Tecnoflon® PFR 94

Perfluoroelastomer

Tecnoflon® PFR 94 is a chemical resistant perfluoroelastomer (FFKM). Tecnoflon® PFR 94 offers the widest range of aggressive media sealing capabilities along with excellent compression set values.

Tecnoflon® PFR 94 is suitable for most applications in temperature ranging from –10 °C to 230 °C, offering outstanding resistance to aggressive media such as hot organic and inorganic acids, caustics, ketones, aldehydes, esters, ethers, alcohols, fuels, solvents, sour gases, hydrocarbons, steam, hot water, ethylene and propylene oxide and mixed process streams. Moreover it can cope with a wide range of potent active pharmaceutical ingredients (API's) and aggressive cleaning agents, being especially suited to withstand steaminplace (SIP) and cleaninplace (CIP) procedures.

Tecnoflon® PFR 94 can be combined with the cure system and other typical fluoroelastomer compounding ingredients; its mixing can be accomplished with two roll mills or internal mixers. Finished goods may be produced by a variety of rubber processing methods.

The primary use for Tecnoflon® PFR 94 is the manufacturing of any kind of elastomeric sealing element such as Orings, gaskets, valve bodies, butterfly valves, pump housings and stators, metal bonded parts, diaphragms, profiles, etc. These sealing elements can be used in mechanical seals, pumps, compressors, valves, reactors, mixers, sprayers, dispensers, quick connect couplings, controls, instrumentation, etc. in a wide range of industrial sectors, such as semiconductor manufacturing, chemical process industry, oil & gas, food and pharma and paint spray.

Tecnoflon® PFR 94 is registered in the FDA Inventory of Effective Premarket Notifications for Food Contact Substances. It can be compounded so that the finished gaskets or seals can be used in food processing equipments (see "food processing compounds" section on pages 6 and 7).

Tecnoflon® PFR 94 is marketed in the form of raw polymer (1 kg and 5 kg boxes) in order to give the transformer the freedom and the opportunity to develop and fine tune compounds and items best suited to the final application.

Handling and safety

Normal care and precautions should be taken to avoid skin contact, eye contact and breathing of fumes. Smoking is prohibited in working areas. Wash hands before eating or smoking. For complete health and safety information, please refer to the material safety data sheet.

Basic characteristics of the raw polymer are as follows

Property	Typical Value	Unit	Test Method
ML (1+10') at 121 °C	35	MU	ASTM D1646
Specific gravity	2.06	g/cm^3	ASTM D792
Colour	Translucent		
Packaging / Form	1 kg and 5 kg / Slabs		

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Black compounds

Test Compound	Unit	65 Shore A	70 Shore A	80 Shore A	90 Shore A	Test Method
Tecnoflon® PFR 94	phr	100	100	100	100	
Luperox® 101XL-45	phr	1.5	1.5	1.5	0.9	
Drimix® TAIC (75 %)	phr	2	2	2	1.2	
N-990 MT Carbon Black	phr	6	15	25	60	
$BaSO_4$ (Blanc Fixe HD 80)	phr	4	–	–	–	
PAT 777	phr	–	–	–	1	
Struktol® WS280	phr	–	–	–	0.5	

Property	Unit	65 Shore A	70 Shore A	80 Shore A	90 Shore A	Test Method
Mooney viscosity ML (1+10') at 121 °C	MU	35	32	40	80	ASTM D1646
Compound density	g/cm^3	2.06	1.99	1.99	1.96	ASTM D792
MDR 12 min at 160 °C arc 0.5 °						ASTM D6601
Minimum torque	lb·in	0.6	0.5	0.7	2.0	
Maximum torque	lb·in	21.5	26.8	35.1	48.0	
t_{s2}	s	39	38	79	44	
t'_{50}	s	56	60	71	111	
t'_{90}	s	115	137	201	296	
MDR 12 min at 150 °C arc 0.5 °						ASTM D6601
Minimum torque	lb·in	0.7	0.6	0.9	–	
Maximum torque	lb·in	21.2	26.5	33.3	–	
t_{s2}	s	73	80	81	–	
t'_{50}	s	121	125	163	–	
t'_{90}	s	279	235	401	–	
Post cure: 4 h at 230 °C						
100 % modulus	MPa	5.1	9.2	15.5	16.5	ASTM D412C
Tensile strength	MPa	16.3	18.5	21.6	17.3	
Elongation at break	%	168	150	135	119	
Hardness	Shore A	65	71	79	92	ASTM D2240
Compression set 25 % deformation, O-ring #214						ASTM D395 method B
70 h at 200 °C	%	21	19	21	32	

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White compounds

Test Compound	Unit	65 Shore A	70 Shore A	80 Shore A	Test Method
Tecnoflon® PFR 94	phr	100	100	100	
Luperox® 101XL-45	phr	1.5	1.5	1.5	
Drimix® TAIC (75 %)	phr	2	2	2	
$BaSO_4$ (Blanc Fixe HD 80)	phr	15	40	40	
SiO_2 (Ultrasil® 360)	phr	–	–	5	
TiO_2 (Ti-Pure® R960)	phr	5	5	5	

Property	Unit	65 Shore A	70 Shore A	80 Shore A	Test Method
Mooney viscosity ML (1+10') at 121 °C	MU	33	45	77	ASTM D1646
Compound density	g/cm^3	2.22	2.40	2.41	ASTM D792
MDR 12 min at 160 °C arc 0.5 °					ASTM D6601
Minimum torque	lb·in	0.7	1.0	1.2	
Maximum torque	lb·in	22.0	33.3	36.3	
t_{s2}	s	31	26	28	
t'_{50}	s	45	46	47	
t'_{90}	s	82	94	97	
MDR 12 min at 150 °C arc 0.5 °					ASTM D6601
Minimum torque	lb·in	0.8	1.0	1.3	
Maximum torque	lb·in	22.6	33.1	36.6	
t_{s2}	s	53	49	47	
t'_{50}	s	93	118	103	
t'_{90}	s	201	255	233	
Post cure: 4 h at 230 °C					
100 % modulus	MPa	4.9	9.1	12.0	ASTM D412C
Tensile strength	MPa	17.5	15.3	17.0	
Elongation at break	%	202	165	125	
Hardness	Shore A	64	72	78	ASTM D2240
Compression set 25 % deformation, O-ring #214					ASTM D395 method B
70 h at 200 °C	%	19	20	23	

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White compounds for semiconductor applications

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 94	100	phr	
Luperox® 101 (92 %)	0.4	phr	
TAIC (100 %)	1.2	phr	
SiO_2 (Ultrasil® 360)	15	phr	

Property	Typical Value	Unit	Test Method
Mooney viscosity ML (1+10') at 121 °C	55	MU	ASTM D1646
Compound density	2.02	g/cm^3	ASTM D792
MDR 12 min at 160 °C arc 0.5 °			ASTM D6601
Minimum torque	1.3	lb·in	
Maximum torque	33.0	lb·in	
t_{s2}	34	s	
t'_{50}	51	s	
t'_{90}	106	s	
MDR 12 min at 150 °C arc 0.5 °			ASTM D6601
Minimum torque	1.4	lb·in	
Maximum torque	32.2	lb·in	
t_{s2}	56	s	
t'_{50}	96	s	
t'_{90}	235	s	
Post cure: 4 h at 230 °C			
100 % modulus	15.1	MPa	ASTM D412C
Tensile strength	21.4	MPa	
Elongation at break	120	%	
Hardness	78	Shore A	ASTM D2240
Compression set 25 % deformation, O-ring #214			ASTM D395 method B
70 h at 200 °C	25	%	

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Low hardness – translucent compound

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 94	100	phr	
Luperox® 101 (92 %)	1	phr	
TAIC (100 %)	1.5	phr	

Property	Typical Value	Unit	Test Method
Mooney viscosity ML (1+10') at 121 °C	27	MU	ASTM D1646
Compound density	2.06	g/cm^3	ASTM D792
MDR 12 min at 160 °C arc 0.5 °			ASTM D6601
Minimum torque	0.5	lb·in	
Maximum torque	17.1	lb·in	
t_{s2}	32	s	
t'_{50}	46	s	
t'_{90}	100	s	
MDR 12 min at 150 °C arc 0.5 °			ASTM D6601
Minimum torque	0.5	lb·in	
Maximum torque	17.0	lb·in	
t_{s2}	50	s	
t'_{50}	81	s	
t'_{90}	230	s	
Post cure: 4 h at 230 °C			
100 % modulus	2.1	MPa	ASTM D412C
Tensile strength	13.2	MPa	
Elongation at break	200	%	
Hardness	58	Shore A	ASTM D2240
Compression set 25 % deformation, O-ring #214			ASTM D395 method B
70 h at 200 °C	31	%	

Food processing compounds

Tecnoflon® PFR 94 is registered in the FDA Inventory of Effective Food Contact Substances (FCS) Notifications, being the subject of Food Contact Notification (FCN #128), with an effective date July 21, 2001. See the list of effective notifications for FCN available on the Agency's web site at:
http://www.accessdata.fda.gov/scripts/fdcc/?set=FCN

The finished compounds are intended for repeated use as components of gaskets or seals used in food processing equipment intended to contact food Types I through VII as described in Table 1 of 21 CFR 176.170(c) as follows:

Table 1: Types of Raw and Processed Foods

- **I.** Nonacid, aqueous products; may contain salt or sugar or both (pH above 5.0)
- **II.** Acid, aqueous products; may contain salt or sugar or both, and including oil-in-water emulsions of low- or high-fat content
- **III.** Aqueous, acid or nonacid products containing free oil or fat; may contain salt, and including water-in-oil emulsions of low- or high-fat content
- **IV.** Dairy products and modifications:
  - **A** Water-in-oil emulsions, high- or low-fat
  - **B** Oil-in-water emulsions, high- or low-fat
- **V.** Low-moisture fats and oil
- **VI.** Beverages:
  - **A** Containing up to 8 percent of alcohol
  - **B** Non-alcoholic
  - **C** Containing more than 8 percent alcohol
- **VII.** Bakery products other than those included under Types VIII or IX of this table:
  - **A** Moist bakery products with surface containing free fat or oil
  - **B** Moist bakery products with surface containing no free fat or oil
- **VIII.** Dry solids with the surface containing no free fat or oil (no end test required)
- **IX.** Dry solids with the surface containing free fat or oil

Data for establishing compliance with the FDA standards for Tecnoflon® PFR 94 based compounds were obtained from cured items having the formulation shown below:

Tecnoflon® PFR 94	**100**	phr
Luperox® 101XL-45	1.5	phr
Drimix® TAIC (75 %)	2	phr

Extraction tests were performed on slabs that were presscured for 10 min at 170 °C, followed by an oven post-cure of 24 h at 200 °C.

Compounding guidelines for food processing

To design FDA compliant compounds, some restrictions have to be taken into account as far as the curatives, the fillers and the process aids are concerned.

1. Curatives
the following restrictions apply in terms of curatives amount:

Tecnoflon® PFR 94	**100**	phr
Luperox® 101XL-45	≤ 1.5	phr
Drimix® TAIC (75 %)	≤ 2	phr

2. Fillers
The following fillers are approved for use in items intended for repeated food contact use, under 21 CFR 177.2600, section v., and provide at the same time excellent processing behaviour and physical properties:

- Barium sulfate
- Silica
- Titanium dioxide
- Carbon black
  (channel process or furnace combustion process; total carbon black not to exceed 50 % by weight of rubber product; furnace combustion black content not to exceed 10 % by weight of rubber products intended for use in contact with milk or edible oils)

3. Process aids

- Carnauba wax
- Struktol® HT 290
  (concentration must not exceed 5 % by weight of the rubber compound)

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Test Compound	Unit	White	Black	Test Method
Tecnoflon® PFR 94	phr	100	100	
Luperox® 101XL-45	phr	1.5	0.7	
Drimix® TAIC (75 %)	phr	2	1.2	
$BaSO_4$ (Blanc Fixe HD 80)	phr	40	20	
TiO_2 (Ti-Pure® R-960)	phr	5	–	
N772 Carbon Black	phr	–	3	

Property	Unit	White	Black	Test Method
Mooney viscosity ML (1+10') at 121 °C	MU	45	39	ASTM D1646
Compound density	g/cm^3	2.40	2.23	ASTM D792
MDR 12 min at 160 °C arc 0.5 °				ASTM D6601
Minimum torque	lb·in	1.0	0.5	
Maximum torque	lb·in	33.3	23.0	
t_{s2}	s	26	60	
t'_{50}	s	46	95	
t'_{90}	s	94	232	
MDR 12 min at 150 °C arc 0.5 °				ASTM D6601
Minimum torque	lb·in	1.1	0.7	
Maximum torque	lb·in	34.0	21.0	
t_{s2}	s	41	140	
t'_{50}	s	78	235	
t'_{90}	s	200	485	
Post cure: 4 h at 230 °C				
100 % modulus	MPa	7.4	6.0	ASTM D412C
Tensile strength	MPa	13.8	16.0	
Elongation at break	%	175	180	
Hardness	Shore A	73	70	ASTM D2240
Compression set 25 % deformation, O-ring #214				ASTM D395 method B
70 h at 200 °C	%	22	35	

Cold flexibility

Property	Typical Value	Unit	Test Method
DSC			
T_g onset	−8	°C	
T_g midpoint	−1	°C	
Retraction curve			ASTM D1329
TR_{10}	−2	°C	
TR_{30}	2	°C	
TR_{50}	4	°C	
TR_{70}	7	°C	

Test Compound	Typical Value	Unit	Test Method
Tecnoflon® PFR 94	100	phr	
Luperox® 101XL-45	1.5	phr	
Drimix® TAIC (75 %)	2	phr	
ZnO	5	phr	
MT N990 Carbon Black	15	phr	

Property	Typical Value	Unit	Test Method
Brittleness temperature			ASTM D2137
100 % pass	−14	°C	
50 % pass	−18	°C	

Polymer solubility

By dissolving PFR 94 with 1 % wt/vol concentration in different solvents, the following solubility values were determined:

Solvent	Solubility
MEK	insoluble
Galden® SV55	79 % soluble
Galden® SV90	76 % soluble
Galden® SV110	65 % soluble
Galden® SV135	< 66 % soluble
Perfluoroheptane	98 % soluble

Considering only Galden® SV grades, the following higher concentrations were tested to determine the upper solubility level for PFR 94:

Solvent	Conc. [% wt/vol]	Tecnoflon® PFR 94
Galden® SV55	1	79 % soluble
	5	77 % soluble
	10	Opalescent (*)
	15	Opalescent (*)
	20	Insoluble
Galden® SV90	1	76 % soluble
	5	61 % soluble
	10	54 % soluble
	15	insoluble
	20	insoluble
Galden® SV135	1	< 66 % soluble
	5	< 61 % soluble
	10	insoluble
	15	insoluble
	20	insoluble

(*) It can't be separated by ultracentrifugation

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Fluid resistance overview

Fluid	Volume Swelling
Inorganic acids	< 10 %
Organic acids	< 10 %
Alkalis	< 10 %
Amines (RT)	< 10 %
Hot amines (> 70 °C)	10 – 30 %
Water / Steam	< 10 %
Ketones	< 10 %
Esters	< 10 %
Ethers	< 10 %
Aldehydes	< 10 %
Alcohols	< 10 %
Hydrocarbons	< 10 %
Sour gas	< 10 %
Lubricants	< 10 %
Fluorinated fluids	30 – 50 %

Fluid resistance

Effect of curatives and fillers

For optimal acid resistance, zinc oxide and Wollastonite fillers are not recommended. The combination of MT N990 carbon black and pure curatives (peroxide and cross-linking agent) instead of the curative masterbatches delivers the best acid fluid resistance. On the other hand, in case of coloured compounds, a white inert mineral filler like barium sulphate along with pure curatives is recommended.

Test Compound	Unit	MT N990	Curative Masterbatches	Austin Black	$BaSO_4$	TiO_2	Silica	Test Method
Tecnoflon® PFR 94	phr	100	100	100	100	100	100	
Luperox® 101 Liquid	phr	1	–	1	1	1	1	
Luperox® 101XL45	phr	–	1.5	–	–	–	–	
TAICROS (pure TAIC)	phr	1.5	–	1.5	1.5	1.5	1.5	
Drimix® TAIC (75 %)	phr	–	2	–	–	–	–	
MT N990 Carbon Black	phr	15	15	–	–	–	–	
Austin Black	phr	–	–	15	–	–	–	
Blanc Fix HD80	phr	–	–	–	40	–	–	
Ti-Pure® R-960	phr	–	–	–	–	40	–	
Ultrasil® 360	phr	–	–	–	–	–	10	
After post-cure								
100 % modulus	MPa	10.8	11.3	6.4	6.9	n.a.	11.5	ASTM D412C
Tensile strength	MPa	17.5	17.8	11.2	13.7	19.6	12.9	
Elongation at break	%	134	131	161	164	97	104	
Hardness	Shore A	73	70	71	72	71	70	ASTM D2240
HNO_3, 65 %, 168 h at 80 °C								
Δ Tensile strength	%	–34	–34	7	–17	–57	–29	
Δ Elongation at break	%	27	33	–2	–5	38	27	
Δ Hardness	Shore A	–4	–4	–1	–9	–14	–2	
Δ Volume	%	0.7	5.1	8	2.6	20	4.2	

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Property	Unit	MT N990	Curative Masterbatches	Austin Black	$BaSO_4$	TiO_2	Silica	Test Method
Acetic acid, 33 % (pH = 2), 336 h at 100 °C								
Δ Tensile strength	%	−10	−29	−3	−37	−38	−29	
Δ Elongation at break	%	−3	−18	2	−10	55	41	
Δ Hardness	Shore A	−3	−1	−1	−12	−5	−3	
Δ Volume	%	0.5	8.4	2.5	7	14	8	
Glacial acetic acid, 336 h at 100 °C								
Δ Tensile strength	%	−19	−21	−22	−31	−42	−29	
Δ Elongation at break	%	−4	−9	−8	−7	28	2	
Δ Hardness	Shore A	−4	−3	−2	−10	1	−2	
Δ Volume	%	2.7	4.0	6.4	4.0	10	4.5	
HF, 49 %, 168 h at 50 °C								
Δ Tensile strength	%	−15	−2	1	−36	−49	−32	
Δ Elongation at break	%	1	8	−2	−6	−25	−8	
Δ Hardness	Shore A	−4	−1	−2	−5	−24	−16	
Δ Volume	%	0.1	1.8	3.3	0.1	56	26	
HCl, 37 %, 72 h at 80 °C								
Δ Tensile strength	%	−7	3	6	−28	−41	−13	
Δ Elongation at break	%	4	8	4	−7	18	16	
Δ Hardness	Shore A	−4	0	0	−4	1	0	
Δ Volume	%	0.1	2.1	2.2	0.9	9	1.2	
Steam, 168 h at 220 °C								
Δ Tensile strength	%	−17	−21	−4	−36	−39	−26	
Δ Elongation at break	%	1	11	−8	−1	41	38	
Δ Hardness	Shore A	−5	−2	−1	−6	1	−2	
Δ Volume	%	0.1	0.8	1.1	0.9	0.3	3.6	

Acid fluids

Property	Typical Value	Unit	Test Method
H_2SO_4, 98 %, 70 h at 60 °C			
Δ Tensile strength	−5	%	
Δ Elongation at break	−12	%	
Δ Hardness	0	Shore A	
Δ Volume	0.1	%	
H_2SO_4, 20 % oleum, 168 h at 23 °C			
Δ Tensile strength	−9	%	
Δ Elongation at break	5	%	
Δ Hardness	−2	Shore A	
Δ Volume	2.8	%	
HNO_3, 90 %, 72 h at 60 °C			
Δ Tensile strength	−54	%	
Δ Elongation at break	−12	%	
Δ Hardness	−12	Shore A	
Δ Volume	31	%	
HF, 50 %, 168 h at 80 °C			
Δ Tensile strength	−15	%	
Δ Elongation at break	10	%	
Δ Hardness	−1	Shore A	
Δ Volume	5	%	
H_3PO_4, 45 %, 168 h at 60 °C			
Δ Tensile strength	−5	%	
Δ Elongation at break	2	%	
Δ Hardness	3	Shore A	
Δ Volume	0.2	%	
H_2S/N_2, 64/36 %, 648 h at 220 °C			
Δ Tensile strength	−17	%	
Δ Elongation at break	11	%	
Δ Volume	−0.3	%	
Chlorosulfonic Acid, 168 h at 23 °C			
Δ Tensile strength	−1	%	
Δ Elongation at break	5	%	
Δ Hardness	−1	Shore A	
Δ Volume	2.8	%	

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Property	Typical Value	Unit	Test Method
Formic acid, 80 %, 72 h at 23 °C			
Δ Tensile strength	0	%	
Δ Elongation at break	−4	%	
Δ Hardness	1	Shore A	
Δ Volume	0.6	%	
Formic acid, 85 %, 168 h at 100 °C			
Δ Tensile strength	−19	%	
Δ Elongation at break	−7	%	
Δ Hardness	−4	Shore A	
Δ Volume	6	%	

Alkaline fluids and amines

Property	Typical Value	Unit	Test Method
Ammonia, anhydrous, 500 h at 100 °C			
Δ Tensile strength	−7	%	
Δ Elongation at break	−6	%	
Δ Hardness	6	Shore A	
Δ Volume	−0.4	%	
Ammonia, 28 % solution, 168 h at 45 °C			
Δ Tensile strength	−19	%	
Δ Elongation at break	3	%	
Δ Hardness	2	Shore A	
Δ Volume	1	%	
Ammonia, 28 % solution, 72 h at 70 °C			
Δ Tensile strength	−15	%	
Δ Elongation at break	−10	%	
Δ Hardness	−2	Shore A	
Δ Volume	1	%	
Ammonia, 28 % solution, 336 h at 100 °C			
Δ Tensile strength	−18	%	
Δ Elongation at break	−4	%	
Δ Hardness	−4	Shore A	
Δ Volume	9	%	
NaOH, 40 %, 72 h at 100 °C			
Δ Tensile strength	10	%	
Δ Elongation at break	4	%	
Δ Hardness	0	Shore A	
Δ Volume	0.6	%	
NaOH, 50 %, 72 h at 150 °C			
Δ Tensile strength	5	%	
Δ Elongation at break	6	%	
Δ Hardness	0	Shore A	
Δ Volume	0.6	%	
Tetramethylammonium hydroxide (TMAH) 25 %, 168 h at 90 °C			
Δ Tensile strength	−3	%	
Δ Elongation at break	−11	%	
Δ Hardness	−1	Shore A	
Δ Volume	0	%	

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Property	Typical Value	Unit	Test Method
n-Butylamine, 168 h at 23 °C			
Δ Tensile strength	−14	%	
Δ Elongation at break	−4	%	
Δ Hardness	1	Shore A	
Δ Volume	1.1	%	
Ethylene diamine, 168 h at 23 °C			
Δ Tensile strength	4	%	
Δ Elongation at break	−5	%	
Δ Hardness	0	Shore A	
Δ Volume	0.2	%	
Ethylene diamine, 72 h at 100 °C			
Δ Tensile strength	−37	%	
Δ Elongation at break	52	%	
Δ Hardness	−7	Shore A	
Δ Volume	18	%	
N-Methyldiethanolamine (MDEA), 168 h at 150 °C			
Δ Tensile strength	−28	%	
Δ Elongation at break	6	%	
Δ Hardness	−4	Shore A	
Δ Volume	5	%	
Dipropylamine, 168 h at 150 °C			
Δ Tensile strength	−34	%	
Δ Elongation at break	1	%	
Δ Hardness	−6	Shore A	
Δ Volume	9	%	
Dipropylamine, 168 h at 200 °C			
Δ Tensile strength	−37	%	
Δ Elongation at break	18	%	
Δ Hardness	−6	Shore A	
Δ Volume	10	%	
Dimethyl sulfoxide (DMSO)/Ethanolamine (MEA) 30/70, 336 h at 80 °C			
Δ Tensile strength	−5	%	
Δ Elongation at break	1	%	
Δ Hardness	−3	Shore A	
Δ Volume	5	%	

For high T (> 70 °C) and concentrated amine service, Tecnoflon® PFR 06HC is recommended.

Paint spray applications

Paint solvents are usually very complex mixtures of different organic species:

Ketones: acetone, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), etc.

Esters: ethyl acetate, butyl acetate, etc.

Alcohols: isopropyl alcohol (IPA), diacetonalcohol, etc.

Ethers: 2-butoxyethanol, methoxy propyl acetate (MPA), etc.

Aromatic HC: toluene, xylenes, styrene, etc.

For each of the organic species families, some significant representatives were chosen:

Ketones: acetone, MEK

Esters: ethyl acetate

Alcohols: IPA

Ethers: MPA

Aromatic HC: toluene

Property	Typical Value	Unit	Test Method
Acetone, 168 h at 23 °C			
Δ Tensile strength	−7	%	
Δ Elongation at break	6	%	
Δ Hardness	−1	Shore A	
Δ Volume	1.3	%	
Methyl ethyl ketone (MEK), 168 h at 23 °C			
Δ Tensile strength	−5	%	
Δ Elongation at break	5	%	
Δ Hardness	0	Shore A	
Δ Volume	0.8	%	
Ethyl acetate, 168 h at 23 °C			
Δ Tensile strength	−10	%	
Δ Elongation at break	−6	%	
Δ Hardness	0	Shore A	
Δ Volume	1.2	%	
Isopropyl alcohol (IPA), 168 h at 70 °C			
Δ Tensile strength	−11	%	
Δ Elongation at break	1	%	
Δ Hardness	−2	Shore A	
Δ Volume	1.6	%	
Methoxypropylacetate (MPA), 168 h at 23 °C			
Δ Tensile strength	5	%	
Δ Elongation at break	2	%	
Δ Hardness	1	Shore A	
Δ Volume	0.1	%	

Property	Typical Value	Unit	Test Method
Toluene, 168 h at 70 °C			
Δ Tensile strength	−14	%	
Δ Elongation at break	−10	%	
Δ Hardness	−4	Shore A	
Δ Volume	0.1	%	

Polar solvents

Property	Typical Value	Unit	Test Method
Methyl Isobutyl Ketone (MIBK), 168 h at 120 °C			
Δ Tensile strength	−28	%	
Δ Elongation at break	6	%	
Δ Hardness	−5	Shore A	
Δ Volume	4.1	%	
Acetonitrile, 168 h at 23 °C			
Δ Tensile strength	−12	%	
Δ Elongation at break	8	%	
Δ Hardness	−2	Shore A	
Δ Volume	0.5	%	
Dimethylformamide, 168 h at 150 °C			
Δ Tensile strength	−18	%	
Δ Elongation at break	−20	%	
Δ Hardness	−3	Shore A	
Δ Volume	7.4	%	

Fluorinated fluid resistance

Property	Typical Value	Unit	Test Method
HFA 123, 720 h at 23 °C			
Δ Tensile strength	−79	%	
Δ Elongation at break	−54	%	
Δ Hardness	−11	Shore A	
Δ Volume	30	%	
Halothane (1-bromo-1-chloro-2,2,2-trifluoroethane), 168 h at 23 °C			
Δ Tensile strength	−53	%	
Δ Elongation at break	−75	%	
Δ Hardness	−5	Shore A	
Δ Volume	17	%	
Galden® HT 135, 168 h at 100 °C			
Δ Volume	60	%	
Galden® ZT 130/Galden® HT 135 50/50, 168 h at 100 °C			
Δ Tensile strength	−79	%	
Δ Elongation at break	−63	%	
Δ Hardness	−8	Shore A	
Δ Volume	54	%	

Tecnoflon® PFR 94, like all perfluoroelastomers, is not recommended for use in highly fluorinated fluids.

Fluid resistance (miscellaneous)

Property	Typical Value	Unit	Test Method
Methylcyclohexane, 168 h at 23 °C			
Δ Tensile strength	−4	%	
Δ Elongation at break	−5	%	
Δ Hardness	0	Shore A	
Δ Volume	0.3	%	
Kerosene, 168 h at 150 °C			
Δ Tensile strength	−21	%	
Δ Elongation at break	−4	%	
Δ Hardness	−1	Shore A	
Δ Volume	4	%	
Fuel C, 504 h at 40 °C			
Δ Volume	6	%	
85 % Fuel C, 15 % Methanol, 504 h at 40 °C			
Δ Volume	5	%	
85 % Fuel C, 15 % Methyl tert-butyl ether (MTBE), 504 h at 40 °C			
Δ Volume	7	%	
ASTM 3 + 1 % Benzylamine, 72 h at 160 °C			
Δ Tensile strength	−25	%	
Δ Elongation at break	−38	%	
Δ Hardness	2	Shore A	
Δ Volume	2.9	%	
GL-5 + 6 % Sturaco® 7098, 168 h at 150 °C			
Δ Tensile strength	−10	%	
Δ Elongation at break	−2	%	
Δ Hardness	−1	Shore A	
Δ Volume	1.8	%	
50 % PARAFLU, 50 % Water, 168 h at 150 °C			
Δ Tensile strength	−6	%	
Δ Elongation at break	−2	%	
Δ Hardness	−2	Shore A	
Δ Volume	0	%	
2.5 % Diethanol amine, 50 % DI Water, 47.5 % Ethylene Glycol, 168 h at 200 °C			
Δ Tensile strength	−19	%	
Δ Elongation at break	15	%	
Δ Hardness	−5	Shore A	
Δ Volume	7	%	

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Property	Typical Value	Unit	Test Method
Ethylene oxide, 168 h at 23 °C			
Δ Tensile strength	−24	%	
Δ Elongation at break	7	%	
Δ Hardness	−3	Shore A	
Δ Volume	1.5	%	
Petroleum, 168 h at 235 °C			
Δ Tensile strength	−24	%	
Δ Elongation at break	17	%	
Δ Hardness	−2	Shore A	
Δ Volume	2.8	%	
Chlorobenzene, 168 h at 100 °C			
Δ Tensile strength	−1	%	
Δ Elongation at break	5	%	
Δ Hardness	−1	Shore A	
Δ Volume	2.8	%	
1,2 - Dichlorobenzene, 168 h at 180 °C			
Δ Tensile strength	−13	%	
Δ Elongation at break	−1	%	
Δ Hardness	−2	Shore A	
Δ Volume	5.7	%	
Phenol, 168 h at 220 °C			
Δ Tensile strength	−15	%	
Δ Elongation at break	10	%	
Δ Hardness	−1	Shore A	
Δ Volume	4.7	%	

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Perfluoroelastomer

Miscellaneous PFR properties

In general, the following properties can be considered as typical or average values for perfluoroelastomers.

Thermal expansion

Following the definition of linear coefficient of thermal expansion: $L = L_0 \cdot (1 + \alpha \cdot \Delta T)$, the average value between 80 and 250 °C is as follows:

$\alpha = 3.5 \cdot 10^{-4}\ 1/K$

Specific heat

Temperature	Unit	Black Compounds	White Compounds	Test Method
50 °C	J/g	0.98	0.83	
100 °C	J/g	1.05	0.86	
150 °C	J/g	1.12	0.91	

Gas permeation

Test Compound	Permeability (T = 30°C)	Unit	Test Method
Nitrogen	250	$(cm^3(STP)\cdot mm/m^2\cdot atm\cdot d)$	
Oxygen	450	$(cm^3(STP)\cdot mm/m^2\cdot atm\cdot d)$	
Helium	5,400	$(cm^3(STP)\cdot mm/m^2\cdot atm\cdot d)$	

Electrical properties

Dielectric constant and loss factor at 50 Hz frequency. Volume and surface resistivity were measured applying 100 V direct tension.

Property	Typical Value	Unit	Test Method
Dielectric constant ε'	3.50		
Loss factor tan(δ)	0.030		
Surface resistivity R_s	$5.0 \cdot 10^{16}$	Ω	
Volume resistivity R_v	$6.1 \cdot 10^{16}$	Ω·cm	

www.solvay.com

SpecialtyPolymers.EMEA@solvay.com | Europe, Middle East and Africa

SpecialtyPolymers.Americas@solvay.com | Americas

SpecialtyPolymers.Asia@solvay.com | Asia Pacific

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