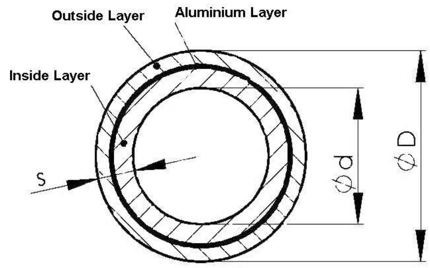
Kalde Klima A.Ş.

PP-R Foil pipe Technical brochure

KALDE PPR 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 thereads – Part 1: Taper external threads and paralel 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: Fitnes for purpose of the systems, Part 7: Guidance for the assessment of conformity



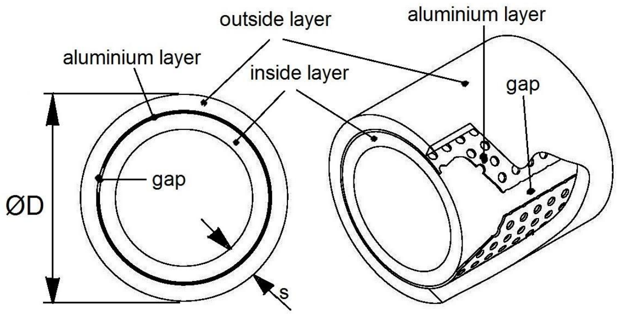


Figure- 1: supperoxy pipe Figure-2 : supper pipe

Note: supperoxy pipe has a completely close aluminium foil layer, but the supper pipe has not completely close aluminium foil layer, there is a gap aproxmity 3-4mm, and the foil layer is perforated or unperforated.

Pipe Dimensions according to 8077 (PN 20)

Outer Diameter and Tolerance ØD, mm		Wall Thickness and Tolerance S, mm		Aluminium Thickness (micron)	Approxmitly Weight kg/m
20	+0,3	2,8	+0,4	120	0,165
25	+0,3	3,5	+0,5	120	0,245
32	+0,3	4,4	+0,6	120	0,405
40	+0,4	5,5	+0,7	120	0,594
50	+0,5	6,9	+0,8	120	0,940
63	+0,6	8,6	+1,0	120	1,490
75	+0,7	10,3	+1,2	120	2,030
90	+0,9	12,3	+1,4	120	2,950
110	+1,1	15,1	+1,7	120	4,400

Pipe Dimensions according to 8077 (PN 25)

Outer Diameter and Tolerance ØD, mm		Wall Thickness and Tolerance S, mm		Aluminium Thickness (micron)	Approxmitly Weight kg/m
20	+0,3	3,4	+0,5	120	0,176
25	+0,3	4,2	+0,6	120	0,265

32	+0,3	5,4	+0,7	120	0,430
40	+0,4	6,7	+0,8	120	0,675
50	+0,5	8,3	+1,0	120	1,035
63	+0,6	10,5	+1,2	120	1,704
75	+0,7	12,5	+1,4	120	2,371
90	+0,9	15,0	+1,6	120	3,393
110	+1,1	18,3	+1,8	120	5,008

Raw material:Polypropylene Random Copolimer (PPR - Type 3)

Polypropylene Random Copolimer (PPR - Type 3) 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 PPR-Type 3. PPR-Type 3 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.

PPR-Type 3 is suitable for DIN 8078 and EN ISO 15874-1 standard.

The metal inserts used in the polypropylene fittings increase the reliability of the products. Kalde's experience in brass fittings for more than 25 years results in high quality pipes with very reliable metal inserts.

Physical Properties

Properties	Testing Methods	Unit	Values
Density, at 23 °C	ISO 1183	g/cm^3	0,9
Melt flow index (MFI)			
MFI 190 °C/5 kg	ISO 1133	g/10 min	<0,8
MFI 230 °C/2, 16 kg	ISO 1133	g/10 min	<0,5
Thermal conductivity at 23 °C	DIN 52612	W/m.K	0,23

Thermal Properties

Properties	Testing Methods	Unit	Values
Melting point	DSC	°C	146
Subjective heat	Calorimeter	Kj/kgK	1,73
Coefficent of linear expansion	ASTM D 696	mm/m(°C)	0,15
Deflection temperature under load 1,8 N/mm^2 0,45 N/mm^2	 ISO 75A-1, -2 ISO 75B-1, -2	 °C °C	 44 72
Brittleness temperature	ASTM D 746	°C	-13
VICAT softening point (1 kg) (5 kg)	ASTM D 1525 ISO 306 DIN 53460	 °C °C	 130 70

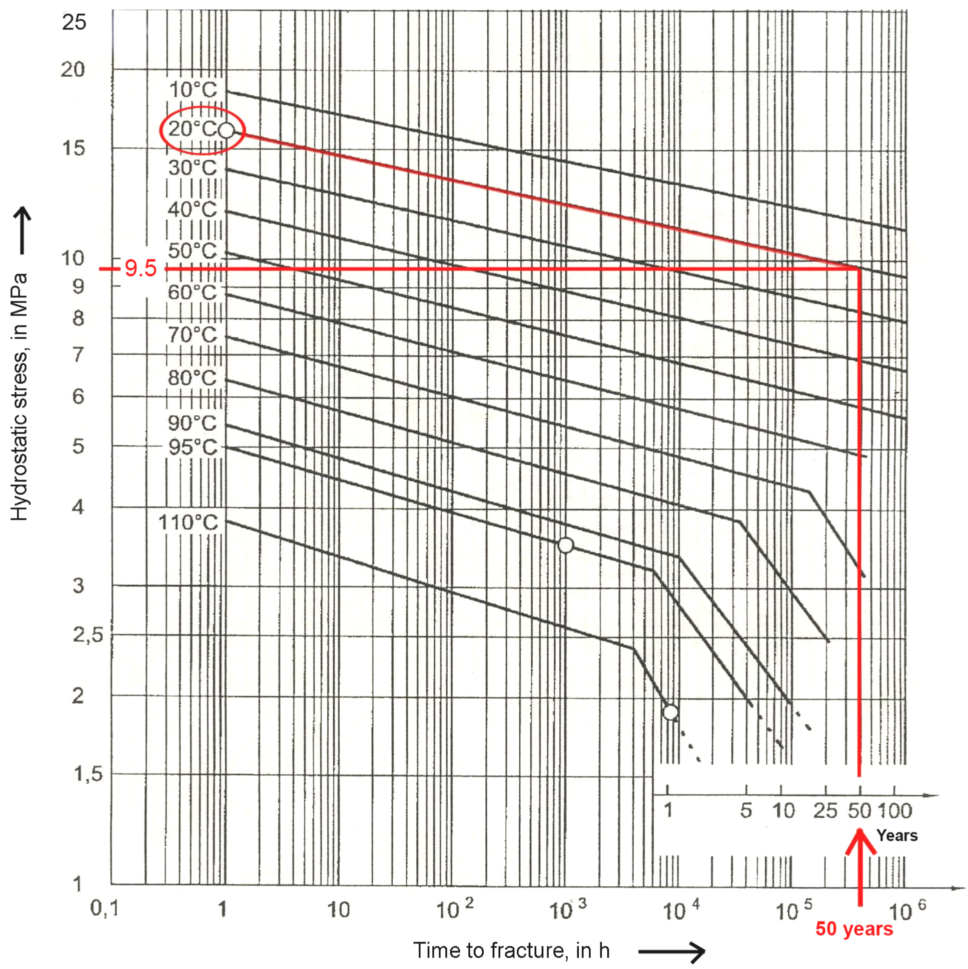
Mechanical Properties

Properties	Testing Methods	Unit	Values
Yield strength (23 °C) At 50 mm/min At 100 mm/min	ISO 527-1,-2 DIN 53455	N/mm² N/mm²	25 27
Elongation at yield (23 °C) At 50 mm/min At 100 mm/min		% %	12 13
Strength (23°C) At 50 mm/min At 100 mm/min		N/mm² N/mm²	34 33
Elongation at break 23 °C At 50mm/min At 100mm/min		% %	>500 >500
Flexural modulus at 23 °C	ASTM D 790	N/ mm²	800
Stiffness modulus, torsion test at23°C	DIN 53447	N/ mm²	185
Hardness (shore D)	ASTM D 2240		60
Charpy impact strength (unnotched) (0 °C)	ISO 179	Joule	No break

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	33	26	17,6	11	7,4	6	5
		PN2,5	PN3,2	PN4	PN6	PN10	PN16	PN20	PN25
		pressure (bar)							
20	1	3,7	4,7	5,9	9,0	15,0	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	21,0	26,4	33,3
	50	3,2	4,0	5,1	7,7	12,9	20,4	25,7	32,4
	100	3,1	3,9	5,0	7,5	12,5	19,9	25,0	31,5
30	1	3,2	4,0	5,0	7,6	12,7	20,2	25,4	32,0
	5	3,0	3,7	4,7	7,2	11,9	18,9	23,8	30,0
	10	2,9	3,6	4,6	7,0	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	4,0	6,0	10,1	16,0	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	15,0	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	23,0
	5	2,1	2,7	3,4	5,1	8,5	13,5	17,0	21,4
	10	2,0	2,6	3,3	4,9	8,2	13,1	16,5	20,8
	25	2,0	2,5	3,1	4,7	7,9	12,6	15,9	20,0
	50	1,9	2,4	3,0	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	3,0	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	18,0
	10	1,7	2,2	2,7	4,1	6,9	11,0	13,9	17,5
	25	1,6	2,1	2,6	4,0	6,6	10,5	13,3	16,7
	50	1,6	2,0	2,5	3,8	6,4	10,2	12,9	16,2
70	1	1,6	2,0	2,5	3,9	6,5	10,3	12,9	16,3
	5	1,5	1,9	2,4	3,6	6,0	9,5	12,0	[illegible]

	10 25 50	1,4 1,2 1,0	1,8 1,5 1,3	2,3 2,0 1,7	3,5 3,0 2,5	5,8 5,0 4,2	9,2 8,0 6,7	11,6 10,0 8,5	14,6 12,7 10,7
80	1 5 10 25	1,3 1,2 1,0 0,8	1,7 1,5 1,2 1,0	2,1 1,9 1,6 1,2	3,2 2,9 2,4 1,9	5,4 4,8 4,0 3,2	8,6 7,6 6,4 5,1	10,8 9,6 8,1 6,5	13,7 12,1 10,2 8,1
95	1 5 (10)[1]	0,9 0,6 (0,5)	1,2 0,8 (0,6)	1,5 1,0 (0,8)	2,3 1,5 (1,3)	3,8 2,6 (2,2)	6,1 4,1 (3,4)	7,6 5,2 (4,3)	9,6 6,5 (5,5)



Hydrostatic pressure performance

Hydrostatic pressure is calculated according to the below formula:

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

<u>**Sample:**</u>

Usage time of the pipe : 50 years
Operating temperature : 20°C
Outside diameter of pipe : Ø32
P = internal pressure, MPa: ?
Wall thickness of pipe : 5,4 mm

d_{em}= outside diameter of the pipe, mm
Hydrostatic stress : 9,5 MPa
e_{min}=minimum wall thickness of the pipe, mm
σ = Hydrostatic stress, MPa
Maksimum operating pressure
1MPa = 10 bar = 14,5 Psi
P= (20x5,4x9,5) / (32– 5,4)
P= 1026/ 26,6
P=38,57 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)
Pmax= Pmax / SF
Pmax= 38,57 / 1.5
Pmax= 25,7 bar (see page 9)

Cassification of service conditions

Application class	Design temperature, T_D °C	Time at T_D years	T_{max} °C	Time at Tmax years	T_{mal} °C	Time at T_{mal} 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

Polypropylene has a very high chemical resistance as a polymer.

The following table lists the chemical resistance of PPR pipe and fittings according to DIN 8078. Since chemical resistance depends on factors such as chemical composition, its concentration and temperature, the table below gives chemical resistance for three different temperatures and different concentrations.

The below abbreviations are used in the table:

W.s. water solution
S.s. saturated solution
R resistant
L limited resistant
NR nonresistant

- insufficient information Compatibilities reported on the table are valid for PP-R not summitted to mechanical stresses.

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	-
Aceptophenone	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	[illegible]	[illegible]

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	HCI/HNO3=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	-	-
Bormine, gas		NR	NR	NR
Bromine, liquid	100 %	NR	NR	NR
Butane, gas	100 %	R	-	-
Butanol	100 %	R	L	L
Butyl acetate	100 %	L	NR	NR
Butyl glycol	100 %	R	-	-
Butyl phenols	S.s	R	-	-
Butyl phthalate	100 %	R	L	L
Chemical or Product	**Concentration**	**Temperature °C**		
		20	**60**	**100**
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
Castor oil	100 %	R	R	-
Caustic soda	Up to 50%	R	L	L
Chlorine, aqueous	S.s	R	L	-
Chlorine, dry gas	100 %	NR	NR	NR
Chlorine, liquid	100 %	NR	NR	NR
Chloroacetic acid	W.s	R	-	-
Chloroethanol ,	100%	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 (ll) chloride	S.s	R	R	-
Copper (ll) nitrate	S.s	R	R	R
Copper (ll)	S.s	R	R	-
Corn oil		R	L	-
Cottonseed oil		R	R	-
Cresol	Greater than 90%	R	-	-
Cyclohexane	100%	R	-	-
Cyclohexanol	100%	R	L	-
Cyclohexanone	100%	L	NR	NR
Chemical or Product	**Concentration**	**Temperature °C**		
		20	**60**	**100**
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	-	-
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	-
Dioctyl 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
Hydrochloric acid	From 35 to 36 %	R	-	-
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	[illegible]	[illegible]

Hydrogen peroxide	Up to 30 %	R	L	-
Hydrogen sulphide, dry gas	100 %	R	R	-
Iodine, in alcohol		R	-	-
Isoctane	100 %	L	NR	NR
Isopropyl alcohol	100 %	R	R	R
Isopropyl ether	100 %	L	-	-
Lactic acid	Up to 90 %	R	R	-
Lanoline		R	L	-
Linseed oil		R	R	R
Chemical or Product	**Concentration**	**Temperature °C**		
		20	**60**	**100**
Magnesium carbonate	S.s	R	R	R
Magnesium chloride	S.s	R	R	-
Magnesium hydroxide	S.s	R	R	-
Magnesium sulphate	S.s	R	R	-
Maleic acid	S.s	R	R	-
Mercury (ll) chloride	S.s	R	R	-
Mercury (ll) cyanide	S.s	R	R	-
Mercury (l) 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	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, fujming (with nitrogen dioxide)		NR	NR	NR
Nitrobenzene	100%	R	L	_
Oleic acid	100 %	R	L	-
Oleum (sulphuric acid with 60 % of SO3)		R	L	-
Olive oil		R	R	L
Oxalic acid	w.s	R	L	NR
Oxygen, gas		R	-	-
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 bicarbonate	S.s	R	R	R
Potassium borate	S.s	R	R	-
Potassium bromated	Up to 10%	R	R	-
Potassium bromide	S.s	R	R	
Potassium carbonate	S.s	R	R	[illegible]

Potassium chlarate	S.s	R	R	
Potassium chloerite	S.s	R	R	
Potassium chromate	S.s	R	R	
Potassium cyanide	W.s	R	-	
Potassium dichromate	S.s	R	R	R
Potassium ferricyanide	S.s	R	R	-
Potassium fluride	S.s	R	R	-
Potassium hydroxide	Up to 50%	R	R	R
Ptassium iodide	S.s	R	-	-
Potassium nitrate	S.s	R	R	-
Potassium pechlorate	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	-	-
Chemical or Product	**Concentration**	**Temperature °C**		
		20	**60**	**100**
Seaweter		R	R	R
Silicon oil		R	R	R
Silver nitrate	S.s	R	R	L
Sodium acetate	S.s	R	R	R
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 phısohate (neutral)		R	R	R
Sodium silicate	W.s	R	R	-
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	NS
Yeast	W.s	R	R	R
Zinc chloride	Sat.w.s	R	R	-
Zinc sulphate	S.s	R	R	-

Polypropylene Tubes with Aluminium Foil

This pipe consists of three layers: the pipe and the coat are made of PPR-Type 3 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

- -hygenic
- -resistance to chemicals
- -high resistance to pressure and heat
- -low heat loss
- -low pressure loss due to the smoothness
- -low thermal expansion
- -oxygen impermeability
- -easy forming, installation and application

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.

Technical Properties, Pipe Dimensions (S=2,5 SDR=6) (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

Technical Properties, Pipe Dimensions (S=2 SDR=5) (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 (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

Operating Conditions (S=2 SDR=5) (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

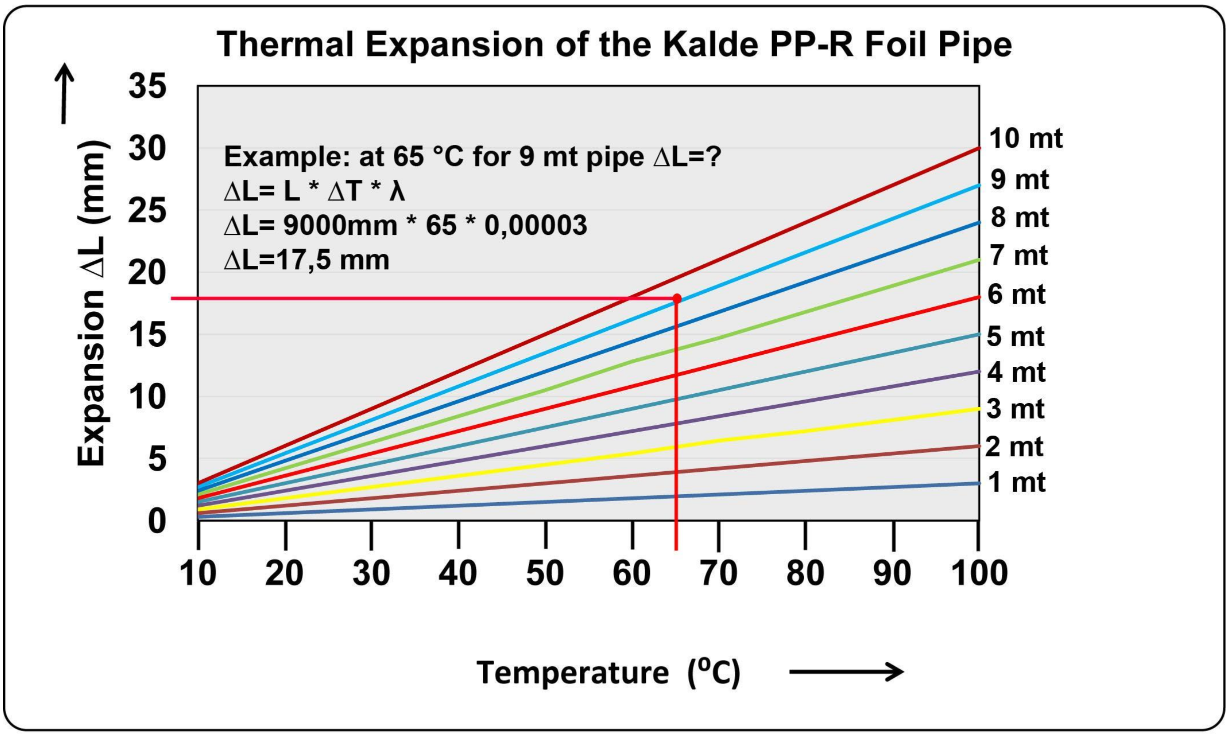
Thermal Expansion in PP-R Tubes with Aluminum Foil

Polypropylene pipes with an aluminum folio have lower expansion coefficients.

The expansion is calculated as follows: $\Delta L = L * \Delta T * \lambda$

where
ΔT = variation of working temperature in Kelvin degrees (K) or Celsius (°C)
ΔL = variation of length in mm
L = initial length of the pipe in m
λ =The approximate value for λ in PP-R tubes with alu folio is 0,3 $*10^{-4}$ (K^{-1}).

Pipe length (m)	Temperature variation ΔT in K									
	10	20	30	40	50	60	70	80	90	100
	Linear expansion ΔL (mm)									
1.0	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
2.0	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
3.0	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
4.0	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00
5.0	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
6.0	1.80	3.60	5.40	7.20	9.00	10.80	12.80	14.40	16.20	18.00
7.0	2.10	4.20	6.43	8.40	10.50	12.60	14.70	16.80	18.90	21.00
8.0	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00
9.0	2.70	5.40	8.10	10.80	13.50	16.20	18.90	21.60	24.30	27.00
10.0	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00



Support Intervals

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

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.

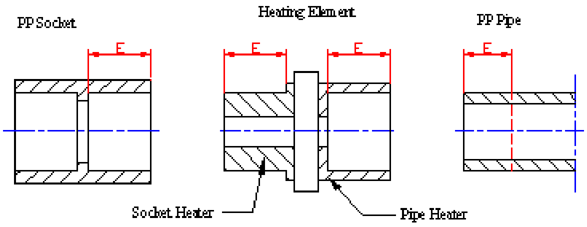
PPRC tubes are joined using mainly two methods:
i) threaded fitting and pipe connections
ii) fusion-welded joints. Fusion-welded joints can also be categorized into two methods. Electrofusion welding, which uses electrofusion fittings, is less practical and more expensive.
iii)Socket welding where electrical heating elements are used to heat the sockets and the pipe ends is the preferred method in Europe. The resulting joints are very reliable, and they are as strong as the pipe itself. The pipe may even break before the socket welded joint under tension.

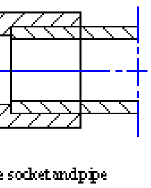
After cutting the pipe perpendicularly, both the pipes and the fittings (these must be clean) are heated with the welding machine (generally up to 260°C ± 10°C) and they are joined without twisting. Since parts made of polypropylene create a homogenous connection, this process is safe.

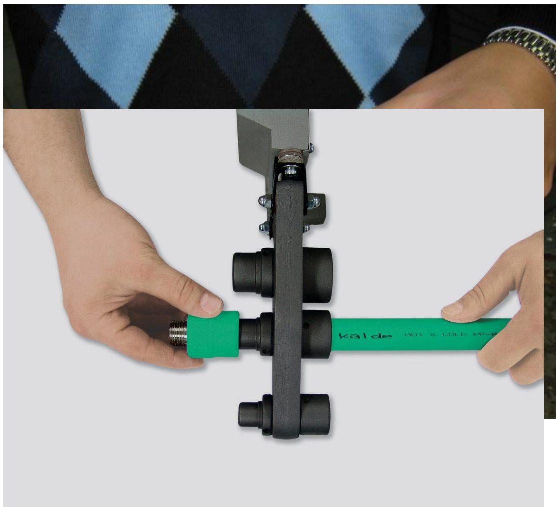
Outer Diameter (mm)	Heating Secs	Joining Secs	Cooling Time (minutes)	Welding length mm
20	7	4	2	16
25	7	4	3	18
32	8	6	4	20
40	12	6	4	22
50	18	6	5	26
63	24	8	6	29
75	30	10	8	32
90	40	11	8	38
110	50	12	8	42

Diameter Ø)mm	E (mm)
20	15
25	17
32	19
40	22
50	24
63	28

75	32
90	38
110	42







Installation

Pipes can be installed under or above the floor and the plaster. The installation is very easy. However, one has to pay attention to the following simple points when installing polypropylene pipes:

Pipes have to discharge the radial and axial expansions: compensations shall be done using fixed points, supporting bracket sleeve (allowing pipe to slide).

Thermal Tensions

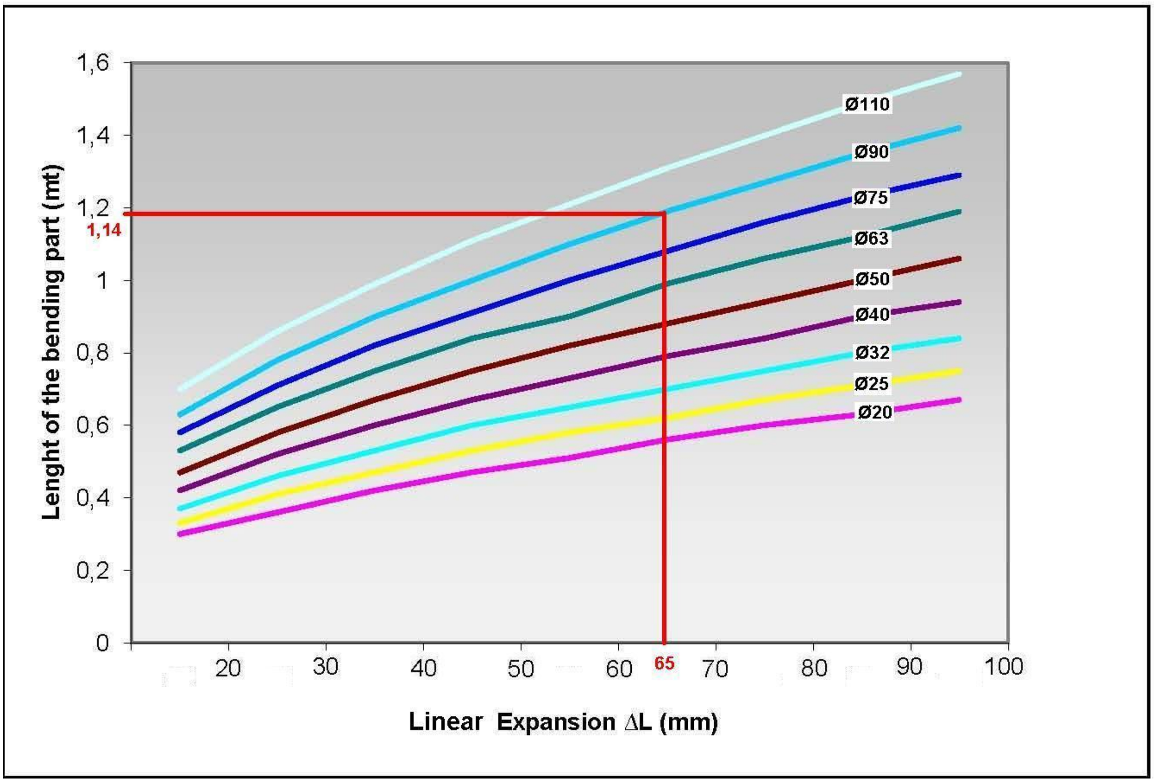
8.1 Introduction

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 piping systems, the most important elements that require taking measures are temperature and external forces as well as the weight of pipe itself, 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

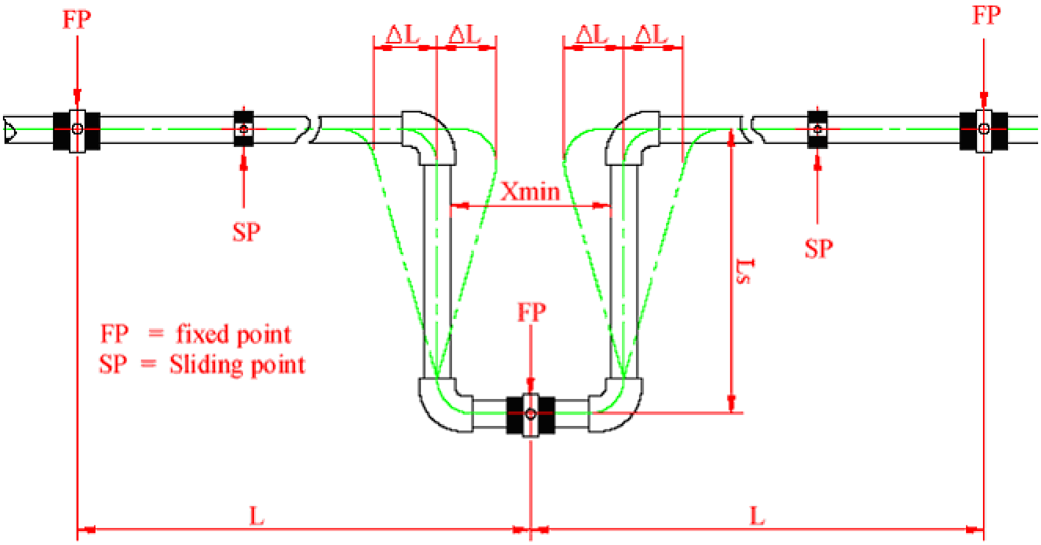
installation. Therefore, thermal tensions must be taken into the same consideration from the basic household installation to those with the highest pressure and temperature values.
Amount of thermal tension in piping is determined upon temperature difference in the pipeline, pipe length and material characteristics. Amount of thermal tension of PPR pipe can be determined using the thermal expansion diagram below.

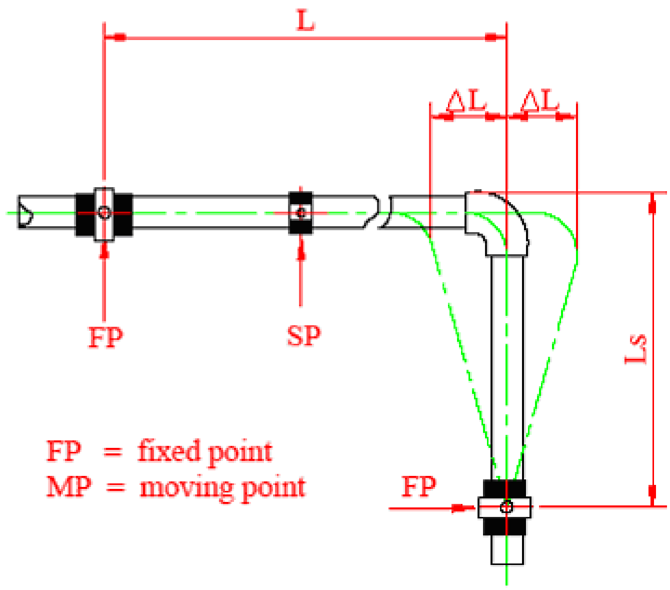


8.2 Removing Expansıons From Installatıon

8.2.1 Omega and (U) Elements

They are designed for using within certain hot pipes. They are used to remove expansions from straight pipes. A twisted pair pipe with Ω shape has a longer life. Each pipe diameter requires using separate tables to design an omega component and calculate force and moments exerted on static points.





Calculation of elongation

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

$Ls=K \sqrt{d} \times \Delta L$

Ls =Lenght of the bending part. mm
d= Outer dimater of the Kalde pipe. mm
ΔL = variation of length. mm
K = 15 (material based constant of Kalde pipe)
FP= Fixed Point
MP= Moving Point

Table 15 - Kalde length of the bending part

Pipe out diameter mm	Lineer Expansion ΔL (mm)								
	20	30	40	50	60	70	80	90	100
	Length of the bending part in (mt)								
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
$\lambda = 0.15$ mm/m-K
L= 12 meter
$\Delta T = 40$ °C

Required
$\Delta L = \lambda \times \Delta T \times L$
$\Delta L = 0.15 \times 40 \times 12 = 72$mm

2.The calculation of the bending length
d= 63 mm
$\Delta L = 72$ mm
K=15

$Ls = K \times \sqrt{d} \times \Delta L$
$Ls = 15 \times \sqrt{63 \times 72} = 1010$mm

Insulation of pipes

PPR 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 complied with.
b) İnsulation 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 outher surface of the insulation.

Condensation can form on any insulating material if the cold water pipes are inadequately lagged; in the case of unsuitable material, 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.

İf 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 shall, 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 table A shall be used, assuming normal service conditions. insulation will not provide permanent protection of the water against warmth.

The specifications of table A 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).

Table A - Recommended minimum thickness of insulation for cold water pipes

Location of pipe	Insulation Thickness λ=0,040 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	4mm
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.	

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. Decree for energy saving (EnEV) regulates the thermal insulation of pipes and fittings in Germany.

Table B - Minimum Thickness of insulation warm water pipes

line	Type of pipe / fitting	Minimum Thickness of insulation refered to thermal conductivity of λ=0,035 W/mK
1	İnner diameter up to 22 mm	20 mm
2	İnner diameter more than 22 mm up to 35 mm	30 mm
3	İnner diameter more than 35 mm up to 100 mm	Same as inner diameter
4	İnner diameter more than 100 mm	100 mm

Insulation Thickness

Pipe Outer Diameter	Available Thickness Acc.to 2 HAVO	Insulation Thickness in K

	λ=0,035 W/mK	λ=0,035 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

Test conditions after mounting

Whilst still accessible, the finished pipework shall be filled with filtered water and completely vented.

Pressure testing shall be carried out in two stages, the first stage being sufficient for smaller sections of the system (e.g. for the test of supply pipes 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 pipe work shows any signs of leakage.

Points to pay attention to when installing PPR 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.
- Never use fire when heating the pipes. Bend the pipes with hot air.
- The pipes and the fittings to be installed should be clean.
- Cut the pipes perpendicularly 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.
- When welding follow the instructions (temperature, heating time, etc.) in the manufacturer's catalogue.
- Do not turn neither the pipes nor the fittings during the welding.
- Do not polypropylene pipes and fittings where water may freeze. The expansion can break the pipe.
- With pipes with folio, clean the rests generated when the folio was sharpened.
- Do not use polypropylene pipes and fittings where water may freeze. The expansion can break the pipe.
- After shaving the aluminum layer make sure that there is no aluminum rests 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 threaded fittings.