Piping*Systems - *Design & Installation

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Technical Information

Introduction

The physical properties and chemical compatibility data provided by most plastic pipe manufacturers is generally reproduced form data supplied by the Raw Material Producer. This data is obtained by testing specimens which are 'ideally' produced and thus lack inherent stresses or orientation. Understandably specimens produced in this manner will provide generally better test result.

The properties given on the following pages have been measured by testing extruded panels or coupons. The object being to provide data more indicative of what will normally be achieved by these materials when produced as pipe or extruded sheet. The information indicates average values for 4mm thick extruded coupons unless stated otherwise.

The data provided is in no way a guarantee of the suitability of the material for any application. It is not possible to apply our test results automatically to finished components. For this reason the suitability of our materials for a specific application must be rechecked by the user.

Materials Information

Material Type - Polypropylene (PP)

SIMTECH'S SR Series Polypropylene piping, as produced by SIMONA, is extruded from A Group 1. Class 1, Grade 0 Polypropylene Homopolymer material per ASTM-D4101, Federal Specifications L-P-39413 and Military Spec Mil P 461096. PP material to be heat stabilized UV stabilized and pigmented to RAL 7032. Temperature stabilizers are added to provide the material with enhanced resistance to aggressive media at elevated temperatures.

Stress Relieved

SIMTECH'S SR Series pipe is Stress Relieved, through a post extrusion annealing process. This process allows the pipe to perform to its fullest potential. SR Series pipe possess higher impact strength, higher quick burst pressures, improved resistance to oxidizing acids and longer service life expectancy, compared to pipe that is not subject to a post extrusion annealing process.

Chemical Resistance

SR Series Polypropylene is especially suitable for handling Dilute Acids, Alkalies, many strong acids and organic solvents.

Polypropylene should not be used to convey Halogens, Halogenated Hydrocarbons, Aromatics or highly concentrated Oxidizing Acids. More detailed information is available in our 'Chemical Resistance Guide'.

Temperature Range

SR Series PP is suitable for application within an operating range from 32°F to 212°F.

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Material Characteristics, PP

Properties	Test Standard	Test Method Test Specimen	Dimension	PP
				Type 1
Mechanical Properties				
Density	DIN 53479	Method C	g/cm^3	0.91
Melting Index Group	DIN 16776	MFI 190-5	Group	006
Tensile Test	DIN 53455	Test Bar 3	—	—
Yield Stress	—	Test Speed 50 mm/min	N/mm^2	33
Elongation At Yield Stress	—	—	%	15
Elongation At Rupture	—	—	%	70
Bending Test	DIN 53457	Test Bar	—	—
Bending Modulus E	1 min.	120 x 10 x 4 mm	N/mm^2	1200
Impact Bending Test	DIN 53453	Charpy	—	
Impact Strength	—	Standard Miniature Bar	kj/m^2	Without Break
Notched Bar Impact Strength	—	Standard Miniature Bar With U-Notch	kj/m^2	7
Surface Hardness				
Ball Impression Hardness	DIN 53456	H 358/30	N/mm^2	70
Shore Hardness	DIN 53505	D	—	72
Thermal Properties				
Crystallite Melting Range	—	Polarization Microscope	K (°C)	160 - 165
Mean Thermal Coefficient Of Linear Expansion	DIN 53752	—	K (°C)	1.6×10^{-4}
Thermal Conductivity	DIN 52612	Two-Plate Method	W/m x K	0.22
Electrical Properties				
Dielectric Strength	DIN 53481	K 20/P 50	kV/mm	52
Impedance	DIN 53482	Annular Electrode	Ohm x cm	$> 10^{16}$
Surface Resistance	DIN 53482	Electrode A	Ohm	10^{14}
Leakage Path Resistance	DIN 53480	Method KC	Step	> 600
Other Properties				
Flammability	DIN 4102	—	Class	B2
Water Absorption	DIN 53495	Method C	% / 24h	< 0.01
Physiologically Harmless	Recommendation	BGA/KTW	—	YES
Chemical Resistance	DIN 8078 Addendum	—	—	Complies

Table 1

Material Type - PVDF

SIMTECH's SR Series Polyvinylidene Fluoride (PVDF) piping (SRvf), as produced by SIMONA, is a crystalline, high molecular weight, engineered polymer, which requires NO stabilizers, antioxidants, fillers, pigmentation or additives of any kind. Due to the stable characteristics of PVDF, SRvf Piping is produced as a 'Natural' product. Being produced from only 'Pure' PVDF, makes SRvf Piping ideal for High-Purity Services where leaching of contaminants from the pipe wall cannot be tolerated. PVDF meets the requirements of USDA/FDA Title 21, Chapter 1, Part 177-2510 for direct contact with food. SRvf Pipe resins meet or exceed the requirements of Table 1 of ASTM D-3222.

Stress Relieved

SIMTECH's SRvf Series Polyvinylidene Fluoride (PVDF) pipe is Stress Relieved, through a post extrusion annealing process. This process allows the pipe to perform to its fullest potential. SRvf Series pipe possess higher impact strength, higher quick burst pressures, improved resistance to oxidizing acids and longer service life expectancy, compared to pipe that is not subject to a post extrusion annealing process.

Material Characteristics, PVDF

Properties	Test Standard	Test Method Test Specimen	Dimension	PVDF
Mechanical Properties				
Density	DIN 53479	Method C	g/cm³	1.78
Tensile Test	DIN 53455	Test Bar 3	—	—
Yield Stress	—	Test Speed 50 mm/min	N/mm²	56
Elongation At Yield Stress	—	—	%	—
Elongation At Rupture	—	—	%	22
Bending Test	DIN 53457	Test Bar	—	—
Bending Modulus E	1 min.	120 x 10 x 4 mm	N/mm²	1950
Impact Bending Test	DIN 53453	Charpy	—	—
Impact Strength	—	Standard Miniature Bar	kj/m²	Without Break
Notched Bar Impact Strength	—	Standard Miniature Bar With U-Notch	kj/m²	12
Surface Hardness				
Ball Impression Hardness	DIN 53456	H 358/30	N/mm²	120
Shore Hardness	DIN 53505	D	—	78
Thermal Properties				
Crystallite Melting Range	—	Polarization Microscope	K (˚C)	170-172
Vicat Softening Temperature	DIN 53460	B/50	K (˚C)	140
Mean Thermal Coefficient Of Linear Expansion	DIN 53752	—	K^{1} ($^{\circ}C^{1}$)	1.3×10^{-4}
Thermal Conductivity	DIN 52612	Two-Plate Method	W/m x K	0.14
Electrical Properties				
Dielectric Strength	DIN 53481	K 20/P 50	kV/mm	22
Impedance	DIN 53482	Annular Electrode	Ohm x cm	$>10^{17}$
Surface Resistance	DIN 53482	Electrode A	Ohm	10^{14}
Leakage Path Resistance	DIN 53480	Method KC	Step	>600
Other Properties				
Flammability	DIN 4102	—	Class	B1
Water Absorption	DIN 53495	Method C	% / 24h	0.02
Physiologically Harmless	Recommendation	—	—	YES

Table 4

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Radiation Resistance

Both Polypropylene and PVDF possess resistance to high energy radiation. However, as can be seen in Table 3, PVDF is far superior to PP.

With regard to the order of magnitude, the lethal dose for human beings is approximately 0.0006 Mrad. From this it can be concluded, PP and PVDF can be used in rooms in which humans are allowed to remain constantly.

Radiation Resistance

Material	Maximum Permissible Dose MRAD*	Dose During Long-Term Exposure MRAD*
PP	3	0.1
PVDF	40	20

* 10^4 j/kg = 1 Mrad

Table 3

Combustion Behavior

DIN 4102 distinguishes between Noncombustible Material (Class A) and Combustible Material (Class B). Plastics, without exception, belong in the latter class.

Further information about the combustion behavior is contained in the Oxygen index (Table 4). This number indicates the minium oxygen concentration in the combustion atmosphere which is necessary for sustained combustion. If the values are less than 20.8% (oxygen content in the atmosphere), ignition and continuous combustion after removal of the source of ignition is possible.

Assessment of Combustion Behavior

Material	Combustion Behavior According to DIN 4120 Class	Ignition Temperature According to ASTM 1929 ˚C	Oxygen According to ASTM 2863 %	Assessment According to UL 94 Class
PP Type 1	B2	345	18	—
PP Type 2	B2	345	18	—
PPs-Flame Retardant	B1	350	28	V - O
PVDF	B1	>600	48	V - O

Table 4

Durability

Durability Figures 1 and 2 illustrate the Regression Curves established for our material through Creep-Rupture/Stress-Time to Failure Testing with water as a medium. These curves are the foundation for establishing the Long Term Hydrostatic Design Basis and thus the Long term Hydrostatic Design Stress (Hoop Stress) rating for our material. Actual pressure ratings achieved by maintaining a constant OD/Wall Thickness Ratio are shown in Table 5 for PP and Table 3 for PVDF.

Durability PP

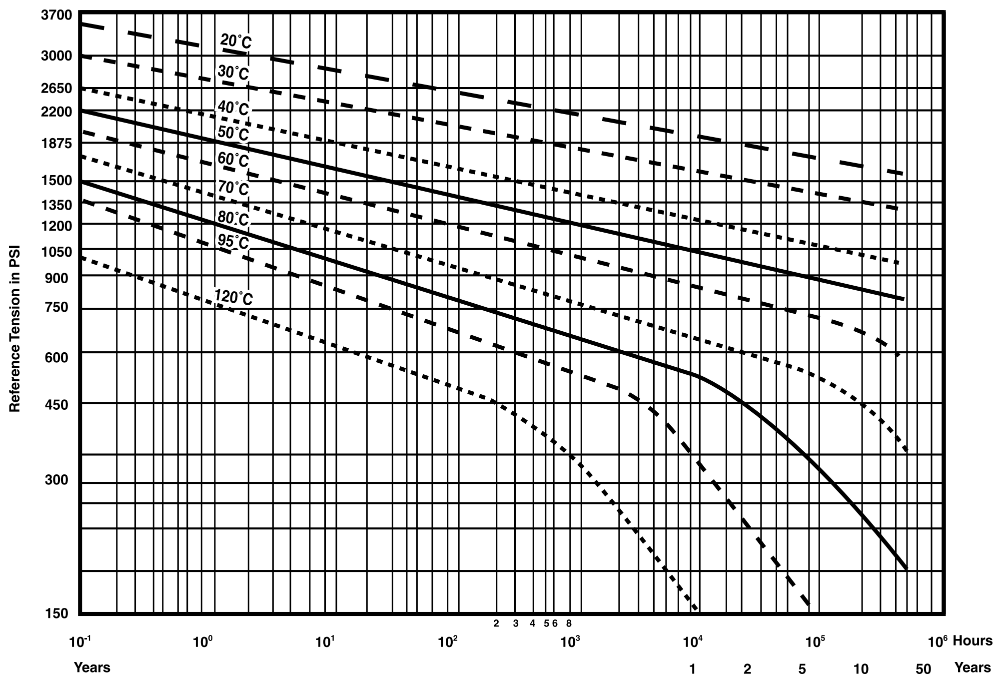

Figure 1

Durability PVDF

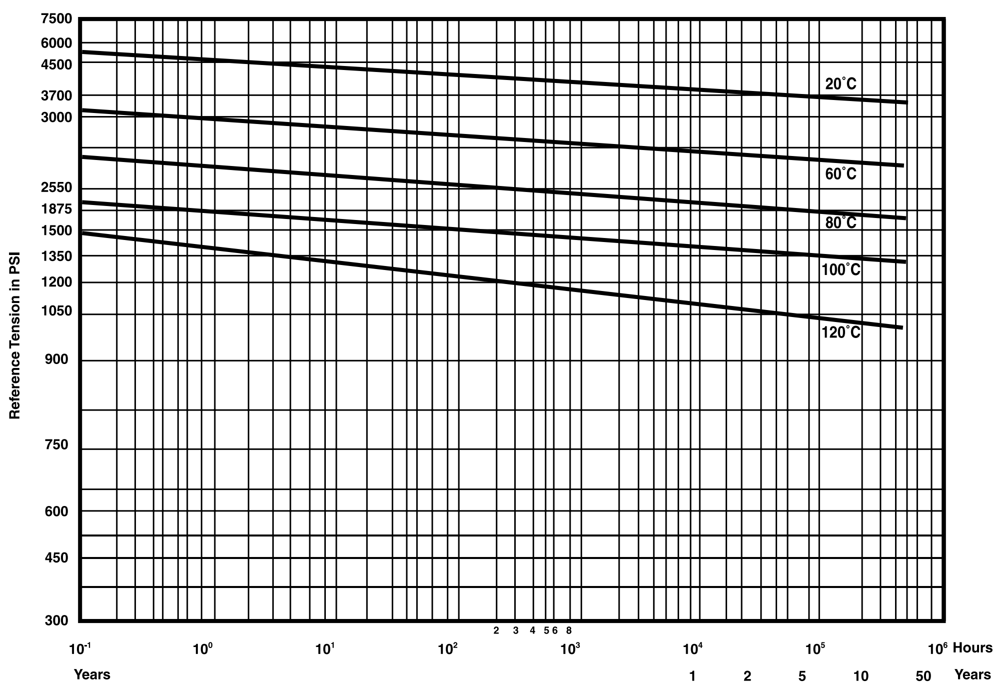

Figure 2

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Material Properties

Weather Resistance

Nearly all thermoplastics used for piping require stabilizers to reduce the effects of sunlight and oxygen. PVDF is the major exception in that it suffers no significant degradation when used outdoors. All other materials are generally compounded with UV stabilizers and anti-oxidants to retard the rate of degradation. While this procedure is effective, it does not totally eliminate the phenomena. To maximize the service life of a system, it can be covered, coated, wrapped or painted. SRvf PVDF does not require protection.

Moisture Absorption

SR Series PP and SRvf Series PVDF are water repellent. There is no swelling or dimensional change. A slight weight gain may be found in testing due merely to traces of moisture on the surface.

Resistance To Rodents and Micro-Organisms

Rodents endeavor to sharpen their teeth by gnawing hard objects. This applies to timber, soft metals and plastics, which neither in terms of taste nor in terms of odor encourage consumption of the material. However, because the smooth surface of polypropylene and PVDF do not provide enough grip for teeth there are virtually no attempts by rodents to gnaw at pipe or the surface of flat panels.

The raw material is not a nutrient for micro organisms such as bacteria, fungi or spores and therefore is not attacked by them. This also applies in respect to Sulfate Reducing Bacteria (SRB's) which can result in metallic piping being pitted to the point of failure.

Electrical Conductivity

The materials PP and PVDF, like all other plastics, form part of the group of electrically insulating materials. This includes all materials which have an impedance in excess of 10^6 Ohm x cm. The stated materials have an impedance of the order of approx 10^{15} ohm x cm. In addition, the surface resistance should be noted. If the value of 10^9 Ohms is exceeded, then the material should be categorized as electrostatically chargeable.

In connection with the construction of plastic pipe systems, electrostatic charges have to be taken into consideration. If the media being transported are not electrically conductive or if the pipes are installed in areas which are subject to explosion hazard, the transport of gases or liquids which can ignite is only free from risk, if a closed system is used. In addition, it is possible to reduce the risk of charging by reduced conveying speed.

Explosive atmospheres in areas in which plastic pipe is to be installed can be avoided by careful ventilation, or by ionizing the air, so that the plastic does not become electrostatically charged. Since electrostatic charges are rarely produced when the relative humidity is in excess of 65%, an increase in the humidity can provide another solution to the problem.

It is fundamentally possible to make electrically nonconducting plastics into plastics that are electrically conductive. Manufacture of certain pipe made from electrically conductive PP or PVDF is possible, but require minimum order quantities for both materials. We look forward to your inquiry in the event of a need.

Pressure Rating and Service Life

Pressure Rating for plastic piping is normally expressed based on a 20°C (68°F) continuous operating temperature, i.e.. 150 psi at approximately 68°F. Higher continuous temperature results in a lower pressure rating in accordance with procedures outlined by ASTM D-2837 and the Plastic Pipe Institute (Division of SPI). The expressed pressure rating of plastic piping represents 50% of the pipes burst pressure after 100,000 hours, or 11.4 years of continuous service. It is then assumed that the theoretical time to failure is 50 years.

SR Series Polypropylene piping is offered as SR150, SR90 and SR45, indicating 150 psi, 90 psi and 45 psi respectively. These ratings were used to avoid confusion in the marketplace. We chose to indicate pressure ratings that matched in the industry norm. However, if you will examine Table 5, you will see that we greatly exceed the Industry Standards, i.e.. SR 150 at 68°F, at 50 years service life can actually be pressurized to 180 psi continuously and still provide a safety factor of 1.7:1 for 50 years.

Permissible Gauge Pressure For SIMTECH Homopolymer Polypropylene Depending Upon Temperature and Time

Temperature		Operation Years	PN10 / SDR 11
F	C		PSI
68°	20°	1	222
		5	203
		10	194
		25	184
		50	180
86°	30°	1	175
		5	165
		10	158
		25	151
		50	145
104°	40°	1	144
		5	129
		10	123
		25	115
		50	110
122°	50°	1	117
		5	106
		10	100
		25	94
		50	88
140°	60°	1	96
		5	84
		10	78
		25	71
		50	65
158°	70°	1	78
		5	68
		10	64
		25	51
		50	46
176°	80°	1	64
		5	49
		10	38
		25	30
		50	22
203°	95°	1	42
		5	24
		10	17

NOTE: The continuous permissible operating pressures shown above are reflective of the improved properties of the Stress Relived Homopolymer Resin Pipe produced by SIMTECH. Ratings include a safety factor of 1.7 at 50 years service life.

Permissible Gauge Pressure For SIMTECH KYNAR 740 PVDF Depending Upon Temperature and Time

Temperature		Operation Years	PN16
F	C		PSI
68°	20°	1	257
		5	252
		10	248
		25	245
		50	244
86°	30°	1	238
		5	234
		10	229
		25	228
		50	226
104°	40°	1	213
		5	209
		10	205
		25	202
		50	200
122°	50°	1	191
		5	187
		10	183
		25	180
		50	173
140°	60°	1	162
		5	161
		10	158
		25	157
		50	154
158°	70°	1	148
		5	146
		10	144
		25	141
		50	136

Temperature		Operation Years	PN16
F	C		PSI
176°	80°	1	128
		5	125
		10	123
		25	120
		50	117
194°	90°	1	109
		5	106
		10	103
		25	88
		50	77
212°	100°	1	91
		5	86
		10	74
		25	62
		50	52
230°	110°	1	77
		5	59
		10	51
		25	42
		50	36
248°	120°	1	59
		5	41
		10	35
		25	30
		50	0
266°	130°	1	58
		5	28
		10	0
284°	140°	1	29
		5	20

Admissible working internal compression for SIMTECH PVDF pipe according to DSV 2205-1, (6.95) supplement 4 in dependence of temperature and time (dimensions according to ISO/DIS 10931-2)

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Pipes Under External Gauge Pressure

External gauge pressure is the same as the difference between external and inner pressure. Accordingly it is also possible to provide information about the pipe loading when there is a vacuum in the interior.

Table 6 below relates to pipes which are not buried (ovality less than 2%) where the ratio of 1 to R is greater than 24. Usually a safety factor of greater than or equal to 2.0 should be taken into consideration.

Temperature		Life in Years	PP Type 1		
˚F	˚C		PN10/SR150	PN6/SR90	PN3.2/SR45
68˚	20˚	1 10	7.5 5.9	1.60 1.30	0.25 0.19
86˚	30˚	1 10	6.5 5.2	1.40 1.10	0.21 0.17
104˚	40˚	1 10	5.7 4.7	1.20 1.00	0.19 0.15
122˚	50˚	1 10	5.0 4.2	1.10 0.90	0.16 0.14
140˚	60˚	1 10	4.3 3.8	0.94 0.81	0.14 0.12
158˚	70˚	1 10	3.8 3.3	0.83 0.72	0.13 0.11
176˚	80˚	1 10	3.4 3.0	0.74 0.65	0.11 0.10
203˚	90˚	1 10	3.0 2.7	0.65 0.58	0.10 0.09

Table 6

PVDF Pipes

There is no pipe standard for PVDF material. In the past, the wall thicknesses have been fixed by the tooling available for PP, HDPE and PVC piping. Hence they are not uniformly loadable.

For SIMTECH PVDF the loading can be determined from Figure 3. We have included a safety factor of 2.0 with a life of 20 years.

Admissible Working Pressure For PVDF Depending On Temperature

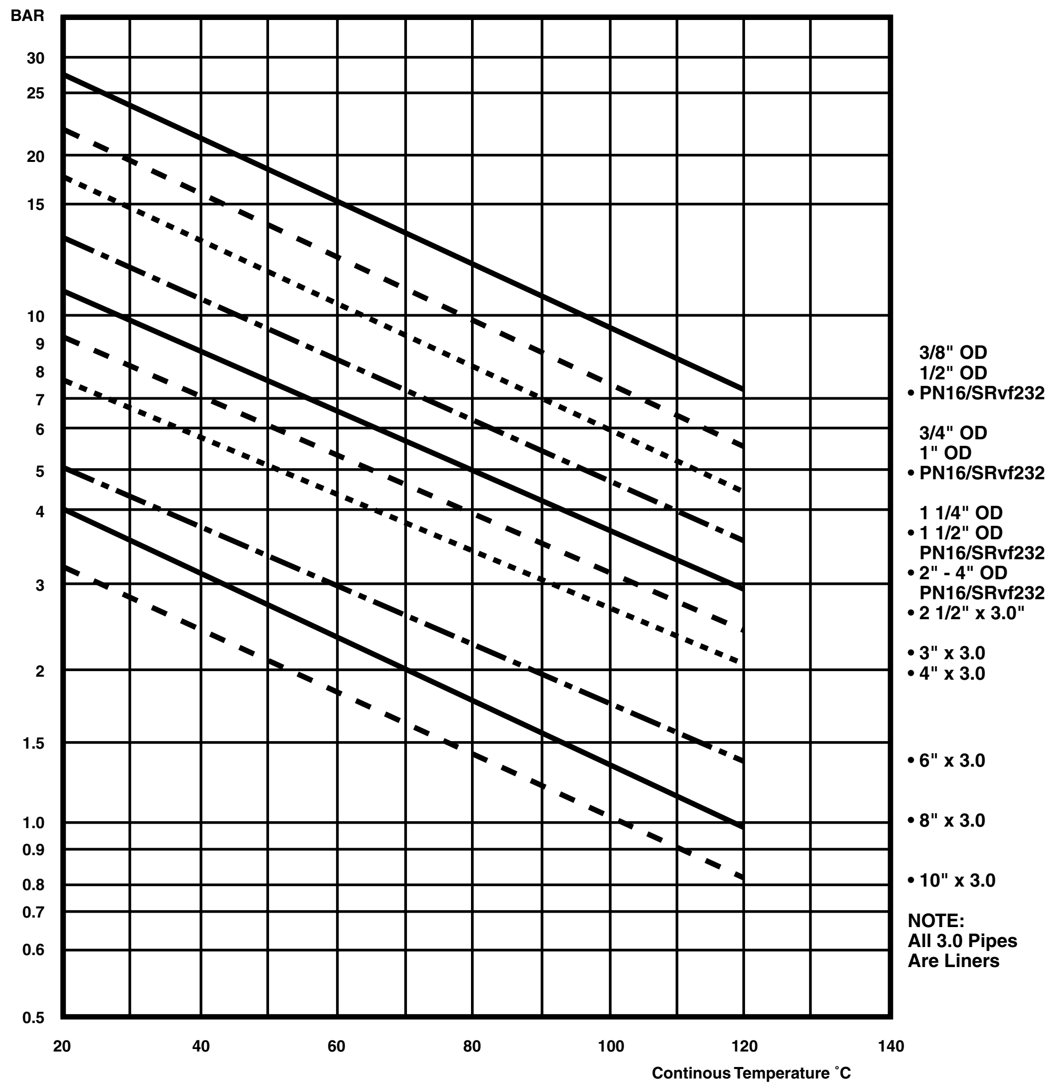


Figure 3

Determination of Pressure Drop

The pressure drop, when there is a steady flow in a pipe and taking into consideration an incompressible medium is:

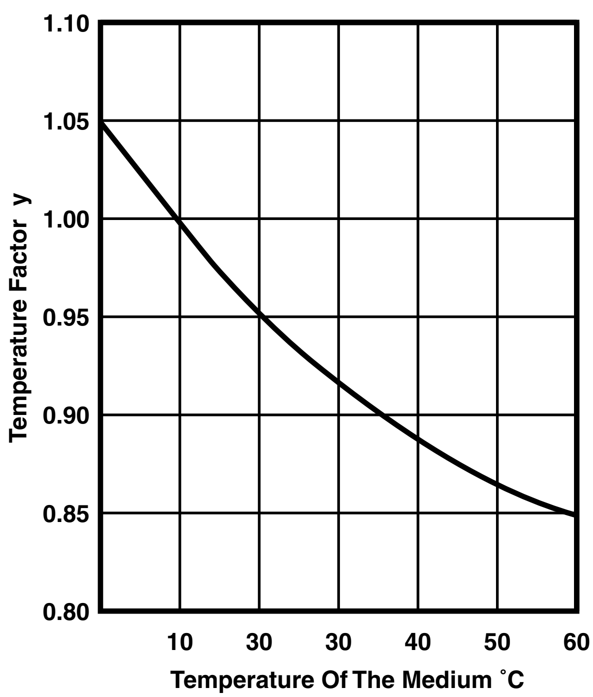
$$\Delta p = \frac{l \times v^2 \times \gamma \times \lambda}{d \times 2}$$

Δp = Pressure drop (Pa)
λ = Friction index of pipe
l = Pipe length (m)
d = Inside width of pipe (m)
γ = Density of medium passing through pipe (kg/m^3)
v = Medium speed of flow (m/s)

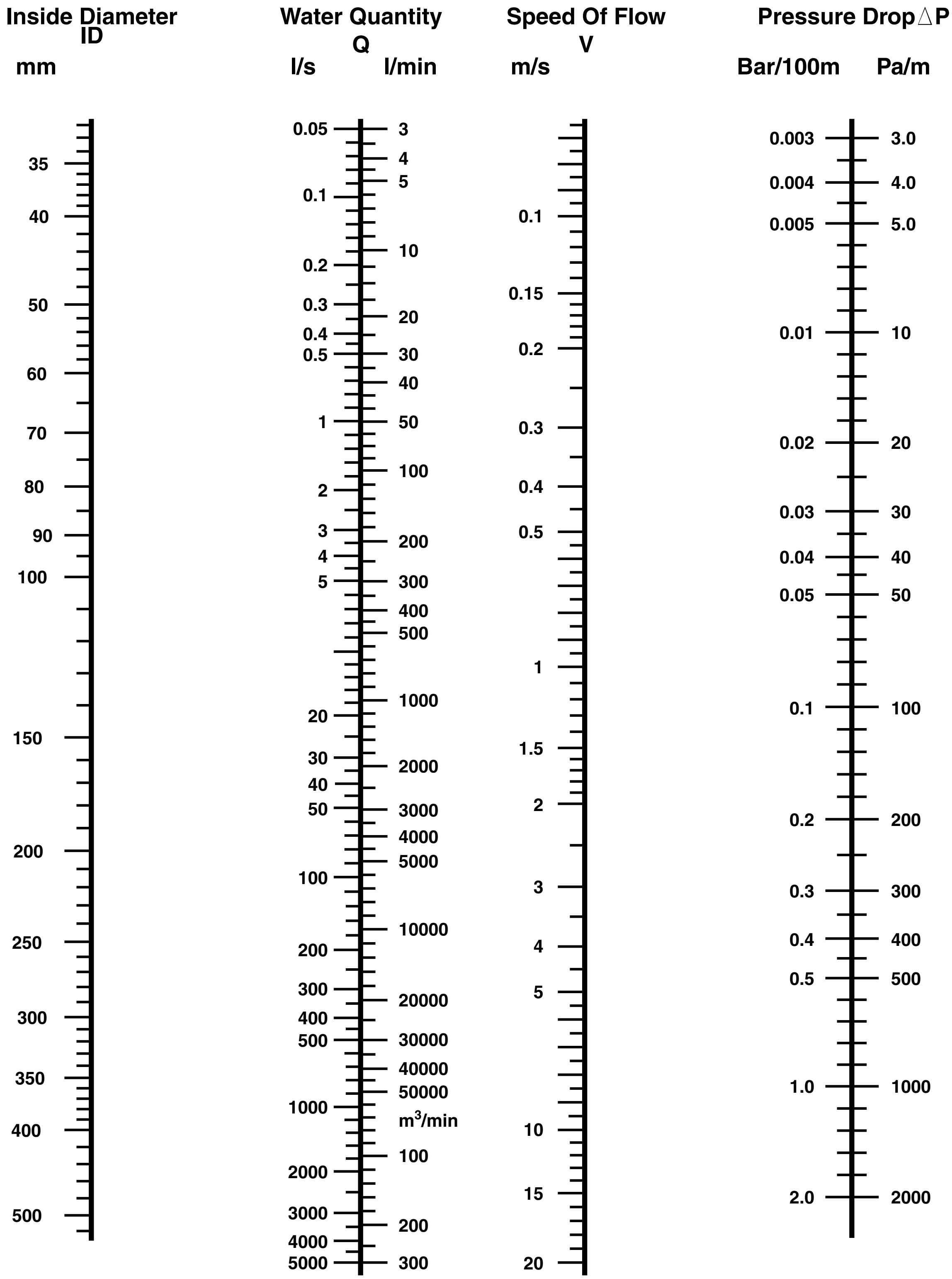
The pipe friction number (λ) depends on flow, viscosity, and roughness of the pipe wall. As an alternative to the above calculation for pressure drop we have provided Nomograph 1. This nomograph is based on turbulent flow of water at 10°C and a pipe roughness of .007 mm. (In practice it is safe to assume turbulent flow.) For other temperatures, the pressure loss, from Nomograph 1, needs to be adjusted by multiplying a correction factor from Figure 4.

Temperature Factor For The Determination Of The Pressure Loss

Figure 4



Determination of the Pressure Losses in Water Pipes



Reference Values For Water At 10˚C

Nomograph 1

Pressure Loss for Simtech PP Pipe

V = Velocity of water in ft./s; P = Pressure drop in psi/100 ft. of pipe based upon the Hazen-Williams method : C = 150.

	Nominal Pipe Size																											
	1	1	1¼	1¼	1½	1½	2	2	2½	2½	3	3	4	4	6	6	8	8	10	10	12	12	14	14	16	16	18	18
FLOW - GPM	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P
1	0.39	0.04	0.24	0.01																								
2	0.78	0.14	0.49	0.04	0.32	0.02																						
5	1.95	0.75	1.22	0.24	0.79	0.08	0.50	0.03	0.35	0.01	0.24	0.01																
7	2.72	1.39	1.71	0.45	1.11	0.16	0.70	0.05	0.49	0.02	0.34	0.02																
10	3.89	2.70	2.45	0.87	1.58	0.30	1.00	0.10	0.70	0.04	0.49	0.03																
15	5.84	5.72	3.67	1.85	2.37	0.64	1.49	0.21	1.05	0.09	0.73	0.06	0.49	0.01														
20	7.78	9.74	4.90	3.15	3.16	1.09	1.99	0.36	1.41	0.15	0.97	0.10	0.65	0.02														
25	9.73	14.72	6.12	4.77	3.95	1.64	2.49	0.54	1.76	0.23	1.22	0.13	0.81	0.03														
30	11.70	20.63	7.34	6.68	4.74	2.30	2.99	0.75	2.11	0.32	1.46	0.17	0.98	0.05														
35			8.57	8.89	5.53	3.07	3.49	1.00	2.46	0.43	1.70	0.23	1.14	0.06	0.54	0.01												
40			9.79	11.38	6.32	3.92	3.98	1.27	2.81	0.55	1.94	0.28	1.30	0.08	0.62	0.02												
45			11.00	14.16	7.11	4.88	4.48	1.59	3.16	0.68	2.19	0.34	1.46	0.10	0.69	0.02												
50					7.90	5.93	4.98	1.93	3.52	0.83	2.43	0.47	1.63	0.13	0.77	0.03	0.59	0.01										
60					9.48	8.31	5.98	2.71	4.22	1.16	2.92	0.63	1.95	0.18	0.92	0.03	0.69	0.02										
70					11.10	11.10	6.97	3.60	4.92	1.54	3.40	0.81	2.28	0.24	1.08	0.04	0.79	0.02										
80							7.97	4.61	5.62	1.97	3.89	1.00	2.60	0.30	1.23	0.05	0.89	0.03										
90							8.96	5.73	6.33	2.46	4.38	1.22	2.93	0.38	1.39	0.06	0.98	0.03										
100							9.96	6.97	7.03	2.99	4.86	1.84	3.25	0.46	1.54	0.07	1.23	0.04	0.49	0.01								
125							12.50	10.50	8.79	4.52	6.08	2.56	4.06	0.69	1.92	0.11	1.48	0.05	0.95	0.02								
150									10.60	6.33	7.29	3.43	4.88	0.70	2.31	0.16	1.72	0.07	1.10	0.02								
175											8.51	4.39	5.69	1.29	2.69	0.21	1.97	0.09	1.26	0.03								
200											9.72	6.64	6.50	1.65	3.08	0.27	2.46	0.13	1.58	0.05	0.99	0.01						
250											12.20	9.31	8.13	2.49	3.85	0.40	2.95	0.19	1.89	0.06	1.19	0.02	0.94	0.01				
300													9.75	3.50	4.62	0.57	3.44	0.26	2.21	0.09	1.39	0.03	1.09	0.02				
350													11.40	4.64	5.39	0.75	3.94	0.32	2.52	0.11	1.59	0.03	1.25	0.02				
400															6.16	0.97	4.43	0.40	2.84	0.14	1.78	0.04	1.40	0.03				
450															6.93	1.20	4.92	0.49	3.15	0.16	1.98	0.05	1.56	0.03	1.11	0.01		
500															7.69	1.46	5.90	0.69	3.78	0.23	2.38	0.07	1.87	0.04	1.23	0.02		
600															9.23	2.04	6.89	0.92	4.41	0.31	2.78	0.10	2.19	0.06	1.48	0.02	1.17	0.01
700															10.80	2.72	7.87	1.17	5.04	0.40	3.17	0.13	2.50	0.07	1.72	0.03	1.36	0.02
800																	8.85	1.46	5.67	0.49	3.57	0.16	2.81	0.09	1.97	0.04	1.55	0.02
900																	9.84	1.78	6.30	0.60	3.97	0.19	3.12	0.11	2.21	0.05	1.75	0.03
1000																			12.60	2.17	7.93	0.70	6.24	0.39	2.46	0.06	1.94	0.03
2000																					9.92	1.07	7.80	0.59	4.92	0.22	3.89	0.13
2500																									6.15	0.33	4.86	0.19
5000																									12.30	1.20	9.72	0.68
7500																											14.60	1.43

Chart PL-1

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Pressure Loss for Simtech PVDF Pipe

V = Velocity of water in ft./s; P = Pressure drop in psi/100 ft. of pipe based upon the Hazen-Williams method : C = 150.

	Nominal Pipe Size																					
	1	1	1¼	1¼	1½	1½	2	2	2½	2½	3	3	4	4	6	6	8	8	10	10	12	12
FLOW - GPM	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P	V	P
1	0.36	0.03	0.21	0.01																		
2	0.71	0.11	0.42	0.03	0.27	0.01																
5	1.78	0.60	1.06	0.17	0.67	0.06	0.41	0.02														
7	2.49	1.11	1.49	0.32	0.94	0.10	0.57	0.03	0.38	0.01												
10	3.55	2.16	2.12	0.62	1.35	0.20	0.81	0.06	0.54	0.02												
15	5.33	4.57	3.19	1.31	2.02	0.43	1.22	0.13	0.81	0.05	0.40	0.01										
20	7.10	7.79	4.25	2.24	2.69	0.74	1.62	0.21	1.07	0.08	0.60	0.02										
25	8.88	11.80	5.31	3.37	3.37	1.11	2.03	0.32	1.34	0.12	0.79	0.04	0.50	0.01								
30	10.70	16.50	6.37	4.73	4.04	1.46	2.43	0.45	1.61	0.17	0.99	0.06	0.62	0.02								
35			7.43	6.30	4.71	2.08	2.84	0.60	1.88	0.22	1.19	0.08	0.74	0.03								
40			8.50	8.06	5.38	2.66	3.24	0.78	2.15	0.29	1.39	0.11	0.87	0.03								
45			9.56	10.00	6.06	3.31	3.65	0.96	2.42	0.36	1.59	0.14	0.99	0.04								
50			10.62	12.20	6.73	4.02	4.05	1.17	2.69	0.43	1.79	0.17	1.12	0.05	0.59	0.01						
60					8.08	5.63	4.86	1.64	3.22	0.60	1.99	0.21	1.24	0.06	0.70	0.02						
70					9.42	7.49	5.67	2.18	3.76	0.80	2.38	0.29	1.49	0.09	0.82	0.02						
80					10.80	9.60	6.48	2.79	4.30	1.03	2.78	0.39	1.74	0.12	0.94	0.03						
90							7.29	3.47	4.83	1.28	3.18	0.49	1.99	0.16	1.05	0.03						
100							8.10	4.22	5.37	1.55	3.57	0.61	2.23	0.19	1.17	0.04	0.75	0.01				
125							10.31	6.38	6.71	2.35	4.96	0.74	2.48	0.24	1.46	0.06	0.93	0.02				
150									8.06	3.29	5.96	1.13	3.10	0.36	1.76	0.08	1.12	0.03				
175									9.40	4.37	6.95	1.58	3.72	0.50	2.05	0.10	1.31	0.03	0.96	0.01		
200									10.70	5.60	7.94	2.10	4.34	0.85	2.34	0.14	1.50	0.04	1.20	0.02		
250											11.90	9.06	6.20	1.81	2.39	0.21	1.87	0.07	1.44	0.03		
300													7.44	2.41	3.51	0.29	2.24	0.10	1.68	0.04		
350													9.93	3.09	4.10	0.39	2.62	0.13	1.92	0.06	1.06	0.01
400													11.20	3.84	4.68	0.49	2.99	0.16	2.16	0.07	1.21	0.02
450														4.67	5.27	0.61	3.37	0.20	2.40	0.08	1.36	0.02
500															5.85	0.75	3.74	0.25	2.87	0.12	1.51	0.03
600															7.02	1.05	4.49	0.35	3.35	0.16	1.81	0.03
700															8.19	1.40	5.24	0.47	3.83	0.20	2.11	0.05
800															9.36	1.79	5.98	0.60	4.31	0.26	2.41	0.06
900															10.50	2.23	6.73	0.75	4.79	0.31	2.71	0.08
1000																	7.48	0.91	9.58	1.11	3.02	0.10
2000																	15.00	3.29	12.00	1.68	6.03	0.36
2500																					7.54	0.55
5000																					15.10	1.97

Chart PL-2

FLOW CHARACTERISTICS

The surface finish on the ID of PP and PVDF pipe is considerably smoother than the bore of steel pipe. In addition, since these materials are not subject to corrosion the coefficient of friction does not deteriorate with time and exposure as with steel pipe.

Coefficient of Friction of plastic Piping

Hazen-Williams Method: C = 150

Pressure loss for PP is shown in Chart PL-1 (Page 14) and PVDF is shown in Chart PL-2 (Page 15). Chart PL-3 provides equivalent footage to be added for fittings.

Pressure Drop for Fittings in Equivalent Feet of Pipe

	Nominal Size										
	½"	¾"	1	1¼"	1½"	2"	2½"	3"	4"	6"	8"
90° Elbow	1.5	2.0	2.7	3.5	4.2	5.5	7.0	8.0	11.0	16.0	20.0
45° Elbow	0.8	1.0	1.3	1.7	2.1	2.7	3.5	4.0	5.5	8.0	10.0
Tee with flow through run	1.0	1.4	1.7	2.3	2.7	4.3	5.1	6.3	8.3	13.0	16.5
Tee with flow through branch	4.0	5.1	6.0	6.9	8.1	12.0	14.3	16.3	22.1	32.0	40.0
Reducer Bushing	1.0	1.1	1.2	1.4	1.7	2.6	3.6	4.4	5.2	7.0	10.0
Male Adapter	1.0	1.3	1.6	2.2	2.6	3.5	-	-	-	-	-
Female Adapter	1.0	1.3	1.6	2.2	2.6	3.5	-	-	-	-	-

Chart PL-3

WATER HAMMER

Shock waves or pressure surges commonly referred to as water hammer are caused by rapid or abrupt change in fluid velocity within the pipe system. In some cases the surges can attain a magnitude sufficient to damage the system. The amount of surge experienced is dependant upon the modulus of the pipe material, the density and velocity of the fluid, the line length and the speed at which flow is stopped or started.

Although plasticpipe is capable of withstanding surges many times its rated pressure, it is recommended that the source of hammer be eliminated or reduced in order to ensure long term system integrity.

Avoid:

- Valves that close or open instantly
- Starting pumps into empty discharge lines unless a slow opening valve is used to gradually increase flow
- Slow closing check valves

It may also be advisable to employ feedback loops or surge suppressors to eliminate hammer.

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Annealed SR Series PP Pipes

SIMTECH Pipe, as manufactured by SIMONA, is extruded utilizing state of the art manufacturing process's and equipment, designed to reduce the inherent stresses in the pipe walls.

SIMTECH PP and PVDF Pipe, as manufactured by SIMONA, are subject to a thermal post extrusion annealing process which significantly reduces the stresses in the pipe wall caused during extrusion process.

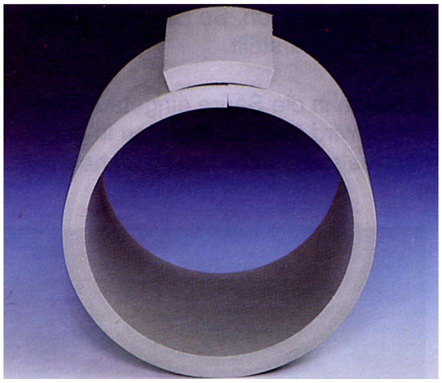

Fig. 1 PP Pipe, Standard Quality.

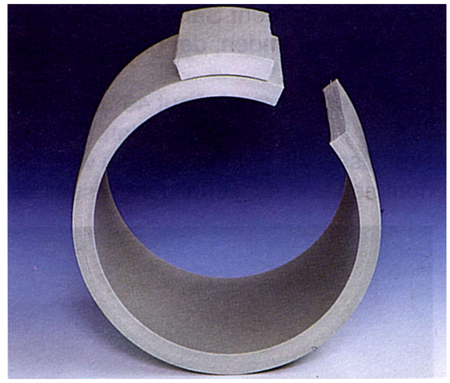

Fig. 2 SIMONA PP Pipe with Post-Extrusion Treatment.

The post-extrusion annealing has the following beneficial effects on the pipe properties:
· Increased resistance to stress cracking commonly found in non-annealed materials.
· Longer life, even with significant chemical concentrations - especially important when used near maximum limit conditions
· Increased impact resistance.
· Low shrinkage - important for socket joints or when the pipes are subsequently heated
· Increased dimensional stability.

Testing

Our Products are recognized world wide in their ability to out perform our competitors. One test which illustrates this is the Chromic Acid Test. For over 20 years SIMONA's SR Series PP has been subjected to the Chromic Acid Test. Only Pipe with very low stresses, i.e., pipes which have been Post-extrusion annealed can withstand such rigorous testing.

Chromium Salts (CrO_3) are dissolved in water until the CrO_3 precipitates to the bottom in significant quantity. Maximum concentration is visually assured

Fig. 3 PP Pipe, Standard Quality After Chromic Acid Test.

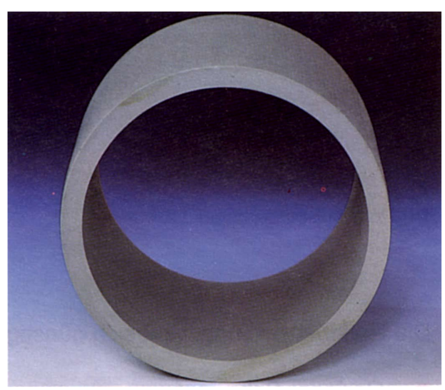

Fig. 4 SIMONA PP Pipe After Chromic Acid Test.

The Chromic Acid is heated to 40°C and continuously stirred during the duration of the test. The specimen pipe is stored in the test fluid for 24 hours. During this test, the pipe is removed several times from the liquid and visually checked for cracks.

If there are excessive inherent stresses, the inside pipe wall will start to crack. In the case of thick-walled pipes, it is possible for these cracks to extend through the entire wall thickness causing the test specimen to be destroyed.

RECEIVING PIPE

As pipe is received, it must always be thoroughly inspected, prior to unloading. The person receiving the pipe must look for any transportation damage caused by over-tightened tie down straps, improper treatment, or a shift in the load.

Pipe received in a closed trailer must be inspected as the trailer is opened. Take extra time to ensure that the pipe has not been damaged by other materials having been stacked on top of it, load shift, or rough handling.

Visually examine the pipe ends for any cracks, splits, gouges, or other forms of damage. Additionally, the pipe should be inspected for severe deformation, which could later cause joining problems. The entire inside diameter of larger diameter pipe (4″ and above) must be checked for any internal splits or cracks, which could have been caused, by loading or transit. The use of a flashlight may be necessary to perform this inspection.

Any damages must be observed by all parties involved, including the driver, and should be clearly noted on the bill of lading and/or delivery ticket. The receiver should retain a copy of this document. In addition, the manufacturer and carrier should be notified, within 24 hours, of any damages, shortages, or mis-shipped products.

HANDLING PIPE

The pipe should be handled with reasonable care. Because thermoplastic pipe is much lighter in weight than metal pipe, there is sometimes a tendency to throw it around. This should be avoided.

The pipe should never be dragged or pushed from a truck bed. Removing and handling pallets of pipe should be done with a forklift. Loose pipe lengths require special handling to avoid damage. Precautions to follow when unloading and handling loose pieces include not banging lengths together or dropping lengths, even from low heights, on hard or uneven surfaces.

In all cases, severe contact with any sharp objects (rocks, angle irons, forks on forklifts, etc.) should be avoided. Also, **the pipe should never be lifted or moved by inserting the forks of a forklift into the pipe ends.**

Plastic pipe becomes more brittle as the temperature decreases. The impact strength and flexibility of Thermoplastics are reduced. Therefore, take extra care when handling skids or loose lengths when the temperature drops below 50° F.

STORING PIPE

If possible, pipe should be stored inside. When this is not possible, the pipe should be stored on level ground, which is dry and free from sharp objects. If different pipe of different Pressure Ratings are stacked together, the pipe with the thickest walls should be on the bottom. If the pipe is in pallets, the pallets should be stacked with the pallet boards touching, rather than pallet boards being placed on the pipe. This will prevent damage to or bowing of the pipe.

If the pipe is stored in racks, it should be continuously supported along its length. If this is not possible, the spacing of the supports should not exceed three feet (3’).

The pipe should be protected from the sun and be in an area with proper ventilation. This will lessen the effects of ultraviolet rays and help prevent heat build-up.

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Welding, Bonding

Welding Material

For the production of permanent connections between pipe and fittings we recommend the following proven methods:
· Butt fusion welding or
· Socket fusion welding

We recommend socket fusion welding for PP or PVDF small diameter material (½″, ¾″, 1″ and 1½″) and butt fusion welding for materials greater than 1½″.

Butt Welding Using A Heating Element

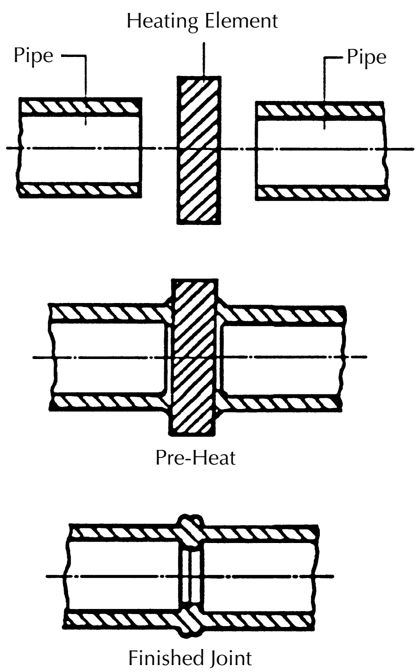

Figure 5

Socket Welding Using a Heater Element

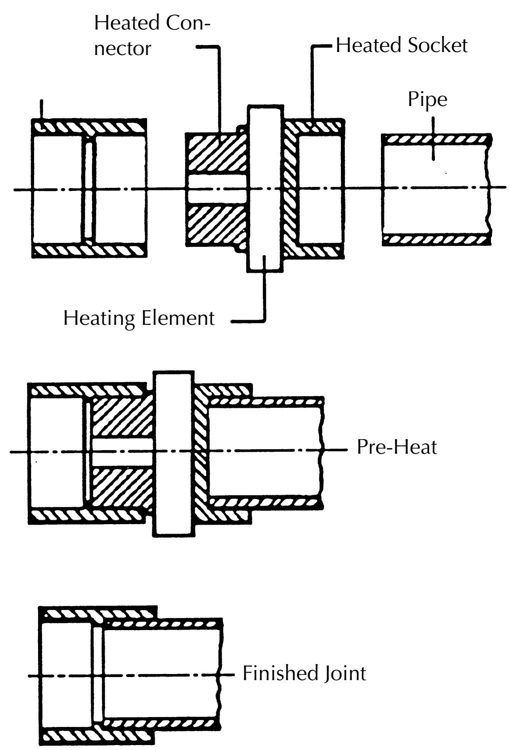

Figure 7

Weldability of Various Types of Material

PP is offered in two types, for PVDF, there is no standard at the moment. Despite this, there are two polymerization methods available in the market. Although the properties in detail differ, welding properties are essentially the same.

PP Type 1 (PP-H) and Type 2 (PP-C, PP -R)

These materials are weldable within the melting index group 006 (HFI 190/5 0.4 0.8 g/10 min.). DVS 2207 part 11 is in preparation at the moment and will contain this information.

PVDF

As already mentioned, two polymerization methods are used on the market.

- Emulsion PVDF
- Suspension PVDF

Without going into detail, it can be stated that pipe or fittings produced from both types of PVDF can be welded to one another quite successfully.

Basic Weld Preparations

The welded area must be protected against unfavorable weather conditions (e.g. the effect of moisture, wind, exposure to the radiation of the sun and temperatures below 0°C).
Once suitable measures such as:

- Preheating
- Covering with a tent
- Heating

have been used to ensure that a uniform pipe wall temperature can be maintained which is suitable for welding, it is possible to work at any external temperature. When there is radiation by the sun, unequally heated pipes must be brought to equilibrium by covering them in the area of the weld until the pipe wall temperatures match.

The connecting faces of the parts to be welded must be free from contamination. Cleaning must take place immediately before welding. The same applies in respect of the heating element which should be cleaned with methylated spirit and a lint-free cloth. The metal surface should be teflon-coated to prevent adhesion of the pipe to the heating element and to make it easier to detach the pipe. In order to prevent excessive cooling by the wind during the operation, the pipe ends opposite to the joint should be closed off.

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Pipe End Preparation

The pipe sections must be axially aligned and clamped in the welding fixture. It is essential to ensure that the parts to be welded can move longitudinally, for example by the use of adjustable roller supports.

The faces to be joined should be machined in the clamped condition with a plane. The thickness of the shaving should be less than or equal to 0.2mm. Any shavings falling into the pipe should be removed using a clean tool. Under no circumstances should the machined faces be touch by hand.

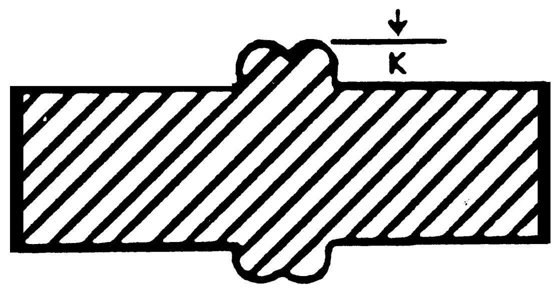
After machining, the pipe ends should be checked for parallelism. The remaining gap should not exceed the values shown in Table 7. At the same time a check should be made to ensure that the vertical offset of the pipe ends is less than 10% of the pipe wall thickness.

Maximum Gap Width Before Welding

Pipe Diameter OD	Maximum Gap Width
≤ 14"	0.5
16 to < 24	1.0
24 to < 32	1.3
32 to ≤ 40	1.5

Table 7

Bead Formation During Butt Fusion Welding With A Heater Element



K=25% of Wall Thickness

Figure 6

Butt Fusion Welding Process

The heater element which has been heated to the welding temperature, (see Reference Values for Butt Welding, Table 8 A & 8B), is inserted between the parts to be welded and the two faces to be joined are pressed on both sides (fig. 5) against the heater element using the correct pressure. See Reference Values for Butt Welding, Table 8A & 8B. For PVDF a temperature of 220°C to 240°C is used.

After heating, the joint faces must be detached from the heater element without damage and without contamination. The time for detachment of the joint faces, the removal of the heater element and the contact of the joint faces with one another is referred to as the change over time. This time should be kept as short as possible.

The faces to be welded should make contact with a speed which is virtually zero. Only then should the pressure be increased gradually (for times see Table 3), and should then be maintained until the pipes have cooled completely.

Sudden cooling off of the area of the welded seam or the application of coolants is not permitted. If the pipe wall thickness is greater, than (20mm), we recommend covering the weld area during the cooling time to achieve uniform cooling, which has a beneficial effect on the quality of the welded seam. After joining a double bead (Fig. 6) must be apparent over the entire circumference.

Reference Values for Butt Welding of Polypropylene (PP)

Diameter & Wall Thickness		Weld Temp °C	Beginning Melt Pressure & Bead Height (Kg./Force)		Heat Soak (Pressure at Near Zero Force)	Change Over Time (Remove Heater & Gradually Increase to Weld Pressure) Seconds		Weld Pressure (Kg./Force)	Cooling Time Before Removing Clamps
			Pressure	Height	Seconds	Change Over	Bring To Pressure		Minutes
½”	PN3.2	-	-	-	-	-	-	-	-
½”	PN6	-	-	-	-	-	-	-	-
½”	PN10	210	1	1/32”	30	3	4	1	3
¾”	PN3.2	-	-	-	-	-	-	-	-
¾”	PN6	-	-	-	-	-	-	-	-
¾”	PN10	210	1	1/32”	35	3	4	1	3
1”	PN3.2	-	-	-	-	-	-	-	-
1”	PN6	-	-	-	-	-	-	-	-
1”	PN10	210	2	1/32”	40	4	4	2	4
1 ¼”	PN3.2	-	-	-	-	-	-	-	-
1 ¼”	PN6	-	-	-	-	-	-	-	-
1 ¼”	PN10	210	3	1/32”	45	4	4	3	5
1 ½”	PN3.2	-	-	-	-	-	-	-	-
1 ½”	PN6	-	-	-	-	-	-	-	-
1 ½”	PN10	215	4	1/32”	50	5	6	4	6
2”	PN3.2	-	2	1/32”	30	3	4	2	3
2”	PN6	210	4	1/32”	45	4	4	4	4
2”	PN10	205	6	1/32”	60	5	6	6	7
2 ½”	PN3.2	-	3	1/32”	35	4	4	3	4
2 ½”	PN6	210	6	1/32”	55	5	6	6	5
2 ½”	PN10	205	9	1/16”	75	5	7	9	8
3”	PN3.2	-	5	1/32”	35	4	4	5	5
3”	PN6	205	8	1/32”	60	5	6	8	8
3”	PN10	200	13	1/16”	90	6	8	13	10
4”	PN3.2	210	7	1/32”	40	4	5	7	5
4”	PN6	205	12	1/32”	70	5	7	12	9
4”	PN10	200	19	1/16”	100	6	10	19	12
6”	PN3.2	210	15	1/32”	60	5	6	15	7
6”	PN6	205	26	1/16”	100	6	8	26	14
6”	PN10	197	41	1/16”	130	8	12	41	22
8”	PN3.2	205	23	1/32”	80	5	6	23	10
8”	PN6	198	41	1/16”	140	6	8	41	17
8”	PN10	195	63	1/16”	200	8	14	63	26
10”	PN3.2	205	36	1/16”	105	6	8	36	11
10”	PN6	195	65	1/16”	155	8	10	65	20
10”	PN10	192	100	3/16”	220	10	15	100	23
12”	PN3.2	200	58	1/16”	120	6	10	58	12
12”	PN6	195	102	3/32”	170	8	10	102	23
12”	PN10	192	158	3/32”	270	12	20	158	37
14”	PN3.2	200	74	1/16”	140	6	10	74	15
14”	PN6	195	130	3/32”	200	10	15	130	27
14”	PN10	192	201	3/32”	325	12	20	201	42
16”	PN3.2	200	93	1/16”	155	8	10	93	19
16”	PN6	193	165	3/32”	220	10	15	165	30
16”	PN10	190	255	3/32”	370	14	25	255	45
18”	PN3.2	195	117	1/16”	160	8	12	117	20
18”	PN6	190	237	3/32”	230	10	15	237	35
18”	PN10	-	322	1/8”	390	16	30	322	53
20”	PN3.2	195	145	1/16”	170	8	12	145	21
20”	PN6	190	257	3/32”	270	12	20	257	36
20”	PN10	-	-	-	-	-	-	-	-
24”	PN3.2	193	232	1/16”	200	10	15	232	26
24”	PN6	190	396	3/32”	325	14	25	396	45
24”	PN10	-	-	-	-	-	-	-	-

Table 8 A

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Reference Values for Butt Welding of Polyvinylidiene Fluoride (PVDF)

Diameter & Wall Thickness		Weld Temp °C	Beginning Melt Pressure & Bead Height (Kg./Force)		Heat Soak (Pressure at Near Zero Force)	Change Over Time (Remove Heater & Gradually Increase to Weld Pressure) Seconds		Weld Pressure (Kg./Force)	Cooling Time Before Removing Clamps
			Pressure	Height	Seconds	Change Over	Bring To Pressure		Minutes
½”	PN 16	230	3	1/32”	25	4	5	3	3
¾”	PN 16	230	3	1/32”	25	4	5	3	3
1	PN 16	230	3	1/32”	30	4	5	3	3
1¼"	PN 16	230	4	1/32”	35	4	5	4	4
1½"	PN 16	230	6	1/32”	40	4	5	6	5
2"	PN 16	230	8	1/32”	45	4	5	8	5
2 ½”	PN 16	230	8	1/32”	50	4	5	8	5
3	PN 16	230	10	1/16”	40	4	5	10	6
4	PN 16	230	16	1/16”	50	4	5	16	7
6	PN 10	230	32	1/16”	70	4	5	32	10
8	PN 10	230	49	1/16”	90	6	5	49	12
10	PN 10	230	78	3/32”	120	8	5	78	14
12	PN 10	230	124	3/32”	150	10	5	124	20

Table 8 B

Socket Fusion Welding

Pipes and connectors are welded with an overlap. Using a socket or bulkhead-shaped heater element, both faces are heated to welding temperature and are then joined. Pipe end heater element and socket element are dimensionally matched to one another (Fig. 7).

Preparation For Socket Welding

Pipe must be cut square and the end must be chamfered. The fitting interior should be thoroughly cleaned using a cleaning agent, e.g. methylated spirits, and absorbent, lint free cloth.

The pipe end should be chamfered on the outside to approximately 15° over a width of 3/32″ (2mm) in the case of diameters up to 1½″ (50 mm), and over a width of 1/8″ (3mm) in the case of larger diameters.

Welding Process

The welding tools are preheated to 260°±10°C. Fitting and pipe should be pushed quickly and axially against the abutment or the marking of the tools and should be held there. The parts to be welded should be heated in accordance with the information and time given in Tables 9 or 10.

After the Heating Time, the fitting and pipes should be withdrawn from the heater element abruptly and without twisting. They should be pushed together right up to the mark or the abutment. The joined parts need to be held together for the length of time stated in Tables 9 or 10.

Reference Values for Heater Element Socket Welding of PP

Pipe		Insertion Time	Maximum Changeover Time	Cooling Time	
OD (Inches)	OD (MM)	PN10/SR150 (sec)	(sec)	Clamped (sec)	Cooling Time (min)
3/8	16	8	4	8	2
1/2	20	10	4	10	2
3/4	25	15	4	15	2
1	32	18	6	15	4
1-1/4	40	22	6	20	4
1-1/2	50	35	6	20	4
2	63	45	8	30	6
2-1/2	75	60	8	30	6
3	90	75	8	40	6
4	110	80	10	50	8

Table 9

Reference Values for Heater Element Socket Welding of PVDF

Pipe		Pipe Pre-Heating Time	Maximum Permissible Changeover Time	Cooling Time	
OD (Inches)	OD (MM)	(sec)	(sec)	Clamped (sec)	Total (min)
3/8	16	4	3	6	2
1/2	20	8	3	12	2
3/4	25	8	3	12	2
1	32	12	5	18	4
1-1/4	40	12	5	18	4
1-1/2	50	16	5	24	4
2	63	16	5	24	6
2-1/2	75	21	7	30	6
3	90	25	7	40	6
4	110	32	7	50	8

Table 10

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Laying, Installation

Support Spacing

Support spacing for plastic pipe is dependent on the pipe material, mean pipe wall temperature, the pipe size and the density of the medium being transported. Figures 8 and 9 contain calculated standard spacing. For simplicity, we have assumed a maximum deflection of:

- f_{max} = 1cm — PP Type 1 and Type 2
- f_{max} = 0.5cm — PVDF

The resulting distances for supporting the pipes apply when the pipes are laid horizontally. When the pipes are installed vertically, the distances between pipe shackles can be multiplied by the factor 1.3.

The distances for supporting the pipes under other condition, i.e. when the wall thickness is thinner, when the medium has a different density or when very low sag is required, other factors should be taken into consideration.

Correction Factor for Other Wall Thickness

Nominal Pressure Rating	Correction Factor PP
PN10/SR150	1.00
PN6/SR90	0.91
PN3.2/SR45	0.80

Table 11

Correction Factor for Media With a Different Density

Density	Correction Factor	
g/cm^3	PP	PVDF
GAS	1.30	1.20
1.00	1.00	1.00
1.25	0.96	0.97
1.50	0.93	0.94
1.75	0.90	0.92

Table 12

Correction Factor for Other Maximum Deflection Values

Deflection	Correction Factor	
f_{max} in cm	PP	PVDF
2.0	1.49	–
1.6	1.11	–
1.0	1.00	–
0.8	0.95	–
0.6	0.88	–
0.5	–	1.00
0.4	0.79	0.95
0.3	–	0.88
0.2	0.67	0.79
0.1	0.56	0.67

Table 13

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Distance Between Supports For SR Series PP Pipe Type 1

Pressure Pipes, PN10/SR150, Media Density, Specific Gravity of 1 for Maximum Deflection After 10 Years of .4 Inches

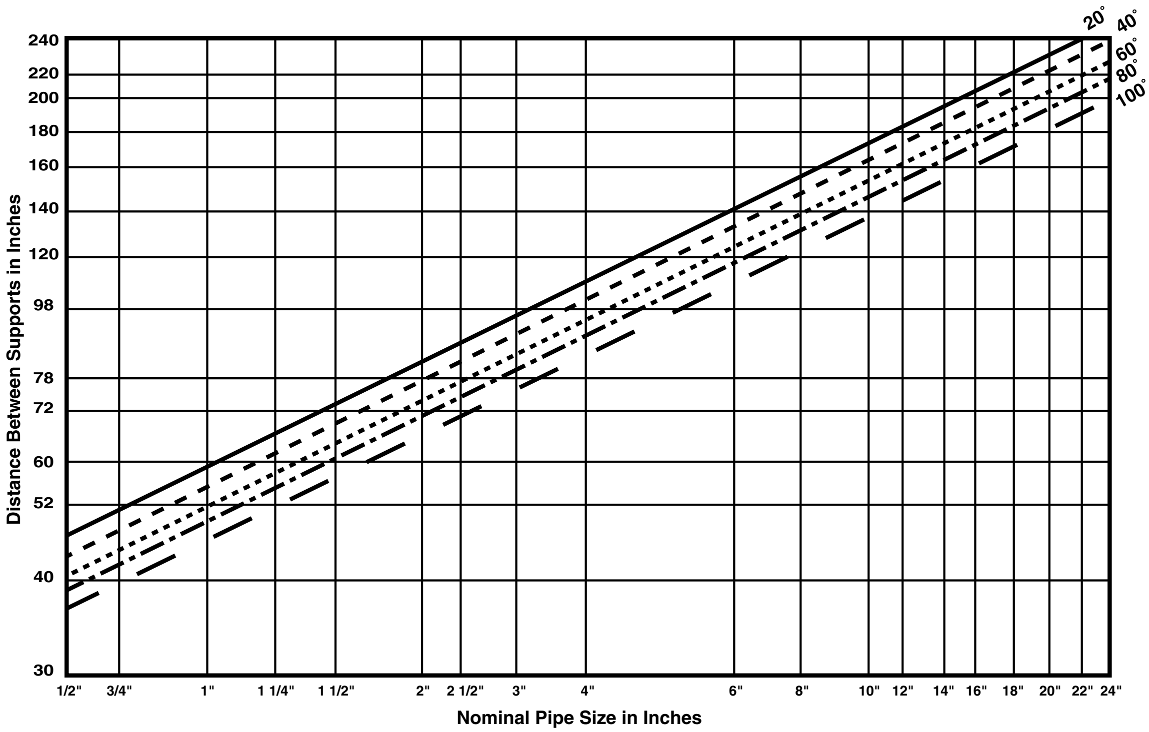

Figure 8

Distance Between Supports For SR Series PVDF Pipe

Pressure Pipes, PN10/SR150, Media Density, Specific Gravity of 1 for Maximum Deflection After 10 Years of .2 Inches

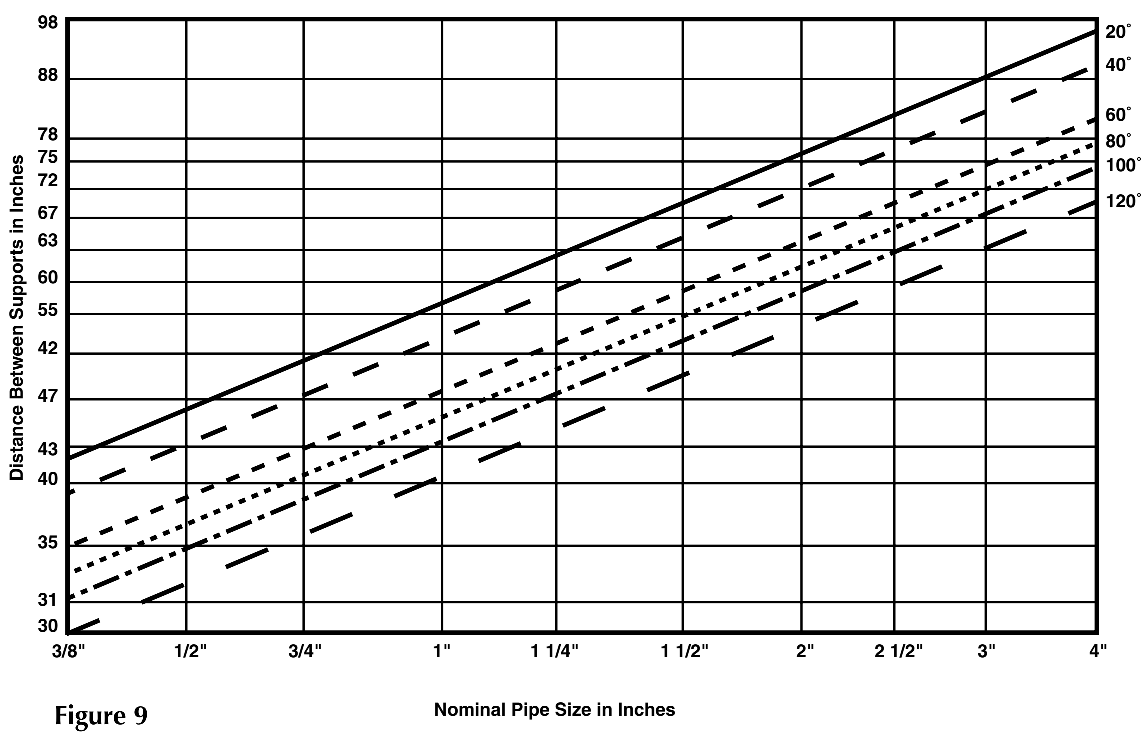

Figure 9

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Providing for Thermal Expansion

The distance between fasteners proposed by SIMTECH is the result of the static conditions. At elevated operating temperatures and with the pipes firmly clamped, it is possible for the material to sag to and increasing extent because of longitudinal expansion of the material. In such isolated cases, we suggest use of expansion loops or expansion joints.

Where the pipe supports are closely spaced, it might be more economical and more advantageous to lay the pipes on Channel or U-Channels, or on Halved Pipes for continuous support.

Longitudinal Expansion

During Design and Installation, longitudinal expansion should be taken into consideration. This can be calculated as follows:

$$\Delta L = \alpha * L * \Delta t$$

where:

- Δ**L** = Length Changes in mm
- **L** = Pipe Length between Fixed Point mm
- Δ**t** = Difference in Pipe Temperature between Installation and Operating Condition. Where Temperature Differences are Large, the Following applies:

  t of pipe approximately 0.9 x **t** of medium

- α = Mean Coefficient of Expansion

PP	0.16mm/m x °K
PVDF	0.13mm/m x °K

Bend

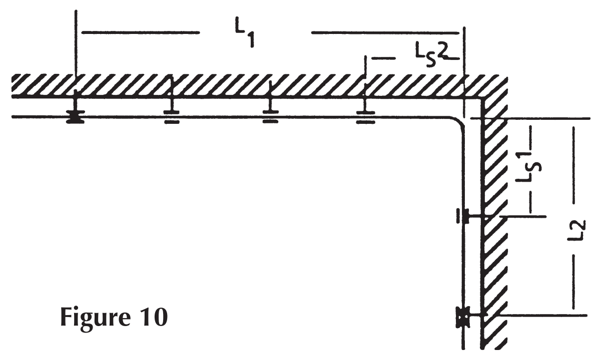

Figure 10

The calculated figure applies to a pipe which can freely move in all directions. However, in practice, opposing frictional forces will occur and part of the loading is taken up by the pipe, so that smaller expansion than those calculated may be obtained.

Where the operating temperature is constantly above the installation temperature, the expansion can be counteracted by preloading the pieces.

Other solutions are elastic installation, changes of directions and branches. The necessary bends can be calculated as follows:

- $L_s = k\sqrt{\Delta L \times OD}$

- **Ls** = Length of half bend in mm
- **k**= Material constant

PP	28
PVDF	24

- **OD** = Pipe OD in mm
- Δ**L** = Length Change

In order to facilitate handling, we have prepared Figures 11 and 12 for materials PP and PVDF. In the case of larger, straight pipes and at high operating temperatures, the use of expansion sockets or expansion joints are recommended.

In the case of larger, straight pipes and at high operating temperatures, the use of expansion loops, expansion sockets or compensators is recommended

Length Of Leg Bend For PP Pipe Depending On Length Changes and Pipe Diameter

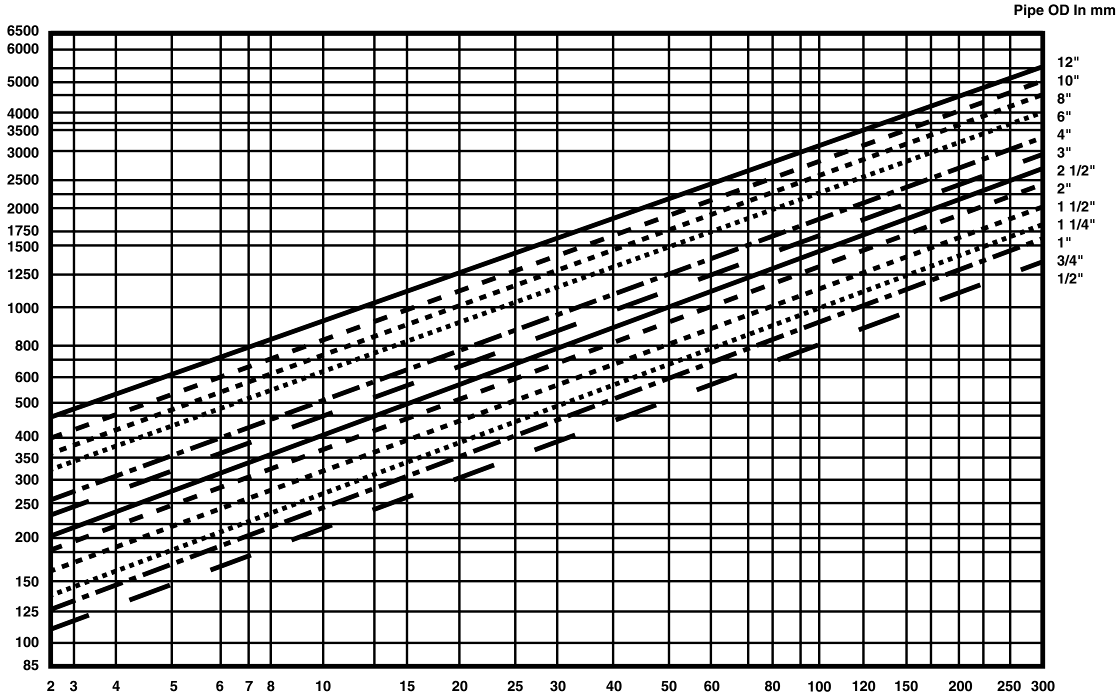

Figure 11

Length Of Leg Bend For PVDF Pipe Depending On Length Changes and Pipe Diameter

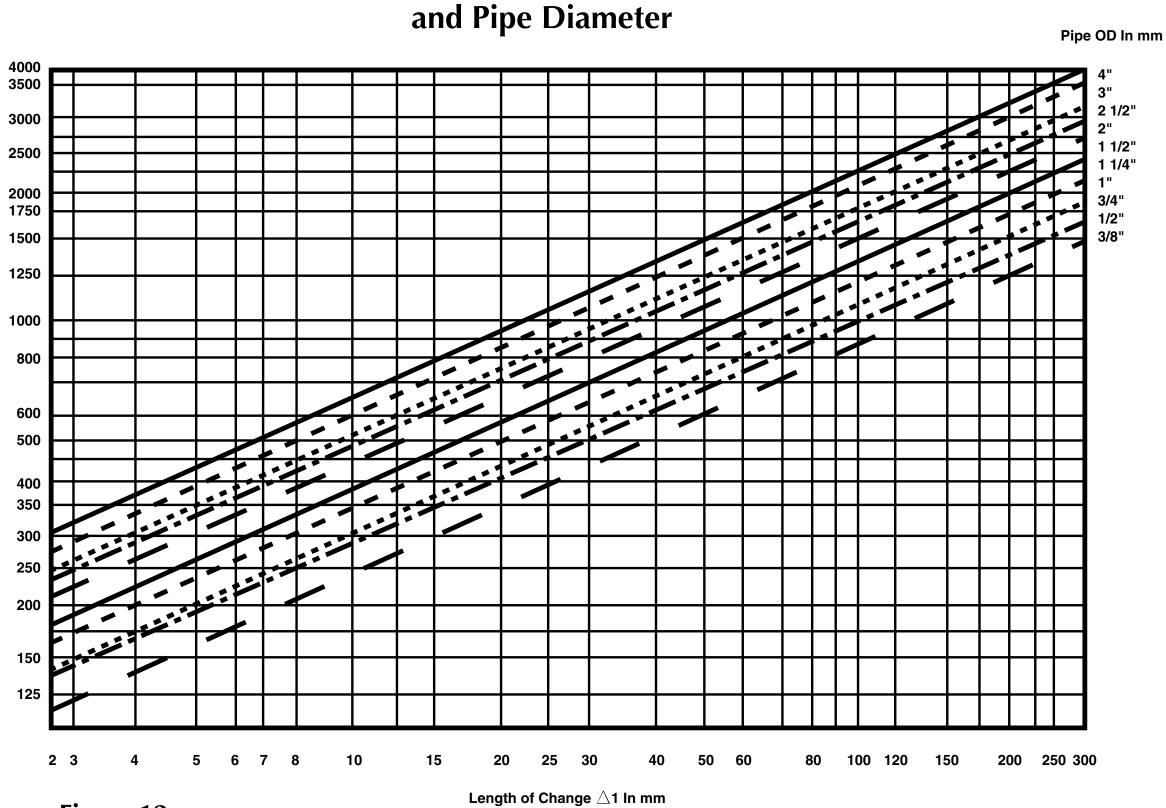

Figure 12

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Admissible Minimum Radius of Bends

It is usual to consider thermoplastic materials as elastic materials, i.e. depending on the temperature at which they are laid, they are more or less laid flexibly, which frequently makes it possible to save fittings and welding. Apart from the laying temperature, the wall thickness an pressure rating of the pipe needs to be taken into consideration. Tables 14 and 15 apply to of materials which are used for underground pipes.

Bending Radius for PP Pipes

Material	Pressure Rating		
	≥ 0˚C	10˚C	20˚C
PP Type 1	75 x OD	50 x OD	30 x OD

Table 14

Factors For Increasing The Bending Radius Of Pipes With Low Pressure Loading

Pressure Rating	Increase of Bending Radius
PN10/SR150	x 1.0
PN6/SR90	x 1.0
PN4/SR	x 1.5
PN3.2/SR45	x 2.0

Table 15

Pressure Testing Using Water

The flexible behavior of plastic pipes leads to expansion during pressure testing. This causes the test result to be affected. The same effect is produced by a change in the pipe wall temperature during testing. For example, in the case of PE-HD, a temperature change in the pipe wall of 10°C will lead to a Pressure Change of 0.5 to 1 Bar. Maximum test pressure should not exceed 150% of the pipe's rated pressure.

Test Conditions For Pressure Systems

Material	PP Type 1 & Type 2	PVDF
Preliminary Test (1)		
Test Pressure	1.5 NP (3)	1.5 PB (3)
Duration of Test	12 Hours	12 Hours
Main Test		
Test Pressure	1.3 NP	1.3 PB
Duration of Test	$\leq$ PN150 3 Hours > PN 150 6 Hours	3 Hours
Maximum Pressure Drop	0.1 BAR/Hour	0.2 Bar
Abbreviated Test(2)		
Test Pressure	1.5 NP	1.5 PB
Duration of test	1 Hour (2)	1 Hour
Maximun Pressure Drop	0.1 BAR/5 MIN.	0.5 BAR/Hour

(1) This is a precondition for the main test. The object of the Preliminary Test is to ensure that any volume changes caused by expansion are more of less eliminated, so that the Main Test, which immediately follows, provides precise information about the System's Pressure Integrity
(2) Duration Time of the Abbreviated test Starts 30 minutes after application of the Test Pressure
(3) Definitions in accordance with DIN 2401
–NP Nominal Pressure
–PB Nominal Operating Pressure

Table 16

Test Conditions For Non-Pressure Systems

Pre-Filling Test (1)	Test Pressure	Duration of Test	Maximum Filling Volume (2)
Hour	BAR	MIN.	L/M^2
1	0.5	15	0.02

(1) Under Test Pressure
(2) For the duration of the pressure. The Dimension relates to the wetted inside area, calculated from the inside width.

Table 17

The pipe should be filled with water and the air vented. The test pressure can be generated by filling the pipes with water in upright pipes or by pumping and should relate to the lowest point of the pipe. The amount of added fluid not required during the test should be measured and must not exceed the value in Table 17.

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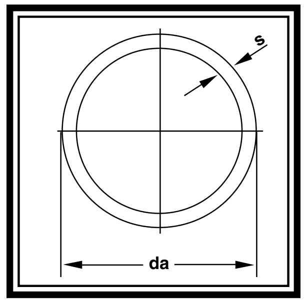
Appendix A

Tolerances

Pipes Made From PP and PVDF



1 The stated values have been determined in accordance with the equation:
Permitted deviation of the mean OD _<400mm: = 0.009 OD, minimum = 0.3mm,
OD=450 to 750mm: = 0.004 OD, = 2.0mm; rounded to 0.1mm

The mean OD is determined by measurements of the periphery, in special cases as the arithmetic mean of two or
several outside diameter pairs measured

2 The values stated have been calculated in accordance with the equation:
Permitted deviation of the wall thickness = 0.1 S=0.2mm; rounded to 0.1mm.

Tolerances Pipes Made From PP

S mm	Permitted Deviation (2) ±
2	0.4
2.2 to 3.0	0.5
3.1 to 3.9	0.6
4.3 to 5.0	0.7
5.1 to 5.8	0.8
6.1 to 7.0	0.9
7.1 to 8.0	1.0
8.2 to 8.7	1.1
9.1 to 10.0	1.2
10.2 to 11.0	1.3
11.1 and 11.4	1.4
12.2 to 12.8	1.5
13.7 and 14.0	1.6
14.2 and 14.6	1.7
15.4 to 15.9	1.8
16.4	1.9
17.4 and 17.9	2.0
18.2	2.1
19.3 to 19.6	2.2
20.1 and 20.5	2.3
21.6 and 22.0	2.4
22.1 to 22.8	2.5
24.3 to 24.9	2.7
25.5	2.8
27.4 and 28.0	3.0
28.3 and 28.7	3.1
30.8	3.3
31.1 and 31.7	3.4
32.3	3.5
34.7	3.7
35.7	3.8
36.4	3.9
38.5	4.1
40.2 and 41.0	4.3
45.3 and 45.5	4.8

OD mm	Permitted Deviation (1) For Average OD ±
10 to 32	0.3
40	0.4
50	0.5
63	0.6
75	0.7
90	0.9
110	1.0
125	1.2
140	1.3
160	1.5
180	1.7
200	1.8
225	1.9
250	2.3
280	2.6
315	2.9
355	3.2
400	3.6
450	3.8
500	4.0
560	4.3
630	4.6

Length	Permitted Deviation
Coil	± 1 %
up to 6m	± 10 mm
up to 12m	± 20 mm

Table 23

Tolerances Pipes Made From PVDF

S mm	Permitted Deviation (2) ±
1.5 to 2.0	0.4
2.0 to 3.0	0.5
3.1 to 4.0	0.6
4.0 to 5.0	0.7
5.1 to 6.0	0.8
6.1 to 7.0	0.9

Length	Permitted Deviation
up to 6m	± 10 mm

OD mm	Permitted Deviation (1) For Average OD ±
16 to 32	0.3
40	0.4
50	0.5
63	0.6
75	0.7
90	0.9
110	1.0
125	1.2
140	1.3
160	1.5
180	1.7
200	1.8
225	1.9
250	2.3

Table 24

Appendix B

SI Unit System

Table 22 lists the internationally applicable basic units. In addition, we list other units which are still admissible, together with the conversion factors for units which are no longer admissible

For easier comprehension, decimal multiples or decimal fractions of the units should be used. This is done by prefixes as listed in Table 21, on this page. The prefix is added to the dimension

Prefixes for the SI Unit System

Power of Ten	Prefix	Prefix For Unit
10^6	Mega	M
10^3	Kilo	k
10^2	Hekto	h
10^1	Deka	da
10^{-1}	Dezi	d
10^{-2}	Zenti	c
10^{-3}	Milli	m
10^{-6}	Mikro	µ

Table 21

Basic Elements Of The International System Of Measurment (SI)

Parameter	Legal Unit = SI Unit	Unit Also Still Admissible	Previous Unit (Conversion Factor)
Mass			
Length Related	kg/m	—	—
Surface Related	kg/m^2	—	—
Volume Related	kg/m^3	$1g/cm^3 = 10^3 kg/m^3$	—
Time			
Speed	m/s	$1km/h = \frac{1}{3.6}$ ms	—
Volume Flow	m^3/s	$1m^3/s = 3600\ m^3/h$	—
Mass Flow	kg/s	1kg/s = 3.6 t/h	—
Force, Energy, Power			
Force	N	$1\ N = 1\ kg\ m/s^2$	1 kp = 9.8 N 10 N
Pressure	N/m^2	$1\ N/mm^2 = 10^6\ N/m^2$	$1\ kp/cm^2 = 0.1\ N/mm^2$
	Pa	$1\ Pa = 1\ N/m^2$	—
	—	$1\ bar = 10^5\ N/m^2$	1 bar = 1.02 at
	—	$= 0.1\ N/mm^2$	= 0.987 atm
	—	$= 10^5$ Pa	= 750 Torr
	—	$= 10^3$ mbar	$= 1.02\ kp/cm^2$
	—	—	= 10 m WS
	—	—	1 mbar - 10 mm WS
Stress	N/m^2	$1\ N/m^2 = 1$ MPa	—
	—	$= 16\ N/m^2$	—
Energy, Work	J	1J = 1 Nm	1 kpcm = 10.2J
	—	= 1 Ws	1 kcal = 4.184 kJ
	—	1kWh = 3.6 MJ	—
Power	W	1 W = 1 J/s	1 PS = 0.7353 kW
	—	= 1 Nm/s	1 kpm/s = 9.8 W
	—	= 1 Va	1 cal/s = 4.184 W
Impact	Nm	—	1 kpcm = 0.1 Nm
	—	—	= 100 Nmm
Impact Resistance	J/m^2	$1kJ/m^2 = \frac{Nmm}{mm^2}$	$1\ kpcm/cm^2 = 1\ kJ/m^2$
Heat			
Temperature	K	1 K = ˚C — 273.15	—
Coefifient of Linear Expansion	1/K	1/K = 1/˚C	—
Thermal Conductivity	$\frac{W}{K \times m}$	—	$1 \frac{kcal}{m \times h \times ˚C} = 1{,}163 \frac{W}{K \times m}$
Heat Transfer	$\frac{W}{K \times m^2}$	—	1\F(kcal, m^2 x h x˚C) $= 1{,}163 \frac{W}{K \times m^2}$
Radiation			
Energy Dose	K/kg —	— —	1 rd = 0.01 j/kg 1 Mrad = 10^6 rd
	—	—	$= 10^4$ J/kg

Table 22

SIMTECH GUIDE SPECIFICATION
S.R. SERIES POLYPROPYLENE PIPING SYSTEM

1.0 **PIPE**

1.1 _Material_

SIMTECH'S SR Series Polypropylene piping, as produced by SIMONA, is extruded from A Group 1. Class 1, Grade 0 Polypropylene Homopolymer material per ASTM-D4101, Federal Specifications L-P-39413 and Military Spec Mil P 461096. PP material to be heat stabilized UV stabilized and pigmented to RAL 7032. UV Stabilizers as well as temperature stabilizers are added to retard the effects of sunlight and to provide the material with enhanced resistance to aggressive media at elevated temperatures.

1.2 _Stress Relieved_

Pipe shall be stress relieved by post-extrusion annealing to eliminate inherent stresses in the pipe wall created by the extrusion process.

1.3 _Pressure Rating_

System (pipe and fittings) shall be pressure rated in accordance with ASTM D-2837. Pipe shall be manufactured to an SDR (standard dimension ratio) in order to provide the same pressure rating in all diameters. Pipe shall be (specifier must select one):

SDR 11	=	150 PSI (PN10)*
SDR 17.6	=	90 PSI (PN6)
SDR 32.5	=	45 PSI (PN3.2)

*PN = Nominal Pressure Rating in Bar

1.4 _Dimensions and Tolerances_

All pipe and fittings shall comply with the dimensions and tolerances outlined in ASTM D-3261.

2.0 **FITTINGS**

2.1 _Pressure Fittings_

All pressure pattern fittings (elbows, tees, flanges and reducers) from ½″ (20 mm) through 16″ (400 mm) shall be injection molded and shall have the same pressure rating as the pipe.

2.2 _Drainage Pattern Fittings_

Drain fittings (wyes, laterals, sanitary tees) may be fabricated by mitering and butt fusion welded or by sidewall fusion techniques. Extrusion welding is permitted. Hot air welding is acceptable. Wall thickness of fabricated fitting shall be the same as the pipe. Where necessary gussets shall be used for support of fabricated fittings.

2.3 _Joining_

All pressure fitting ½″ (20 mm) through 1½″ (50 mm) shall be socket fusion type joints. Pressure fittings, drainage pattern fittings and pipe 2″ and larger shall be joined by butt fusion welding. All fusion welded joints to be performed in accordance with ASTM D-2657-87 and piping manufacturers recommendations.

3.0 **APPROVED MANUFACTURER**

All pipe and fittings shall be SIMTECH
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SIMTECH GUIDE SPECIFICATION
S.R. SERIES POLYVINYLIDENE FLUORIDE PIPING SYSTEM

1.0 **PIPE**

1.1 Material
Pipe shall be extruded from virgin, pure, unpigmented homopolymer with polyvinylidene fluoride resin. Material shall meet or exceed requirements of Table 1 of ASTM D-3222. Pipe manufacturing shall not employ any stabilizers, antioxidants, fillers, pigmentation or additives of any kind. Pipe shall have a 2.5 safety factor for a 50 year life. Pipe shall be furnished in 5m (16.4 ft) length.

1.2 Stress Relieved
Pipe shall be stress relieved by post-extrusion annealing to eliminate inherent stresses in the pipe wall created by the extrusion process.

1.3 Pressure Rating
System (pipe and fittings) shall be pressure rated in accordance with ASTM D-2837. Pipe shall be manufactured to an SDR (standard dimension ratio) in order to provide the same pressure rating in all diameters. Pipe shall be (specifier must select one):

*PN16 (3/8″- 4″) = 232 psi
*PN10 (2″ - 12″) = 150 psi

** PN = Nominal pressure rating in bar*

1.4 Dimensions and Tolerances
All pipe and fittings shall comply with the dimensions and tolerances outlined in ASTM D-3261.

2.0 **FITTINGS**

2.1 Pressure Fittings
All pressure pattern fittings (elbows, tees, flanges and reducers) from 3/8″ (16 mm) through 12″ (315 mm) shall be injection molded and shall have the same pressure rating as the pipe. Fittings shall not contain any stabilizer, antioxidants, fillers, pigmentation or additives of any kind. All fittings shall have a 2.5 safety factor for a 50 year life.

2.2 Drainage Pattern Fittings
Drain fittings (wyes, laterals, sanitary tees) may be fabricated by mitering and butt fusion welding or by sidewall fusion techniques. Extrusion welding is permitted. Hot air welding is not acceptable. Wall thickness of fabricated fitting shall be the same as the pipe.

2.3 Joining
All pressure fitting 3/8″ (16 mm) through 1½″ (50 mm) shall be interference fit socket fusion type joints. Pressure fittings, drainage pattern fittings and pipe 2″ and larger shall be joined by butt fusion welding. All fusion welded joints to be performed in accordance with ASTM D-2657-87 and piping manufacturers recommendations.

3.0 **APPROVED MANUFACTURER**
All pipe and fittings shall be SIMTECH
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www.simtechUSA.com

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E-mail: info@simtechUSA.com
Web site: www.simtechUSA.com

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