AQUASYSTEM

The PP-R piping system for hot and cold water and heating

Technical Manual 2011

+GF+

GEORG FISCHER
PIPING SYSTEMS

AQUASYSTEM

AQUASYSTEM has been designed and produced as a piping system for hot and cold water supply and heating. The integrated system of components is easy to use and install, meets the rigorous demands of the water services and offers excellent value for money.

The highest standards of technology, production and logistics all come together in guaranteeing the best product for the end user:

- Quality
- Experience
- Reliability

Aquasystem is an ideal cost effective solution to piping systems in schools, hospitals, hotels, accommodation and office blocks and in modular construction.

A wide range of pipe and fittings are available up to d125.
Please ask about our AQUABIG range up to d250.

Size range	d20-d125
Pressure (PP-RCT fibre pipe)	PN20 @ 20°C
Temperature range	0°C - 95°C
Thermal expansion coefficient (PP-RCT fibre pipe)	0.04mm/m°C
Thermal conductivity (PP-RCT fibre pipe)	0.24 @ 20°C
Approvals	WRAS, KIWA, CSTB, LR, RINA
Jointing technique	Socket Fusion, Electrofusion

AQUASYSTEM

PP-R: the characteristics of the material

AQUASYSTEM is made of Polypropylene Random Copolymer (PP-R). The chemical inertness of the material ensures that the fittings and pipe are odourless and tasteless as well as physiologically and microbiologically safe. The quality of our material gives high resistance to temperature and pressure and can guarantee a long life.

- High heat stability
- High strength
- Hygienically safe

Properties		Valves	Unit	DIN	ISO
Flow index				DIN 53735	ISO 1133
MFI 190/5		0.4	g/10 min	Code T	Procedure 18
MFI 230/2.16		0.25	g/10 min	Code M	Procedure 12
MFI 230/5		1.25	g/10 min	Code V	Procedure 20
Density a 23°C		0.90-0.91	g/cm^3	DIN 53479	ISO/R 1183
Resistance (Charpy)					
	23°C	n.r.	kJ/ m^2	DIN 53479	ISO 179/2D
	-30°C	40	kJ/ m^2	normal scale	ISO 179/2D
Notch resistance					
(notch-engraved sample test)	23°C	25	kJ/ m^2	DIN 53453	ISO 179/2C
	-30°C	2.5	kJ/ m^2	normal scale	ISO 179/2C
Resistance (Izod)					
	23°C	n.r.	kJ/ m^2	-	ISO 180/1C
	-30°C	28	kJ/ m^2	-	ISO 180/1C
Scratching resistance					
(engraved sample test) (Izod)	23°C	23	kJ/ m^2	-	ISO 180/1A
	-30°C	2.5	kJ/ m^2	-	ISO 180/1A
	23°C	27	kJ/ m^2	-	ASTM D 256
	-30°C	4	kJ/ m^2	-	ASTM D 256
Traction test					
Yield test		27	N/mm^2	DIN 53455	ISO 527
Yield Elasticity		11	%	Forwarding speed	Forwarding speed
Breakage Elongation		› 800	%		-
Traction Module E		900	N/mm^2	DIN 53457	ISO 527
Elasticity yield to tangental tension		450	N/mm^2	DIN 53445	ISO/R 537/method A.
Bending stress 3.5%		24	N/mm^2	DIN 53452	ISO 178 standard
Brinell hardness test		49	N/mm^2	DIN 53456	test 5.1
VICAT A/°C Melting point		135-145	°C	(H358/30)	ISO 2039 (H358/30)
Dimensional heat stability °C		75	°C	DIN 53460	ISO 306
				DIN 53461	ISO 75/B
Surface Resistance		›10^{13}	Ω	DIN 53482	
Mass resistivity		›10^{16}	Ω cm	DIN 53482	
Dielectric loss angle (tg.) (10^{6}Hz)		2 x 10^{-4}	-	DIN 53483	
Relative dielectric constant (10^{6}Hz)		2.3	-	DIN 53483	
Dielectric rigidity		75	kV/mm	ASTM D149	
Thermal conductivity at 20°C (PP-R)		0.22	W/mK	52612	VDE 0304 (1-4)
Thermal conductivity at 20°C (PP-RCT fibre pipe)		0.24	W/mK		
Thermal expansion coefficient (PP-R)		0.15	mm/m°C		
Thermal expansion coefficient (PP-RCT)		0.04	mm/m°C		
Specific heat 20°C		2.0	KJ/KgK		

The above characteristics are the results of the tests on extruded samples after 96 hours storage at normal room conditions 23/50 (2) DIN 50014 and represent indicative values.

Outstanding features of AQUASYSTEM

Some of the best advantages offered by AQUASYSTEM compared with traditional systems are listed below:

Reduced installation time
Compared with traditional systems, AQUASYSTEM can reduce installation times by at least 30%.

Chemical resistance
AQUASYSTEM will not corrode and is resistant to most chemicals used in water supply and distribution systems. For advice on a particular application then please contact us.

Low thermal conductivity
The thermal conductivity of AQUASYSTEM is very low therefore heat losses are reduced in the hot water supply and heating systems. This does not remove the statutory requirements for insulation on pipework, but can improve the effect of insulation for both heat loss and prevention of condensation.

Long Life
AQUASYSTEM is designed to operate for over 50 years at the temperature and pressure conditions listed in the table, "Permissible working pressure"

Hygienically safe
AQUASYSTEM is certified as non-toxic and is suitable for contact with drinking water.

Abrasion resistance
The high abrasion resistance of AQUASYSTEM guarantees a long installed life.

Noise reduction
AQUASYSTEM has a high sound reduction index for absorbing sound waves and limiting noise transmission through pipes.

High elasticity
Resistance against impact and bending stresses..

Smooth surface
The internal surface of the pipework remains smooth thereby reducing pressure losses and there is no encrustation of the pipework.

Outstanding features of AQUASYSTEM fibre pipe

AQUASYSTEM Fibre pipe is made from the latest generation of PP-R (PP-RCT) combined with a multi-layer structure.

PP-RCT is polypropylene Random copolymer with an enhanced Crystalline structure and improved Temperature resistance.

- Improved pressure resistance
- Improved resistance to crack propagation
- Enhanced long term strength
- Increased impact resistance

The multilayer structure gives the following benefits:

- Higher stiffness
- Lower thermal expansion coefficient
- Dimensional stability

AQUASYSTEM fibre pipe is fully compatible with traditional PP-R.

Key features of AQUASYSTEM Fibre Pipe

Maximum working pressure 20 bar at 20°C Cold Water 10 bar at 60°C Hot Water (EN ISO 15874 Class 1) 10 bar at 70°C Hot Water (EN ISO 15874 Class 2) Based on a 50 year life expectancy	
Operating temperature range (see permissible working pressure table)	0-95°C
Thermal expansion coefficient	0.04 mm/m°C
Thermal conductivity	0.24 W/m°C
Colour	Grey with 4 wide beige stripes

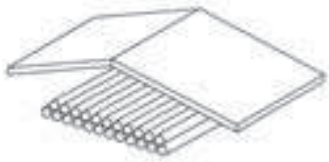
SDR Values

d20 - d25	SDR7.4/S3.2
d32 - d125	SDR9/S4

+GF+

Precautions

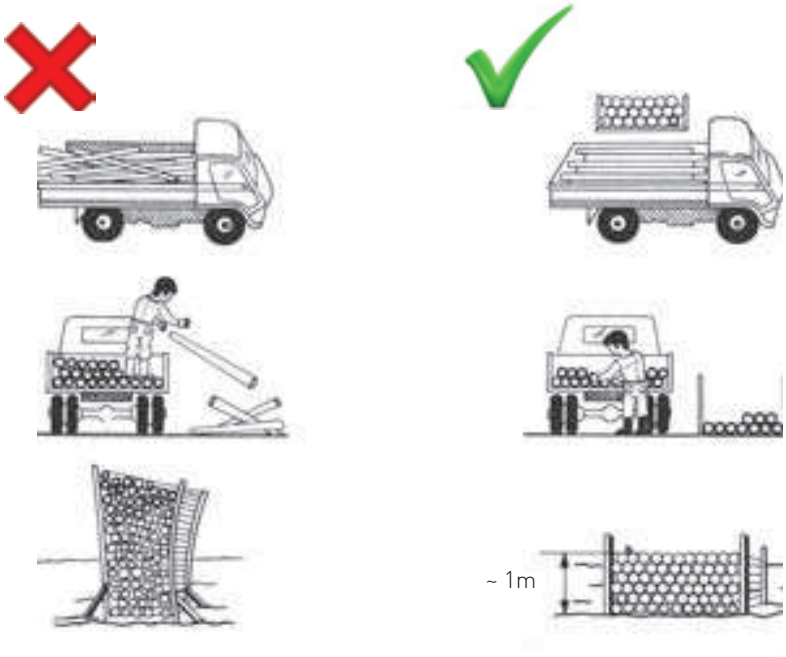
UV Radiation
PP-R, although UV stabilised, should not be directly exposed to the sun.



Low temperatures
With temperatures close to zero, PP-R can become brittle, therefore impact to the pipework should be avoided. Care should also be taken to ensure that the medium in the pipework does not freeze, consequently damaging the piping system.

Threaded connections to metal
It is not recommended to join AQUASYSTEM threaded fittings to conical or other unsuitable metal fittings. Where it is necessary to join to metal threads, it is recommended to use PTFE tape.

Transport and storage
Please observe the tips below for material transport and storage.



Applications

AQUASYSTEM is recommended for the following applications:

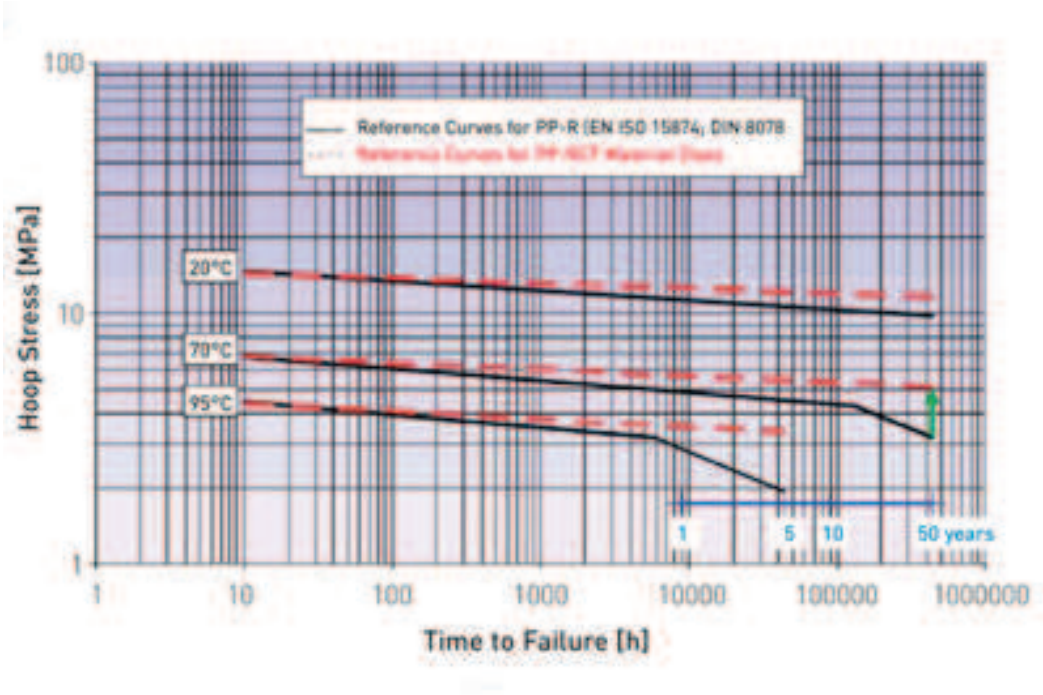
- **Hot and cold water**
- **Heating**
- **Chilled water**
- **Compressed air (please seek advice if synthetic oils are used)**

AQUASYSTEM is suitable for a wide range of installations:

- **Schools**
- **Hospitals**
- **Hotels**
- **Accommodation blocks**
- **Office blocks**
- **Modular Construction**

Regression curves

Regression curves show the admissible pressure during the lifetime depending on the service temperature



PP-RCT material has better long term strength at high temperatures compared with standard PP-R material.

Permissible working pressure

Permissible pressure according to DIN 8077/78 and EN ISO 15874 Safety factor of 1.25

Water Temperature	Service Life (years)	PP-RCT Fibre Pipe working pressure (bar)
10°C	1 5 10 25 50	29.2 28.6 28.1 27.6 27.2
20°C	1 5 10 25 50	25.0 24.2 23.9 23.5 23.1
30°C	1 5 10 25 50	22.1 21.3 20.9 20.5 20.4
40°C	1 5 10 25 50	18.6 18.0 17.7 17.3 17.1
50°C	1 5 10 25 50	16.0 15.5 15.2 14.8 14.8
60°C	1 5 10 25 50	13.5 13.0 12.7 12.4 12.2
70°C	1 5 10 25 50	11.3 10.9 10.7 10.4 10.2
80°C	1 5 10 25	9.5 9.0 8.9 8.6
95°C	1 5	7.1 6.7

Working pressure

AQUASYSTEM PP-R Pipe Sizing

Determining the required pipe diameter of AQUASYSTEM fibre pipe

The following formula can be used as an approximation for a given flow rate:

$$d_i = 35.7\sqrt{\frac{Q}{v}}$$

Where v = flow velocity (m/s)
d_i = inside diameter of pipe (mm)
Q = flow rate (l/s)

The following values are generally accepted design velocities for water-like media:
Delivery system, v = 1.0 – 3.0 m/s
Suction system, v = 0.5 - 1.0 m/s

AQUASYSTEM fibre pipe sizes

Pipe Outside diameter (mm)	Wall thickness diameter (mm)	Pipe Inside diameter (mm)
20	2.8	14.4
25	3.5	18.0
32	3.6	24.8
40	4.5	31.0
50	5.6	38.8
63	7.1	48.8
75	8.4	58.2
90	10.1	69.8
110	12.3	85.4
125	14.0	97.0

AQUASYSTEM PP-R Pressure Loses

Pressure loss in AQUASYSTEM fibre pipe

The pressure losses in a straight length of AQUASYSTEM fibre pipe can be calculated using the following formula:.

$$\Delta p_R = \lambda \cdot \frac{L}{d_i} \cdot \frac{\rho}{2 \cdot 10^2} \cdot v^2$$

Where Δp_R = pressure loss in a straight length of pipe (bar)
λ = pipe friction factor; for smooth plastic pipe and turbulent flow, λ = 0.02.
L = length of straight length of pipe (m)
d_i = inside diameter of pipe (mm)
ρ = density of transported media (kg/m^3) (1 g/cm^3 = 1000 kg/m^3)
v = flow velocity (m/s)

The following chart can be used to determine the pressure loss and flow velocities in AQUASYSTEM fibre pipe.

Calculated flow velocity, v (m/s) and pressure loss, p (mbar/m) in AQUASYSTEM fibre pipe at a given flow rate, Q.

Q l/s	Q l/m	Pipe Outside Diameter (mm)	20	25	32	40	50	63	75	90	110	125
0.05	3.0	p	0.65	0.21	0.04							
		v	0.31	0.20	0.10							
0.06	3.6	p	0.94	0.31	0.06							
		v	0.37	0.24	0.12							
0.07	4.2	p	1.28	0.42	0.08							
		v	0.43	0.28	0.14							
0.08	4.8	p	1.68	0.55	0.11	0.04						
		v	0.49	0.31	0.17	0.11						
0.09	5.4	p	2.12	0.69	0.14	0.05						
		v	0.55	0.35	0.19	0.12						
0.10	6.0	p	2.62	0.86	0.17	0.06						
		v	0.61	0.39	0.21	0.13						
0.12	7.2	p	3.77	1.24	0.25	0.08	0.03					
		v	0.74	0.47	0.25	0.16	0.10					
0.14	8.4	p	5.13	1.68	0.34	0.11	0.04					
		v	0.86	0.55	0.29	0.19	0.12					
0.16	9.6	p	6.70	2.20	0.44	0.14	0.05					
		v	0.98	0.63	0.33	0.21	0.14					
0.18	10.8	p	8.48	2.78	0.56	0.18	0.06	0.02				
		v	1.11	0.71	0.37	0.24	0.15	0.10				
0.20	12.0	p	10.47	3.43	0.69	0.23	0.07	0.02				
		v	1.23	0.79	0.41	0.26	0.17	0.11				
0.30	18.0	p	23.56	7.72	1.56	0.51	0.17	0.05	0.02			
		v	1.84	1.18	0.62	0.40	0.25	0.16	0.11			
0.40	24.0	p	41.89	13.73	2.76	0.91	0.29	0.09	0.04	0.02		
		v	2.46	1.57	0.83	0.53	0.34	0.21	0.15	0.10		
0.50	30.0	p	65.46	21.45	4.32	1.42	0.46	0.15	0.06	0.02		
		v	3.07	1.96	1.04	0.66	0.42	0.27	0.19	0.13		
0.60	36.0	p	94.26	30.89	6.22	2.04	0.66	0.21	0.09	0.04	0.01	
		v	3.68	2.36	1.24	0.79	0.51	0.32	0.23	0.16	0.10	
0.70	42.0	p	128.29	42.04	8.47	2.77	0.90	0.29	0.12	0.05	0.02	
		v	4.30	2.75	1.45	0.93	0.59	0.37	0.26	0.18	0.12	
0.80	48.0	p	167.57	54.91	11.06	3.62	1.18	0.37	0.16	0.06	0.02	0.01
		v	4.91	3.14	1.66	1.06	0.68	0.43	0.30	0.21	0.14	0.11
0.90	54.0	p		69.49	14.00	4.59	1.49	0.47	0.20	0.08	0.03	0.02
		v		3.54	1.86	1.19	0.76	0.48	0.34	0.24	0.16	0.12
1.00	60.0	p		85.79	17.28	5.66	1.84	0.59	0.24	0.10	0.04	0.02
		v		3.93	2.07	1.32	0.85	0.53	0.38	0.26	0.17	0.14
1.20	72.0	p		123.54	24.88	8.15	2.65	0.84	0.35	0.14	0.05	0.03
		v		4.72	2.48	1.59	1.01	0.64	0.45	0.31	0.21	0.16
1.40	84.0	p			33.87	11.10	3.61	1.15	0.48	0.19	0.07	0.04
		v			2.90	1.85	1.18	0.75	0.53	0.37	0.24	0.19
1.60	96.0	p			44.24	14.50	4.72	1.50	0.62	0.25	0.09	0.05
		v			3.31	2.12	1.35	0.86	0.60	0.42	0.28	0.22
1.80	108.0	p			55.99	18.35	5.97	1.90	0.79	0.32	0.12	0.06
		v			3.73	2.38	1.52	0.96	0.68	0.47	0.31	0.24
2.00	120	p			69.12	22.65	7.37	2.34	0.97	0.39	0.14	0.08
		v			4.14	2.65	1.69	1.07	0.75	0.52	0.35	0.27
2.20	132	p			83.64	27.41	8.92	2.84	1.18	0.47	0.17	0.09
		v			4.55	2.91	1.86	1.18	0.83	0.57	0.38	0.30
2.40	144	p			99.54	32.62	10.62	3.37	1.40	0.56	0.21	0.11
		v			4.97	3.18	2.03	1.28	0.90	0.63	0.42	0.32
2.60	156	p				38.28	12.46	3.96	1.64	0.66	0.24	0.13
		v				3.44	2.20	1.39	0.98	0.68	0.45	0.35
2.80	168	p				44.39	14.45	4.59	1.90	0.77	0.28	0.15
		v				3.71	2.37	1.50	1.05	0.73	0.49	0.38
3.00	180	p				50.96	16.59	5.27	2.18	0.88	0.32	0.17
		v				3.97	2.54	1.60	1.13	0.78	0.52	0.41
3.20	192	p				57.98	18.88	6.00	2.49	1.00	0.37	0.19
		v				4.24	2.71	1.71	1.20	0.84	0.56	0.43
3.40	204	p				65.46	21.31	6.77	2.81	1.13	0.41	0.22
		v				4.50	2.88	1.82	1.28	0.89	0.59	0.46
3.60	216	p				73.39	23.89	7.59	3.15	1.27	0.46	0.24
		v				4.77	3.04	1.92	1.35	0.94	0.63	0.49

Q l/s	Q l/m	Pipe Outside Diameter (mm)	20	25	32	40	50	63	75	90	110	125
3.80	228	p					26.62	8.46	3.51	1.41	0.52	0.27
		v					3.21	2.03	1.43	0.99	0.66	0.51
4.00	240	p					29.50	9.37	3.88	1.57	0.57	0.30
		v					3.38	2.14	1.50	1.05	0.70	0.54
4.20	252	p					32.52	10.33	4.28	1.73	0.63	0.33
		v					3.55	2.25	1.58	1.10	0.73	0.57
4.40	264	p					35.69	11.34	4.70	1.89	0.69	0.37
		v					3.72	2.35	1.65	1.15	0.77	0.60
4.60	276	p					39.01	12.39	5.14	2.07	0.76	0.40
		v					3.89	2.46	1.73	1.20	0.80	0.62
4.80	288	p					42.48	13.50	5.59	2.25	0.82	0.43
		v					4.06	2.57	1.80	1.25	0.84	0.65
5.00	300	p					46.09	14.64	6.07	2.45	0.89	0.47
		v					4.23	2.67	1.88	1.31	0.87	0.68
5.20	312	p					49.85	15.84	6.56	2.65	0.97	0.51
		v					4.40	2.78	1.95	1.36	0.91	0.70
5.40	324	p					53.76	17.08	7.08	2.85	1.04	0.55
		v					4.57	2.89	2.03	1.41	0.94	0.73
5.60	336	p					57.81	18.37	7.61	3.07	1.12	0.59
		v					4.74	2.99	2.11	1.46	0.98	0.76
5.80	348	p					62.02	19.71	8.17	3.29	1.20	0.64
		v					4.91	3.10	2.18	1.52	1.01	0.78
6.00	360	p						21.09	8.74	3.52	1.28	0.68
		v						3.21	2.26	1.57	1.05	0.81
6.20	372	p						22.52	9.33	3.76	1.37	0.73
		v						3.31	2.33	1.62	1.08	0.84
6.40	384	p						23.99	9.94	4.01	1.46	0.77
		v						3.42	2.41	1.67	1.12	0.87
6.60	396	p						25.52	10.58	4.26	1.55	0.82
		v						3.53	2.48	1.72	1.15	0.89
6.80	408	p						27.09	11.23	4.52	1.65	0.87
		v						3.64	2.56	1.78	1.19	0.92
7.00	420	p						28.70	11.90	4.79	1.75	0.93
		v						3.74	2.63	1.83	1.22	0.95
7.20	432	p						30.37	12.59	5.07	1.85	0.98
		v						3.85	2.71	1.88	1.26	0.97
7.40	444	p						32.08	13.29	5.36	1.95	1.03
		v						3.96	2.78	1.93	1.29	1.00
7.60	456	p						33.83	14.02	5.65	2.06	1.09
		v						4.06	2.86	1.99	1.33	1.03
7.80	468	p						35.64	14.77	5.95	2.17	1.15
		v						4.17	2.93	2.04	1.36	1.06
8.00	480	p						37.49	15.54	6.26	2.28	1.21
		v						4.28	3.01	2.09	1.40	1.08
8.20	492	p						39.39	16.32	6.58	2.40	1.27
		v						4.38	3.08	2.14	1.43	1.11
20.00	1200	p									14.28	7.55
		v									3.49	2.71
20.20	1212	p									14.56	7.70
		v									3.53	2.73
20.40	1224	p									14.85	7.86
		v									3.56	2.76
20.60	1236	p									15.14	8.01
		v									3.60	2.79
20.80	1248	p									15.44	8.17
		v									3.63	2.81
21.00	1260	p									15.74	8.33
		v									3.67	2.84
21.20	1272	p									16.04	8.48
		v									3.70	2.87
21.40	1284	p									16.34	8.65
		v									3.74	2.90
21.60	1296	p									16.65	8.81
		v									3.77	2.92
21.80	1308	p									16.96	8.97
		v									3.81	2.95
22.00	1320	p									17.27	9.14
		v									3.84	2.98
22.20	1332	p									17.59	9.30
		v									3.88	3.00
22.40	1344	p									17.91	9.47
		v									3.91	3.03

Q l/s	Q l/m	Pipe Outside Diameter (mm)	20	25	32	40	50	63	75	90	110	125
22.60	1356	p									18.23	9.64
		v									3.95	3.06
22.80	1368	p									18.55	9.81
		v									3.98	3.09
23.00	1380	p									18.88	9.99
		v									4.02	3.11
23.20	1392	p									19.21	10.16
		v									4.05	3.14
23.40	1404	p									19.54	10.34
		v									4.09	3.17
23.60	1416	p									19.88	10.51
		v									4.12	3.19
23.80	1428	p									20.22	10.69
		v									4.16	3.22
24.00	1440	p									20.56	10.87
		v									4.19	3.25
24.20	1452	p									20.90	11.06
		v									4.22	3.27
24.40	1464	p									21.25	11.24
		v									4.26	3.30
24.60	1476	p									21.60	11.42
		v									4.29	3.33
24.80	1488	p									21.95	11.61
		v									4.33	3.36
25.00	1500	p									22.31	11.80
		v									4.36	3.38
25.20	1512	p									22.66	11.99
		v									4.40	3.41
25.40	1524	p									23.02	12.18
		v									4.43	3.44
25.60	1536	p									23.39	12.37
		v									4.47	3.46
25.80	1548	p									23.76	12.57
		v									4.50	3.49
26.00	1560	p									24.13	12.76
		v									4.54	3.52
26.20	1572	p									24.50	12.96
		v									4.57	3.55
26.40	1584	p									24.87	13.16
		v									4.61	3.57
26.60	1596	p									25.25	13.36
		v									4.64	3.60
26.80	1608	p									25.63	13.56
		v									4.68	3.63
27.00	1620	p									26.02	13.76
		v									4.71	3.65
27.20	1632	p									26.40	13.97
		v									4.75	3.68
27.40	1644	p									26.79	14.17
		v									4.78	3.71
27.60	1656	p									27.19	14.38
		v									4.82	3.73
27.80	1668	p									27.58	14.59
		v									4.85	3.76
28.00	1680	p									27.98	14.80
		v									4.89	3.79
28.20	1692	p									28.38	15.01
		v									4.92	3.82
28.40	1704	p									28.79	15.23
		v									4.96	3.84
28.60	1716	p									29.19	15.44
		v									4.99	3.87
28.80	1728	p										15.66
		v										3.90
29.00	1740	p										15.88
		v										3.92
29.20	1752	p										16.10
		v										3.95
29.40	1764	p										16.32
		v										3.98
29.60	1776	p										16.54
		v										4.01

Q l/s	Q l/m	Pipe Outside Diameter (mm)	20	25	32	40	50	63	75	90	110	125
29.80	1788	p										16.76
		v										4.03
30.00	1800	p										16.99
		v										4.06
30.20	1812	p										17.22
		v										4.09
30.40	1824	p										17.45
		v										4.11
30.60	1836	p										17.68
		v										4.14
30.80	1848	p										17.91
		v										4.17
31.00	1860	p										18.14
		v										4.19
31.20	1872	p										18.38
		v										4.22
31.40	1884	p										18.61
		v										4.25
31.60	1896	p										18.85
		v										4.28
31.80	1908	p										19.09
		v										4.30
32.00	1920	p										19.33
		v										4.33
32.20	1932	p										19.57
		v										4.36
32.40	1944	p										19.82
		v										4.38
32.60	1956	p										20.06
		v										4.41
32.80	1968	p										20.31
		v										4.44
33.00	1980	p										20.56
		v										4.47
33.20	1992	p										20.81
		v										4.49
33.40	2004	p										21.06
		v										4.52
33.60	2016	p										21.31
		v										4.55
33.80	2028	p										21.57
		v										4.57
34.00	2040	p										21.82
		v										4.60
34.20	2052	p										22.08
		v										4.63
34.40	2064	p										22.34
		v										4.66
34.60	2076	p										22.60
		v										4.68
34.80	2088	p										22.86
		v										4.71
35.00	2100	p										23.13
		v										4.74
35.20	2112	p										23.39
		v										4.76
35.40	2124	p										23.66
		v										4.79
35.60	2136	p										23.93
		v										4.82
35.80	2148	p										24.20
		v										4.84
36.00	2160	p										24.47
		v										4.87
36.20	2172	p										24.74
		v										4.90
36.40	2184	p										25.01
		v										4.93
36.60	2196	p										25.29
		v										4.95
36.80	2208	p										25.57
		v										4.98

Pressure loss in AQUASYSTEM fittings

The pressure loss in a fitting depends on the type of fitting as well as the flow in the fitting. The coefficient of resistance, ζ is used for the calculations.

Coefficient of resistance, ζ for AQUASYSTEM fittings.

Description	Symbol	Coefficient of resistance
Equal coupling		0,25
Elbow 90°		2,00
Elbow 45°		0,60
Equal tee 90°		1,80
Reduced tee 90°		3,60
Equal tee 90°		1,30
Reduced tee 90°		2,60
Equal tee 90°		4,20
Reduced tee 90°		9,00
Equal tee 90°		2,20
Reduced tee 90°		5,00
Threaded tee 90°, male		0,80
Concentric reductions up to 2 size		0,55
Concentric reductions up to 3 size		0,85
Threaded fitting, male		0,40
Threaded fitting, male, reduced		0,85
Threaded elbow, male		2,20
Threaded elbow, male, reduced		3,50

To calculate the total pressure loss in all fittings in a pipeline, take the sum of the individual losses, i.e. the sum of all the ζ values. The pressure loss can then be calculated according to the following formula:

$$\Delta p_{Fi} = \Sigma \xi \cdot \frac{v^2}{2 \cdot 10^5} \cdot \rho$$

Where Δp_{Fi} = pressure loss of all fittings (bar)
$\Sigma\zeta$ = sum of the coefficient of resistances
v = flow velocity (m/s)
ρ = density of transported media (kg/m^3) (1 g/cm^3 = 1000 kg/m^3)

Pressure loss

Pipe bracketing

AQUASYSTEM pipes need regularly spaced pipe supports and the bracketing distance depends on factors such as temperature and pipe diameter.

The inner diameter of the support must be greater than the external diameter of the pipe, so as to allow pipe movement due to expansion / contraction.

Bracket support distances for fibre pipe

	Bracket distances (cm)						
d (mm)	20°C	30°C	40°C	50°C	60°C	70°C	80°C
20	95	90	85	80	75	70	65
25	105	100	95	90	85	80	75
32	120	115	110	105	100	95	90
40	140	135	130	125	120	115	110
50	160	155	150	145	140	135	130
63	180	175	170	165	160	150	145
75	190	185	180	175	170	160	155
90	205	195	190	180	175	170	165
110	220	210	200	190	180	175	170
125	230	220	210	200	190	180	175

The above values are for horizontal installations. These distances can be increased by 30% for vertical pipe installations (i.e. multiply the values given by 1.3)

Thermal expansion

All materials expand or contract with an increase or decrease in temperature. During the design and installation of AQUASYSTEM, it is important to calculate the change in length caused by a possible difference between the operating temperature and the installation temperature.

The amount of expansion or contraction is dependent on the coefficient of linear expansion, α, which is the elongation of a 1m length of pipe for a temperature increase of 1°C.

AQUASYSTEM PP-RCT fibre pipe, average linear thermal expansion coefficient:
$\alpha = 0.04$mm/m°C

Calculating the change in length

Changes in length are calculated using the following formula:

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

Where ΔL = change in length (mm)
α = coefficient of expansion (mm/m°C)
L = original length (m)
ΔT = temperature difference (°C)

ΔT is the difference between the installation temperature and the working temperature.

Note: If the operating temperature is higher than the installation temperature, then the pipe length increases. If the operating temperature is lower than the installation temperature, then the pipe contracts.

Calculating the flexible section length

Changes in length are usually accommodated by flexible sections at changes of direction of the pipework or in expansion loops. The movement of the flexible section, a, must not be restrained by fixed pipe brackets or protrusions of wall, girders etc..

The length of the flexible section, a, can be calculated using the following formula:

$$a = k \times \sqrt{\Delta L \times od}$$

Where ΔL = change in length (mm)
k = 20 (constant for PP-RCT fibre)
L = original length (m)
ΔT = temperature difference (°C)

Thermal expansion

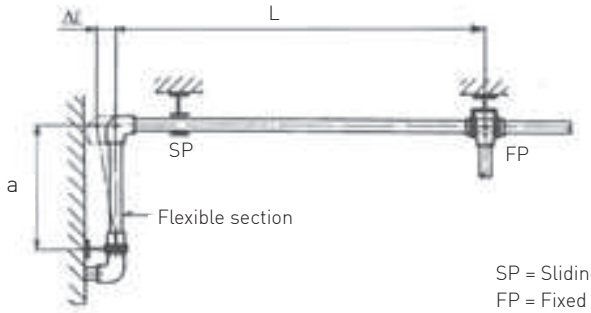
Change in length, ΔL in mm, for AQUASYSTEM fibre pipe

	Temperature difference ΔT in °C							
Pipe Length (m)	10	20	30	40	50	60	70	80
0.1	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32
0.2	0.08	0.16	0.24	0.32	0.40	0.48	0.28	0.64
0.3	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96
0.4	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28
0.5	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60
0.6	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92
0.7	0.28	0.56	0.84	1.12	1.40	1.68	1.96	2.24
0.8	0.32	0.64	0.96	1.28	1.60	1.92	2.24	2.56
0.9	0.36	0.72	1.08	1.44	1.80	2.16	2.52	2.88
1.0	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20
2.0	0.80	1.60	2.40	3.20	4.00	4.80	5.60	6.40
3.0	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60
4.0	1.60	3.20	4.80	6.40	8.00	10.00	12.00	12.80
5.0	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00
6.0	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20
7.0	2.80	5.60	8.40	11.20	14.00	16.80	19.60	22.40
8.0	3.20	6.40	9.60	12.80	16.00	19.20	22.40	25.60
9.0	3.60	7.20	10.80	14.40	18.00	21.60	25.20	28.80
10.0	4.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00

Installation of flexible sections

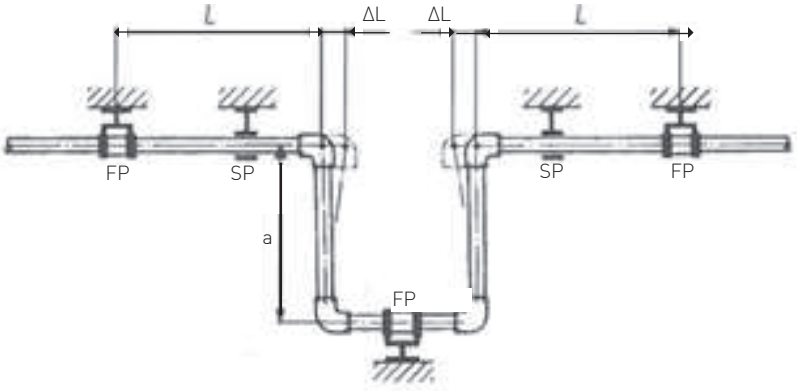
It is important to control the direction and amount of thermal movement by correct positioning of fixed points and to ensure the pipe can moved freely within loose brackets.

The following example shows how to install fixed and sliding brackets at a change of direction.



SP = Sliding Point
FP = Fixed Point
a = Flexible section length

When it is not possible to compensate for expansion/contraction in a flexible section at a change of direction, or substantial changes in length of a straight section need to be taken up, then an expansion loop can be installed. Here, the change in length is distributed over two flexible sections.



SP = Sliding Point
FP = Fixed Point
a = Flexible section length

Instructions for Socket Fusion

1. **Cut the pipe**
   Cut the pipe at a right angle, if necessary remove swarf from the inside.

2. **Clean the fitting and pipe**
   Clean the internal surface of the fitting and the outside of the pipe using Tangit KS cleaner and a lint free cloth. (Dirt or grease on the fitting or pipe can result in a joint failure).

3. **Mark the insertion depth**
   Mark the insertion depth into the heater bush and fitting (see table) on the pipe.
   The mark must remain visible under heating and jointing.

4. **Clean the heater bushes**
   Clean the heater bushes with Tangit KS cleaner and a lint free cloth. To clean inside the smaller bushes the cloth can be wrapped around a piece of dowel or wooden pencil. The heater bushes should be wiped clean after each welding.

5. **Check the fusion temperature**
   Once the socket fusion machine is on and has been allowed to heat up, check the fusion temperature, which must range between 253°C and 274°C. The temperature is checked using Tempil sticks. The yellow stick melts at 253°C and the red stick melts at 274°C. When the yellow stick melts and the red one does not melt, the heater bushes are at the correct temperature for the fusion. After checking the fusion temperature, wipe the heater bushes with a clean cloth.

6. **Heat the pipe and fitting**
   Push the pipe and the fitting simultaneously onto the heater bushes up to the insertion depth mark (this must remain visible).
   The pipe and the fitting are held on the heater bushes with a gentle pressure and kept straight and level.
   A timer should be used to ensure the correct heating time (see table) has elapsed.

7. **Joint the pipe and fitting**
   Align the pipe and fitting and bring them together. Push the pipe into the fitting up to the insertion depth mark (which must remain visible). Do not twist the pipe whilst pushing together. Maintain a gentle pressure whilst holding them together for the correct time (see table).

8. **Fusion inspection**
   Inspect the outer fusion bead. An even bead from the fitting and one from the pipe should be visible all the way around the pipe. Ensure the newly made joint remains stress-free until the cooling time (see table) has elapsed.

Pipe diameter (mm)	Minimum wall thickness (mm)	Insert depth (mm)	Heating time (sec.)	Holding time (sec.)	Cooling time (min.)
20	3.4	14	6	4	2
25	4.2	16	7	4	3
32	5.4	18	8	6	4
40	6.7	20	12	6	4
50	8.4	23	18	6	5
63	10.5	26	25	8	6
75	12.5	28	30	8	8
90	15.0	31	40	10	8
110	18.4	33	50	10	8
125	20.8	40	60	10	8

Socket fusion

+GF+

Instructions for Electrofusion

1. **Cut the pipe**
   Cut the pipe at a right angle, if necessary remove swarf from the inside

2. **Scrape the pipe ends**
   The pipe ends should be scraped with a blade all the way around the pipe and to a depth greater than the insertion depth. This can be by a hand scraper or rotary scraper.

3. **Clean the fitting and pipe**
   Clean the internal surface of the fitting and the outside of the pipe using Tangit KS cleaner and a lint free cloth. (Dirt or grease on the fitting or pipe can result in a joint failure).

4. **Mark the insertion depth**
   Mark the insertion depth into the fitting on the pipe.

5. **Insert the pipe into the fitting**
   Insert the scraped pipe ends into the fitting up to the insertion depth mark. Align both ends of the pipe and secure the fitting and the pipe.

6. **Attach the electrofusion machine cables**
   Attach the clamps to make the connection between the cables and the resistor pins on the fitting.

7. **Follow the electrofusion machine instructions**
   The barcode on the fitting can be read to transmit fusion data to machine
   Complete the fusion procedure in accordance with the machine instructions. Ensure the newly made joint remains stress-free until the cooling time (see table) has elapsed. About 2 hours hardening time must be allowed from when the fitting is cool before conducting pressure tests.

Minimum cooling time without moving coupler and pipe

Pipe Diameter (mm)	Cooling time (Mins)
20	10
25	10
32	10
40	15
50	15
63	20
75	25
90	30
110	35
125	40

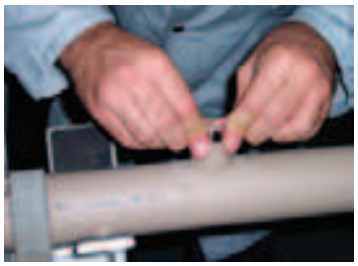
Installation of Saddles

Assemble the special heating tools for saddles with a standard socket welder. Once the socket welder is on, check the temperature, which must be in the range of 253-274°C (this operation may be performed by means of Tempil sticks). Wipe the heating tools with a clean cloth. Clean the surfaces to be welded with Tangit KS cleaner and a lint free cloth.

Drill the pipe with the specific drill, taking into consideration the saddle spigot diameter. The swarf will be taken out, avoiding any pipe contamination. It is possible to smooth the hole mouth changing the turning drill direction.

Push the saddle heating tool with the spigot into the pipe hole and the saddle into the other tool. Heat the pipe surface and the saddle for 30 seconds.

Once the heating process is over, remove the socket welder and push the saddles spigot into the pipe hole with a light pressure until the surfaces will meet entirely. Keep the position for 15-20 seconds and the system cool down for 30 minutes, before making the pressure test.



Fully accredited training courses are available.

Visit: www.georgefischer.co.uk

or email: uk.ps@georgfischer.com

GF Piping Systems › worldwide at home

Our sales companies and representatives
ensure local customer support in over 100 countries.

www.georgefischer.co.uk

The technical data is not binding. They neither constitute expressly warranted characteristics nor guaranteed properties nor a guaranteed durability. They are subject to modification. Our General Terms of Sale apply.

Adding Quality to People's Lives

Australia
George Fischer Pty Ltd
Riverwood NSW 2210 Australia
Phone +61(0)2/9502 8000
australia.ps@georgfischer.com
www.georgefischer.com.au

Austria
Georg Fischer
Rohrleitungssysteme GmbH
3130 Herzogenburg
Phone +43(0)2782/856 43-0
austria.ps@georgfischer.com
www.georgfischer.at

Georg Fischer Fittings GmbH
3160 Traisen
Phone +43 (0)2762 90300
fittings.ps@georgfischer.com
www.fittings.at

Belgium / Luxembourg
Georg Fischer NV/SA
1070 Bruxelles/Brüssel
Phone +32(0)2/556 40 20
be.ps@georgfischer.com
www.georgfischer.be

Brazil
George Fischer Ltda
04795-100 São Paulo
Phone +55(0)11/5687 1311
br.ps@georgfischer.com

China
Georg Fischer
Piping Systems Ltd Shanghai
Pudong, Shanghai 201319
Phone +86(0)21/58 13 33 33
china.ps@georgfischer.com
www.cn.piping.georgfischer.com

Denmark / Iceland
Georg Fischer A/S
2630 Taastrup
Phone +45 (0)70 22 19 75
info.dk.ps@georgfischer.com
www.georgfischer.dk

France
Georg Fischer SAS
95932 Roissy Charles de Gaulle Cedex
Phone +33(0)1 41 84 68 84
fr.ps@georgfischer.com
www.georgefischer.fr

Germany
Georg Fischer GmbH
73095 Albershausen
Phone +49(0)7161/302-0
info.de.ps@georgfischer.com
www.georgfischer.de

India
Georg Fischer Piping Systems Ltd
400 076 Mumbai
Phone +91 224007 2001
in.ps@georgfischer.com
www.georgfischer.in

Italy
Georg Fischer S.p.A.
20063 Cernusco S/N (MI)
Phone +3902/921 861
it.ps@georgfischer.com
www.georgfischer.it

Georg Fischer TPA Srl
Via Bonazzi, 32
IT-40013 Castel Maggiore (BO)
Phone +39 051-632 42 11
tpa.ps@georgfischer.com
www.alprene.com

Japan
Georg Fischer Ltd
556-0011 Osaka,
Phone +81(0)6/6635 2691
jp.ps@georgfischer.com
www.georgfischer.jp

Korea
Georg Fischer Piping Systems
Guro-3 dong, Guro-gu, Seoul, Korea
Phone +82(0)2 2081 1450
Fax +82(0)2 2081 1453
kor.ps@georgfischer.com

Malaysia
Georg Fischer (M) Sdn. Bhd.
40460 Shah Alam, Selangor
Phone +60 (0)3-5122 5585
conne.kong@georgfischer.com

Mexico
Georg Fischer S.A. de C.V.
Apodaca, Nuevo Leon
CP66636 Mexico
Phone +52 (81)1340 8586
Fax +52 (81)1522 8906

Middle East
George Fischer Piping Systems
Dubai, United Arab Emirates
Phone +971 4 289 41 20
gfdubai@emirates.net.ae
www.piping.georgfischer.com

Netherlands
Georg Fischer N.V.
8161 PA Epe
Phone +31(0)578/678 222
nl.ps@georgfischer.com
www.georgfischer.nl

Georg Fischer WAGA NV
NL-8160 AG Epe
Phone +31 (0)578-678 378
waga.ps@georgfischer.com
www.waga.nl

Norway
Georg Fischer AS
1351 Rud
Phone +47(0)67 18 29 00
no.ps@georgfischer.com
www.georgfischer.no

Poland
Georg Fischer Sp. z o.o.
02-226 Warszawa
Phone +48(0)22/313 10 50
poland.ps@georgfischer.com
www.georgfischer.pl

Romania
Georg Fischer
Piping Systems Ltd
020257 Bucharest - Sector 2
Phone +40(0)21/230 53 80
ro.ps@georgfischer.com

Russia
Georg Fischer Piping Systems
Moscow 125047
Tel. +7 495 258 60 80
ru.ps@georgfischer.com

Singapore
George Fischer Pte Ltd
528 872 Singapore
Phone +65(0)67 47 06 11
sgp.ps@georgfischer.com
www.georgefischer.com.sg

Spain / Portugal
Georg Fischer S.A.
280046 Madrid
Phone +34(0)91/781 98 90
es.ps@georgfischer.com
www.georgfischer.es

Sweden / Finland
Georg Fischer AB
12523 Älvsjö-Stockholm
Phone +46(0)8 506 775 00
info.se.ps@georgfischer.com
www.georgfischer.se

Switzerland
Georg Fischer
Rohrleitungssysteme (Schweiz) AG
8201 Schaffhausen
Phone +41(0)52 631 30 26
ch.ps@georgfischer.com
www.piping.georgfischer.ch

Taiwan
Georg Fischer Piping Systems
San Chung City, Taipei Hsien
Phone +886 2 8512 2822 Ext. 15
Fax +886 2 8512 2823

United Kingdom / Ireland
George Fischer Sales Limited
Coventry, CV2 2ST
Phone +44(0)2476 535 535
uk.ps@georgfischer.com
www.georgefischer.co.uk

USA / Canada / Latin America / Caribbean
Georg Fischer LLC
Tustin, CA 92780-7258
Phone +1(714) 731 88 00
Toll Free 800/854 40 90
us.ps@georgfischer.com
www.us.piping.georgefischer.com

Export
Georg Fischer
Piping Systems (Switzerland) Ltd.
8201 Schaffhausen
Phone +41(0)52-631 30 26
Fax +41(0)52-631 28 93
export.ps@georgfischer.com
www.piping.georgfischer.ch

LITGF0746
George Fischer Sales Limited

+GF+

GEORG FISCHER
PIPING SYSTEMS