B

POLYPROPYLENE (PPR AND PPH)

Asahi/America is the pioneer of piping systems made of polypropylene in the United States. For over 15 years, polypropylene systems have been successfully applied for a wide variety of applications. Polypropylene is used in double containment systems, chemical piping, and pure water systems. It is chemically resistant to many strong and weak acids. In addition, it is one of the few materials that is recommended for strong bases such as sodium hydroxide. It is not ideal for strong oxidizing acids, aromatics, and chlorinated hydrocarbons. An all inclusive chemical resistant table is available in Section E. Polypropylene has an extended operating range up to a maximum temperature of 200° F. See Appendix A for pressure rating charts on all materials.

Polypropylene is a fairly ductile material at ambient temperatures and it demonstrates good impact strength. Polypropylene is available in two grades: copolymer and homopolymer. Homopolymer polypropylene is a Type I resin according to ASTM D 4101 and is produced from 100% propylene monomer. Copolymer polypropylene is a blend of (6%) ethylene and (94%) propylene. Copolymer resins generally exhibit better mechanical strength and offer higher safety factors into a system design. In addition, copolymer PP shows a greater purity level when tested in a static leach test, making it the ideal material for pure water systems. Table B-1 shows the differences between the two types of polypropylenes. Asahi/America uses both types of material based on the application.

Copolymer is referred to as PPR, with the R designating the term random copolymer. PPH is the standard designation for homopolymer polypropylene.

Toxicity

Polypropylene (PPR and PPH materials) comply with the relevant food stuff regulations as defined by ONÖRM B 5014, Part 1, FDA, BGA, KTW guidelines. Other modified polypropylenes are not compliant due to additives. Such materials include PPH-s, PPR-el, and PPR-s-el, which have been modified for improved fire ratings and electro-conductivity. These are discussed in the next section.

Table B-1. Polypropylene Physical Properties

Characteristic	Standard	Units	PPR	PPH
Density	ISO/R 1183	g/cm^3	0.91	0.91
Melt Flow Index	MFI 190/5 Code T ISO 1133 DIN 53 735	g/10 min	0.50	0.50
Tensile Strength at Yield	ISO/R 527 DIN 53 455	psi N/mm^2	3625 25	4350 30
Tensile Strength at Break	ISO/R 527 DIN 53 455	psi N/mm^2	5800 40	6525 45
Percent Elongation at Break	ISO/R 527 DIN 53 455	%	>50	>50
Modulus Elasticity (tensile test)	ISO 178 DIN 53 457	psi N/mm^2	108750 750	166750 1150
Charpy Impact Strength 23° C, notched	ISO 179/2C DIN 53 453	kJ/m^2	20	50
Charpy Impact Strength -30° C, notched	ISO 179/2D DIN 53 453	kJ/m^2	50	35
Coefficient of Thermal Expansion	DIN 53 752	1/° C 1/° F	1.5×10^{-4} 8.33×10^{-5}	1.5×10^{-4} 8.33×10^{-5}
Crystallinity Melt Temperature	DIN 53 736	° C ° F	150 - 154 302 - 309	160 - 165 320 - 329
Deflection Temperature Under Load Method A Method B	 DIN 53 461 ISO 75	 ° C/° F ° C/° F	 45/113 68/154	 50/122 90/194
UL 94 Fire Rating	UL 94	—	94-HB	94-HB
Thermal Conductivity (23° C)	DIN 52 612	W/mK	0.24	0.22
Surface Resistivity	DIN 53 482	Ohm	$>10^{13}$	$>10^{13}$
Specific Volume Resistivity	DIN 53 482 part 1	Ohm cm	$>10^{16}$	$>10^{16}$
Dielectric Strength	DIN 53 481	kV/mm	75	75
Color	RAL	—	gray	gray

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B

POLYETHYLENE (PE80 AND PE100)

Polyethylene is one of the most common thermoplastic materials. Polyethylene is available in a diverse variety of grades providing varying physical properties for specified applications. PE is commonly available in low density (LDPE), medium density, (MDPE), high density (HDPE), and ultra high molecular weight (UHMWPE) forms. Within each of the designations there are various classes of material. Classes of polyethylene are specified according to ASTM D-3350 which depicts the differences between grades of material.

In piping systems the most common type of PE is high density polyethylene. Due to the extensive range of HDPE materials, discussion will be centered around materials offered by Asahi/America. The first grade of HDPE offered by A/A is generally known as PE80. PE80 is a black color material that is 100% UV resistant. PE80 has fairly good chemical resistance to strong and weak acids, as well as many base chemicals. It has a maximum operating temperature range of 140° F. PE80 also has fairly ductile properties in cold temperature conditions.

PE80 is generally used for simple, less aggressive applications. It can be readily applied in double containment pipe systems, and is ideal for wastewater applications.

The other material, HDPE, offered by Asahi/America, is PE100. This is a special high grade PE that is not commonly available. For certain applications, only PE100 can be used. PE100 is available in both blue and black color depending on the application, but it is not limited to those colors.

PE100 is a further development of PE materials by modifying the polymerization process. PE100 has a higher density than PE80. PE100 also has superior mechanical strength and a higher cell classification as compared to PE80. It provides higher pressure ratings and higher safety factors in all applications. It is one of few materials available to the market that meets Cal-OSHA requirements for thermoplastic use in unprotected compressed gas applications. Due to its extremely ductile nature, it will resist shattering in all failure modes and even in cold temperatures.

PE100 has a maximum temperature rating of 140° F. It is available in multiple pressure ratings and is commonly available in a high pressure rated version of 230 psi at 70° F. See Appendix A for system pressure ratings. In general, PE100 material offers higher pressure rated piping systems without the addition of more material or a thicker wall, which can lead to greater pressure drop in larger diameter systems.

Table B-3. Polyethylene Physical Properties

Characteristic	Standard	Units	PE80	PE100
Density	ISO/R 1183	g/cm^3	0.953	0.96
Melt Flow Index	MFI 190/5 Code T ISO 1133 DIN 53 735	g/10 min	0.4 - 0.5	0.3 - 0.55
Tensile Strength at Yield	ISO/R 527 DIN 53 455	psi N/mm^2	3045 21	3480 - 3625 24 - 25
Tensile Strength at Break	ISO/R 527 DIN 53 455	psi N/mm^2	4350 - 4785 30 - 33	5365 37
Percent Elongation at Break	ISO/R 527 DIN 53 455	%	>600	>600
Modulus Elasticity (tensile test)	ISO 178 DIN 53 457	psi N/mm^2	116000 800	145000 1000
Charpy Impact Strength 23° C, notched	ISO 179/2C DIN 53 453	kJ/m^2	10	17 - 26
Charpy Impact Strength -30° C, notched	ISO 179/2D DIN 53 453	kJ/m^2	16	9 - 13
Coefficient of Thermal Expansion	DIN 53 752	1/°C	2.0×10^{-4}	2.0×10^{-4}
Crystallinity Melt Temperature	DIN 53 736	° C ° F	128 - 133 262 - 271	128 - 135 262 - 275
Deflection Temperature Under Load Method A Method B	 DIN 53 461 ISO 75	 ° C/° F ° C/° F	 42/108 73/163	 41/105 61/141
UL 94 Fire Rating	UL 94	—	V 2	V 2
Thermal Conductivity (23° C)	DIN 52 612	W/mK	0.43	0.40
Surface Resistivity	DIN 53 482	Ohm	$>10^{15}$	$>10^{15}$
Specific Volume Resistivity	DIN 53 482 part 1	Ohm cm	$>10^{15}$	$>10^{15}$
Dielectric Strength	DIN 53 481	kV/mm	53	22 - 53
Color	RAL	—	black	blue or black

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