Solef® PVDF

A Remarkable Combination of Properties

Solef® PVDF is a fluorinated semi-crystalline thermoplastic which is obtained by polymerizing vinylidene fluoride. This fluorinated polymer has been manufactured and marketed for more than 30 years, using both suspension and emulsion process developed and perfected by Solvay Specialty Polymers. Solef® PVDF, without any additives, has the intrinsic stability inherent to fluoropolymers, even when exposed to harsh environments. It provides the user with a unique combination of properties leading to longer equipment life. The most important properties of Solef® PVDF are listed below:

- Excellent chemical resistance to most aggressive substances and solvents
- Excellent mechanical strength and toughness
- High abrasion resistance
- High temperature capabilities: continuous use service temperature up to 150 °C (302 °F)
- Excellent ageing resistance
- High purity
- Resistance to UV and nuclear radiations
- Excellent intrinsic fire resistance
- Low permeability to most gases and liquids
- Easily melt-processed by standard methods of extrusion and molding
- Wide range of rigid and flexible grades available

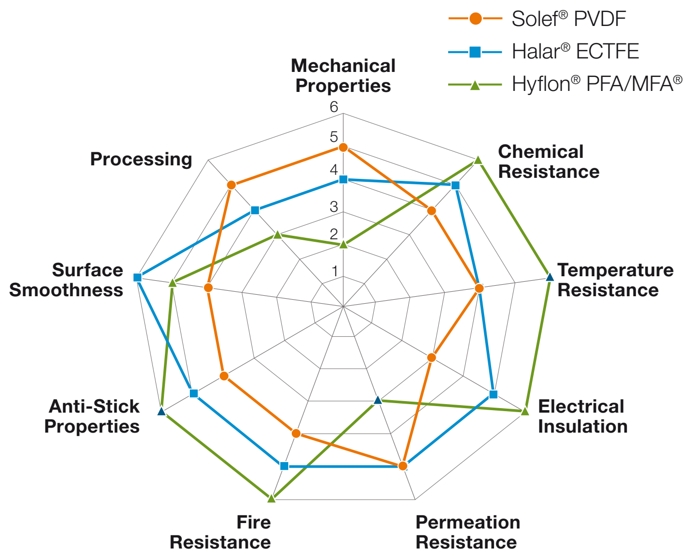
Besides the PVDF homopolymers, Solvay Specialty Polymers offers a wide products range of VF2-HFP c opolymers, and VF2-CTFE copolymers which stand out for their better cold temperature behavior. The VF2-CTFE range comprises the Solef® 60000 series, which offers an improved balance between good cold temperature properties and thermomechanical properties of the homopolymers.

PVDF is extensively used in the general chemical processing industry, the high purity semiconductor market, and the wire and cable industry. Solvay Specialty Polymers today offers a growing choice of PVDF grades which are associated with new applications such as the Oil & Gas industry, Automotive, Building industry, Electronics, Chimney linings, Lithium Batteries, Fuel cells, Food and Pharmaceutical industries.

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

- Halar® ECTFE (copolymer of ethylene and chlorotrifluoroethylene)
- Hyflon® PFA/MFA® (copolymer of tetrafluoroethylene and perfluoroalkylvinylethers)
- Hylar® PVDF for coating applications

Relative performance of melt processable fluoropolymers



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SOLVAY

a Passion for Progress®

SOLVAY SPECIALTY POLYMERS
More Products with More Performance™

Typical Properties

Solef® PVDF

SOLVAY

Typical properties

P = powder. G = granules	Test Method	Units	Homopolymers										Copolymers			
			6008	6010	6012	1015	6020	5130	9007	9009	460	41308	11010	21510	31508	60512
			Low molecular weight PVDF homopolymer	Medium molecular weight PVDF homopolymer	High molecular weight PVDF homopolymer	Very high molecular weight PVDF homopolymer	Ultra high molecular weight PVDF homopolymer	Ultra high molecular weight functionalized PVDF homopolymer	Low molecular weight PVDF homopolymer	Medium molecular weight PVDF homopolymer	Branched high molecular weight PVDF homopolymer	Enhanced adhesion PVDF for multilayer structures	Flexible PVDF copolymer	Very flexible PVDF copolymer	Improved low-temperature flexibility PVDF copolymer	Special PVDF grade for high-pressure flexible piping
			P & G	P & G	P & G	P	P	P	P & G	P & G	P & G	P & G	P & G	P & G	P & G	G
Physical properties																
Density @ 23 °C (73 °F)	ASTM D792	g/cm^3 (Lb/ft^3)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)	1.75–1.80 (110–112)
Water absorption (24h at 23 °C / 73.4 °F)	ASTM D570	%	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.2	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Melt flow index (230 °C / 446 °F)	ASTM D1238	g/10 min														
21.6 kg			–	–	–	2.8–4.6	≤ 0.2	–	–	–	10	–	–	–	–	–
10 kg			–	–	4–6	–	–	–	–	–	–	–	–	–	–	2.5–4
5 kg			16–30	4–8	–	–	–	–	20–38	10–20	–	18–24	4–8	3–9	–	–
3.8 kg			–	–	–	–	–	–	16–26	7–13	–	–	–	–	–	–
2.16 kg			5.5–11	–	–	–	–	–	–	–	–	6–8	–	–	3–8	–
Mechanical properties																
Tensile @ 23 °C (73.4 °F)	ASTM D638 (Type IV specimen, 2 mm thick)															
Stress at yield (50 mm/min)		MPa (psi)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	50–60 (7,200–8,700)	–	–	45–60 (6,500–8,700)	45–60 (6,500–8,700)	35–55 (5,000–8,000)	45–50 (6,500–7,200)	20–35 (2,900–5,000)	15–18 (2,175–2,610)	14–35 (2,030–5,075)	34–40 (4,930–5,800)
Stress at break (50 mm/min)		MPa (psi)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	–	–	30–50 (4,400–7,300)	30–50 (4,400–7,300)	30–50 (4,400–7,300)	20–40 (2,900–5,800)	20–40 (2,900–5,800)	20–40 (2,900–5,800)	14–30 (2,030–4,350)	34–40 (4,930–5,800)
Elongation at yield (50 mm/min)		%	5–10	5–10	5–10	5–10	–	–	5–10	5–10	10–15	5–10	10–12	12–15	10–12	9–12
Elongation at break (50 mm/min)		%	20–300	20–300	20–300	20–300	–	–	20–300	20–300	20–300	20–300	200–600	600–750	350–600	100–300
Modulus (1 mm/min)		MPa (kpsi)	1,800–2,500 (260–360)	1,700–2,500 (250–360)	1,700–2,500 (250–360)	1,700–2,500 (250–360)	1,300–2,000 (188–290)	1,000–1,500 (145–218)	1,400–2,200 (200–320)	1,400–2,200 (200–320)	1,000–1,500 (145–218)	1,600–2,200 (230–320)	800–1,200 (120–180)	360–480 (52–70)	400–600 (58–87)	1,250–1,400 (181.3–203)
Notched Charpy strength (4 mm thick, 2 m/s, 23 °C/73 °F)	ASTM D6110	J/m (ft·lbf/in)	40–120 (0.7–2.0)	100–200 (2–4)	150–250 (3–5)	400–500 (7.5–10)	–	–	40–120 (0.7–2.0)	40–120 (0.7–2.0)	–	40–120 (0.7–2.0)	150–200 (3–5)	–	–	400–1,000 (7.5–18.7)***
IZOD impact (notched V 10 mm, 23 °C / 73.4 °F, 4 mm thick)	ASTM D256	J/m (ft·lbf/in)	–	–	–	–	–	–	–	–	107 (2)	–	–	180 (3.37)	1,000 (18.7)***	–
Shore D hardness (2 mm thick)	ASTM D2240	–	73–80	73–80	72–78	72–78	–	–	73–80	73–80	73–80	–	70–75	58–62	50–55	70
Abrasion resistance	TABER CS 17, 1 kg	mg/1,000 rev	5–10	5–10	5–10	5–10	–	–	5–10	5–10	5–10	5–10	5–15	5–15	5–10	5–10
Friction coefficient: static / dynamic	ASTM D1894	–	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	–	–	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.25–0.35 / 0.25–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.15–0.35	0.2–0.4 / 0.2–0.3
Thermal properties																
Crystallinity by DSC																
Melting point	ASTM D3418	°C (°F)	170–175 (338–347)	170–175 (338–347)	170–175 (338–347)	170–175 (338–347)	171–175 (340–347)	158–166 (316–331)	162–168 (324–334)	162–168 (324–334)	155–160 (311–320)	167–171 (333–339)	158–162 (316–324)	130–136 (266–277)	167–171 (333–339)	170–174 (338–345)
Heat of fusion (80 °C / 176 °F to end of melting)	ASTM D3417	J/g (BTU/lb)	58–67 (25–29)	58–66 (25–28)	55–65 (23–28)	57–66 (24–28)	55–65 (23–28)	40–48 (17–21)	53–60 (22–26)	53–60 (22–26)	42–50 (17–21)	50–55 (21–23)	35–40 (15–18)	20–24 (9–10)	23–29 (8.2–14.2)	41–50 (18–21.5)
Cristallizing point	ASTM D3418	°C (°F)	134–144 (273–291)	137–144 (279–291)	137–145 (279–293)	137–144 (279–291)	133–138 (271–280)	124–130 (255–266)	133–140 (271–284)	133–140 (271–284)	128–135 (262–275)	130–140 (266–284)	115–130 (239–266)	89–93 (192–199)	125–131 (259–265)	142–146 (288–295)
Cristallization heat	ASTM D3417	J/g (BTU/lb)	54–60 (23–26)	54–60 (23–26)	50–60 (21–26)	50–56 (21–24)	48–55 (21–24)	37–45 (16–19)	53–60 (22–26)	53–60 (22–26)	42–50 (17–21)	48–54 (20–23)	30–40 (13–18)	20–24 (9–10)	22–28 (7–13)	42–50 (18–21.5)
VICAT point	ASTM D1525 2A	°C (°F)	135–145 (275–295)	135–145 (275–295)	135–145 (275–295)	135–145 (275–295)	135–145 (275–295)	–	–	–	–	–	90–105 (194–220)	155 (239)	110 (230)	167 (333)
Glass transition (Tg)	ASTM D4065	°C (°F)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	–40 (–40)	–39 (–38)	–40 (–40)	–35 (–31)	–40 (–40)	–28 (–18)	–40 (–40)
Molding shrinkage (linear)		%	2–3	2–3	2–3	–	–	–	2–3	2–3	–	–	2–3	2–3	2–3	2–3
Thermal stability	TGA. T° for 1 % w loss in air	°C (°F)	375–400 (707–752)	>400 (>752)*	>400 (>752)*	375–400 (707–752)	375–400 (707–752)	> 375 (> 707)	375–400 (707–752)	375–400 (707–752)	375–400 (707–752)	> 375 (> 707)	330–350 (626–662)	340–375 (644–707)	320–340 (608–644)	320–340 (608–644)
Linear thermal expansion coefficient	ASTM D696	10^{-6}/K (10^{-6}/°F)	140 (78)	140 (78)	140 (78)	140 (78)	140 (78)	–	140 (78)	140 (78)	126 (70)	140 (78)	180 (100)	180 (100)	130–150 (72–83)	130–180 (72–100)
Thermal conductivity @ 23 °C (73.4 °F)	ASTM C177	W/m·K (BTU·in/h·ft²·°F)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	–	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.2 (1.4)	0.19 (1.3)	0.18 (1.2)	0.2 (1.4)	0.2 (1.4)
Specific heat		J/g·K (BTU/lb·°F)														
@ 23 °C (73.4 °F)			1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	–	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	–	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)	1.2 (0.28)
@ 100 °C (212 °F)			1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	–	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	–	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)	1.6 (0.38)
Electrical properties																
Surface resistivity voltage < 1 V, after 2 min, 500 V @ 23 °C (73.4 °F)	ASTM D257	Ω	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$
Volume resistivity intensity = 10 mA, after 2 min @ 23 °C (73.4 °F)	ASTM D257	Ω·cm	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$	$\geq 10^{14}$
Dielectric strength @ 23 °C (73.4 °F), 1 mm thick	ASTM D149	kV/mm	20–25	20–25	20–25	20–25	20–25	–	20–25	20–25	10	–	15–25	15–20	20–25	–
Fire resistance																
UL-94 flammability test	UL-94	Class	V–0	V–0	V–0	V–0	V–0	–	V–0	V–0	V–0	–	V–0	–	V–0	–
Limiting oxygen index (sheet 3 mm thick)	ASTM D2863	%	44	44	44	44	44	–	44	44	44	–	44**	44**	48	–

Mechanical properties are significantly affected by the sample preparation method.
Typical property values are reported in this document.
They should not be interpreted as sales specifications.

* Results achieved with formulated grade (code: XXXX/0000)

** Formulations with higher values available: the Limiting Oxygen Index of the /0003 formulation is 65 %; the Limiting Oxygen Index of the /0009 formulation is > 90 %.

*** Partial break