1.1 The Scope

K-Aqua products offer a superior German quality piping system, that could be equally installed in the residential and the industrial field:

- Sanitary applications.
- Heating & air-conditioning systems.
- Compressed air installations.
- Watering systems for greenhouses and gardens.
- Transporting liquid material.

For calculating the resistance, lifespan and safety of the **K-Aqua** system, depending on the average working temperature:

PN 20	10 bar	70° C

The **K-Aqua** system should last for a minimum of 50 years. **K-Aqua** is an excellent choice for piping of clean hot & cold water.

- Potable water application
- Heating system construction
- Climate technology
- Chilled water technology
- Swimming-pool technology
- Chemical transport due to high chemical resistance
- Rainwater application
- Irrigation
- Compressed air systems
- Under- floor- heating- systems
- Application in the field of ship building
- Agriculture

1.2 Chemical Resistance

K-Aqua is a polyolefin polymer that features a high molecular weight. Therefore, it is more resistant to chemicals such as: acid, lime or cement. See table of chemical resistance. The resistance of **K-Aqua** products which are not submitted to the following factors: mechanical stress, various fluids, 20, 60 and 100° C temperatures according to ISO TR10358:1993.

1.3 Resistance to Current Strays

Like most thermoplastic products, **K-Aqua** is a poor electrical conductor. Therefore, there is no risk of stray currents occurring.

1.4 Soundproofness

The elasticity of **K-Aqua** pipes makes it viable to absorb and eliminate almost all vibrations, that would normally occur in the traditional cast iron pipes. Therefore, **K-Aqua** is highly soundproof at no extra cost.

1.5 Low Thermal Conductivity

K-Aqua has a low thermal conductivity (0.24 W/ m.K) that reduces the heat dispersion of the fluid that it conveys. Also, it reduces the condensation, which normally forms on the outside of the generic metal pipes, under specific hygrometric conditions.

1.6 Low Pressure Loss

The inside surface of **K-Aqua** is sleek, smooth with very few irregularities (0.0070 µ), which convey a significant reduction in pressure loss. As result, limestone cannot build up inside the pipe.

1.7 No-Toxicity

The raw material used for the production of **K-Aqua** is absolutely non-toxic and complies with the most up-to-date national and international regulations.

1.8 Easy Workability

One of the major attractions of the **K-Aqua** system is that it is extremely light and easy to weld and install. Our pipes with diameters ranging from 20 mm to 250 mm are extremely simple to assemble, providing the suitable polyfusion device. (See chapter 3)

1.9 UV Resistance

K-Fiber UV Pipes black cooled pipes are UV-resistant but must not be installed without protection in an exposed area. **K-Aqua** pipes and fittings are equipped with a stabilizer which allows for safe transport and installation. However, they should not be stored for more than six months in the open air.

1.10 Cracking Resistance Under Stress

The values determining the time resistance capacity of the **K-Aqua** system are the following:

Mechanical stress = Pressure

Thermal strain = Temperature

Stress duration = Time

The relationship between the above parameters can be controlled through regression curves.
K-Aqua minimum resistance values have been determined through internal pressure tests, at various temperature intervals: 20, 40, 60, 80, 95, 110° C. A logarithmic graphic representation shows the comparative tensions, the lifetime (in years), and the regression curves at various temperatures according to the DIN 8078 standard. See figure page 17 and 23

1.11 Advantages of the K-Aqua Piping System

K-Aqua provides all the necessary parts, for a complete and easy installation, from the beginning to the end. Saying goodbye to the conventional problems of the past. It is guaranteed to feel and see the difference with the **K-Aqua** piping system.

- **K-Aqua** is manufactured with superior German quality.
- **K-Aqua** made of corrosion resistant material, putting an end to old corrosion complications.
- Enjoy some serenity and peacefulness with **K-Aqua** because it is not as noisy as metal pipes.
- Unlike the alternatives, **K-Aqua** is made of opaque polypropylene, which is a nonpolluting material, preventing algae from growing.
- **K-Aqua** is completely recyclable, with no risk of air pollution, making it an environmentally friendly system.

1.12 Material Properties PP-R

Table 1: Physical properties PP-R

Property	Typical	Value	Test Method
Density	905	kg/m^3	ISO 1183
Melt Flow Rate (230° C / 2.16 kg)	0,25	g/10 min	ISO 1133
Flexural Modulus (2 mm/min)	800	MPa	ISO 178
Tensile Modulus (1 mm/min)	900	MPa	ISO 527
Tensile Strain at Yield (50 mm/min)	13,5	%	ISO 527-2
Tensile Strain at Yield (50 mm/min)	25	MPa	ISO 527-2
Thermal Conductivity	0,24	w/(m K)	DIN 52612
Coefficient of Thermal Expansion (0° C/70° C)	1,5*10E-4	1/K	DIN 53752
Charpy Impact Strength unotched (23° C)	NO break		ISO 179/1eU
Charpy Impact Strength unotched (0° C)	NO break		ISO 179/1eU
Charpy Impact Strength unotched (-20° C)	40	kJ/m^2	ISO 179/1eU
Charpy Impact Strength notched (23° C)	20	kJ/m^2	ISO 179/1eA
Charpy Impact Strength notched (0° C)	3,5	kJ/m^2	ISO 179/1eA
Charpy Impact Strength notched (-20° C)	2	kJ/m^2	ISO 179/1eA

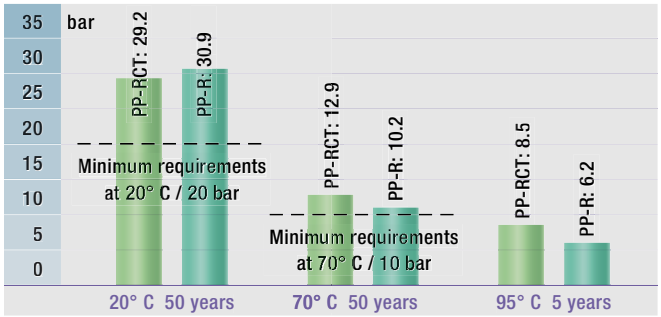
1.13 Material Properties PP-RCT

PP-RCT (Polypropylene-Random Crystallinity Temperature) is a material classification used to describe the second-generation class of PP-R materials. Introduced by Borealis in 2004 through its RA7050 range materials, it sets a milestone in the advancement of PP pressure piping systems. The pipe class has recently been included in EN ISO 15874, the global standard for plastics piping systems for hot and cold water pipe installations. PP-RCT is a polypropylene-random-copolymer with a special crystallinity which provides an improved pressure resistance, especially at elevated temperatures.

Pressure tests according to ISO 9080 on pipes manufactured from PP-RCT materials demonstrate 50 years service life at 70° C of 5 MPa, compared to the 3.2 MPa for standard PP-R materials. These very capabilities allow PP-RCT to increase performance and competitiveness for PP-R producers, and offer advantages for building designers and end-users alike.

Using PP-RCT in your pipe design will allow for increased performance vs. standard PP-R such as:

- increased pressure class with the same dimensioning
- higher hydraulic capacity with same outer diameter
- weight reduction (from 14 % up to 25 %) in pipe
- higher percentage of smaller pipes in actual installations (percentage depends upon specific design)
- cost efficient system due to beneficial dimensioning
- easier installation
- greater possibilities to tailor your heating PP-R pipe design
- opening up for special applications such as larger diameter mains for skyrise airconditioning systems
- weldable with known PP welding procedures
- fully established in domestic- as well as global standards incl. ISO and DIN



Higher pressure load through improved crystalline structure

With a special method of treatment of the material even smaller and more crystals are formed on the PP-RCT compared to PP-R. This means even more safety in permanent application because of higher pressure resistance at higher temperatures.

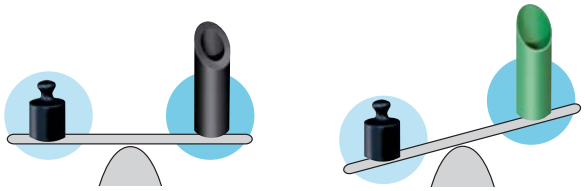
PP-R Pipes PP-RCT Pipes

Higher flow

The reduced wall thickness leads to a higher flow rate at same and higher pressure load to increased flow rate.

Higher stability at high temperatures

Through the special manufacturing of PP-RCT maximum working temperatures at higher pressure resistance were raised.



Lower weight

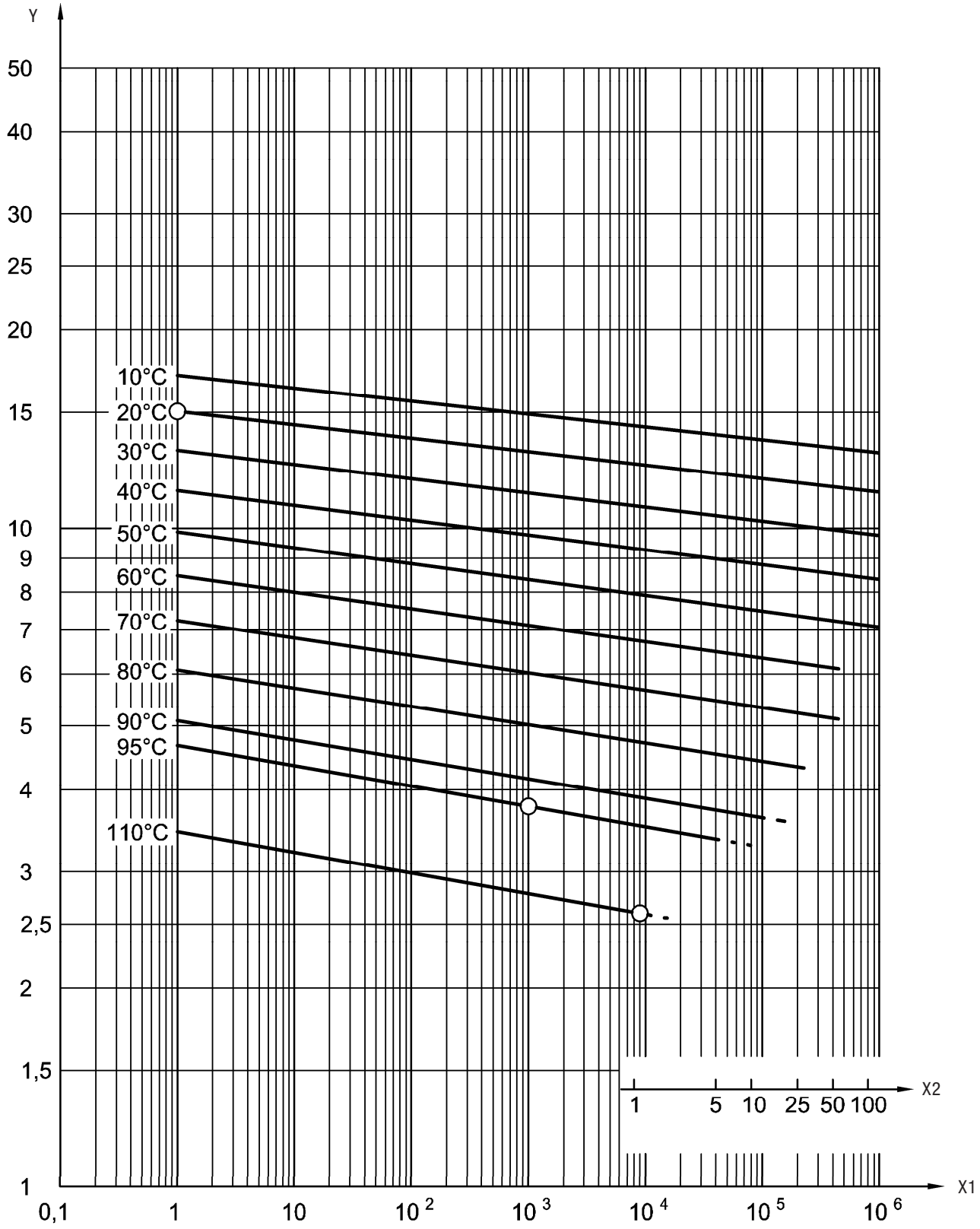
Through reduced wall thickness the weight of the PP-RCT pipes is considerably reduced.

Table 4: Physical properties PP-RCT

Property	Typical	Value	Test Method
Density	905	kg/m³	ISO 1183
Melt Flow Rate (230° C / 2.16 kg)	0,3	g/10 min	ISO 1133
Tensile Stress at Yield (50 mm/min)	25	MPa	ISO 527-2
Tensile Strain at Yield (50 mm/min)	10	%	ISO 527-2
Modulus of Elasticity in Tension (1 mm/min)	900	MPa	ISO 527
Charpy Impact Strength notched (+23° C) Charpy Impact Strength notched (0° C) Charpy Impact Strength notched (-20° C)	40 4 2	kJ/m² kJ/m² kJ/m²	ISO 179/1eA ISO 179/1eA ISO 179/1eA
Mean Linear Thermal Coefficient of Expansion from 0° C to 70° C	1,5	*10-4K-1	DIN 53752
Thermal Conductivity	0,24	WK-1m-1	DIN 52612 Part 1
Surface Resistance	> 1012	Ohm	DIN 53482/VDE 0303 Part 2

DIN EN ISO 15874-2:2013-06
EN ISO 15874-2:2013 (D/E)

Figure 2 - Reference curves for expected strength of PP-RCT



Key

X1 time, t_1, to fracture, in hours

X2 time, t_2, to fracture, in years

Y = hoopstress, α, in megapascal

Table 5 - Allowable operation pressures for PP-RCT, conveying water
Safety factor (SF) = 1,25

DIN 8077:2008-09

Temperature °C	Years of service	Pipe series S									
		20	16	12,5	8,3	8	5	4	3,2	2,5	2
		Diameter/Wall thicknesses SDR									
		41	33	26	17,6	17	11	9	7,4	6	5
		Allowable operation pressure bar									
10	1	5,7	7,2	9,1	13,7	14,4	22,8	28,8	36,2	45,6	57,4
	5	5,5	7,0	8,8	13,3	14,0	22,1	27,9	35,1	44,2	55,7
	10	5,5	6,9	8,7	13,1	13,8	21,9	27,5	34,7	43,7	55,0
	25	5,4	6,8	8,5	12,9	13,5	21,5	27,1	34,1	42,9	54,0
	50	5,3	6,7	8,4	12,7	13,4	21,2	26,7	33,6	42,3	53,3
	100	5,2	6,6	8,3	12,6	13,2	20,9	26,3	33,2	41,8	52,6
20	1	5,0	6,3	7,9	11,9	12,5	19,9	25,0	31,5	39,7	50,0
	5	4,8	6,1	7,6	11,6	12,1	19,3	24,2	30,5	38,5	48,4
	10	4,7	6,0	7,5	11,4	12,0	19,0	23,9	30,1	37,9	47,8
	25	4,6	5,9	7,4	11,2	11,7	18,6	23,5	29,6	37,2	46,9
	50	4,6	5,8	7,3	11,0	11,6	18,4	23,1	29,2	36,7	46,2
	100	4,5	5,7	7,2	10,9	11,4	18,1	22,8	28,8	36,2	45,6
30	1	4,3	5,4	6,8	10,3	10,8	17,2	21,7	27,3	34,4	43,3
	5	4,1	5,2	6,6	10,0	10,5	16,6	20,9	26,4	33,2	41,8
	10	4,1	5,1	6,5	9,8	10,3	16,4	20,6	26,0	32,7	41,2
	25	4,0	5,0	6,4	9,6	10,1	16,1	20,2	25,5	32,1	40,4
	50	3,9	5,0	6,3	9,5	10,0	15,8	19,9	25,1	31,6	39,8
	100	3,9	4,9	6,2	9,4	9,8	15,6	19,7	24,8	31,2	39,3
40	1	3,7	4,6	5,9	8,9	9,3	14,8	18,6	23,5	29,6	37,2
	5	3,5	4,5	5,7	8,6	9,0	14,3	18,0	22,6	28,5	35,9
	10	3,5	4,4	5,6	8,4	8,8	14,1	17,7	22,3	28,1	35,4
	25	3,4	4,3	5,4	8,3	8,7	13,8	17,3	21,8	27,5	34,6
	50	3,4	4,3	5,4	8,1	8,5	13,6	17,1	21,5	27,1	34,1
	100	3,3	4,2	5,3	8,0	8,4	13,3	16,8	21,2	26,7	33,6
50	1	3,1	4,0	5,0	7,6	8,0	12,6	15,9	20,1	25,3	31,8
	5	3,0	3,8	4,8	7,3	7,7	12,2	15,3	19,3	24,3	30,6
	10	3,0	3,7	4,7	7,2	7,5	12,0	15,1	19,0	23,9	30,1
	25	2,9	3,7	4,6	7,0	7,4	11,7	14,7	18,6	23,4	29,5
	50	2,9	3,6	4,6	6,9	7,2	11,5	14,5	18,3	23,0	29,0
	100	2,8	3,5	4,5	6,8	7,1	11,3	14,3	18,0	22,6	28,5

Temperature °C	Years of service	Pipe series S									
		20	16	12,5	8,3	8	5	4	3,2	2,5	2
		Diameter/Wall thicknesses SDR									
		41	33	26	17,6	17	11	9	7,4	6	5
		Allowable operation pressure bar									
60	1	2,7	3,4	4,2	6,4	6,7	10,7	13,5	17,0	21,4	27,0
	5	2,5	3,2	4,1	6,2	6,5	10,3	13,0	16,3	20,6	25,9
	10	2,5	3,2	4,0	6,1	6,4	10,1	12,7	16,0	20,2	25,5
	25	2,4	3,1	3,9	5,9	6,2	9,9	12,4	15,7	19,8	24,9
	50	2,4	3,0	3,8	5,8	6,1	9,7	12,2	15,4	19,4	24,5
70	1	2,2	2,8	3,6	5,4	5,7	9,0	11,3	14,3	18,0	22,7
	5	2,1	2,7	3,4	5,2	5,4	8,6	10,9	13,7	17,3	21,7
	10	2,1	2,6	3,3	5,1	5,3	8,5	10,7	13,5	16,9	21,3
	25	2,0	2,6	3,3	5,0	5,2	8,3	10,4	13,1	16,5	20,8
	50	2,0	2,5	3,2	4,9	5,1	8,1	10,2	12,9	16,2	20,5
80	1	1,8	2,3	3,0	4,5	4,7	7,5	9,5	11,9	15,0	18,9
	5	1,8	2,2	2,8	4,3	4,5	7,2	9,0	11,4	14,4	18,1
	10	1,7	2,2	2,8	4,2	4,4	7,0	8,9	11,2	14,1	17,7
	25	1,7	2,1	2,7	4,1	4,3	6,9	8,6	10,9	13,7	17,2
95	1	1,4	1,7	2,2	3,4	3,5	5,6	7,1	8,9	11,2	14,2
	5	1,3	1,7	2,1	3,2	3,3	5,3	6,7	8,5	10,7	13,5
	(10)[a]	(1,3)	(1,6)	(2,1)	(3,1)	(3,3)	(5,2)	(6,6)	(8,3)	(10,5)	(13,2)

[a]) The values between parentheses apply in cases where it can be demonstrated that the test was carried out for more than a year at 110° C

Table 5 - Allowable operation pressures for PP-RCT, conveying water
Safety factor (SF) = 1,5

DIN 8077:2008-09

Temperature °C	Years of service	Pipe series S									
		20	16	12,5	8,3	8	5	4	3,2	2,5	2
		Diameter/Wall thicknesses SDR									
		41	33	26	17,6	17	11	9	7,4	6	5
		Allowable operation pressure bar									
10	1	4,7	6,0	7,5	11,4	12,0	19,0	24,0	30,2	38,0	47,9
	5	4,6	5,8	7,3	11,1	11,6	18,4	23,2	29,3	36,9	46,4
	10	4,5	5,7	7,2	10,9	11,5	18,2	22,9	28,9	36,4	45,8
	25	4,5	5,6	7,1	10,7	11,3	17,9	22,5	28,4	35,7	45,0
	50	4,4	5,5	7,0	10,6	11,1	17,7	22,2	28,0	35,3	44,4
	100	4,3	5,5	6,9	10,5	11,0	17,4	21,9	27,6	34,8	43,8
20	1	4,1	5,2	6,6	9,9	10,4	16,6	20,9	26,3	33,1	41,7
	5	4,0	5,0	6,4	9,6	10,1	16,0	20,2	25,4	32,0	40,4
	10	3,9	5,0	6,3	9,5	10,0	15,8	19,9	25,1	31,6	39,8
	25	3,9	4,9	6,1	9,3	9,8	15,5	19,6	24,6	31,0	39,1
	50	3,8	4,8	6,1	9,2	9,6	15,3	19,3	24,3	30,6	38,5
	100	3,8	4,7	6,0	9,1	9,5	15,1	19,0	24,0	30,2	38,0
30	1	3,6	4,5	5,7	8,6	9,0	14,3	18,1	22,7	28,7	36,1
	5	3,4	4,3	5,5	8,3	8,7	13,9	17,4	22,0	27,7	34,9
	10	3,4	4,3	5,4	8,2	8,6	13,6	17,2	21,7	27,3	34,4
	25	3,3	4,2	5,3	8,0	8,4	13,4	16,9	21,2	26,8	33,7
	50	3,3	4,1	5,2	7,9	8,3	13,2	16,6	20,9	26,4	33,2
	100	3,2	4,1	5,1	7,8	8,2	13,0	16,4	20,6	26,0	32,7
40	1	3,1	3,9	4,9	7,4	7,8	12,3	15,5	19,6	24,6	31,0
	5	2,9	3,7	4,7	7,1	7,5	11,9	15,0	18,9	23,8	29,9
	10	2,9	3,7	4,6	7,0	7,4	11,7	14,7	18,6	23,4	29,5
	25	2,8	3,6	4,5	6,9	7,2	11,5	14,4	18,2	22,9	28,9
	50	2,8	3,5	4,5	6,8	7,1	11,3	14,2	17,9	22,6	28,4
	100	2,8	3,5	4,4	6,7	7,0	11,1	14,0	17,6	22,2	28,0
50	1	2,6	3,3	4,2	6,3	6,6	10,5	13,3	16,7	21,0	26,5
	5	2,5	3,2	4,0	6,1	6,4	10,1	12,8	16,1	20,3	25,5
	10	2,5	3,1	3,9	6,0	6,3	10,0	12,6	15,8	19,9	25,1
	25	2,4	3,0	3,8	5,8	6,1	9,7	12,3	15,5	19,5	24,6
	50	2,4	3,0	3,8	5,7	6,0	9,6	12,1	15,2	19,2	24,2
	100	2,3	2,9	3,7	5,7	5,9	9,4	11,9	15,0	18,9	23,8

Temperature °C	Years of service	Pipe series S									
		20	16	12,5	8,3	8	5	4	3,2	2,5	2
		Diameter/Wall thicknesses SDR									
		41	33	26	17,6	17	11	9	7,4	6	5
		Allowable operation pressure bar									
60	1	2,2	2,8	3,5	5,3	5,6	8,9	11,2	14,2	17,8	22,5
	5	2,1	2,7	3,4	5,1	5,4	8,6	10,8	13,6	17,1	21,6
	10	2,1	2,6	3,3	5,0	5,3	8,4	10,6	13,4	16,8	21,2
	25	2,0	2,6	3,2	4,9	5,2	8,2	10,4	13,1	16,5	20,7
	50	2,0	2,5	3,2	4,8	5,1	8,1	10,2	12,8	16,2	20,4
70	1	1,8	2,3	3,0	4,5	4,7	7,5	9,4	11,9	15,0	18,9
	5	1,8	2,2	2,8	4,3	4,5	7,2	9,1	11,4	14,4	18,1
	10	1,7	2,2	2,8	4,2	4,4	7,0	8,9	11,2	14,1	17,8
	25	1,7	2,1	2,7	4,1	4,3	6,9	8,7	10,9	13,8	17,4
	50	1,7	2,1	2,7	4,0	4,2	6,8	8,5	10,7	13,5	17,0
80	1	1,5	1,9	2,5	3,7	3,9	6,2	7,9	9,9	12,5	15,8
	5	1,5	1,9	2,3	3,6	3,7	6,0	7,5	9,5	12,0	15,1
	10	1,4	1,8	2,3	3,5	3,7	5,9	7,4	9,3	11,7	14,8
	25	1,4	1,8	2,2	3,4	3,6	5,7	7,2	9,1	11,4	14,4
95	1	1,1	1,4	1,8	2,8	2,9	4,7	5,9	7,4	9,4	11,8
	5	1,1	1,4	1,7	2,6	2,8	4,4	5,6	7,1	8,9	11,2
	(10)[a]	(1,1)	(1,3)	(1,7)	(2,6)	(2,7)	(4,3)	(5,5)	(6,9)	(8,7)	(11,0)

[a]) The values between parentheses apply in cases where it can be demonstrated that the test was carried out for more than a year at 110° C

1.14 Table of chemical resistance for PP

Environment	Conc. %	Temperature 20° C	60° C	100° C
Acetic acid (glacial)	97	A	B (80° C)	-
Acetic acid	50	A	A (80° C)	-
Acetic acid	40	A	-	-
Acetic acid	10	A	A	-
Acetone	100	A	A	-
Acetophenone	100	B	B	-
Acriflavine (2 % solution in H_20)	2	A	A	- (80° C)
Acrylic emulsions		A	A	-
Aluminum chloride		A	A	-
Aluminum fluoride		A	A	-
Aluminum sulfate		A	A	-
Alums (all types)		A	A	-
Ammonia (aqueous)	30	A	-	-
Ammonia gas (dry)		A	A	-
Ammonium carbonate	Satd.	A	A	-
Ammonium chloride	Satd.	A	A	-
Ammonium fluoride	20	A	A	-
Ammonium hydroxide	10	A	A	-
Ammonium metaphosphate	Satd.	A	A	-
Ammonium nitrate	Satd.	A	A	-
Ammonium persulfate	Satd.	A	A	-
Ammonium sulfate	Satd.	A	A	-
Ammonium sulfide	Satd.	A	A	-
Ammonium thiocyanate	Satd.	A	A	-
Amyl acetate	100	B	C	-
Amyl alcohol	100	A	B	-
Amyl chloride	100	C	C	-
Aniline	100	A	A	-
Anisole	100	B	B	-
Antimony chloride		A	A	-
Aviation fuel (115/145 octane)	100	B	C	-
Aviation turbine fuel	100	B	C	-
Barium carbonate	Satd.	A	A	-
Barium chloride	Satd.	A	A	-
Barium hydroxide		A	A	-
Barium sulfate	Satd.	A	A	-
Barium sulfide	Satd.	A	A	-
Beer		A	A	-
Benzene	100	B	C	C
Benzoic acid	A	A	-	-
Benzyl alcohol		A	A (80° C)	-
Bismuth carbonate	Satd.	A	A	-
Borax		A	A	-
Boric acid		A	A	-
Brine	Satd.	A	A	-
Bromine liquid	100	D	-	-
Bromine water	(a)	C	-	-
Butyl acetate	100	C	C	-
Butyl alcohol	100	A	A	-
Calcium carbonate	Stad.	A	A	-
Calcium chlorate	Satd.	A	A	-
Calcium chloride	50	A	A	-
Calcium hydroxide		A	A	-
Calcium hypochlorite bleach	20(a)	A	B	-
Calcium nitrate		A	A	-
Calcium phosphate	50	A	-	-

Environment	Conc. %	Temperature 20° C	60° C	100° C
Calcium sulfate		A	A	-
Calcium sulfite		A	A	-
Carbon dioxide (dry)		A	A	-
Carbon dioxide (wet)		A	A	-
Carbon disulfide	100	B	C	-
Carbon monoxide		A	A	-
Carbon tetrachloride	100	C	C	C
Carbonic acid		A	A	-
Castor oil		A	-	-
Cetyl alcohol	100	A	-	-
Chlorine (gas)	100	D	D	-
Chlorobenzene	100	C	C	-
Chloroform	100	C	D	D
Chlorosulfonic acid	100	D	D	D
Chrome alum		A	A	-
Chromic acid	80(a)	A	-	-
Chromic acid	50(a)	A	A	-
Chromic acid	10(a)	A	A	-
Chromic/sulfuric acid		D	D	-
Cider		A	A	-
Citric acid	10	A	A	-
Copper chloride	Satd.	A	A	-
Copper cyanide	Satd.	A	A	-
Copper fluoride	Satd.	A	A	-
Copper nitrate	Satd.	A	A	-
Copper sulfate	Satd.	A	A	-
Cottonseed oil		A	A	-
Cuprous chloride	Satd.	A	A	-
Cyclohexanol	100	A	B	-
Cyclohexanone	100	B	C	-
Decalin	100	C	C	C
Detergents	2	A	A	A
Developers (photographic)		A	A	-
Dibutyl phthalate	100	A	B	D
Dichloroethylene	100	A	-	-
Diethanolamine	100	A	A	-
Diisooctyl phthalate	100	A	A	-
Emulsifiers		A	A	-
Ethanolamine	100	A	A	-
Ethyl acetate	100	B	B	-
Ethyl alcohol	96	A	A (80° C)	-
Ethyl chloride	100	C	C	-
Ethylene dichloride	100	B	-	-
Ethylene glycol		A	A	-
Ethylene oxide	100	B (10° C)	-	-
Ethyl ether	100	B	-	-
Fatty acids (C_6)	100	A	A	-
Ferric chloride	Satd.	A	A	-
Ferric nitrate	Satd.	A	A	-
Ferric sulfate	Satd.	A	A	-
Ferrous chloride	Satd.	A	A	-
Ferrous sulfate	Satd.	A	A	-
Fluorosilicic acid		A	A	-
Formaldehyde	40	A	A	-
Formic acid	100	A	-	-
Formic acid	10	A	A	-
Fructose		A	A	-
Fruit juices		A	A	-

Environment	Conc. %	Temperature 20° C	60° C	100° C
Furfural	100	C	C	-
Gas liquor		C	-	-
Gasoline	100	B	C	C
Gearbox oil	100	A	B	-
Gelatin		A	A	-
Glucose	20	A	A	-
Glycerin	100	A	A	A
Glycol		A	A	-
Hexane	100	A	B	-
Hydrobromic acid	50(a)	A	A	-
Hydrobromic acid	30(a)	A	B	D
Hydrobromic acid	20	A	A (80° C)	-
Hydrobromic acid	10	A	A (80° C)	B
Hydrobromic acid	2	A	A	A
50-50 HCl-HNO_3	(a)	B	D (80° C)	-
Hydrofluoric acid	40	A	-	-
Hydrofluoric acid	60(a)	A	A (40° C)	-
Hydrogen chloride gas (dry)	100	A	A	-
Hydrogen peroxide	30	A	-	D
Hydrogen peroxide	10	A	B	-
Hydrogen peroxide	3	A	-	-
Hydrogen sulfide		A	A	-
Hydroquinone		A	A	-
Inks		A	A	-
Iodine tincture		A	-	-
Isooctane	100	C	C	-
Isopropyl alcohol	100	A	A	-
Ketones		A	-	-
Lactic acid	20	A	A	-
Lanolin	100	A	A	-
Lead acetate	Satd.	A	A	-
Linseed oil	100	A	A	-
Lubricating oil	100	A	B	-
Magenta dye (aqueous solution)	2	A	A some staining	- -
Magnesium carbonate	Satd.	A	A	-
Magnesium chloride	Satd.	A	A	-
Magnesium hydroxide	Satd.	A	A	-
Magnesium nitrate	Satd.	A	A	-
Magnesium sulfate	Satd.	A	A	-
Magnesium sulfite	Satd.	A	A	-
Meat juices		A	A	-
Mercuric chloride	40	A	A	-
Mercuric cyanide	Satd.	A	A	-
Mercurous nitrate	Satd.	A	A	-
Mercury	100	A	A	-
Methyl alcohol	100	A	A	-
Methylene chloride	100	A	-	-
Methyl ethyl ketone	100	A	B	-
Milk and its products		A	A	A
Mineral oil	100	A	B	-
Molasses		A	A	-
Motor oil	100	A	B	-
Naphthalene	100	A	A	A
Nickel chloride	Satd.	A	A	-
Nickel nitrate	Satd.	A	A	-
Nickel sulfate	Satd.	A	A	-
Nitric acid	fuming	D	D	D

Environment	Conc. %	Temperature 20° C	60° C	100° C
Nitric acid	70(a)	C	D	-
Nitric acid	60	A	D (80° C)	-
Nitric acid	10	A	A	A
50-50 HNO_3-HCl	(a)	B	D (80° C)	-
50-50 HNO_3-H_2SO_4	(a)	C	D (80° C)	-
Nitrobenzene	100	A	A	-
Oleic acid		A	B	-
Oleum		-	-	D
Olive oil	100	A	A	-
Oxalic acid (aqueous)	50	A	B	-
Paraffin	100	A	B	-
Paraffin wax	100	A	A	-
Petrol	100	B	C	-
Petroleum ether (boiling point 100°-140° C)	100	C	C	-
Phenol	100	A	A	-
Phosphoric acid	95	A	A	-
Plating solutions, brass		A	A	-
Plating solutions, cadmium		A	A	-
Plating solutions, chromium		A	A	-
Plating solutions, copper		A	A	-
Plating solutions, gold		A	A	-
Plating solutions, indium		A	A	-
Plating solutions, lead		A	A	-
Plating solutions, nickel		A	A	-
Plating solutions, rhodium		A	A	-
Plating solutions, silver		A	A	-
Plating solutions, tin		A	A	-
Plating solutions, zinc		A	A	-
Potassium bicarbonate	Satd.	A	A	-
Potassium borate	1	A	A	-
Potassium bromate	10	A	A	-
Potassium bromide	Satd.	A	A	-
Potassium carbonate	Satd.	A	A	-
Potassium chlorate	Satd.	A	A	-
Potassium chloride	Satd.	A	A	-
Potassium chromate	40	A	A	-
Potassium cyanide	Satd.	A	A	-
Potassium dichromate	40	A	A	-
Potassium ferri-/ferrocyanide		A	A	-
Potassium fluoride		A	A	-
Potassium hydroxide	50	A	A	-
Potassium hydroxide	10	A	A	A
Potassium nitrate	Satd.	A	A	-
Potassium perborate	Satd.	A	A	-
Potassium perchlorate	10	A	A	-
Potassium permanganate	20	A	A	-
Potassium sulfate		A	A	-
Potassium sulfide		A	A	-
Potassium sulfite		A	A	-
Propyl alcohol	100	A	A	-
Pyridine	100	A	-	-
Silicone oil	100	A	A	-
Soap solution (concentrated)		A	A	-
Sodium acetate		A	A	-
Sodium bicarbonate	Satd.	A	A	-
Sodium bisulfate	Satd.	A	A	-
Sodium bisulfite	Satd.	A	A	-

Environment	Conc. %	Temperature 20° C	60° C	100° C
Sodium borate		A	A	-
Sodium bromide oil solution		A	A	-
Sodium carbonate	Satd.	A	A	-
Sodium chlorate	Satd.	A	A	-
Sodium chloride	Satd.	A	A	A
Sodium chlorite	2	A	A (80° C)	-
Sodium chlorite	5	A (80° C)	A	-
Sodium chlorite	10	A (80° C)	A	-
Sodium chlorite	20	A (80° C)	A	-
Sodium cyanide	Satd.	A	A	-
Sodium dichromate	Satd.	A	A	-
Sodium ferricyanide	Satd.	A	A	-
Sodium ferrocyanicle	Satd.	A	A	-
Sodium fluoride	Satd.	A	A	-
Sodium hydroxide	50	A	A	-
Sodium hydroxide	10	A	A	A
Sodium hypochlorite	20	A	B	B
Sodium nitrate		A	A	-
Sodium nitrite		A	A	-
Sodium silicate		A	A	-
Sodium sulfate	Satd.	A	A	-
Sodium sulfide	25	A	A	-
Sodium sulfite	Satd.	A	A	-
Stannic chloride	Satd.	A	A	-
Stannous chloride	Satd.	A	A	-
Starch		A	A	-
Sugars and syrups		A	A	-
Sulfamic acid		A	A (80° C)	-
Sulfates of Calcium and magnesium	Satd.	A	A	-
Sulfates of potassium and sodium	Satd.	A	A	-
Sulfur		A	A	-
Sulfuric acid	98(a)	C	-	D
Sulfuric acid	60	A	B (80° C)	-
Sulfuric acid	50	A	B	-
Sulfuric acid	10	A	A	A
50-50 H_2SO_4/HNO_3	(a)	C	D (80° C)	-
Tallow		A	A	-
Tannic acid	10	A	A	-
Tartaric acid		A	A	-
Tetrahydrofuran	100	C	C	C
Tetralin	100	C	C	C
Toluene	100	C	C	-
Transformer oil	100	A	C	-
Trichloroacetic acid	10	A	A	-
Trichloroethylene	100	A	A (80° C)	-
Turpentine	100	C	C	C
Urea		A	A	-
Urine		A	A	-
Water (distilled, soft, hard and vapor)		A	A	A
Wet chlorine gas		-	D (70° C)	-
Whiskey		A	A	A
White Paraffin	100	A	B (80° C)	-
White spirit	100	B	C	-
Wines		A	A	-
Xylene	100	C	C	C
Yeast		A	A	-
Zinc chloride	Satd.	A	A	-
Zinc oxide		A	A	-
Zinc sulfate	Satd.	A	A	-

(a) May produce cracking in material under stress

This chart shows the chemical resistance of polypropylene resin under static conditions and not under pressure.

Note: the user is advised to carry out his/her own tests to determine the suitability of polypropylene in a particular environment.

A = Negligible effect

The material should be suitable for all applications where these environmental conditions exist.

B = Limited absorption or attack

The material should be suitable for most applications but the user is advised to carry out his/her own tests to determine the suitability of polypropylene in a particular environment.

C = Extensive absorption and/or rapid permeation

The material should be suitable for applications where only intermittent service is involved, or where the swelling produced has no detrimental effect on the part. The user should carry out his/her own tests to determine the suitability of polypropylene in a particular environment.

D = Extensive attack

The specimen dissolves or disintegrates. Polypropylene is not recommended.

Note:

This table should be used only as a guide. Polypropylene subjected to mechanical stress may behave different and show different result. For any doubts we recommend to contact the K-Aqua Customer Service.

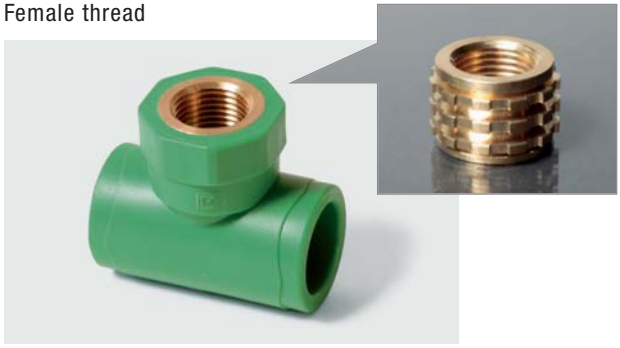
1.15 Material Properties Transition/Threaded Parts

Transition/threaded parts:

Male thread

R = Conical male thread acc. to ISO 7 / DIN EN 10226

Female thread



Rp = Cylindrical female thread acc. to ISO 7 / DIN EN 10226

Rc = Conical female thread acc. to ISO 7 / DIN EN 10226

Note: Threaded parts acc. to ISO 7 / DIN EN 10226 additional seal recommended (e.g. PTFE tape for sealing)
Threaded parts acc. to EN – ISO 228 additional seal required (gasket or O-ring)

The K-Aqua threaded parts have a special designed profile that avoids the turning of the insert once it is injected!

Diagram and chart to determine the temperature dependent linear expansion of multilayer pipes with inlayed fiberglass layer

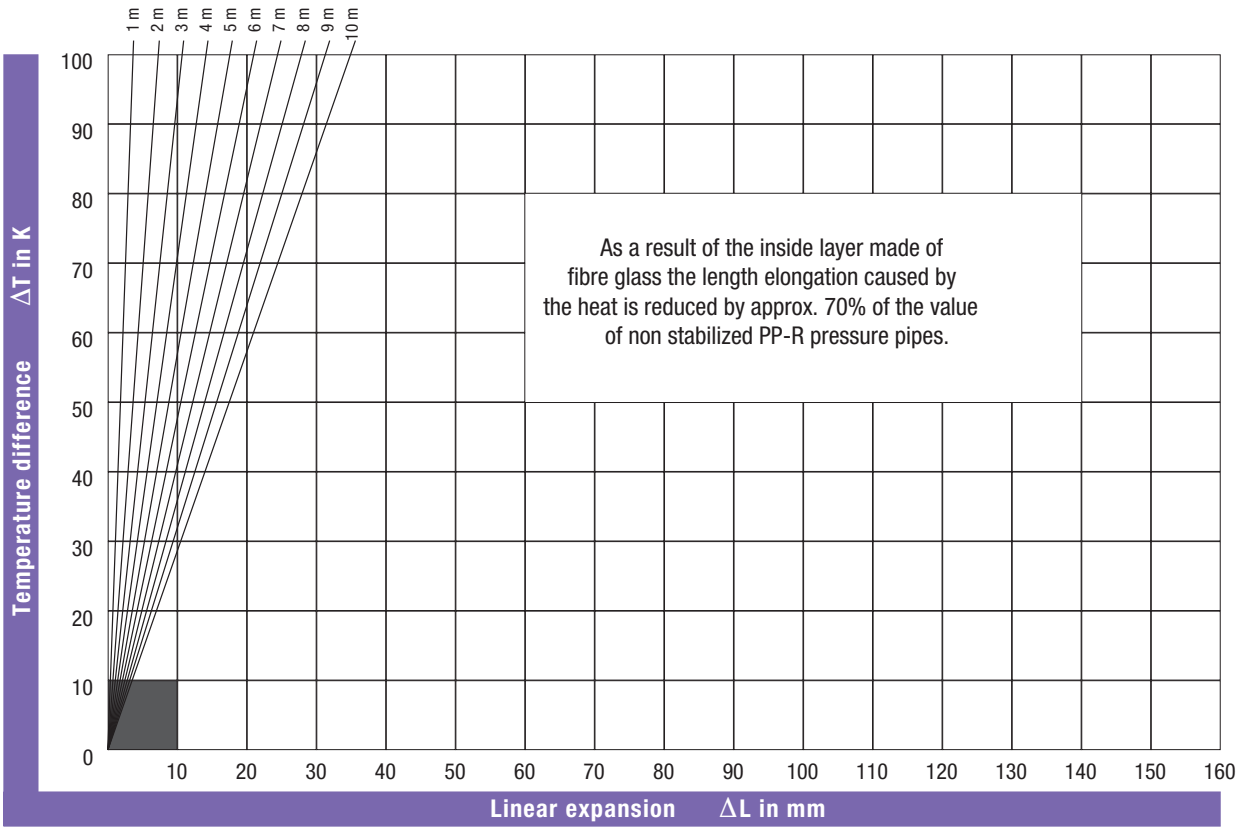


Figure 6

Pipe length	Temperature difference ΔT in K									
	10	20	30	40	50	60	70	80	90	100
0,1 m	0,04	0,07	0,11	0,14	0,18	0,21	0,25	0,28	0,32	0,35
0,2 m	0,07	0,14	0,21	0,28	0,35	0,42	0,49	0,56	0,63	0,70
0,3 m	0,11	0,21	0,32	0,42	0,53	0,63	0,74	0,84	0,95	1,05
0,4 m	0,14	0,28	0,42	0,56	0,70	0,84	0,98	1,12	1,26	1,40
0,5 m	0,18	0,35	0,53	0,70	0,88	1,05	1,23	1,40	1,58	1,75
0,6 m	0,21	0,42	0,63	0,84	1,05	1,26	1,47	1,68	1,89	2,10
0,7 m	0,25	0,49	0,74	0,98	1,23	1,47	1,72	1,96	2,21	2,45
0,8 m	0,28	0,56	0,84	1,12	1,40	1,68	1,96	2,24	2,52	2,80
0,9 m	0,32	0,63	0,95	1,26	1,58	1,89	2,21	2,52	2,84	3,15
1,0 m	0,35	0,70	1,05	1,40	1,75	2,10	2,45	2,80	3,15	3,50
2,0 m	0,70	1,40	2,10	2,80	3,50	4,20	4,90	5,60	6,30	7,00
3,0 m	1,05	2,10	3,15	4,20	5,25	6,30	7,35	8,40	9,45	10,50
4,0 m	1,40	2,80	4,20	5,60	7,00	8,40	9,80	11,20	12,60	14,00
5,0 m	1,75	3,50	5,25	7,00	8,75	10,50	12,25	14,00	15,75	17,50
6,0 m	2,10	4,20	6,30	8,40	10,50	12,60	14,70	16,80	18,90	21,00
7,0 m	2,45	4,90	7,35	9,80	12,25	14,70	17,15	19,60	22,05	24,50
8,0 m	2,80	5,60	8,40	11,20	14,00	16,80	19,60	22,40	25,20	28,00
9,0 m	3,15	6,30	9,45	12,60	15,75	18,90	22,05	25,20	28,35	31,50
10,0 m	3,50	7,00	10,50	14,00	17,50	21,00	24,50	28,00	31,50	35,00

Linear expansion ΔL in mm

Figure 6/1