PVDF: Polyvintlidene Fluoride

Polyvinylidene fluoride (PVDF) is a thermoplastic that is distinguished from other fluorinated polymers by its ease of processing, good welding characteristics, and good heat formability. PVDF also has high mechanical strength, excellent chemical resistance, and high operating temperature capabilities. It has the widest range of applications of any of the thermoplastics used for rigid piping systems.

The excellent chemical resistance of PVDF means that it is extensively used in the chemical industry as a piping system for aggressive liquids, and in the field of tank construction and lining. PVDF is a homopolymer without additives such as stabilizers and processing agents. It also displays excellent flame retardant properties. Consequently, PVDF is listed with many worldwide agencies as suitable for use with foodstuffs, dairy products, hot and cold water in the semi-conductor and pharmaceutical industries, and for other applications in the food and drug sector.

Physiologically non-toxic, the smooth surface finish of PVDF does not encourage the growth of microorganisms. When coupled with its low friction coefficient, these natural anti fouling characteristics make PVDF ideally suited to applications involving ultra-pure liquids.

PVDF also has good resistance to UV and gamma radiation, including ageing resistance. However, in the case of direct radiation from UV lamps with a wavelength of 184 nanometer, it is recommended to use a stainless steel diaphragm valve or a 90° bend at the connection points to reflect the UV light.

PVDF does not support combustion after removal of a flame, and thus it falls into the class V-0 according to UL94 This material meets FMRC 4910 clean rooms materials flammability test protocol.
PVDF has excellent welding characteristics, and can be joined by either heating element socket fusion welding, heating element butt fusion welding, non-contact Infra-Red (IR) welding or electro fusion welding techniques. Additionally, PVDF systems can be joined using flanges, threaded connections and mechanical couplings. PVDF piping systems are available from IPS in metric dimensions according to DIN 8077/8078 and DIN 16962.

General properties of PVC-U

In comparison to other thermoplastics such as polypropylene, PVDF exhibits thermal stability up to 120°C, (short term 140°C for drainage systems). PVDF also has good impact strength, which rises further as the temperature increases.

Some important advantages of polypropylene are:

- Low specific weight of 0.91g/cm^3
- High long term creep resistance
- Excellent chemical resistance
- High resistance to thermal ageing
- Outstanding welding characteristics
- Excellent abrasion resistance
- Smooth internal surfaces

High purity grades of PVDF

PVDF UHP is an extremely pure grade of polyvinylidene fluoride containing no UV or heat stabilizers, lubricants or flame-retardent additives. Consequently it is particularly suitable for ultra-pure water piping installations and for the transportation of clear chemical liquids in the semiconductor or pharmaceutical industries.

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Materials

Properties of Polypropylene (average values)		
Property	Vlaue	Unit
Density	1.76	g / cm^3
Tensile Strength	>50	MPa
Elongation at Break	80	%
Notched Impact Strength at 23°C	11	kJ/ m^2
Modulus of Elasticity (Young's Modulus)	2000	MPa
Coefficient of liner Expansion	0.12	mm/m °C
Maximum Operating Temperature	140	°C
Minimum Operating Temperature	-40	°C
Crystalline Melting Temperature	174	°C
Surface Resistance	$>10_{12}$	Ω
Thermal Conductivity	0.13	w / m · K
Flammability	V-0	UL_{94}
Colour	Natural	

Chemical resistance

PVDF has an outstanding resistance to inorganic and organic acids, oxidizing media, aliphatic and aromatic hydrocarbons, alcohols and halogenated solvents. PVDF is resistant to halogens, in particular bromine (but not fluorine) and to weak bases. It is degraded by fuming sulphuric acid, some strong basic amines, concentrated and hot alkalis as well as alkaline metals.

PVDF swells in high-polar solvents such as acetone and ethyl acetate. It is also slightly soluble in aphoristic solvents, for example dimethyl form amide and dimethyl sulphide. For further information on the suitability of PVDF for your application, consult the chemical resistance tables or our technical department.

Weathering resistance

Piping systems in PVDF are resistant to UV, and therefore they do not need to be protected against degradation when used outdoors.

Physiological characteristics

PVDF is physiologically non-toxic, and meets the European Directive 90/128/EEC relating to plastic materials in contact with foodstuffs. It is particularly suitable for high purity applications handling hot and cold water in the semi-conductor and pharmaceutical industries, and for applications in the food and drug sector.

Characteristics of PVDF UHP (Ultra High Purity Grade)

PVDF UHP piping is manufactured from an ultra high purity grade resin in natural colour. The manufacturing process is carried out under controlled clean room conditions, and the finished product is rinsed with de-ionized water before protective packaging. PVDF UHP pipes and fittings meet the high demands of the semiconductor industry - for example they are able to maintain the specific resistance of de-ionized and ultra pure water above 18 MΩ.cm (0.055µS)

The performance characteristics of PVDF UHP are broadly similar to those of standard grades of PVDF, therefore it is possible to reference the application and installation guidelines contained in this document. However to achieve the highest levels of performance it is recommended that welding be carried out using the Infra-Red (IR) non-contact butt fusion welding method. This method consistently produces the smallest weld profile and the weld details are computer recorded, enabling complete traceability from raw material to installed system.

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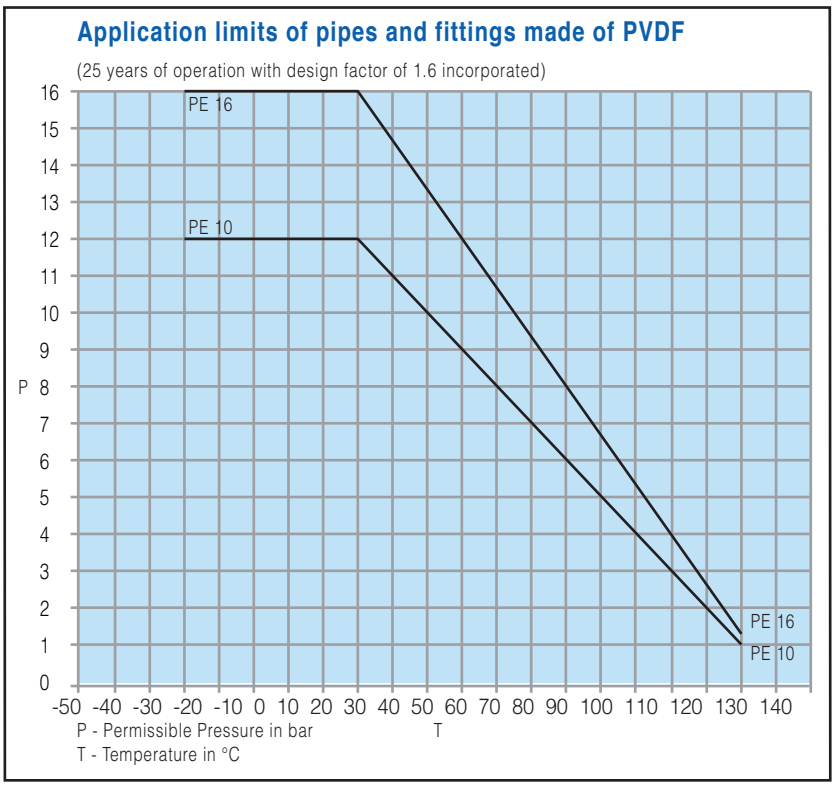
Pressure ratings for PVDF pipe, fittings and valves

For guidance, the following table gives an indication of the available pressure ratings for polyethylene pipes, fittings and valves. The pressure rating of individual items should always be verified with our technical department before installation.

Product	Size (O.D.)	Pressure Rating at 20°C
PVDF Pipe S - 16 / SDR33	63mm - 400mm	10.0
PVDF Pipe S - 10 / SDR21	20mm - 280mm	16.0 bar
PVDF Socket Fusion Fittings	20mm - 110mm	20.0 bar*
* Adaptor Fittings 10.0 bar		
PVDF Butt Fusion Fittings S-16 / SDR33	90mm - 315mm	10.0 bar
PVDF Butt Fusion Fittings S-10 / SDR21	20mm - 280mm	16.0 bar
PVDF Electro-Fusion Fittings	20mm - 63mm	16.0 bar
PVDF Ball Valves	20mm - 75mm	16.0 bar
PVDF Ball Valves	90mm - 110mm	10.0 bar
PVDF Diaphragm Valves	20mm - 110mm	10.0 bar
PVDF Butterfly Valves	90mm - 140mm	10.0 bar
PVDF Butterfly Valves	160mm - 225mm	6.0 bar

Pressure ratings for thermoplastic pipes are determined in a water environment at a temperature of 20°C. As the temperature of the media (and/or the piping environment) increases, the thermoplastic material becomes more ductile, causing a decrease in the tensile strength. Because of this, the pressure rating of the system must be reduced as the temperature rises to allow for safe operation. The application limits for PVDF piping is shown in the following diagram:



PVDF pipe availability

Metric Size ISO 161		Standard Grade			UHP Ultra High Purity Grade	
Size	Series SDR Working Pressure	Ventilation *	S-16 SDR 33 PN 10	S-10 SDR33 PN 16	S-16 SDR 33 PN 10	S-10 SDR21 PN 16
16	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			16 1.5 16 0.14		
20	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			20 1.9 16 0.21		20 1.9 16 0.21
25	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			25 1.9 16 0.27		25 1.9 16 0.27
32	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			32 2.4 16 0.55		32 2.4 16 0.55
40	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			40 2.4 16 0.55		40 2.4 16 0.55
50	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)			50 3.0 16 0.85		50 3.0 16 0.85
63	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	63 2.5 - 0.93	63 2.5 10 0.93	63 30 16 1.09		63 30 16 1.09
75	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		75 2.5 10 1.11	75 3.6 16 1.55		75 3.6 16 1.55
90	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		90 2.8 10 1.48	90 4.3 16 2.22	90 2.8 10 1.48	90 4.3 16 2.22
110	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	110 3.0 - 1.94	110 3.4 10 2.20	110 5.3 16 3.32	110 3.4 10 2.20	110 5.3 16 3.32
125	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		125 3.9 10 2.84	125 6.0 16 4.24	125 3.9 10 2.84	125 6.0 16 4.24
140	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	140 3.0 - 2.49	140 4.3 10 3.52	140 6.7 16 5.31	140 4.3 10 3.52	140 6.7 16 5.31
160	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	160 3.0 - 2.86	160 4.9 10 4.54	160 7.7 16 6.96	160 4.9 10 4.54	160 7.7 16 6.96
180	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		180 5.5 10 5.74	180 8.6 16 8.74	180 5.5 10 5.74	180 8.6 16 8.74
200	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	200 3.0 - 3.58	200 6.2 10 7.19	200 9.6 16 10.74	200 6.2 10 7.19	200 9.6 16 10.74
225	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		225 6.9 10 8.95	225 10.8 16 13.67	225 6.9 10 8.95	225 10.8 16 13.67
250	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	250 3.0 - 4.48	250 7.7 10 11.09	250 11.09 16 16.73	250 7.7 10 11.09	250 11.09 16 16.73
280	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)		280 8.6 10 13.86	280 13.4 16 21.11	280 8.6 10 13.86	280 13.4 16 21.11
315	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	315 4.0 - 7.47	315 9.7 10 17.55		315 9.7 10 17.55	
355	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	355 4.0 - 9.34	355 10.9 10 22.00			
400	O.D (mm) Wall (mm) Max WP (bar) Weight/m (kg)	400 5.0 - 11.81	400 12.3 10 28.03			

* Listed by FM Global as meeting the FMRC 4910 Clen Room Materials Flammability Test protocol