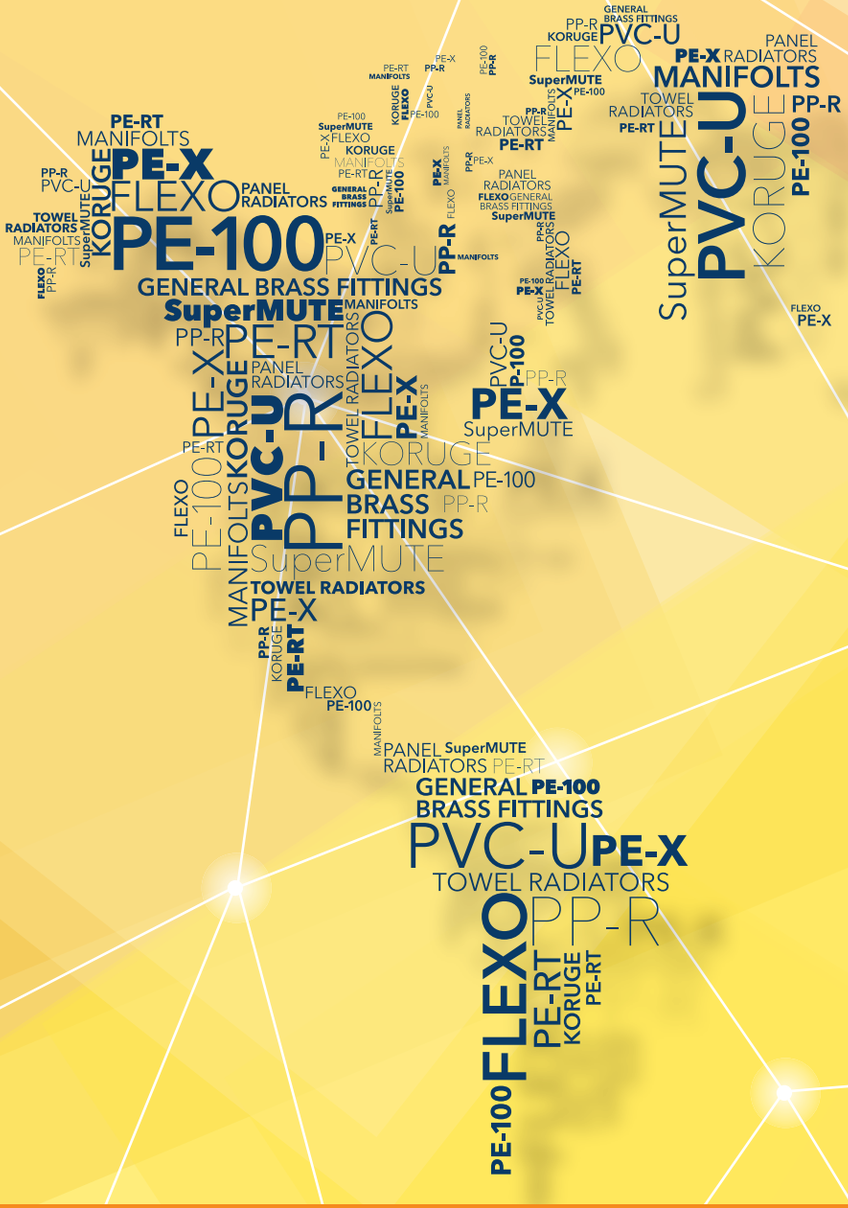
01.08.2020

PP-R Systems

kalde®
First Choice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PP-R
PVC-U
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SuperMUTE
PE-100
GENERAL BRASS FITTINGS
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KORUGE
PE-RT

Kalde is the “First Choice” all around the world.

Why Kalde?

Kalde produces high quality products, designs and develops integrated solutions for customers worldwide.

It is among the leading companies in production of pipes and fittings with its knowledge and expertise of more then 40 years.

The headquarters of the company is located in Istanbul where the continents of Asia and Europe meet.

Our strategical location at the junction of Europe, Asia and Africa together with a reliable supply chain give us unique advantages in providing our business partners and customers with high quality service as well as the competition in the global markets. Currently, our products are exported to more than 40 countries worldwide including Germany, Hungary, Romania, Austria, Greece, Bulgaria, Russia, Ukraine, Egypt, Syria, Lebanon, etc.

Kalde has product design, development and quality control facilities in 300.000 m^2.

Kalde produces a wide range of products including PP-R pipes, PP-R fittings, PP-R and brass valves, Al-pex & PE-RT pipes, screw fittings, press fittings, PE-X pipes and collectors. Kalde has internationally accredited certificates from respected organisations such as DVGW SKZ (Germany), CSTB (France) and AENOR (Spain). Furthermore, our management system has been certified by ISO.
We are proud of our high quality products and experiences...

Our vision is providing our customers with an increasingly wide portfolio of high quality products and solutions with continuous research and development.

Our goal is to develop long term partnerships with our customers and suppliers.

We create integrated solutions by team work as well as collaboration with our customers and partners.

Having market-focused teams of around 1500 professionals supported by a strong management, we offer our business partners and customers worldwide with value-adding solutions.

As result of these reasons, kalde® Kalde is the “First Choice” of the users worldwide

Kalde Value Commitment.

Kalde was established by four young engineers dedicated to provide customers with the best service in 1977.

This spirit is still alive and is the essence of our mission statement.

The Success of Kalde is the Result of Various Factors.

- **High quality** products.
- Utilization of best **practices.**
- Products meeting your **unique** requirements.
- **Proven** products.
- **Total** customer satisfaction.
- **Long term** relationships with each customer.
- A **dedicated** team of around 1500 professionals.

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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 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

PP-R Systems

Raw Material: Polypropylene Random Copolimer (PP-R)

Polypropylene Random Copolimer (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}	$1,5 \times 10^{-4}$
Surface Resistance (ohm)	DIN IEC 60093	Ω	$>10^{12}$
Deflection temperature under load 1,8 N/mm^2 0,45 N/mm^2	 ISO 75A-1, -2 ISO 75B-1, -2	 °C °C	 49 70
VICAT softening point (1 kg) (5 kg)	ASTM D 1525 ISO 306 DIN 53460	 °C °C	 130 70
Melting point	DSC	°C	146

Mechanical Properties

Properties	Testing Methods	Unit	Values
Tensile stres 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 at 0 °C	ISO 179/1eA	kJ/m^2 kJ/m^2	22 4,5
Charpy impact strength (unnotched) (0 C°)	ISO 179	Joule	No break
Hardness (shore D)	ISO 868		60

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

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

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: $\Delta L = L * \Delta T * \alpha$

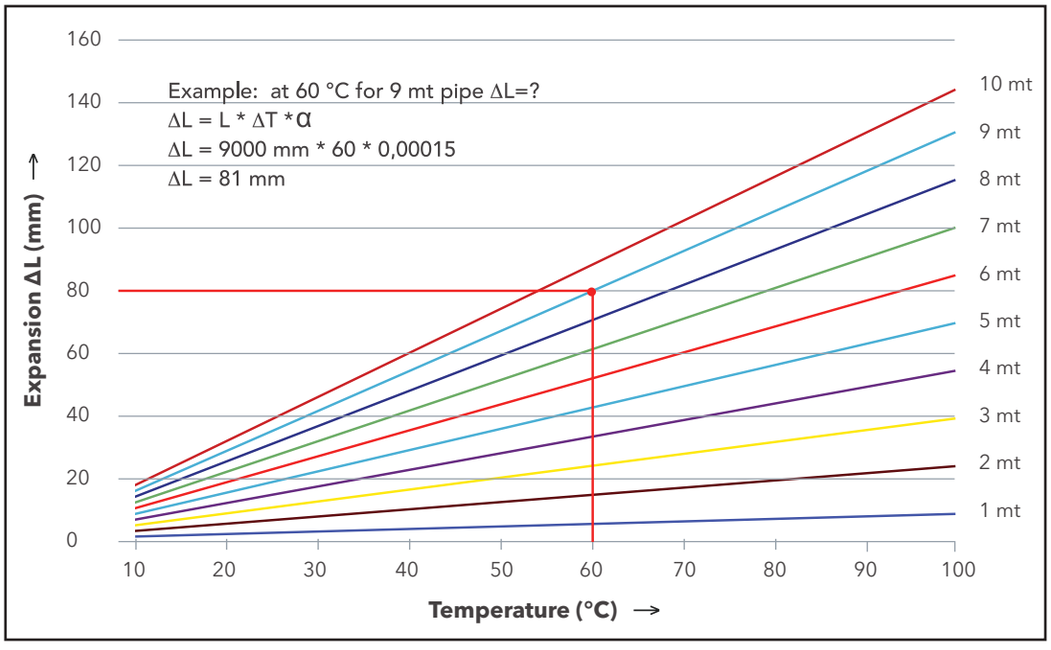
where

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 longation. But if the water temperature circulating in the pipe is lower than the environmental temperature, the result will be a shortage.

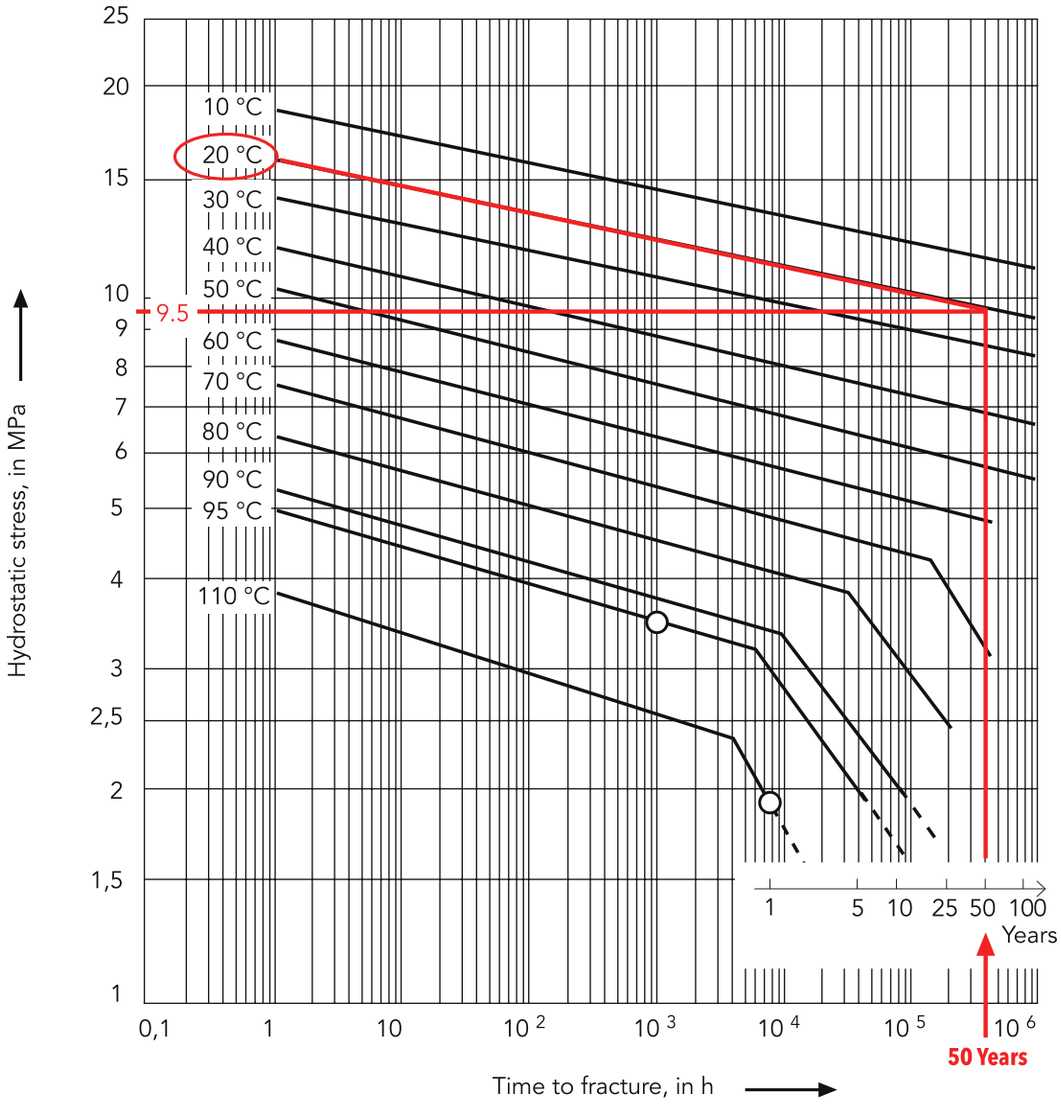
Thermal Expansion of the Kalde PP-R Pipe



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

Tempareture (°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

Hydrostatic Pressure Performance



Hydrostatic pressure is calculated according to the below formula:

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

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.

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 x 5,4 x 9,5) / (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 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

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	-	-
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/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	-	-

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 (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	-
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	-	-

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	-
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
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 cloride	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, 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
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 fluride	S.s	R	R	-

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
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	-	-
Seaweter		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

- Hygenic
- 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

Thermal Expansion in PP-R Tubes with Aluminum Foil

Polypropylene pipes with aluminum foil have lower expansion coeficients.

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

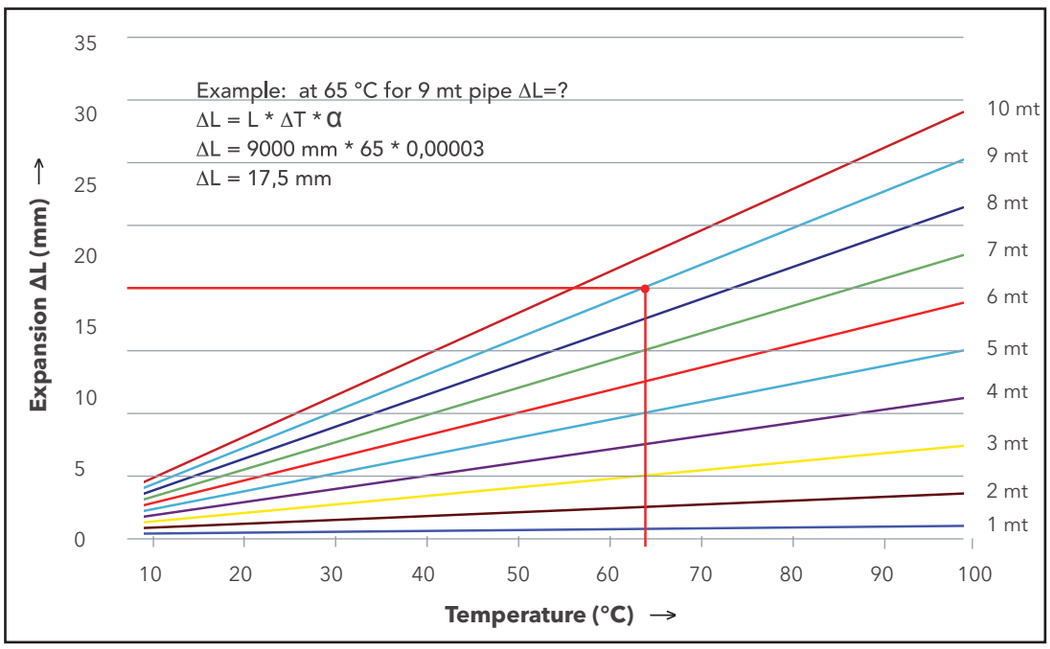
where

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 for α in PP-R tubes with alu foil is 0,3 $*10^{-4}$ (K^{-1}).

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	0,03	0,15	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
2.0	0,06	0,30	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
3.0	0,09	0,45	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10	9.00
4.0	0,12	0,60	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00
5.0	0,15	0,75	1.50	3.00	4.50	6.00	7.50	9.00	10.50	12.00	13.50	15.00
6.0	0,18	0,90	1.80	3.60	5.40	7.20	9.00	10.80	12.80	14.40	16.20	18.00
7.0	0,21	1,05	2.10	4.20	6.43	8.40	10.50	12.60	14.70	16.80	18.90	21.00
8.0	0,24	1,20	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00
9.0	0,27	1,35	2.70	5.40	8.10	10.80	13.50	16.20	18.90	21.60	24.30	27.00
10.0	0,30	1,50	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00	27.00	30.00

Note: When the water temperature circulating in the pipe is higher than the environmental temperature, the pipe will elongate. 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



PP-R Systems

Polypropylene Pipes with Fiberglass

This pipe consists of three layers: the pipe and the coat are made of PP-R with a fiberglas-mixed PP-R inbetween.

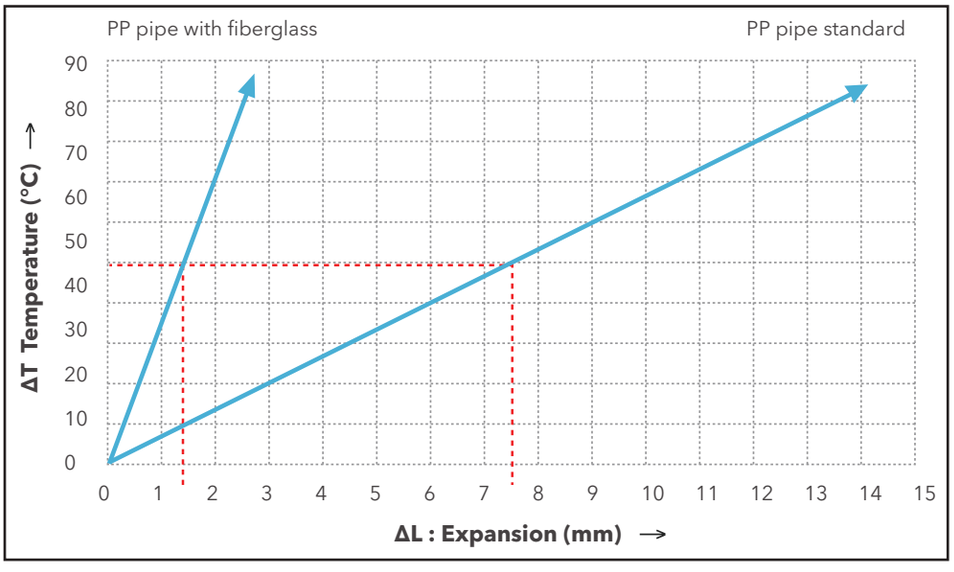
Characteristics

- Hygenic.
- Resistance to chemicals.
- High resistance to pressure and heat.
- Low heat loss.
- Low pressure loss due to the smoothness.
- Low thermal expansion.
- Expansion: 0.035 mm/mK.
- Lighter than standard PP-r pipes.
- The heat conductivity is less than alu-foiled PP-R pipes and same as PP-R standard pipes.
- Higher discharge related to the bigger inner diameter.

Advantages

- %75 less expansion than standard PP-R pipes.
- No need to shave the pipe for welding.
- Lower costs, you use less brackets due to less expansion.
- More resistance despite smaller wall thickness.
- %20 more flow than standard pipes.
- Same or lower heat conductivity in comparison to standard PP-R and aluminum foiled pipes.
- Easy welding and mounting.

Expansion Comparison Between PP Pipes with Fiberglass and Standard Pipe



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

Thermal Expansion in Polypropylene Pipes with Fiberglass

Polypropylene pipes with fiberglass have an expansion coefficient that is much higher than metal pipes. It is critical to take this characteristic into consideration during installations.

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

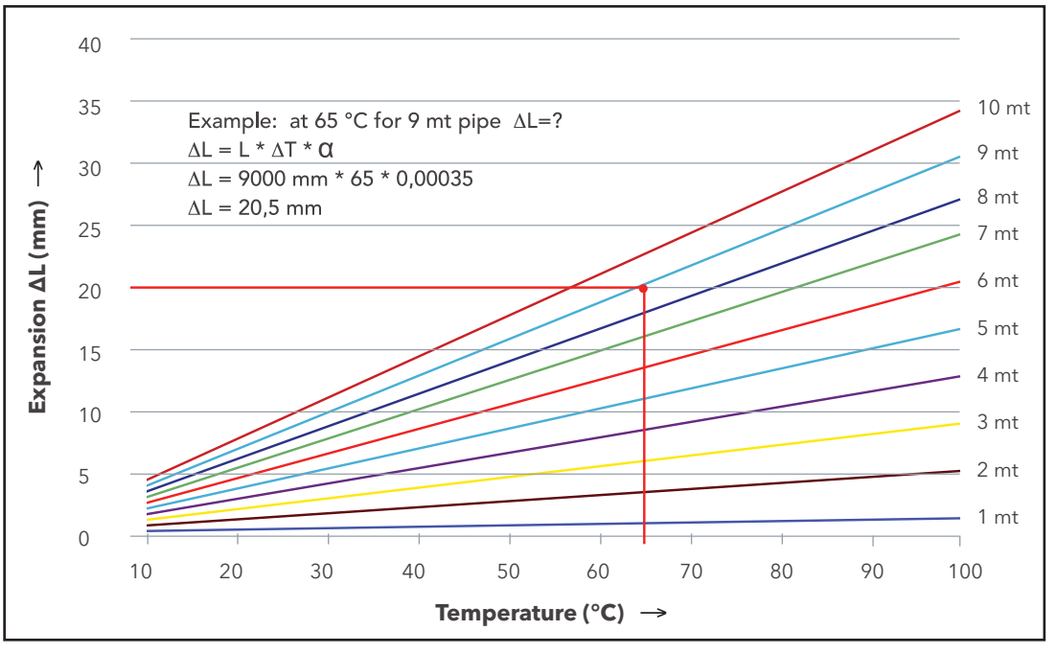
where

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 for α in PP-R tubes with alu foil is 0,35 $*10^{-4}$ (K^{-1}).

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	0,035	0,17	0,35	0,70	1,05	1,40	1,75	2,10	2,45	2,80	3,15	3,50
2.0	0,070	0,35	0,70	1,40	2,10	2,80	3,50	4,20	4,90	5,60	6,30	7,00
3.0	0,105	0,52	1,05	2,10	3,15	4,20	5,25	6,30	7,35	8,40	9,45	10,50
4.0	0,140	0,70	1,40	2,80	4,20	5,60	7,00	8,40	9,80	11,20	12,60	14,00
5.0	0,175	0,87	1,75	3,50	5,25	7,00	8,75	10,50	12,25	14,00	15,75	17,50
6.0	0,210	1,05	2,10	4,20	6,30	8,40	10,50	12,60	14,70	16,80	18,90	21,00
7.0	0,245	1,22	2,45	4,90	7,35	9,80	12,25	14,70	17,15	19,60	22,05	24,50
8.0	0,280	1,40	2,80	5,60	8,40	11,20	14,00	16,80	19,60	22,40	25,20	28,00
9.0	0,315	1,57	3,15	6,30	9,45	12,60	15,75	18,90	22,05	25,20	28,35	31,50
10.0	0,350	1,75	3,50	7,00	10,50	14,00	17,50	21,00	24,50	28,00	31,50	35,00

Note: When the water temperature circulating in the pipe is higher than the environmental temperature, the pipe will elongate. 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 Fiber-glass Pipe



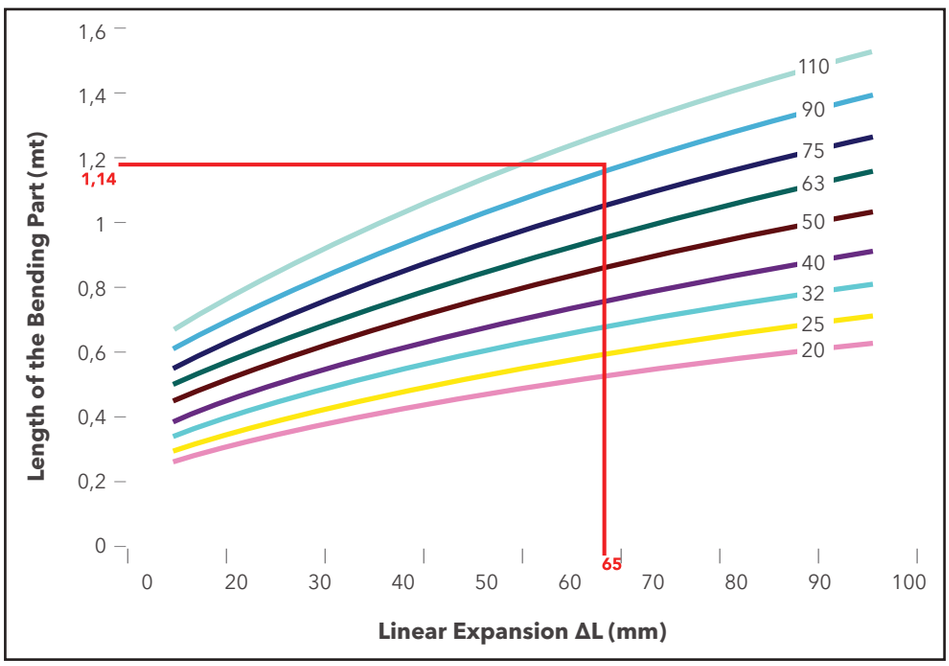
Mounting and Installation

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.



Removing Expansions from Installation

Omega and (U) Elements

Omega and U parts designed for use in hot pipes. As an alternative, metal (belows) compansation also can 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:

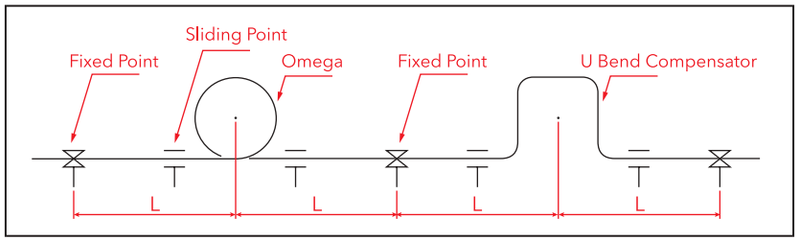


Figure - 1 Omega and U part

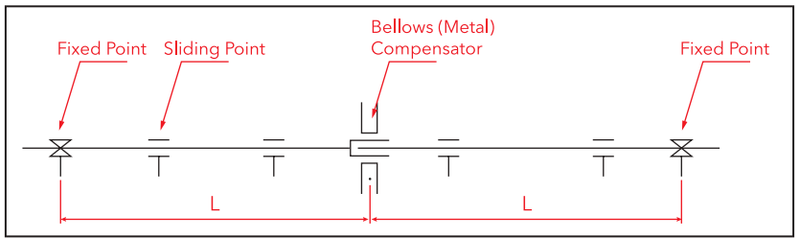


Figure - 2 Metal compansator

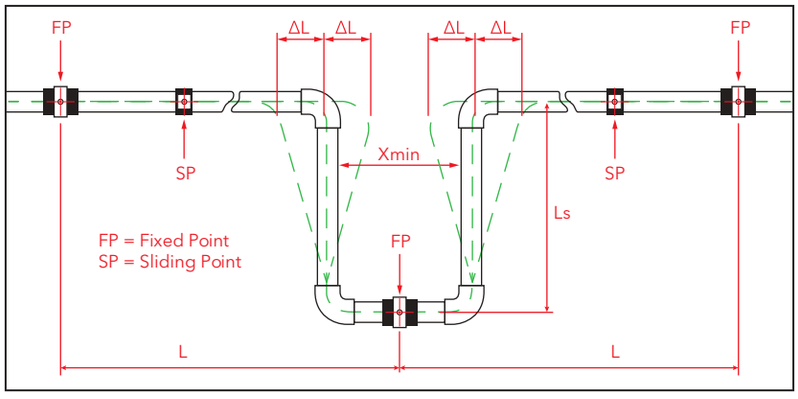


Figure - 3 U part (calculation distance of bending part)

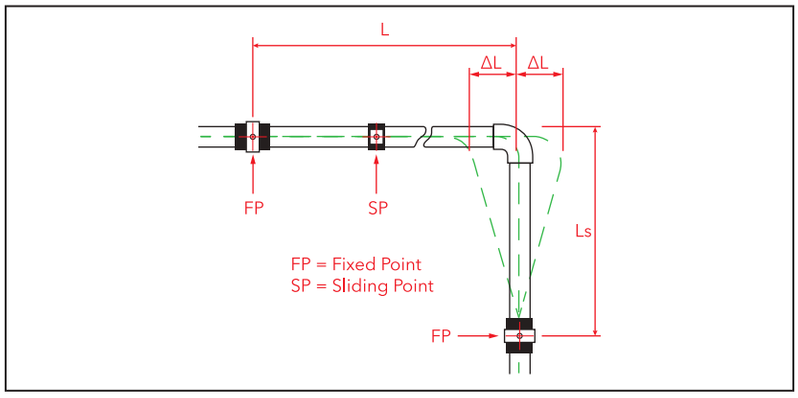


Figure - 4 Calculation distance of bending part

Calculation of Elongation

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

Ls = c x $\sqrt{d \times \Delta L}$.

Ls = Lenght of the bending part mm.

d = Outer dimater of the Kalde pipe mm.

ΔL = Variation of length mm.

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

ΔL = λ x ΔT x L

ΔL = 0.15 x 40 x 12 = 72 mm

2. The calculation of the bending length

d = 63 mm

ΔL = 72 mm

C = 15

Ls = c x $\sqrt{d \times \Delta L}$

Ls = 15 x $\sqrt{63 \times 72}$ = 1010 mm

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

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:

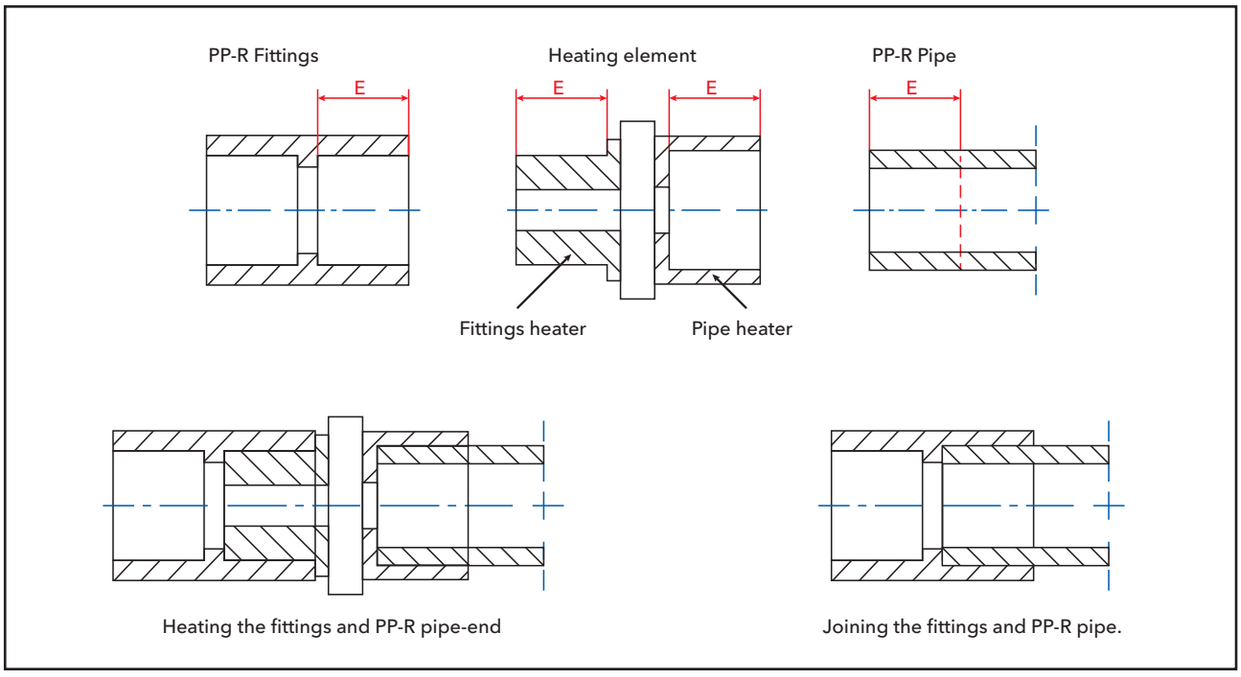
- According to the size of pipes and fittings welding part (Teflon coated) mounted welding machine, welding parts is heated until it ches the temperature (260 ° C ± 10).
- To be welded pipe, pipe cutting scissors cut perpendicular to the axis of the pipe, (outer foil pipes, after cutting proses the on surface of the pipe aluminum foil must shaved with shave aparatus.)
- 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)

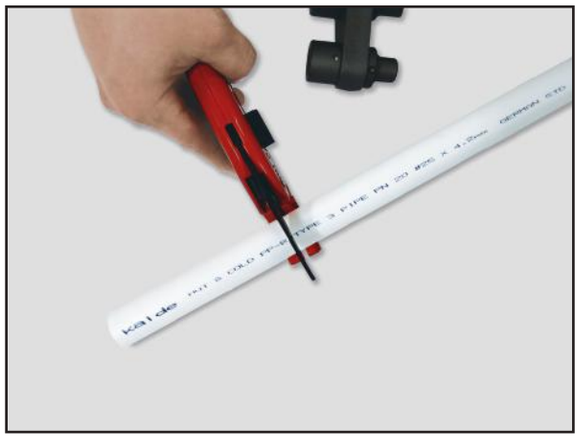
Welding Table

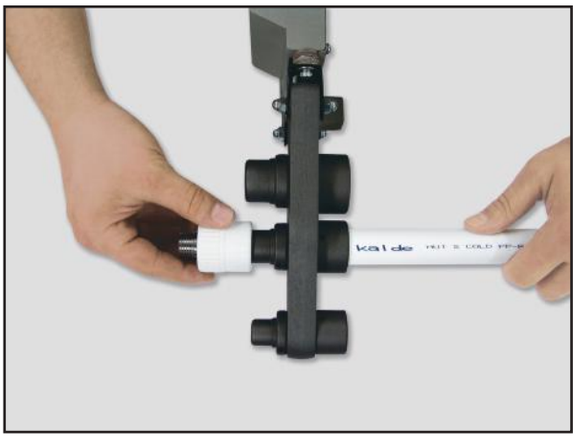
Outer Diameter (mm)	Heating (secs)	Joining (secs)	Cooling Time (minutes)	Welding Length (mm)
20	7	4	2	16
25	7	4	3	18
32	8	6	4	20
40	12	6	4	22
50	18	6	5	26
63	24	8	6	29
75	30	10	8	32
90	40	11	8	38
110	50	12	8	42

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 Fittings
E
Heating element
E
E
PP-R Pipe
E
Fittings heater
Pipe heater
Heating the fittings and PP-R pipe-end
Joining the fittings and PP-R pipe.

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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 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 outher 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 l=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	4 mm
Pipes in wall recess, next to hot pipes	13 mm
Pipes on concrete floor	4 mm
*) for other values of l, 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 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 Refered to Thermal Conductivity of l=0.035 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 l = 0.035 W/mK	Insulation Thickness in Kalde Pipes l = 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

Calculation of Economic Pipe Insulation Material Thickness

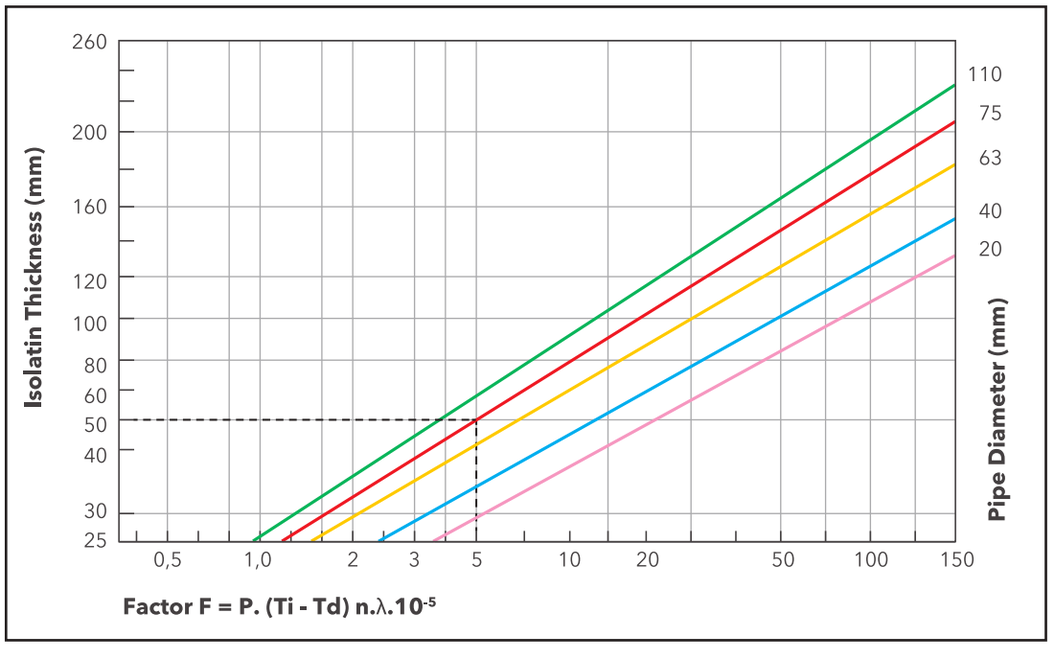
Optimum values of the thickness of the pipe insulation material is shown in chart of economic insulation thickness. Such F factor F = P. (Ti - Td) n.λ.10-5 is calculated by Equation.

where in,
P = Heat energy costs (€ / kWh) in Euro,
n = Annual operating time (hours / year)
λ = Thermal conductivity coefficient of insulation material (W/mk)
Ti = Fluid temperature, °C
Td = 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?

$F = P. (Ti - Td) n. \lambda.10^{-5}$
$F = 30x (80-20) x8000x0.035x10^{-5}$
F = 5.04
Looking at the economic insulation thickness chart (below), only the insulation thickness of 50 mm.

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

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, m²	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

Pressure loss in straight pipes:

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

$\Delta Pd = (\partial . L/d1)(p.v/2) * 10^{-5}$ (bar)
ΔPd = Pipe pressure loss (bar)
∂ = Pipe friction coefficient (for most cases 0,02)
L = Length of pipe (m)
d1 = Inside diameter of pipe (m)
p = Fluid density (kg/m^3)
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. Than 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.

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

Polypropylene Tube and Fittings

PN-20 | Polypropylene Tube

Code	Size	Pcs.
3202-tbe-200000	ø20	100
3202-tbe-250000	ø25	80
3202-tbe-320000	ø32	40
3202-tbe-400000	ø40	32
3202-tbe-500000	ø50	20
3202-tbe-630000	ø63	16
3202-tbe-750000	ø75	12
3202-tbe-900000	ø90	8
3202-tbe-110000	ø110	4
3202-tbe-125000	ø125	4

PN-10 | Polypropylene Tube

Code	Size	Pcs.
3202-tbe-200010	ø20	100
3202-tbe-250010	ø25	80
3202-tbe-320010	ø32	40
3202-tbe-400010	ø40	32
3202-tbe-500010	ø50	20
3202-tbe-630010	ø63	16
3202-tbe-750010	ø75	12
3202-tbe-900010	ø90	8
3202-tbe-110010	ø110	4
3202-tbe-125010	ø125	4

PN-25 | Polypropylene Tube with Fiberglass

Code	Size	Pcs.
3202-tfr-200000	ø20	100
3202-tfr-250000	ø25	80
3202-tfr-320000	ø32	40
3202-tfr-400000	ø40	32
3202-tfr-500000	ø50	20
3202-tfr-630000	ø63	16
3202-tfr-750000	ø75	12
3202-tfr-900000	ø90	8
3202-tfr-110000	ø110	4
3202-tfr-125000	ø125	4

PN-20 | Polypropylene Tube with Fiberglass

Code	Size	Pcs.
3202-tfr-200020	ø20	100
3202-tfr-250020	ø25	80
3202-tfr-320020	ø32	40
3202-tfr-400020	ø40	32
3202-tfr-500020	ø50	20
3202-tfr-630020	ø63	16
3202-tfr-750020	ø75	12
3202-tfr-900020	ø90	8
3202-tfr-110020	ø110	4
3202-tfr-125020	ø125	4

PN-25 | Polypropylene Tube with Supperoxy

Code	Size	Pcs.
3202-tox-200000	ø20	100
3202-tox-250000	ø25	80
3202-tox-320000	ø32	40
3202-tox-400000	ø40	32
3202-tox-500000	ø50	20
3202-tox-630000	ø63	16
3202-tox-750000	ø75	
3202-tox-900000	ø90	
3202-tox-110000	ø110	

PN-20 | Polypropylene Tube with Supperoxy

Code	Size	Pcs.
3202-tox-200020	ø20	100
3202-tox-250020	ø25	80
3202-tox-320020	ø32	40
3202-tox-400020	ø40	32
3202-tox-500020	ø50	20
3202-tox-630020	ø63	16
3202-tox-750020	ø75	
3202-tox-900020	ø90	
3202-tox-110020	ø110	

PP Bridge

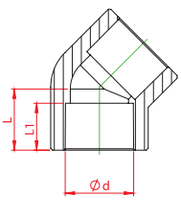
Code	Size	H	Pcs.
3202-twc-200000	ø20	40	140
3202-twc-250000	ø25	50	75
3202-twc-320000	ø32	64	36
3202-twc-400002	ø40	80	25

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

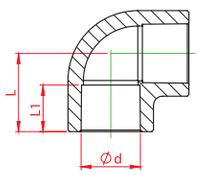
Elbow 45°

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



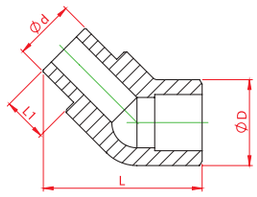
Elbow 90°

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



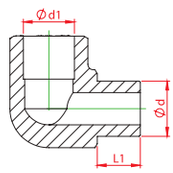
Tail Elbow 45°

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



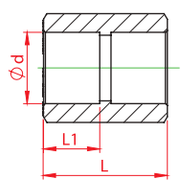
Tail Elbow 90°

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



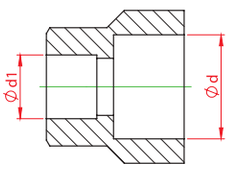
Tail Elbow 90°

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



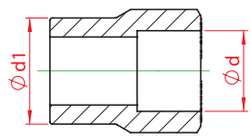
Reducing Female Coupling

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



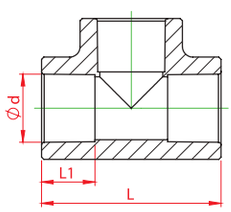
Reducing Coupling

Code	Size	d	d1	Pcs.
3212-rdc-252000	ø25 x 20	19	20	700
3212-rdc-322000	ø32 x 20	19	20	500
3212-rdc-322500	ø32 x 25	24	25	400
3212-rdc-402000	ø40 x 20	19	20	325
3212-rdc-402500	ø40 x 25	24	25	300
3212-rdc-403200	ø40 x 32	31	32	225
3212-rdc-502000	ø50 x 20	19	20	175
3212-rdc-502500	ø50 x 25	24	25	175
3212-rdc-503200	ø50 x 32	31	32	150
3212-rdc-504000	ø50 x 40	39	40	110
3212-rdc-632000	ø63 x 20	19	20	100
3212-rdc-632500	ø63 x 25	24	25	100
3212-rdc-633200	ø63 x 32	31	32	80
3212-rdc-634000	ø63 x 40	39	40	80
3212-rdc-635000	ø63 x 50	48,5	50	56
3212-rdc-752000	ø75 x 20	19	20	70
3212-rdc-752500	ø75 x 25	24	25	70
3212-rdc-753200	ø75 x 32	31	32	55
3212-rdc-754000	ø75 x 40	39	40	55
3212-rdc-755000	ø75 x 50	48,5	50	50
3212-rdc-756300	ø75 x 63	61,5	63	36
3212-rdc-905000	ø90 x 50	48,5	50	36
3212-rdc-906300	ø90 x 63	61,5	63	36
3212-rdc-907500	ø90 x 75	73,5	75	27
3212-rdc-110630	ø110 x 63	61,5	63	16
3212-rdc-110750	ø110 x 75	73,5	75	16
3212-rdc-110900	ø110 x 90	108,5	90	16



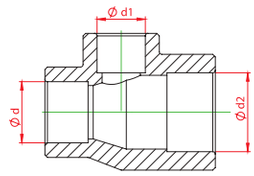
Tee

Code	Size	d	L1	L	Pcs.
3212-teo-200000	ø20	19	14,5	52	350
3212-teo-250000	ø25	24	16	60	200
3212-teo-320000	ø32	31	18	72	100
3212-teo-400000	ø40	39	20,5	86	60
3212-teo-500000	ø50	48,5	23,5	101	30
3212-teo-630000	ø63	61,5	27,5	124	16
3212-teo-750000	ø75	73,5	30	140	12
3212-teo-900000	ø90	88,5	33	160	4
3212-teo-110000	ø110	108,5	37	188	2



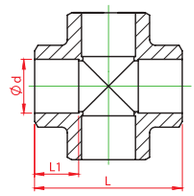
Inegal Tee

Code	Size	d	d2	d1	Pcs.
3212-tio-202520	ø20 x 25 x 20	19	19	24	250
3212-tio-252020	ø25 x 20 x 20	24	19	19	225
3212-tio-252025	ø25 x 20 x 25	24	24	19	240
3212-tio-252520	ø25 x 25 x 20	24	19	24	200
3212-tio-253225	ø25 x 32 x 25	24	24	31	120
3212-tio-322020	ø32 x 20 x 20	31	19	19	130
3212-tio-322025	ø32 x 20 x 25	31	24	19	125
3212-tio-322032	ø32 x 20 x 32	31	31	19	115
3212-tio-322520	ø32 x 25 x 20	31	19	24	125
3212-tio-322525	ø32 x 25 x 25	31	24	24	120
3212-tio-322532	ø32 x 25 x 32	31	31	24	115
3212-tio-323225	ø32 x 32 x 25	31	24	31	120
3212-tio-402040	ø40 x 20 x 40	39	39	19	80
3212-tio-402540	ø40 x 25 x 40	39	39	24	80
3212-tio-403240	ø40 x 32 x 40	39	39	31	65
3212-tio-502050	ø50 x 20 x 50	48,5	48,5	19	40
3212-tio-502550	ø50 x 25 x 50	48,5	48,5	24	40
3212-tio-503250	ø50 x 32 x 50	48,5	48,5	31	36
3212-tio-504050	ø50 x 40 x 50	48,5	48,5	39	36
3212-tio-632063	ø63 x 20 x 63	61,5	61,5	19	24
3212-tio-632563	ø63 x 25 x 63	61,5	61,5	24	24
3212-tio-633263	ø63 x 32 x 63	61,5	61,5	31	24
3212-tio-634063	ø63 x 40 x 63	61,5	61,5	39	20
3212-tio-635063	ø63 x 50 x 63	61,5	61,5	48,5	20
3212-tio-752075	ø75 x 20 x 75	73,5	73,5	19	12
3212-tio-752575	ø75 x 25 x 75	73,5	73,5	24	12
3212-tio-753275	ø75 x 32 x 75	73,5	73,5	31	12
3212-tio-754075	ø75 x 40 x 75	73,5	73,5	39	12
3212-tio-755075	ø75 x 50 x 75	73,5	73,5	48,5	12
3212-tio-756375	ø75 x 63 x 75	73,5	73,5	61,5	12
3212-tio-905090	ø90 x 50 x 90	88,5	88,5	48,5	6
3212-tio-906390	ø90 x 63 x 90	88,5	88,5	61,5	6
3212-tio-115011	ø110 x 50 x 110	108,5	108,5	48,5	3
3212-tio-116311	ø110 x 63 x 110	108,5	108,5	61,5	3



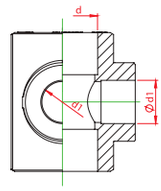
Cross

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



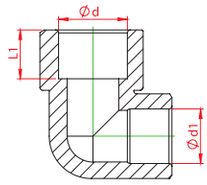
Cross Tee

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



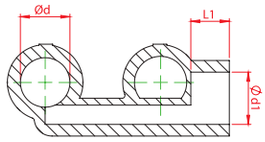
Reduction Elbow

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



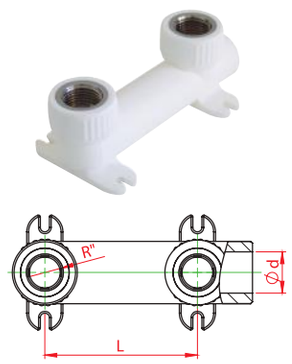
Tee Branch

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



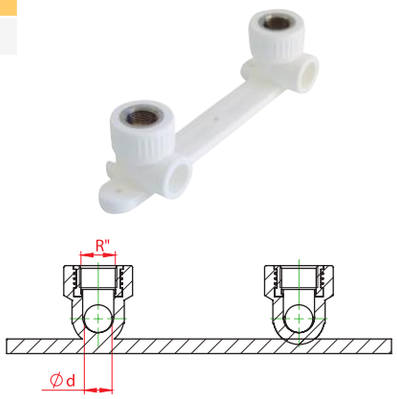
Wallplate Elbow - Double

Code	Size	d	R"	L	Pcs.
3222-btt-200b00	ø20 x 1/2"	19	1/2"	90	60
3222-btt-250b00	ø25 x 1/2"	24	1/2"	90	55



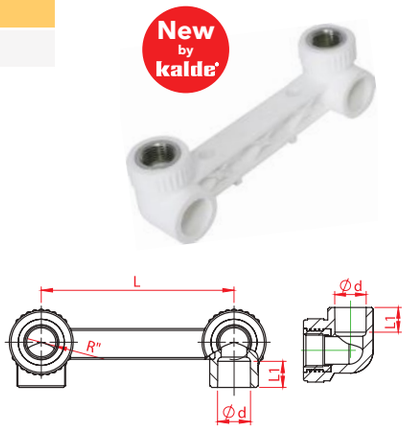
Special Wallplate Elbow - Double

Code	Size	d	R"	Pcs.
3222-bat-200b04	ø20 x 1/2"	19	1/2"	48
3222-bat-250b04	ø25 x 1/2"	24	1/2"	48



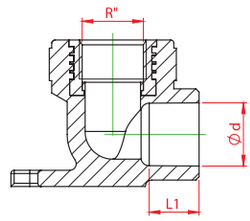
Special Wallplate Elbow - Double Grilled

Code	Size	d	R"	L1	L	Pcs.
3222-bat-200b05	ø20 x 1/2"	19	1/2"	14,5	150	56
3222-bat-250b05	ø25 x 1/2"	24	1/2"	16	150	50



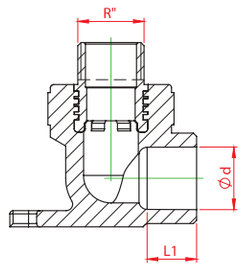
Wallplate Elbow Female

Code	Size	d	R"	L1	Pcs.
3222-bat-200b01	ø20 x 1/2"	19	1/2"	14,5	100
3222-bat-250b01	ø25 x 1/2"	24	1/2"	16	80
3222-bat-250c01	ø25 x 3/4"	24	3/4"	16	80



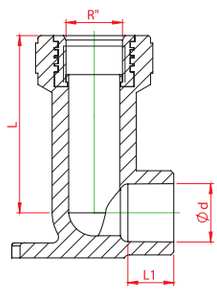
Wallplate Elbow Male

Code	Size	d	R"	L1	Pcs.
3222-btm-200b00	ø20 x 1/2"	19	1/2"	14,5	100



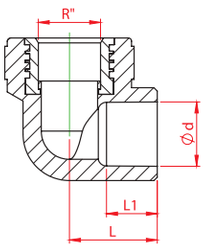
Wallplate Elbow Female - Long

Code	Size	d	R"	L1	L	Pcs.
3222-btl-200b00	ø20 x 1/2"	19	1/2"	14,5	63,5	75



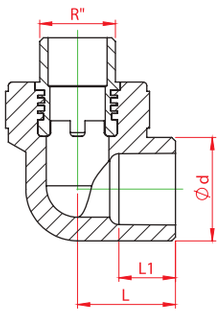
Female Elbow

Code	Size	d	R"	L1	L	Pcs.
3222-efo-200b00	ø20 x 1/2"	19	1/2"	15	30	160
3222-efo-200c00	ø20 x 3/4"	19	3/4"	15	29,5	130
3222-efo-250b00	ø25 x 1/2"	24	1/2"	17	31,5	120
3222-efo-250c00	ø25 x 3/4"	24	3/4"	17	33,5	100
3222-efo-320c00	ø32 x 3/4"	31	3/4"	19	43,5	60
3222-efo-321000	ø32 x 1"	31	1"	19	43,5	56
3222-efo-401a06	ø40 x 1 1/4"	39	1 1/4"	22	55	28



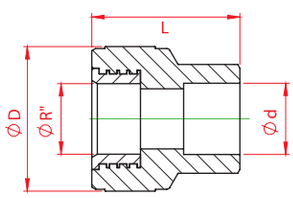
Male Elbow

Code	Size	d	R"	L1	L	Pcs.
3222-emo-200b00	ø20 x 1/2"	19	1/2"	15	50	150
3222-emo-200c00	ø20 x 3/4"	19	3/4"	15	50	110
3222-emo-250b00	ø25 x 1/2"	24	1/2"	17	50	110
3222-emo-250c00	ø25 x 3/4"	24	3/4"	17	53	100
3222-emo-320c00	ø32 x 3/4"	31	3/4"	19	64	60
3222-emo-321000	ø32 x 1"	31	1"	19	64	50
3222-emo-401a06	ø40 x 1 1/4"	39	1 1/4"	22	64	24



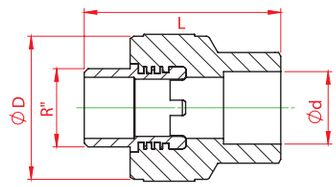
Female Nipple

Code	Size	d	R"	D	L	Pcs.
3222-nfo-200b00	ø20 x 1/2"	19	1/2"	38,5	39,5	200
3222-nfo-200c00	ø20 x 3/4"	19	3/4"	42,5	37	180
3222-nfo-250b00	ø25 x 1/2"	24	1/2"	37,5	36,5	200
3222-nfo-250c00	ø25 x 3/4"	24	3/4"	44	38,5	150
3222-nfo-320b00	ø32 x 1/2"	31	1/2"	47,5	40,5	110
3222-nfo-320c00	ø32 x 3/4"	31	3/4"	47,5	40,5	110
3222-nfo-321000	ø32 x 1"	31	1"	53	44	90



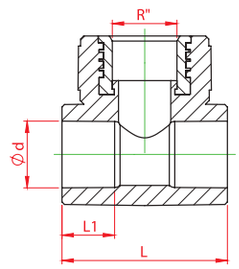
Male Nipple

Code	Size	d	R"	D	L	Pcs.
3222-nmo-200b00	ø20 x 1/2"	19	1/2"	37	46,5	200
3222-nmo-200c00	ø20 x 3/4"	19	3/4"	42,5	49,5	150
3222-nmo-250b00	ø25 x 1/2"	24	1/2"	37,5	49	180
3222-nmo-250c00	ø25 x 3/4"	24	3/4"	42	49,5	140
3222-nmo-320b00	ø32 x 1/2"	31	1/2"	47,5	52	100
3222-nmo-320c00	ø32 x 3/4"	31	3/4"	47,5	52,5	100
3222-nmo-321000	ø32 x 1"	31	1"	48	53,5	90



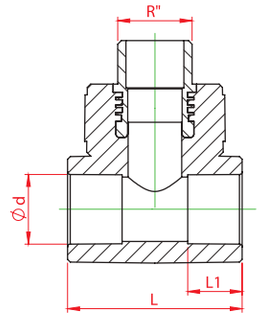
Female Tee

Code	Size	d	R"	L1	L	Pcs.
3222-tfo-200b20	ø20 x 1/2" x 20	19	1/2"	14,5	48	125
3222-tfo-200c20	ø20 x 3/4" x 20	19	3/4"	14,5	60	100
3222-tfo-250b25	ø25 x 1/2" x 25	24	1/2"	16	57	100
3222-tfo-250c25	ø25 x 3/4" x 25	24	3/4"	16	65	80
3222-tfo-320c32	ø32 x 3/4" x 32	31	3/4"	18	72	45
3222-tfo-321032	ø32 x 1" x 32	31	1"	18	76	40
3222-tfo-401a40	ø40 x 1 1/4" x 40	39	1 1/4"	20,5	98	20



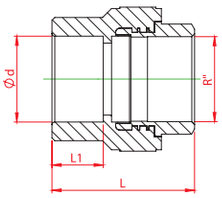
Male Tee

Code	Size	d	R"	L1	L	Pcs.
3222-tmo-200b20	ø20 x 1/2" x 20	19	1/2"	14,5	48	120
3222-tmo-200c20	ø20 x 3/4" x 20	19	3/4"	14,5	60	90
3222-tmo-250b25	ø25 x 1/2" x 25	24	1/2"	16	57	100
3222-tmo-250c25	ø25 x 3/4" x 25	24	3/4"	16	65	80
3222-tmo-320c32	ø32 x 3/4" x 32	31	3/4"	18	72	45
3222-tmo-321032	ø32 x 1" x 32	31	1"	18	76	40
3222-tmo-401a40	ø40 x 1 1/4" x 40	39	1 1/4"	20,5	98	18



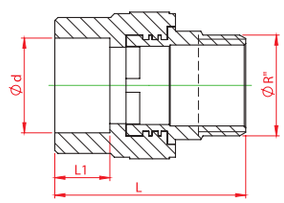
Female Nipple - Octa

Code	Size	d	R"	L1	L	Pcs.
3222-nfo-321006	ø32 x 1"	31	1"	18	56	70
3222-nfo-401a06	ø40 x 1 1/4"	39	1 1/4"	20,5	58,5	40
3222-nfo-501b06	ø50 x 1 1/2"	48,5	1 1/2"	23,5	63	30
3222-nfo-632006	ø63 x 2"	61,5	2"	27,5	73	18
3222-nfo-752b06	ø75 x 2 1/2"	73,5	2 1/2"	30	77,5	12
3222-nfo-903006	ø90 x 3"	88,5	3"	33	93,5	7
3222-nfo-110406	ø110 x 4"	108,5	4"	37	100	3



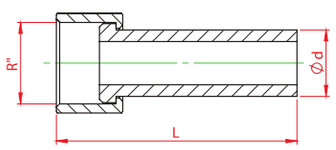
Male Nipple - Octa

Code	Size	d	R"	L1	L	Pcs.
3222-nmo-321006	ø32 x 1"	31	1"	18	62,5	80
3222-nmo-401a06	ø40 x 1 1/4"	39	1 1/4"	20,5	71	36
3222-nmo-501b06	ø50 x 1 1/2"	48,5	1 1/2"	23,5	76	36
3222-nmo-632006	ø63 x 2"	61,5	2"	27,5	88	15
3222-nmo-752b06	ø75 x 2 1/2"	73,5	2 1/2"	30	99	8
3222-nmo-903006	ø90 x 3"	88,5	3"	33	116	6
3222-nmo-110406	ø110 x 4"	108,5	4"	37	128	3



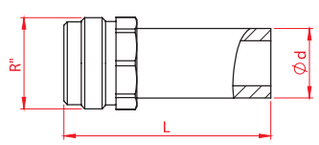
Transition Nipple - Female

Code	Size	d	R"	L	Pcs.
3252-tnf-200c00	ø20 x 3/4"	19	3/4"	60	200
3252-tnf-251000	ø25 x 1"	24	1"	65	200
3252-tnf-321a00	ø32 x 1 1/4"	31	1 1/4"	70	125



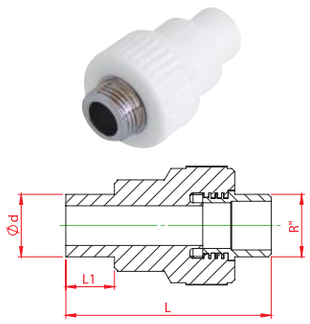
Transition Nipple - Male

Code	Size	d	R"	L	Pcs.
3252-tnm-200c00	ø20 x 3/4"	31	3/4"	60	200
3252-tnm-251000	ø25 x 1"	39	1"	65	200
3252-tnm-321a00	ø32 x 1 1/4"	48,5	1 1/4"	70	150



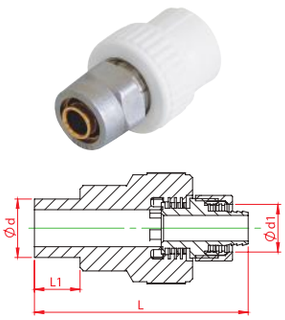
Male Tail Nipple

Code	Size	d	R"	L1	L	Pcs.
3222-nmo-200b01	ø20 x 1/2"	20,5	1/2"	14,5	64,5	100
3222-nmo-250c01	ø25 x 3/4"	25,5	3/4"	16	67,5	80



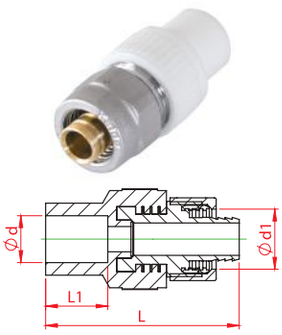
Female Nipple for PE-X Connection

Code	Size	d	d1	L1	L	Pcs.
3222-nfo-200b16	ø20 x 16	19	20,4	14,5	63,5	180



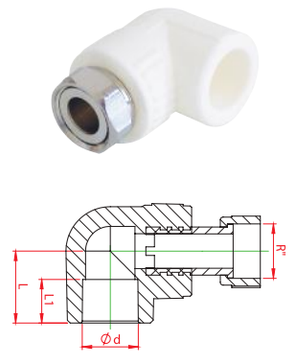
Male Nipple for PE-X Connection

Code	Size	d	d1	L1	L	Pcs.
3222-nmt-200b16	ø20 x 16	20,5	20,9	14,5	52,5	250



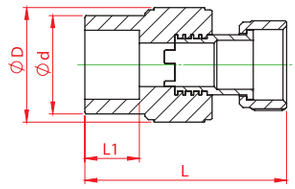
Elbow with Loose Nut

Code	Size	d	R"	L1	L	Pcs.
3222-tue-200b00	ø20 x 1/2"	19	1/2"	14,5	25	180
3222-tue-200c00	ø20 x 3/4"	19	3/4"	14,5	27	150
3222-tue-250c00	ø25 x 3/4"	24	3/4"	16	29	100
3222-tue-251000	ø25 x 1"	24	1"	16	29	80
3222-tue-321000	ø32 x 1"	31	1"	18	36	50
3222-tue-321a00	ø32 x 1 1/4"	31	1 1/4"	18	38	40



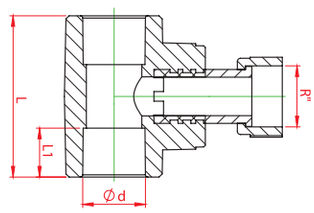
Nipple with Loose Nut

Code	Size	d	D	L1	L	Pcs.
3222-tun-200b00	ø20 x 1/2"	19	30,5	14,5	53	210
3222-tun-200c00	ø20 x 3/4"	19	30,5	14,5	55	210
3222-tun-250c00	ø25 x 3/4"	24	36	16	56	150
3222-tun-251000	ø25 x 1"	24	47,5	16	60	80
3222-tun-321000	ø32 x 1"	31	47,5	18	60,5	80
3222-tun-321a00	ø32 x 1 1/4"	31	47,5	18	61	80



Tee with Loose Nut

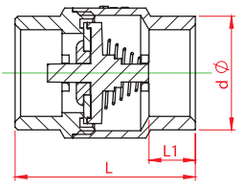
Code	Size	d	R"	L1	L	Pcs.
3222-tut-200b00	ø20 x 1/2" x 20	19	1/2"	14,5	43,5	150
3222-tut-200c00	ø20 x 3/4" x 20	19	3/4"	14,5	65	80
3222-tut-250c00	ø25 x 3/4" x 25	24	3/4"	16	65	60
3222-tut-251000	ø25 x 1" x 25	24	1"	16	65	60
3222-tut-321000	ø32 x 1" x 32	31	1"	18	76	40
3222-tut-321a00	ø32 x 1 1/4" x 32	31	1 1/4"	18	76	30



Check Valve

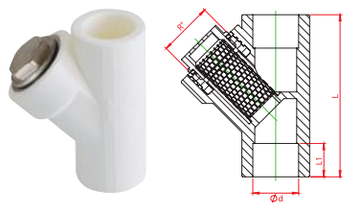
Code	Size	d	L1	L	Pcs.
3222-cvl-0b0000	ø20	19	14,5	58	100
3222-cvl-0c0000	ø25	24	16	61,5	60

New by kalde



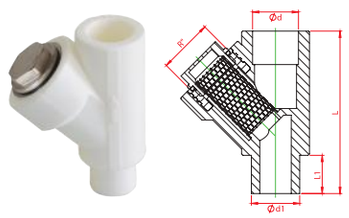
Filter - Female / Female

Code	Size	d	R"	L1	L	Pcs.
3222-flt-200001	ø20	19	1/2"	14,5	66,5	100
3222-flt-250001	ø25	24	3/4"	16	85	60
3222-flt-320001	ø32	31	1"	18	95	30



Filter - Male / Female

Code	Size	d	d1	R"	L1	L	Pcs.
3222-flt-200000	ø20	19	20	1/2"	14,5	65	100
3222-flt-250000	ø25	24	25	3/4"	16	71	60
3222-flt-320000	ø32	31	32	1"	18	98	30



Sealed Filter - Female / Female

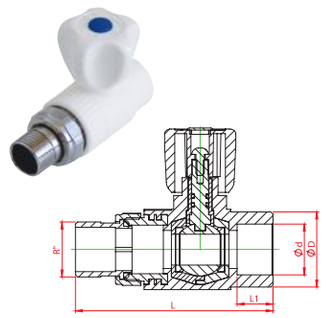
Code	Size	d	d1	R"	L1	L	Pcs.
3222-fls-200001	ø20	19	19	1/2"	14,5	66,5	100
3222-fls-250001	ø25	24	24	3/4"	16	85	60
3222-fls-320001	ø32	31	31	1"	18	95	30

Sealed Filter - Male / Female

Code	Size	d	d1	R"	L1	L	Pcs.
3222-fls-200000	ø20	19	20	1/2"	14,5	65	100
3222-fls-250000	ø25	24	25	3/4"	16	71	50
3222-fls-320000	ø32	31	32	1"	18	98	30

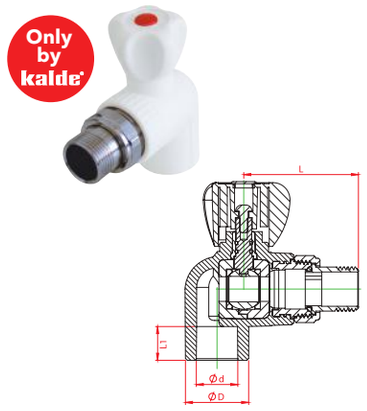
Ball Valve for Radiator - Straight

Code	Size	d	D	R"	L1	L	Pcs.
3242-vlr-200b00	ø20 x 1/2"	19	28	1/2"	14,5	85	60
3242-vlr-200c00	ø20 x 3/4"	19	28	3/4"	14,5	90	60
3242-vlr-250b00	ø25 x 1/2"	24	35	1/2"	16	90	60
3242-vlr-250c00	ø25 x 3/4"	24	35	3/4"	16	90	50



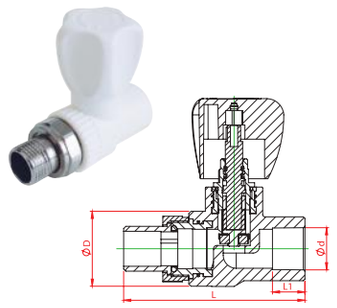
Ball Valve for Radiator - Elbow

Code	Size	d	D	L1	L	Pcs.
3242-vre-200b00	ø20 x 1/2"	19	28	14,5	55	60
3242-vre-200c00	ø20 x 3/4"	19	28	14,5	56,5	50
3242-vre-250b00	ø25 x 1/2"	24	35	16	54	50
3242-vre-250c00	ø25 x 3/4"	24	35	16	57	40



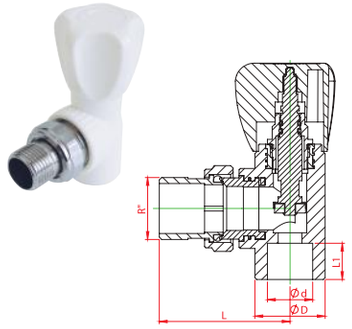
Valve for Radiator - Straight

Code	Size	d	D	L1	L	Pcs.
3242-vsr-200b00	ø20 x 1/2"	19	28	14,5	85	60



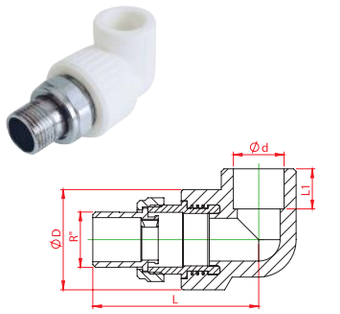
Valve for Radiator - Elbow

Code	Size	d	D	R"	L1	L	Pcs.
3242-vse-200b00	ø20 x 1/2"	19	28	1/2"	14,5	57	60



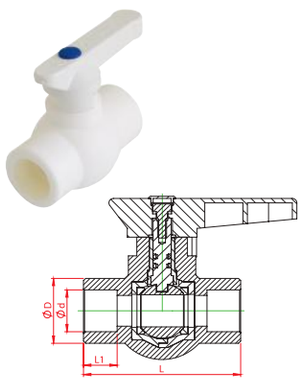
Elbow with Transition Union for Radiator

Code	Size	d	D	R"	L1	L	Pcs.
3222-tre-200b00	ø20 x 1/2"	19	34	1/2"	14,5	68	100



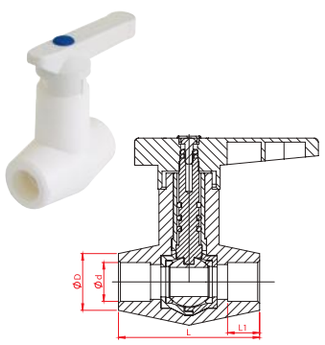
Ball Valve

Code	Size	d	D	L1	L	Pcs.
3242-vlb-200003	ø20	19	29	14,5	63,5	60
3242-vlb-250003	ø25	24	34,5	16	71,8	50
3242-vlb-320003	ø32	31	45,5	18	85	25
3242-vlb-400003	ø40	39	56	20,5	108	15
3242-vlb-500003	ø50	48,5	69	23,5	120	10
3242-vlb-630003	ø63	61,5	87	27,5	143	6
3242-vlb-750003	ø75	73,5	99	30	150,5	5



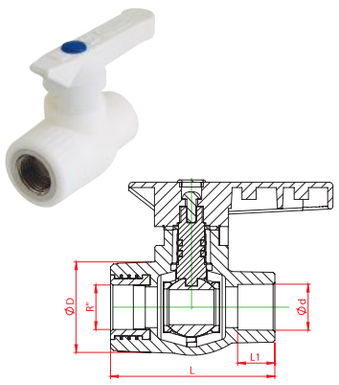
Ball Valve - Long

Code	Size	d	D	L1	L	Pcs.
3242-vlb-200002	ø20	19	33,5	14,5	69,5	40
3242-vlb-250002	ø25	24	38	16	78,5	30



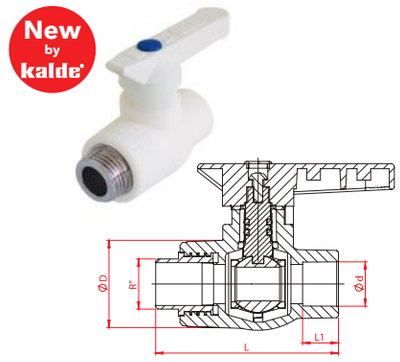
Ball Valve with Female Nipple

Code	Size	d	D	R"	L1	L	Pcs.
3242-vlb-200b04	ø20 x 1/2"	19	36,5	1/2"	14,5	65	55
3242-vlb-250c04	ø25 x 3/4"	24	42	3/4"	16	76,5	45
3242-vlb-321004	ø32 x 1"	31	48	1"	18	87	20



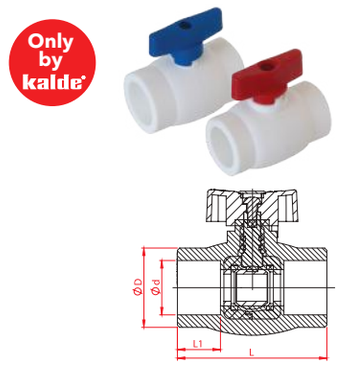
Ball Valve with Male Nipple

Code	Size	d	D	R"	L1	L	Pcs.
3242-vlb-200b05	ø20 x 1/2"	19	36,5	1/2"	14,5	77,5	50
3242-vlb-250c05	ø25 x 3/4"	24	42	3/4"	16	83	40



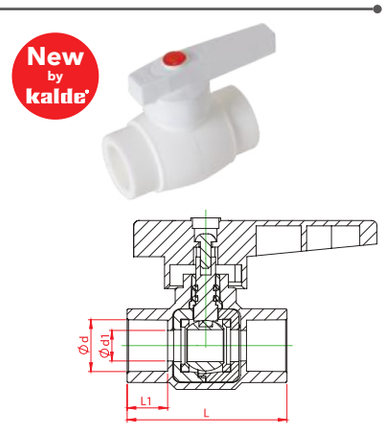
Mini Ball Valve - Buterfly

Code	Size	d	D	L1	L	Pcs.
3242-vlm-200001	ø20 ●	19	11,5	14,5	60	120
3242-vlm-200002	ø20 ●	19	11,5	14,5	60	120
3242-vlm-250001	ø25 ●	24	14	16	64,5	80
3242-vlm-250002	ø25 ●	24	14	16	64,5	80
3242-vlm-320001	ø32 ●	31	16,5	18	74,5	40
3242-vlm-320002	ø32 ●	31	16,5	18	74,5	40



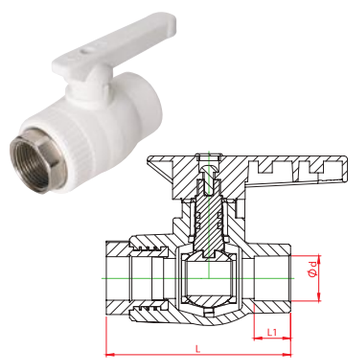
Mini Ball Valve

Code	Size	d	d1	L1	L	Pcs.
3242-vlm-200000	ø20	19	11,5	14,5	60	100
3242-vlm-250000	ø25	24	14	16	64,5	75
3242-vlm-320000	ø32	31	16,5	18	74,5	40



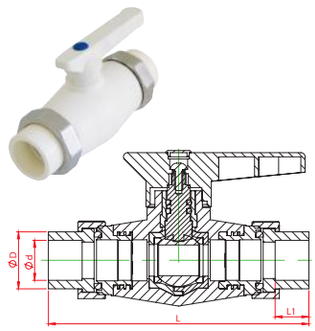
Femail Ball Valve - Hexagonal

Code	Size	d	L1	L	Pcs.
3242-vlb-321104	ø32 x 1"	31	18	86	20



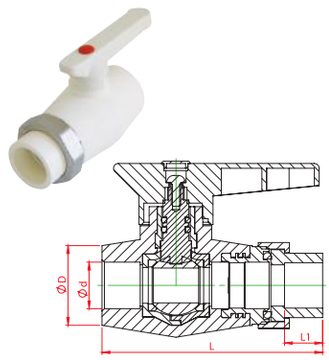
Ball Valve with Double Transtion Union

Code	Size	d	D	L1	L	Pcs.
3242-vlb-200005	ø20	19	27	14,5	120	40
3242-vlb-250005	ø25	24	34	16	129	30
3242-vlb-320005	ø32	31	40	18	150	20
3242-vlb-400005	ø40	39	41	20,5	181	10
3242-vlb-500005	ø50	48,5	64,5	23,5	204	6



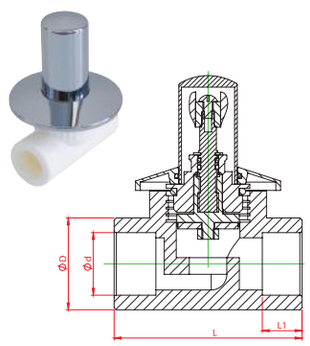
Ball Valve with Single Transtion Union

Code	Size	d	D	L1	L	Pcs.
3242-vlb-200006	ø20	19	32	14,5	90	45
3242-vlb-250006	ø25	24	38	16	95	35
3242-vlb-320006	ø32	31	48,5	18	115	25



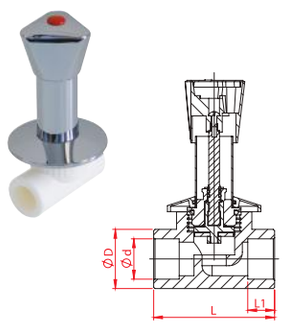
Chrome-Plated Valve - Hidden

Code	Size	d	D	L1	L	Pcs.
3242-vle-200000	ø20 x 1/2"	19	29	14,5	72	45
3242-vle-250000	ø25 x 3/4"	24	35	16	73	35
3242-vle-320000	ø32 x 1"	31	44	18	89	25



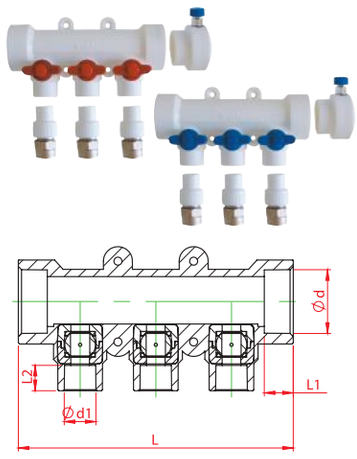
Chrome-Plated Valve

Code	Size	d	D	L1	L	Pcs.
3242-vlk-200000	ø20 x 1/2"	19	29	14,5	72	30
3242-vlk-250000	ø25 x 3/4"	24	35	16	73	25
3242-vlk-320000	ø32 x 1"	31	44	18	89	20



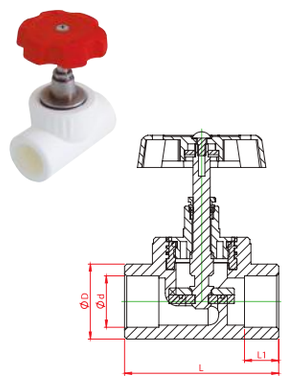
PP Manifold

Code	Size	d1	d	L2	L1	L	Pcs.
932-set-1400220	2 ways	19	39	14,5	18	122	9
932-set-1400320	3 ways	19	39	14,5	18	169	6
932-set-1400420	4 ways	19	39	14,5	18	218	5
932-set-1400520	5 ways	19	39	14,5	18	261	4
932-set-1400620	6 ways	19	39	14,5	18	309	3
932-set-1400720	7 ways	19	39	14,5	18	358	3
932-set-1400820	8 ways	19	39	14,5	18	398	3



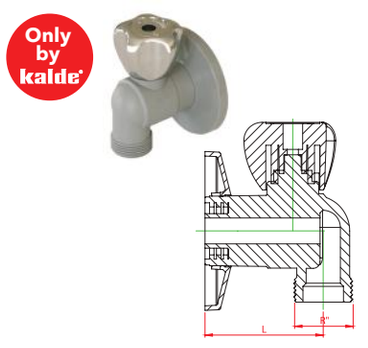
Valve

Code	Size	d	D	L1	L	Pcs.
3242-vlf-200000	ø20	19	29	14,5	72	40
3242-vlf-250000	ø25	24	35	16	73	30
3242-vlf-320000	ø32	31	44	18	89	20
3242-vlf-400000	ø40	39	55	20,5	101	15



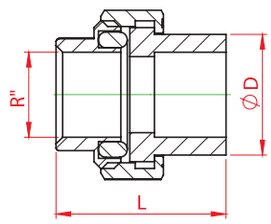
Valve - Laundry

Code	Size	R"	L	Pcs.
3243-vlc-0b0c00	ø1/2" x 3/4"	1/2"	63	45



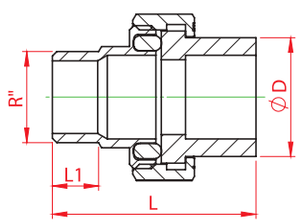
Transition Union - Female

Code	Size	D	R"	L	Pcs.
3272-tuf-200b00	ø20 x 1/2"	27	1/2"	38,5	200
3272-tuf-250c00	ø25 x 3/4"	34	3/4"	43,5	120
3272-tuf-321000	ø32 x 1"	40	1"	46,5	80
3272-tuf-401a00	ø40 x 1 1/4"	51	1 1/4"	50	50
3252-tuf-200b00	ø20 x 1/2"	27	1/2"	36,5	200
3252-tuf-200c00	ø20 x 3/4"	27	3/4"	39	200
3252-tuf-250b00	ø25 x 1/2"	34	1/2"	41	120
3252-tuf-250c00	ø25 x 3/4"	34	3/4"	41	100
3252-tuf-251000	ø25 x 1"	34	1"	44,5	120
3252-tuf-320c00	ø32 x 3/4"	40	3/4"	42,5	100
3252-tuf-321000	ø32 x 1"	40	1"	44	80
3252-tuf-321a00	ø32 x 1 1/4"	40	1 1/4"	48	80
3252-tuf-401a00	ø40 x 1 1/4"	51	1 1/4"	49,5	50
3252-tuf-501b00	ø50 x 1 1/2"	64,5	1 1/2"	53	36
3252-tuf-632000	ø63 x 2"	82	2"	64	14
3252-tuf-752b00	ø75 x 2 1/2"	97,5	2 1/2"	72,5	12
3252-tuf-903000	ø90 x 3"	117	3"	79	6
3252-tuf-110400	ø110 x 4"	145	4"	89	3



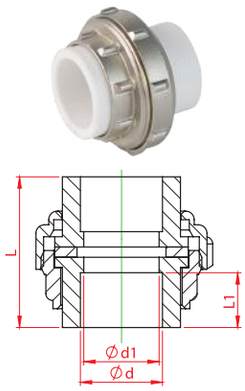
Transition Union - Male

Code	Size	D	R"	L1	L	Pcs.
3272-tum-200b00	ø20 x 1/2"	27	1/2"	14,5	51	200
3272-tum-250c00	ø25 x 3/4"	34	3/4"	16	56	120
3272-tum-321000	ø32 x 1"	40	1"	18	54,6	80
3272-tum-401a00	ø40 x 1 1/4"	51	1 1/4"	20,5	60,5	40
3252-tum-200b00	ø20 x 1/2"	27	1/2"	14,5	45	180
3252-tum-200c00	ø20 x 3/4"	27	3/4"	14,5	45	200
3252-tum-250b00	ø25 x 1/2"	34	1/2"	16	50	120
3252-tum-250c00	ø25 x 3/4"	34	3/4"	16	56,5	100
3252-tum-251000	ø25 x 1"	34	1"	16	50	100
3252-tum-320c00	ø32 x 3/4"	40	3/4"	18	51,5	80
3252-tum-321000	ø32 x 1"	40	1"	18	59,5	70
3252-tum-321a00	ø32 x 1 1/4"	40	1 1/4"	18	59,5	70
3252-tum-401a00	ø40 x 1 1/4"	51	1 1/4"	20,5	60,5	40
3252-tum-501b00	ø50 x 1 1/2"	64,5	1 1/2"	23,5	64	30
3252-tum-632000	ø63 x 2"	82	2"	27,5	76	14
3252-tum-752b00	ø75 x 2 1/2"	97,5	2 1/2"	30	97	8
3252-tum-903000	ø90 x 3"	117	3"	33	105	5
3252-tum-110400	ø110 x 4"	145	4"	37	113	3



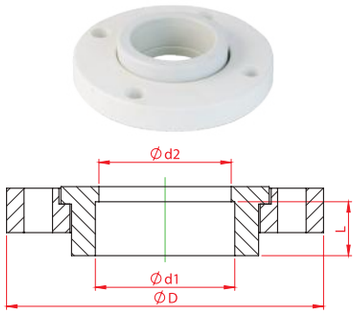
Coupling with Loose Nut

Code	Size	d	d1	L1	L	Pcs.
3252 -mft- 200000	ø20	19	17	14,5	44	150
3252 -mft- 250000	ø25	24	22,5	16	49,5	90
3252 -mft- 320000	ø32	31	29,5	18	53	60



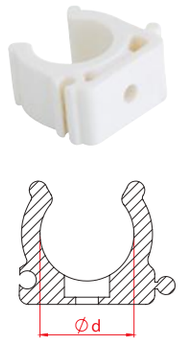
Flange Set

Code	Size	d1	d2	D	L	Pcs.
3222-sls-500000	ø50	48,5	44,5	160	24	25
3222-sls-630000	ø63	61,5	54	160	28	15
3222-sls-750000	ø75	73,5	69	176,5	30,5	10
3222-sls-900000	ø90	88,5	83	197	34	10
3222-sls-110000	ø110	108,5	103	217,5	40	6



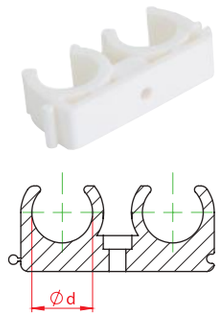
Single Bracket

Code	Size	d	Pcs.
3592-bck-160001	ø16	16	5000
3592-bck-202201	ø20 x 22	20	5000
3592-bck-252701	ø25 x 27	25	5000
3592-bck-323401	ø32 x 34	32	2000
3592-bck-404201	ø40 x 42	40	2000
3592-bck-505201	ø50 x 52	50	1500



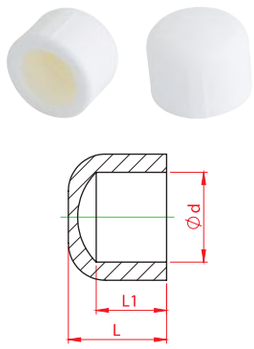
Double Bracket

Code	Size	d	Pcs.
3592-bck-160000	ø16 x 16	16	3000
3592-bck-202200	ø20 x 22	20	2500
3592-bck-252700	ø25 x 27	25	2000
3592-bck-323400	ø32 x 34	32	1000



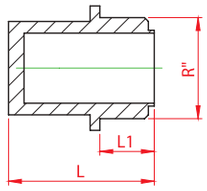
Stopend

Code	Size	d	L1	L	Pcs.
3292-ste-200000	ø20	19	14,5	24,5	1125
3292-ste-250000	ø25	24	16	26	750
3292-ste-320000	ø32	31	18	31	375
3292-ste-400000	ø40	39	20,5	36	220
3292-ste-500000	ø50	48,5	23,5	43	115
3292-ste-630000	ø63	61,5	27,5	48,5	60
3292-ste-750000	ø75	73,5	30	63	36
3292-ste-900000	ø90	88,5	33	68	24
3292-ste-110000	ø110	108,5	37	76,5	12



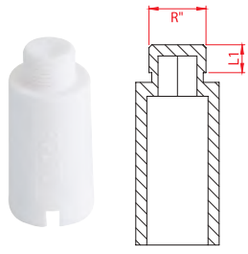
Stopend

Code	Size	R"	L1	L	Pcs.
3292-ste-200b00	ø20 x 1/2"	19	12,5	37,5	800
3292-ste-250c00	ø25 x 3/4"	24	14	35	600
3292-ste-321000	ø32 x 1"	31	16	38	400



Stopend

Code	Size	R"	L1	Pcs.
3292-stu-200000	ø20 x 1/2"	1/2"	10	275

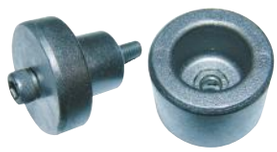


Welding Machine

Code	Size	Pcs.
3292-wmh-000001	Standard	
3292-wmh-000000	Model 2006	5

Welding Apparatus

Code	Size	Pcs.
3292-die-200000	ø20	1
3292-die-250000	ø25	1
3292-die-320000	ø32	1
3292-die-400000	ø40	1
3292-die-500000	ø50	1
3292-die-630000	ø63	1
3292-die-750000	ø75	1
3292-die-900000	ø90	1
3292-die-110000	ø110	1



Tube Sharpener

Code	Size	Pcs.
3292-shv-202500	ø20 x 25	
3292-shv-324000	ø32 x 40	
3292-shv-506300	ø50 x 63	
3292-shv-759000	ø75 x 90	

Scissors

Code	Size	Pcs.
3592-sss-000002	16 / 42	100
3592-sss-000003	16 / 42 Automatic	50

Notes

Notes

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