy industry) USP Class VI (Pharmacy products)
Resistant to CIP Media (Cleaning in Place)	e.g. bases, 5% conc., 80 °C Nitric acid, 2% conc., 80 °C
Resistant to SIP Media (Sterilization in Place)	Peracetic acid, 1% conc., 60 °C Steam, 140 °C
Universal Resistance	EPDM is suited for use with aqueous media and cleaning agents HNBR and FKM are well-suited for use in greasy / fatty media, but demonstrate less resistance to cleaning agents Fluoroprene® XP 40 can be universally used in applications involving aqueous or greasy / fatty media, cleaning agents or steam

ADI ANIMAL DERIVED INGREDIENT free ®

Optimizing Friction

The friction between elastic materials and hard surfaces is significantly different from that between metal surfaces.

The commonly known conditions in frictional processes, such as fluid film friction (the two moving bodies are completely separated by a film of lubricant), mixed friction (the two bodies only touch at their roughest points), and dry friction (no lubricants used) cannot adequately describe the conditions for friction in sealing materials.

Due to the elasticity of the sealing material, the elastomer conforms to the roughness of the surface, greatly increasing the frictional force. The softer the elastomer is and the more force is exerted in pressing it against the surface, the more intense this effect is.

As such, when addressing friction in elastomers, other conditions than those for classical friction between two solid bodies apply.

For the following reasons, it is necessary to reduce friction in sealing materials:

- Reducing adhesion between seals or between the seal and the housing walls. This is especially important in automated installation processes. For example, O-rings should not "stick" to one another, but should actually slide slightly in the assembly facilities.
- Reducing friction in seal installation. When e.g. O-rings have to be pushed over rotary shafts or cranks, in cases of high friction the rings can become slightly twisted and subsequently not sit correctly in the groove, increasing the risk of leakage.
- Reducing friction in dynamic sealing applications in order to increase the seal's service life.

Freudenberg Process Seals offers all coating methods currently available on the market. The most important are:

Dusting with Talc (hydrated magnesium silicate)

Prevents seals from sticking to one another or to the housing walls. Talc is helpful in installation, but is not well-suited as long-term lubrication for dynamic applications. Talc can also contaminate automated installation systems.

Dipping in Emulsions

Produces the same effect as dusting with talc. The coating is, however, not a loose powder, but clings to the surface. As such, this option presents a lower risk of contamination.

Greasing or Oiling

Upon request, seals can be delivered lightly greased or oiled. Note, however, that installation systems can be clogged or contaminated by greases and oils.

For dynamic sealing applications, the seals should only be greased shortly prior to their installation, as this assures a good long-term lubrication. Generally speaking, the resistance of the sealing material used to greases and oils should be checked (See also pp. 24-25).

Coating with PTFE Lacquer

PTFE lacquers, which permanently coat the seal surface, greatly reduce friction. In continuous dynamic operation, however, the relatively soft PTFE coating will wear off to some degree.

Even after wear on the seal, a certain degree of friction reduction will remain, as the PTFE fills in the valleys in the roughness profiles of the mating surfaces. The lubricating PTFE coating is not as elastic as the basic sealing material it protects. As a result, in cases of substantial expansion cracks can form in the PTFE coating, which can in turn cause the coating to flake off and / or the seal to leak.

Chemical Transformation of the Surface

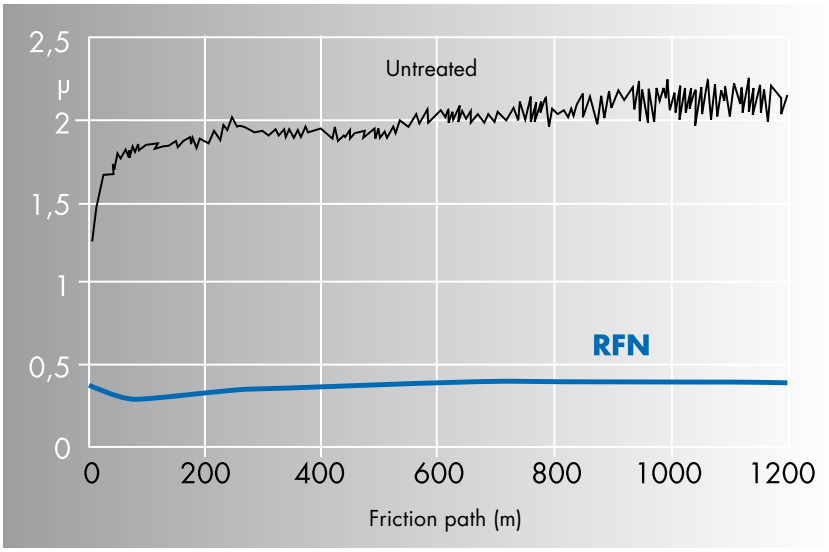
Halogenation:

In this method, the sealing material's surface is hardened at the micro-level, reducing the extent to which it is pressed into the rough opposing surface. This increases lubrication. In cases of high dynamic load, however, the outer layer wears off, causing the ring to lose said lubrication. This method is an excellent choice for processes involving automated O-ring installation systems, as the rings remain dry and no powder is needed; the machines remain clean and free of friction for a considerable length of time.

RFN® Method (Reduced Friction by Nanotechnology)

With this method, developed by Freudenberg Research Services, the surface characteristics can be changed so as to significantly and lastingly reduce adhesion and therefore components' sticking to one another. Further, the surface can also be made extremely hard and accordingly low-friction and low-wear, making RFN-treated products suitable for dynamic applications. This special process allows the materials to retain their original elasticity, as well as their chemical stability. RFN treatment has been approved for drinking water applications and is resistant to CIP / SIP cleaning agents.

Assessing the Wear Resistance of RFN



Lubricants

In addition to the strain put on sealing materials by the medium to be sealed – the food or beverage itself, as well as cleaning or sterilizing agents – lubricants represent the third group of materials to be considered when planning and designing sealing solutions.

Designers have several options in order to reduce friction between moving machine parts. In the first steps, the focus is on using materials that demonstrate good anti-frictional properties. These primarily include plastics such as polyamides (PA), polyoxymethylene (POM), polyetheretherketone (PEEK) and above all polytetrafluorethylene (PTFE). However, these materials are limited in their dynamic load capacity. If bearings are subjected to stronger forces, metallic friction bearings or roller bearings have to be used. The same applies for high transverse forces on pistons or rods in translatory motion.

In such cases, it becomes necessary to use lubricants. For applications involving foodstuffs production, lubricants must fulfill – in addition to the generally applicable technical requirements – the following preconditions:

- Compatibility with foodstuffs legislation
- Any and all potential health risks must be ruled out
- Tasteless and odorless
- International approvals

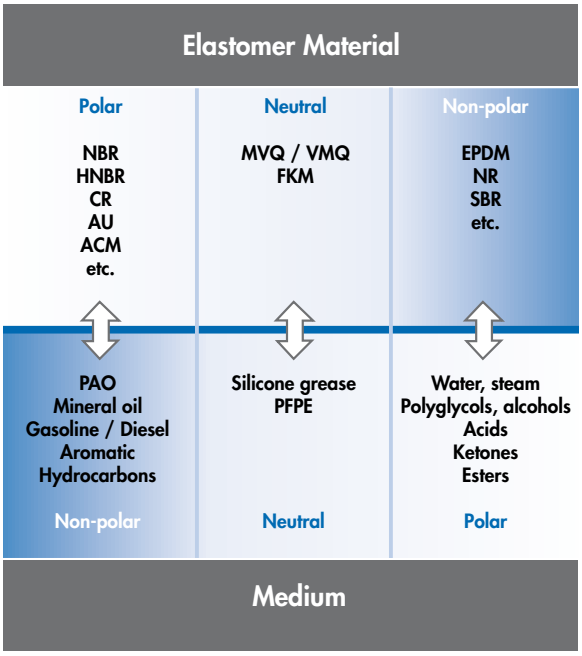
Furthermore, different operating conditions can require application-specific characteristics from lubricants, e.g. resistance to different media, cleaning and sterilizing agents, as well as chemical compatibility with plastics and elastomer sealing materials.

We have performed extensive testing on the compatibility of lubricants and sealing materials in cooperation with our affiliate Klüber Lubrication in Munich. Based on these tests, Klüber has developed a number of lubricants that not only meet but greatly exceed the requirements for foodstuffs production, while simultaneously ensuring lubricant-seal compatibility.

KLÜBER LUBRICATION

Following the basic principle of "like dissolves like", the first consideration in selecting the best lubricant is the polarity of the two materials. Polar materials can be easily dissolved by polar media, just as non-polar materials can be by non-polar media. Accordingly, if a polar sealing material (e.g. NBR or HNBR) is to be used, then the base oil of the lubricant should be non-polar, e.g. mineral oil or poly-alpha-olefin (PAO). Similarly, polar base oils such as polyalkylene glycol (PAG) should be used with non-polar sealing materials (e.g. EPDM).
In especially critical cases, it becomes necessary to fall back on chemically inert elastomers such as FKM, FFKM and VMQ, or alternatively on inert lubricants such as perfluoropolyether (PFPE) or silicone grease.

The interactions between the three parameters medium, sealing material and lubricant are highly complex, making it necessary for each application to be individually tested. Should you need individual consultation, both the chemical engineering resources of Freudenberg Process Seals and the experts at Klüber Lubrication are there to support you.



The Markets and Their Requirements for Materials and Seals

Beverages

Special Characteristics of the Industry

Whereas their chemical compositions make alcoholic and carbonated beverages quite stable, non-carbonated drinking water is a highly sensitive product, and its production processes call for a high level of attention to hygiene and cleanliness. As such, this industry poses a unique challenge for sealing solutions. Given the powerful cleaning agents and conditions utilized in fruit juice production, as well as the flavoring additives, not just any elastomer or plastic can be used.

		Cleaning			Sterilization
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)
O-rings	70 EPDM 291	++	++	+	++
	85 EPDM 292	++	++	+	++
	75 Fluoroprene® XP 40	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++
	70 NBR 150	++	0	–	– –
	85 NBR 151	++	0	–	– –
	75 HNBR 231142	++	+	0	+
	70 FKM 37508	+	+	0	+
	78 VMQ 166898	+	++	+	–
	70 VMQ 117055	+	++	+	–
Customer-specific precision moldings	70 EPDM 291	++	++	+	++
	85 EPDM 292	++	++	+	++
	75 Fluoroprene® XP 41	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++
	70 NBR 150	++	0	–	– –
	85 NBR 151	++	0	–	– –
	75 HNBR 231142	++	+	0	+
	70 FKM 37508	+	+	0	+
	70 VMQ 117055	+	++	+	–

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

	Filling			Products		
Steam (140–160 °C)	Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Juices, juice beverages and spritzers	Near water products	Water (carbonated and non-carbonated)
++	++	+	++	++	+	++
++	++	+	++	++	+	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
– –	–	– –	–	+	+	++
– –	–	– –	–	+	+	++
–	0	–	+	+	+	++
–	0	–	++	++	++	++
– –	++	++	++	++	++	++
– –	++	++	++	++	++	++
++	++	+	++	++	+	++
++	++	+	++	++	+	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
– –	–	– –	–	+	+	++
– –	–	– –	–	+	+	++
–	0	–	+	+	+	++
–	0	–	++	++	++	++
– –	++	++	++	++	++	++

Beverages

		Cleaning			Sterilization
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)
Seals for butterfly valves	75 EPDM 253356	++	++	+	++
	75 Fluoroprene® XP 41	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++
	75 HNBR 253436	++	+	0	+
	70 FKM 37508	+	+	0	+
	75 FKM 253543	+	+	0	+
	76 VMQ 176643	+	++	+	–
Diaphragms	60 EPDM 290	++	++	+	++
	70 EPDM 291	++	++	+	++
	75 Fluoroprene® XP 40	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++
	70 NBR 150	++	0	–	– –
	70 FKM 37508	+	+	0	+
	70 VMQ 117055	+	++	+	–
Clamp seals	70 EPDM 291	++	++	+	++
	78 EPDM 37803	++	+	–	+
	70 NBR 150	++	0	–	– –
	65 NBR 37786	+	0	–	– –
	70 FKM 37805	+	0	–	0
	70 VMQ 37804	+	+	+	– –
Seals for dairy couplings	80 EPDM 37739	++	+	–	+
	80 NBR 37738	+	0	–	– –
	70 FKM 37639	+	0	–	0
	80 VMQ 37740	+	+	+	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

	Filling			Products		
Steam (140–160 °C)	Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Juices, juice beverages and spritzers	Near water products	Water (carbonated and non-carbonated)
++	++	+	++	++	+	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
–	0	–	+	+	+	++
–	0	–	++	++	++	++
–	0	–	++	++	++	++
– –	++	++	++	++	++	++
++	++	+	++	++	+	++
++	++	+	++	++	+	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
– –	–	– –	–	+	+	++
–	0	–	++	++	++	++
– –	++	++	++	++	++	++
++	++	+	++	++	+	++
0	+	+	+	++	+	++
– –	–	– –	–	+	+	++
– –	– –	– –	–	+	+	++
– –	–	–	++	++	++	++
– –	+	+	++	++	++	++
0	+	+	+	++	+	++
– –	– –	– –	–	+	+	++
– –	–	–	++	++	++	++
– –	+	+	++	++	++	++

Brewery

Special Characteristics of the Industry

The need for clean and hygienic facilities, as well as numerous other factors, makes precisely tailored sealing technologies indispensable in beer production. In addition to the at times extreme cleaning processes, the sealing material must also be able to withstand salt deposits and beer's high concentration of CO_2. These processes generally use a concentration of up to 3% acid at a temperature of 80 °C to remove the salt deposits from the pipe system. High temperatures are also a factor in both the production and cleaning (steam sterilization) processes and represent a further thermal strain on seals. Lastly, the beer wort also contributes to seals' short service lives. Taken together, these factors make carefully selecting the ideal sealing material crucial.

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
O-rings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	78 VMQ 166898	+	++	+	–	– –
	70 VMQ 117055	+	++	+	–	– –
Customer-specific precision moldings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products			
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Types of beer	Mixed beer beverages	Near water products	Water (carbonated and non-carbonated)
++	+	++	++	++	++	++
++	+	++	++	++	++	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
–	– –	–	++	++	++	++
–	– –	–	++	++	++	++
0	–	+	++	++	++	++
0	–	++	++	++	++	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
++	+	++	++	++	++	++
++	+	++	++	++	++	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
–	– –	–	++	++	++	++
–	– –	–	++	++	++	++
0	–	+	++	++	++	++
0	–	++	++	++	++	++
++	++	++	++	++	++	++

Brewery

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
Seals for butterfly valves	75 EPDM 253356	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	75 HNBR 253436	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	75 FKM 253543	+	+	0	+	–
	76 VMQ 176643	+	++	+	–	– –
Diaphragms	60 EPDM 290	++	++	+	++	++
	70 EPDM 291	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –
Clamp seals	70 EPDM 291	++	++	+	++	++
	78 EPDM 37803	++	+	–	+	0
	70 NBR 150	++	0	–	– –	– –
	65 NBR 37786	+	0	–	– –	– –
	70 FKM 37805	+	0	–	0	– –
	70 VMQ 37804	+	+	+	– –	– –
Seals for dairy couplings	80 EPDM 37739	++	+	–	+	0
	80 NBR 37738	+	0	–	– –	– –
	70 FKM 37639	+	0	–	0	– –
	80 VMQ 37740	+	+	+	– –	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products			
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Types of beer	Mixed beer beverages	Near water products	Water (carbonated and non-carbonated)
++	+	++	++	++	++	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
0	–	+	++	++	++	++
0	–	++	++	++	++	++
0	–	++	++	++	++	++
++	++	++	++	++	++	++
++	+	++	++	++	++	++
++	+	++	++	++	++	++
++	++	++	++	++	++	++
++	++	++	++	++	++	++
–	– –	–	++	++	++	++
0	–	++	++	++	++	++
++	++	++	++	++	++	++
++	+	++	++	++	++	++
+	+	+	++	++	++	++
–	– –	–	++	++	++	++
– –	– –	–	++	++	++	++
–	–	++	++	++	++	++
+	+	++	++	++	++	++
+	+	+	++	++	++	++
– –	– –	–	++	++	++	++
–	–	++	++	++	++	++
+	+	++	++	++	++	++

Dairy

Special Characteristics of the Industry

In the dairy industry, influences such as the high fat content of the production media have to be taken into consideration when choosing materials. For example EPDM materials, which are highly resistant to CIP / SIP media, demonstrate only limited resistance to media containing fats. Further, applications involving these media tend to utilize intensive cleaning processes with bases – and as such higher acidic concentrations and higher temperatures – in order to eliminate residual fats and proteins from the pipe system. Lastly, some dairy production facilities use considerably longer steam sterilization processes than do breweries, making seals capable of withstanding these strains necessary.

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
O-rings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	78 VMQ 166898	+	++	+	–	– –
	70 VMQ 117055	+	++	+	–	– –
Customer-specific precision moldings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products				
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Milk 3.5% Fat	Sour cream 24% Fat	Cream 30% Fat	Half-fat butter 39% Fat	Butter 82% Fat
++	+	++	++	++	++	0	– –
++	+	++	++	++	++	0	– –
++	++	++	++	++	++	++	++
++	++	++	++	++	++	++	++
–	– –	–	++	++	++	++	++
–	– –	–	++	++	++	++	++
0	–	+	++	++	++	++	++
0	–	++	++	++	++	++	++
++	++	++	++	++	++	++	++
++	++	++	++	++	++	++	++
++	+	++	++	++	++	0	– –
++	+	++	++	++	++	0	– –
++	++	++	++	++	++	++	++
++	++	++	++	++	++	++	++
–	– –	–	++	++	++	++	++
–	– –	–	++	++	++	++	++
0	–	+	++	++	++	++	++
0	–	++	++	++	++	++	++
++	++	++	++	++	++	++	++

Dairy

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
Seals for butterfly valves	75 EPDM 253356	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	75 HNBR 253436	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	75 FKM 253543	+	+	0	+	–
	76 VMQ 176643	+	++	+	–	– –
Diaphragms	60 EPDM 290	++	++	+	++	++
	70 EPDM 291	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –
Clamp seals	70 EPDM 291	++	++	+	++	++
	78 EPDM 37803	++	+	–	+	0
	70 NBR 150	++	0	–	– –	– –
	65 NBR 37786	+	0	–	– –	– –
	70 FKM 37805	+	0	–	0	– –
	70 VMQ 37804	+	+	+	– –	– –
Seals for dairy couplings	80 EPDM 37739	++	+	–	+	0
	80 NBR 37738	+	0	–	– –	– –
	70 FKM 37639	+	0	–	0	– –
	80 VMQ 37740	+	+	+	– –	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products				
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Milk 3.5% Fat	Sour cream 24% Fat	Cream 30% Fat	Half-fat butter 39% Fat	Butter 82% Fat
++	+	++	++	++	++	0	– –
++	++	++	++	++	++	++	++
++	++	++	++	++	++	++	++
0	–	+	++	++	++	++	++
0	–	++	++	++	++	++	++
0	–	++	++	++	++	++	++
++	++	++	++	++	++	++	++
++	+	++	++	++	++	0	– –
++	+	++	++	++	++	0	– –
++	++	++	++	++	++	++	++
++	++	++	++	++	++	++	++
–	– –	–	++	++	++	++	++
0	–	++	++	++	++	++	++
++	++	++	++	++	++	++	++
++	+	++	++	++	++	0	– –
+	+	+	++	+	+	–	– –
–	– –	–	++	++	++	++	++
– –	– –	–	++	++	++	++	++
–	–	++	++	++	++	++	++
+	+	++	++	++	++	++	++
+	+	+	+	+	–	– –	– –
– –	– –	–	++	++	++	++	++
–	–	++	++	++	++	++	++
+	+	++	++	++	++	++	++

Chocolate

Special Characteristics of the Industry

Due to its extremely intensive cleaning processes, this industry poses a particular challenge for seals. To produce chocolate, the ingredients containing fat must often be heated to extremely high temperatures. Not all sealing materials can stand up to these temperatures. Further, ingredients such as nuts, raisins or crispy flakes can be extremely detrimental to seal service life. If the production process includes sugar crystallization, the fine, pasty mass of crystals can also damage seals. Lastly, manufacturers often utilize flavoring additives to broaden their variety of flavors, which not all sealing materials are resistant to.

Product	Material	Cocoa butter	Cocoa powder	Sugar mass
O-rings	70 EPDM 291	– –	++	++
	85 EPDM 292	– –	++	++
	75 Fluoroprene® XP 40	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	++	+
	85 NBR 151	++	++	+
	75 HNBR 231142	++	++	+
	70 FKM 37508	++	++	++
	78 VMQ 166898	++	++	++
	70 VMQ 117055	++	++	++
Customer-specific precision moldings	70 EPDM 291	– –	++	++
	85 EPDM 292	– –	++	++
	75 Fluoroprene® XP 41	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	++	+
	85 NBR 151	++	++	+
	75 HNBR 231142	++	++	+
	70 FKM 37508	++	++	++
	70 VMQ 117055	++	++	++

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Chocolate			
Chocolate mass to 90 °C	Milk products max. 30% Fat	Highly concentrated colors and flavoring agents	Soy lecithin
– –	++	– –	0
– –	++	– –	0
++	++	0	++
++	++	+	++
+	++	– –	++
+	++	– –	++
+	++	– –	++
++	++	–	++
++	++	– –	++
++	++	– –	++
– –	++	– –	0
– –	++	– –	0
++	++	0	++
++	++	+	++
+	++	– –	++
+	++	– –	++
+	++	– –	++
++	++	–	++
++	++	– –	++

Chocolate

Product	Material	Cocoa butter	Cocoa powder	Sugar mass
Seals for butterfly valves	75 EPDM 253356	– –	++	++
	75 Fluoroprene® XP 41	++	++	++
	75 Simriz® 484 / 494	++	++	++
	75 HNBR 253436	++	++	+
	70 FKM 37508	++	++	++
	75 FKM 253543	++	++	++
	76 VMQ 176643	++	++	++
Diaphragms	60 EPDM 290	– –	++	++
	70 EPDM 291	– –	++	++
	75 Fluoroprene® XP 40	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	++	+
	70 FKM 37508	++	++	++
	70 VMQ 117055	++	++	++
Clamp seals	70 EPDM 291	– –	++	++
	78 EPDM 37803	– –	++	++
	70 NBR 150	++	++	+
	65 NBR 37786	++	++	+
	70 FKM 37805	++	++	++
	70 VMQ 37804	++	++	++
Seals for dairy couplings	80 EPDM 37739	– –	++	++
	80 NBR 37738	++	++	+
	70 FKM 37639	++	++	++
	80 VMQ 37740	++	++	++

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Chocolate			
Chocolate mass to 90 °C	Milk products max. 30% Fat	Highly concentrated colors and flavoring agents	Soy lecithin
– –	++	– –	0
++	++	0	++
++	++	+	++
+	++	– –	++
++	++	–	++
++	++	–	++
++	++	– –	++
– –	++	– –	0
– –	++	– –	0
++	++	0	++
++	++	+	++
+	++	– –	++
++	++	–	++
++	++	– –	++
– –	++	– –	0
– –	++	– –	0
+	++	– –	++
+	++	– –	++
++	++	–	++
++	++	–	++
– –	++	– –	0
+	++	– –	++
++	++	–	++
++	++	–	++

Fruit Preserves

Special Characteristics of the Industry

While fruit preserves are not as thick as chocolate, the fruit chunks and sugar crystallization present sealing challenges of their own. Fruit particles and seeds can become lodged in the seal, leading to clogging and / or leakage. Sealing materials used in this industry must be resistant to flavoring additives and additives containing fat, as well as to aggressive cleaning media.

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
O-rings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	78 VMQ 166898	+	++	+	–	– –
	70 VMQ 117055	+	++	+	–	– –
Customer-specific precision moldings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Fruit Preserves			
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Fruit mass	Sugar mass	Highly concentrated flavoring agents	Gelling agents
++	+	++	++	++	– –	++
++	+	++	++	++	– –	++
++	++	++	++	++	0	++
++	++	++	++	++	+	++
–	– –	–	0	+	– –	0
–	– –	–	0	+	– –	0
0	–	+	+	+	– –	+
0	–	++	++	++	–	++
++	++	++	++	++	– –	++
++	++	++	++	++	– –	++
++	+	++	++	++	– –	++
++	+	++	++	++	– –	++
++	++	++	++	++	0	++
++	++	++	++	++	+	++
–	– –	–	0	+	– –	0
–	– –	–	0	+	– –	0
0	–	+	+	+	– –	+
0	–	++	++	++	–	++
++	++	++	++	++	– –	++

Fruit Preserves

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
Seals for butterfly valves	75 EPDM 253356	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	75 HNBR 253436	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	75 FKM 253543	+	+	0	+	–
	76 VMQ 176643	+	++	+	–	– –
Diaphragms	60 EPDM 290	++	++	+	++	++
	70 EPDM 291	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –
Clamp seals	70 EPDM 291	++	++	+	++	++
	78 EPDM 37803	++	+	–	+	0
	70 NBR 150	++	0	–	– –	– –
	65 NBR 37786	+	0	–	– –	– –
	70 FKM 37805	+	0	–	0	– –
	70 VMQ 37804	+	+	+	– –	– –
Seals for dairy couplings	80 EPDM 37739	++	+	–	+	0
	80 NBR 37738	+	0	–	– –	– –
	70 FKM 37639	+	0	–	0	– –
	80 VMQ 37740	+	+	+	– –	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Fruit Preserves			
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Fruit mass	Sugar mass	Highly concentrated flavoring agents	Gelling agents
++	+	++	++	++	– –	++
++	++	++	++	++	0	++
++	++	++	++	++	+	++
0	–	+	+	+	– –	+
0	–	++	++	++	–	++
0	–	++	++	++	–	++
++	++	++	++	++	– –	++
++	+	++	++	++	– –	++
++	+	++	++	++	– –	++
++	++	++	++	++	0	++
++	++	++	++	++	+	++
–	– –	–	0	+	– –	0
0	–	++	++	++	–	++
++	++	++	++	++	– –	++
++	+	++	++	++	– –	++
+	+	+	++	++	– –	++
–	– –	–	0	+	– –	0
– –	– –	–	0	+	– –	0
–	–	++	+	++	– –	++
+	+	++	++	++	– –	++
+	+	+	++	++	– –	++
– –	– –	–	0	+	– –	0
–	–	++	+	++	– –	++
+	+	++	++	++	– –	++

Ice Cream

Special Characteristics of the Industry

On the one hand the percentage of fat contained in ice cream mixtures presents a danger for sealing materials used in ice cream manufacturing processes; on the other, ingredients such as fruit chunks, which can become lodged in the sealing and lead to leakage, can also be problematic. The seal also has to dependably withstand sudden changes in temperature, e.g. producing the cold product at 0 °C after steam sterilization at 140 °C. Additionally, CIP / SIP chemical resistance should be ensured.

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
O-rings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	78 VMQ 166898	+	++	+	–	– –
	70 VMQ 117055	+	++	+	–	– –
Customer-specific precision moldings	70 EPDM 291	++	++	+	++	++
	85 EPDM 292	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	85 NBR 151	++	0	–	– –	– –
	75 HNBR 231142	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products				
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Fruit mass	Sugar mass	Cream max. 30% Fat	Highly concentrated coloring and flavoring agents	Lecithin and eggs
++	+	++	++	++	++	– –	0
++	+	++	++	++	++	– –	0
++	++	++	++	++	++	0	++
++	++	++	++	++	++	+	++
–	– –	–	0	+	++	– –	++
–	– –	–	0	+	++	– –	++
0	–	+	+	+	++	– –	++
0	–	++	++	++	++	–	++
++	++	++	++	++	++	– –	++
++	++	++	++	++	++	– –	++
++	+	++	++	++	++	– –	0
++	+	++	++	++	++	– –	0
++	++	++	++	++	++	0	++
++	++	++	++	++	++	+	++
–	– –	–	0	+	++	– –	++
–	– –	–	0	+	++	– –	++
0	–	+	+	+	++	– –	++
0	–	++	++	++	++	–	++
++	++	++	++	++	++	– –	++

Ice Cream

		Cleaning			Sterilization	
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid	Steam (125–140 °C)	Steam (140–160 °C)
Seals for butterfly valves	75 EPDM 253356	++	++	+	++	++
	75 Fluoroprene® XP 41	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	75 HNBR 253436	++	+	0	+	–
	70 FKM 37508	+	+	0	+	–
	75 FKM 253543	+	+	0	+	–
	76 VMQ 176643	+	++	+	–	– –
Diaphragms	60 EPDM 290	++	++	+	++	++
	70 EPDM 291	++	++	+	++	++
	75 Fluoroprene® XP 40	++	++	++	++	++
	75 Simriz® 484 / 494	++	++	++	++	++
	70 NBR 150	++	0	–	– –	– –
	70 FKM 37508	+	+	0	+	–
	70 VMQ 117055	+	++	+	–	– –
Clamp seals	70 EPDM 291	++	++	+	++	++
	78 EPDM 37803	++	+	–	+	0
	70 NBR 150	++	0	–	– –	– –
	65 NBR 37786	+	0	–	– –	– –
	70 FKM 37805	+	0	–	0	– –
	70 VMQ 37804	+	+	+	– –	– –
Seals for dairy couplings	80 EPDM 37739	++	+	–	+	0
	80 NBR 37738	+	0	–	– –	– –
	70 FKM 37639	+	0	–	0	– –
	80 VMQ 37740	+	+	+	– –	– –

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Filling			Products				
Aseptic cold filling – dry (hydrogen peroxide)	Aseptic cold filling – wet (peracetic acid)	Hot filling	Fruit mass	Sugar mass	Cream max. 30% Fat	Highly concentrated coloring and flavoring agents	Lecithin and eggs
++	+	++	++	++	++	– –	0
++	++	++	++	++	++	0	++
++	++	++	++	++	++	+	++
0	–	+	+	+	++	– –	++
0	–	++	++	++	++	–	++
0	–	++	++	++	++	–	++
++	++	++	++	++	++	– –	++
++	+	++	++	++	++	– –	0
++	+	++	++	++	++	– –	0
++	++	++	++	++	++	0	++
++	++	++	++	++	++	+	++
–	– –	–	0	+	++	– –	++
0	–	++	++	++	++	–	++
++	++	++	++	++	++	– –	++
++	+	++	++	++	++	– –	0
+	+	+	++	++	+	– –	–
–	– –	–	0	+	++	– –	++
– –	– –	–	0	+	++	– –	++
–	–	++	+	++	++	– –	++
+	+	++	++	++	++	– –	++
+	+	+	++	++	+	– –	–
– –	– –	–	0	+	++	– –	++
–	–	++	+	++	++	– –	++
+	+	++	++	++	++	– –	++

Convenience Products

Special Characteristics of the Industry

The cleaning media used for open and closed processes in the manufacture of convenience products can pose serious challenges for seals. Here, too, a broad variety of products are involved, from powders to pastes and fluids, each of which places different demands on seals. Further, some convenience products call for a high degree of low-temperature flexibility, which not all sealing materials can offer while still being resistant to the media used.

		Cleaning		
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid
O-rings	70 EPDM 291	++	++	+
	85 EPDM 292	++	++	+
	75 Fluoroprene® XP 40	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	0	–
	85 NBR 151	++	0	–
	75 HNBR 231142	++	+	0
	70 FKM 37508	+	+	0
	78 VMQ 166898	+	++	+
	70 VMQ 117055	+	++	+
Customer-specific precision moldings	70 EPDM 291	++	++	+
	85 EPDM 292	++	++	+
	75 Fluoroprene® XP 41	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	0	–
	85 NBR 151	++	0	–
	75 HNBR 231142	++	+	0
	70 FKM 37508	+	+	0
	70 VMQ 117055	+	++	+

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Sterilization		Products			
Steam (125–140 °C)	Steam (140–160 °C)	Frozen products	Fine foods (soups, sauces, pâtés, etc.)	Fresh meats	Fish & seafood
++	++	++	++	+	+
++	++	++	++	+	+
++	++	+	++	++	++
++	++	++	++	++	++
– –	– –	++	++	++	++
– –	– –	++	++	++	++
+	–	++	++	++	++
+	–	0	++	++	++
–	– –	++	++	++	++
–	– –	++	++	++	++
++	++	++	++	+	+
++	++	++	++	+	+
++	++	+	++	++	++
++	++	++	++	++	++
– –	– –	++	++	++	++
– –	– –	++	++	++	++
+	–	++	++	++	++
+	–	0	++	++	++
–	– –	++	++	++	++

Convenience Products

		Cleaning		
Product	Material	Caustic CIP	Acidic CIP Phosphoric acid	Acidic CIP Nitric acid
Seals for butterfly valves	75 EPDM 253356	++	++	+
	75 Fluoroprene® XP 40	++	++	++
	75 Simriz® 484 / 494	++	++	++
	75 HNBR 253436	++	+	0
	70 FKM 37508	+	+	0
	75 FKM 253543	+	+	0
	76 VMQ 176643	+	++	+
Diaphragms	60 EPDM 290	++	++	+
	70 EPDM 291	++	++	+
	75 Fluoroprene® XP 41	++	++	++
	75 Simriz® 484 / 494	++	++	++
	70 NBR 150	++	0	–
	70 FKM 37508	+	+	0
	70 VMQ 117055	+	++	+
Clamp seals	70 EPDM 291	++	++	+
	78 EPDM 37803	++	+	–
	70 NBR 150	++	0	–
	65 NBR 37786	+	0	–
	70 FKM 37805	+	0	–
	70 VMQ 37804	+	+	+
Seals for dairy couplings	80 EPDM 37739	++	+	–
	80 NBR 37738	+	0	–
	70 FKM 37639	+	0	–
	80 VMQ 37740	+	+	+

++ Very well-suited + Well-suited 0 To some extent well-suited – Only suitable for short-term use – – Definitely not suitable

Sterilization		Products			
Steam (125–140 °C)	Steam (140–160 °C)	Frozen products	Fine foods (soups, sauces, pâtés, etc.)	Fresh meats	Fish & seafood
++	++	++	++	+	+
++	++	+	++	++	++
++	++	++	++	++	++
+	–	++	++	++	++
+	–	0	++	++	++
+	–	0	++	++	++
–	– –	++	++	++	++
++	++	++	++	+	+
++	++	++	++	+	+
++	++	+	++	++	++
++	++	++	++	++	++
– –	– –	++	++	++	++
+	–	0	++	++	++
–	– –	++	++	++	++
++	++	++	++	+	+
+	0	++	++	+	+
– –	– –	++	++	++	++
– –	– –	++	++	++	++
0	– –	0	++	++	++
– –	– –	++	++	++	++
+	0	++	++	+	+
– –	– –	++	++	++	++
0	– –	0	++	++	++
– –	– –	++	++	++	++

Elastomer Materials in the Food and Beverage Industry

Freudenberg Process Seals offers globally recognized materials expertise, especially in the development and manufacture of elastomer materials. The development of the material compounds is consistently carried out in keeping with the highly varied application fields in the food and beverage industry, ensuring that the flexible advantages of the elastomers are optimally matched to the respective requirements profile with regard to media resistance, thermal performance, pressure and other key parameters (please see also the overview of elastomer materials on pp. 112 / 113).

EPDM
Ethylene Propylene Diene Rubber

EPDM is a polymer composed of ethylene, propylene and a small percentage of a diene and is particularly well-suited for applications involving polar media. Its outstanding resistance to water and aqueous systems has helped make EPDM, with ca. 70%, one of the most broadly used materials in food production and processing.

General Characteristics:

- Very good resistance to aging, ozone and light
- Often used for profile strips and sealing strips that will be exposed to weathering
- High degree of cold and heat resistance, ca. –50 °C to +150 °C
- Good mechanical properties
- Very good abrasion resistance
- Very good resistance to water and polar-oxidative media
- Excellent elastic performance

70 EPDM 291

Application Profile Food & Drug:
EPDM seals exhibit good media resistance in hot water, steam, acids and bases. They are highly suited for use in polar media, and accordingly with CIP / SIP media. CIP (Cleaning in Place) involves the use of diluted acids or bases combined with cleaning additives; SIP (Sterilization in Place) utilizes disinfectants, steam, oxidizing media (e.g. peracetic acid) and / or polar organic solvents (e.g. acetic acid).

However, EPDM is not well-suited for products containing high concentrations of fats and oils. Though it performs well with animal fats at low temperatures, it cannot be used with pure fats or oils at higher temperatures.

Suitable applications for 70 EPDM 291:

- In hot water and water steam (constant 180 °C, short-term 210 °C)
- Acids (hydrochloric, nitric and phosphoric acid)
- Bases (sodium hydroxide, potassium hydroxide)
- Ozone (40 °C, 1000 pphm)
- CIP / SIP media for continuous operation facilities in the food and beverage and pharmaceutical industries
- Recommended lubricant for installation: silicone grease (e.g. Paraliq GTE 703 with NSF H1 approval)

Technical Specifications	
Material	EPDM
Color	Black
Cross-linking	Peroxide
Hardness Shore A (DIN 53505)	75 ± 5 (test plate)
Hardness IRHD (DIN ISO 48 M)	70 +5 /–8 (O-ring)
Density (DIN EN ISO 1183)	1.09 g/cm³
Tensile strength (DIN53504)	>12 N/mm²
Elongation at break (DIN 53504)	>140%
Volume resistivity	>10⁹ Ohms
Surface resistivity	>10⁹ Ohms
Compression set (24 h, 150 °C, 25 %) (DIN ISO 815)	<20%
Temperature resistance	–40 °C to +150 °C (+180 °C in water and water steam)

Approvals
FDA conformity (CFR 21 Part 177.2600)
BfR conformity: Recommendation 21
Animal derived ingredient free (ADI Free®)
3-A® Sanitary Class II (Note: Class II due to poor fat resistance, sterilization up to 121 °C and cleaning up to 82 °C possible)
USP Class VI
Drinking water: DVGW (W270 and 534), KTW, WRc-NSF, NSF 61, ÖVGW, ACS, WQC
BAM: Can be used in pure oxygen up to 60 °C, max.15 bar and from 60 to 90 °C, max 10 bar
Ozone: At 40 °C, up to 1000 pphm

EPDM in the Dairy Industry

EPDM cannot be used with all products containing fat, which limits but does not preclude its use in the dairy industry. According to DIN 11483, which applies to dairy production facilities, EPDM is only recommended for use with products containing up to 15% fat. But that is no longer accurate, as can be seen in the fat diagram. Combining the factors of fat content and temperature, the diagram provides general indications for EPDM's application range. If the process parameters are below the curve, EPDM can and should be used; another elastomer should be used only if the parameters are over the curve. EPDM is also only partly suitable in accordance with the 3-A® Sanitary Standards, which rate it as a Class II material. Nevertheless, in low-temperature applications with relatively low-fat media, EPDM remains suitable for contact with perishable foodstuffs. Further, its excellent cleaning and sterilization aspects, unmatched in its price segment, make EPDM an especially attractive choice for such applications.

EPDM in the Beverage Industry

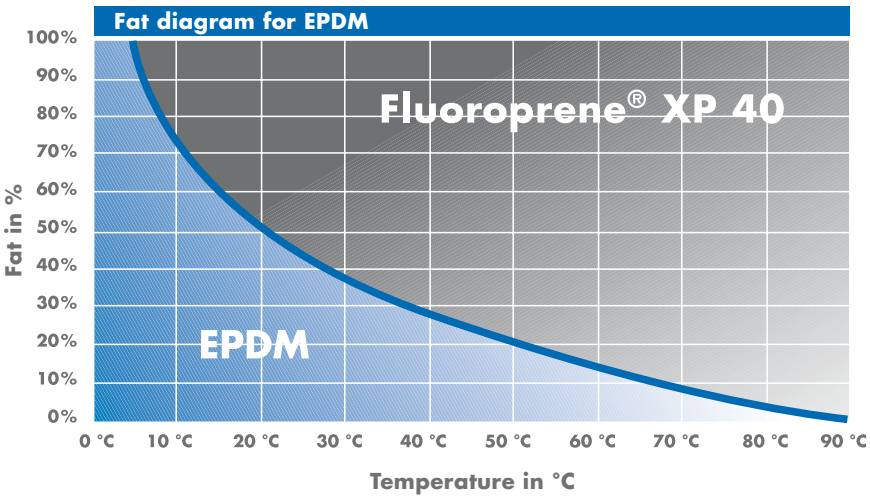
EPDM is very well-suited for use in the beverage industry, given its well-known excellent performance in the aqueous media common in breweries, mineral water and soft drink production. EPDM seals for butterfly valves work just as well in viscous beer wort as in mineral water, and can be more easily cleaned than conventional elastomers. Here the only limitations apply to contact with citrus juices and flavoring agents.

EPDM in Cleaning Processes

In modern manufacturing processes in use in the food and beverage industry, cleaning media have a major influence on the choice of sealing material. DIN Norm 11483, Part 2, an approval framework for the use of cleaning media and materials established in 1984, shows how important the interaction of the two factors is. The rapid advances in cleaning media and sealing materials moved Freudenberg to launch a comprehensive compatibility project in cooperation with leading CIP / SIP media producers, in which elastomers were tested in a variety of modern cleaning agents under the maximum recommended operating temperatures and concentrations. EPDM performed exceptionally well in the test; only media containing formic acid or nitric acid, as well as high temperatures and concentrations, can harm it.

Products / compounds

- O-rings and customer-specific parts made of 70 EPDM 291/85 EPDM 292
- Seals for butterfly valves made of 75 EPDM 253356
- Clamp seals made of 78 EPDM 37803
- Seals for dairy couplings made of 80 EPDM 37739
- Diaphragms made of 70 EPDM 291/60 EPDM 290



Fluoroprene® XP

Fluoroprene® XP 40 is an especially highly fluorinated material with a special monomer composition, allowing its performance to rival that of perfluoroelastomers ***(see p. 64).***

Fluoroprene® XP 40 seals are characterized by their outstanding and multi-faceted resistance. As this blue Fluoroprene material performs extremely well in both fatty media and in cleaning processes, it offers the ideal substitute for HNBR and FKM in food production and pharmaceutical applications. Fluoroprene® XP's broad application range allows manufacturers to significantly reduce the variety of materials they work with, resulting in substantial long-term savings in terms of inventory storage and production facility maintenance.

General Characteristics:

- Outstanding temperature resistance
- Very good resistance to ozone, weathering, aging and oxygen
- Outstanding resistance to mineral oils, fats and greases
- Low gas permeability
- Shows very good resistance in non-polar media
- Shows significant swelling in polar solvents and ketones
- Temperature range from –15 °C to +200 °C

75 Fluoroprene® XP 40

Application Profile Food & Drug:
75 Fluoroprene® XP 40 is the only compound that combines the very good performance of EPDM materials in polar media (water, acids, bases) with FKM fluoroelastomer types' excellent resistance in all non-polar media (fats and greases, oils and hydrocarbons). Its excellent performance in steam, hot water and nearly all bases and acids makes it the first choice for applications involving aggressive CIP / SIP cleaning agents and high fat concentrations.

Suitable applications for Fluoroprene® XP in:

- Animal and vegetable fats, oils and waxes
- Aliphatic and aromatic hydrocarbons
- Essential oils / Flavoring agents
- High temperature ranges
- CIP / SIP media for continuous operation facilities in the food and beverage and pharmaceutical industries
- Oxidizing media (e.g. hypochlorite) and / or polar, organic solvents (e.g. acetic acid)
- Concentrated acids (e.g. nitric acid, formic acid)
- Concentrated oxidizing media (e.g. peracetic acid)

Technical Specifications	
Color	Dark blue
Hardness Shore A (DIN 53505)	75 ± 5 (test plate)
Hardness IRHD (DIN ISO 48 M)	70 +5 /–8 (O-ring)
Density (DIN EN ISO 1183)	1.98 g/cm³
Modulus at 100% elongation (DIN 53504)	4.5 N/mm²
Tensile strength (DIN53504)	>18 N/mm²
Elongation at break (DIN 53504)	>250%
Compression set (24 h, 200 °C, 25%) (DIN ISO 815)	<30%
Temperature resistance	–15 °C to +200 °C

Approvals
FDA-compliant (CFR 21 Part 177.2600)
Animal derived ingredient free (ADI Free®)
3-A® Sanitary Standards Class I (sterilization temperature 121 °C, cleaning temperature 82 °C)
USP Class VI

Fluoroprene® XP in the Dairy Industry

To date, a diverse range of materials have been used in the dairy industry. EPDM, which is very commonly used in the food and beverage industry, has demonstrated the best cleanability; however, it cannot be used in all products containing fat. The disadvantage of FKM fluoroelastomer and HNBR materials is that they cannot be used with all cleaning processes. Fluoroprene® XP 40 has been specifically designed to meet the high requirements of the food and beverage industry and as such also those of the dairy industry. It is rated as a Class I material according to the 3-A® Sanitary Standards and can therefore safely be used in pure olive oil and in butter with 82% fat. Furthermore, it is readily cleanable and is compatible with modern, aggressive CIP / SIP media.

Fluoroprene® XP in the Beverage Industry

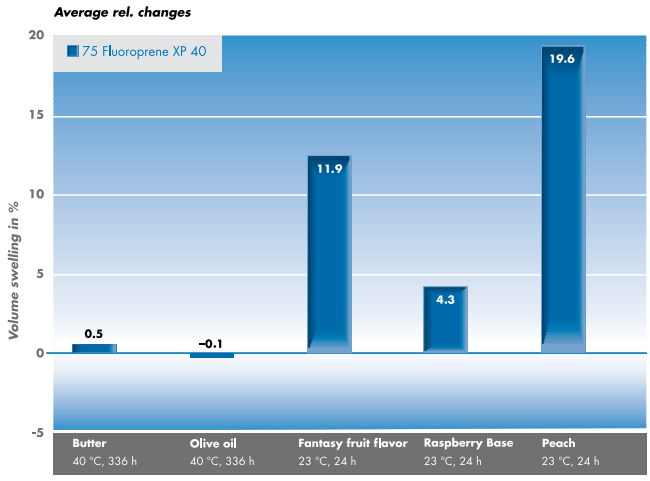
While FKM fluoroelastomer materials swell significantly in flavoring agents like "raspberry" and "fantasy fruit" even at room temperature, Fluoroprene® XP 40 offers good resistance to these substances. There are, however, certain flavoring agents such as "peach" that can pose problems even for XP 40; here the only sustainable solution would be a perfluoroelastomer.

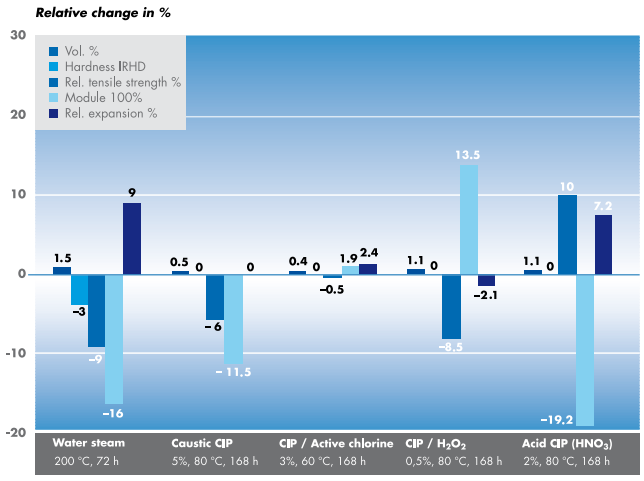
Fluoroprene® XP in Cleaning Processes

Working in cooperation with leading CIP / SIP media producers, Freudenberg launched a comprehensive compatibility project, in which the most aggressive modern cleaning agents were selected and the maximum recommended operating temperatures and concentrations for elastomers were tested. This was done by storing the respective elastomer samples at the highest allowable operating concentrations and temperatures for more than one week. Even at higher temperatures and acidic concentrations (20%) than those common to cleaning processes in the food and beverage industry, the new Fluoroprene® XP 40 demonstrated exemplary resistance, making it suitable for use in nearly all cleaning media and surpassing even the performance of EPDM.

Products / compounds

- O-rings made of 75 Fluoroprene® XP 40 / 85 Fluoroprene® XP 42
- Customer-specific parts made of 75 Fluoroprene® XP 40 / 41
- Diaphragms made of 75 Fluoroprene® XP 40
- Profiles made of 75 Fluoroprene® XP 41





FKM – Fluoroelastomer

FKM is a high-quality material that can be adapted to different application requirements thanks to its modifiable composition.

With the polymerization of vinylidene fluoride (VF) and the selective employment of variable proportions of hexafluoropropylene (HFP), tetrafluoroethylene (TFE), 1-hydropentafluoropropylene (HFPE) and perfluoromethylvinylether (FMVE), co-, ter- and tetrapolymers with different compositions and fluoric concentrations of between 65 and 71% can be produced. In this way, the material can be designed for different requirements regarding media resistance and low-temperature flexibility. The food and beverage industry works with FKM whenever temperatures over 140 °C are used in a process or media are applied that attack other elastomers such as EPDM or HNBR.

General Characteristics:

- Outstanding temperature resistance
- High degree of chemical stability
- Very good resistance to ozone, weathering, aging and oxygen
- Outstanding resistance to mineral oils, fats and greases
- Low gas permeability
- Shows very good resistance in non-polar media
- Shows significant swelling in polar solvents, ketones and amines
- Temperature range from –20 °C to +200 °C, special variants from –35 °C to +200 °C

70 FKM 37508

Application Profile Food & Drug:
Fluoroelastomers with specifically tailored compositions and a peroxide cross-linking system offer excellent resistance to hot water, steam and alcohols.

FKM is very well-suited for use in animal and vegetable fats, oils and waxes, aliphatic and aromatic hydrocarbons, some essential oils, and in high-temperature applications. It also performs well in CIP / SIP media for continuous operation facilities in the food and beverage and pharmaceutical industries. It should be kept in mind, however, that the use of bases, acids and oxidizing media such as peracetic acid in cleaning processes is not always possible.

Technical Specifications	
Material	Fluoro-elastomer
Color	Red (70 FKM 37508) or: black
Cross-linking	Bisphenolic
Hardness Shore A (DIN 53505)	75 ± 5 (measured on a test plate)
Hardness IRHD (DIN ISO 48 M)	70 +5 /–8 (O-ring)
Tensile strength (DIN 53504)	15.7 N/mm²
Elongation at break (DIN 53504	160%
Volume resistivity	>10⁹ Ohms
Surface resistivity	>10⁹ Ohms
Compression set (24 h, 175 °C, 25%) (DIN ISO 815)	15 %
Temperature resistance	–15 °C to +200 °C

Approvals
FDA-compliant (CFR 21 Part 177.2600)
Animal derived ingredient free (ADI free®)
3-A® Sanitary Standards Class I (sterilization temperature 149 °C, cleaning temperature 82 °C)
USP Plastic Class VI at 121 °C

FKM in the Beverage and Dairy Industries

FKM is a good choice for applications involving the processing or production of pure citrus juices, as well as in some concentrated essential oils. It cannot be universally recommended for all flavoring agents and flavoring agent mixtures, however, as they represent an exceptionally disparate and difficult group of media. It is certainly worth discussing your specific application scenario with the Freudenberg Material Center, as in many cases FKM offers a more economical alternative to other sealing materials.

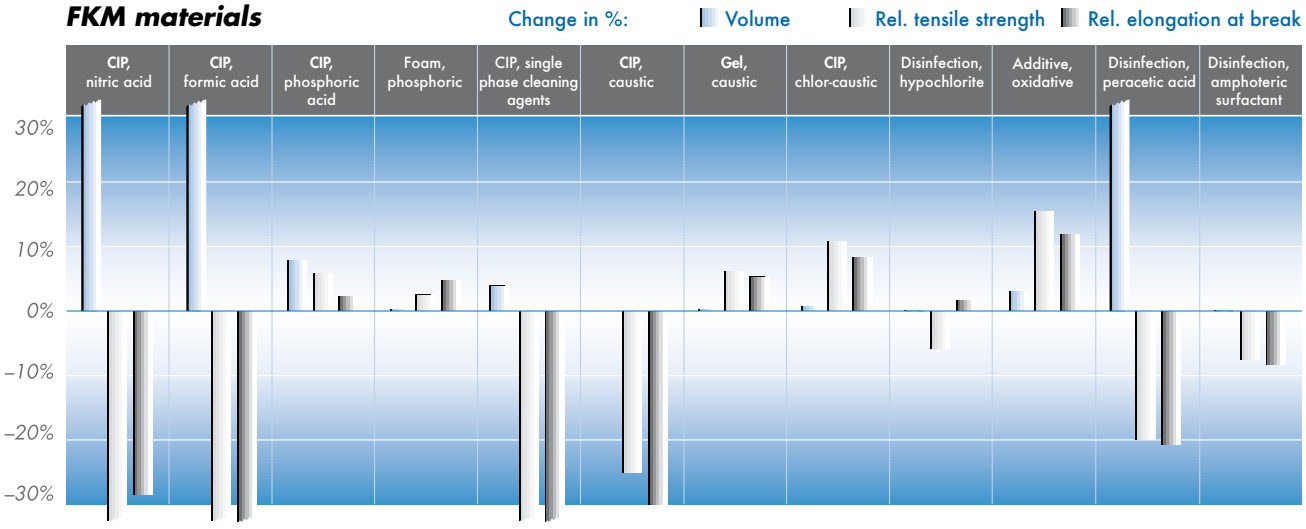
FKM in Cleaning Processes

In modern manufacturing processes in use in the food and beverage industry, cleaning media have a major influence on the choice of sealing material. DIN Norm 11483, Part 2, an approval framework for the use of cleaning media and materials established in 1984, shows how important the interaction of the two factors is. The rapid advances in cleaning media and sealing materials moved Freudenberg to launch a comprehensive compatibility project in cooperation with leading CIP / SIP media producers, in which elastomers were tested in a variety of modern cleaning agents under the maximum recommended operating temperatures and concentrations. FKM is not resistant to cleaners and disinfectants containing nitric, formic or peracetic acid. If you are unsure about which material to use, please contact our materials consulting staff, who will help you to find the optimal materials solution for your specific application.

Products / compounds

- O-rings, customer-specific parts made of 75 FKM 37508
- Diaphragms made of 75 FKM 180497
- Seals for butterfly valves made of 75 FKM 253543
- Clamp seals made of 70 FKM 37805
- Seals for dairy couplings made of 70 FKM 37639

FKM materials



Simriz® – Perfluoroelastomer

Perfluoroelastomers, which are produced using specially perfluorated, i.e., completely hydrogen-free monomers and corresponding compounding and processing techniques, represent the high-end solution in materials technologies.

Simriz® stands out for its broad range of chemical resistance, which is similar to that of PTFE, combined with the elastic qualities of an elastomer. With Simriz®, Freudenberg offers a complete product range in high-quality FFKM materials. In addition to Simriz® compounds for standard and high-temperature applications, there is a variant which conforms to both FDA and USP Class VI standards, making it ideally suited for use with food and pharmaceutical products.

General Characteristics:

Conventionally, the highest temperature and media resistance have been reserved for PTFE materials with a 76% degree of fluorination. However, PTFE's susceptibility to cold flow and its lack of elasticity greatly limit the scope of suitable operating conditions; when high pressures and constant temperature changes are to be expected, pure PTFE seals are not advisable. Simriz® materials in contrast combine resistance performance comparable to that of PTFE with the elastic properties of elastomers, allowing many sealing problems to be better and more simply solved. Simriz® demonstrates extremely consistent and reliable performance in static and dynamic applications, in applications involving constant temperature changes, and in aggressive media. Further, Simriz® as FFKM offers the highest degree of fluorination among elastomers. The high bond energy between carbon and fluorine atoms makes the material extremely resistant to a variety of chemicals from different reactive, functional groups and suitable for use in polar and non-polar media, even in higher concentrations and at higher temperatures. Its temperature resistance range (approx. –10 °C to +325 °C) is also extremely broad for an elastomer.

75 Simriz® 484/494

Application Profile Food & Drug:
At first sight, Simriz® might seem "over-engineered" for the usual demands of the food and beverage and pharmaceutical industries. Yet its advantages become clear when viewed in light of the money it saves in repair and shutdown costs, especially in applications related to safety; Simriz® offers reliability that pays for itself.

Suitable applications for Simriz®:
- Water and water steam
- Concentrated acids (e.g. nitric acid 60%)
- Amines (e.g. ethylenediamine)
- Organic acids (e.g. acetic acid)
- Ketones (e.g. methyl ethyl ketone)
- Bases (e.g. caustic soda, potassium hydroxide)
- Organic solvents (e.g. methanol)

Simriz® replaces elastomers such as EPDM and FKM in applications where they cannot offer sufficient temperature or media resistance, but where elasticity is indispensable. Hygienic Design applications, for example, offer minimal tolerance regarding sealing elements being free of dead spaces and being readily cleanable. Thermal expansion and media swelling also have to be kept to a minimum. In light of these strict demands on purity, maximum resistance to CIP / SIP (Cleaning in Place / Sterilization in Place) processes and temperatures above 150 °C, Simriz® 484 from Freudenberg Process Seals offers recognized high performance.

Technical Specifications	
Material	Perfluoroelastomer, FFKM
Color	Black
Hardness Shore A (DIN 53505)	75 ± 5 (test plate)
Density (DIN EN ISO 1183)	2.02 g/cm³
Modulus at 100% elongation (DIN 53504)	8.6 N/mm²
Tensile strength (DIN 53504)	22.1 N/mm²
Elongation at break (DIN 53504)	165%
Compression set (70 h, 200 °C, 25%) (DIN ISO 815)	33%
Temperature resistance	–10 °C to +230 °C (short-term to 260 °C)

Approvals
FDA-compliant (CFR 21 Part 177.2600)
Animal derived ingredient free (ADI free®)
USP Plastic Class VI at 121 °C

Simriz® in the Beverage Industry

As a high-performance material, Simriz® may seem "over-engineered" for many applications in the beverage industry and therefore an unnecessarily expensive choice. Yet – especially in media containing flavoring agents – Simriz® offers reliable performance that ensures your production processes run smoothly.

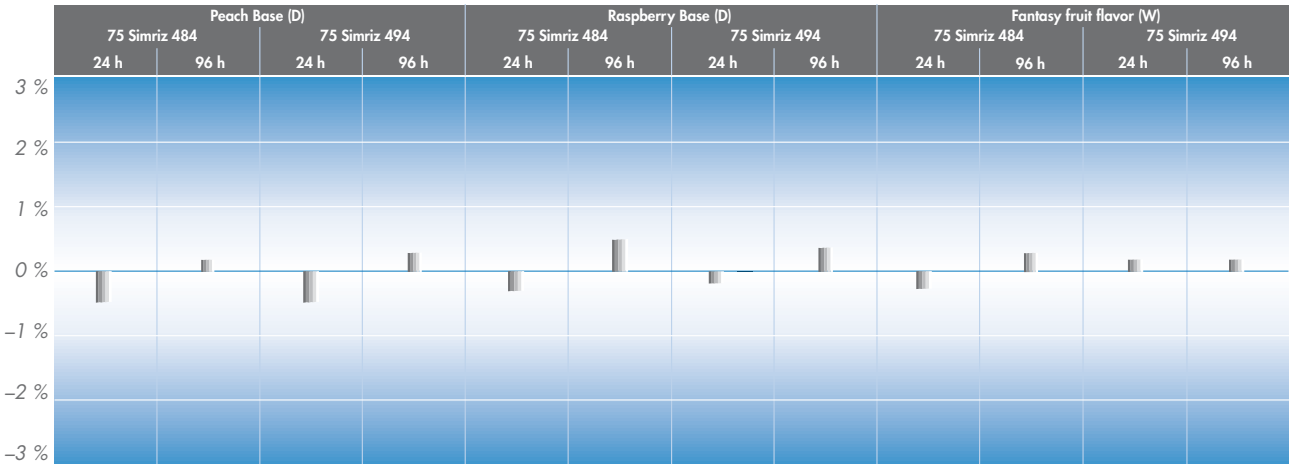
Note:
Simriz®'s coefficient of thermal expansion, just as with all FFKM materials, is higher than those of other elastomers. This higher degree of volumetric expansion should be taken into consideration in the groove design to avoid mechanical overload and gap extrusion.

Our experts will be glad to help you in checking or designing the grooves for your specific needs.

Products / compounds

- O-rings, customer-specific molded parts made of Simriz® 484/494
- Diaphragms made of Simriz® 484/494

Simriz® materials



HNBR
Hydrogenated Nitrile Butadiene Rubber

HNBR is a material produced by the complete or partial hydrogenation of the butadiene components of normal NBR polymerizates. Accordingly HNBR offers media resistance comparable to that of NBR, but is more stable when exposed to heat and oxidation. It also demonstrates a high degree of mechanical durability and improved wear resistance.

HNBR is often used in dairies and other milk-processing facilities where the fat content of the production media is so high as to make using EPDM infeasible.

General Characteristics:

- In some cases better media resistance than NBR
- Better heat and oxidation stability than NBR
- Good mechanical durability
- Improved wear resistance
- Good performance in water and steam
- Temperature resistance from –30 °C to +150 °C

75 HNBR 231142

Application Profile Food & Drug:
HNBR is a very good choice for applications involving mechanical load, as well as in oils and waxes and in animal and vegetable fats. It is also well-suited for use with CIP / SIP media in continuous operation facilities in the food and beverage and pharmaceutical industries. These processes involve the use of diluted acids and bases with cleaning additives (Cleaning in Place), as well as disinfectants, steam, mildly oxidative media and / or polar and organic solvents such as acetic acid (Sterilization in Place). HNBR can however not be used in concentrated acids (e.g. nitric acid, formic acid) or concentrated oxidative media (e.g. peracetic acid).

Technical Specifications	
Material	HNBR
Color	Black
Cross-linking	Peroxide
Hardness Shore A (DIN 53505)	75 ± 5 (test plate)
Density (DIN EN ISO 1183)	1.20 ± 0.02 g/cm³
Modulus at 100% elongation (DIN 53504)	10 N/mm²
Tensile strength (DIN 53504)	26 N/mm²
Elongation at break (DIN 53504)	202%
Compression set (24 h, 150 °C, 25%) (DIN ISO 815)	22%
Temperature resistance	–35 °C bis +140 °C

Approvals
FDA-compliant (CFR 21 Part 177.2600)
Animal derived ingredient free (ADI free®)
3-A® Sanitary Standards Class I (sterilization temperature 121 °C, cleaning temperature 82 °C)
Germany: (DVGW), KTW, W270, GB (WRAS)

HNBR in the Beverage Industry

As HNBR is highly resistant to fats and oils, it certainly represents an interesting alternative material for the beverage industry, where especially the use of essential oils, e.g. those contained in hops, can safely and reliably be sealed using HNBR.

HNBR in Cleaning Processes

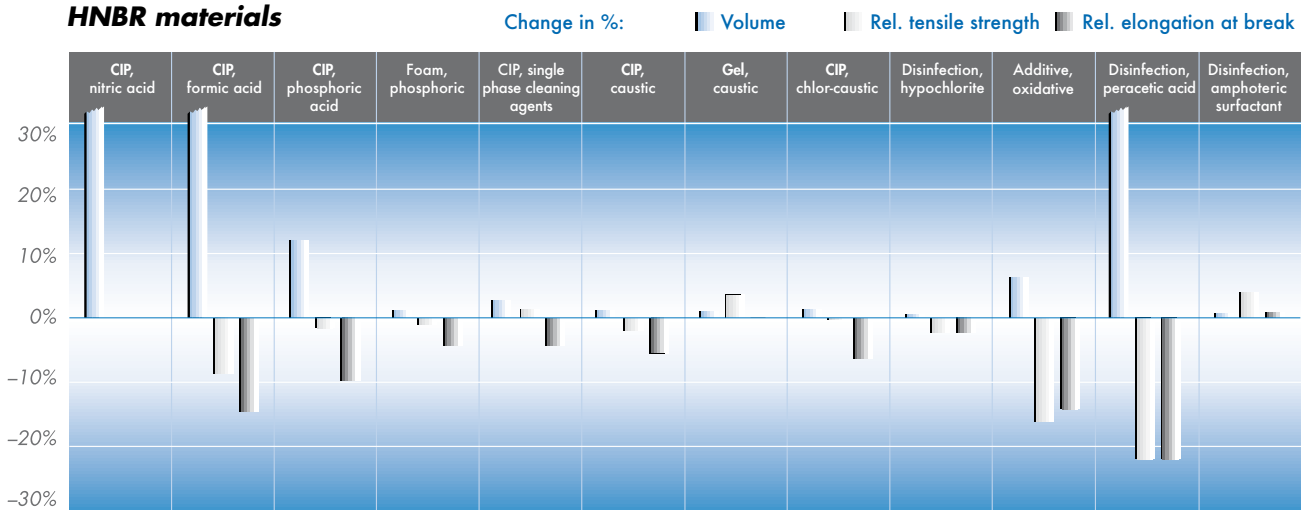
Not every type of material commonly used in the food and beverage industry is automatically well-suited for use in different types of cleaning processes and agents. The enormous advances in the development of CIP / SIP processes over the last several years have made it indispensable to adapt materials development accordingly. In this regard, a DIN norm for the harmonization of cleaning media and sealing materials was established as early as 1984. Furthermore, Freudenberg and leading CIP / SIP media producers launched a comprehensive compatibility project, the results of which allow precise prognoses as to materials performance with regard to temperature and CIP / SIP media concentrations.

HNBR can be harmed by cleaning agents and disinfectants containing nitric, formic or peracetic acid. If you are unsure about materials compatibility please contact our materials consulting staff, who will be pleased to find the optimal solution for your needs.

Products / compounds

- O-rings, customer-specific parts made of 75 HNBR 231142
- Seals for butterfly valves made of 75 HNBR 253436
- Diaphragms made of 75 HNBR 181070/85 HNBR 181071

HNBR materials



NBR – Nitrile Butadiene Rubber

NBR is a polymerizate of butadiene and acrylonitrile. The acrylonitrile (ACN) content can vary from 18% to 50% and has a major influence on the polymerizate's characteristics. An NBR with low ACN content, for example, will have very good low-temperature flexibility and good general elasticity. In contrast the higher the percentage of ACN, the better the material's media resistance.

When the level of ACN is increased, gas permeability and low-temperature flexibility are reduced; as such, NBR is currently only sporadically used in the food and beverage industry, primarily in applications involving considerable mechanical forces and a correspondingly high amount of kinetic energy being transferred to the seal. NBR can easily withstand such stresses provided the temperature range is not too extreme, and also represents an extremely economical sealing solution.

General Characteristics:

- Very good wear resistance
- The level of ACN must be tailored to the specific application, so that the optimal balance of chemical resistance and low-temperature flexibility is achieved
- Good resistance to mineral oil and fuels, outstanding resistance to vegetable and animal oils, silicones, diluted acids and bases at room temperature
- In aromatic and chlorinated hydrocarbons, and in polar solvents, NBR is prone to swelling
- Temperature resistance from –30 °C to +100 °C, special compounds retain their flexibility down to –55 °C

70 NBR 150

Freudenberg Process Seals offers the compound 70 NBR 150, described below, as the standard solution within its NBR family. For other applications, we also offer the harder variant 85 NBR 151.

Application Profile Food & Drug:
NBR demonstrates very good performance in applications involving mechanical loads and in oils, fats and waxes. Its temperature resistance in hot water ranges up to 100 °C. NBR should not be used in concentrated acids (e.g. nitric or formic acid), concentrated oxidizing media (e.g. peracetic acid), or in aromatic or chlorinated hydrocarbons.

Products / compounds

- O-rings, customer-specific parts made of 70 NBR 150 and 85 NBR 151
- Diaphragms made of 62 NBR 152 / 52 NBR 153
- Clamp seals made of 65 NBR 37786
- Seals for dairy couplings made of 80 NBR 37738

Technical Specifications	
Material	Nitrile butadiene rubber
Color	Black
Cross-linking	Peroxide
Shore A (DIN 53505)	70 ± 5 (test plate)
Density (DIN EN ISO 1183)	1.17±0,02 g/cm³
Rebound resilience (DIN 53512)	28%
Modulus at 100% elongation (DIN 53504)	5.5 N/mm²
Tensile strength (DIN 53504)	18.5 N/mm²
Elongation at break (DIN 53504)	240%
Tear resistance (DIN 53515)	10 N/mm
Compression set (DIN ISO 815) (22 h, 100 °C, 25%)	< 20%
Temperature resistance	–20 °C to +100 °C

Approvals
FDA-compliant (CFR 21 Part 177.2600)
BfR conformity: Recommendation 21
Animal derived ingredient free (ADI free®)
3-A® Sanitary Standards Class II (sterilization temperature 121 °C, cleaning temperature 82 °C)
Drinking water: DVGW (W270 and W549) KTW, WRc-NSF

VMQ – Silicone Rubber

VMQ silicone rubbers are high-polymer vinyl methyl polysiloxanes. Silicone is very commonly used in seals for butterfly valves.

Silicone's minimal volume expansion in media and its high elasticity ensure that seals for butterfly valves offer reliable performance throughout their service lives. A further argument for VMQ silicone in contact with foodstuffs and pharmaceuticals is its purity, clearly visible by checking its transparency, though silicone's mechanical durability and chemical resistance, especially to cleansers, are not optimal.

General Characteristics:

- Outstanding resistance to warmth and heat
- The best low-temperature flexibility
- Technical performance largely unaffected by temperature
- Very good resistance to weathering, aging and ozone
- High gas permeability
- Very good physiological characteristics
- Very good dielectric properties
- Good resistance to synthetic, animal and vegetable oils; glycols, non-flammable hydraulic fluids, and various solvents
- Not resistant to low molecular weight esters or ethers, aliphatic or aromatic hydrocarbons
- Temperature resistance from –60 °C to +200 °C

70 VMQ 117055

Application Profile Food & Drug:
As silicone rubber, VMQ is especially well-suited for use in animal and vegetable fats, oils and waxes, and in essential oils; it can also be used in high temperature ranges. VMQ is equally suitable for use in continuous operation facilities with CIP / SIP cleaning media in the food and beverage and pharmaceutical industries, except where steam sterilization is used.

VMQ should not be used in concentrated acids (e.g. nitric or formic acid), concentrated oxidizing media (e.g. peracetic acid), in water or steam over 100 °C, esters or ethers, or aromatic hydrocarbons.

It should also be kept in mind that, though VMQ does not swell, it can lose hardness and tensile strength when exposed to certain media.

Products / compounds

- O-rings, customer-specific molded parts made of 70 VMQ 117055
- Diaphragms made of 60 VMQ 117117/ 75 VMQ 176643
- Seals for butterfly valves made of 75 VMQ 176643
- Clamp seals made of 70 VMQ 37804
- Seals for dairy couplings made of 70 VMQ 37740

Technical Specifications	
Material	Silicone (vinyl methyl silicone rubber)
Color	Transparent
Cross-linking	Peroxide
Hardness Shore A (DIN 53505)	70 ± 5 (test plate)
Density (DIN EN ISO 1183)	1.18±0.02 g/cm³
Rebound resilience (DIN 53512)	32%
Tensile strength (DIN 53504)	9.8 N/mm²
Elongation at break (DIN 53504)	470%
Compression set (DIN ISO 815) (22 h, 175 °C, 25%)	< 30%
Temperature resistance	–50 °C to +200 °C

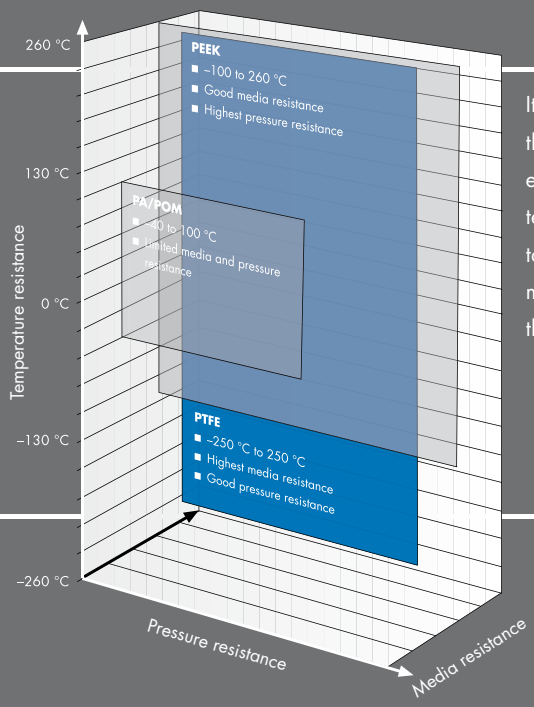
Approvals
FDA-compliant (CFR 21 Part 177.2600)
Animal derived ingredient free (ADI free®)
3-A® Sanitary Standards Class I (sterilization temperature 149 °C, cleaning temperature 82 °C)
USP Plastic Class VI at 121 °C

Engineering Plastics in the Food and Beverage Industry

Engineering plastics have many qualities that make them well-suited to applications in the food and beverage industry. By combining their base polymers with other materials, e.g. reinforcing fibers, lubricants or other polymers, the range of potential applications can be broadened considerably.

Characteristics of Thermoplastics:

- Low density
- Chemical resistance
- High wear resistance
- Outstanding electrical properties
- Good energy absorption
- Very good workability
- High ultimate strength



It should be noted that, depending on their quality, thermoplastics offer markedly different performance as regards temperature, pressure and media resistance; these differences must be kept in mind when selecting the best material for the application at hand.

PTFE – Polytetrafluoroethylene

Thanks to its composition, PTFE possesses a number of properties ideally suited to use in the food and beverage and pharmaceutical industries. Its chemical resistance outstrips that of all elastomer materials and thermoplastics, making its application portfolio in nearly all media an exceptionally broad one.

This material's extremely broad thermal application range allows it to even be used with liquid gases. It should be kept in mind, however, that PTFE is not elastic; as such, it cannot simply be used to replace elastomer materials.

General Characteristics

- PTFE is highly non-reactive. This is due to the extremely strong bonds between its carbon and fluorine atoms, as fluorine is the most electronegative element of all. As a result, most substances are incapable of breaking these bonds and reacting with PTFE chemically.
- Molten or dissolved sodium and potassium represent exceptions to the rule.
- PTFE has a very low coefficient of friction, or in other words: PTFE slides on PTFE with as much friction as wet ice over wet ice. Further, the static friction and dynamic friction are equal, allowing a smooth transition from motionlessness to motion, preventing the so-called "stick-slip effect".
- There are practically no materials that can stick to PTFE. Targeted etching can be used to prepare the surface for bonding.
- Density: 2.10 to 2.30 g/cm³, hardness 55 to 60 Shore D.
- PTFE is extremely resistant to all acids and bases, alcohols, ketones, benzines, oils, etc. The only substances to which PTFE is not resistant are very strong reducing agents such as solutions of alkali metals (e.g. sodium) in liquid ammonia; and powerful oxidizing agents such as elemental fluorine at high temperatures.
- PTFE offers reliable performance in a thermal range from –200 °C to +250 °C. When exposed to extremely high temperatures of over 400 °C, the material releases highly toxic pyrolysis products, e.g. fluorophosgene (COF_2). Though special types of PTFE can be welded, this is not possible with standard PTFE.
- PTFE can be engineered with a certain degree of memory effect. This is due to the extremely long molecules it is composed of. When PTFE is heated, it reverts to its initial form.

Options for Optimizing PTFE

As a base material, unfilled PTFE demonstrates a few undesirable characteristics, such as poor cold flow behavior, relatively low wear resistance, poor resistance to high-energy radiation and poor sticking behavior; these problems can however be eliminated with the appropriate modifications involving the mixture of PTFE with various additives (please see also the table on p. 73).

Typical products:

- RWDR HTS II
- U-packings
- Bellows
- Friction bearings
- V-Seal Set packings
- O-rings

Material			PTFE virgin	PTFE + glass fibers	PTFE + carbon	PTFE + carbon fibers	PTFE + bronze
Characteristics	**Testing norm**	**Unit**					
Additive content		% of weight	–	25	25	10	40
Density	ASTM D792	g/cm²	2.15	2.22	2.10	2.03	3.0
Ball indentation hardness	DIN 2039-1	N/mm²	27	34	37	35	41
Tensile strength*	DIN 12086-2	MPa	PD 29/CD 33	PD 14/CD 17	PD 12/CD 16	PD 18/CD 19	PD 24/CD 25
Elongation at break	DIN 12086-2	%	PD 354/CD 357	PD 353/CD 356	PD 120/CD 170	PD 307/CD 295	PD 343/CD 293
Tensile E-module	In-house standard T=40 °C	MPa	PD 446/ CD 383	PD 674/ CD 752	PD 925/ CD 959	PD 673/ CD 670	PD 760/ CD 771
Deformation under load: 23 °C, 24 h, 15N/mm²	Comp. to ASTM D621	%	PD13.8/ CD 16.4	PD 11.6/ CD 13.9	PD 7.0/CD 6.3	PD 11.9/ CD 13.0	PD 8.4/CD 9.1
Permanent deformation	Comp. to ASTM D621	%	PD 7.0/CD 8.3	PD 6.2/CD 7.8	PD 3.2/CD 2.8	PD 5.9/CD 6.8	PD 4.1/CD 4.8
Yield stress 1%	ASTM D695	MPa	PD 11.0	PD 12.5	PD 13.7	PD 11.9	PD 13.1
Yield stress 5%	ASTM D695	MPa	PD 15.7	PD 16.8	PD 19.6	PD 16.8	PD 19.1
Surface resistance	ASTM D257	Ω	> 10^{17}	> 10^{15}	> 10^{2}	> 10^{10}	> 10^{12}
Thermal conduction	ASTM 1461	W/m·K	0.24	0.30	0.68	0.37	0.47
Coefficient of linear thermal expansion at 50–100 °C	DIN 53752	10^{5}·K⁴	10.6	9.8	8.2	11.7	8.8

PD = Pressing direction, CD = Circumferential direction

NOTE: Carbon, carbon fibers and bronze compounds are not FDA-approved

Additives Are Mixed With PTFE for the Following Reasons:

- The wear resistance is increased several-fold.
- The resistance to creep and to deformation under load are increased several-fold.
- Depending on the additive, the degree of thermal conduction can be significantly increased.
- The degree of thermal expansion is reduced.
- If needed, the proper additives can change PTFE's electrical properties.
- The choice of filler can also influence the wear behavior of the opposing surface.

Processing PTFE:

PTFE cannot be injection-molded. Instead, different compounds can be used to form semi-finished products (pipes, bars and plates), which can then be made into finished products in a subsequent processing step.

PEEK – Polyetheretherketone

PEEK offers comparable chemical resistance and superior mechanical performance. Due to its nearly universal chemical resistance and extremely high temperature resistance (up to a constant temperature of 260 °C), PEEK is becoming increasingly popular.

As PEEK's lack of elasticity makes it less than ideal for gaskets, it is much more often used in backup rings for O-rings under high pressure or in V-Seal Set packings as compression rings. Though PEEK conforms to FDA standards, here, too, its mechanical qualities can be modified using additives such as glass fibers, carbon fibers or PTFE. Unlike PTFE, PEEK can also be injection-molded.

POM, PA, PU

With POM, PA and PU, Freudenberg Process Seals offers three additional high-performance materials for the food and beverage industry.

POM – Polyoxymethylene

Polyoxymethylene (abbreviated POM, also called polyacetal) is a semi-crystalline thermoplastic. POM has been on the market since 1956 and is employed as an engineering plastic due to its high rigidity, low frictional coefficient and excellent dimensional stability, especially for precision parts. POM is distinguished by its high stability, hardness and rigidity in a broad temperature range. It is still highly durable even at such low temperatures as –40 °C, offers a high degree of abrasion resistance and a low frictional coefficient, high dimensional stability under heat, and low water absorption. Its basic color is opaque white due to its high crystallinity, but the material can be dyed in all muted colors. POM has a density of ρ = 1.41 to 1.42 kg/m³. POM only absorbs little water, so little that it is irrelevant in operation: in a normal climate about 0.2 %, under full water saturation at 23 °C only about 0.8%. Consequently, the physical characteristics of molded parts show no significant change. POM's high chemical resistance and low water absorption predestine it for applications in the food and beverage industry. Many types comply with FDA and / or BfR standards. Due to its high crystallinity, POM is more rigid and firmer at a temperature range of 50–120 °C than other thermoplastics. At room temperature, POM has a distinctive elastic limit of approximately 8%. Below this limit it demonstrates good resilience even under repeated stress and therefore is particularly well-suited for elastic elements. High rupture strength and a low tendency to creep round out POM's advantages.

Suitable Applications for POM

POM's mechanical characteristics, combined with its good frictional and wear performance, make it ideal for a broad spectrum of engineering applications.

PA – Polyamide

The majority of commercially interesting polyamides are semi-crystalline thermoplastics and are characterized by their high degrees of strength, stiffness and toughness; they also demonstrate good chemical resistance and workability. Polyamides' characteristics are predominantly determined by the amide groups, which interact with one another through hydrogen bonding. Polyamides are highly wear resistant and possess good frictional properties. Their mechanical characteristics can be enhanced by means of reinforcement with fiberglass or carbon fibers, allowing e.g. their strength and impact toughness to be tailored to specific applications.

Suitable Applications for PA – Polyamides

Due to their high strength, PA materials are especially well-suited to use in mechanical elements such as gears, friction bearings and guides.

As regards sealing solutions, PA rings are often used as thrust rings for various sealing elements.

- Extremely durable
- Good shock-absorbing capacity
- Good dry running characteristics
- Low tendency to creep
- Water absorption PA6 2.5% – 3.5%, PA12 0.2% – 0.5%

Typical PA / POM products:

- Backup rings
- Guide rings

PU – Polyurethane

Polyurethane (PU or PUR) is a plastic that can be processed using nearly all conventional methods. Polyurethanes are linear or cross-linked high polymers formed by reactions between di- or polyisocyanates and hydroxyl carriers such as polyols; chain extenders and cross-linkers; or other components. Regardless of the components, all reactions yield urethane, hence the material's name. Thanks to the highly polar urethane group common to all polyurethanes, these materials are especially characterized by:

- High tensile strength (far in excess of 60 MPa)
- High elongation at break (in some cases over 1,000%)
- Elasticity
- Wear resistance
- Oil resistance
- Ozone resistance

Further, specific raw materials can be added to make polyurethanes resistant to hydrolysis, acids and bases (such as those used in CIP).

Generally speaking, polyurethanes should not be used with amines, glycols or chlorinated solvents.

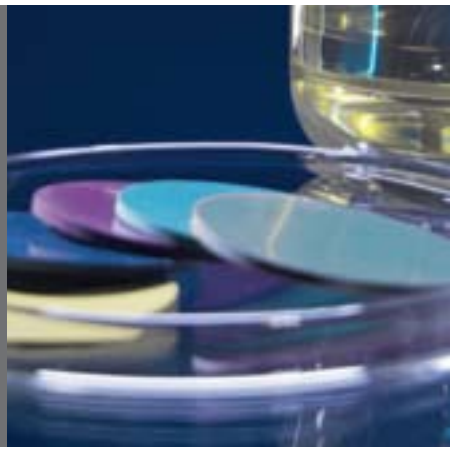
As the urethane group is non-toxic and highly biologically compatible, polyurethanes are especially well-suited for applications involving drinking water and food, in compliance with KTW and FDA standards.

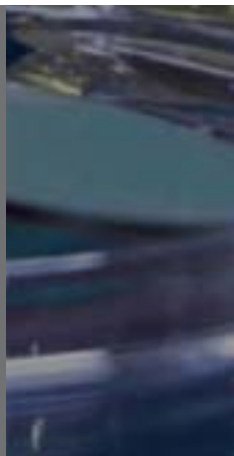
Thermoplastic polyurethanes make up a valuable subgroup. Using e.g. injection molding or extrusion, these often expensive granulates can be formed into extremely high-quality components at a reasonable price.

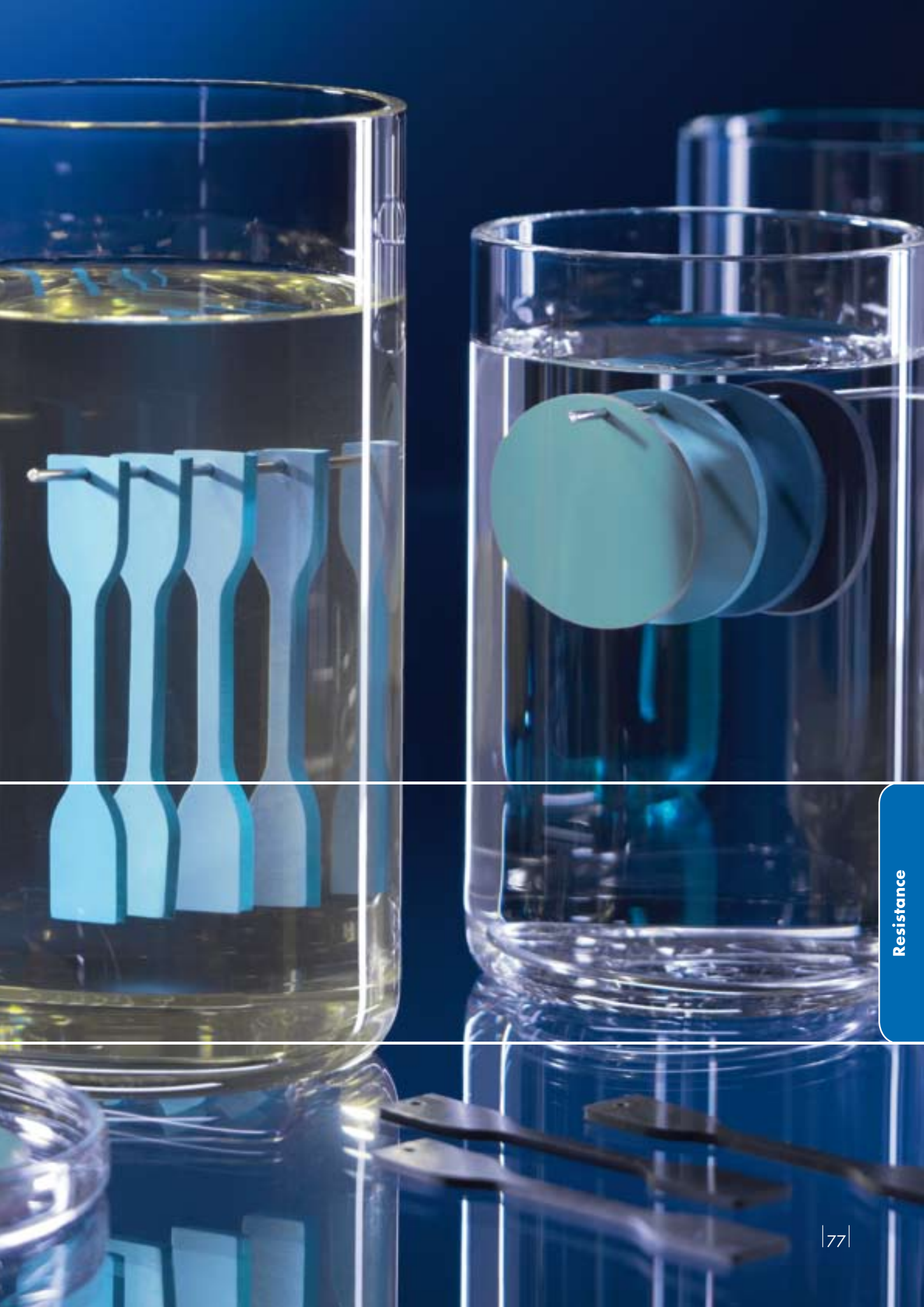
Typical PU products:

- U-Packings
- Wipers

Resistance Properties of Materials



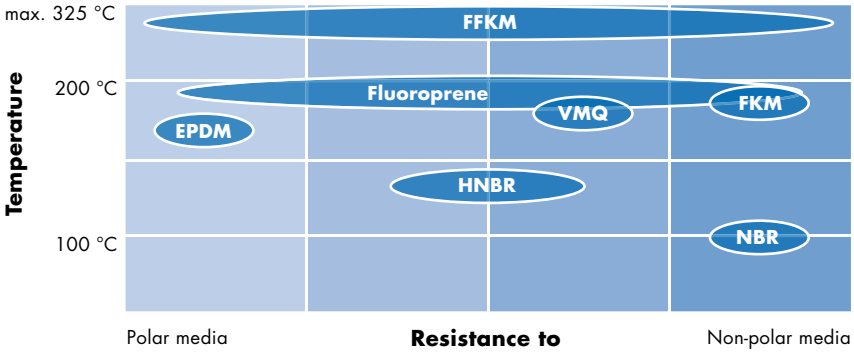




Resistance

Seals are used in a broad variety of media, and are accordingly subjected to very specific operating conditions. Depending on the duration and nature of their exposure to these media, aging processes spark changes in elastomers that can result in stiffening, softening or loss of material strength. This can be seen e.g. in swelling, cracking, brittleness or discoloration. The higher the temperature, the more these aging processes are accelerated.

Elastomer materials



When elastomers come in contact with media, the former are subjected to two different processes that can affect their sealing performance: physical swelling and chemical reactions. In contrast to swelling, the chemical reactions are irreversible. Generally speaking, the basic chemical principle of "like dissolves like" applies; polar elastomers will swell in polar media, while non-polar elastomers are only partially resistant to non-polar media.

No single elastomer can be used universally; the requirements regarding media resistance and upper and lower temperature limits must be taken into consideration and be combined with the intended application in selecting the most suitable material.

Temperature

Temperature can have a major influence on the physical properties of elastic materials. If we consider the E-module (elasticity module) in connection with temperature, we can see that at lower temperatures the E-module remains constant at a high level, which characterizes the glassy state. As the temperature rises, we see the glass transition range, where the E-module drops dramatically before again reaching a constant level. The elastic plateau, where the material demonstrates good elasticity, represents its application range as a sealing material. If the temperature continues to rise, the E-module will fall, as a result of which the material will begin to age or even melt (Graphic 1, p. 79).

The transition from the elastic to the glassy state range is especially important, as in many cases it also represents the lowest possible operating temperature. Depending on the other forces at work in field operation, the actual lower limit will be somewhat higher (i.e., the beginning of the glass transition range) or lower (the beginning of the glassy state). Simply stated, this means that elastomers in static applications can be used at lower temperatures than they can in dynamic applications. Graphic 2 on p. 79 shows an overview of the thermal application ranges of various elastomers. The red areas indicate temperature ranges which standard types can only withstand for short periods of time, or which are covered by special-purpose variants.

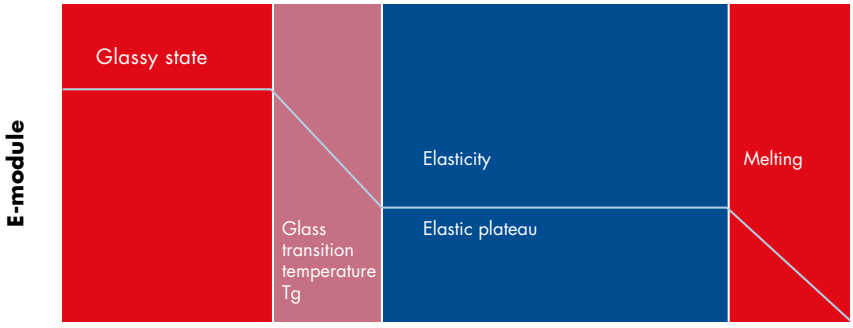
Fat

Though fat is not an aggressive medium in the conventional sense, it nevertheless warrants discussion. Roughly 70% of the seals used in food production facilities are made of EPDM, making it the standard material. It is only when EPDM cannot be used – such as with products with high fat content – that an alternative must be found. Yet the use of other materials can result in various disadvantages, such as changed cleaning cycles, a higher price, or additional storage costs. In the past, EPDM was not used at all in the dairy industry. Today's technologically advanced EPDM materials demonstrate significantly better performance and can certainly be used in many applications – despite the high fat content of the products involved. If EPDM seals are to be used, products with different levels of fat content result in different upper temperature limits of processing:

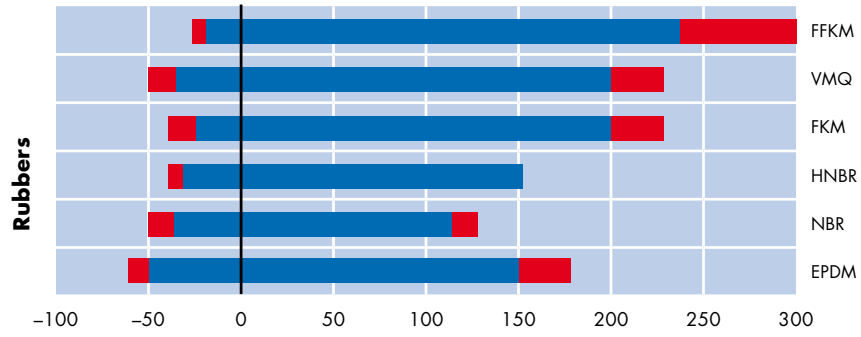
- For 3.5% fat milk, up to a temperature of 80 °C
- For 30% fat cream, up to a maximum of 35 °C
- For 82% fat butter, only up to a maximum of 8 °C

The graphic on page 59 shows the application range of EPDM as a function of fat content and temperature. Below the line, EPDM can be used; above the line, Fluoroprene® XP 40 should be used, provided there are no limitations regarding cleaning.

Aging and viscous flowing



Graphic 1 ■ Application range ■ Threshold range **Temperature**



Graphic 2 ■ Application range ■ Threshold range **Temperature**

Resistance

Cleaning Processes

- CIP "Cleaning In Place" is fully automatic cleaning without disassembling the machine
- COP "Cleaning Out of Place" (or also "Cleaning Open Plant") refers to cleaning after disassembling, opening, etc.
- SIP "Sterilization In Place": sterilization, either using peracetic acid, hydrogen peroxide, etc. ("cold sterilization"); or with steam ("hot")
- WIP "Washing In Place": with partially manual work (scrubbing, brushing, etc.)
- WOP "Washing Out of Place": completely manual dismantling and cleaning

Typical Cleaning Procedure

- Pre-rinsing to roughly remove product residues (water, cold or warm according to product)
- Cleaning with a caustic cleaner (caustic soda or potash solution) and different additives (surfactants, complexing agents, anti-foaming agents, etc.)
- Rinsing off the caustic cleaning agent with water
- Acid cleaning to remove e.g. calcification (phosphoric or nitric acid as well as additives)
- Flushing out the acid with water
- Disinfection to kill microorganisms (peracetic acid and / or hydrogen peroxide mixtures, alternatively using steam)
- Final rinsing with water of drinking water quality or higher, according to use.

When selecting and designing seals, not only the sealing material's resistance to the actual product, but also to various cleaning agents and steam temperatures of up to 140 °C are among the most important considerations. Aggressive acid-, alkali- and peroxide-based cleaning media often pose greater challenges than does the production medium itself. Further, the high temperatures involved in the cleaning processes exacerbate the effects of the media on the material.

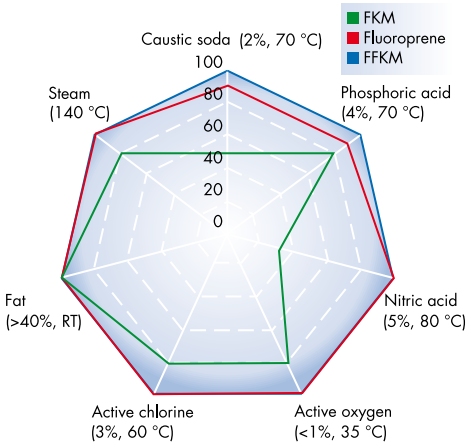
Hygienic Design:

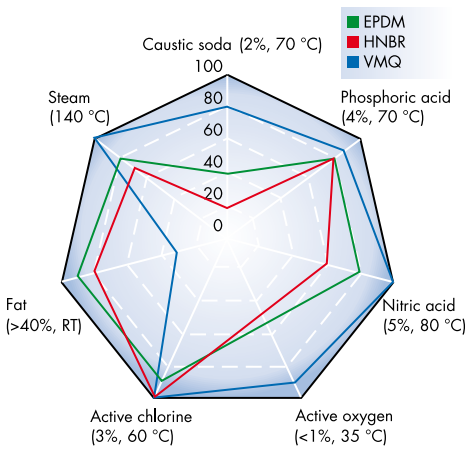
The goal of aseptic process engineering is to produce seals free of dead space and installed leak-free. The groove must be up to 90% filled and the material cannot be prone to swelling of over 5%; otherwise gap extrusion will allow sealing material particles to contaminate the production medium.

The sealing material's durability and resistance with regard to the production, CIP and SIP parameters, and Hygienic Design requirements must be ensured. Elastomer materials that come into contact with the actual product must be sufficiently resistant to preclude their breakdown – in production or in CIP cleaning cycles – and the subsequent possibility of foreign matter jeopardizing product quality.

Class Details	Product	Operating conc. (%)	Temperature (°C)	Exposure Time (min)
CIP or circulation cleaners containing nitric acid or surfactants	Acidplus VA 35	0.5–2%	20–80 °C	Not specified
CIP or circulation cleaners containing formic acid and surfactants	Beta VA 11	0.5–3%	10–70 °C	30–60
CIP or circulation cleaners containing phosphoric acid and surfactants	DIVbrau VA 10	1–4%	10–70 °C	20–60
Phosphoric acid-based foam cleaners	Acifoam VF 10	3–10%	20–40 °C	Not specified
Caustic, single-phase cleaners containing EDTA for circulation cleaning	Solo VC 27	0.5–5%	40–80 °C	Not specified
CIP or circulation cleaners containing bases and surfactants	Highstar VC 77	0.5–5%	40–80 °C	Not specified
Caustic gel cleaners	Powergel VG 1	2–10%	20–40 °C	Not specified
Chlorinated alkali CIP or circulation cleaners	DivoCIP VC 94	0.3–3%	20–60 °C	Not specified
Hypochlorite-based disinfectants	Divosan Hypochlorite VT 3	0.25–1%	Room temp.	Not specified
Cleaning boosters containing surfactants, oxidants	Divo Peroxy	0.2–0.5%	20–80 °C	Not specified
Disinfectants containing peracetic acid	Divosan forte VT 6	0.04–2%	20–60 °C	Not specified
Amphoteric surfactant-based disinfectants	TEGO 2000 VT 25	0.25–1%	Room temp.	> 20

Freudenberg Process Seals carries out extensive exposure testing. The database for the CIP / SIP cleaning agents alone consists of over 200 analyzed compositions and more than 3,500 individual measurements. The standard testing conditions focus on commonly used CIP / SIP media and tests were carried out using the highest recommended operational concentrations and temperatures. The exposure time was a minimum of 1 week, in some cases up to 4 weeks.





Test Results

EPDM

EPDM is highly resistant to acids, bases and oxidizing media, as well as cleaning agents and sterilization (including steam). But at higher temperatures and concentrations EPDM swells in media containing fat and can therefore not be used as a universal sealing material. The operational temperatures range between –40 °C to +150 °C in air and up to 180 °C in steam (briefly even up to 210 °C).

HNBR

If a seal is mainly to be resistant to non-polar media, the use of HNBR can be taken into consideration. Seals made of this material cover a broader range of applications; however, their durability in aggressive CIP / SIP cleaning agents is lower. HNBR should not be used in concentrated acids. Operational temperatures in air and in water reach up to +150 °C.

VMQ

If the seal does not necessarily have to be sterilized with hot steam, apart from HNBR, silicone (VMQ) can be used. This material is resistant to a broad range of non-polar and polar media, but in steam it can only be used in temperatures up to +120 °C. Its temperature range in air is from –50 °C to +200 °C.

FKM

If a seal is required that can be used in non-polar media such as fat and oil up to +180 °C and that is also resistant to CIP / SIP media and steam, fluororubber (FKM) should be used. This elastomer compound is also well-suited for the sealing of citrus juices and aromatic oils. Its temperature range in air is from –15 °C to +200 °C.

Fluoroprene® XP

Seals made of Fluoroprene® XP 40 can also be used if EPDM is infeasible because the fat concentration of the media which is to be sealed is too high. This sealing material not only shows an excellent resistance to acid, bases and steam but also to fats and most flavoring agents. It can be used at temperatures of –10 °C to +200 °C.

Simriz®

If the requirements are so high that none of the previously mentioned sealing materials is suitable, seals made of perfluoroelastomers (FFKM) are used. Simriz® offers comprehensive media resistance up to +260 °C.

Resistance

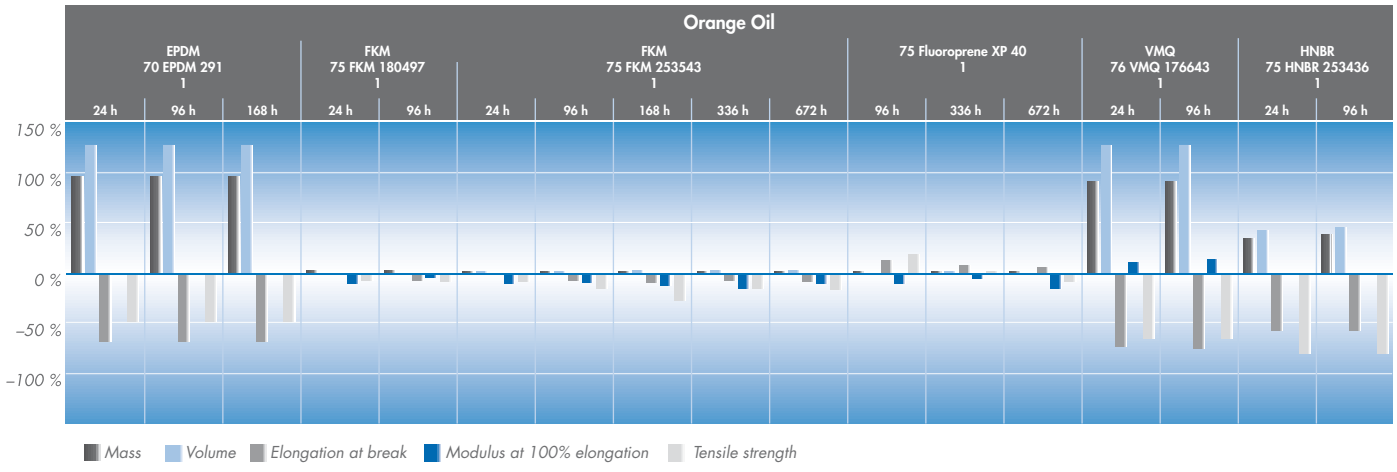
Apart from the challenging cleaning processes, flavoring agents used in the food and beverage industry also make choosing the right material essential. Consequently, various flavors such as peach, fantasy fruit and orange oil can have quite different effects on materials' resistance.

Flavoring Agents

Flavoring agents consist of various chemical ingredients; therefore a classification based on their elastomer-destroying potential is difficult, even more difficult than for e.g. CIP cleaning agents. Moreover, the ingredients that are dangerous for the elastomers can under certain conditions become even more harmful. Traditionally, FKM is used in these media, since it is highly resistant to aliphatic and aromatic hydrocarbons as well as oils and fats. FKM can also be used in media such as essential oils and citrus flavoring agents, while EPDM swells considerably due to its high proportion of non-polar ingredients and is therefore not suitable.

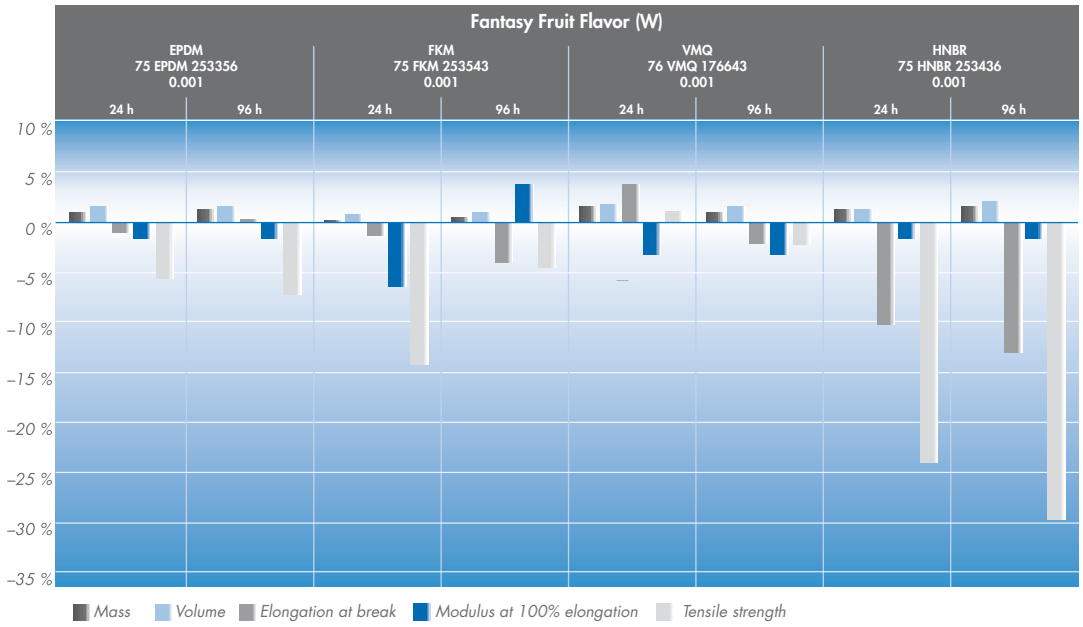
As the majority of flavoring agents also contain substances known to be harmful to elastomers such as aldehydes, ketones and carboxylic acids, at times there is no alternative but to resort to using FDA-approved perfluoroelastomers as universally resistant sealing materials. Yet Fluoroprene® XP 40, which offers significantly better chemical resistance than does FKM, offers a newly developed alternative to this expensive solution. Well-founded durability and resistance testing is essential in making reliable materials recommendations. Here it is not enough to rely on conventional volumetric change testing; it is equally important to gauge the effects of chemicals on the material. These effects can be measured in changes to the material's elongation at break, modulus at 100% elongation, and tensile strength. Even in solutions as weak as 1/10 of a percent, flavoring agents can drastically impact the tensile strength of elastomers.

Elastomers in Orange Oil



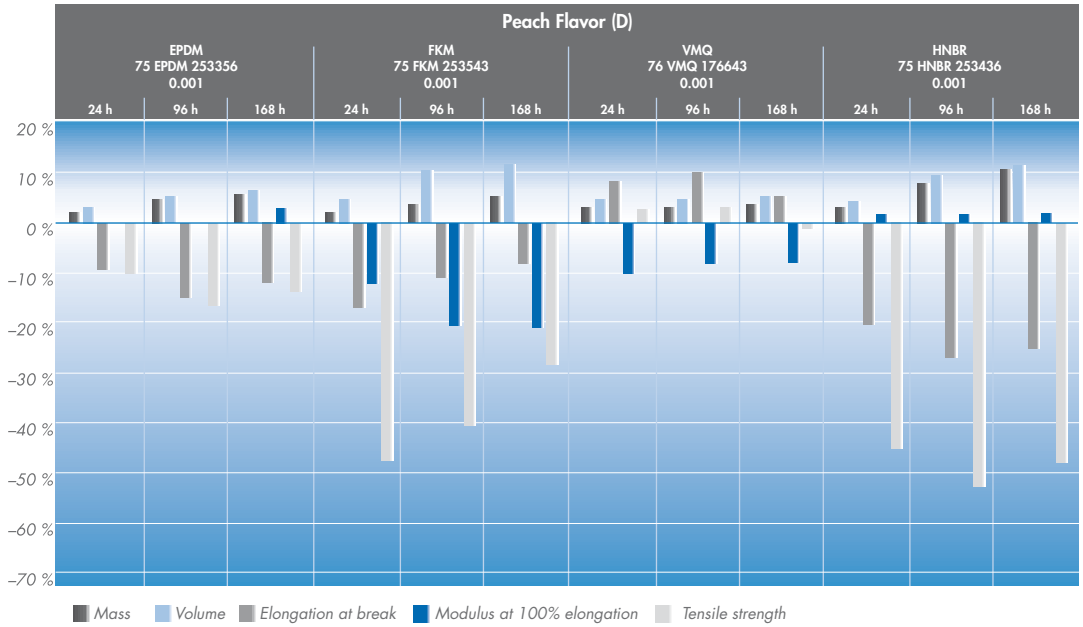
Silicones and EPDM materials clearly swell far too much in orange oil. Even the swelling behavior of HNBR exceeds the tolerable limit. Fluoroelastomers are in contrast highly resistant.

Elastomers in Fantasy Fruit Flavor



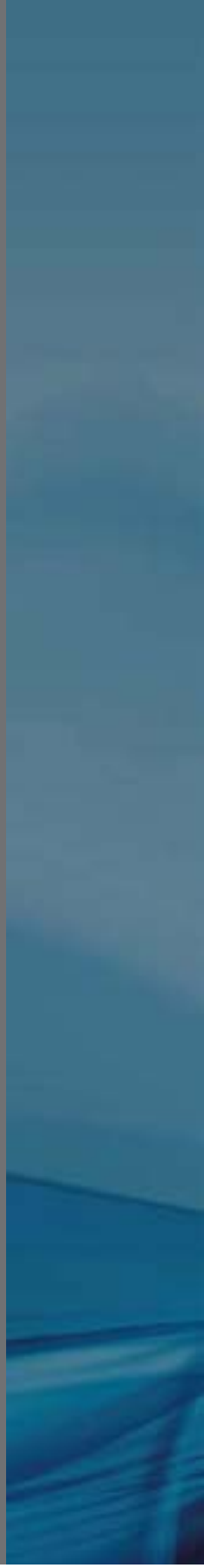
Given its poor tensile properties in Fantasy Fruit, HNBR should not be used with it.

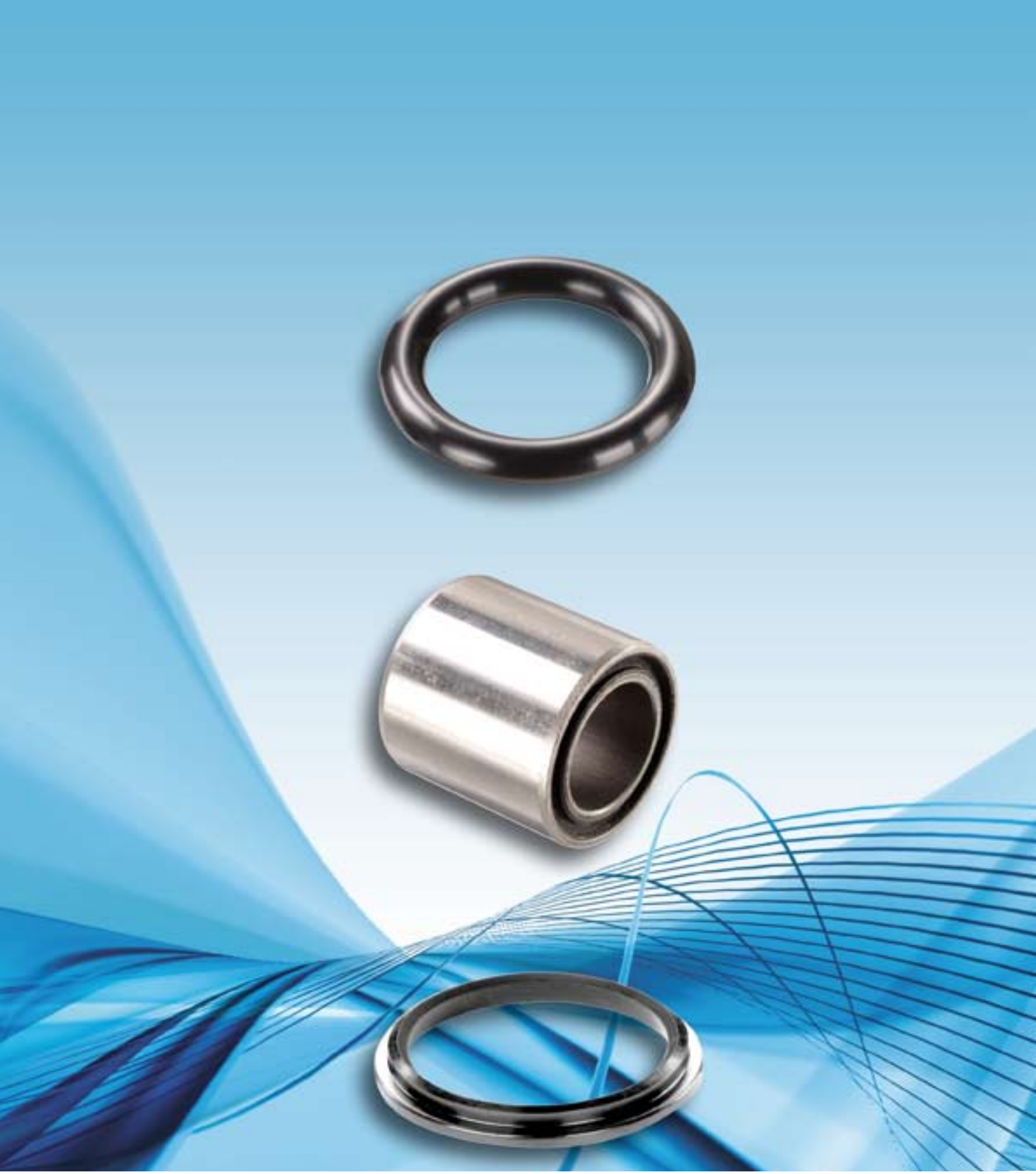
Elastomers in Peach Flavor



EPDM and silicone (VMQ) show the best resistance to the flavor mixture peach base, which contains a heavy concentration of aldehydes; HNBR and FKM are subject to drastic losses in tensile performance.

Sealing and Vibration Technology Products





O-Rings

O-rings are the most commonly used sealing element in all industrial branches, and are characterized by their excellent price / performance ratio and broad range of applications.

O-rings can be manufactured in nearly all conventional elastomers in standard dimensions or in smaller quantities for customer-specific dimensions. The range of available O-rings covers all media resistance requirements. In comparison to other sealing systems, the required installation space is extremely small, allowing material-saving designs. Though simple in form, O-rings can nonetheless be safely used in a variety of installation configurations: as axial or radial static seals, or for dynamic applications involving translatory and / or rotary movement.

Function

- Static sealing for axial and radial applications
- Dynamic sealing for applications with translatory and rotary movement

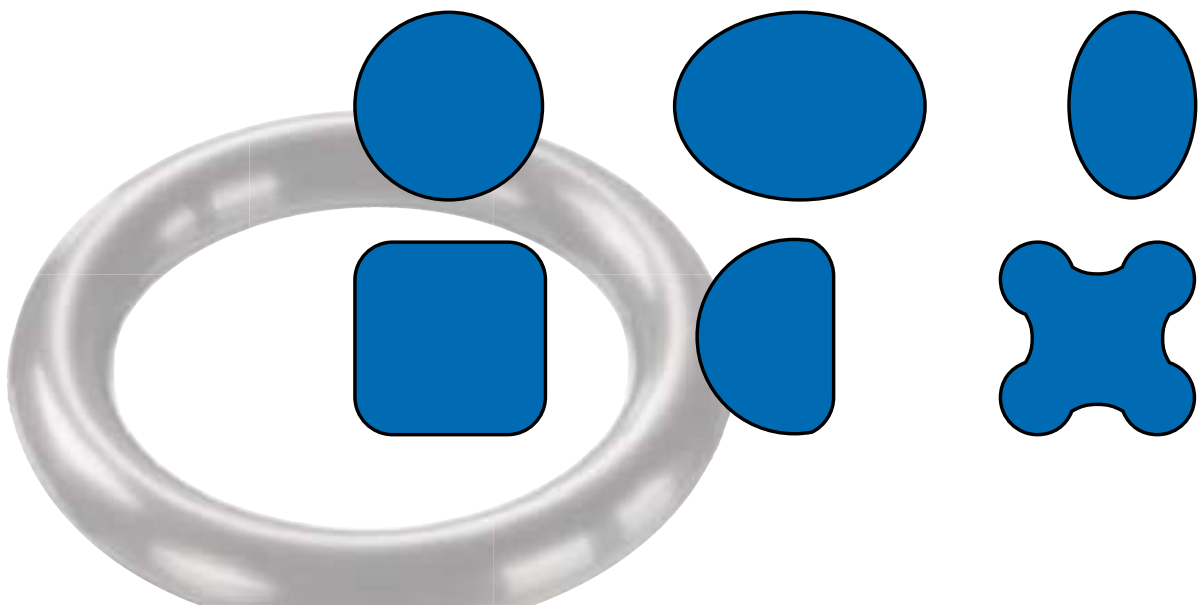
Dimensions

- Available in inch (US standard) and metric dimensions in accordance with DIN 3771
- Numerous intermediate sizes are also available, thanks to our extensive inventory of tools
- Special sizes of over 500 mm mostly require new tools
- Standardized cross-section diameters from 1 mm to 6.99 mm, smaller and larger dimensions available upon request

Types

- Compression and injection molded standard variants
- Special models and larger dimensions: endless extruded cord, spliced or batch vulcanized
- In addition to standard round, we also offer seals with oval, square, semicircular and four-lipped cross-sections
- Customer-specific types can be created with new tools
- Special variants with treated surfaces, e.g. antistick and lubricated coatings, paint, lacquer, or nanotechnological modifications to optimize performance
- PTFE casing (with seam) or complete FEP encapsulation for use in highly aggressive media
  (Please see also the section on FEP O-rings, pp. 88–89)

Available Cross-Sections



Design Notes

General	■ The makeup of O-ring sealing systems (groove, sealing surface) is described in the relevant norms (e.g. DIN 3771 and 3601/1)
Compression	Depending on the application, the following benchmarks apply to standard cases (compression as a % of the cross-section diameter): ■ Static seals: 15–30% ■ Dynamic seals – hydraulic: min. 6% ■ Dynamic seals – pneumatic: 2–6%
Degree of groove fill	■ O-ring volume is as a rule 70 to 90% of the groove volume ■ It should be kept in mind that the elastomer is more susceptible to thermal expansion than its metal housing ■ Applications in the food and beverage industry require seals that prevent leakage into dead spaces, the groove can be filled to over 100%, and specialized types of grooves should be utilized
Stretching	■ Max. 6% in constant use ■ Max. 25% of the elongation at break cited in the information sheet when assembled ■ If stretching is considerable, correspondingly long periods of elastic recovery should be planned
Compression strain	■ Max: 3% after installation, otherwise risk of deformation and shearing
Gap widths and surfaces	■ The acceptable gap widths and surface qualities depend on the material's hardness rating and the operational parameters. Standard values can be found in the relevant standards (e.g. DIN 3771 and ISO 3601/1) and in Freudenberg's product literature ■ Note: In dynamic applications involving plastic housings, it should be kept in mind that such housings poorly dissipate friction heat, which can result in localized overheating ■ Housings made of plastics reinforced with fiberglass should not be used in dynamic applications or those involving pulsating pressures, as the O-rings will rapidly break down under such strains

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Special Installation Notes:

- Edges should be rounded with min. r=0.1mm
- If, due to the design of the application, O-rings must be stretched over sharp corners or threaded parts, these surfaces should be covered with bushings / casings where possible.
- In radial sealing applications, there should be lead-in chamfers on the pistons / rods and / or on the housing. The dimensions for the fibers are listed in the catalogues.
- Be sure to avoid twisting the piston during installation. If necessary, use a compatible assembly grease.
- For applications in the food and beverage industry, coated O-rings are advisable (e.g. PTFE lacquer, RFNTM coating).
- When O-rings are installed in housings, the former are compressed. Here it must be ensured that the O-rings do not deform or shear.

Applications

O-Rings are utilized in countless applications and in nearly all branches. An overview of the primary applications:

- Static cover seals, axial-sealing
- Static piston and rod seals, radial-sealing
- Dynamic seals involving translatory movement (hydraulic or pneumatic)
- Dynamic seals involving rotation
- Valve seals
- Flange seals

Your Advantages at a Glance

- Can be used universally
- Available in all dimensions
- Available in all types of elastomer
- Easy to install
- Good price / performance ratio
- Little installation space required

FEP-Encapsulated O-Rings

FEP-encapsulated O-rings consist of an elastomer O-ring in a casing of modified PTFE (FEP), combining high media resistance and elasticity into outstanding seals.

FEP O-rings comprise an elastomer core providing elastic contact pressure and an encapsulation for reliable sealing in aggressive media. Depending on the desired operational temperature range, FKM or VMQ silicone is used as the core material. The encapsulation is made of FEP (fluorinated ethylene propylene) or PFA (perfluoroalkoxy). FEP O-rings are exclusively used for static sealing applications, as movement and abrasive media would destroy them.

FEP O-rings are principally available in all metric and inch dimensions, inner diameters and thicknesses. Given that FEP O-rings' encapsulation greatly limits their ability to withstand elongation and compression strain, the installation spaces should be designed accordingly, especially for seals with small diameters.

FEP / PFA encapsulations are FDA-approved. Further, upon request the ring core can also be made of an FDA-compliant FKM compound. The different materials combinations influence both the sealing characteristics and the price range: PTFE-encapsulated O-rings are less expensive, but the construction of the application must be so designed as to prevent media penetrating the encapsulation's seam. Solid PTFE O-rings in contrast are extremely resistant to media but lack elasticity.

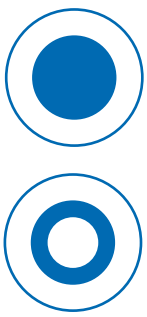
Function

- Elastomer core provides elastic contact pressure
- FEP or PFA encapsulation effectively protects the seal from aggressive media

Dimensions

- Principally all metric and inch cross-sections are available, all standard dimensions are in stock
- FEP / PFA O-rings are available in all inner diameters at no additional tooling cost; however, the smallest possible inner diameter is limited by the O-ring's thickness
- Pure PTFE O-rings are available in all dimensions, as they are machine-manufactured

Types

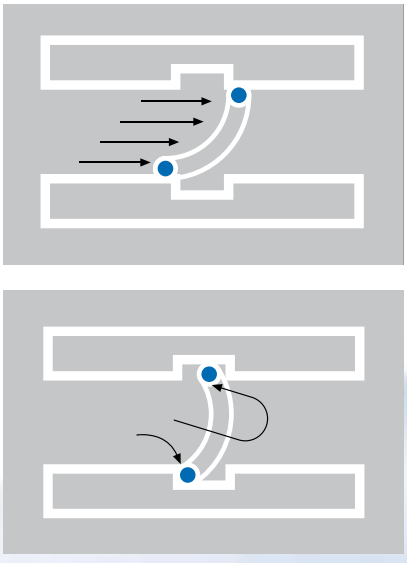


FKM core / FEP encapsulation	Very good compression set and temperature range from –20 °C to +200 °C
VMQ core / FEP encapsulation	For extremely low temperatures down to –60 °C, up to +200 °C
FKM core / PFA encapsulation	For high wear resistance and temperatures from –20 °C to +200 °C
VMQ core / PFA encapsulation	For high wear resistance and extreme temperatures from –60 °C to +260 °C
For applications in delicate devices and requiring little contact pressure, we also offer O-rings with hollow VMQ cores	
For O-rings with oval, square or semicircular cross-sections (all with rounded edges), please contact Freudenberg Process Seals	

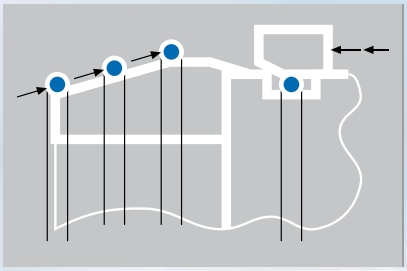
Design Notes

Dimensions	■ Cross-sections from 1.6 to 25.4 mm ■ Inner diameters from 10 to 600 mm ■ Special dimensions available upon request
Coarseness	No more than 50 µm on contact surfaces
Lead-in chamfers	Chamfer angle of 30° to 40°, length must be min. 50% of the thickness
Preparation	■ Any parts that come into contact with the seal during assembly or in operation must be clean and free of burrs ■ All edges must be rounded ■ Given the rings' reduced elasticity and compressibility, the installation space should be axially accessible ■ Otherwise, extra care should be given to using clean, smooth and burr-free pins or mounting sleeves ■ After insertion in the groove, the ring should return to its normal dimensions ■ If you have detailed questions, please contact Freudenberg Process Seals

Installation and Assembly



Inside Sealing – Grooves in Housings



Outside Sealing – Grooves on Shafts

Inside Sealing – Grooves in Housings

- Seal must be deformed to fit in the housing
- To make assembly easier, soak the ring in hot water for 10 minutes and then immediately fit it into the groove
- To do so, push the ring's leading edge past the groove
- Carefully position the ring's trailing edge in the groove and pull back on the leading edge until the ring snaps into the groove (rod should be inserted while the ring is still warm and pliable)
- Use installation aids if necessary

Outside Sealing – Grooves on Shafts

- Use an assembly aid for installation
- Soak the ring in hot water for 10 minutes, then slide over the installation aid quickly and smoothly until the ring snaps into the groove
- If necessary, compress the ring to its original form by means of a second ring (by applying pressure)

Applications

FEP / PFA encapsulated O-rings are primarily used with challenging applications:

- Aggressive media that call for universal chemical resistance
- High thermal demands regarding high and low temperatures
- Can be used in machines in the food and beverage industry with different media and aggressive cleaning agents
- Can be an economic alternative if only a small quantity is needed, since no tools are necessary for manufacture

Your Advantages at a Glance

- Highly resistant to nearly all chemicals
- Can be used universally
- Tool-independent dimensions, multiple standard dimensions available in stock

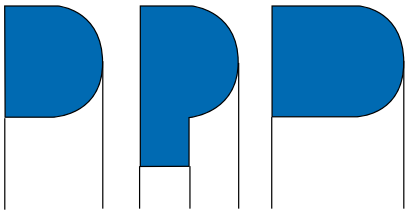
Pipe Connections

Freudenberg Process Seals offers three different models for static seals in standardized pipe connections used in the food and beverage and pharmaceutical industries:

- ***The classic seal for dairy couplings in compliance with DIN 11851***
- ***Clamp seals in compliance with DIN 32676 and ISO 2852***
- ***O-rings for aseptic clamp connections in compliance with DIN 11864***

Seals for Dairy Couplings

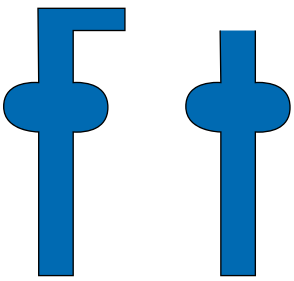
Seals for dairy couplings are standardized seal connections that can be used to easily connect and seal pipe connections for liquid media. Seals for dairy couplings standardized according to DIN 11851 are very common in the food and beverage industry and have been used countless times to connect pipes. Their essential advantage is their extremely quick and uncomplicated installation thanks to their easy separation from the flange, so that they can also be frequently disassembled without difficulty. They are an economical solution and are particularly suitable for smaller systems not operating continuously. However, it should be taken into account that this seal component is best suited for less demanding applications. Consequently, seals for dairy couplings do not meet Hygienic Design requirements, since the compression is problematic due to the lack of metallic stops and gaps could form, extending into the product area. Seals for dairy couplings are available in various materials, from NBR, EPDM and FKM to VMQ and PTFE, for a maximum operating pressure of up to 40 bar.



Standard | With lip | High version

Clamp Seals

Clamp seals were developed to provide fast and reliable pipe connections for production facilities that are in continuous operation but nonetheless need to be easily disassembled. The primary advantage of clamp seals is their ease of installation, as the flange is designed symmetrically, precluding the need for the seal to be installed with a particular orientation. As the seal dimensions have been standardized in compliance with ISO 2852 (inch) and DIN 32676 (metric), they are especially affordable and available in stock. We recommend the compounds 70 EPDM 291 and 70 NBR 150 for clamp seals.



Type A | Type B

As clamp seals do not contain a metallic stop there is the danger that, if they are overly compressed or not seated properly upon installation, leakage can occur.

O-rings for aseptic Clamp Connections

So as to ensure that Hygienic Design requirements are met, we have developed clamp seals with aseptic O-rings compliant with DIN 11864, which optimally combine the advantages of easy installation and a sealing area free of dead space. Aseptic O-rings are available in stock in specialized high-performance materials with diverse approvals.

Function

- Static sealing
- Designed for standardized pipe connections

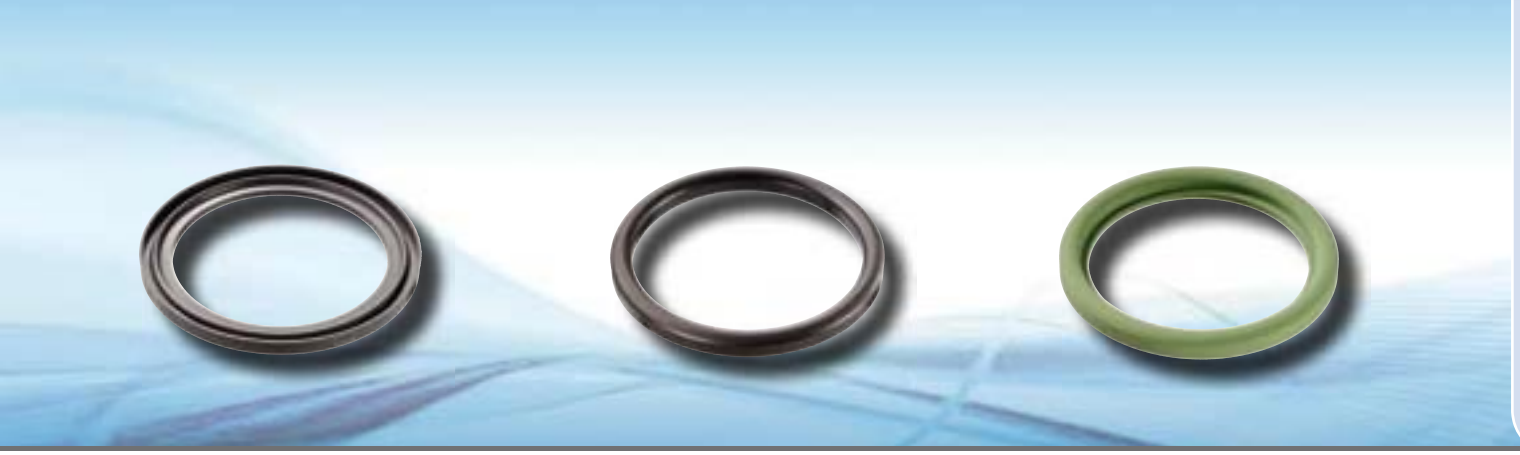
Dimensions

Dimensions for Seals for Dairy Couplings

- Standard form, with lip, and high version
- Standard dimensions from DN15 to DN100

Dimensions for Conventional Clamp Seals

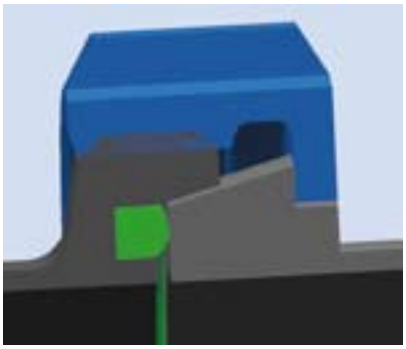
- In compliance with ISO 2852 Standard dimensions from DN12 to DN219
- In compliance with DIN 32676 Standard dimensions from DN10 to DN200



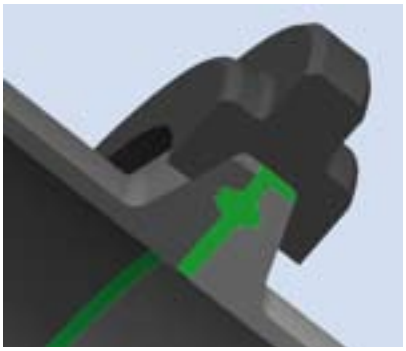
Dimensions for Aseptic Clamp Seals in Compliance with DIN 11864

- Series A: Standard dimensions from DN10 to DN100
- Series B: Standard dimensions from DN13.5 to DN114.3

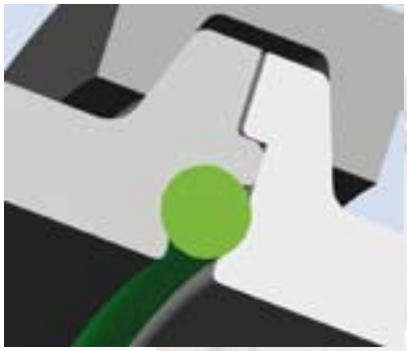
Types



Seals for dairy couplings



Conventional clamp seals



Aseptic clamp seals

Design Notes

General	Adhere to the relevant norms
Surfaces	As laid out in the relevant norms, inner surfaces that come into contact with media R_a<= 0,8 µm
Material	FDA-compliant, hardness between 75 and 85 IRHD, homogeneous material, free of burrs, visible cuts and pores
Design	Preferably clamp seals with aseptic O-rings in compliance with DIN 11864
Preparation	Where applicable, check pipe inclinations for cracking and ensure proper pipe alignment during assembly

Applications

Clamp seals and seals for dairy couplings cover a broad range of applications for sealing pipe connections:

- Suitable for use in a wide variety of pipe connections in the food and beverage and pharmaceutical industries
- Ideal for flange connections that need to be opened on a regular basis
- Used in non-critical media

Your Advantages at a Glance

- Standardized sealing element
- Very commonly used in food, beverage and pharmaceutical production
- Especially fast and easy assembly, regardless of the direction of installation
- Can be removed quickly
- Aseptic O-ring version for compliance with Hygienic Design
- Available in several approved materials variants

Diaphragms

Diaphragms are sealing elements made of elastomer and form a reliable but flexible separating wall between different component spaces, ensuring that different media remain separated while also converting volume changes into force.

Diaphragms are especially interesting sealing components for the food and beverage industry, where they can perform a number of different functions: activating device valves and switches, pumping and compressing liquids and gases, and separating or storing media or pressures. Available in all basic elastomer variants, or with application-specific modifications such as fabric reinforcements, metal inserts or foil layers, diaphragms are extremely dependable and resistant to media. They are also extremely affordable solutions, as the minimal requirements with regard to tolerances and surface qualities of surrounding components make it possible to produce them inexpensively.

Function

- Regulation and switching using pressure that is converted into force
- Separation of media in component spaces with nearly identical pressure levels
- Pumping and compression of liquids and gases
- Measuring volume flows
- Activating valves

Dimensions

- Min. Ø 5 mm to max. Ø 1,000 mm (or larger for individualized applications)

Types

Diaphragm types	■ Flat diaphragms ■ Convoluted diaphragms ■ Plate-shaped diaphragms ■ Rolling diaphragms ■ Individual designs available upon request
Materials	■ MB: as pure rubber diaphragm ■ GMB: with fabric inserts or layers ■ MBM: with metal inserts and / or foil ■ GMBM: with metal inserts and fabric layers or inserts and / or foil ■ Diaphragms with PTFE, modified PTFE, and electrically conductive foils, etc.

Design Notes

General	■ In designing diaphragms, it is advisable to use FEM analysis to reduce development and testing times ■ The diaphragm's construction position (0-position) should be selected such that the diaphragm is not under load when the machinery is not in use ■ The operational forces should not overstretch the diaphragm or produce any extremely high peaks in load ■ The diaphragm's mountings must in some cases be able to withstand considerable forces and should be designed accordingly. Here too it is advisable to utilize FEM analysis
Choice of materials	■ The elastomer base material, as well as any applicable fabric, metal or plastic materials, must be resistant to all media involved in operation. Freudenberg Process Seals' materials experts will be glad to advise you ■ For applications involving highly aggressive media, it is advisable to use a layer of PTFE for protection

Your Advantages at a Glance

- Good media resistance
- Broad range of possible functions and applications
- Economical and maintenance-free
- Highly dependable
- Diverse approvals and compliances

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

After individual customer-specific design and testing in cooperation with Freudenberg Process Seals

Applications

Since diaphragms can be very closely tailored to specific applications in terms of their form and design, they can be used in an impressively broad spectrum of functions. In the food and beverage industry, they are most often used in the following areas:

- Actuators
- Valves
- Water reservoirs
- Pumps
- Compressors
- Hygienic valves
- Control valves

Molded Parts

Molded parts are components that cannot be assigned to a standardized group in terms of their geometries and applications; instead, they are designed for specific sealing problems.

In complex applications, it is often difficult if not impossible to use standard components for optimal sealing function. In such cases, molded parts are designed to precisely match the application in question, becoming customer-specific solutions. This can be accomplished by modifying standard seals such as O-rings; or by designing the materials and geometry for a wholly individualized molded seal. Typical molded seals in the food and beverage industry include U-packings and seals for butterfly valves, as well as impellers for pumps.

The use of molded seals entails an extensive development process, in which the customer is intensively involved. Freudenberg Process Seals is often included in the development of machinery and components from the start so as to ensure high system reliability through tailor-made sealing solutions.

Function

Various sealing functions, depending on the application and seal, such as:

- Pressure-free sealing through the use of restoring force
- Self-amplifying sealing function under pressure
- Reduction of incoming pressure
- Sealing against media permeation

Dimensions

- Vary widely depending on the design and application, from only a few millimeters up to a meter

Types

- Elastomer composites in materials combinations with metals, ceramics or plastics
- Precision molded parts
- Elastomer bellows
- Extruded profile sections

Design Notes

When developing molded seals, the customer and seal manufacturer should work together intensively from the outset in order to avoid unnecessary steps and to considerably cut down the development time. The development diagram below shows the ideal process.

So as to preclude the need for constant revisions, new versions and repeated testing in the development process, Freudenberg can use FEM analysis prior to construction of the sample mold in order to determine potential strains on, deformation and swelling of the component under operational conditions.

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

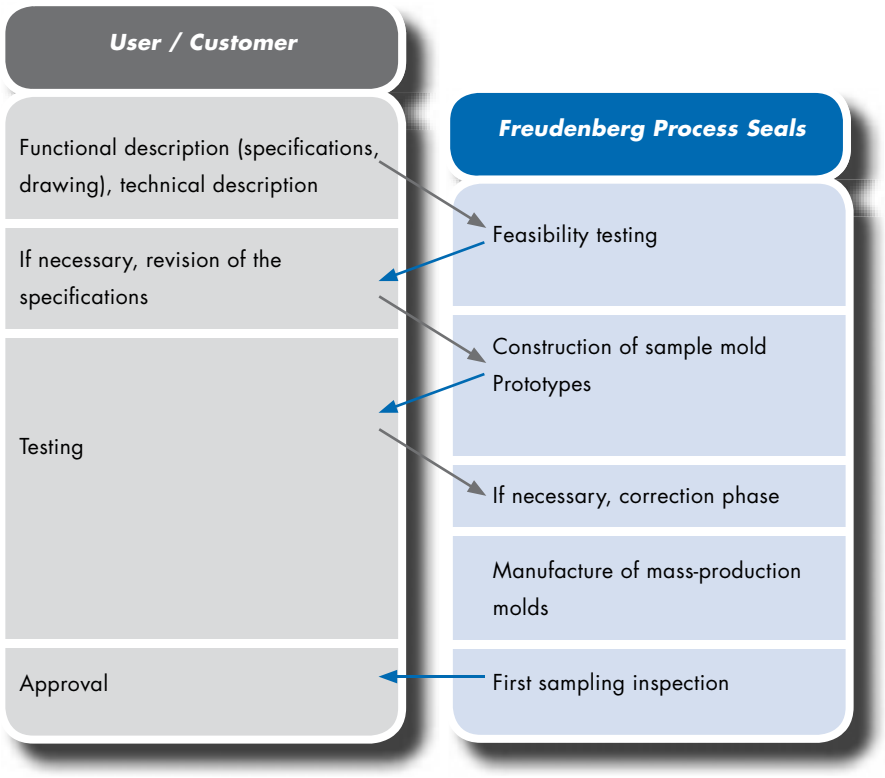
Applications

Generally speaking, molded seals are used when standard seal types cannot suitably meet the needs of a specific application. Typical applications include:

- Bottle head seals and valve seats for fillers
- Molded seals for double seat valves and sterile valves
- Profile gaskets for separators
- Frame gaskets for filters
- Fittings

Your Advantages at a Glance

- Global leader in sealing expertise
- Focused branch-specific and application-specific know-how
- Well-founded materials and manufacturing expertise
- Reliable quality management
- Extensive testing facilities for dependable prognoses
- Innovative simulation and analysis methods



Seals for Butterfly Valves

Seals for butterfly valves ensure the reliable function of butterfly and disc valves. In the food and beverage industry, they are used wherever a shut-off valve is sufficient and a more extensive flow regulation is not necessary.

Shut-off butterflies, butterfly and valve gaskets are normally four-part units composed of a two-part housing with a threaded connector, weld-on end or clamp connector; a valve disc; and a butterfly valve seal. It is only the last component that guarantees the integrity of the entire unit, making it indispensable in preventing all three types of potential leakage – at the pipe seal, the flange and the actuator.

Despite the simplicity of their basic design, seals for butterfly valves are expected to master extremely demanding operating conditions: when the valve is open, the gasket should only minimally reduce the pipe diameter, and should be nearly free of dead space. The valve should be easy to close, but at the same time should close securely enough to seal perfectly. Optimal materials, torque-reducing geometries, and highly realistic testing are needed in order to combine all desired qualities.

When the valve is closing, new strains are placed on it by the high flow speed. This flow creates a major pressure differential and pressure fluctuations, both of which can blow the seal out into the pipe. In order to optimally tailor seal design to prevent this, Freudenberg Process Seals utilizes efficient and highly effective analytic models such as FEM.

Function

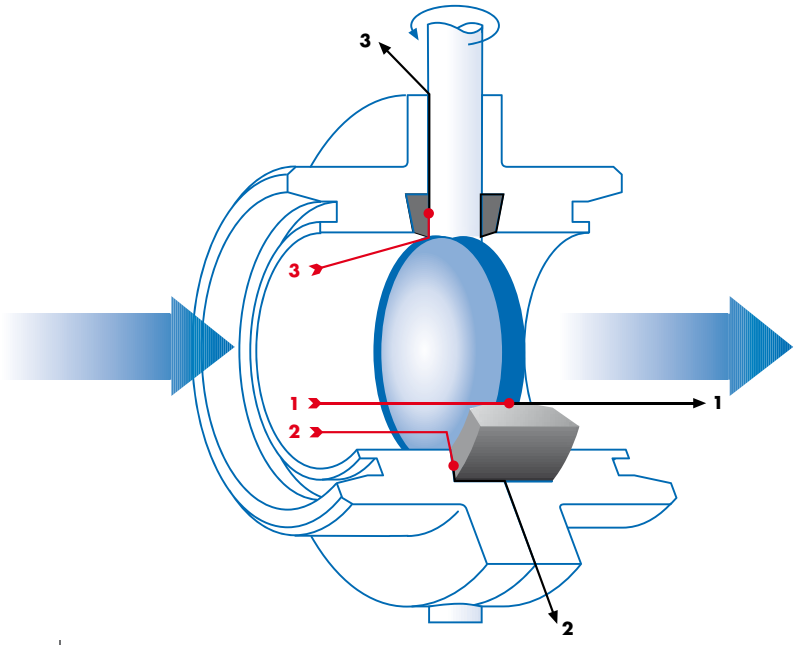
- Opening and closing pipeways

Dimensions

- Fit standard DIN and ISO pipe dimensions
- Standard metric DN 15 to DN 250
- Standard inch 1" to 6"
- Individual dimensions available upon request

Types

- Customer-specific types available upon request thanks to FEM calculations
- Special models with additional coatings (e.g. RFN™)



(1) Optimal compression on the butterfly valve (or "valve disc") ensures that the sealing location is reliably sealed. Here the goal is the ideal compromise between the integrity of the closed valve and the torque involved in actuating it.

(2) The quasi-static sealing location is also worth examining. If the compression is oriented correctly, the leakage of production and cleaning media is reliably prevented.

(3) The axle lead-through represents a particularly difficult sealing location. The optimal design dependably prevents leaks.

Design Notes

Dimensions	■ Information on the min. and max. dimensions for the flanges and valves are necessary for gasket design ■ Minimum necessary and maximum allowable actuating forces should be included in design considerations ■ Use of a patented Freudenberg design to reduce torque
Tolerances	Lowest possible tolerances with regard to the gasket and installation space
Surfaces	■ Perfectly smooth (no gaps or seams) in the dynamic area ■ The sealing butterfly should be polished on its sealing surface (R_{max} 2.5µm R_a 0.05–0.3µm) ■ The shaft should be polished in the sealing area (R_{max} 2.5µm R_a 0.05–0.3µm)

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Assembly

- When stretching the gasket over the valve, be careful to avoid sharp edges and threaded surfaces on the shafts

Applications

Beverage Industry

- EPDM materials are normally used
- Thermal resistance in steam and sterilization to 140 °C constant, short-term to 160 °C
- Suitable for aqueous media and cleaning processes
- For applications involving nitric or formic acid, high temperatures and media concentrations, EPDM represents the more economical solution. In extreme cases, however, EPDM is not optimal either. Alternatives are available; please contact Freudenberg Process Seals for further options

Dairy Industry

- EPDM, VMQ silicone or HNBR is normally used, depending on the fat content and temperature
- In certain cleaning media HNBR, FKM and VMQ silicone cannot match EPDM's service life; however, unlike EPDM they are resistant to fats, making them well-suited for use at high temperatures and concentrations

Pharmaceutical Industry

- FKM is resistant to certain oils and some aromatic oils, but shows limited resistance to cleaning media. It is also more prone to swelling in acids including peracetic acid, making it necessary to select compatible cleaning media when using FKM
- EPDM, FKM, VMQ silicone or HNBR is used, depending on the production media and solvents
- Certain applications in the flavor and extract manufacturing, pharmaceutical and chemical industries exceed the resistance properties of EPDM, VMQ silicone, and HNBR. In such cases, Freudenberg Process Seals recommends the use of Fluoroprene® or Simriz® (FFKM)

Your Advantages at a Glance

- Patented torque-reducing design allows high-frequency operating cycles, low actuating force and minimal abrasion
- Extremely easy to assemble
- Leak-free and dead space-free variants available
- Low-friction coatings available
- A broad range of materials variants for high media and temperature resistance

Rotary Shaft Seals

Only Freudenberg offers the original Simmerring® as a rotary shaft seal used to seal rotary shafts and spindles, and to protect bearings. This sealing system is primarily intended for use with applications involving rotary motion.

Simmerring® Radiamatic® HTS II rotary shaft seals are a custom-developed product made of PTFE and can be used in a broad spectrum of food and beverage industry applications. They stand out because of their low friction, a product of PTFE's own low coefficient of friction in conjunction with the low contact pressure exerted on the rotary shaft by the lip. The primary advantage of HTS II rotary shaft seals is their high media resistance; thanks to their design, the media to be sealed exclusively come into contact with PTFE, a material that performs exceptionally well in nearly all media and cleaning agents, and which makes especially hygienic processes in food and beverage production possible. HTS II rotary shaft seals also offer outstanding sealing performance with minimal contact pressure, which is generated by the geometry of the sealing lip joint and the memory effect of the PTFE. This concept minimizes abrasion while simultaneously ensuring a reliable seal. Special variants are also available for more extreme demands, e.g. higher pressures, dead space-free design, or extremely dusty operating conditions. Lastly, the seal's innovative lip design also makes it possible to affordably reduce the number of components needed for individual applications.

Function

- Dynamic sealing for applications involving rotary motion
- Sealing pressure is generated by the lip design and PTFE's memory effect

Dimensions

- Machine manufactured independent of molds, therefore no limits on any dimension
- Standard dimensions from 10 to 125 mm shaft diameter available in stock
- Smaller or larger dimensions available upon request

Types

HTS II 9535	With standard lip for conventional applications	
HTS II 9536 SL	With additional dust lip for use in extremely dirty environments that pose a risk of foreign objects getting under the sealing lip, and in applications involving high pressures and / or vacuum	
HTS II 9537 DR	With extended metal clamping ring for high pressures and pressure spikes, as well as for better heat transfer	
HTS II 9538 DL	With a double lip for high security standards	
HTS II 9539 VL	Dead space-free version with protruding sealing lip for Hygienic Design applications	
WADB 9461	Extremely compact shaft seal for tight installation spaces, to be used in combination with a secondary seal with FKM or virgin PTFE on the surface that will come into contact with media	

Design Notes

General	■ HTS II rotary shaft seals must be installed as a unit consisting of a PTFE sealing ring and a stainless steel retaining ring ■ The retaining ring is deformed in installation and can therefore not be reused ■ The installation space must be axially accessible ■ Lead-in chamfers on both the shaft and housing should be included to prevent ring damage		
Surfaces	Peak-to-valley heights	R_a	R_t
	Housing	< 1.8 µm	< 10 µm
	Shaft, twist-free	0.1 – 0.2 µm	0.5 – 1.0 µm
	Hardness for running surfaces	45 – 65 HRC	

Your Advantages at a Glance

- Can be variably and highly reliably used in the food and beverage industry
- Highly resistant to media and temperatures
- Dead space-free variants available for hygienic applications
- Minimal abrasion
- Available in all dimensions
- Economical to use, as they make secondary seals unnecessary

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Special installation notes

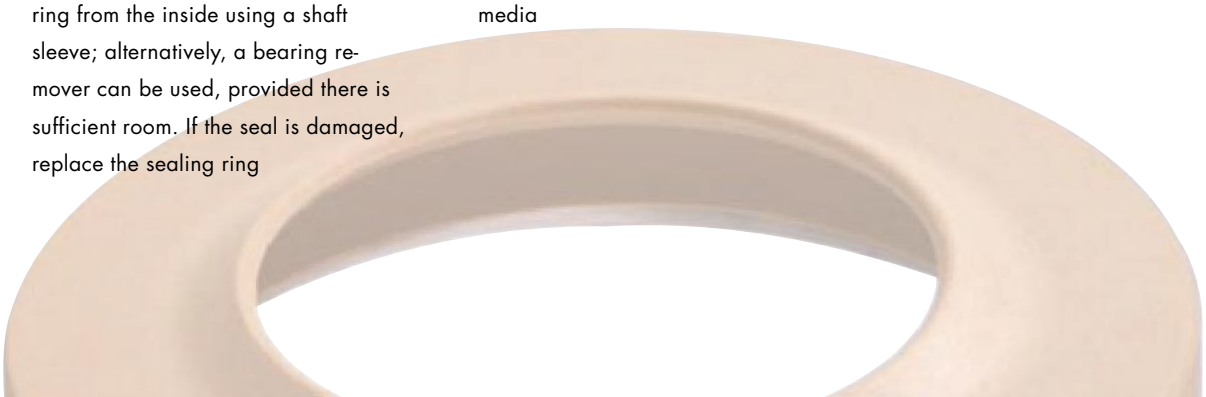
- Must always be assembled as a combination of sealing ring and clamping ring
- If seal is disassembled, the clamping ring must be replaced due to its deformation
- If possible, use pressing tools with built-in stops to avoid excessive axial compression and the risk of damaging the seal
- To aid in assembly, the ring can be lightly oiled if desired
- If possible, disassemble the sealing ring from the inside using a shaft sleeve; alternatively, a bearing remover can be used, provided there is sufficient room. If the seal is damaged, replace the sealing ring

Applications

Thanks to its variable form, the HTS II rotary shaft seal offers an enormous application range for production processes involving the sealing of media, the separation of lubricants and media, and the secure sealing of cleaning processes.

Suitable for use in:

- Beverage filling facilities
- Food and beverage production machinery
- Process equipment used in pharmaceutical and cosmetics manufacturing
- Mixers and separators
- Machines with a high rotational speed
- Cleaning and sterilization processes
- The reliable sealing of dangerous substances and highly valuable production media



PTFE Bellows

Bellows are components made of elastomers or plastics, primarily used to protect moving machine parts from external influences.

Wherever reciprocating mechanical parts need to be protected from environmental influences or aggressive media, bellows serve as reliable sealing components. They can also be used to compensate for movements, expansions, as well as offset motion, misalignments and vibrations. When used in combination with check valves, they can also (provided the installation space allows) be used to circulate or pump gases and liquids utilizing volume change.

Depending on the choice of material, the application range of bellows is extremely broad:

Virgin PTFE:
Very commonly used throughout the chemical industry

Modified PTFE:
Low-porosity variant for the food and beverage and pharmaceutical industries

Conductive PTFE:
Designed to prevent static electrical buildup

Filled PTFE:
Those parts of the bellows under the most stress are reinforced with fiberglass or carbon fibers, e.g. where the bellows are mounted on a pump head

Function

- Protecting piston rods, linkages and other machine parts involving axial and in some cases radial motion
- Compensating for motion and displacements between two connecting components
- Circulating and pumping gases and liquids using volume changes

Dimensions

- Smallest standardized inner diameter: 10 mm (smaller diameters available upon request)
- Largest external diameter: theoretically unlimited. Please consult Freudenberg Process Seals

Types

FBA-9000	Compensators for low pressures
FBC-9002	Compensators for moderate pressures
FV series	Individual solutions for pump and valve bellows
FBAX-9001	Variants of FBA-9000 available upon request, as well as an extensive range of individual, customer-specific variants

Detailed information on specific dimensions and types can be found in our product brochures.

Design Notes

Compensators	Standard models, as well as metal-reinforced special variants
Valve and pump bellows	Design guidelines based on individual experience in development and testing
Special installation notes	■ The flange contact surfaces must be smooth and clean ■ PTFE bellows should not be over-expanded ■ PTFE flanges should be handled carefully due to their ductility ■ It may be advisable to use soft-material seals between the flange and bellows ■ The screw holes and flange thickness listed for types FBA-9000 and FBC-9002 are smaller than those in the DIN norm sheets

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Applications

Applications of bellows as compensators:

- Compensating for expansion and vibration
- Compensating for misalignments and displacements in pipes
- Fluids circulation in the chemical and food and beverage industries
- Rod protection in the chemical and food and beverage industries
- Protecting from dust and contamination, e.g. for weighing equipment in filling plants

Applications of valve and pump bellows:

- In feed pumps and metering pumps
- For control and shut-off valves in the chemical, pharmaceutical and food and beverage industries
- In plant engineering in the food and beverage industry

Your Advantages at a Glance

- Highly resistant to nearly all chemicals
- Dependable sealing to prevent media contamination
- Highly affordable thanks to machine manufacture
- Special variants and small made-to-order batches are possible
- Compensator bellows in DN 10 to DN 500 available in stock
- Innovative materials combinations for dealing with heavier loads and for reliable mounting

PTFE U-Packings

U-packings are unidirectional sealing elements with a U-shaped cross-section and a reinforcing metal spring, which are used for sealing applications involving rotary or translatory motion.

PTFE U-packings are sealing components that enjoy a wide range of uses in the food and beverage industry, from ball valves to piston pumps. They are ideal for the sealing of pressures, as the system pressure amplifies their sealing function; further, thanks to PTFE's excellent media resistance, this is also true in aggressive media.

PTFE U-packings contain metal springs, which compensate for the loss of initial load caused by PTFE's tendency to creep. The contact pressure can be tailored to the parameters of the individual application scenario by means of U, V or O-shaped springs – open or crimped. PTFE U-packings are available as axial or radial sealing models for sealing applications involving translatory or rotary motion. Radial sealing models are available in inside and outside sealing versions.

Function

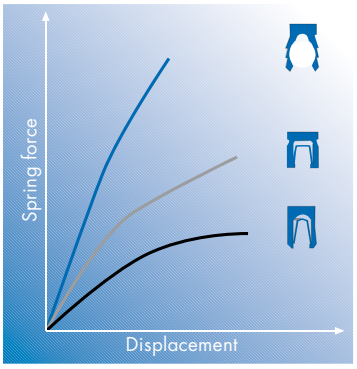
- Sealing rotary and translatory motion
- Sealing aggressive media and pressures

Dimensions

- Machine manufactured, as such available in nearly all dimensions
- Springs to match the dimensions are manufactured from endless material
- Standard dimensions (cf. Types) available in stock

Types

Axial sealing	■ Variant with dynamic internal sealing lip for use as a rod seal Standard rod diameters from 10 to 200 mm ■ Variant with external sealing lip for use as a piston seal Standard piston diameters from 15 to 200 mm
Radial sealing	■ With inward sealing function for use as a pressure seal (dimensions upon request) ■ With outward sealing function for use as a vacuum seal (dimensions upon request)
Spring types	■ V-spring with a great degree of spring displacement and soft spring characteristics for reduced friction, can be used for dynamic and static sealing, and for rotation sealing ■ U-spring with a great degree of spring displacement and higher load, for sealing higher pressures ■ Round spring for high load with a low degree of spring displacement, for sealing extremely high pressures. Its special design distributes the spring load over a number of different sealing lips (see graphic)
Materials variants	■ Pure PTFE ■ PTFE with fiberglass ■ PTFE with carbon ■ PTFE with carbon fibers ■ PTFE with glass and / or molybdenum ■ PTFE with Ekonol ■ PTFE with aramid ■ UHMW PE (polyethylene) ■ PEEK



Spring types and their characteristics (schematic representation)

Design Notes

Pressures	■ Maximum allowable pressures for dynamic applications: 45 MPa ■ Maximum allowable pressures for static applications: 120 MPa ■ For 25 MPa or more, please consult Freudenberg Process Seals' Technical Consulting Department, if necessary use back-up rings
Lead-in chamfers	20° standard
Surface roughness	Sealing surfaces in accordance with the diagram ■ Lead-in chamfers <1.6µm ■ Groove flanks <2.5 µm
Hardness	■ Optimal running surface hardness 20–65 HRC ■ Penetration depth min. 300 µm

Your Advantages at a Glance

- Universal media resistance and broad temperature range
- Highly dependable
- Resistant to aging
- No stick-slip effect
- Special variants for higher pressures
- Special hygienic variants with minimal dead space

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Special Installation Notes

Avoid stretching or compressing the rings during installation. If stretching or compression is unavoidable, please consult Freudenberg Process Seals. Lightly oil the rings prior to installation.

Applications

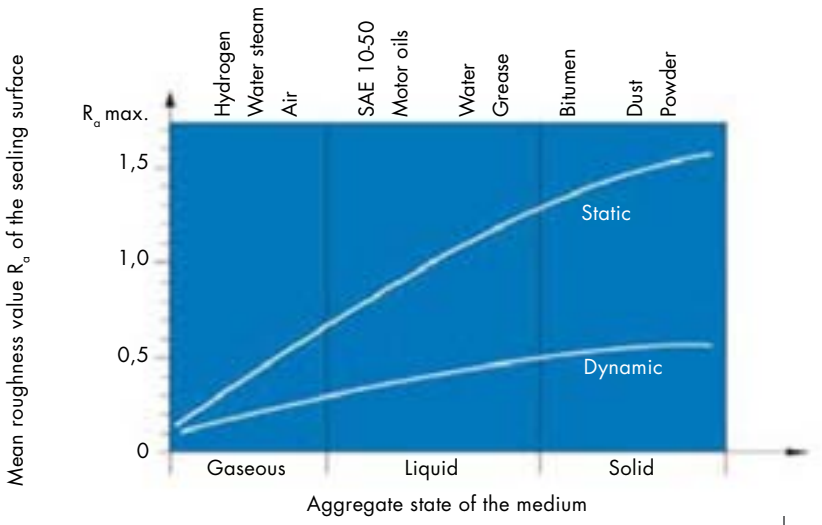
Fields

- Food and beverage industry
- Pharmaceutical industry
- Beverage industry
- Chemical industry

Suitable for Use In

- Ball valves
- Flanges and lids
- Pivot joints
- Distribution manifolds
- Hot water and steam valves
- Piston pumps
- Bearings

Recommendations for Sealing Surfaces



V-Seal Set Packings

V-Seal Set packings are multi-part sealing sets primarily used in applications involving translatory motion. As they offer lower friction and require less initial load, they represent a worthwhile alternative to U-packings.

V-Seal Set packings normally consist of a compression ring, several V-packing rings and a backup ring, providing reliable sealing for spindles on regulating and shut-off valves; rods on plunger pumps and hydraulic cylinders; and pivot joints and agitators. Predominantly used with translatory motion but also with slow rotation, they generate less friction and require considerably less initial axial load than do e.g. stuffing box packings.

As the standard materials for V-Seal Set packings are PTFE and PTFE-carbon compounds, they can be especially affordably machine manufactured from semi-finished products. Special-purpose V-Seal Set packings made of PTFE-impregnated Nomex fabric in contrast require tools, but are also better suited for higher pressures, as they are less susceptible to cold flow. Freudenberg has a broad range of suitable tools in its inventory.

Further materials such as polyethylene, PEEK and Univerdit (a compound of PTFE and graphite) are also available upon request, as are specialized profiles, should none of the three standard options be compatible with your individual application.

Function

- Multi-part sealing set consisting of a compression ring, V-packing rings and a backup ring
- Predominantly used with translatory motion, or occasionally with slower axial motion

Dimensions

PTFE and PTFE compounds

- Available in all inventory-standard dimensions
- Customer-specific dimensions are possible

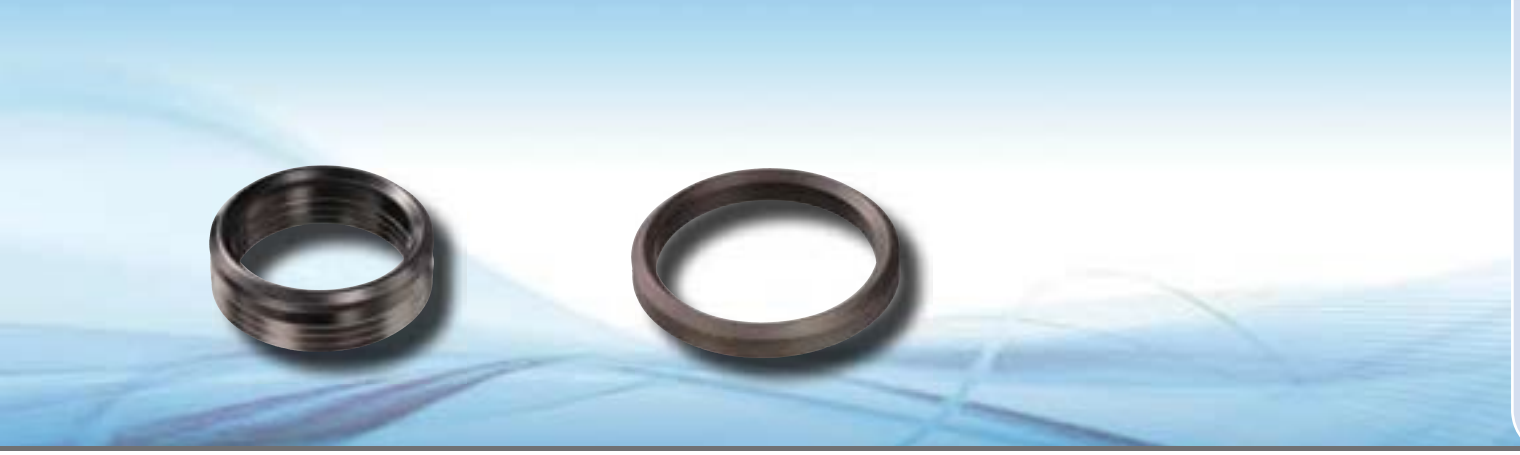
PTFE-fabric

- Extensive inventory of tools available
- Special customer-specific dimensions available upon request

Types

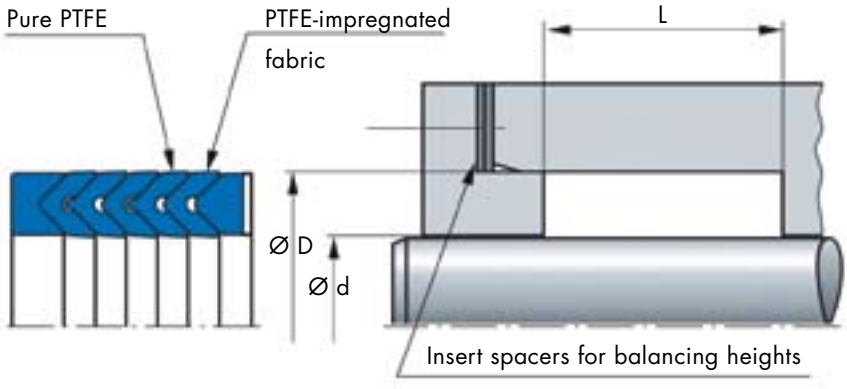
PTFE and PTFE compounds	■ DM 9403: stable profile for static sealing and pulsating pressures up to 300 bar ■ DM 9406: relatively rigid lip profile for dynamic sealing and pressures up to 200 bar ■ DM 9409: flexible lip profile for dynamic sealing, pressures up to 50 bar and vacuum
PTFE-fabric form-pressed	■ Packing rings made of PTFE-impregnated fabric or for certain applications ■ packing ring combination of PTFE-impregnated fabric and PTFE / PTFE compound for pressures up to 700 bar with low friction

DM 9403 DM 9406 DM 9409



Design Notes

PTFE/PTFE compound V-Seal Set packings	■ Due to their lack of elasticity and high degree of thermal expansion, V-Seal Set packings must be preloaded using a spring device ■ The spring force should be tailored to the seal's design, dimensions and operating conditions. The higher the amount of spring force, the less leakage. You can receive the essential parameters from Freudenberg Process Seals ■ When using a spring device for installation on the side turned away from the pressure, set the spring force to maximum ■ For information on allowable installation space tolerances and the characteristics of their surfaces, please consult Freudenberg Process Seals
PTFE-fabric V-Seal Set packings	■ As a rule, can be installed without preloading ■ Installation space must be adjustable (see graphic) ■ Tolerances and surface characteristics match those of the PTFE / PTFE compound variant
General	In the standard version, V-Seal Set packings consist of a compression ring, a backup ring, and 3 V-packing rings. Should you need to deviate from this standard, please consult Freudenberg Process Seals
Special installation notes	So as to avoid damaging the seal during installation, the installation space and rods / shafts should include lead-in chamfers



Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

Applications

Primary fields of application for V-Seal Set packings:

- Regulation and shut-off valves
- Dosing systems
- Agitators
- Pivot joints

Predominantly used to seal:

- Spindles of control and regulation valves
- Rods (translatory motion, possibly in combination with minor rotation)
- Low-speed shafts

Your Advantages at a Glance

- Highly variable to cover a broad range of applications
- High pressure resistance (PTFE and PTFE compounds up to 30 MPa, fabric-reinforced top covers up to 70 MPa)
- Very good temperature resistance (–200 to +260 °C)
- No tooling costs for PTFE / PTFE compound variants
- The height of the set is adjustable
- Low friction
- Universal chemical resistance
- Low susceptibility to cold flow and extrusion in PTFE-fabric variant

Stuffing Box Packings

From centrifugal and piston pumps to applications on spindles and valves – stuffing box packings are a type of seal broadly used throughout the food and beverage industry and achieve sealing by compressing the packing.

The functional principle of a stuffing box packing consists in the axial compression of endless woven cords pressed into rings. This process generates a radial compression on the sealing location, which must be greater than the internal pressure to ensure reliable sealing. Using different weaves and materials to match the respective chemical and thermal requirements, stuffing box packings can be tailored to a variety of application scenarios. In addition to the classic woven packings, Freudenberg Process Seals also offers the newly developed Valtec packings, which consist of a non-woven material impregnated with PTFE, winded and compressed into rings.

Pressures can greatly influence sealing function. When there is no pressure on the packing, a good compression set is necessary to maintain a good seal using resilience. Stuffing box packings are self-amplifying under pressure: their maximum pressure load is influenced by the gap width. To improve their gliding ability and therefore cross-permeability, stuffing box packings are also impregnated with lubricants.

Function

- Sealing in pressure-free environments by means of restoring force
- Self-amplifying sealing function under pressure (the higher the pressure, the better the sealing)

Dimensions and Types

- Double, triple and quadruple diagonal-braided, with quadratic cross-section, available by the meter from 3 mm to 25 mm diameters
- Tube-braided packings, also available as double-layer bands
- Braided packings as pre-cut components or pressed in ring form
- Graphite versions as pre-pressed rings and bushings
- PTFE-impregnated packings (Valtec) as rings or bushings
- Packing rings can be combined into different sets, e.g. with anti-extrusion versions on the outside and low-friction rings on the inside
- "Lantern rings" can be used for lubrication, shut-off or cooling
- Versions with internal or external springs for plunger pumps
- Grafiflex as cover seals in internal pressure-supported systems

Double | Triple | Quadruple | Concentric

Design Notes

Packing cross-sections	For centrifugal pumps, plunger pumps and agitators: s = 1.4 x ½ d (d = shaft diameter in mm) For valves: s = 1.2 x ½ d (d = spindle diameter in mm)
Surfaces	Surface roughness for shafts, spindles, and valves: Ra<0.25 µm Surface roughness for housings: Ra<0.25 µm
Spindle hardness	Min. 40 HRc, for heavier loads 60 HRc
Amount of guide play in the spindle	Less than 1/1000 of the spindle diameter
Gap widths	Max. allowable gap between spindle and gland / housing = 2/100 of the packing width, for larger widths use packings with high-durability aramid yarns
Radial shaft deflection	Max. 0.001 x the shaft diameter

Recommended Number of Rings

For valves

Media pressure (bar)	Recommended number of rings
< 10	3
10–30	4
30–60	5
60–100	6
100–250	7
250–500	8

For centrifugal pumps and mixers

Media pressure (bar)	Recommended number of rings
< 5	3
5–10	4
10–20	5
20–30	6
> 30	7

For plungers

Media pressure (bar)	Recommended number of rings	
	Without spring preloading	With spring preloading
10	3	2
16	3–4	2–3
25	4	2–3
40	4–5	3
64	5	3–4
100	5–6	3–4
160	6	4
250	6–7	4
400	7	4–5
630	7–8	4–5
1000	8	5

Your Advantages at a Glance

- Broad variety of applications
- Ideal for higher pressures up to 1,000 bar (in special cases up to 3,000 bar)
- Broad temperature range from –200 °C to +550 °C (as graphite variant up to +700 °C)
- High media resistance
- Numerous economical standard dimensions
- Simple assembly
- Special TA Luft (German Clean Air Act)-compliant variants
- FDA-compliant materials

Installation and Assembly

General

Please refer to the appendix General Assembly & Installation Instructions p. 114

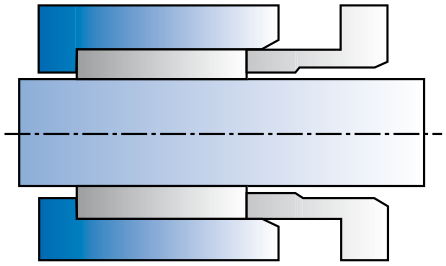
Special Installation Notes

- Installation space must be axially accessible
- Ensure that the gland goes far enough into the stuffing box and check the reset path
- Use a cutting gauge when cutting the material
- Form-pressed rings should be opened axially, then slightly flexed radially and laid over the shaft, cut end first. Next, press the sleeve completely into the installation space and tighten it according to the component specifications

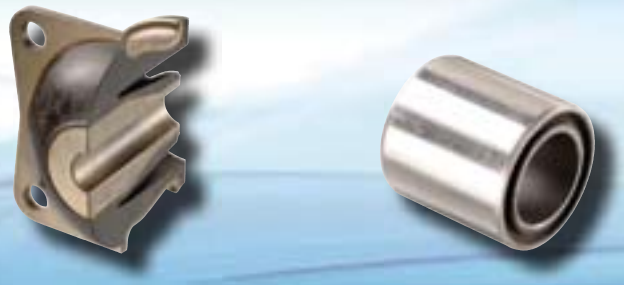
Applications

- Valves
- Mixers
- Homogenizers
- Agitators
- Piston and plunger pumps

Stuffing Box Design



Vibration Technology



Despite precise manufacturing methods and forward-thinking design, motion in machines and assemblies creates vibrations that can in turn produce increased operating noise or even damage. Our vibration technology solutions reliably insulate and dampen these vibrations.

Rotational, linear and other types of motion in machines place extreme strains on them and can lead to the breakdown of individual machine elements or bearings, generate dynamic strains in assemblies, or produce excessive noise during operation. These factors can be minimized by means of vibration technology solutions especially designed for the forces in question. The result: a significantly longer service life for the machine, reduced costs due to the possibility of using lightweight designs, and reduced noise pollution.

Optimally designing vibration control elements requires well-founded know-how. Freudenberg Process Seals offers leading expertise in development, choice of materials, and manufacture. Using the latest calculation models, even complex scenarios such as multi-body vibrations can be simulated prior to production, efficiently reducing development times and costs. From simple buffers to complex hydro-mounts, we offer a broad range of vibration technology components.

Function

- Damping and insulating high-frequency and low-frequency vibrations
- Protecting machines, assemblies and surrounding components
- Insulating structure-borne noise

Types

- Round mounts
- Ultra bushings
- V-mounts
- Hydro-mounts
- Hydro-bushings
- M-mounts
- O-shape mounts
- Spherical mounts
- Buffers

Design Notes

Installation	Vibration control elements are equipped with drilled holes, threaded holes and / or threaded bolts for mounting, making installation and removal quick and easy
General	■ Ensure that there is a flat surface between the frame and the mass to be supported ■ Minor tolerance-related misalignment / angular misalignment can be compensated for ■ Ensure that the flange is securely seated in the supporting area ■ When bolting on control elements, never exert torque on the elastomer
Ultra bushings	■ Are pressed onto the corresponding component ■ Inner and outer bushings are pre-set with the correct fit ■ Pressing force should be distributed evenly over the front face of the precision sleeve

Applications

Vibration control elements from Freudenberg Process Seals are primarily used in the following fields:

Mounts for entire machines

- Insulating vibrations generated by the machine
- Compensating for any unevenness in the contact area through the elastomer (in M-mounts, also through height adjustment)
- Hydro-mounts are used for very gentle support and to insulate structure-borne noise

Mounts for individual machine components

- Connecting and bearing individual components and assemblies by means of ultra bushings, M-mounts, round mounts or O-shape mounts

Limiting motion

- Shock absorption and limiting motion within the machine by means of buffers and stops

Your Advantages at a Glance

- Longer service life for machines and assemblies
- Effective protection for components / surrounding components
- Reduced noise and strain
- Lower weight and less material needed due to the lightweight designs vibration control makes possible
- Available as standard and individualized solutions in various materials
- Fast and dependable design using FEM analysis

Cooperation with Professional Associations

Freudenberg Process Seals' commitment to cooperating with associations of the food and beverage and pharmaceutical industries forms the basis for its market specialization and contributes to finding industry-specific solutions for trends and innovations as they develop.

Freudenberg Process Seals is a member of and / or works with the following associations:

EHEDG (European Hygienic Engineering & Design Group)
The EHEDG is a consortium of equipment manufacturers, representatives of the food and beverage industry, research institutions and public health authorities. More than 120 companies from over 20 countries worldwide (mainly from Europe) are active in the EHEDG. Consequently, the EHEDG offers a broad base of support and sound guidelines for all aspects of the hygienic design and engineering of plants and machines to produce "safe" foodstuffs, beverages and pharmaceutical products. Freudenberg Process Seals is actively involved in promoting the standards of Hygienic Design, e.g. through its involvement in the creation of guidelines.

Hygienic Processing
Hygienic Processing is a joint project involving several partners. It is supported by a network of experts from the fields of research and industry. Hygienic Processing's topics comprise

- Hygienic Design
- Safety & health requirements
- Materials & material surfaces
- The disinfection of packaging materials
- Cleaning
- Efficiency & availability

DIN (German Institute for Standardization)
The DIN (Deutsches Institut für Normung e.V.) develops norms and standards as a service for the commercial sector, the government and society. A private enterprise with the legal status of a non-profit organization, it has had its head office in Berlin since 1917. The DIN's principal duty is to develop consensus-based standards together with representatives of interested parties, in a timely manner and in keeping with the needs of the market. Approx. 26,000 experts contribute their knowledge to the development of standards. Due to a contract with the Federal Republic of Germany, the DIN is recognized as the national standards organization among the European and international standards organizations. Today, almost 90 percent of the DIN's work is European and / or international in nature.

Freudenberg Process Seals offers professional support on seals and elastomers through various committees. We are mainly active in the Valves for the Food and Beverage Industry (Armaturen für die Lebensmittelindustrie) workgroup.

ESA
(European Sealing Association)

The European Sealing Association (ESA) was founded as a non-profit organization in 1992. Today, it represents 85% of the entire media sealing industry in Europe. The member companies are concerned with the manufacturing, delivery and application of sealing materials, as well as the critical components used to safely store media during processing and application.

VDMA (German Engineering Federation)

The VDMA (Verband Deutscher Maschinen- und Anlagenbau) is one of the most important service providers for associations and offers the largest industrial network for the industrial goods industry in Europe. The VDMA represents 3,000 predominantly medium-sized member companies from the industrial goods industry, making it one of the largest and most significant industrial associations in Europe.

In the VDMA the whole process chain is represented – from the components to the plant, from the system supplier to the system integrator, to the service provider. The VDMA promotes both branch-specific and comprehensive cooperation. Freudenberg Process Seals is participating in this cooperation, taking an active part in the meetings of its Engineering Group's workgroup on Technology.

ISPE (International Society for Pharmaceutical Engineering)

The ISPE is the largest global non-profit organization for the continuing development of the pharmaceutical industry and continuing training of those working in it. Founded in 1980, today it has over 25,000 members in 90 countries. The ISPE is an independent organization, led by experienced representatives from the most recognized companies in the field of pharmaceutical manufacturing, and provides a forum where experts from the fields of industry and management, independent consultants, and students can exchange ideas and experiences.

3-A® Sanitary Standards

3-A® Sanitary Standards, Inc. is a non-profit organization representing machine and plant engineers, plant operators and regulatory bodies. Its long years of experience have yielded numerous standards and best practices that set the tone for the dairy and food and beverage industries and their facilities worldwide.

Overview of Elastomer Materials

Material Type	Material Identification	Color	Cross-linking	Hardness Shore A (DIN 53505)	Density (DIN EN ISO 1183)/g/cm³	Modulus at 100% elongation (DIN 53504)/N/mm²	Tensile Strength (DIN 53504)/ N/mm²
EPDM	60 EPDM 290	Black	Peroxide	65 ± 5	1.06	4.2	12.8
	70 EPDM 291	Black	Peroxide	75 ± 5	1.10	9.8	16.2
	85 EPDM 292	Black	Peroxide	85 ± 5	1.16	–	18.0
	75 EPDM 253356	Black	Peroxide	75 ± 5	1.06	4.9	13.2
	78 EPDM 37803	Black	Peroxide	78 ± 5	1.11	–	14.0
VMQ	78 VMQ 166898	Light blue	Peroxide	78 ± 5	1.20	2.9	9.5
	75 VMQ 176643	Red	Peroxide	76 ± 5	1.20	2.7	9.6
	70 VMQ 117055	Transparent	Peroxide	70 ± 5	1.18	–	9.8
	70 VMQ 37804	White	Platinum	70 ± 5	1.19	–	9.0
NBR	70 NBR 150	Black	Peroxide	70 ± 5	1.17	5.5	18.5
	85 NBR 151	Black	Peroxide	85 ± 5	1.26	17.3	17.6
	65 NBR 37786	White	Sulfur	65 ± 5	1.32	–	8.0
HNBR	75 HNBR 231142	Black	Peroxide	75 ± 5	1.20	10.0	26.0
	75 HNBR 253436	Green	Peroxide	75 ± 5	1.11	5.9	16.0
Fluoroprene® XP	XP 40	Dark blue	Peroxide	75 ± 5	1.98	4.5	23.5
	XP 41	Dark blue	Peroxide	75 ± 5	1.98	4.5	23.5
FKM	70 FKM 37508	Red	Bisphenol	75 ± 5	1.99		15.7
	75 FKM 253543	Blue	Peroxide	74 ± 5	2.04	3.4	13.1
FFKM	75 FFKM 494	Black	Peroxide	75 ± 5	1.91	9.7	16.8

Elongation at Break (DIN 53504)/%	Compression Set (DIN ISO 815), 24h, 100 °C/%	Compression Set (DIN ISO 815), 24h, 150 °C/%	Compression Set (DIN ISO 815), 24h, 175 °C/%	Compression Set (DIN ISO 815), 24h, 200 °C/%	Compression Set (DIN ISO 815), 70h, 200 °C/%	Temperature Range in Air/°C	Product Type
225		12				–40 to +150	Diaphragms
165		15				–40 to +150	O-rings Molded parts Diaphragms Clamp seals
130		13				–40 to +150	O-rings Molded parts
205		12				–30 to +140	Seals for butterfly valves
110		20				–40 to +150	Clamp seals
410			27			–40 to +200	O-rings
420			16			–40 to +200	Seals for butterfly valves
470			30			–50 to +200	O-rings Molded parts Diaphragms
257			23			–30 to +200	Clamp seals
240	12					–20 to +100	O-rings Molded parts Diaphragms Clamp seals
105	12					–20 to +100	O-rings Molded parts
437	23					–20 to +120	Clamp seals
202		22				–35 to +140	O-rings Molded parts
175		18				–25 to +140	Seals for butterfly valves
350				26		–15 to +200	O-rings
350				26		–15 to +200	Seals for butterfly valves
160				9		–15 to +200	O-rings Seals for butterfly valves Diaphragms
400				24		–15 to +200	Seals for butterfly valves
161					20	–10 to +230	O-rings

General Assembly & Installation Instructions

Cleanliness	For all types of seals, it is imperative that both the installation space and the seal itself are clean. Metallic particles and shavings are particularly dangerous.
Sealing surfaces	The sealing surfaces must at least have the surface roughness indicated in the catalogue. Check for scratches, gouges and cavities.
Surrounding area	If seals have to be stretched over sharp edges or threaded surfaces, these should be rounded off or covered with protective sleeves.
Storage conditions	Prior to installation, ensure that the seal was properly stored. If the seal is individually wrapped, do not remove it from its package until you are ready to install it (cf. p. 17).
Assembly aids	It is always important to ensure that tools and other aids do not damage the seal or the installation space. Installation sleeves, expansion mandrels, chamfers and rounded brass pins are well-suited; screwdrivers are not.
Lubricants	If you choose to use a lubricant, ensure that it is compatible with your sealing material (cf. p. 24).
Positioning	For many seals (e.g. U-packings and radial shaft seals), it is important to install them with the correct positioning / in the correct direction.

Legal Notices

Freudenberg Process Seals GmbH & Co. KG has carefully prepared the contents of this handbook. The information is based on our decades of research into the development and manufacture of sealing solutions as part of the Freudenberg Group and reflects our current state of knowledge. However, as seal performance is not only dependent on the seal itself, but also on various other parameters connected to the individual application and beyond our control, Freudenberg Process Seals GmbH & Co. KG does not assume any liability for the statements made in this document, e.g. statements as to the expected service life of a sealing system.

As such, the information contained in this handbook should provide only general and non-binding guidelines. We recommend discussing specific, individual applications with our technical consultants and testing them in advance if necessary; should you need testing, we will be glad to support you using our test plant.

List of Abbreviations

Abbreviation	Full Name	Description
ADI-free®	Animal Derived Ingredient-free	Assurance that no products derived from animals are used in manufacture
AWQC	Australien Water Quality Criteria	Australian organization for drinking water standards
BfR	Bundesamt für Risikobewertung	(German Federal Office for Risk Assessment): e.g. BfR 15/21: Recommendation for silicones / rubbers that come into contact with food products
CIP	Cleaning in Place	A cleaning method used for "closed" plants in the process industries
COP	Cleaning Out of Place / Cleaning Open Plant	A cleaning method used in the process industries
DIN	Deutsches Institut für Normung	German Institute for Standardization
DN	Diamètre Nominal / Nominal Diameter	Nominal pipe size / nominal diameter
DVGW	Deutscher Verein des Gas- und Wasserfaches	German Technical and Scientific Association for Gas and Water
DVR	Druckverformungsrest	Compression set, a mechanical performance parameter for elastomers
EHEDG	European Hygienic Engineering & Design Group	Consortium of plant engineers and operators in the food and pharmaceuticals industries
EPDM	Ethylene Propylene Diene Rubber	A base elastomer
ESA	European Sealing Association	An industrial association
ETA-DK	European Technical Approvals - Denmark	Danish organisation for issues concerning drinking water
EU Directive 1935/2004	A regulation from the European Union	Refers to the labelling and traceability of materials and objects intended to come into contact with food products. Went into effect on October 27, 2006
FDA	Food and Drug Administration	A federal body in the United States responsible for the regulation of medications and pharmaceuticals, part of the United States Department of Health and Human Services
FEM	Finite Element Method	A calculation method used to determine forces and loads in components
FEP	Fluorinated Ethylene Propylene	A thermoplastic
FKM	Fluoroelastomer	A base elastomer
Fluoroprene® XP		A registered trademark fluoroelastomer
GMB		Elastomer diaphragm with fabric
GMBM		Elastomer diaphragm with metal inserts and fabric / foil
HNBR	Hydrogenated Nitrile Butadiene Rubber	A base elastomer
HTS II		Radial shaft seal made of PTFE
Hygienic Design		Requirements for the design of processing plants used in the food and beverage and pharmaceutical industries
IRHD	International Rubber Hardness Degree	A scale for measuring the hardness of elastomers
ISPE	International Society for Pharmaceutical Engineering	International industrial association
KTW	Kunststoffe im Trinkwasser	(Plastics in Drinking Water): a German norm for the use of plastics and elastomers in drinking water facilities
MB		Elastomer diaphragm
MBM		Elastomer diaphragm with metal inserts
NBR	(Acrylo-)Nitrile Butadiene Rubber	A base elastomer
NSF 51	National Sanitation Foundations	NSF 51/61 A norm defining the standards for applications involving food and drink / drinking water (USA)
ÖVGW	Östereichischer Verein des Gas- und Wasserfaches	Austrian Gas and Water Union
PA	Polyamide	A thermoplastic
PFA	Perfluoroalkoxy Copolymer	A thermoplastic
POM	Polyoxymethylene	A thermoplastic
PTFE	Polytetrafluorethylene	A thermoplastic
PU	Polyurethane	A base elastomer
RFN®	Reduced Friction by Nanotechnology	A patented Freudenberg method for reducing friction in elastomer seals
safe®	Secure Adaptive Freudenberg Encryption	A product labeling technology ensuring reliable identification
Shore A		A scale for measuring the hardness of elastomers
Simriz® (FFKM)	Perfluoroelastomer	A base elastomer
SIP	Sterilization In Place	A sterilization method used in the process industries
VDMA	Verein Deutscher Maschinen- und Anlagen-bauer	(German Engineering Federation): a German industrial association
VMQ	Vinyl Methyl Polysiloxane	A base elastomer
W270		A part of KTW testing: W 270 is concerned with the "propagation of microorganisms on materials used in drinking water applications – testing and assessment"
WIP	Washing In Place	A cleaning method used in the process industries
WOP	Washing Out of Place	A cleaning method used in the process industries
WRAS	Water Regulations Advisory Scheme	A norm / an organization responsible for the approval of machinery used in drinking water plants (Great Britain)

Freudenberg Process Seals GmbH & Co. KG
Lorscher Straße 13, 69469 Weinheim, Germany
Phone +49 (0) 62 01 80 8919-00
www.freudenberg-process-seals.com

Freudenberg
Process Seals