

Hyflon[®]



SOLVAY

asking more from chemistry[®]

Hyflon[®] PFA

Typical Properties

**SPECIALTY
POLYMERS**

Hyflon® PFA

Perfluoroalkoxy Fluorocarbon Resins

Hyflon® PFA is the product name for the Solvay Specialty Polymers range of melt processable perfluoroalkoxy fluorocarbon resins specifically designed for high temperature service and virtually universal chemical resistance. It represents a family of semi-crystalline resins which combines exceptional value with high performance properties.

The Hyflon® PFA range consists of two product series: the P series and the M series. Both can be used in applications as diverse as tubing, fittings, tank linings, tower packing, fittings and valve linings, films, high purity, fibers, heat tracing wiring, avionics and specialty cables.

The P series features a higher melting point.

The M series can offer:

- Intrinsic processing stability due to the presence of the more stable methyl side chains
- Improved surface smoothness, which reduces the tendency for adhesion and growth of bacteria
- Remarkably higher transmittance values over the whole spectrum resulting in improved clarity

Perfluoroalkoxy fluorocarbon resins are copolymers of tetrafluoroethylene and perfluoroalkylvinylethers. The type and frequency of the side chains dictate the thermo-mechanical properties of the polymer. As a general rule a high number of side chains will provide:

- Lower thermal rating
(low melting point and low creep resistance)
- High tenacity (high stress/strain at break)
- High flex-life

The polymer molecular weight is another important parameter affecting the mechanical properties of a specific composition. Usually the Melt Flow Index MFI (measured at 372 °C with a 5 kg weight) is used to provide an indication of the molecular weight: a high molecular weight leads to high viscosity that is low MFI resin.

As a general rule, low MFI resins show:

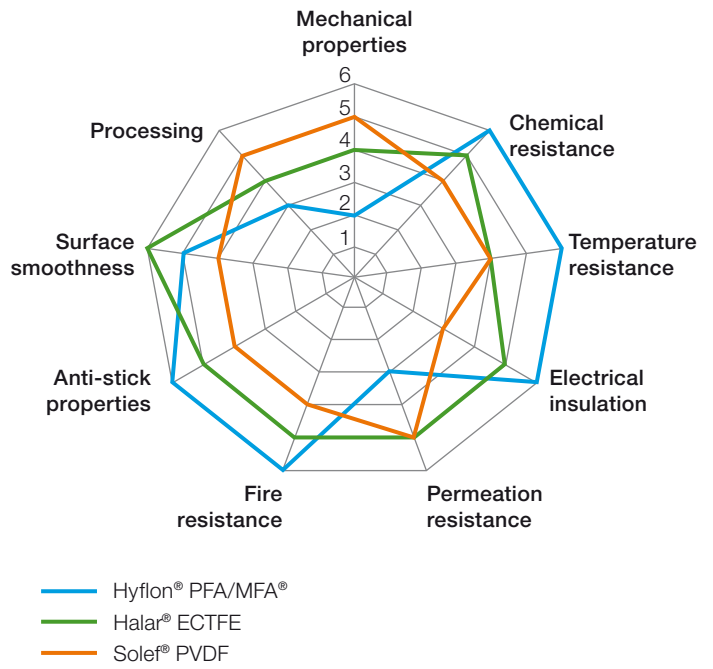
- High tenacity
- High flex-life

The size of the side chains can be used to balance the effect of low molecular weight and a big co-monomer will allow the design of high flex life materials also at high MFI.

In addition to the Hyflon® resins, Solvay Specialty Polymers offers a wide range of other fluoropolymers which are also easily processable by injection, extrusion, and all conventional processing techniques:

- Solef® PVDF (polyvinylidene fluoride)
- Halar® ECTFE (copolymer of ethylene and chlorotrifluoroethylene)
- Hylar® PVDF for coating applications

Relative performance of melt processable fluoropolymers



Hyflon® PFA grades

Grade	Description
P series	
Hyflon® P125	High viscosity resin for pressure tubing with superior heat resistance for compression and transfer molding
Hyflon® P120	High viscosity resin for lining and special cables with superior heat resistance
Hyflon® P420	High viscosity resin for extrusion
Hyflon® P450	Low viscosity resin for cable extrusion and injection molding
M series	
Hyflon® M620	High viscosity resin for extrusion, compression and transfer molding
Hyflon® M640	Low viscosity resin for cable extrusion and injection molding

Typical Properties of Hyflon® PFA P Series Grades

	Unit	P125	P120	P420	P450	Test Method
Physical properties						
Density at 23°C/73°F	g/cm ³ (lb/ft ³)	2.12–2.17 (132–135)	2.12–2.17 (132–135)	2.12–2.17 (132–135)	2.12–2.17 (132–135)	ASTM D792
Water absorption (7 days at 100°C/212°F)	%	< 0.1	< 0.1	< 0.1	< 0.1	ASTM D570
Melt flow index at 372°C/702°F, 5 kg	g/10 min	1.5–3.0	2.5–5.0	1.5–3.0	10–17	ASTM D1238
Mechanical properties						
Tensile at 23°C/73°F						ASTM D1708
Stress at yield (50 mm/min)	MPa (psi)	14–15 (2,000–2,150)	14–15 (2,000–2,150)	14–15 (2,000–2,150)	14–15 (2,000–2,150)	
Stress at break (50 mm/min)	MPa (psi)	> 26 (3,750)	> 26 (3,750)	> 26 (3,750)	> 21 (3,045)	
Elongation at yield (50 mm/min)	%	9–11	9–11	9–11	9–11	
Elongation at break (50 mm/min)	%	> 300	> 300	> 300	> 275	
Modulus (1 mm/min)	MPa (kpsi)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	
Flexural at 23°C/73°F						ASTM D790
Modulus (2.5 mm/min)	MPa (kpsi)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	
Notched charpy strength (4 mm thick, 2 m/s, 23°C/73°F)	J/m (ft·lbf/in)	no break	no break	no break	no break	ASTM D6110
Shore D hardness (2 mm thick)		55–60	55–60	55–60	55–60	ASTM D2240
Abrasion resistance	mg/1,000 rev	10–20	10–20	10–20	10–20	TABER CS 17, 1 kg
Friction coefficient		0.1–0.2	0.1–0.2	0.1–0.2	0.1–0.2	ASTM D1894
Folding endurance (0.3 mm film, 90 cycles/min)	1,000 cycles	50–80	50–80	90–120	4–6	ASTM D2176

	Unit	P125	P120	P420	P450	Test Method
Thermal properties						
Crystallinity by DSC						
Melting point	°C (°F)	310–316 (590–601)	310–316 (590–601)	300–310 (572–590)	300–310 (572–590)	ASTM D3418
Heat of fusion (250 °C/482 °F to end of melting)	J/g (BTU/lb)	25–35 (10.7–15.0)	34–45 (14.6–19.3)	25–35 (10.7–15.0)	25–35 (10.7–15.0)	ASTM D3418
Crystallization point	°C (°F)	275–285 (527–545)	275–285 (527–545)	275–285 (527–545)	275–285 (527–545)	ASTM D3418
Crystallization heat	J/g (BTU/lb)	25–35 (10.7–15.0)	35–45 (15.0–19.3)	25–35 (10.7–15.0)	25–35 (10.7–15.0)	ASTM D3418
Glass transition (T _g)	°C (°F)	90 (194)	90 (194)	90 (194)	90 (194)	DMTA
Molding shrinkage (linear)	%	3–5	3–5	3–5	3–5	ASTM D955
Thermal stability	°C (°F)	420–440 (788–824)	420–440 (788–824)	420–440 (788–824)	420–440 (788–824)	TGA. T° for 1% w loss in air
Linear thermal expansion coefficient	10 ⁻⁶ /K (10 ⁻⁶ /°F)	120–200 (67–111)	120–200 (67–111)	120–200 (67–111)	120–200 (67–111)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft ² ·°F)	0.15–0.25 (1.0–1.7)	0.15–0.25 (1.0–1.7)	0.15–0.25 (1.0–1.7)	0.15–0.25 (1.0–1.7)	ASTM C177
Specific heat at 23 °C/73 °F	J/g·K (BTU/lb·°F)	0.9–1.1 (0.21–0.26)	0.9–1.1 (0.21–0.26)	0.9–1.1 (0.21–0.26)	0.9–1.1 (0.21–0.26)	ASTM E1269
Electrical properties						
Surface resistivity	Ω	> 10 ¹⁷	> 10 ¹⁷	> 10 ¹⁷	> 10 ¹⁷	ASTM D257, DIN 53483
Volume resistivity	Ω·cm	> 10 ¹⁷	> 10 ¹⁷	> 10 ¹⁷	> 10 ¹⁷	ASTM D257, DIN 53483
Dielectric constant (50 Hz–100 kHz)		2.0	2.0	2.0	2.0	ASTM D150
Dissipation factor (50 Hz–100 kHz)		< 5·10 ⁻⁴	< 5·10 ⁻⁴	< 5·10 ⁻⁴	< 5·10 ⁻⁴	ASTM D150
Fire resistance						
UL-94 flammability test	Class	V-0	V-0	V-0	V-0	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	95	95	95	95	ASTM D2863

Typical Properties of Hyflon® PFA M Series Grades

	Unit	M620	M640	Test Method
Physical properties				
Density at 23 °C/73 °F	g/cm ³ (lb/ft ³)	2.12–2.17 (132–135)	2.12–2.17 (132–135)	ASTM D792
Water absorption (7 days at 100 °C/212 °F)	%	< 0.1	< 0.1	ASTM D570
Melt flow index at 372 °C/702 °F, 5 kg	g/10 min	2–5	10–17	ASTM D1238
Mechanical properties				
Tensile at 23 °C/73 °F				ASTM D1708
Stress at yield (50 mm/min)	MPa (psi)	12–15 (1,750–2,150)	12–15 (1,750–2,150)	
Stress at break (50 mm/min)	MPa (psi)	> 26 (3,750)	> 21 (3,045)	
Elongation at yield (50 mm/min)	%	9–11	9–11	
Elongation at break (50 mm/min)	%	> 300	> 275	
Modulus (1 mm/min)	MPa (kpsi)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	
Flexural at 23 °C/73 °F				ASTM D790
Modulus (2.5 mm/min)	MPa (kpsi)	500–600 (72.5–87.0)	500–600 (72.5–87.0)	
Notched charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	J/m (ft·lbf/in)	no break	no break	ASTM D6110
Shore D hardness (2 mm thick)		55–60	55–60	ASTM D2240
Abrasion resistance	mg/1,000 rev	10–20	10–20	TABER CS 17, 1 kg
Friction coefficient		0.1–0.2	0.1–0.2	ASTM D1894
Folding endurance (0.3 mm film, 90 cycles/min)	1,000 cycles	70–100	4–6	ASTM D2176

	Unit	M620	M640	Test Method
Thermal properties				
Crystallinity by DSC				
Melting point	°C (°F)	280–290 (536–554)	280–290 (536–554)	ASTM D3418
Heat of fusion (250 °C/482 °F to end of melting)	J/g (BTU/lb)	18–26 (7.7–11.2)	18–26 (7.7–11.2)	ASTM D3418
Crystallization point	°C (°F)	255–265 (491–509)	255–265 (491–509)	ASTM D3418
Crystallization heat	J/g (BTU/lb)	18–26 (7.7–11.2)	18–26 (7.7–11.2)	ASTM D3418
Glass transition (T _g)	°C (°F)	85 (185)	85 (185)	DMTA
Molding shrinkage (linear)	%	3–5	3–5	ASTM D955
Thermal stability	°C (°F)	420–440 (788–824)	420–440 (788–824)	TGA. T° for 1% w loss in air
Linear thermal expansion coefficient	10 ⁻⁶ /K (10 ⁻⁶ /°F)	120–200 (67–111)	120–200 (67–111)	ASTM D696
Thermal conductivity at 23 °C/73 °F	W/m·K (BTU·in/h·ft ² ·°F)	0.15–0.25 (1.0–1.7)	0.15–0.25 (1.0–1.7)	ASTM C177
Specific heat at 23 °C/73 °F	J/g·K (BTU/lb·°F)	0.9–1.1 (0.21–0.26)	0.9–1.1 (0.21–0.26)	ASTM E1269
Electrical properties				
Surface resistivity	Ω	> 10 ¹⁷	> 10 ¹⁷	ASTM D257, DIN 53483
Volume resistivity	Ω·cm	> 10 ¹⁷	> 10 ¹⁷	ASTM D257, DIN 53483
Dielectric constant (50 Hz–100 kHz)		2.0	2.0	ASTM D150
Dissipation factor (50 Hz–100 kHz)		< 5·10 ⁻⁴	< 5·10 ⁻⁴	ASTM D150
Fire resistance				
UL-94 flammability test	Class	V–0	V–0	UL-94
Limiting oxygen index (sheet 3 mm thick)	%	95	95	ASTM D2863



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