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PP PROGEF
Planning Fundamentals

Plan, Build, Operate

Materials and Piping Systems

PP PROGEF

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Planning Fundamentals PP (09/2026)

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PP - Polypropylene

1.1 Reference values

Property	PP-R value[1]	β PP-H-value[1]	Units	Test standard
Density	0.90 - 0.91	0.90 - 0.91	g/cm³	EN ISO 1183-1
Yield stress[2]	25	31	N/mm²	EN ISO 527-1
Tensile modulus[2]	900	1'300	N/mm²	EN ISO 527-1
Charpy notched impact strength[2]	20	50	kJ/ m²	EN ISO 179-1/1eA
Charpy notched impact strength at 0 °C (32 °F)	3.4	4.8	kJ/m²	EN ISO 179-1/1eA
Heat distortion temperature HDT B 0.45 MPa	75 167	95 203	°C °F	EN ISO 75-2
Water absorption[2]	0.1	0.1	%	EN ISO 62
Color	Neutral/ 7'032	7'032		RAL
Limiting oxygen index (LOI)	19	19	%	ISO 4589-1

[1] Typical characteristics measured at the material should not be used for calculations.
[2] At 23 °C (73.4 °F)

General

Polypropylene (PP) is a semi- crystalline thermoplastic belonging to the polyolefins. Its density is lower than that of other thermoplastics. Its mechanical characteristics, its chemical resistance and especially its relatively high heat deflection temperature have made polypropylene one of the most important materials used in piping installations today. PP is formed by the polymerisation of propylene (C_3H_6) using Ziegler-Natta catalysts.

There are three different material types which are conventionally supplied for piping installations:

- Isotactic PP-homopolymer (PP-H)
- PP block copolymer (PP-B)
- PP random copolymer (PP-R)

Because of its high long-term behavior, PP-H types are preferred for industrial applications. The more flexible PP-R is used predominantly in plumbing applications because of its low tensile modulus and high long-term creep resistance at high temperature. PP-B is mainly used for sewage piping systems because of its high impact strength especially at low temperatures and its relatively low resistance to elevated temperatures. Most of the PP grades are offered with nucleating agents because PP crystallizes at least 10 times slower than PE. This way, we achieve lower internal stress and a more homogenous morphology. It is differentiated between α and β nucleation. Nucleation is realized by adding only few ppm (parts per million) of nucleating agents. PP, just like PE, belongs to the non-polar materials. For this reason, PP does not dissolve in common solvents and, in addition, hardly swells. As a result, PP pipe cannot be solvent-cemented. The appropriate jointing method for this material is welding. For industrial applications, GF Industry & Infrastructure Flow Solutions uses beta nucleated PP-H (PROGEF Standard, PROGEF Plus) and PP-R (PROGEF Standard, PROGEF Natural). The long-term behavior was tested in long-term tests according to ISO 1167 and calculated according to ISO 9080. According to ISO 12162, our industrial materials are classified as MRS 10.

Advantages of PP

- Low weight
- Good abrasion resistance (abrasion resistance)
- Corrosion resistance
- Balanced ratio of stiffness and toughness
- Good chemical resistance
- Weldable
- High temperature resistance

UV and weather resistance

PP is generally UV sensitive. For the non-pigmented PROGEF Natural system, extended exposure to direct sunlight must be avoided in any case. For indoor applications, PROGEF Natural needs to be protected when installed directly under light sources emitting UV radiation. For PROGEF Standard & PROGEF Plus, additional UV protection is beneficial for outdoor applications. For indoor applications, additional protection for these systems is not required. Contact the responsible GF Industry & Infrastructure Flow Solutions representative for information on suitable protective measures.

Chemical resistance



Polypropylene shows a good resistance against a broad range of media. For detailed information, observe the list of chemical resistance from GF Industry & Infrastructure Flow Solutions or contact the responsible GF Industry & Infrastructure Flow Solutions representative.

Abrasion resistance



PP has a good resistance against abrasion. For many applications, PP demonstrates similar or better properties than metals.

Application limits



The application limits of the material on the one hand depend on embrittlement and softening temperatures and on the other hand on the nature and the expected service life of the application. The pressure-temperature diagrams give details on application temperatures and pressures.

Combustion behavior



Polypropylene is a flammable plastic. The oxygen index amounts to 19 %. With an oxygen index below 21 %, a plastic material is considered to be flammable PP drips and continues to burn without soot after removing the flame. Basically toxic substances are released by all burning processes, while carbon monoxide is generally the combustion product most dangerous to humans. When PP burns, primarily carbon dioxide, carbon monoxide and water are formed.

Electrical properties



Like most thermoplastics, polypropylene is non-conductive. This means that no electrochemical corrosion takes place in PP systems.

However, the non-conductive properties have to be taken into account because an electrostatic charge can build up in the pipe. Polypropylene provides good electrical insulation properties. The specific volume resistance is at least 10^{16} Ωcm, the dielectric strength is 75 kV/mm. Because of the possible development of electrostatic charges, caution is recommended when using PP in applications where there is a hazard of ignition or explosion.

Physiological properties



Formulations used by GF Industry & Infrastructure Flow Solutions are generally non-toxic and biologically inert. For details regarding existing approvals for applications with drinking water or foodstuffs, please contact the responsible GF Industry & Infrastructure Flow Solutions representative.

1.2 Long-term behavior of PP

Calculation (based on EN ISO 15494:2015)

The following long-term behaviors show the long-term behavior of PP-H, PP-B and PP-R. For the temperature range from +10 °C to +110 °C, fracture lines are displayed. These are called LPL curves (Lower Predictable Limit); this means according to the definition that 97.5 % of all fracture points are on or above the corresponding curve.

Typically for semi-crystalline plastics like PP, the long-term curves show a knee. The curves are plotted in a double logarithmic diagram (i.e. not linear). Please take this into account when reading values for stress or time.

The long-term behavior was calculated by using the extrapolation method according to EN ISO 9080. With the following equation (4-parameter model), which was derived from that diagram, stress, temperature or time can be calculated for the temperature range of +10 °C to +95 °C.

The dotted lines of the curves apply if tests with longer testing times are carried out at 90 °C, 95 °C and 110 °C.

⚠ The 110 °C curve has been determined separately by using water inside and air outside; it cannot be calculated with the formulas below.

First branch (left-hand portion of the curves as shown in the following long-term behaviors)

PP-H

$$\log t = -46.346 - 9601.1 \cdot \frac{\log \sigma}{T} + 20381.5 \cdot \frac{1}{T} + 15.24 \cdot \log \sigma$$

PP-B

$$\log t = -56.086 - 10157.8 \cdot \frac{\log \sigma}{T} + 23971.7 \cdot \frac{1}{T} + 13.32 \cdot \log \sigma$$

PP-R

$$\log t = -55.725 - 9484.1 \cdot \frac{\log \sigma}{T} + 25502.2 \cdot \frac{1}{T} + 6.39 \cdot \log \sigma$$

Second branch (right-hand portion of the curves as shown in the following long-term behaviors)

PP-H

$$\log t = -18.387 + 8918.5 \cdot \frac{1}{T} - 4.1 \cdot \log \sigma$$

PP-B

$$\log t = -13.699 + 6970.3 \cdot \frac{1}{T} - 3.82 \cdot \log \sigma$$

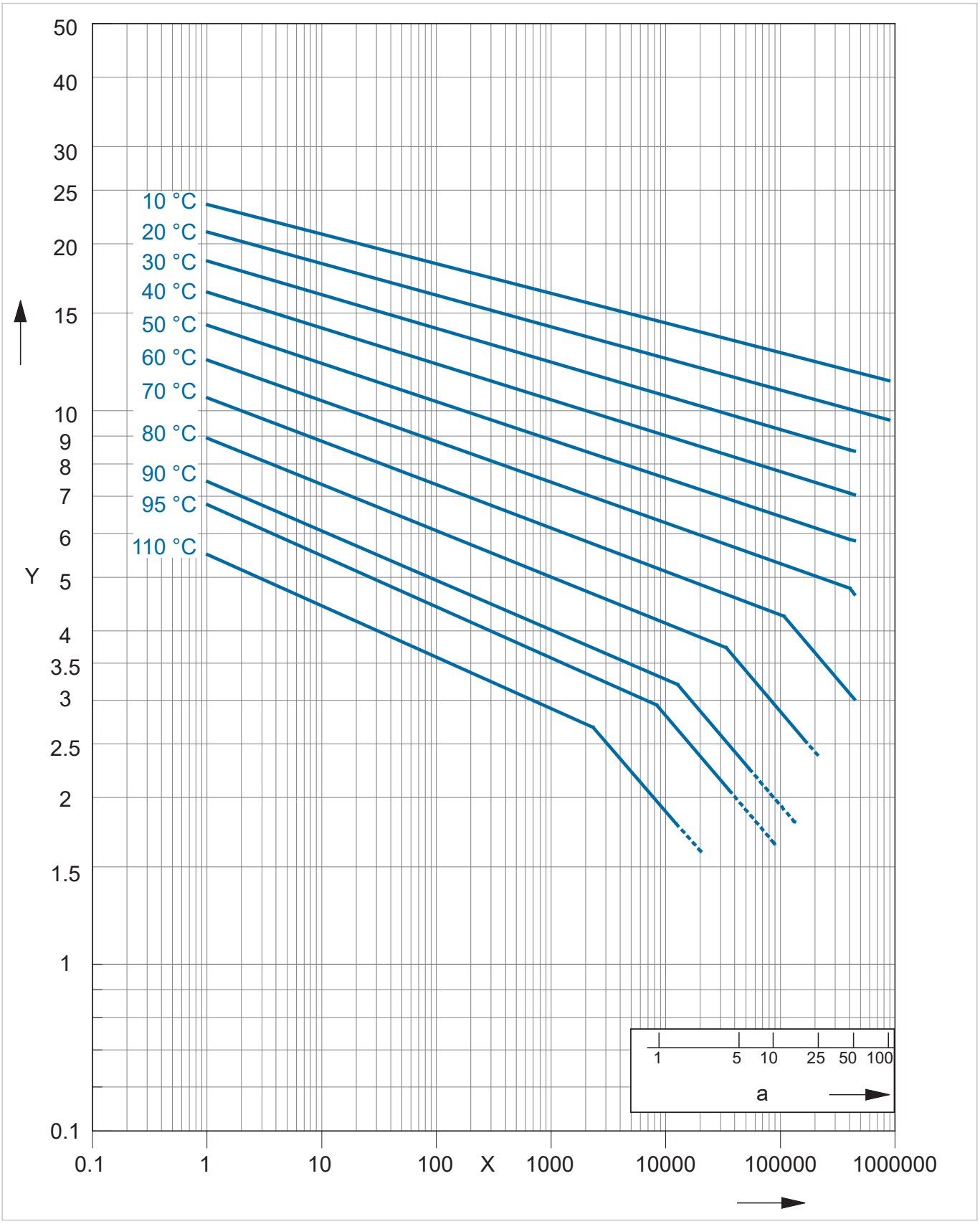
PP-R

$$\log t = -19.98 + 9507 \cdot \frac{1}{T} - 4.11 \cdot \log \sigma$$

t Time to failure (h)
T Medium temperature (K)
σ Hoop stress (MPa) (1 MPa = 1 N/mm^2)

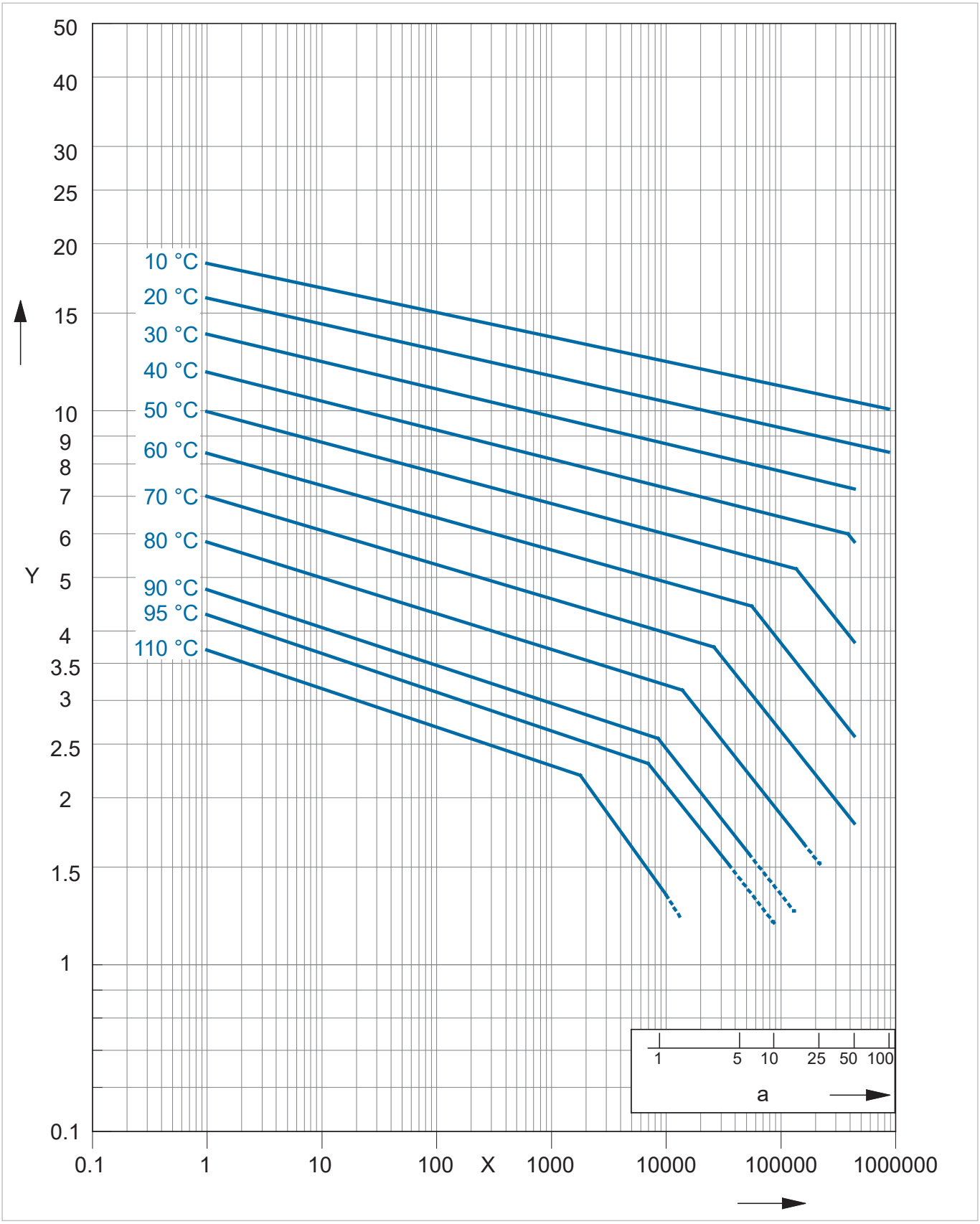
The pressure-temperature diagram that we provide for pipe and fittings made of PP-H and PP-R is derived from the long-term behavior, including the design factor, for a service life of 25 years.

Long-term behavior PP-H (according EN ISO 15494:2015)



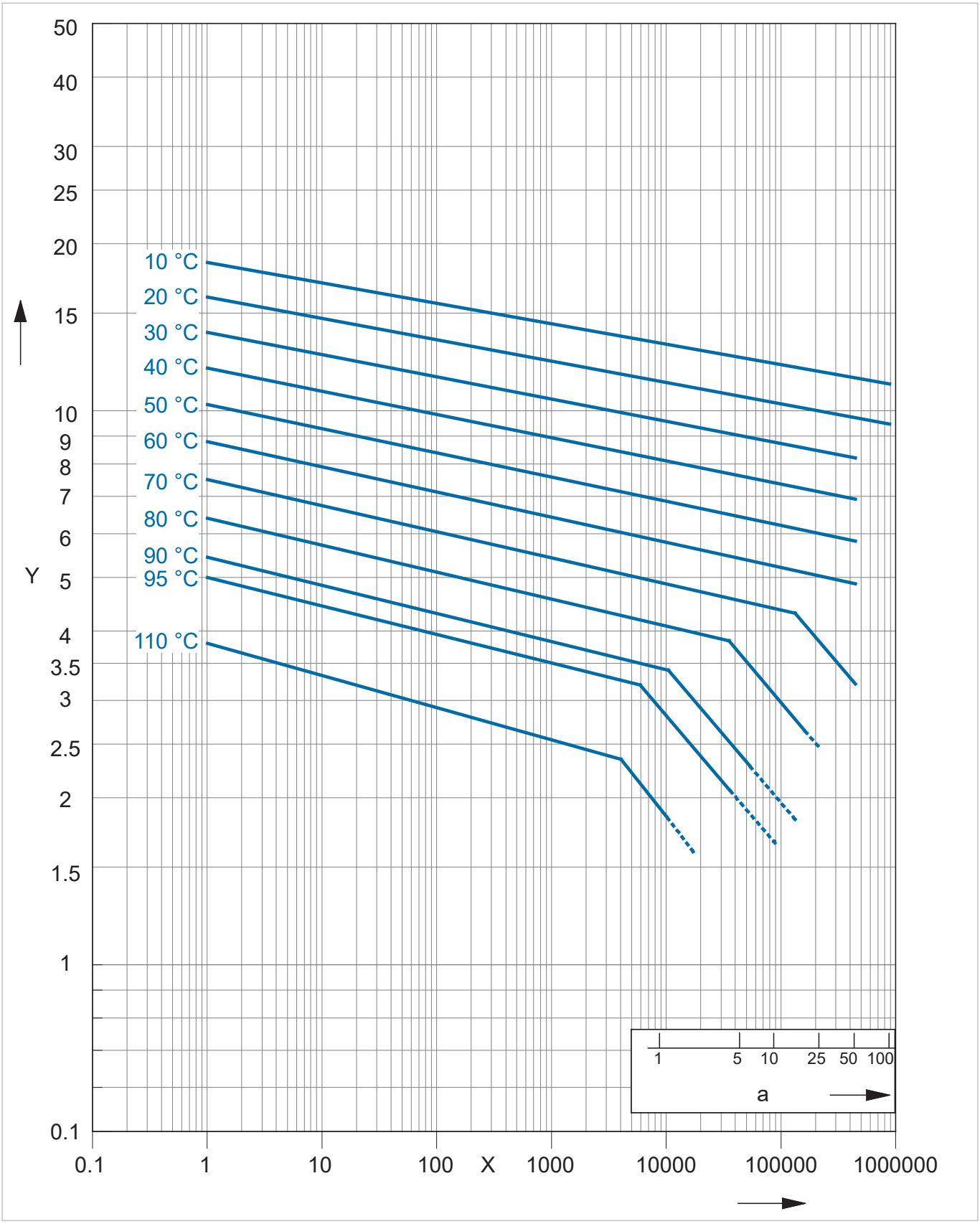
Y Hoop stress (MPa) (1 MPa = 1 N/mm²)
X Time to failure (h)
a Years

Long-term behavior PP-B (according EN ISO 15494:2015)



Y Hoop stress (MPa) (1 MPa = 1 N/mm²)
X Time to failure (h)
a Years

Long-term behavior PP-R (according EN ISO 15494:2015)



Y Hoop stress (MPa) (1 MPa = 1 N/mm²)
X Time to failure (h)
a Years

1.3 Pressure-temperature diagram for PP

PROGEF Standard and PROGEF Plus piping system (PP-H)

The following pressure-temperature diagrams for PP pipe and fittings are valid for a service life of 25 years. The pressure-temperature curves are calculated with design factors of C=1.6 and C=2.0. For designs with the design factor C=1.6, a static verification is recommended. For chemical applications or piping systems that require approval by the building authorities, the dashed curve applies taking into account the toughness factors A1 according to DVS 2205-1.

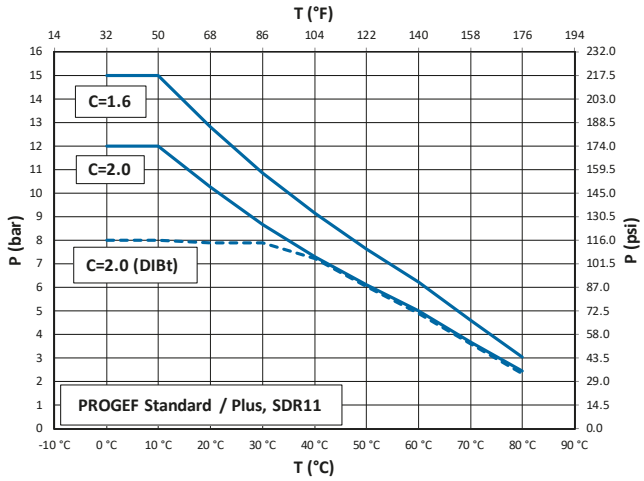
The long-term welding factor fs (or long-term joining factor) must be taken into account if relevant (e.g. stress check in longitudinal direction).

The diagrams can be used for water or media resembling water, in other words, media which have no reduction factor for chemical resistance.

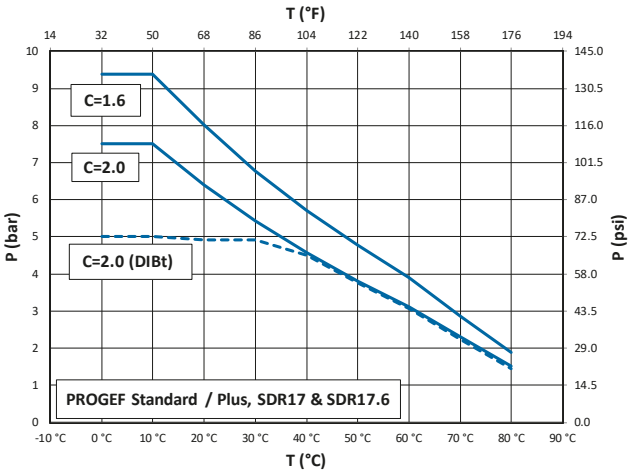
⚠ Please take into account the pressure-temperature diagrams for valves and special fittings. Because of the construction and/or sealing material used, differences are possible when compared to pipe and fittings. More information is available in the Planning Fundamentals of the relevant types of valves and special fittings.

Pressure-temperature diagrams for PP pipe and injection-molded fittings

PP, SDR11



PP, SDR17, SDR17.6



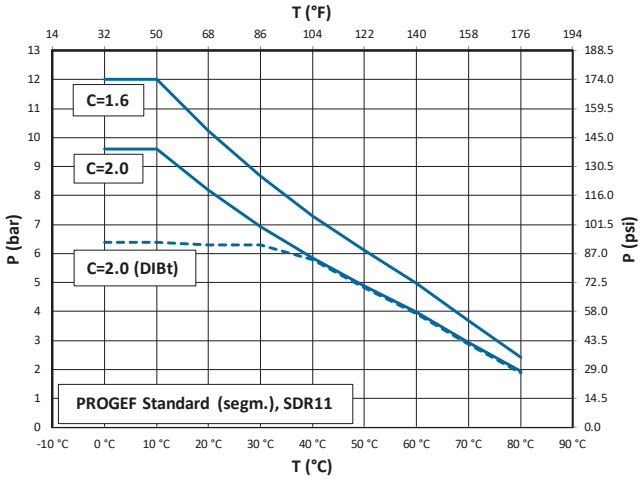
P Permissible pressure (bar, psi)
T Temperature (°C, °F)

⚠ The permissible operating pressure can be used as a guide value for constant operating conditions (pressure, temperature). For changing operating conditions, it is recommended to perform a strength check in accordance with DVS 2210-1.

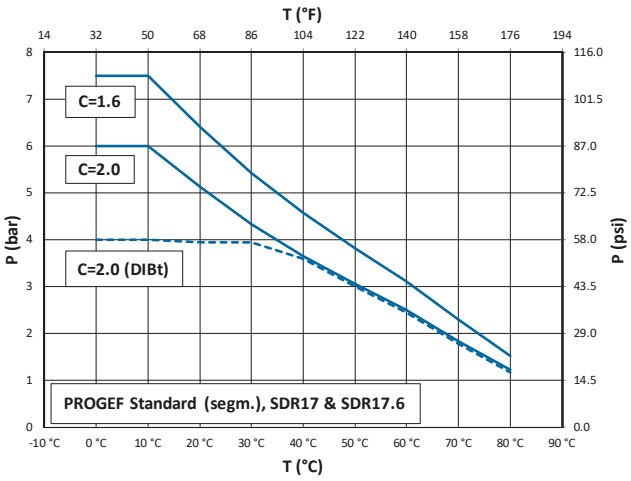
Pressure-temperature diagrams for PP segment-welded fittings

Segment-welded fittings have a reduction factor of 0.8 for the operating pressure/nominal pressure.

PP segment welded fittings, SDR11



PP segment welded fittings, SDR17, SDR17.6



P Permissible pressure (bar, psi)
T Temperature (°C, °F)

The permissible operating pressure can be used as a guide value for constant operating conditions (pressure, temperature). For changing operating conditions, it is recommended to perform a strength check in accordance with DVS 2210-1.

PROGEF Natural piping system (PP-n)

The following pressure-temperature diagram for PROGEF Natural pipe and fittings is valid for a service life of 25 years. The pressure-temperature curves have been calculated with design factors of C=1.6 and C=2.0. For designs with the design factor C=1.6, a static verification is recommended. For chemical applications and piping systems requiring approval by the building authorities, the dashed curve applies taking into account the toughness factors A1 according to DVS 2205-1.

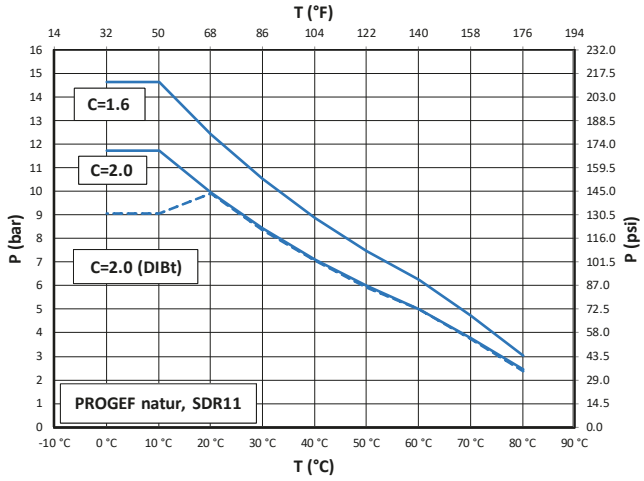
The long-term welding factor fs (or long-term joining factor) must be taken into account if relevant (e.g. stress check in longitudinal direction).

It can be used for water or media resembling water, in other words, media that have no reduction factor for chemical resistance.

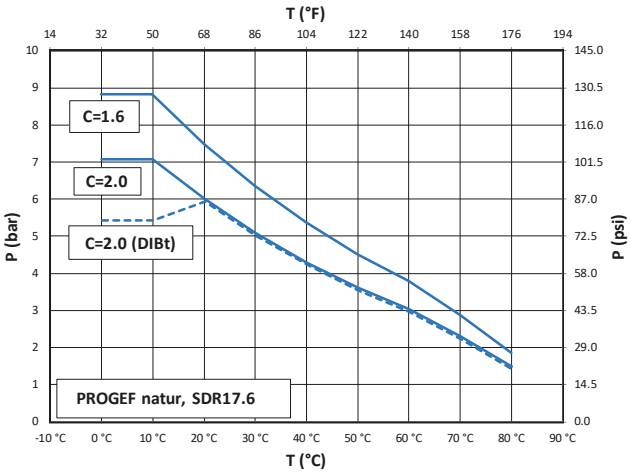
⚠ Please take into account the pressure-temperature diagrams for valves and special fittings. Because of the construction and/or sealing material used, differences are possible when compared to pipe and fittings. More information is available in the Planning Fundamentals of the relevant types of valves and special fittings.

Using PROGEF Natural at higher temperatures can cause a discoloration of the material.

PROGEF Natural, SDR11



PROGEF Natural, SDR17.6



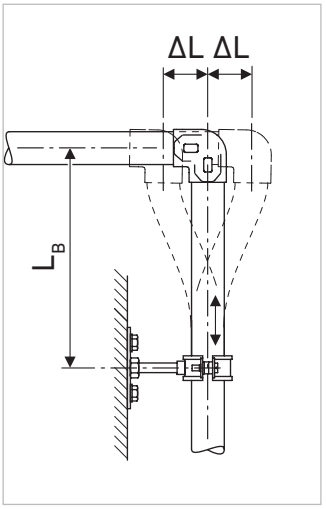
P Permissible pressure (bar, psi)
T Temperature (°C, °F)

⚠ The permissible operating pressure can be used as a guide value for constant operating conditions (pressure, temperature). For changing operating conditions, it is recommended to perform a strength check in accordance with DVS 2210-1.

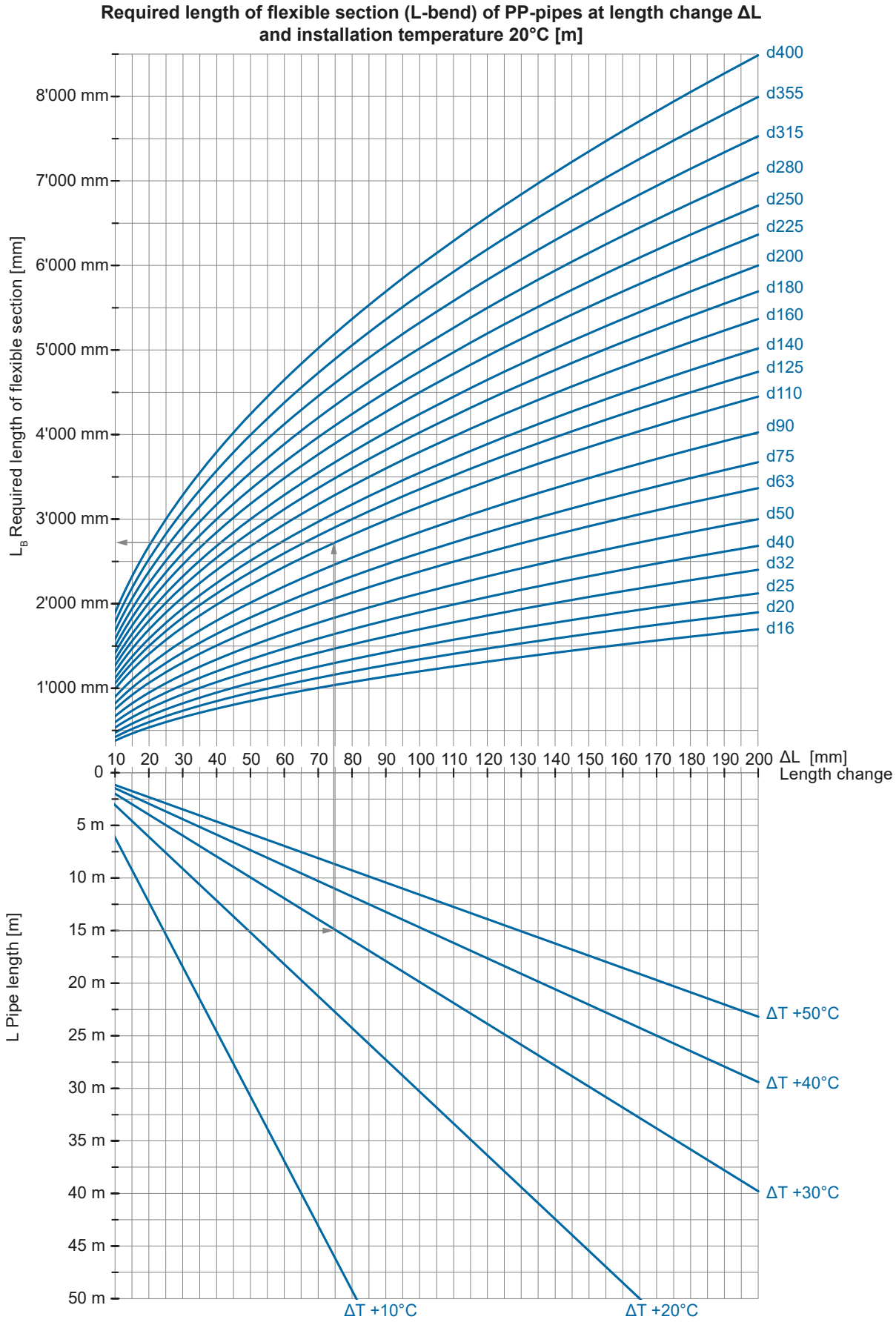
1.4 Flexible sections of PP piping systems

Properties of PP			
Symbol	Designation	Value	Unit
K	Proportionality factor for flexible sections	30	-
ΔL	Length change	-	mm/inch
d	Outer pipe diameter	-	mm
L_B	Required length of flexible section (L-bend)	-	mm/inch

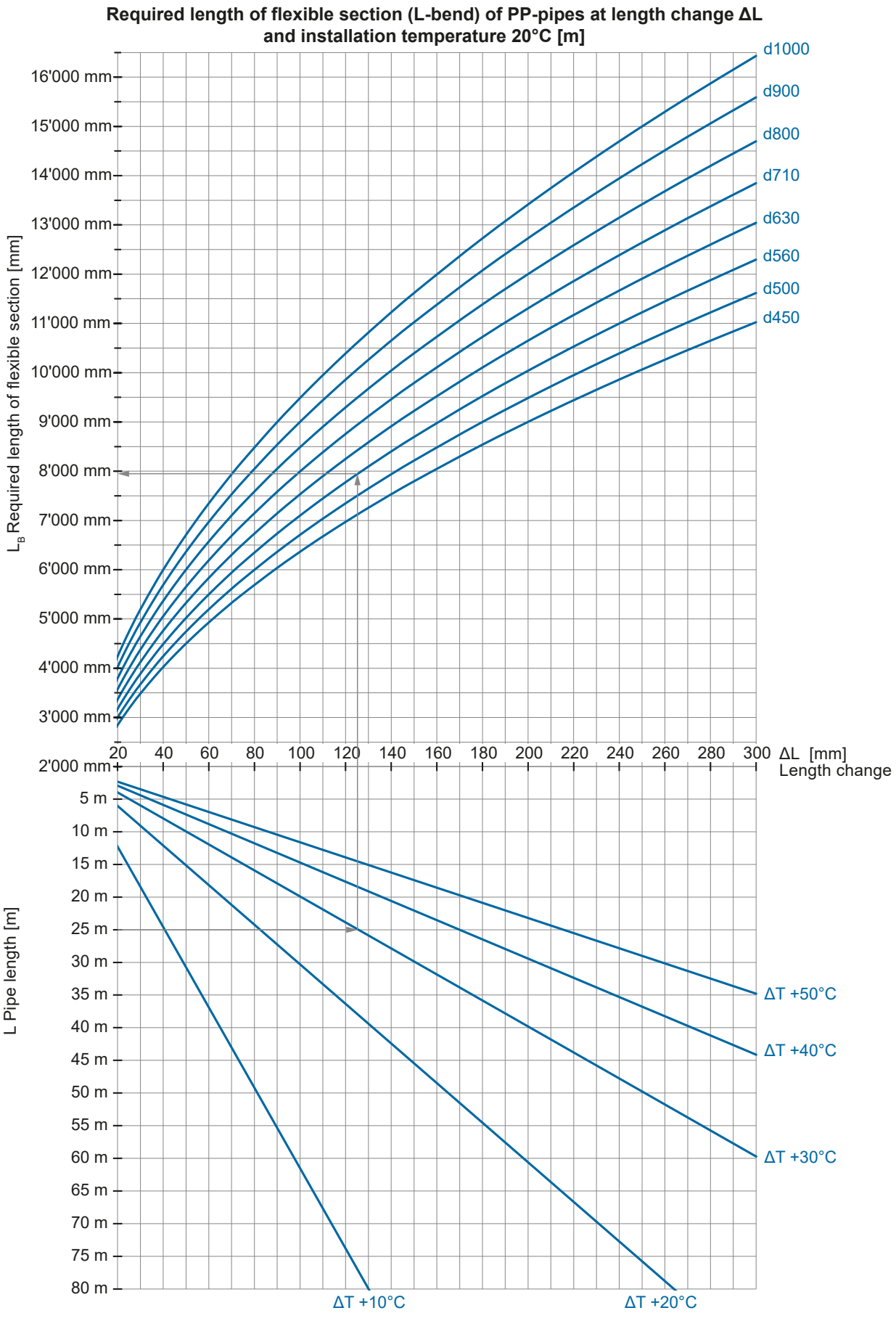
$L_B = K * (d * \Delta L)^{\wedge 0.5}$



Flexible sections diagram - Outer pipe diameter d16 - d400



Flexible sections diagram - Outer pipe diameter d450 - d1000



Required length of flexible section L_B at length change ΔL, [mm]

ΔL	Outer Pipe Diameter d (mm)																				
(mm)	16 (mm)	20 (mm)	25 (mm)	32 (mm)	40 (mm)	50 (mm)	63 (mm)	75 (mm)	90 (mm)	110 (mm)	125 (mm)	140 (mm)	160 (mm)	180 (mm)	200 (mm)	225 (mm)	250 (mm)	280 (mm)	315 (mm)	355 (mm)	400 (mm)
15	465	520	580	655	735	820	920	1'000	1'100	1'200	1'300	1'350	1'450	1'550	1'650	1'750	1'850	1'950	2'050	2'200	2'300
30	655	735	820	930	1'050	1'150	1'300	1'400	1'550	1'700	1'850	1'950	2'100	2'200	2'300	2'450	2'600	2'750	2'900	3'100	3'300
45	805	900	1'000	1'150	1'250	1'400	1'600	1'750	1'900	2'100	2'250	2'400	2'550	2'700	2'850	3'000	3'200	3'350	3'550	3'800	4'000
60	930	1'050	1'150	1'300	1'450	1'650	1'850	2'000	2'200	2'450	2'600	2'750	2'950	3'100	3'300	3'500	3'650	3'900	4'100	4'400	4'650
75	1'050	1'150	1'300	1'450	1'650	1'850	2'050	2'250	2'450	2'700	2'900	3'050	3'300	3'500	3'650	3'900	4'100	4'350	4'600	4'900	5'200
90	1'150	1'250	1'400	1'600	1'800	2'000	2'250	2'450	2'700	3'000	3'200	3'350	3'600	3'800	4'000	4'250	4'500	4'750	5'050	5'350	5'700
105	1'250	1'350	1'550	1'750	1'950	2'150	2'450	2'650	2'900	3'200	3'450	3'650	3'900	4'100	4'350	4'600	4'850	5'150	5'450	5'800	6'150
120	1'300	1'450	1'650	1'850	2'100	2'300	2'600	2'850	3'100	3'450	3'650	3'900	4'150	4'400	4'650	4'950	5'200	5'500	5'850	6'200	6'550
135	1'400	1'550	1'750	1'950	2'200	2'450	2'750	3'000	3'300	3'650	3'900	4'100	4'400	4'700	4'950	5'250	5'500	5'850	6'200	6'550	6'950
150	1'450	1'650	1'850	2'100	2'300	2'600	2'900	3'200	3'500	3'850	4'100	4'350	4'650	4'950	5'200	5'500	5'800	6'150	6'500	6'900	7'350
165	1'550	1'700	1'950	2'200	2'450	2'700	3'050	3'350	3'650	4'050	4'300	4'550	4'850	5'150	5'450	5'800	6'100	6'450	6'850	7'250	7'700
180	1'600	1'800	2'000	2'300	2'550	2'850	3'200	3'500	3'800	4'200	4'500	4'750	5'100	5'400	5'700	6'050	6'350	6'750	7'150	7'600	8'050
195	1'700	1'850	2'100	2'350	2'650	2'950	3'350	3'650	3'950	4'400	4'700	4'950	5'300	5'600	5'900	6'300	6'600	7'000	7'450	7'900	8'400
210	1'750	1'950	2'150	2'450	2'750	3'050	3'450	3'750	4'100	4'550	4'850	5'150	5'500	5'850	6'150	6'500	6'850	7'250	7'700	8'200	8'700
225	1'800	2'000	2'250	2'550	2'850	3'200	3'550	3'900	4'250	4'700	5'050	5'300	5'700	6'050	6'350	6'750	7'100	7'550	8'000	8'500	9'000
240	1'850	2'100	2'300	2'650	2'950	3'300	3'700	4'000	4'400	4'850	5'200	5'500	5'900	6'250	6'550	6'950	7'350	7'800	8'250	8'750	9'300
255	1'900	2'150	2'400	2'700	3'050	3'400	3'800	4'150	4'550	5'000	5'350	5'650	6'050	6'450	6'750	7'200	7'550	8'000	8'500	9'050	9'600
270	1'950	2'200	2'450	2'800	3'100	3'500	3'900	4'250	4'700	5'150	5'500	5'850	6'250	6'600	6'950	7'400	7'800	8'250	8'750	9'300	9'850
285	2'050	2'250	2'550	2'850	3'200	3'600	4'000	4'400	4'800	5'300	5'650	6'000	6'400	6'800	7'150	7'600	8'000	8'450	9'000	9'550	10'150
300	2'100	2'300	2'600	2'950	3'300	3'650	4'100	4'500	4'950	5'450	5'800	6'150	6'550	6'950	7'350	7'800	8'200	8'700	9'200	9'800	10'400

ΔL	Outer Pipe Diameter d (mm)							
(mm)	450 (mm)	500 (mm)	560 (mm)	630 (mm)	710 (mm)	800 (mm)	900 (mm)	1000 (mm)
15	2'450	2'600	2'750	2'900	3'100	3'300	3'500	3'650
30	3'500	3'650	3'900	4'100	4'400	4'650	4'950	5'200
45	4'250	4'500	4'750	5'050	5'350	5'700	6'050	6'350
60	4'950	5'200	5'500	5'850	6'200	6'550	6'950	7'350
75	5'500	5'800	6'150	6'500	6'900	7'350	7'800	8'200
90	6'050	6'350	6'750	7'150	7'600	8'050	8'550	9'000
105	6'500	6'850	7'250	7'700	8'200	8'700	9'200	9'700
120	6'950	7'350	7'800	8'250	8'750	9'300	9'850	10'400
135	7'400	7'800	8'250	8'750	9'300	9'850	10'450	11'000
150	7'800	8'200	8'700	9'200	9'800	10'400	11'000	11'600
165	8'150	8'600	9'100	9'650	10'250	10'900	11'550	12'200
180	8'550	9'000	9'500	10'100	10'700	11'400	12'050	12'750
195	8'900	9'350	9'900	10'500	11'150	11'850	12'550	13'250
210	9'200	9'700	10'300	10'900	11'600	12'300	13'050	13'750
225	9'550	10'050	10'650	11'300	12'000	12'750	13'500	14'250
240	9'850	10'400	11'000	11'650	12'400	13'150	13'950	14'700
255	10'150	10'700	11'350	12'000	12'750	13'550	14'350	15'150
270	10'450	11'000	11'650	12'350	13'150	13'950	14'800	15'600
285	10'750	11'300	12'000	12'700	13'500	14'300	15'200	16'000
300	11'000	11'600	12'300	13'050	13'850	14'700	15'600	16'450

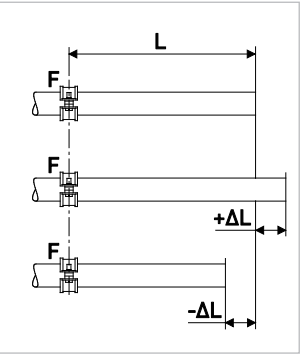
Required length of flexible section L_B at length change ΔL, [inch]

ΔL	Outer Pipe Diameter d (mm)																				
(inch)	16 (inch)	20 (inch)	25 (inch)	32 (inch)	40 (inch)	50 (inch)	63 (inch)	75 (inch)	90 (inch)	110 (inch)	125 (inch)	140 (inch)	160 (inch)	180 (inch)	200 (inch)	225 (inch)	250 (inch)	280 (inch)	315 (inch)	355 (inch)	400 (inch)
0.5	15.5	17.3	19.4	21.9	24.5	27.4	30.7	33.5	36.7	40.6	43.3	45.8	49.0	52.0	54.8	58.1	61.2	64.8	68.7	73.0	77.5
1.0	21.9	24.5	27.4	31.0	34.6	38.7	43.5	47.4	52.0	57.4	61.2	64.8	69.3	73.5	77.5	82.2	86.6	91.7	97.2	103	110
1.5	26.8	30.0	33.5	37.9	42.4	47.4	53.2	58.1	63.6	70.4	75.0	79.4	84.9	90.0	94.9	101	106	112	119	126	134
2.0	31.0	34.6	38.7	43.8	49.0	54.8	61.5	67.1	73.5	81.2	86.6	91.7	98.0	104	110	116	122	130	137	146	155
2.5	34.6	38.7	43.3	49.0	54.8	61.2	68.7	75.0	82.2	90.8	96.8	102	110	116	122	130	137	145	154	163	173
3.0	37.9	42.4	47.4	53.7	60.0	67.1	75.3	82.2	90.0	99.5	106	112	120	127	134	142	150	159	168	179	190
3.5	41.0	45.8	51.2	58.0	64.8	72.5	81.3	88.7	97.2	107	115	121	130	137	145	154	162	171	182	193	205
4.0	43.8	49.0	54.8	62.0	69.3	77.5	86.9	94.9	104	115	122	130	139	147	155	164	173	183	194	206	219
4.5	46.5	52.0	58.1	65.7	73.5	82.2	92.2	101	110	122	130	137	147	156	164	174	184	194	206	219	232
5.0	49.0	54.8	61.2	69.3	77.5	86.6	97.2	106	116	128	137	145	155	164	173	184	194	205	217	231	245
6.0	56.1	62.7	70.1	79.3	88.6	99.1	111	121	133	147	157	166	177	188	198	210	222	234	249	264	280
7.0	62.6	70.0	78.3	88.5	99.0	111	124	136	148	164	175	185	198	210	221	235	247	262	278	295	313
8.0	68.7	76.9	85.9	97.2	109	122	136	149	163	180	192	203	217	231	243	258	272	288	305	324	344
9.0	74.5	83.3	93.2	105	118	132	148	161	177	195	208	220	236	250	263	279	295	312	331	351	373
10.0	80.0	89.4	100	113	126	141	159	173	190	210	224	237	253	268	283	300	316	335	355	377	400
11.0	85.2	95.3	107	120	135	151	169	184	202	223	238	252	269	286	301	320	337	356	378	401	426
12.0	90.2	101	113	128	143	159	179	195	214	236	252	267	285	302	319	338	356	377	400	425	451
13.0	94.9	106	119	134	150	168	188	206	225	249	265	281	300	318	336	356	375	397	421	447	475
14.0	99.5	111	124	141	157	176	197	215	236	261	278	294	315	334	352	373	393	416	442	469	498
15.0	104	116	130	147	164	184	206	225	246	272	290	307	329	349	367	390	411	435	461	490	520

ΔL	Outer Pipe Diameter d (mm)							
(inch)	450 (inch)	500 (inch)	560 (inch)	630 (inch)	710 (inch)	800 (inch)	900 (inch)	1000 (inch)
0.5	82.2	86.6	91.7	97.2	103	110	116	122
1.0	116	122	130	137	146	155	164	173
1.5	142	150	159	168	179	190	201	212
2.0	164	173	183	194	206	219	232	245
2.5	184	194	205	217	231	245	260	274
3.0	201	212	224	238	253	268	285	300
3.5	217	229	242	257	273	290	307	324
4.0	232	245	259	275	292	310	329	346
4.5	246	260	275	292	310	329	349	367
5.0	260	274	290	307	326	346	367	387
6.0	297	313	332	352	373	396	420	443
7.0	332	350	370	393	417	443	470	495
8.0	365	384	407	431	458	486	516	543
9.0	395	417	441	468	496	527	559	589
10.0	424	447	473	502	533	566	600	632
11.0	452	476	504	535	568	602	639	674
12.0	478	504	533	566	601	638	676	713
13.0	503	531	562	596	632	671	712	751
14.0	528	556	589	624	663	704	746	787
15.0	551	581	615	652	692	735	779	822

1.5 Length changes of PP

Properties of PP			
Symbol	Designation	Value	Unit
T_{min}	Temperature min.	0 / +32	°C / °F
T_{max}	Temperature max.	+95 / +203	°C / °F
ΔT	Temperature difference	-	°C / °F
α_{min}	Linear thermal expansion coefficient @20°C/68°F	0.16	mm/m K
α_{max}	Linear thermal expansion coefficient @max. temperature	0.18	mm/m K
ΔL	Length change	-	mm
L	Pipe length	-	m/inch
F	Fix point	-	-



$\Delta L = L \cdot \Delta T \cdot \alpha$

Thermal length change ΔL (mm) between 20°C and any end temperature

Pipe length L	End temperature (°C)										
	0	10	20	30	40	50	60	70	80	90	95
(m)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
1	-3.2	-1.6	0.0	1.6	3.3	5.0	6.8	8.6	11	12	13
2	-6.3	-3.2	0.0	3.3	6.6	10	14	17	21	25	27
3	-9.5	-4.8	0.0	4.9	9.9	15	20	26	32	37	40
4	-13	-6.4	0.0	6.5	13	20	27	35	42	50	54
5	-16	-7.9	0.0	8.1	17	25	34	43	53	62	67
6	-19	-9.5	0.0	9.8	20	30	41	52	63	75	80
7	-22	-11	0.0	11	23	35	48	60	74	87	94
8	-25	-13	0.0	13	26	40	54	69	84	99	107
9	-28	-14	0.0	15	30	45	61	78	95	112	121
10	-32	-16	0.0	16	33	50	68	86	105	124	134
12	-38	-19	0.0	20	40	60	82	104	126	149	161
14	-44	-22	0.0	23	46	70	95	121	147	174	188
16	-50	-25	0.0	26	53	80	109	138	168	199	215
18	-57	-29	0.0	29	59	90	122	155	189	224	241
20	-63	-32	0.0	33	66	101	136	173	210	249	268
30	-95	-48	0.0	49	99	151	204	259	315	373	402
40	-126	-64	0.0	65	132	201	272	345	420	497	536
50	-158	-79	0.0	81	165	251	340	431	525	621	670

Thermal length change ΔL (inch) between 68°F and any end temperature

Pipe length L	End temperature (°F)										
	32	50	68	86	104	122	140	158	176	194	203
(ft)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)	(inch)
3	-0.11	-0.06	0.00	0.06	0.12	0.18	0.24	0.31	0.38	0.45	0.48
6	-0.23	-0.11	0.00	0.12	0.24	0.36	0.49	0.62	0.76	0.89	0.97
10	-0.38	-0.19	0.00	0.20	0.40	0.60	0.82	1.04	1.26	1.49	1.61
15	-0.57	-0.29	0.00	0.29	0.59	0.90	1.22	1.55	1.89	2.24	2.41
20	-0.76	-0.38	0.00	0.39	0.79	1.21	1.63	2.07	2.52	2.98	3.22
25	-0.95	-0.48	0.00	0.49	0.99	1.51	2.04	2.59	3.15	3.73	4.02
30	-1.13	-0.57	0.00	0.59	1.19	1.81	2.45	3.11	3.78	4.47	4.83
35	-1.32	-0.67	0.00	0.68	1.39	2.11	2.86	3.62	4.41	5.22	5.63
40	-1.51	-0.76	0.00	0.78	1.58	2.41	3.26	4.14	5.04	5.96	6.44
45	-1.70	-0.86	0.00	0.88	1.78	2.71	3.67	4.66	5.67	6.71	7.24
50	-1.89	-0.95	0.00	0.98	1.98	3.02	4.08	5.18	6.30	7.46	8.04
60	-2.27	-1.14	0.00	1.17	2.38	3.62	4.90	6.21	7.56	8.95	9.65
70	-2.65	-1.33	0.00	1.37	2.77	4.22	5.71	7.25	8.82	10.4	11.3
80	-3.02	-1.52	0.00	1.56	3.17	4.82	6.53	8.28	10.1	11.9	12.9
90	-3.40	-1.71	0.00	1.76	3.56	5.43	7.34	9.32	11.3	13.4	14.5
100	-3.78	-1.91	0.00	1.95	3.96	6.03	8.16	10.4	12.6	14.9	16.1
125	-4.73	-2.38	0.00	2.44	4.95	7.54	10.2	12.9	15.8	18.6	20.1
150	-5.67	-2.86	0.00	2.93	5.94	9.05	12.2	15.5	18.9	22.4	24.1

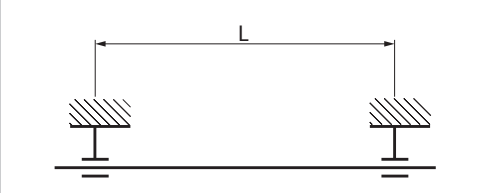
Thermal length change ΔL (mm/m) between any start temperature and any end temperature

Start temperature (°C)	End temperature (°C)										
	0	10	20	30	40	50	60	70	80	90	95
	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)	(mm/m)
0	0.00	1.56	3.15	4.78	6.45	8.18	9.95	11.78	13.65	15.58	16.56
10	-1.56	0.00	1.59	3.21	4.89	6.61	8.39	10.21	12.09	14.01	14.99
20	-3.15	-1.59	0.00	1.63	3.30	5.03	6.80	8.63	10.50	12.43	13.41
30	-4.78	-3.21	-1.63	0.00	1.68	3.40	5.18	7.00	8.88	10.80	11.78
40	-6.45	-4.89	-3.30	-1.68	0.00	1.73	3.50	5.33	7.20	9.13	10.11
50	-8.18	-6.61	-5.03	-3.40	-1.73	0.00	1.78	3.60	5.48	7.40	8.38
60	-9.95	-8.39	-6.80	-5.18	-3.50	-1.78	0.00	1.83	3.70	5.63	6.61
70	-11.78	-10.21	-8.63	-7.00	-5.33	-3.60	-1.83	0.00	1.88	3.80	4.78
80	-13.65	-12.09	-10.50	-8.88	-7.20	-5.48	-3.70	-1.88	0.00	1.93	2.91
90	-15.58	-14.01	-12.43	-10.80	-9.13	-7.40	-5.63	-3.80	-1.93	0.00	0.98
95	-16.56	-14.99	-13.41	-11.78	-10.11	-8.38	-6.61	-4.78	-2.91	-0.98	0.00

Thermal length change ΔL (inch/ft) between any start temperature and any end temperature

Start temperature (°F)	End temperature (°F)										
	32	50	68	86	104	122	140	158	176	194	203
	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)	(inch/ft)
32	0.000	0.019	0.038	0.057	0.077	0.098	0.119	0.141	0.164	0.187	0.199
50	-0.019	0.000	0.019	0.039	0.059	0.079	0.101	0.123	0.145	0.168	0.180
68	-0.038	-0.019	0.000	0.020	0.040	0.060	0.082	0.104	0.126	0.149	0.161
86	-0.057	-0.039	-0.020	0.000	0.020	0.041	0.062	0.084	0.107	0.130	0.141
104	-0.077	-0.059	-0.040	-0.020	0.000	0.021	0.042	0.064	0.086	0.110	0.121
122	-0.098	-0.079	-0.060	-0.041	-0.021	0.000	0.021	0.043	0.066	0.089	0.101
140	-0.119	-0.101	-0.082	-0.062	-0.042	-0.021	0.000	0.022	0.044	0.068	0.079
158	-0.141	-0.123	-0.104	-0.084	-0.064	-0.043	-0.022	0.000	0.023	0.046	0.057
176	-0.164	-0.145	-0.126	-0.107	-0.086	-0.066	-0.044	-0.023	0.000	0.023	0.035
194	-0.187	-0.168	-0.149	-0.130	-0.110	-0.089	-0.068	-0.046	-0.023	0.000	0.012
203	-0.199	-0.180	-0.161	-0.141	-0.121	-0.101	-0.079	-0.057	-0.035	-0.012	0.000

1.6 Pipe support spacing for PP pipes



PP-H pipe for liquids with a density of 1 g/cm³

d (mm)	Pipe support spacing L for SDR11 pipe (mm)						
	≤ 20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
16	650	625	600	575	550	525	500
20	700	675	650	625	600	575	550
25	800	775	750	725	700	675	650
32	950	925	900	875	850	800	750
40	1'100	1'075	1'050	1'000	950	925	875
50	1'250	1'225	1'200	1'150	1'100	1'050	1'000
63	1'450	1'425	1'400	1'350	1'300	1'250	1'200
75	1'550	1'500	1'450	1'400	1'350	1'300	1'250
90	1'650	1'600	1'550	1'500	1'450	1'400	1'350
110	1'850	1'800	1'750	1'700	1'600	1'500	1'400
125	2'000	1'950	1'900	1'800	1'700	1'600	1'500
140	2'100	2'050	2'000	1'900	1'800	1'700	1'600
160	2'250	2'200	2'100	2'000	1'900	1'800	1'700
180	2'350	2'300	2'200	2'100	2'000	1'900	1'800
200	2'500	2'400	2'300	2'200	2'100	2'000	1'900
225	2'650	2'550	2'450	2'350	2'250	2'150	2'000
250	2'800	2'700	2'600	2'500	2'400	2'300	2'150
280	2'950	2'850	2'750	2'650	2'550	2'450	2'300
315	3'150	3'050	2'950	2'850	2'700	2'600	2'450
355	3'350	3'250	3'150	3'000	2'850	2'750	2'600
400	3'550	3'450	3'350	3'200	3'050	2'900	2'750
450	3'800	3'700	3'600	3'450	3'300	3'100	2'950
500	4'100	4'000	3'850	3'700	3'500	3'350	3'150
560	4'400	4'300	4'200	4'000	3'800	3'600	3'400
630	4'800	4'700	4'500	4'300	4'100	3'900	3'700

For other SDRs, multiply the values given in the table by the following factor:

- SDR17 and SDR17.6: 0.91

The pipe support spacing given in the table may be increased by 30 % in the case of vertical pipe runs, i.e. multiply the values given by 1.3.

PP-H pipe for liquids with a density other than 1 g/cm³

If the liquid to be transported has a density not equal 1 g/cm³, then the Pipe support spacing in the table above should be multiplied by the factor given in the following table to obtain different support spacings.

Density of medium (g/cm³)	Type of medium	Type of medium
1.00	Water	1.00
1.25	Other media	0.96
1.50		0.92
1.75		0.88
2.00		0.84
≤ 0.01	Gaseous media	1.30 for SDR11 1.47 for SDR17.6 and SDR17

PP-R pipe for liquids with a density of 1 g/cm³

d (mm)	Pipe support spacing L for SDR11 pipe (mm)						
	≤ 20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
16	500	475	450	425	425	400	375
20	525	500	500	475	450	425	425
25	600	575	575	550	525	500	500
32	725	700	675	650	650	600	575
40	825	800	800	750	725	700	650
50	950	925	900	875	825	775	750
63	1'100	1'075	1'050	1'025	975	925	900
75	1'150	1'150	1'100	1'050	1'000	975	950
90	1'250	1'200	1'150	1'150	1'100	1'050	1'000
110	1'400	1'350	1'300	1'300	1'200	1'125	1'050
125	1'500	1'450	1'450	1'350	1'300	1'200	1'150
140	1'600	1'550	1'500	1'450	1'350	1'275	1'200
160	1'700	1'650	1'600	1'500	1'450	1'350	1'300
180	1'750	1'750	1'650	1'600	1'500	1'425	1'350
200	1'900	1'800	1'750	1'650	1'600	1'500	1'450
225	2'000	1'900	1'850	1'750	1'700	1'600	1'500
250	2'100	2'050	1'950	1'900	1'800	1'700	1'600
280	2'950	2'850	2'750	2'650	2'550	2'450	2'300
315	2'350	2'300	2'200	2'150	2'050	1'950	1'850
355	2'500	2'425	2'350	2'250	2'125	2'050	1'950
400	2'650	2'575	2'500	2'400	2'275	2'175	2'050
450	2'850	2'775	2'700	2'575	2'475	2'325	2'200
500	3'075	3'000	2'875	2'775	2'625	2'500	2'350
560	3'300	3'225	3'150	3'000	2'850	2'700	2'550
630	3'600	3'525	3'375	3'225	3'075	2'925	2'775

For other SDRs, multiply the values given in the table by the following factor:

- SDR17 and SDR17.6: 0.91

The pipe support spacing given in the table may be increased by 30 % in the case of vertical pipe runs, i.e. multiply the values given by 1.3.

PP-R pipe for liquids with a density other than 1 g/cm³

If the liquid to be transported has a density not equal 1 g/cm³, then the Pipe support spacing in the table above should be multiplied by the factor given in the following table to obtain different support spacings.

Density of medium (g/cm³)	Type of medium	Type of medium
1.00	Water	1.00
1.25	Other media	0.96
1.50		0.92
1.75		0.88
2.00		0.84
≤ 0.01	Gaseous media	1.30 for SDR11 1.47 for SDR17.6 and SDR17

1.7 Pressure test with water or a similar incompressible test medium for PP

Pressure drop

The guidelines for an expansion-related pressure decrease in pipe are:

Material	Pressure drop (bar/h)
PP	0.8

*According to DVS 2210-1ff

Determining the test pressure

The permissible test pressure is calculated according to the following formula:

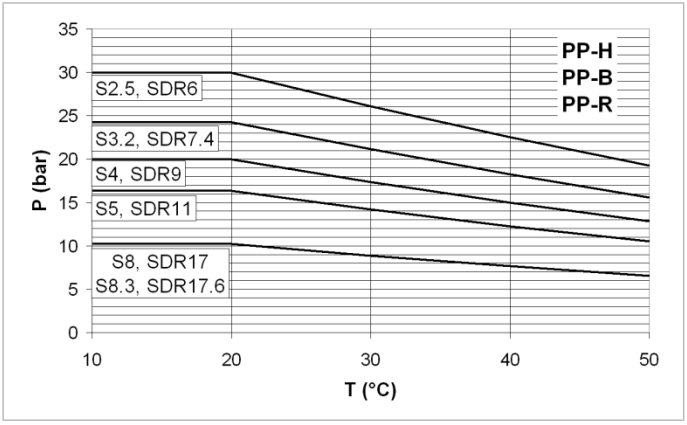
$$P_{p(zul)} = \frac{1}{SDR} \cdot \frac{20 \cdot \sigma_{v(T,\,100\,h)}}{S_p \cdot A_G}$$

$\sigma_{v(T,\,100\,h)}$ Long-term creep strength for pipe wall temperature T_R (at t = 100 h)
S_p Minimum safety factor for long-term creep strength
A_G Processing or geometry-specific factor that reduces the allowable test pressure
T_R Pipe wall temperature: average value of test medium temperature and pipe surface temperature

In general, the weakest link in the system (in terms of PN rating) determines the maximum test pressure.
If valves are installed in the system, the maximum test pressure shall not exceed the nominal pressure (PN) of the valves.
At test temperatures above 20 °C, the maximum test pressure shall be limited according to the valve-specific pressure-temperature diagrams.

Material	S_p Minimum safety factor DVS 2210-1 Suppl.2
PP-H	1.8
PP-R	1.4

Test pressure diagram for PP



P Permissible test pressure (bar)
T Pipe wall temperature (°C)

1.8 Relevant standards and guidelines for pipe and fittings made of PP

Standards and guidelines for pipe and fittings made of PP (edition: July 2015)

Norm	Bezeichnung
ISO 3213	Polypropylene (PP) pipe - Effect of time and temperature on the expected strength
ISO 9623	PE/metal and PP/metal adaptor fittings for pipe for fluids under pressure - Design lengths and size of threads - Metric series
EN ISO 15494	Plastics piping systems for industrial applications - Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system - Metric series
DIN 8077	Polypropylene (PP) pipe - PP-H, PP-B, PP-R, PP-RCT - Dimensions
DIN 8078	Polypropylene (PP) pipe - PP-H, PP-B, PP-R, PP-RCT - General quality requirements and testing
DIN 8078 Supplement 1	Pipes of polypropylene (PP); chemical resistance of pipe and fittings
DIN 28000-4	Chemical apparatus - Documentation in the life cycle of process plants - Part 4: Graphical symbols of valves, pipe and actuators
DVS 2207-6	Fusioning of thermoplastics - Non-contact heated tool butt fusion of pipe, piping system components and sheets - Methods, equipment, parameters
DVS 2207-11	Fusioning of thermoplastics - Heated tool fusioning of pipe, piping parts and panels made of PP
DVS 2210-1	Industrial piping systems made of thermoplastics - Planning and execution - Above-ground pipe systems
DVS 2210-1 Supplement 1	Industrial piping made of thermoplastics - Design and execution - Above-ground pipe systems - Calculation example
DVS 2210-1 Supplement 2	Industrial piping made of thermoplastics - Design and execution - Above-ground pipe systems - Recommendations for the internal pressure and leak tests
DVS 2210-1 Supplement 3	Industrial piping made of thermoplastics -Design and execution - Above-ground pipe systems - Flange connections: Description, requirements and assembly
DVS 2210-2	Industrial piping made of thermoplastics - Design, structure and installation of two-pipe systems

1.9 PROGEF Standard, PROGEF Plus, and PROGEF Natural Systems by GF

PROGEF systems out of polypropylene show excellent physical properties and mechanical characteristics. The high-quality material allows applications in a very broad temperature range. Thanks to its high chemical resistance, good abrasion resistance and high impact strength, PROGEF Standard meets all requirements of demanding industrial environments. Cleaned and packed in specified processes, the silicone-free or oil-free PROGEF Plus system has a high pureness factor. The system is widely used in demanding applications in microelectronics as well as in coating and surface treatment. PROGEF Natural is a translucent, unpigmented polypropylene that is wherever pure solutions are needed. Its beneficial properties, such as excellent clean, smooth surface, together with the bead and crevice-free welding, ensure the system quality.



Pipes



Fittings



Jointing technology



Automation



Valves

Essential system properties

- High impact strength
- High operating temperature range
- High surface quality for PROGEF Plus
- Highest cleanliness and protection against contamination for PROGEF Plus
- Bead and crevice-free jointing technology for PROGEF Natural

Most important market segments

- Water treatment
- Chemical process industry
- Microelectronics
- Energy

Technical data

Nominal pressure	Up to 10 bar (145 psi)
Temperature range	0 °C to 80 °C (32 °F to 176 °F)
Jointing technology	Socket fusion
	Butt fusion
	Infrared (IR) fusion
	Bead and crevice-free fusion (BCF) for PROGEF Natural
Standards and guidelines[1)]	ISO, EN, DIN, DVS
Approvals[1)]	FDA, USP 25 class VI, DIBt, DNV, Lloyd's Register
Fire performance	Class E according to EN 13501-1[2)]

1) For additional information about standards, guidelines and approvals, see www.gfps.com

2) Tested according to EN ISO 11925-2

PROGEF Standard, PROGEF Plus product overview

The following table uses metric units of measure.

Products	SDR	PN (bar)
Pipes	7.4	16
	11	10
	17.	6
Socket fusion fittings	11	10
Butt fusion fittings, IR-compatible	11	10
	17.6	10
Ball valves	11	10
	17.6	10
Diaphragm valves	11	10
	17.6	10
Butterfly valves		10
Check valves	11/17.6	10
		6
	11	10
Pressure regulating valves	11	10
Ventilating and bleed valves		10
Flanges PP-V / PP-Steel		
Gaskets EPDM / FKM		
Pipe clips PP / PE		
Automation		



PROGEF Standard
PROGEF Plus

Product overview PROGEF Natural

Products	SDR	PN (bar)	d (mm) / DN (mm)	20 / 15	25 / 20	32 / 25	40 / 32	50 / 40	63 / 50	75 / 65	90 / 80	110 / 100
Pipes	11	10										
	17.6	6										
Butt fusion fittings, IR and BCF-compatible	11	10										
	17.6	6										
Sanitary adapter	11	10										
Ball valves PP-H body/ PP-R	11	10										
Ball valves PP-H Flange connector		10										
Diaphragm valves PP-R	11	10										
Diaphragm valves PP-H Flange connector		10										
Butterfly valves PP-H		10										
Cone check valves PP-H body/PP-R	11	10										
Cone check valves PP-H Flange connector		10										
Flange PP-V / PP-Steel												
Flange gaskets EPDM / FKM												
Pipe clips PP / PE												
Automation										Upon request		

For more information about the system specification of PROGEF Standard, Plus, Natural, visit www.gfps.com

Excellence in Flow

Visit our webpage to get in touch with your local specialist:
www.gfps.com/our-locations

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