

PP-R Systems

Kalde PP-R Tubes and Fittings for Hot & Cold Water and Heating Installation Systems

Applied Norms

DIN 8077	Polypropylene (PP) pipes' dimensions
DIN 8078	Polypropylene (PP) pipes' general quality requirements and testing
DIN 16962 (6-9)	Pipe joints and elements for polypropylene (PP) pressure pipelines, types 1 and 2; injection moulded elbows for socket-welding, dimensions
DIN 16962	Pipe joints and components of polypropylene (PP) for pipes under pressure, - Part 5: General quality requirements, testing
DIN 1988	Drinking water line installation
DIN 4109	Sound insulation in building construction
DVS 2207 (11)	Welding regulations for plastic pipes
DVS 2208.1	Machines and devices for welding thermoplastic pipes
DIN 10266-1	Pipe threads where pressure tight joints are made on the threads - Part 1: Taper external threads and parallel internal threads - Dimension, tolerances and designation
DIN 16928	Pipe connections and components - Pipes of thermoplastic materials; pipe joints, elements for pipes, laying; general directions
EN ISO 15874	Plastics piping systems for hot and cold water installations – polypropylene; Part 1: General, Part 2: Pipe, Part 3: Fittings, Part 5: Fitness for purpose of the systems, Part 7: Guidance for the assessment of conformity

PP-R Systems

Raw Material: Polypropylene Random Copolymer (PP-R)

Polypropylene Random Copolymer (PP-R) is widely used in hot water, floor- and radiator heating systems as well as in industrial liquid distribution systems. Most commonly, this material can be found in drinking water installations.

Kalde pipes are produced using solely PP-R. PP-R has several advantages over other materials: long duration, better flexibility, high resistance to pressure and heat, high molecular weight, low MFR, high acoustic and thermal insulation.

PP-R is suitable for DIN 8078 and EN ISO 15874-1 standards.

The metal inserts used in the polypropylene fittings increase the reliability of the products. Kalde's experience in brass fittings for more than 35 years results in high quality fittings with very reliable metal inserts.

Physical and Thermal Properties

Properties	Testing Methods	Unit	Values
Density, at 23 °C	ISO 1183	g/cm ³	0,9
Melt flow index (MFI) 230 °C/2, 16 kg	ISO 1133	g/10 min	0,3
Thermal conductivity at 23 °C	DIN 52612-1	W/m.K	0,23
Coefficient of linear expansion K ⁻¹ average between 0 °C up to 110 °C	DIN 53712	K ⁻¹	1,5 x10 ⁻⁴
Surface Resistance (ohm)	DIN IEC 60093	Ω	>10 ¹²
Deflection temperature under load			
1,8 N/mm ²	ISO 75A-1, -2	°C	49
0,45 N/mm ²	ISO 75B-1, -2	°C	70
VICAT softening point (1 kg)	ASTM D 1525	°C	130
(5 kg)	ISO 306 DIN 53460	°C	70
Melting point	DSC	°C	146

Mechanical Properties

Properties	Testing Methods	Unit	Values
Tensile stress at yield (23 °C) At 50 mm/min	ISO 527-1,-2	N/mm ²	25
Tensile strain at yield At 50 mm/min		%	10
Flexural modulus at 23 °C	ISO 527	N/mm ²	800
Charpy impact strength (notched) at 23 °C	ISO 179/1eA	kJ/ m ²	22
at 0 °C		kJ/ m ²	4,5
Charpy impact strength (unnotched) (0 °C)	ISO 179	Joule	No break
Hardness (shore D)	ISO 868		60

PP-R Systems

Pipe Dimension - PN10 According to DIN 8077

Outer Diameter (mm)	Diameter Tolerance (mm)	Wall Thickness, (mm) S:5 SDR:11 (mm)	Thickness Tolerance (mm)	Approx. Weight (kg/m)
20	+0,3	1,9	+0,3	0,107
25	+0,3	2,3	+0,4	0,158
32	+0,3	2,9	+0,4	0,240
40	+0,4	3,7	+0,5	0,401
50	+0,5	4,6	+0,6	0,605
63	+0,6	5,8	+0,7	0,960
75	+0,7	6,8	+0,8	1,360
90	+0,9	8,2	+1,0	1,960
110	+1,1	10,0	+1,2	3,002

Operating Conditions (S:5 SDR:11) (PN 10)

Temperature (C)	Life (years)	Pressure (bar)
20	50	12,9
40	50	9,2
60	50	6,4
70	50	4,2
80	25	3,2
95	5	2,6

Pipe Dimension - PN16 According to DIN 8077

Outer Diameter (mm)	Diameter Tolerance (mm)	Wall Thickness, (mm) S:3,2 SDR:7,4 (mm)	Thickness Tolerance (mm)	Approx. Weight (kg/m)
20	+0,3	2,8	+0,4	0,150
25	+0,3	3,5	+0,5	0,215
32	+0,3	4,4	+0,6	0,343
40	+0,4	5,5	+0,7	0,547
50	+0,5	6,9	+0,8	0,854
63	+0,6	8,6	+1,0	1,347
75	+0,7	10,3	+1,2	1,920
90	+0,9	12,3	+1,4	2,755
110	+1,1	15,1	+1,7	4,116

Operating Conditions (S:3,2 SDR:7,4) (PN 16)

Temperature (C)	Life (years)	Pressure (bar)
20	50	20,4
40	50	14,5
60	50	10,2
70	50	6,7
80	25	5,1
95	5	4,1

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Pipe Dimension - PN20 According to DIN 8077

Outer Diameter (mm)	Diameter Tolerance (mm)	Wall Thickness, (mm) S:2,5 SDR:6 (mm)	Thickness Tolerance (mm)	Approx. Weight (kg/m)
20	+0,3	3,4	+0,5	0,170
25	+0,3	4,2	+0,6	0,258
32	+0,3	5,4	+0,7	0,415
40	+0,4	6,7	+0,8	0,642
50	+0,5	8,3	+1,0	0,992
63	+0,6	10,5	+1,2	1,580
75	+0,7	12,5	+1,4	2,245
90	+0,9	15,0	+1,7	3,227
110	+1,1	18,3	+2,0	4,812

Operating Conditions (S:2,5 SDR:6) (PN 20)

Temperature (C)	Life (years)	Pressure (bar)
20	50	25,7
40	50	18,3
60	50	12,9
70	50	8,5
80	25	6,5
95	5	5,2

Fitting Dimension - PN25 According to DIN 8078 (S:2, SDR:5)

Nominal Diameter (Ød) (mm)	Wall Thickness (s) (mm)	Thickness Tolerance (mm)
20	4,1	+0,6
25	5,1	+0,7
32	6,5	+0,8
40	8,1	+1,0
50	10,1	+1,2
63	12,7	+1,4
75	15,1	+1,7
90	18,1	+2,0
110	22,1	+2,3

PP-R Systems

Thermal Expansion in PP-R Tubes

The polypropylene pipes have an expansion coefficient that is much higher than the metal pipes. It is critical to take this characteristic into consideration during installations.

Calculation of thermal expansion is as follows: $\Delta L = L * \Delta T * \alpha$

where

ΔT = The difference between environmental temperature and water temperature in Kelvin degrees (K) or Celsius (°C).

ΔL = Variation of length in mm.

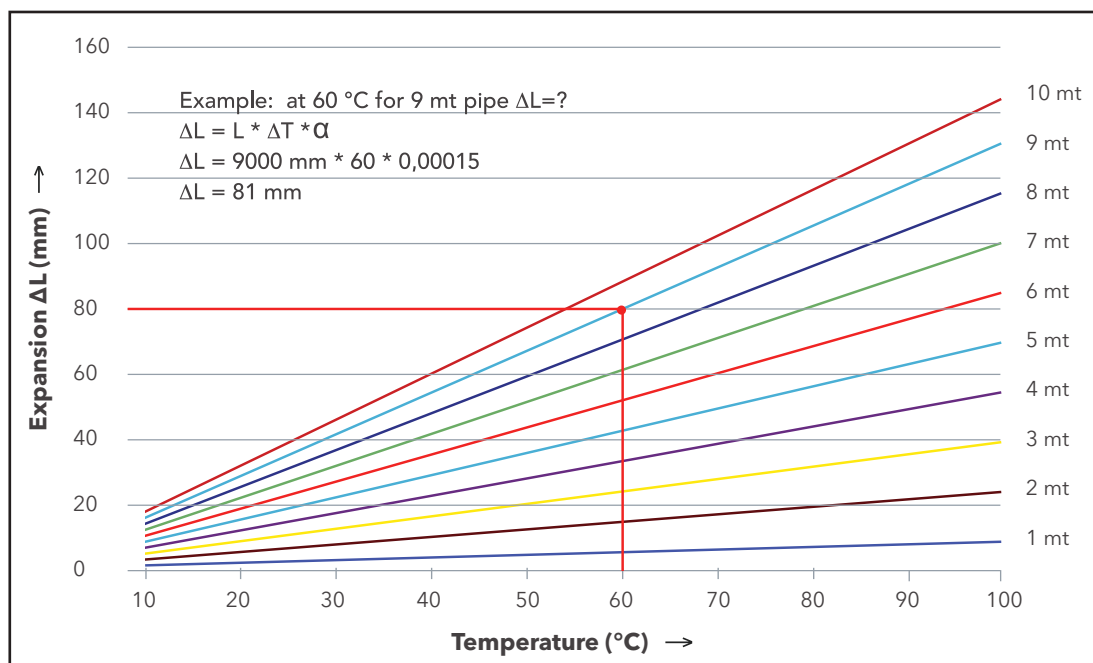
L = Initial length of the pipe in m.

α = Coefficient of linear thermal expansion. The value of α is $1,5 * 10^{-4}$ (K⁻¹) for PP-R tubes.

Pipe Length (m)	Temperature Variation ΔT in K											
	1	5	10	20	30	40	50	60	70	80	90	100
	Linear Expansion ΔL (mm)											
1.0	0.15	0.75	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
2.0	0.30	1.50	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00
3.0	0.45	2.25	4.50	9.00	13.50	18.00	22.50	27.00	31.50	36.00	40.50	45.00
4.0	0.60	3.00	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00
5.0	0.75	3.75	7.50	15.00	22.50	30.00	37.50	45.00	52.50	60.00	67.50	75.00
6.0	0.90	4.50	9.00	18.00	27.00	36.00	45.00	54.00	63.00	72.00	81.00	90.00
7.0	1.05	5.25	10.50	21.00	31.50	42.00	52.50	63.00	73.50	84.00	94.50	105.00
8.0	1.20	6.00	12.00	24.00	36.00	48.00	60.00	72.00	84.00	96.00	108.00	120.00
9.0	1.35	6.75	13.50	27.00	40.50	54.00	67.50	81.00	94.50	108.00	121.50	135.00
10.0	1.50	7.50	15.00	30.00	45.00	60.00	75.00	90.00	105.00	120.00	135.00	150.00

Note: When the water temperature circulating in the pipe is higher than the environmental temperature, the result will be an elongation. But if the water temperature circulating in the pipe is lower than the environmental temperature, the result will be a shortage.

Thermal Expansion of the Kalde PP-R Pipe



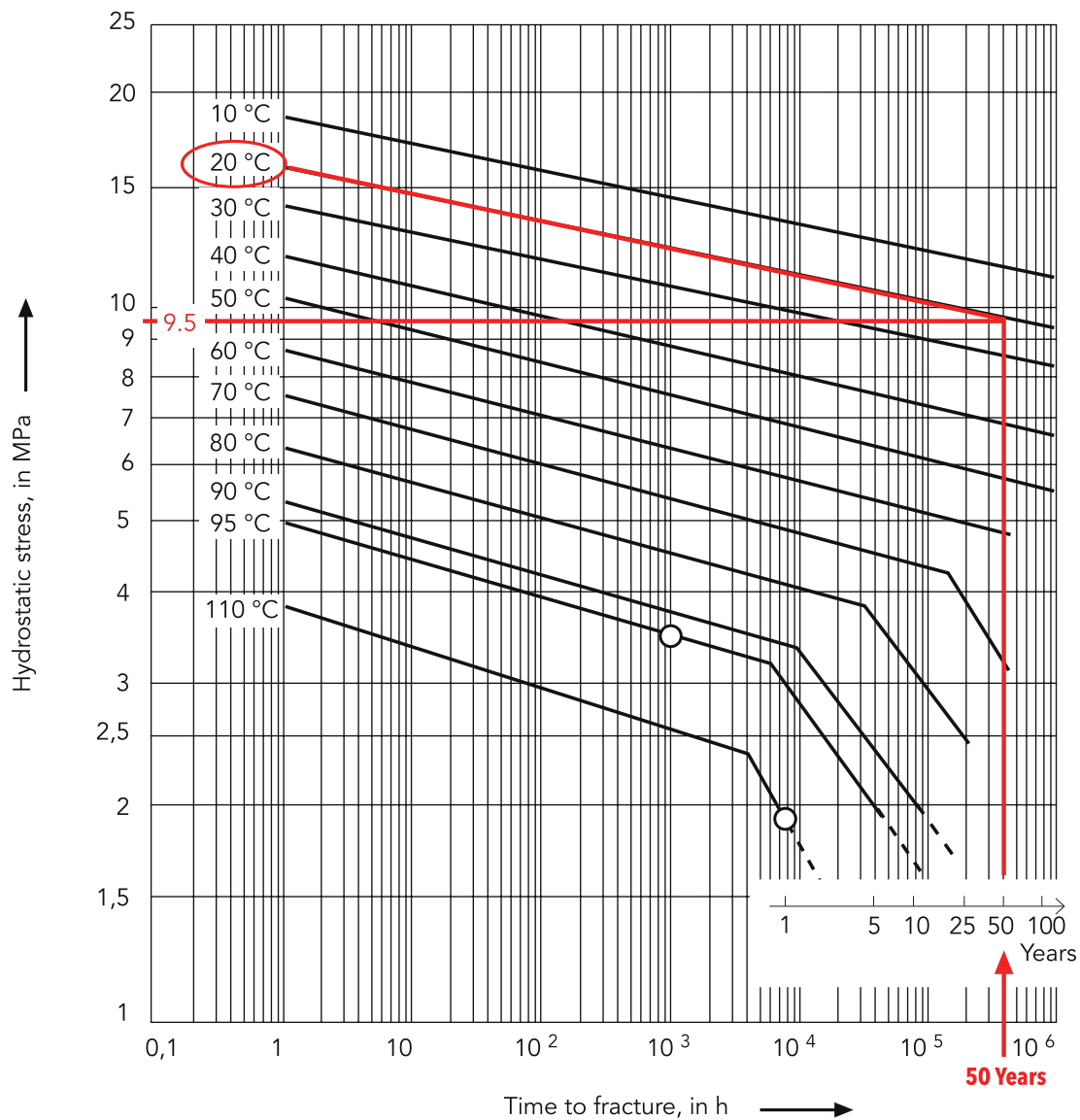
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Operating Life According to DIN 8077 (SF=1.5 PP-R 80)

Temperature (°C)	Operation Life	Series (S)							
		20	16	12.5	8.3	5	3.2	2.5	2
		Standard Dimension Rate (SDR)							
		41 PN2,5	33 PN3,2	26 PN4	17.6 PN6	11 PN10	7.4 PN16	6 PN20	5 PN25
		Pressure (bar)							
20	1	3.7	4.7	5.9	9	15	23.7	29.9	37.7
	5	3.5	4.4	5.6	8.4	14.1	22.3	28.1	35.4
	10	3.4	4.3	5.4	8.2	13.7	21.7	27.4	34.5
	25	3.3	4.1	5.2	7.9	13.2	21	26.4	33.3
	50	3.2	4	5.1	7.7	12.9	20.4	25.7	32.4
	100	3.1	3.9	5	7.5	12.5	19.9	25	31.5
30	1	3.2	4	5	7.6	12.7	20.2	25.4	32
	5	3	3.7	4.7	7.2	11.9	18.9	23.8	30
	10	2.9	3.6	4.6	7	11.6	18.4	23.2	29.2
	25	2.8	3.5	4.4	6.7	11.2	17.7	22.3	28.1
	50	2.7	3.4	4.3	6.5	10.9	17.2	21.7	27.4
	100	2.6	3.3	4.2	6.3	10.6	16.8	21.1	26.6
40	1	2.7	3.4	4.3	6.5	10.8	17.1	21.6	27.2
	5	2.5	3.2	4	6	10.1	16	20.2	25.4
	10	2.4	3.1	3.9	5.9	9.8	15.5	19.6	24.7
	25	2.3	2.9	3.7	5.6	9.4	15	18.8	23.7
	50	2.3	2.9	3.6	5.5	9.2	14.5	18.3	23.1
	100	2.2	2.8	3.5	5.3	8.9	14.1	17.8	22.4
50	1	2.3	2.8	3.6	5.5	9.1	14.5	18.2	23
	5	2.1	2.7	3.4	5.1	8.5	13.5	17	21.4
	10	2	2.6	3.3	4.9	8.2	13.1	16.5	20.8
	25	2	2.5	3.1	4.7	7.9	12.6	15.9	20
	50	1.9	2.4	3	4.6	7.7	12.2	15.4	19.4
	100	1.8	2.3	2.9	4.5	7.5	11.8	14.9	18.8
60	1	1.9	2.4	3	4.6	7.7	12.2	15.4	19.4
	5	1.8	2.2	2.8	4.3	7.1	11.3	14.3	18
	10	1.7	2.2	2.7	4.1	6.9	11	13.9	17.5
	25	1.6	2.1	2.6	4	6.6	10.5	13.3	16.7
	50	1.6	2	2.5	3.8	6.4	10.2	12.9	16.2
70	1	1.6	2	2.5	3.9	6.5	10.3	12.9	16.3
	5	1.5	1.9	2.4	3.6	6	9.5	12	15.1
	10	1.4	1.8	2.3	3.5	5.8	9.2	11.6	14.6
	25	1.2	1.5	2	3	5	8	10	12.7
	50	1	1.3	1.7	2.5	4.2	6.7	8.5	10.7
80	1	1.3	1.7	2.1	3.2	5.4	8.6	10.8	13.7
	5	1.2	1.5	1.9	2.9	4.8	7.6	9.6	12.1
	10	1	1.2	1.6	2.4	4	6.4	8.1	10.2
	25	0.8	1	1.2	1.9	3.2	5.1	6.5	8.1
95	1	0.9	1.2	1.5	2.3	3.8	6.1	7.6	9.6
	5	0.6	0.8	1	1.5	2.6	4.1	5.2	6.5
	(10)1)	-0.5	-0.6	-0.8	-1.3	-2.2	-3.4	-4.3	-5.5

PP-R Systems

Hydrostatic Pressure Performance



Hydrostatic pressure is calculated according to the below formula:

$$P = \frac{2 \cdot e_{\min} \cdot \sigma}{d_e - e_{\min}}$$

- P** = Internal pressure, MPa.
- d_e** = Outside diameter of the pipe, mm.
- e_{min}** = Minimum wall thickness of the pipe, mm.
- σ** = Hydrostatic stress, MPa.
- 1MPa** = 10 bar = 14.5 Psi.

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Sample:

Usage time of the pipe : 50 years
 Operating temperature : 20°C
 Outside diameter of pipe : ø32
 Wall thickness of pipe : 5,4 mm
 Hydrostatic stress : 9.5 MPa

Maksimum operating pressure

$$P = (20 \times 5,4 \times 9,5) / (32 - 5,4)$$

$$P = 1026 / 26,6$$

$$P = 38,57 \text{ bar}$$

This result shows the maximum resistance in a certain time, in order to find the maximum pressure, the value the maximum resistance should be divided by safety factor (for example, Kalde pipe safety factor is SF:1,5)

$$P_{\max} = P_{\max} / SF$$

$$P_{\max} = 38,57 / 1,5$$

$$P_{\max} = 25,7 \text{ bar (see page 11)}$$

Classification of Service Conditions

Application Class	Design Temperature, TD (°C)	Time at TD (years)	Tmax (°C)	Time at max (years)	Tmal (°C)	Time at Tmal (h)	Typical Field of Application
1	60	49	80	1	95	100	Hot water supply (60°C)
2	70	49	80	1	95	100	Hot water supply (70°C)

Chemical Resistance

It's highly resistant as a polypropylene polymer.

The tables annexed show the chemical resistances of Kalde-SuperMUTE PP-R waste water pipes and fittings as per TS 11448.

Since the chemical resistance depends on factors such as chemical composition, concentration and temperature, the tables below provide the chemical resistance for various temperatures and various concentrations.

The Abbreviations Below are Used in the Tables.

W.s. Water solution
S.s Saturated solution
R Resistant
L Limited resistant
NR Not resistant

PP-R Systems

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Acetic acid	Up to 40 %	R	R	-
Acetic acid	50 %	R	R	L
Acetic acid, glacial	> 96 %	S	L	NR
Acetic anhydride	100 %	R	-	-
Acetone	100 %	R	R	-
Acephenone	100 %	R	L	-
Acrylonitrile	100 %	R	-	-
Air		R	R	R
Allyl alcohol	100 %	R	R	-
Almond oil		R	-	-
Alum	W.s	R	R	-
Ammonia, aqueous	S.s	R	R	-
Ammonia, dry gas	100 %	R	-	-
Ammonia, liquid	100 %	R	-	-
Ammonium acetate	S.s	R	R	-
Ammonium chloride	S.s	R	R	-
Ammonium fluoride	Up to 20%	R	R	-
Ammonium hydrogen carbonate	S.s	R	R	-
Ammonium metaphosphate	S.s	R	R	R
Ammonium nitrate	S.s	R	R	R
Ammonium persulphate	S.s	R	R	-
Ammonium phosphate	S.s	R	-	-
Ammonium sulphate	S.s	R	R	R
Ammonium sulphide	S.s	R	R	-
Amyl acetate	100 %	L	-	-
Amyl alcohol	100 %	R	R	R
Aniline	100 %	R	R	-
Apple juice		R	-	-
Aqua regia	HCl/HNO ₃ =3/1	NR	NR	NR
Barium bromide	S.s	R	R	R
Barium carbonate	S.s	R	R	R
Barium chloride	S.s	R	R	R
Barium hydroxide	S.s	R	R	R
Barium sulphide	S.s	R	R	R
Beer		R	R	-
Benzene	100 %	L	NR	NR
Benzoic acid	S.s	R	R	-
Benzyl alcohol	100 %	R	L	-
Borax	W.s	R	R	-
Boric acid	S.s	R	-	-
Boron trifluoride	S.s	R	-	-

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Bormine, gas	100 %	NR	NR	NR
Bromine, liquid	100 %	NR	NR	NR
Butane, gas	100 %	R	-	-
Butyl acetate	100 %	L	NR	NR
Butyl glycol	100 %	R	-	-
Butyl phenols	S.s	R	-	-
Butyl phthalate	100 %	R	L	L
Calcium carbonate	S.s	R	R	R
Calcium chlorate	S.s	R	R	-
Calcium chloride	S.s	R	R	R
Calcium hydroxide	S.s	R	R	R
Calcium hypochlorite	W.s	R	-	-
Calcium nitrate	S.s	R	R	-
Camphor oil		NR	NR	NR
Carbon dioxide, dry gas		R	R	-
Carbon dioxide, wet gas		R	R	-
Carbon disulphide	100 %	R	NR	NR
Carbon monoxide, gas		R	R	-
Carbon tetrachloride	100 %	NR	NR	NR
Caustic soda	Up to 50%	R	L	L
Chlorine, aqueous	S.s	R	L	-
Chlorine, dry gas	100 %	NR	NR	NR
Chloroacetic acid	W.s	R	-	-
Chloroform	100%	L	NR	NR
Chlorosulphonic acid	100%	NR	NR	NR
Chrome alum	W.s	R	R	-
Chromic acid	Up to 40%	R	L	NS
Citric acid	S.s	R	R	R
Coconut oil		R	-	-
Copper (II) chloride	S.s	R	R	-
Copper (II) nitrate	S.s	R	R	R
Copper (II)	S.s	R	R	-
Corn oil		R	L	-
Cottonseed oil		R	R	-
Decalin (decahydronaphthalene)	100%	NR	NR	NR
Dextrin	W.s	R	R	-
Dextrose	W.s	R	R	R
Dibutyl phthalate	100%	R	L	NR
Dichloroacetic acid	100%	L	-	-
Dichloroethylene (A and B)	100%	L	-	-
Diethanolamine	100%	R	-	-

PP-R Systems

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Diethyl ether	100%	R	L	-
Diethylene glycol	100%	R	R	-
Diglycolic acid	S.s	R	-	-
Diisooctyl	100%	R	L	-
Dimethyl amine, gas		R	-	-
Dimethyl formamide	100%	R	R	-
Diethyl phthalate	100%	L	L	-
Dioxane	100%	L	L	-
Distilled water	100%	R	R	R
Ethanolamine	100%	R	-	-
Ethyl acetate	100%	L	NR	NR
Ferric chloride	S.s	R	R	R
Formaldehyde	40 %	R	-	-
Formic acid	10 %	R	R	L
Formic acid	85 %	R	NR	NR
Formic acid, anhydrous	100 %	R	L	L
Fructose	W.s	R	R	R
Fruit juice		R	R	R
Gasoline, petrol (aliphatic hydrocarbons)		NR	NR	NR
Gelatine		R	R	-
Glucose	20 %	R	R	R
Glycerine	100 %	R	R	R
Glycolic acid	30 %	R	-	-
Heptane	100 %	L	NR	NR
Hexane	100 %	R	L	-
Hydrobromic acid	Up to 48 %	R	L	NR
Hydrochloric acid	Up to 20 %	R	R	R
Hydrochloric acid	30 %	R	L	L
Hydrofluoric acid	w.s	R	-	-
Hydrofluoric acid	40 %	R	-	-
Hydrogen	100 %	R	-	-
Hydrogen chloride, dry gas	100 %	R	R	-
Hydrogen peroxide	Up to 10 %	R	-	-
Hydrogen peroxide	Up to 30 %	R	L	-
Hydrogen sulphide, dry gas	100 %	R	R	-
Iodine, in alcohol		R	-	-
Isopropyl alcohol	100 %	R	R	R
Isopropyl ether	100 %	L	-	-
Lanoline		R	L	-
Linseed oil		R	R	R
Magnesium carbonate	S.s	R	R	R

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Magmesium chloride	S.s	R	R	-
Magnesium hydroxide	S.s	R	R	-
Magnesium sulphate	S.s	R	R	-
Maleic acid	S.s	R	R	-
Mercury (II) chloride	S.s	R	R	-
Mercury (II) cyanide	S.s	R	R	-
Mercury (I) nitrate	W.s	R	R	-
Mercury	100 %	R	R	-
Methyl acetate	100 %	R	R	-
Methyl alcohol	5 %	R	L	L
Methyl amine	Up to 32 %	R	-	-
Methyl bromide	100 %	NR		NR
Methyl ethyl ketone	100 %	R	-	-
Methylene chloride	100 %	L	NR	NR
Milk		R	R	R
Monochloroacetic acid	>85 %	R	R	-
Naphtha		R	NR	NR
Nickel chloride	S.s	R	R	-
Nickel nitrate	S.s	R	R	-
Nickel sulphate	S.s	R	R	-
Nitric acid	Up to 30 %	R	NR	NR
Nitric acid	From 40 to 50 %	L	NR	NR
Nitric acid, fuming (with nitrogen dioxide)		NR	NR	NR
Nitrobenzene	100%	R	L	-
Oleic acid	100 %	R	L	-
Oleum (sulphuric acid with 60 % of SO ₃)		R	L	-
Olive oil		R	R	L
Oxalic acid	w.s	R	L	NR
Paraffin oil (FL65)		R	L	NR
Peanut oil		R	R	-
Peppermint oil		R	-	-
Perchloric acid	(2N) 20%	R	-	-
Petroleum ether (ligroin)		L	L	-
Phenol	5%	R	R	-
Phenol	90%	R	-	-
Phosphine, gas		R	R	-
Phosphoric acid	Up.to 85%	R	R	R
Phosphorus oxychloride	100%	L	-	-
Picric acid	S.s	R	-	-
Potassium borate	S.s	R	R	-
Potassium fluoride	S.s	R	R	-

PP-R Systems

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Potassium hydroxide	Up to 50%	R	R	R
Potassium iodide	S.s	R	-	-
Potassium nitrate	S.s	R	R	-
Potassium perchlorate	10%	R	R	-
Potassium permanganate	(2 N) 30%	R	-	-
Potassium persulphate	S.s	R	R	-
Potassium sulphate	S.s	R	R	-
Propane, gas	100%	R	-	-
Propionic acid	>50%	R	-	-
Pyridine	100%	L	-	-
Seawater		R	R	R
Silicon oil		R	R	R
Silver nitrate	S.s	R	R	L
Sodium benzoate	35%	R	L	-
Sodium bicarbonate	S.s	R	R	R
Sodium carbonate	Up to 50%	R	R	L
Sodium chlorate	S.s	R	R	-
Sodium chloride	S.s	R	R	-
Sodium chlorite	2%	R	L	NR
Sodium chlorite	20%	R	L	NR
Sodium dichromate	S.s	R	R	R
Sodium hydrogen carbonate	S.s	R	R	R
Sodium hydrogen sulphate	S.s	R	R	-
Sodium hydrogen sulphite	S.s	R	-	-
Sodium hydroxide	1%	R	R	R
Sodium hydroxide	From 10 to 60 %	R	R	R
Sodium hypochlorite	5%	R	R	-
Sodium hypochlorite	10%-15%	R	-	-
Sodium hypochlorite	20%	R	L	-
Sodium metaphosphate	W.s	R	-	-
Sodium nitrate	S.s	R	R	-
Sodium perorate	S.s	R	R	-
Sodium phisohate (neutral)		R	R	R
Sodium silicate	W.s	R	R	-

**Chemical Resistance of Polypropylene,
at 20, 60 and 100°C (ISO 10358)**

Chemical or Product	Concentration	Temperature °C		
		20	60	100
Sodium sulphate	S.s	R	R	-
Sodium sulphide	S.s	R	-	-
Sodium sulphite	40%	R	R	R
Sodium thiosulphate (hypo)	S.s	R	-	-
Soybean oil		R	L	-
Succinic acid	S.s	R	R	-
Sulphuric acid	Up to 10%	R	R	R
Sulphuric dioxide, dry or wet	10%	R	R	-
Sulphur acid	From 10 to 30 %	R	R	-
Sulphuric acid	50 %	R	L	L
Sulphuric acid	96 %	R	L	NR
Sulphuric acid	98 %	L	NR	NR
Sulphurous acid	Up to 30 %	R	-	-
Tartaric acid	S.s	R	R	-
Tetrahydrofuran	100 %	L	NR	NR
Tetralin	100 %	NR	NR	NR
Thiophene	100 %	R	L	-
Tin(IV) chloride	W.s	R	R	-
Tin (II) chloride	S.s	R	R	-
Toluene	100 %	L	NR	NR
Trichloroacetic acid	Up to 50 %	R	R	-
Trichloroethylene	100 %	NR	NR	NR
Triethanolamine	W.s	R	-	-
Turpentine		NR	NR	NR
Urea	S.s	R	R	-
Vinegar		R	R	-
Water brackish, mineral, potable		R	R	R
Whiskey		R	R	-
Wines		R	R	-
Xylene	100%	NR	NR	NR
Yeast	W.s	R	R	R
Zinc chloride	Sat.w.s	R	R	-
Zinc chloride	S.s	R	R	-

PP-R Systems

Polypropylene Tubes with Aluminum Foil

This pipe consists of three layers: the pipe and the coat are made of PP-R with an aluminum foil inbetween. The foil is attached with wrapping welding and by using a special PP film to establish the mechanical connection between the aluminum foil and the PP-layer.

Characteristics

- Hygienic
- Resistance to chemicals
- High resistance to pressure and heat
- Low heat loss
- Low pressure loss due to the smoothness
- Low thermal expansion
- Easy forming, installation and application
- Oxygen impermeability

Oxygen Impermeability

Oxygen penetration reduces the system life by corroding the radiator and the heater device. Oxygen diffusion from the air is one of the most common ways of oxygen penetrating into the system. Plastic pipes do not prevent this diffusion. The aluminum foil increases the life of the radiator and the heater by acting as a barrier

PP-R Systems

Technical Properties, Pipe Dimensions (PN 20)

Inner Pipe		Aluminum	Outer Pipe	Outside Layer
Outer Diameter, mm	Wall Thickness, mm	Thickness (micron)	Outer Diameter, mm	Thickness, mm
20	2,8	150	21,8	0,5
25	3,5	150	26,8	0,5
32	4,4	150	33,8	0,5
40	5,5	150	41,8	0,5
50	6,9	150	51,8	0,5
63	8,6	150	64,8	0,5
75	10,3	150	76,8	0,5
90	12,3	150	91,8	0,5
110	15,1	150	111,8	0,5

Operating Conditions (PN 20)

Temperature (C)	Life (years)	Pressure (bar)
20	50	25,7
40	50	18,3
60	50	12,9
70	50	8,5
80	25	6,5
95	5	5,2

Technical Properties, Pipe Dimensions (PN 25)

Inner Pipe		Aluminum	Outer Pipe	Outside Layer
Outer Diameter, mm	Wall Thickness, mm	Thickness (micron)	Outer Diameter, mm	Thickness, mm
20	3,4	150	21,8	0,5
25	4,2	150	26,8	0,5
32	5,4	150	33,8	0,5
40	6,7	150	41,8	0,5
50	8,3	150	51,8	0,5
63	10,5	150	64,8	0,5
75	12,5	150	76,8	0,5
90	15,0	150	91,8	0,5
110	18,3	150	111,8	0,5

Operating Conditions (PN 25)

Temperature (C)	Life (years)	Pressure (bar)
20	50	32,4
40	50	23,1
60	50	16,2
70	50	10,7
80	25	8,1
95	5	6,5

PP-R Systems

Pipe Dimension (PN 20)

Outer Diameter (mm)	Diameter Tolerance (mm)	Wall Thickness, (mm)	Thickness Tolerance (mm)	Approx. Weight (kg/m)
20	+0,3	2,8	+0,4	0,155
25	+0,3	3,5	+0,5	0,230
32	+0,3	4,4	+0,6	0,380
40	+0,4	5,5	+0,7	0,607
50	+0,5	6,9	+0,8	0,910
63	+0,6	8,6	+1,0	1,440
75	+0,7	10,3	+1,2	2,040
90	+0,9	12,3	+1,4	2,905
110	+1,1	15,1	+1,7	4,380

Operating Life According to DIN 8078 (PN 20)

Temperature (C)	Life (years)	Pressure (bar)
20	50	25,7
40	50	18,3
60	50	12,9
70	50	8,5
80	25	6,5
95	5	5,2

Pipe Dimension (PN 25)

Outer Diameter (mm)	Diameter Tolerance (mm)	Wall Thickness, (mm)	Thickness Tolerance (mm)	Approx. Weight (kg/m)
20	+0,3	3,4	+0,5	0,180
25	+0,3	4,2	+0,6	0,270
32	+0,3	5,4	+0,7	0,415
40	+0,4	6,7	+0,8	0,665
50	+0,5	8,3	+1,0	1,030
63	+0,6	10,5	+1,2	1,620
75	+0,7	12,5	+1,4	2,310
90	+0,9	15,0	+1,6	3,326
110	+1,1	18,3	+2,0	4,950

Operating Life According to DIN 8078 (PN 25)

Temperature (C)	Life (years)	Pressure (bar)
20	50	32,4
40	50	23,1
60	50	16,2
70	50	10,7
80	25	8,1
95	5	6,5

PP-R Systems

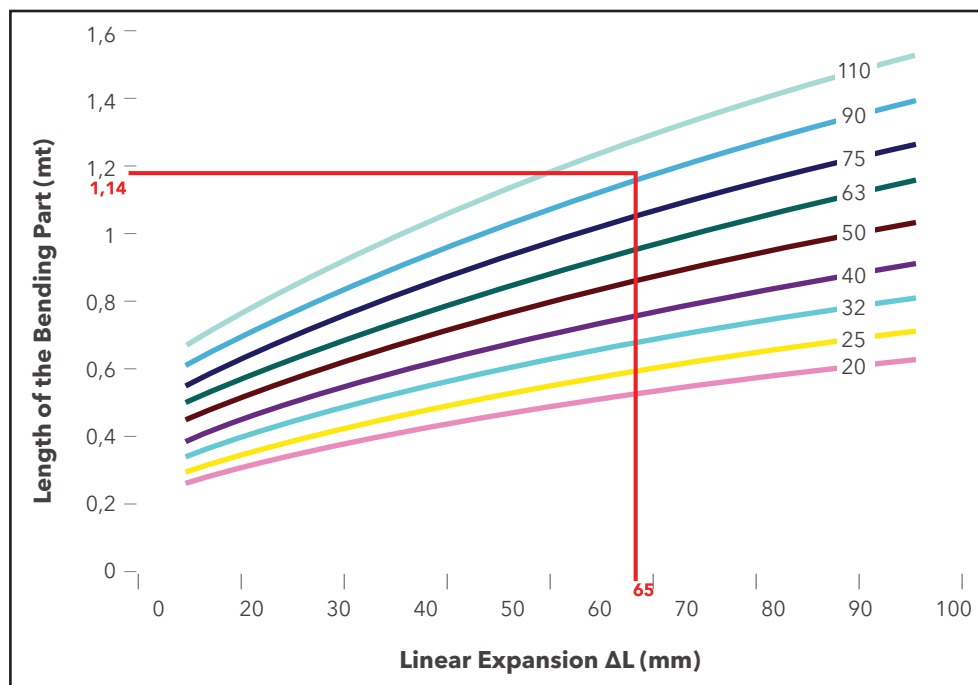
Mounting and Installation

Thermal Tensions

Piping systems are used to convey gas and fluids in a broad area with various pressure and temperatures. Piping materials go through size changes due to changes in temperature, external forces, time-dependent effects (fatigue and relaxation), changes in internal structure, humidity value and some other reasons. When considering pipe systems, the most important elements that require taking measures are temperature and external forces as well as the weight of pipe itself, (other heavy materials used in pipelines; valves, watermeter, filter etc.) weight of fluid being conveyed, operating temperature, and internal and external pressure.

Thermal tensions result from static points blocking the pipe motion in all directions and preventing pipe's angular movement, and the sliding support that hinders the same in two directions.

A piping system should be designed so as to have the longest service life against its intended use, the lowest business and investment cost, and to work in the safest way. This can be ensured by making a thermal tension analysis of the installation. Therefore, thermal tensions must be taken into the same consideration from the basic household installation to those with the highest pressure and temperature values. Amount of thermal tension in piping is determined upon temperature difference in the pipeline, pipe length and material characteristics. Amount of thermal tension of PP-R pipe can be determined using the thermal expansion diagram below.



PP-R Systems

Removing Expansions from Installation

Omega and (U) Elements

Omega and U parts designed for use in hot pipes. As an alternative, metal (belows) compensator also can be used instead of the omega and U parts.. these parts, are used to get extensions in straight pipelines. these components, application forms and calculations of the system are given below.

Use some shape:

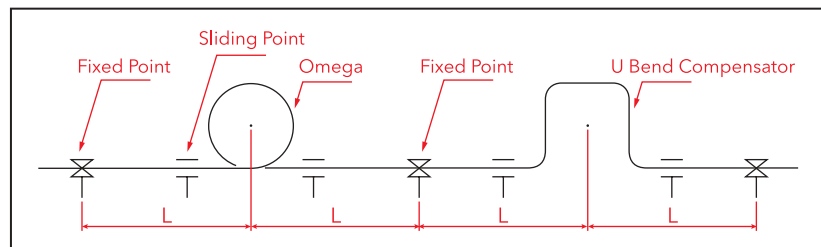


Figure - 1 Omega and U part

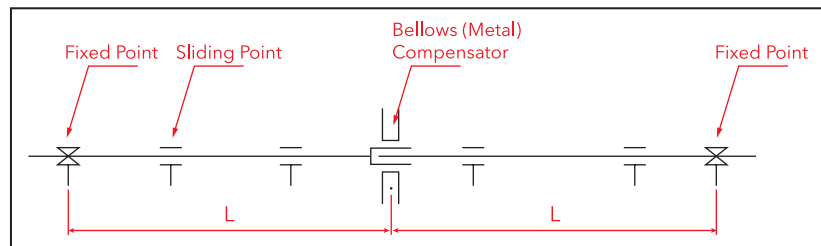


Figure - 2 Metal compensator

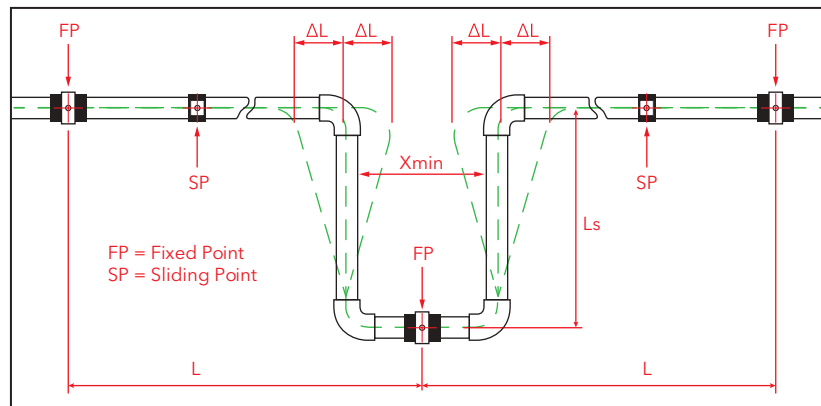


Figure - 3 U part (calculation distance of bending part)

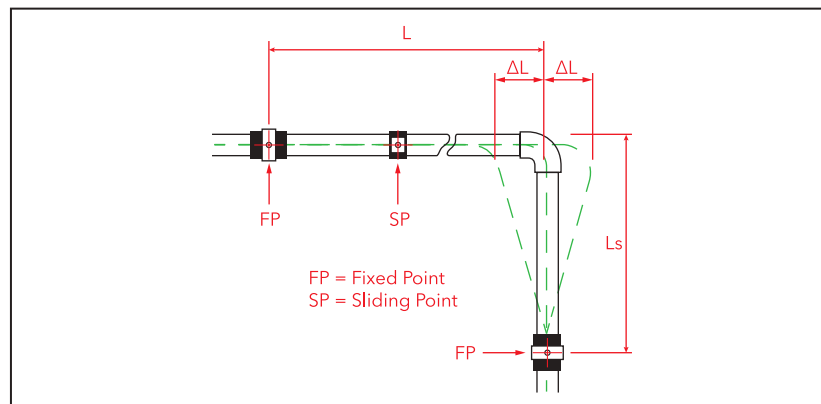


Figure - 4 Calculation distance of bending part

Calculation of Elongation

Length of the bending part is calculated with the following formula.

$$L_s = c \times \sqrt{d \times \Delta L}$$

L_s = Length of the bending part mm.

d = Outer diameter of the Kalde pipe mm.

ΔL = Variation of length mm.

C = 15 (material based constant of Kalde pipe).

FP = Fixed Point.

MP = Moving Point.

Kalde Length of the Bending Part

Pipe Out Diameter (mm)	Linear Expansion ΔL (mm)								
	1	5	10	20	30	40	50	60	70
	Length of the Bending Part in (m)								
Ø20	0.30	0.36	0.42	0.47	0.51	0.56	0.60	0.63	0.67
Ø25	0.33	0.41	0.47	0.53	0.58	0.62	0.67	0.71	0.75
Ø32	0.37	0.46	0.53	0.60	0.65	0.70	0.75	0.80	0.84
Ø40	0.42	0.52	0.60	0.67	0.73	0.79	0.84	0.90	0.94
Ø50	0.47	0.58	0.67	0.75	0.82	0.88	0.94	1.00	1.06
Ø63	0.53	0.65	0.75	0.84	0.90	0.99	1.06	1.12	1.19
Ø75	0.58	0.71	0.82	0.91	1.00	1.08	1.16	1.23	1.29
Ø90	0.63	0.78	0.90	1.00	1.10	1.19	1.27	1.35	1.42
Ø110	0.70	0.86	0.99	1.11	1.21	1.31	1.40	1.49	1.57

Example

1. Calculation of elongation

Temperature difference between cold water and environment

Input

α = 0.15 mm/m-K

L = 12 meter

ΔT = 40 °C

Required

$\Delta L = \alpha \times \Delta T \times L$

$\Delta L = 0.15 \times 40 \times 12 = 72 \text{ mm}$

2. The calculation of the bending length

d = 63 mm

ΔL = 72 mm

C = 15

$$L_s = c \times \sqrt{d \times \Delta L}$$

$$L_s = 15 \times \sqrt{63 \times 72} = 1010 \text{ mm}$$

PP-R Systems

Support Intervals

The choice of support points depends on the pipe diameter, the layout of the pipelines, as well as the location of the heavy valves and fittings. There is no rule in this regard. The pipe support intervals are given in the tables below. Heavy valves and device on pipelines should be installed as close to the supports as possible.

Kalde PP-R Pipe SDR:6 - SDR: 7.4 (PN20 - PN16)

Temperature ΔT (K)	Pipe Diameter d (mm)								
	20	25	32	40	50	63	75	90	110
	Support Intervals in cm								
20	60	70	90	100	120	140	150	160	180
30	60	70	90	100	120	140	150	160	180
40	60	70	80	90	110	130	140	150	170
50	60	70	80	90	110	130	140	150	170
60	50	60	70	80	100	110	120	140	160
70	50	60	70	80	90	100	110	120	140

Kalde Foil Pipe SDR:6 - SDR: 7.4 (PN25 - PN20)

Temperature ΔT (K)	Pipe Diameter d (mm)								
	20	25	32	40	50	63	75	90	110
	Support Intervals in cm								
20	110	120	140	160	180	200	210	220	240
30	110	120	140	160	180	200	210	220	230
40	110	120	130	150	170	190	200	210	220
50	110	120	130	150	170	190	200	210	210
60	100	110	120	140	160	180	190	200	200
70	90	100	110	130	150	170	180	190	200

Kalde PP-R Pipe SDR:11 (PN10) (Temperature of Medium:20°C)

Temperature ΔT (K)	Pipe Diameter d (mm)								
	20	25	32	40	50	63	75	90	110
	Support Intervals in cm								
20	60	70	90	100	120	140	150	160	180

Kalde Fiberglas Pipe SDR:6 - SDR:7.4 (PN25 - PN20)

Temperature ΔT (K)	Pipe Diameter d (mm)								
	20	25	32	40	50	63	75	90	110
	Support Intervals in cm								
20	90	100	110	120	140	160	170	180	200
30	90	100	110	120	140	160	170	180	200
40	80	90	100	110	130	150	160	170	180
50	80	90	100	110	130	150	160	170	180
60	70	80	90	100	120	140	150	160	170
70	70	80	90	100	120	120	140	150	160

PP-R Systems

Welding Technique

Welding takes only a few seconds. The quality of an installation depends on the tightness, stability and lifetime of its connections. When the welded joint cools down, it can be fully loaded.

PP-R pipes and fittings, combined with socket welding. This operation is done with welding machines. Surfaces to be welded must be clean.

Welding sequence:

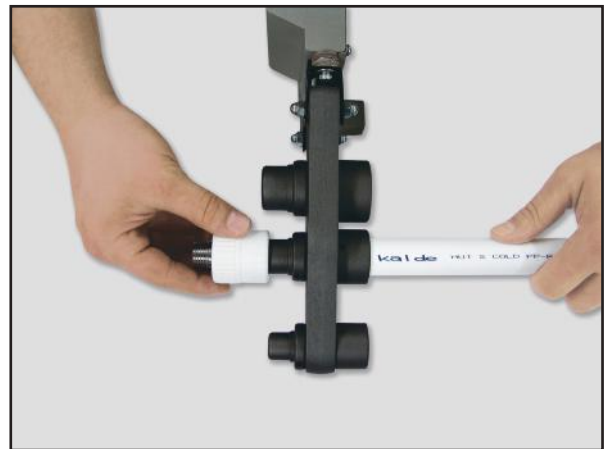
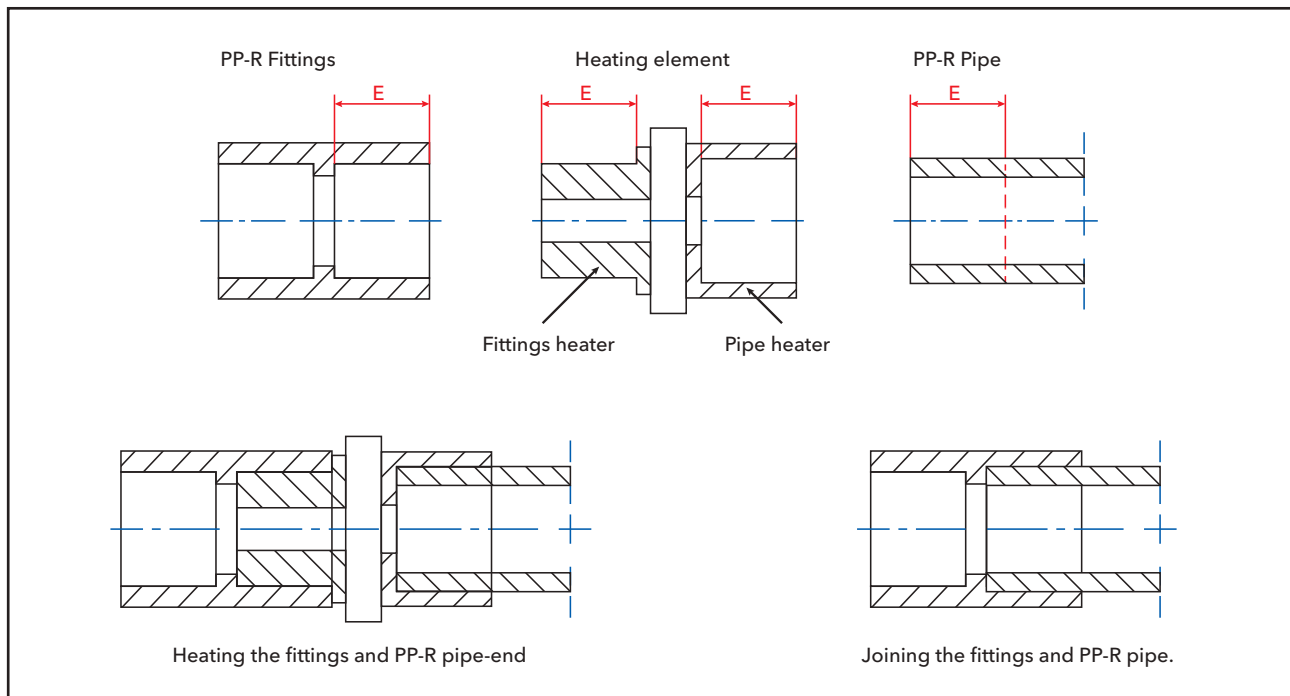
- According to the size of pipes and fittings welding part (Teflon coated) mounted welding machine, welding parts is heated until it reaches the temperature ($260^{\circ}\text{C} \pm 10$).
- To be welded pipe, pipe cutting scissors cut perpendicular to the axis of the pipe, (outer foil pipes, after cutting process the outer surface of the pipe aluminum foil must be shaved with a shaving apparatus.)
- Pipe welding distance is marked. (see Chart of welding)
- Pipes and fittings, gently inserted into welding parts.
- A certain period of the welding machine the heated pipe and fitting, getting out from welding parts, and are combined with each other. (see Chart of welding)

Welding Table

Outer Diameter (mm)	Heating (secs)	Joining (secs)	Cooling Time (minutes)	Welding Length (mm)
20	7	4	2	16
25	7	4	3	18
32	8	6	4	20
40	12	6	4	22
50	18	6	5	26
63	24	8	6	29
75	30	10	8	32
90	40	11	8	38
110	50	12	8	42

Diameter (Ø), (mm)	E, (mm)
20	15
25	17
32	19
40	22
50	24
63	28
75	32
90	38
110	42

PP-R Systems



PP-R Systems

Insulation of Pipes

PP-r tubes require less insulation compared to other types of pipes under the same conditions. Nevertheless, in cold and hot climates some insulation is required against freezing and heat loss over heating. These are caused by factors such as sun light, rain, snow when the pipes are laid outside. Another advantage of the insulation layer is the protection it provides against impacts.

General

Pipe insulation shall be designed to meet the following requirements.

- a) Legal and other obligations shall be complied with.
- b) Insulation material shall be adequately protected against moisture.
- c) The insulation materials shall ensure that the water is maintained at the designed operating temperature.

The insulating effect is mainly a function of the thickness of the insulation and its thermal conductivity, and increases in direct proportion to the temperature. The performance of insulating materials is impaired if they are moist. Opencell and fibrous insulating materials shall be provided with a vapour barrier bonded to the outer surface of the insulation. Condensation can form on any insulating material if the cold water pipes are inadequately lagged. If unsuitable materials this may lead to the moisture penetrating to the pipe. Thus, closed-cell materials with a high moisture resistance should be used to insulate cold water pipes. All but joints, cuts, seams and ends shall be sealed. If pipes are located in areas where frost damage is likely, even insulation cannot always prevent freezing if the system is not in service. The pipes should, therefore, be drained or otherwise protected.

Protection of cold water system against warmth and condensation.

Cold water pipework shall be adequately protected against heat sources and condensation, if necessary.

Cold water pipe shall be installed sufficiently clear of heat sources (e.g. hot pipes, chimneys, boilers). Where this is not possible, the pipes shall be insulated so that the water quality is not impaired by warmth.

For residential applications, the insulation thickness specified in the following table shall be used, assuming normal service conditions. Insulation will not provide permanent protection of the water against warmth.

The specifications of the table are also applicable where the protection against condensation on the outer surface of the insulation is concerned, assuming a water temperature of 10°C.

Protection against condensation is not required if the pipe is provided with a suitable sheathing (e.g. ducted pipe).

Recommended Minimum Thickness of Insulation for Cold Water Pipes

Location of Pipe	Insulation Thickness $\lambda=0,040 \text{ W/mK}$ *)
Exposed pipes, in unheated room (e.g. cellar)	4 mm
Exposed pipes, in heated room	9 mm
Ducted pipes, (cold water only)	4 mm
Ducted pipes, (cold and hot water)	13 mm
Chased pipes, risers	4 mm
Pipes in wall recess, next to hot pipes	13 mm
Pipes on concrete floor	4 mm

*) for other values of λ , the thickness is to be obtained by conversion, on the basis of a pipe diameter of 20 mm.

PP-R Systems

Protection of Hot Water Pipes Against Heat Loss

The minimum requirements specified in the Heizungsanlagen-Verordnung (heating system regulation) shall be complied with for restricting the heat loss of hot pipes, including circulation pipes.

Thermal Insulation of Warm Water Pipes

The decree for energy saving thermal protection and energy saving technique for buildings shall be considered.
Decree for energy saving (EnEV-in Germany) regulates the thermal insulation of pipes and fittings.

Minimum Thickness of Insulation Warm Water Pipes

Line	Type of Pipe / Fitting	Minimum Thickness of Insulation Referred to Thermal Conductivity of $\lambda=0.035 \text{ W/mK}$
1	Inner diameter up to 22 mm	20 mm
2	Inner diameter more than 22 mm up to 35 mm	30 mm
3	Inner diameter more than 35 mm up to 100 mm	Same as inner diameter
4	Inner diameter more than 100 mm	100 mm

Insulation Thickness

Pipe Outer Diameter	Available Thickness Acc.to 2 HAVO $\lambda = 0.035 \text{ W/mK}$	Insulation Thickness in Kalde Pipes $\lambda = 0.035 \text{ W/mK}$
20x3,4 mm	20 mm	20 mm
25x4,2 mm	20 mm	20 mm
32x5,4 mm	20 mm	20 mm
40x6,7 mm	30 mm	30 mm
50x8,3 mm	30 mm	30 mm
63x10,5 mm	42 mm	42 mm
75x12,5 mm	50 mm	50 mm
90x15,0mm	60 mm	60 mm
110x18,3mm	73,4 mm	73,4 mm

PP-R Systems

Calculation of Economic Pipe Insulation Material Thickness

Optimum values of the thickness of the pipe insulation material is shown in chart of economic insulation thickness.
Such F factor $F = P \cdot (T_i - T_d) \cdot n \cdot \lambda \cdot 10^{-5}$ is calculated by Equation.

where in,

P = Heat energy costs (€ / kWh) in Euro,

n = Annual operating time (hours / year)

λ = Thermal conductivity coefficient of insulation material (W/mk)

T_i = Fluid temperature, °C

T_d = The ambient temperature, °C

Example:

Pipe diameter: 75mm

The temperature of water in the pipe: 80 °C,

Ambient temperature: 20 °C

Heat energy cost: 30 € / kWh,

Line, annual working hours: 8000h

Insulation material, thermal conductivity coefficient: 0.035 W/mk

In this case, what is the economic pipe insulation thickness?

$$F = P \cdot (T_i - T_d) \cdot n \cdot \lambda \cdot 10^{-5}$$

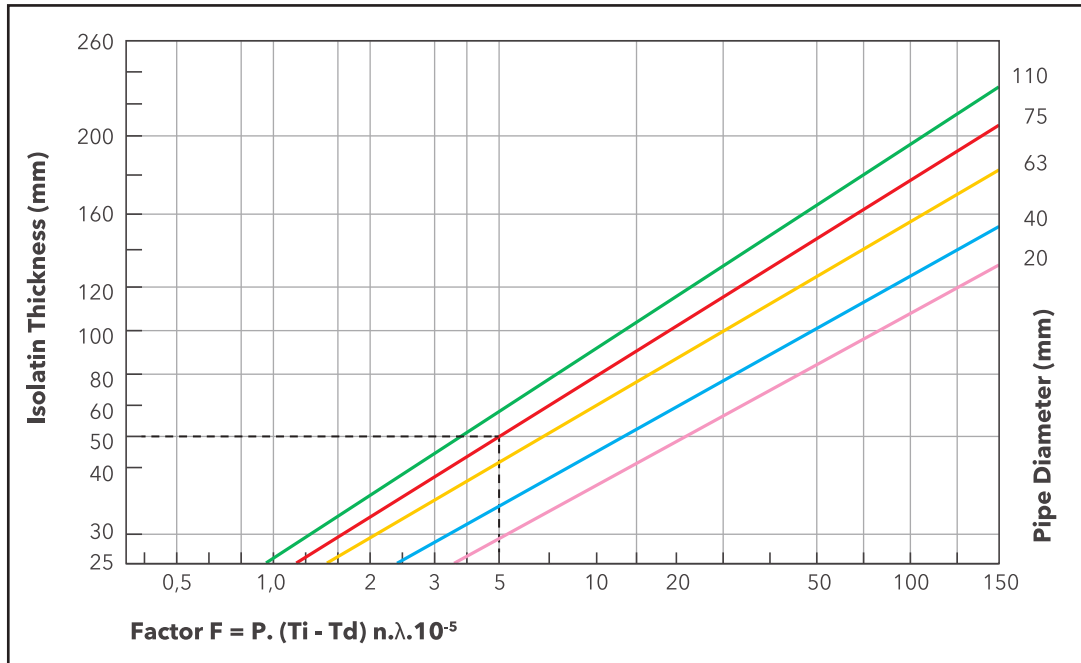
$$F = 30 \times (80 - 20) \times 8000 \times 0.035 \times 10^{-5}$$

$$F = 5.04$$

Looking at the economic insulation thickness chart (below), only the insulation thickness of 50 mm.

PP-R Systems

Economic Insulation Thickness Chart



Several Thermal Insulation Materials and Their Properties

Materials	User's Location	Temperature Range	Coefficient of Thermal Conductivity
Glass wool	Heating systems, pipes are used to provide heat and sound insulation.	(-20°C) - (+250°C)	20°C de 0,039 W/mk
Polyethylene foam	Central heating, cooling, air-conditioning systems	(-80°C) - (+95°C)	10°C de 0,033 W/mk 40°C de 0,040 W/mk
Elostrometrik polyolefin	Central heating, cooling, ventilation, heat pump systems	(-80°C) - (+95°C)	10°C de 0,033 W/mk 40°C de 0,038 W/mk
Polyurethane foam	Cooling tanks	(-100°C) - (+90°C)	20°C de 0,022 W/mk

PP-R Systems

Pressure Losses

	Dimension of Pipes (ut diameter x wall thickness) (mm)									
		20x3,4	25x4,2	32x5,4	40x6,7	50x8,3	63x10,5	75x12,5	90x15,0	110x18,3
	d1, mm	13,2	16,6	21,2	26,6	33,4	42	50	60	73,4
q	A, m ²	0,137	0,216	0,353	0,555	0,876	1,385	1,962	2,826	4,229
0,01	ΔPd	0,00055	0,00028	0,00013	0,00007	0,00003	0,00002	0,00001	0,00001	0,00000
	v	0,07299	0,04630	0,02833	0,01802	0,01142	0,00722	0,00510	0,00354	0,00236
0,05	ΔPd	0,00276	0,00139	0,00067	0,00034	0,00017	0,00009	0,00005	0,00003	0,00002
	v	0,36496	0,23148	0,14164	0,09009	0,05708	0,03610	0,02548	0,01769	0,01182
0,1	ΔPd	0,00553	0,00279	0,00134	0,00068	0,00034	0,00017	0,00010	0,00006	0,00003
	v	0,72993	0,46296	0,28329	0,18018	0,11416	0,07220	0,05097	0,03539	0,02365
0,2	ΔPd	0,01106	0,00558	0,00267	0,00135	0,00068	0,00034	0,00020	0,00012	0,00006
	v	1,45985	0,92593	0,56657	0,36036	0,22831	0,14440	0,10194	0,07077	0,04729
0,5	ΔPd	0,02765	0,01394	0,00668	0,00339	0,00171	0,00086	0,00051	0,00029	0,00016
	v	3,64964	2,31481	1,41643	0,90090	0,57078	0,36101	0,25484	0,17693	0,11823
1	ΔPd	0,05530	0,02789	0,01336	0,00677	0,00342	0,00172	0,00102	0,00059	0,00032
	v	7,29927	4,62963	2,83286	1,80180	1,14155	0,72202	0,50968	0,35386	0,23646
1,5	ΔPd	0,08295	0,04183	0,02004	0,01016	0,00513	0,00258	0,00153	0,00088	0,00048
	v	10,94891	6,94444	4,24929	2,70270	1,71233	1,08303	0,76453	0,53079	0,35469
2	ΔPd	0,11060	0,05578	0,02673	0,01355	0,00684	0,00344	0,00204	0,00118	0,00064
	v	14,59854	9,25926	5,66572	3,60360	2,28311	1,44404	1,01937	0,70771	0,47293
2,5	ΔPd	0,13824	0,06972	0,03341	0,01693	0,00854	0,00430	0,00255	0,00147	0,00081
	v	18,24818	11,57407	7,08215	4,50450	2,85388	1,80505	1,27421	0,88464	0,59116
3	ΔPd	0,16589	0,08367	0,04009	0,02032	0,01025	0,00516	0,00306	0,00177	0,00097
	v	21,89781	13,88889	8,49858	5,40541	3,42466	2,16606	1,52905	1,06157	0,70939
3,5	ΔPd	0,19354	0,09761	0,04677	0,02371	0,01196	0,00602	0,00357	0,00206	0,00113
	v	25,54745	16,20370	9,91501	6,30631	3,99543	2,52708	1,78389	1,23850	0,82762
4	ΔPd	0,22119	0,11156	0,00296	0,00150	0,00076	0,00001	0,00000	0,00000	0,00000
	v	29,19708	18,51852	0,62660	0,39854	0,25250	0,00213	0,00039	0,00027	0,00000
4,5	ΔPd	0,24884	0,12550	0,06013	0,03048	0,01538	0,00774	0,00459	0,00265	0,00145
	v	32,84672	20,83333	12,74788	8,10811	5,13699	3,24910	2,29358	1,59236	1,06408
5	ΔPd	0,02595	0,03253	0,04163	0,05216	0,06557	0,08244	0,09810	0,11775	0,14404
	v	3,42500	5,40000	8,82500	13,87500	21,90000	34,62500	49,05000	70,65000	105,72500
5,5	ΔPd	0,01142	0,01431	0,01832	0,02295	0,02885	0,03627	0,04316	0,05181	0,06338
	v	1,50700	2,37600	3,88300	6,10500	9,63600	15,23500	21,58200	31,08600	46,51900
6	ΔPd	0,33179	0,16734	0,08018	0,04064	0,02051	0,01031	0,00612	0,00354	0,00193
	v	43,79562	27,77778	16,99717	10,81081	6,84932	4,33213	3,05810	2,12314	1,41878
6,5	ΔPd	0,35943	0,18128	0,08686	0,04403	0,02222	0,01117	0,00663	0,00383	0,00209
	v	47,44526	30,09259	18,41360	11,71171	7,42009	4,69314	3,31295	2,30007	1,53701
7	ΔPd	0,38708	0,19523	0,09354	0,04742	0,02392	0,01203	0,00714	0,00413	0,00226
	v	51,09489	32,40741	19,83003	12,61261	7,99087	5,05415	3,56779	2,47700	1,65524
7,5	ΔPd	0,41473	0,20917	0,10022	0,05080	0,02563	0,01289	0,00765	0,00442	0,00242
	v	54,74453	34,72222	21,24646	13,51351	8,56164	5,41516	3,82263	2,65393	1,77347
8	ΔPd	0,44238	0,22311	0,10690	0,05419	0,02734	0,01375	0,00815	0,00472	0,00258
	v	58,39416	37,03704	22,66289	14,41441	9,13242	5,77617	4,07747	2,83086	1,89170
9	ΔPd	0,49768	0,25100	0,12026	0,06096	0,03076	0,01547	0,00917	0,00531	0,00290
	v	65,69343	41,66667	25,49575	16,21622	10,27397	6,49819	4,58716	3,18471	2,12816
10	ΔPd	0,55298	0,27889	0,13363	0,06774	0,03418	0,01719	0,01019	0,00590	0,00322
	v	72,99270	46,29630	28,32861	18,01802	11,41553	7,22022	5,09684	3,53857	2,36463

PP-R Systems

Pressure loss in straight pipes:

The d'arcy formula is used to calculate the pressure loss in the pipes

$$\Delta P_d = (\partial \cdot L / d_1) (p \cdot v / 2) \cdot 10^{-5} \text{ (bar)}$$

ΔP_d = Pipe pressure loss (bar)

∂ = Pipe friction coefficient (for most cases 0,02)

L = Length of pipe (m)

d_1 = Inside diameter of pipe (m)

p = Fluid density (kg/m³)

V = Flow velocity (m/s)

D = Outside diameter of pipe (m)

S = Wall thickness (mm)

q = Flow rate (L/S)

Pipe Laying

Pipes in the ground should be isolated against thermal insulation and corrosion.

Penetration of moisture and water through the pipes underground and insulation material should be avoided.

Water in buried service pipes may be polluted by waste water. Thus, where the distance between drinking and waste water pipes does not exceed 1 m, the former shall not be laid deeper than the latter. The minimum clear distance between drinking water pipes and other pipes shall be 0.2 m. Where this distance cannot be maintained, protective measures (e.g. enclosing pipe in a duct) shall be taken.

Pipes embedded in a building element (e.g. wall or floor) shall be suitably wrapped or coated so as to ensure that the pipe and building element are not in direct contact.

Test Procedure (DIN 1988-2)

The finished installation shall be filtered and vacuumed in order to be filled with water to start testing.

Pressure testing shall be carried out in two stages, the first stage being sufficient for smaller sections of the system (e.g. for testing supply and branch pipes in wet rooms).

- a) For the first stage, a test pressure equal to the permissible working pressure plus 5 bar shall be produced twice within 30 minutes at 10-minute intervals. Then it shall be checked whether, over a further period of 30 minutes, the pressure has dropped by more than 0,6 bar (with a rate of 0.1 bar per minute) and leakage has occurred.
- b) The second stage shall follow the first stage without interval and shall last two hours. Then, it shall be checked whether the pressure has dropped by more than 0.2 bar and the pipework shows any signs of leakage.

PP-R Systems

Points to Pay Attention to When Installing Polypropylene Pipes and Fittings

- Do not expose the pipes and fittings to the sun. Protect the pipes against hard and sharp objects.
Do not use accidentally damaged pipes for installation.
- Bend the pipes with hot air. Never use fire when heating the pipes.
- The pipes and the fittings to be installed should be clean.
- Cut the pipes, perpendicular to the axis of pipe with a proper scissor, do not use other sharp objects that can cause impurity in the pipes.
- Mark the welding length on the pipe before welding.
- Information about the welding process (heating time, standby time, cooling time, etc.) In the manufacturer's catalog.
- Protect polypropylene pipe and fittings where water may freeze. Expansion due to freezing water inside the pipe may damage it.
- After shaving the aluminum layer make sure that there is no aluminum parts on the welding surface, otherwise it will cause leakage.
- Cold weather weakens the resistance of polypropylene against hit and it becomes fragile.
- Protect the pipes against hit when there is a risk of freezing.
- To prevent leaks in your installation use teflon tapes with the threaded fittings.
- Use teflon for sealing when assembling threaded parts and do not overload to screw it. If linen is used as sealing material; care should be taken not to over wrap, In case of excessive use, brass inserts or other brass parts may cause fatigue cracking or breakage over time and separation of plastic and metal from each other.
- Before installation, the products to be used must be visually checked, if there are cracks, broken etc. defects should be returned to our company for replacement without using the product.
- After the installation is finished, the products in the system should be tested for leakage. If there are leaking products should be returned to our company to be replaced with a new one.

Note: Products that have not been checked and tested before and after installation are excluded from the warranty. Any damages arising from this reason are the responsibility of the installation company.

Color Codes Definitions

White 	Green 	Grey 	Black 	Brown 
3202-XXX-0X0000	3201-XXX-0X0000	3203-XXX-0X0000	3205-XXX-0X0000	3204-XXX-0X0000

- All PP fittings and pipes are available in white/grey/green.
- Nominal pressure: PN25 for fittings.
- Packaging quantities are subject to change without notice.

PP-R Systems

PP Bridge

Code	Size	H	Pcs.
3202-twc-200000	ø20	40	140
3202-twc-250000	ø25	50	75
3202-twc-320000	ø32	64	36
3202-twc-400002	ø40	80	25



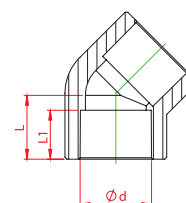
PP C-Bridge

Code	Size	H	Pcs.
3202-twc-200001	ø20	38	275
3202-twc-250001	ø25	51	150
3202-twc-320001	ø32	66	70



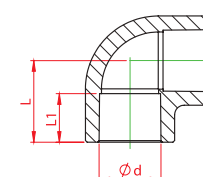
Elbow 45°

Code	Size	d	L1	L	Pcs.
3212-elb-200045	ø20	19	15	20	575
3212-elb-250045	ø25	24	17	23	360
3212-elb-320045	ø32	31	19	27	190
3212-elb-400045	ø40	39	22	31	100
3212-elb-500045	ø50	48,5	24	36	56
3212-elb-630045	ø63	61,5	28	42	25
3212-elb-750045	ø75	73,5	32	50	18
3212-elb-900045	ø90	88,5	38	59	12
3212-elb-110045	ø110	108,5	42	66	6



Elbow 90°

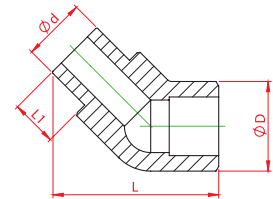
Code	Size	d	L1	L	Pcs.
3212-elb-200000	ø20	19	15	26	500
3212-elb-250000	ø25	24	17	30	300
3212-elb-320000	ø32	31	19	36	155
3212-elb-400000	ø40	39	22	43	75
3212-elb-500000	ø50	48,5	24	50,5	40
3212-elb-630000	ø63	61,5	28	62	20
3212-elb-750000	ø75	73,5	32	70	16
3212-elb-900000	ø90	88,5	38	80	6
3212-elb-110000	ø110	108,5	42	94	4



PP-R Systems

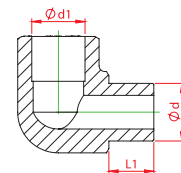
Tail Elbow 45°

Code	Size	d	D	L1	L	Pcs.
3212-elt-200045	ø20	20,5	30	14,5	65	400
3212-elt-250045	ø25	25,5	35	16	73	250



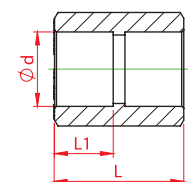
Tail Elbow 90°

Code	Size	d	d1	L1	Pcs.
3212-elt-200000	ø20	20,5	19	14,5	400
3212-elt-250000	ø25	25,5	24	16	250



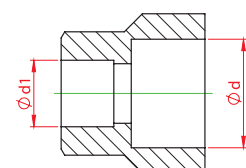
Tail Elbow 90°

Code	Size	d	L1	L	Pcs.
3212-muf-200000	ø20	19	15	33	675
3212-muf-250000	ø25	24	17	37	400
3212-muf-320000	ø32	31	19	42	225
3212-muf-400000	ø40	39	22	46	140
3212-muf-500000	ø50	48,5	24	53	80
3212-muf-630000	ø63	61,5	28	62	48
3212-muf-750000	ø75	73,5	32	69	28
3212-muf-900000	ø90	88,5	38	79	20
3212-muf-110000	ø110	108,5	42	86	10



Reducing Female Coupling

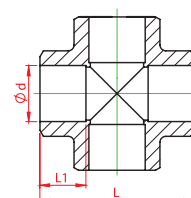
Code	Size	d	d1	Pcs.
3212-rdf-252000	ø25 x 20	24	19	400
3212-rdf-322000	ø32 x 20	31	19	250
3212-rdf-322500	ø32 x 25	31	24	250
3212-rdf-402000	ø40 x 20	39	19	175
3212-rdf-402500	ø40 x 25	39	24	175



PP-R Systems

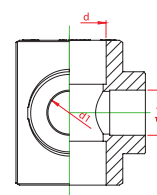
Cross

Code	Size	d	L1	L	Pcs.
3212-crs-200000	ø20	19	15	53	240
3212-crs-250000	ø25	24	17	64	140
3212-crs-320000	ø32	31	19	74	75



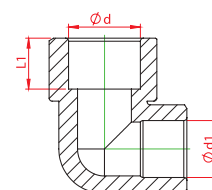
Cross Tee

Code	Size	d	d1	Pcs.
3212-cdl-322000	ø32 x 20	31	19	100
3212-cdl-322500	ø32 x 25	31	24	100
3212-cdl-402000	ø40 x 20	39	19	70
3212-cdl-402500	ø40 x 25	39	24	70



Reduction Elbow

Code	Size	d	d1	L1	Pcs.
3212-elr-252000	ø25 x 20	19	19	16	300
3212-elr-322500	ø32 x 25	24	24	18	200



Tee Branch

Code	Size	d	d1	L1	Pcs.
3212-byp-202000	ø20 x 20	19	19	14,5	140
3212-byp-252500	ø25 x 25	24	24	16	80
3212-byp-252000	ø25 x 20	19	24	16	100

