STÖFFL RUDOLF Ges.m.b.H. Technische Produkte

Elastomer Properties

Natural Rubber (NR) (in this catalog „NK“ for the German designation „Naturkautschuk“	Common names, trade names: SMR, Latex, smoked sheets, Para
+	very good resilience and mechanical properties (tensile strength, elongation, abrasion resistance)
+	ability to recover after applied deformation
-	fair/poor resistance to oil, heat, weathering and ozone
-	flammable

Styrene-butadiene rubber (SBR)	Trade names: BUNA-S®, KER®, EUROPRENE®
+	better abrasion resistance and ageing resistance than NR
+	withstands for short periods of time higher temperatures than NR
-	fair/poor resistance to oils, greases and fuels
-	less tear growth resistance than NR; flammable

Butyl rubber (IIR)	Trade names: BUTYL, BUCAR®
+	good resistance to weathering and ozone; very low permeability to air and gases; good electrical resistance
+	good low temperature properties; highly dampening material against aperiodic oscillations
+	good resistance to hot water and chemicals
-	low resilience; no resistance to oils and greases
-	flammable

Ethylene-propylene rubber (EPDM)	Trade names: NORDEL®, KELTAN®, VISTALON®, DURTRAL®, BUNA EP®
+	excellent resistance to weathering, ageing, ozone, chemicals, hot water/steam and polar solvents such as acetone, methanol or esters; excellent electrical insulating properties
+	very good heat resistance, good low temperature properties
-	fair resistance to aliphatic and aromatic hydrocarbons (mineral oils, gasoline, fuels)
-	flammable

Nitrile rubber (NBR)	Trade names: PERBUNAN®, BUNA-N®, HYCAR®, EUROPRENEN®, NIPOL®
+	very good resistance to oil and fuels; good mechanical strength; good compression set properties
+	better heat resistance than SBR, low gas permeability
-	fair weathering resistance; flammable with formation of toxic flue gases
-	poor resistance to aromatics and polar solvents

Hydrogenated nitrile rubber (HNBR)	Trade names: THERBAN®, ZETPOL®
+	very good mechanical properties; very good abrasion resistance, very good heat resistance
+	very good ageing, weathering and ozone resistance
+	very good oil/grease resistance and resistance to fuels; very good hot water/steam resistance
-	poor resistance to aromatics and polar solvents
-	poor electrical properties; flammable with formation of toxic flues gases

Chloroprene rubber (CR)	Trade names: NEOPRENE®, BAYPRENE®, DENKA CHLOROPRENE®
+	good resistance to heat, ageing, weathering and ozone
+	moderate resistance to oil; good mechanical properties and resilience
+	not flammable (in own flame)
-	depending on CR-type more or less stiffening, crystallization tendency at low temperatures
-	poor resistance to fuels

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Chlorsulfonated polyethylene (CSM)	Trade name: HYPALON®
+	good resistance to ageing, weathering and ozone; low gas permeability
+	good resistance to chemicals (especially to strongly oxidizing agents)
-	poor low temperature properties
-	poor resistance to fuels

Polyacrylate rubber (ACM)	Trade names: HYCAR®, VAMAC®, CANACRYL®
+	very good resistance to ageing, weathering and ozone
+	very good resistance to fuels, oils and greases
+	good heat resistance
-	poor low temperature flexibility and poor resistance to chemicals; poor hydrolysis resistance
-	fair mechanical properties; low resilience

Polyurethane rubber (PU)	Trade names: VULKOLLAN®, UREPAN®, ADIPRENE®, VIBRATHANE®
+	very good resistance to ageing, weathering and ozone
+	very good abrasion resistance, high tensile strength
+	low gas permeability
-	water sensitive, especially at temperatures of more than 50° C
-	poor compression set properties at elevated temperatures, flammable

Silicone rubber (Q)	Trade names: SILOPREN®, SILASTIC®
+	excellent heat resistance and low temperature resistance; excellent resistance to weathering, ageing and ozone
+	good electrical insulating properties; constant values of mechanical properties over a wide temperature range
+	physiologically unobjectionable
-	moderate mechanical properties; moderate resistance to oil; sensitive to hot water and steam
-	poor resistance to fuels

Fluorosilicone rubber (MFQ)	
+	very good heat and low temperature resistance; excellent resistance to weathering, ageing and ozone
+	good electrical insulating properties; constant values of mechanical properties over a wide temperature range
+	good resistance to oils and fuels
-	moderate mechanical properties
-	very high-priced material

Fluoro rubber (FPM)	Trade names: VITON®, FLUOREL®, TECNOFLON®, DAI-EL®
+	very good resistance to heat and low temperatures; excellent resistance to weathering, ageing and ozone
+	very good resistance to chemicals; low gas permeability
+	not flammable in own flame
-	hot water and steam sensitive; sensitive to the effect of amines, organic acids and polar solvents
-	poor low temperature flexibility

FPM, FKM, Viton® - Properties

The Difference between FPM, FKM and Viton®
All of these designations actually stand for one single base material only – fluoro rubber. FPM is the international abbreviation according to DIN/ISO, whereas FKM is the short form for the fluoroelastomer category according to the American standard ASTM. Viton® is the registered trade mark of DuPont Dow Elastomers.

The Exceptional Strengths of FPM
FPM are materials based on fluoroelastomers. These materials offer one of the most highest resistances to heat and chemical media of all elastomers ever developed. They withstand hundreds of ordinary to most aggressive fluids over a wide temperature range. Additionally, they retain reliable and leakage free sealing force in situations where ordinary elastomers already have failed long before.

Fluoroelastomers do not come cheap. This is why they primarily were used only for small parts in environments where in contact with hot and corrosive fluids. Today, however, as a result of higher energy costs, stringent environmental regulations, extended warranties and increasing maintenance costs, many users have rethought and now consider FPM very well as a cost-effective material, especially when regarding complete lifetime of a product.

Temperature Resistance
Fluoropolymers in general feature excellent heat resistance. FPM retains its elastic properties even at a continuous operating temperature of 200° C. When talking about temperature resistance, it has to be considered over which period of time materials are exposed to heat or elevated temperatures. Figure 1 shows the relation between operating temperature and hours of use. Besides the ability to withstand short excursions of more than 300° C, laboratory tests have confirmed that products made of FPM still remained soft and elastic even after ageing in a heat cabinet over a period of three years at a temperature of 190° C. If you compare these values with the performance of other elastomers they seem even more significant. Nitrile rubber (NBR), for example, continuously and usefully serves only up to a maximum temperature of 120° C. Similar in temperature performance are the materials chloroprene (CR) and chlorosulfonated polyethylene. Aged at a temperature of 200° C, products made of these materials would embrittle only after a few hours.

Fig 1: Temperature resistance of FPM in air

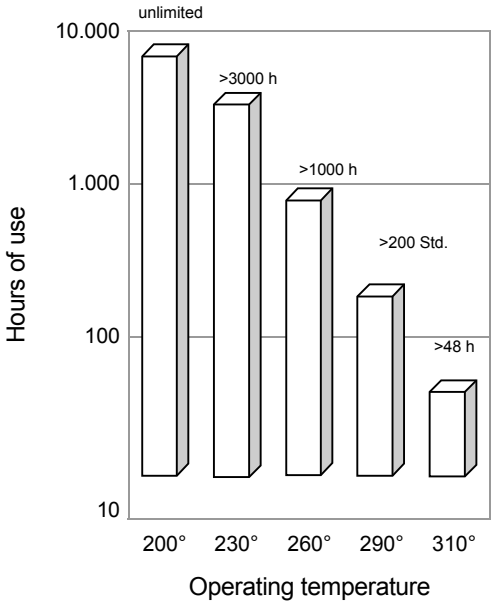
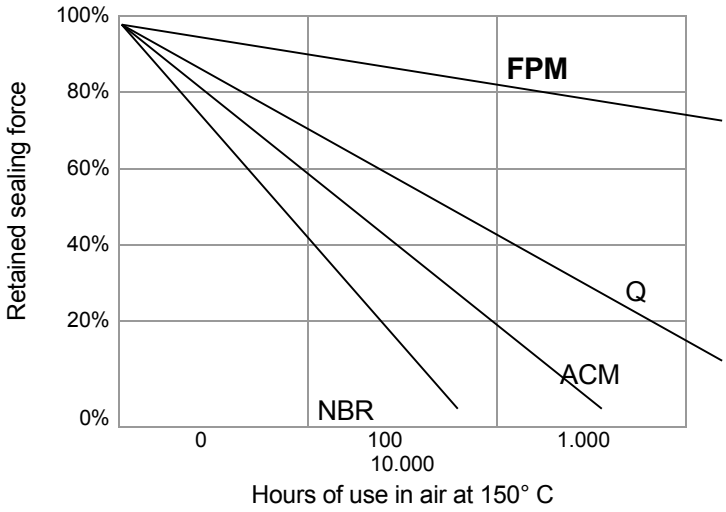
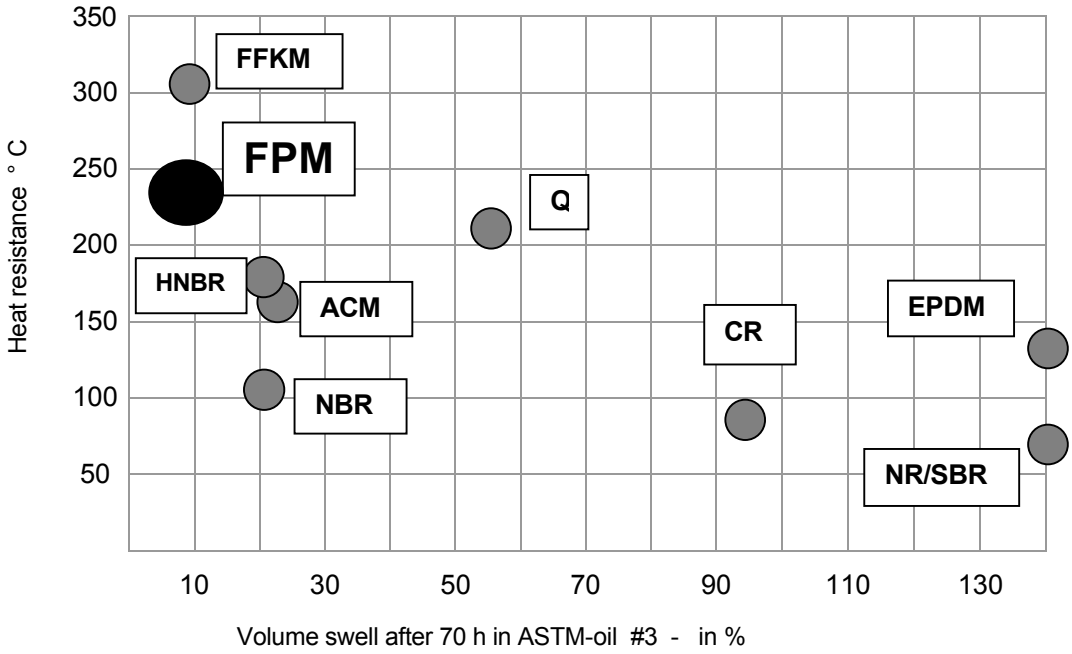


Fig 2: Long-term sealing force of FPM in comparison with other elastomers



Swell Resistance

Fig 3 - Heat- and oil resistance of FPM in comparison with other elastomers



Long-Term Retention of Sealing Force
Resistance to compression set is another very important physical property in sealing technology. The lower the compression set values the better the sealing force and ability to recover from applied deformation. In combination with exposure to high temperatures, FPM even more shows its superior compression set properties. Without any problems values of 8% at 200° C can be achieved.
FPM also is unbeatable, when regarding sealing force over a longer period of time. All other common elastomers fail long before (figure 2). These characteristics then are of special importance when designing long-life, high-quality machines, where absolute product reliability is demanded, when high guarantees are required or when the risks of causing environmental damage due to seal failure or leakage get uncalculable.

Low Temperature Resistance
Experience has shown that sealings made of FPM in dynamic applications usefully serve at temperatures down to approx. –20° C. In case of static use they even can work at temperatures down to –40° C. Furthermore, experience has shown that the more thin-walled parts are, the lower is the operating temperature they can work at. Same effect when the sealing is continuously in contact with media that slightly causes swell. This appearance of swell improves the low temperature flexibility and allows use at even lower temperatures.

Flame Retardance
FPM is based upon fluorocarbon elastomers. The chemical bond of fluorine to carbon is extremely strong. Thus, under conditions of fire, its resistance to breaking and damage exceeds that of all other hydrocarbon elastomers.

Use in Vacuum
FPM contains no plasticizers and thus exhibits very low outgassing in use under extreme vacuum conditions. Loss of weight of only 2-3 % in vacuum applications is typical for this material. Therefore FPM is the ideally suited material for sealings requiring ultimate pureness, lowest outgassing rates and minimal volume changes in extreme vacuums.

Weathering and Ozone Resistance
The combination of atmospheric oxygen with sunlight and ozone (weathering) is a very aggressive and corrosive effect. But also in this respect FPM offers best resistance. As a matter of fact, even after 20 years of exposure to direct sunlight no cracking or splitting was observed. But also direct exposure to ozone has no effect on FPM. For example, after 300 hours of continuous ageing at a temperature of 60° C in an environment containing 150 ppm ozone no cracks could be observed. For comparison, parts produced from natural rubber would end up with cracked and splitted surfaces and get useless after just 10 minutes under same conditions. The extremely good weathering and ozone resistance of FPM also is shown in the fact that UV-radiation does not have any effect on colored parts made of FPM.

Gas Permeability
Products made of FPM have very low gas permeability.

FFKM=perfluoroelastomer

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Elastomer Properties
Selection Chart

Characteristic	NR	SBR	IIR	EPDM	NBR	HNBR	CR	CSM	ACM	PU	Q	MFQ	FPM
Durometer range Shore A	30-90	35-95	30-80	30-90	30-95	45-90	30-90	45-90	50-90	55-95	30-85	40-80	45-95
Tensile strength without fillers	1	5	4	5	5	4	3	5	5	2	3	3	4
Tensile strength filler-reinforced	1	2	3	3	2	1	2	3	3	1	3	3	3
Elongation at break	1	2	2	3	2	2	2	3	3	2	3	3	3
Impact resilience	2	3	5	3	3	3	3	4	5	3	3	3	5
Abrasion resistance	2	2	3	3	2	2	2	3	4	1	4	4	4
Tear-growth resistance	2	3	3	3	3	2	2	4	4	3	5	5	4
Compression set at –40° C	3	3	5	4	5	5	5	5	5	5	3	3	5
Compression set at +20° C	2	3	4	3	3	2	3	5	3	3	2	2	2
Compression set at +100° C	5	5	2	2	5	2	4	5	5	5	1	1	1
Temperature resistance from/to in °C	-40 +70	-30 +80	-30 +90	-35 +120	-20 +80	-50 +140	-30 +90	-10 +90	-5 +150	-40 +80	-60 +200	-55 +175	-20 +200
Low temperature flexibility	2	3	2	2	3	3	3	5	5	4	1	1	5
Ageing resistance	3	3	2	1	3	1	2	2	2	2	1	1	1
Resistance to ozone	4	4	2	1	3	1	2	2	2	2	1	1	1
Resistance to fuels	5	5	5	5	1	1	2	2	1	1	5	1	1
Oil- and grease resistance	5	5	5	5	1	1	2	2	1	1	3	1	1
Resistance to acids	3	3	2	1	4	4	2	2	5	5	5	5	1
Resistance to bases	3	3	2	2	3	3	2	2	5	5	5	5	1
Resistance to hot water	3	2	1	1	3	2	3	3	5	5	5	5	2
Gas permeability	5	4	1	4	2	2	3	3	3	1	5	5	2

1 = excellent 2 = very good 3 = good 4 = fair 5 = poor

NR	Natural rubber	**CSM**	Chlorosulfonated polyethylene
SBR	Styrene-butadiene rubber	**ACM**	Polyacrylate rubber
IIR	Butyl rubber	**PU**	Polyurethane rubber
EPDM	Ethylene-propylene rubber	**Q**	Silicone rubber
NBR	Butadiene-acrylo-nitrile rubber	**MFQ**	Fluorosilicone rubber
HNBR	Hydrogenated nitrile rubber	**FPM**	Fluoro rubber
CR	Chloroprene rubber		

The range of properties that can be developed for any given polymer is limited by the material itself, and will vary within that range with compound formulation. All properties in a particular class are not found in a single compound. However, it is often possible to raise or lower some ratings to acceptable levels through creative compounding. The information presented herein is intentionally general in
nature as it represents a consensus based on input from many sources. Selecting the best elastomer for a particular application isn't always easy or clear cut. Temperature and other environmental factors can affect the long-term physical properties of a compound. The best course is to seek a balance of properties desired for an application. Information about the original material and service
conditions can help when seeking a replacement material for an existing product.

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