PIPES AND FITTINGS FOR USE IN HOT & COLD TAP WATER AND HEATING SYSTEMS

TECHNICAL INSTALLATION MANUAL

Aquaterra

Polypropylene Pipes and Fittings

Your Guarantee for High Quality Construction Materials and Engineering Solutions.

AQUAGAS
Plastic Industries L.L.C.

Introductions

AQUAGAS Plastic Industries is a leading manufacturing of high quality construction materials and advanced engineering solutions founded in year 2010. AQUAGAS Plastic Industries manufacture pipes and fittings with an extensive range of market segments and applications covering Soil and waste drainage, Cold/hot water piping system, Cooling/heating systems, Cooling and chilled water piping for all residential, commercial and industrial developments.

With over years of experience, state of the art manufacturing facilities and large production capacity in the Middle East, AQUAGAS Plastic Industries manufacture products to international quality standards and caters to customers' demands by ensuring timely delivery and providing exceptional services.

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1. FEATURES OF AQUATERRA SYSTEM

AQUATerra polypropylene pipes and fittings are produced using the highest quality of 100% virgin type 3 polypropylene with 50 years estimated and guaranteed service life complying with the following standards:

- DIN8077, Germany.
- DIN8078, Germany.
- DIN16962, Germany.
- EN ISO 15874 Europe.

AQUATERRA PPR Pipes are manufactured with an acceptable tolerences in the ID and wall thickness as per the DIN standards 8077 & 8078 and EN ISO 15874

Pipes types and options vary as per the application type.

1.1 AREAS OF APPLICATION:

- POTABLE WATER PIPELINE NETWORKS
- For cold, warm and hot water installations including boiler connections, riser lines, gravity lines, and floor level distribution and concealed lines.
- Underground heating system.
- Radiators connections.
- Compressed air and Industrial pipelines including aggressive media under consideration of chemical resistance.
- agricultural pipelines

Installer can choose one of the different types of pipes to suit the operating conditions:

1.2 PIPES TYPES:

- PN16 Plain PPR Pipes.
- PN20 Plain PPR Pipes.
- PN20 PPR Fiber Composite Pipes.
- PN25 PPR Fiber Composite Pipes.
- SDR 9 PP-RCT Fiber Composite Pipes.
- SDR 7.4 PP-RCT Fiber Composite Pipes.
- SDR 6 PP-RCT Fiber Composite Pipes.
- SDR 6 UV protected Fiber Composite pipes.
- SDR 7.4 UV protected Fiber Composite pipes.

1.3 AQUATERRA FITTINGS:

As fittings are the most critical part of the system, AQUATerra fittings are produced in a PN-25 pressure class making the fittings the strongest part in the system.

All metal inserts fittings are BSPT type and made of brass nickel plated, DZR/Brass joined with the PP-R confirming no direct contact between the water and the brass parts to avoid any zincification or oxidation of the metals which can affect the quality of the potable water.

The threaded joints of adaptors comply with the requirements of the DIN 2999 resp Iso7; i.e. cylindrical female threads, and conical male threads.

Male threads for connecting backnut comply with the requirements of DIN ISO 228, part 1.

1.4 JOINTING METHOD:

- Fusion type in accordance to the DVS (German welding ins.) specifications: 2207, part 11, Section 3.2 DIN 16962.

1.5 TOOLS AND DEVICES:

- For socket welding by heating elements according to DVS leaflet 2208, Part 1, Section 5, Schedule 2, Type A.

2. FEATURES OF RAW MATERIAL:

RA140, R200P

Polypropylene Random Copolymer (PPR Type 3) for Pressure Pipes Systems.

RA 7050-GN

Polypropylene random copolymer crystalline temperature (PPR-CT Type 4) for Pressure Pipes Systems.

2.1 DESCRIPTION

RA140, R200P is a high moleculer weight, low melt flow rate polypropylene random copolymer (PP-R).

RA7050-GN is a PP-RCT, a Polypropylene-Random-Copolymer with an enhanced crystalline structure brought about by a special β-nucleation and with an improved Temperature resistance.
Proof of the excellent performance characteristics of Beta-PPR™ RA7050-GN is, for example, a categorised required strength (CRS) of 5 MPa at 70°C and 50 years (according to ISO 12162) in comparison to a value of 3.21 MPa for standard PP-R.
The colour of Beta-PPR™ RA7050-GN is green similar to RAL 6024.

2.2 APPLICATIONS

RA140, R200P together with the appropriate additive package is recommended for the production of PP-R Pipes and fittings used in: Heating, Plumbing, Domestic water, Relining, and Industrial applications.

The product is suitable for plain, and Faser Composite Multilayer PP-R pipes.

2.3 SPECIFICATIONS

RA140, R200P is intended to fulfill the following standards and regulations, providing the appropriate industrial manufacturing standard procedures are used and a continuous quality system is implemented: DIN 8077, DIN 8078 and EN ISO 15874.

2.4 SPECIAL FEATURES

RA140, R200P is a natural grade used for production of pipes and fittings. The material is in pallet form and includes selected additive package which ensure:

- Enhanced process ability
- High temperature resistance
- Economical pipe production
- Low incidence on taste and odour
- Excellent product consistency
- Good impact strength

The pipe systems will show high durability, no corrosion, good weld ability, homogeneous joints, low tendency to incrustations and fast and easy installation.

2.5 Physical properties

Property	Typical Value	Test Method
Density	905 kg/m3	ISO 1183
Melt Flow Rate (230 °C/2.16 kg)	0,25 g/10min	ISO 1133
Flexural Modulus (2 mm/min)	800 MPa	ISO 178
Tensile Modulus (1mm/min)	900 MPa	ISO 527
Tensile Strain at Yield (50 mm/min)	13,5 %	ISO 527-2
Tensile Stress at Yield (50 mm/min)	25 MPa	ISO 527-2
Thermal Conductivity	0,21 W/(m K)	DIN 52612
Coefficient of Thermal Expansion (0 °C/70 °C)	1,5*10E-4/K	DIN 53752

3. DIMENSION

- Pipes: According to EN ISO 15874-2 , DIN 8077
- Fittings: According to EN ISO 15874-3, DIN 16962.

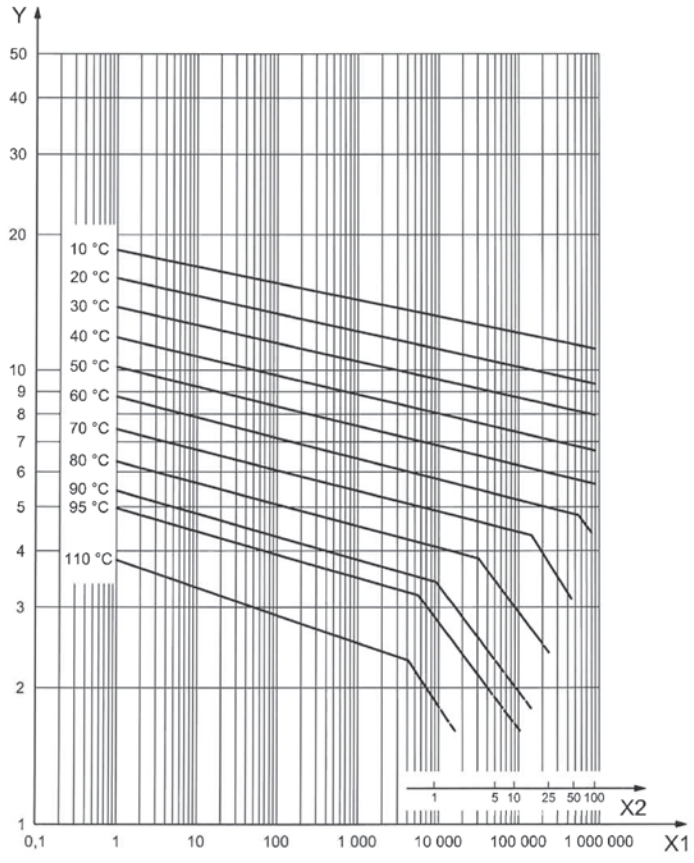
4. QUALITY CONTROL

- PPR Pipes: According to DIN 8078 for PP-R 80.
- PPRCT Pipes: According to DIN 8078 for PP-RCT.
- PPR Fittings: According to DIN 16962 part 5 A (E Type 3).
- PPRCT Fittings: According to DIN 16962 (Type 4)

5. CHEMICAL RESISTANCE

- Detailed information on the chemical resistance of polypropylene pipes and pipelines is available in page 23.

6. LIFETIME



Key
X1 time, t_1, to fracture, in hours
X2 time, t_2, to fracture, in years
Y hoop stress, σ, in megapascal

Figure 3 — Reference curves for expected strength of PP-R

7. MARKING

7.1 Pipes

Pipes included in the Aquaterra system are designed in compliance with DIN 8077 and DIN 8078 standards. Figure showing an example of the length of the pipe with markings used by the manufacturer of the system. Symbols shown of figure have the following meaning:

7.2 Normal Pipe :

- producer logo:	**(logo)**
- product/system name	**AQUATERRA**
- raw material symbol	**PP-R**
- dimensions (diameter x wall thickness) e.g.	**32 x 5.4**
- dimensional class	**A**
- application class / working pressure/ Working temperature/ Life time :	**Class 1/10 bar/60 oC / 50 years**
- pressure series for cold water flow e.g.	**PN20**
- production line number e.g.	**L2**
- raw material code e.g.	**H608741**
- production date (DD/MM/YY / hour : minute) e.g.	**11/06/2016 / 08:00**
- standard number	**EN ISO 15874 , DIN 8077/8078**
- DVGW Approval Number :	**DVGW- 8317CR0300**
- Production Batch number :	**ADH83470332161710**

7.3 Multi Layer Pipes :

- producer logo:	**(logo)**
- product/system name	**AQUATERRA**
- Faser Composite Stabi – fiber reinforced multilayer pipe - Faser Composite Aluminum Stabil – fiber reinforced multilayer pipe with aluminum layer - Faser Composite UV Stabil – fiber reinforced multilayer pipe with uv protection	
- raw material symbol	**PP-R**
- dimensions (diameter x wall thickness) e.g.	**32 x 5.4**
- pressure series for cold water flow e.g.	**PN25**
- standard number	**DIN 8077/8078**
- production line number e.g.	**EXT=02**
- production date (DD/MM/YY / hour : minute) e.g.	**13/08/16 / 06:59**
- Production Batch number :	**ADH83470332161710**

7.4 PP-RCT Pipes :

- producer logo:	**(logo)**
- product/system name	**AQUATERRA**
- Faser Composite Stabi – fiber reinforced multilayer pipe	
- raw material symbol	**PP-RCT**
- dimensions (diameter x wall thickness) e.g.	**32 x 4.4**
- pressure series for cold water flow e.g.	**PN20**
- standard number	**DIN 8077/8078**
- production line number e.g.	**L=02**
- production date (DD/MM/YY / hour : minute) e.g.	**13/08/16 06:59**
- Production Batch number :	**ADH83470332161710**

7.5 UV PP-R Pipes :

- producer logo:	**(logo)**
- product/system name	**AQUATERRA**
- Faser Composite Stabi – fiber reinforced multilayer pipe	
- raw material symbol	**UV PP-RCT**
- dimensions (diameter x wall thickness) e.g.	**32 x 5.4**
- pressure series for cold water flow e.g.	**PN25**
- standard number	**DIN 8077/8078**
- production line number e.g.	**L=02**
- production date (DD/MM/YY / hour : minute) e.g.	**13/08/16 / 06:59**
- Production Batch number :	**ADH83470332161710**

8. DIMENSION OF PP-R AND PP-RCT PRESSURE SERIES PIPES

SDR 9				
O.D	Wall thickness	I.D	Unitary Capacity	Weight
20	2.3	15.4	0.186	0.127
25	2.8	19.4	0.295	0.191
32	3.6	24.8	0.483	0.313
40	4.5	31	0.754	0.487
50	5.6	38.8	1.182	0.755
63	7.1	48.8	1.869	1.2
75	8.4	58.2	2.659	1.69
90	10.1	69.8	3.825	2.44
110	12.3	85.4	5.725	3.62
125	14	97	7.386	4.66
160	17.9	124.2	12.109	7.62

SDR 7.4				
O.D	Wall thickness	I.D	Unitary Capacity	Weight
20	2.8	14.4	0.163	0.151
25	3.5	18	0.254	0.236
32	4.4	23.2	0.423	0.389
40	5.5	29	0.660	0.605
50	6.9	36.2	1.029	0.934
63	8.6	45.8	1.647	1.484
75	10.3	54.4	2.323	2.11
90	12.3	65.4	3.358	2.931
110	15.1	79.8	4.999	4.32
125	17.1	90.8	6.472	5.53
160	21.9	116.2	10.599	9.04

SDR 6				
O.D	Wall thickness	I.D	Unitary Capacity	Weight
20	3.4	13.2	0.137	0.172
25	4.2	16.6	0.216	0.226
32	5.4	21.2	0.353	0.434
40	6.7	26.6	0.555	0.671
50	8.3	33.4	0.876	1.05
63	10.5	42	1.385	1.65
75	12.5	50	1.963	2.34
90	15	60	2.826	3.36
110	18.3	73.4	4.229	5.04
125	20.8	83.4	5.460	6.47
160	26.6	106.8	8.954	10.6

9. RELATIVE PN FOR EACH PIPE TYPE

Pipe Type	SDR 9	SDR 7.4	SDR 6
Plain PPR Pipe	NA	PN 16	PN 20
Faser Multilayer PPR Pipes	NA	PN 20	PN 25
Faser Multilayer PP-RCT Pipes	PN 20	PN 25	PN 32

10. OPERATING CONDITIONS

Temperature [°C]	Years of service	Pipe grade (according DIN 8077/8078)			
		Nominal pressure			
		PN 10	PN 16	PN 20	PN 25
		Permissible working pressure [bar] *			
10	1 5 10 25 50 100	17,6 16,5 16,1 15,6 15,2 14,8	28,2 26,5 25,8 25,0 24,3 23,7	35,2 33,1 32,3 31,2 30,4 29,6	44.2 41.8 40.4 39.1 38.1 37.1
20	1 5 10 25 50 100	14,9 14,1 13,7 13,3 12,9 12,5	23,9 22,6 22,0 21,3 20,7 19,5	29,9 28,3 27,5 26,7 25,9 25,1	37.8 35.4 34.4 33.4 32.4 31.4
30	1 5 10 25 50	12,8 12,0 11,6 11,2 10,9	20,5 19,2 18,6 17,9 17,5	25,6 24,0 23,2 22,4 21,9	32.1 30.1 29.1 28.1 27.4
40	1 5 10 25 50	10,8 10,1 9,9 9,5 9,2	17,3 16,2 15,8 15,2 14,7	21,6 20,3 19,7 18,9 18,4	27.1 25.4 24.7 23.7 23.1
50	1 5 10 25 50	9,1 8,5 8,3 8,0 7,7	14,6 13,7 13,2 12,8 12,4	18,3 17,1 16,5 16,0 15,5	23.1 21.4 20.7 20.0 19.4
60	1 5 10 25 50	7,7 7,2 6,9 6,7 6,5	12,4 11,5 11,1 10,7 10,4	15,5 14,4 13,9 13,3 12,9	19.4 18 17.4 16.7 16
70	1 5 10 25 50	6,5 6,0 5,8 4,9 4,3	10,5 9,6 9,3 7,9 6,8	13,1 12,0 11,6 9,9 8,5	16.4 15.0 14.7 12.7 10.7
80	1 5 10 25	5,5 4,8 4,0 3,2	8,8 7,7 6,4 5,1	10,9 9,6 8,0 6,4	13.7 12.0 10.0 8.0
95	1 5 (10)	3,9 2,6 2,2	6,2 4,1 3,5	7,7 5,2 4,3	9.7 6.3 5.3

Explanations:

* Permissible working pressure as given at safety factor 1,5

– recommended application cold water installation

– recommended application hot water installation

– recommended application central heating installation

11. CHARACTERISTICS OF PIPES

Characters	Type	Unit	PP-R value
Specific gravity	PP-R	g / cm3	0,9
Thermal expansion coefficient (elongation)	PP-R Plain Pipes	mm / m ˚C	0.18
	PP-R+Fiber Pipes		0.035
Thermal conductivity coefficient	All types of pipes	W / m ˚C	0.21

12. FIRE PROTECTION

AQUATerra pipes and fittings are classified under Fire Classification B 2 according to DIN 4102, Section 4. Since all pipes and fittings are made of pure polypropylene, AQUATerra pipes do not exhibit increased conflagration gas toxicity.

Generally, all pipe lead through must possess the same classification as the penetrated elements. For example, in a wall with fire resistance duration of 90 minutes (F 90), the pipe lead through must also possess a fire resistance duration of 90 minutes (R 90).

13. PP-RCT

Polypropylene Random Copolymer Crystalline Temperature (PP-RCT Type 4) is the latest invention in polymers piping industry, developed with a crystalline structure that exhibits an improved pressure rating at elevated temperatures.

A special nucleation process that enables the pipe to operate at higher pressures at elevated temperatures with the same wall thickness of normal PPR, this high pressure rating allow to down-gauge to a thinner wall pipe offering higher hydraulic capacities and cost savings.

Permissible working. Pressure and temperature for PP-RCT

Temperature	Operating Time [years]	SDR 11 PP-RCT	SDR 9 PP-RCT	SDR 7.4 PP-RCT	SDR 6 PP-RCT
20˚C	10	15.8	19.9	25.1	31.6
	25	15.5	19.6	24.6	31
	50	15.3	19.3	24.3	30.6
30˚C	10	13.6	17.2	21.7	27.3
	25	13.4	16.9	21.2	26.8
	50	13.2	16.6	20.9	26.4
40˚C	10	11.7	14.7	18.6	23.4
	25	11.5	14.4	18.2	22.9
	50	11.3	14.2	17.9	22.6
60˚C	10	8.4	10.6	13.4	16.8
	25	8.2	10.4	13.1	16.5
	50	8.1	10.2	12.8	16.2
70˚C	10	7	8.9	11.2	14.1
	25	6.9	8.7	10.9	13.8
	50	6.8	8.5	10.7	13.5
80˚C	10	5.9	7.4	9.3	11.7
	25	5.7	7.2	9.1	11.4
95˚C	5	4.4	5.6	7.1	8.9

Permissible operating pressures in bar (including a safety factor of 1.5)

Permissible working. Pressure and temperature for PP-RCT

Temperature	Operating Time [years]	SDR 11 PP-RCT	SDR 9 PP-RCT	SDR 7.4 PP-RCT	SDR 6 PP-RCT
20˚C	10	19	23.9	30.1	37.9
	25	18.6	23.5	29.6	37.2
	50	18.4	23.1	29.2	36.7
30˚C	10	16.4	20.6	26	32.7
	25	16.1	20.2	25.5	32.1
	50	15.8	19.9	25.1	31.6
40˚C	10	14.1	17.7	22.3	28.1
	25	13.8	17.3	21.8	27.5
	50	13.6	17.1	21.5	27.1
60˚C	10	10.1	12.7	16	20.2
	25	9.9	12.4	15.7	19.8
	50	9.7	12.2	15.4	19.4
70˚C	10	8.5	10.7	13.5	16.9
	25	8.3	10.4	13.1	16.5
	50	8.1	10.2	12.9	16.2
80˚C	10	7	8.9	11.2	14.1
	25	6.9	8.6	10.9	13.7
95˚C	5	5.3	6.7	8.5	10.7

Permissible operating pressures in bar (including a safety factor of 1.25)

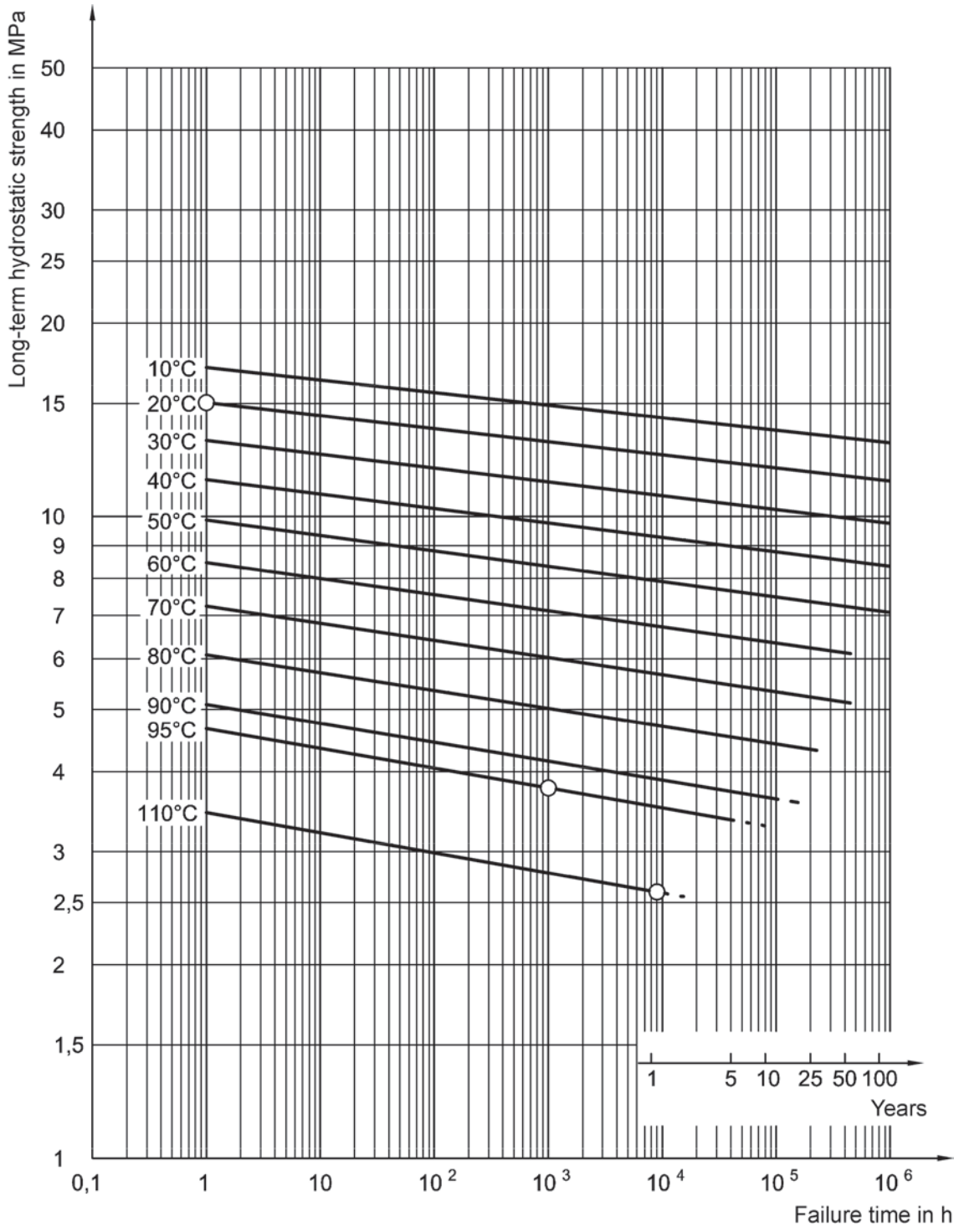


Figure 4 — Reference characteristic curves of the long-term hydrostatic strength (minimum curves) for PP-RCT pipes

14. DISINFECTION OF AQUATERRA PIPING SYSTEM

In proven cases of contamination, the disinfection of drinking water installations must only be carried out for the limited period of time. Prophylactic disinfection measures do not comply with the minimum quality requirements of the Drinking Water Ordinance. The disinfection of drinking water installations can only be successful, if all sources of contamination have been removed before hand. The limit values for disinfectant concentration specified in the Drinking Water Ordinance represent maximum values, which were set in accordance with hygienic and toxicological standards. However, no conclusions should be drawn automatically from these values with regard to the resistance of product materials to the disinfectant agents. Only trained specialists may carry out the disinfection of drinking water installations. The disinfection measures must be recorded in writing.

Disinfection measures carried out incorrectly can damage the drinking water installation. A combined thermal-chemical disinfection procedure is not permitted.

The thermal disinfection AQUATerra pipe systems must be carried out as follow:

- The water heater and the entire circulation system must be heated to at least 70°C.
- Open all draw-off points in succession or line by line.
- Hot water at a temperature of 70°C must be allowed to run from all draw-off points for at least three minutes.
- Do not allow the temperature to drop during the disinfection process.
- Do not exceed the maximum to eliminate the risk of scalding.

The total thermal disinfection time for drinking water installations must not exceed 150 hours per year. Longer disinfection times or excessive temperatures can reduce the service life of the drinking water and can damage the system.

14.1 Chemical disinfection – “shock disinfection”

During the process of chemical disinfection (“shock disinfection”) in accordance with Pt. 7.5.2 of the ÖNORM-Standard B 5019, the disinfecting agent can be fed into the cold water circulation or the warm water circulation, respectively. When the disinfecting agent is fed into the warm water circulation, the temperatures must first be reduced to below 25°C. Carrying out “shock disinfections” at higher temperatures is not permissible, as premature material damage cannot be ruled out. In relation to the service life of the installed system, the number of disinfecting procedures must not exceed 5 cycles. No drinking water may be drawn either during the disinfection process or the subsequent flushing of the system with cold water.

14.2 Concentration and contact times of chemical for chemical disinfection

Active component	Chemical Formula	Max. Concentration Applied	Contact time	Max. water Temperature in the system
Chlorine Dioxide	ClO_2	6 mg/l as ClO_2	8 to 12 hrs	<25° C
Hypochlorite	ClO^-	50mg/l as Cl_2 (chorine)	8 to 12 hrs	<25° C
Permanganate	MnO_4^-	15 mg/l	24 hrs	<25° C
Hydrogen Peroxide	H_2O_2	150 mg/l	24 hrs	<25° C

During the application the applied concentration and application temperature may not be exceeded at any point within the pipe system.

14.3 Continuous metered addition of chemicals – “permanent disinfection”

The continuous metered addition of chemicals according to Pt. 9 of the ÖNORM-Standard B 5019 is only permissible in instances when repeated decontamination processes (thermal, chemical, according to Section 7 the ÖNORM-Standard) did not produce the desired results and where the systems in question have low levels of biofilm.

It must be stated that the continuous metered addition of chemicals can in no way replace the structural measure until such a time as the refurbishment takes place, and not as prophylactic measure against Legionella.

If the time frame and the maximum water temperature are exceeded, damage the component parts of the pipe systems (Pipe, seals, etc.) cannot be ruled out. This applies to all prevalent materials used in plumbing technology (types of metal, plastic and elastomers).

The following table lists the concentration and contact times of chemicals on the basis of ÖNORM-Standard B 5019.

14.4 Concentration and contact times of chemical for continuous metered addition

Active Component	Chemical Formula	Max. Concentration Applied	Max. period of Application	Max. water Temperature in the system
Chlorine Dioxide**	ClO_2	0,4 mg/l als ClO_2	4 months	60°C
Hypochlorite	ClO^-	0,3 mg/l als Cl_2(chlor)	4 months	60°C
Chlorine	Cl_2	0,3 mg/l als Cl_2(chlor)	4 months	60°C
Chlorine Dioxide**	ClO_2	0,4 mg/l als ClO_2	18 months	<25° C
Hypochlorite	ClO^-	0,3 mg/l als Cl_2(chlor)	18 months	<25° C
Chlorine	Cl_2	0,3 mg/l als Cl_2(chlor)	18 months	<25° C

** For the disinfection process using chlorine dioxide (listed as ClO_2) the maximum amount that can be added into the pipe system is 0.4 mg/l ClO_2.

15. INSULATION

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

15.1 General

Pipe insulation shall be designed to meet the following requirements:

a) Legal and other obligations
b) Insulation material shall be adequately protected against moisture.
c) Insulation material 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. Open-cell and fibrous insulating materials shall be provided with a vapor barrier bonded to the outer surface of the insulation.

Condensation can form on any insulating material if the cold water pipes are inadequately lagged. Unsuitable material 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 shall, therefore, be drained or otherwise protected.

15.2 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 far away from 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 the heat.

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

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

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

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

Location of pipe	Insulation Thickness λ=0,040 W/mK *)
Exposed pipes, in unheated room (e.g.cellar)	4 mm
exposed pipes, in heated room	9 mm
Ducted pipes, (cold water only)	4 mm
Ducted pipes, (cold and hot water)	13 mm
Chased pipes, risers	4mm
Pipes in wall recess, next to hot pipes	13 mm
Pipes on concrete floor	4 mm
for other values of λ, the thickness is to be obtained by conversion, on the basis of a pipe diameter of 20 mm	

15.3 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.

15.4 Thermal insulation of warm water pipes

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

Table B - Minimum Thickness of insulation hot water pipes

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

16. DESIGNING

16.1 Course of water system design

Aquaterra System installation and design is in compliance with the standards DIN2000 and DIN1988. The process of design of cold and warm water systems is divided into the following phases:

a) segmentation of system into design sections featuring with a constant flow,

b) determination of design flows for individual sections,

c) choice of pipe diameters for design sections,

d) determination of pressure drops,

e) determination of minimum water pressure required for the system.

16.2 Course of central heating system design

The process of designing a central heating system divides into the following phases:

a) calculation of power losses for every room,

b) choice of radiators, determination of supply water temperature and temperature drop,

c) segmentation of system into design sections,

d) determination of design flows for individual sections,

e) choice of appropriate pipe diameter for every section,

f) calculation of pressure losses in the system.

16.3 Dimensioning of pipes – hydraulic calculation

• Design flow

The value of design flow, individual for every design section, is determined based on the number of draw-off points, with water draw-off diversity factor taken into account. For every draw-off point, the standard water discharge and pressure required upstream this point is determined.

4) DIN 2000. Water supply system. Design requirments.

5) DIN 1988. Technische Regeln für Trinkwasser-Installationen (TRWI). Allgemeines. Technische Regel des DVGW. Teil 1 bis 8.

Table 1. Formulas for determination of design flows in main water systems for various types of building objects (after DIN 1988, Teil 3).

Type of object *	Formula	Remarks
Residential buildings	$q = 0{,}682\ (\Sigma q_n)^{0.45} - 0{,}14$	for $0{,}07 \le \Sigma q_n \le 20$ dm³/s and for fittings with $q_n < 0{,}5$ dm³/s
	$q = 1{,}7\ (\Sigma q_n)^{0.21} - 0{,}7$	for $\Sigma q_n > 20$ dm³/s and for fittings with $q_n \ge 0{,}5$ dm³/s
Office and administration buildings	$q = 0{,}682\ (\Sigma q_n)^{0.45} - 0{,}14$	for $\Sigma q_n \le 20$ dm³/s
	$q = 0{,}4\ (\Sigma q_n)^{0.54} + 0{,}48$	for $\Sigma q_n > 20$ dm³/s
Hotels and department stores	$q = 0{,}4\ (\Sigma q_n)^{0.366}$	For draw–off points with $q_n > 0{,}5$ dm³/s oraz w obszarze $1 < \Sigma q_n \le 20$ dm³/s
	$q = 0{,}698\ (\Sigma q_n)^{0.5} - 0{,}12$	For draw–off points with $q_n < 0{,}5$ dm³/s and within the range of $0{,}1 < \Sigma q_n \le 20$ dm³/s
	$q = 1{,}08\ (\Sigma q_n)^{0.5} - 1{,}82$	for $\Sigma q_n > 20$ dm³/s (for hotels)
	$q = 0{,}698\ (\Sigma q_n)^{0.5} - 0{,}12$	for $\Sigma q_n > 20$ dm³/s (for department stores)
Hospitals	$q = 0{,}698\ (\Sigma q_n)^{0.5} - 0{,}12$	for $\Sigma q_n \le 20$ dm³/s
	$q = 0{,}25\ (\Sigma q_n)^{0.65} + 1{,}25$	for $\Sigma q_n > 20$ dm³/s
Schools	$q = 4{,}4\ (\Sigma q_n)^{0.27} - 3{,}41$	for $1{,}5 < \Sigma q_n \le 20$ dm³/s; for $\Sigma q_n \le 1{,}5$ dm³/s $q = \Sigma q_n$
	$q = -22{,}5\ (\Sigma q_n)^{-0.5} + 11{,}5$	for $\Sigma q_n > 20$ dm³/s

Remarks:

q_n – standard discharge from draw–off points, dm³/s

Σq_n – sum of all standard water discharges from draw–off points served by dimensioned section of a system, dm³/s

q – design flow, dm³/s

* For main water systems in objects other than listed above, the formula for calculation of design flow should be selected depending on how the users utilise the system.

Standard discharges from draw–off points are given in Table 2., whereas design flows of water determined according to the formula for residential buildings are shown in Table 3.

Table 2. Standard water discharges from draw-off points and required pressures upstream draw-off point (after PN 92/B-01706).

Type of draw–off point		Required pressure MPa	Standard water discharge		
			mixed[1]		Cold only or warm only
			q_n cold, dm^3/s	q_n warm, dm^3/s	q_n dm^3/s
Tap valve:					
Without spray[2]	...Dn 15[4]	0,05			0,3
	...Dn 20	0,05			0,5
	...Dn 25	0,05			1,0
With spray	...Dn 10	0,1			0,15
	...Dn 15	0,1			0,15
Shower head	...Dn 15	0,1	0,1	0,1	0,2
Toilet flush valve	...Dn 15	0,12			0,7
	...Dn 20	0,12			1,0
	...Dn 25	0,04			1,0
Flush valve for urinals	...Dn 15	0,1			0,3
Dish washer (home)	...Dn 15	0,1			0,15
Automatic washing machine (home)	...Dn 15	0,1			0,25
Tap units					
For showers	...Dn 15	0,1	0,15	0,15	
For bathtubs	...Dn 15	0,1	0,15	0,15	
For sinks	...Dn 15	0,1	0,07	0,07	
For wash bowls	...Dn 15	0,1	0,07	0,07	
For sitting baths	...Dn 15	0,1	0,07	0,07	
Tap mixing unit	...Dn 20	0,1	0,3	0,3	
Flushing cistern	...Dn 15	0,05			0,13
Electric boiler [3]	...Dn 15	0,1			0,1

Remarks:

[1] cold water Tz = 15°C, warm warer Tc = 55°C

[2] for valves with hose L ≤ 10 m, pressure 0,15 MPa

[3] with throttle screw fully open

[4] Dn – nominal diameter of draw–off point, mm

16.4 Velocity of flow

For dimensioning of conduits operating under pressure and assembled from elements of AQUATerra system, it is recommended to assume the following maximum flow velocities:

- Water systems:

  a) in connections from risers to draw-off points . . . . . .2,0 m/s,

  b) in risers . . . . . 2,0 m/s,

  c) in distributing pipes . . . . . 1,5 m/s,

  d) in tap water connections (home) . . . 1,5 m/s.

- Central heating systems

Due to resistance of flow, velocities recommended for central heating systems are within the range of 0.2 to 1.0 m/sec.

In specific cases it is allowed to assume greater values of flow velocity, provided the system is protected against generation of noise and vibrations. Noise level for the system should not exceed permissible values stated in the PN-87/B-02151/02[6] standard.

16.5 Linear hydraulic resistance

Linear pressure losses for individual design sections are calculated from the *Darcy-Weisbach* formula:

$$\Delta h_l = R \cdot L = \lambda \cdot \frac{L}{Dw} \cdot \frac{v^2}{2 \cdot g} \qquad \text{[formula 1]}$$

where:

Δh_l - linear pressure losses head, [m H_2O][7],
R - unitary linear pressure losses head, [hPa/m], [%][8],
L - coefficient of linear resistance, [-],
λ - length of design section, [m],
Dw - inside diameter of the conduit, [m],
v - average velocity of flow through the section, [m/s],
g - acceleration of gravity, [m/s^2].

The value of coefficient λ should be calculated using the *Colebrook-White* formula, assuming that the value of absolute roughness coefficient „k" for pipes made of polypropylene equals to 0,007 mm. In order to facilitate calculation of linear pressure losses, the values of elementary pressure losses „R" for various flows, conduit diameters and typical design temperatures are shown in Attachment 2 (Table 1 to Table 11).

16.6 Local hydraulic resistance (pressure losses on fittings)

Local pressure losses caused by the presence of fittings, couplings and fixtures in the system are calculated according to the *Weisbach* formula:

$$\Delta h_m = \zeta \cdot \frac{v^2}{2 \cdot g} \qquad \text{[formula 2]}$$

where:

Δh_m - local pressure losses head, [m H_2O][9],
ζ - coefficient of local resistance, [-],
v - average velocity of flow in the section, [m/s],
g - acceleration of gravity, [m/s^2].

The value of the coefficient z for fittings and couplings belonging to the AQUATerra can be found in Table 1 (Attachment 3). The values of local resistance coefficient given in the table have been calculated on the basis of technical literature and author's own studies and calculations.

The values of ζ for fixtures and other water system fittings are published by manufacturers of respective equipment and can also be found in the Polish standard No. PN-76/M-34034[10]

16.7 Gradients (slopes) of conduits

The selected values of gradients or slopes of conduits should ensure proper draining and venting of the system.

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[6] *PN-87/B-02151/02. Building acoustics. Noise protection in buildings. Permissible values of noise level in buildings.*
[7] *Pressure losses' head expressed in meters of water column (see Attachment 1: Calculation aids).*
[8] *Unitary head of pressure loss equal to 1 hPa/m is equivalent to hydraulic drop expressed in %.*
[9] *Pressure losses head expressed in metres of water column (see Attachment 1: Calculation aids).*
[10] *Pipelines. Principles for calculations of pressure losses.*

17. CONVERSION OF SELECTED UNIT OF MEASURE

17.1 Conversion of pressure units

Bar	m H_2O *	at	daPa	hPa	MPa
0	0	0	0	0	0,0
1	10	1	10000	1000	0,1
2	20	2	20000	2000	0,2
3	30	3	30000	3000	0,3
4	40	4	40000	4000	0,4
5	50	5	50000	5000	0,5
6	60	6	60000	6000	0,6
7	70	7	70000	7000	0,7
8	80	8	80000	8000	0,8
9	90	9	90000	9000	0,9
10	100	10	100000	10000	1,0

17.2 Conversion of units of flow

dm^3/s	dm^3/min	m^3/h
0	0	0
2	120	7,2
4	240	14,4
6	360	21,6
8	480	28,8
10	600	36
12	720	43,2
14	840	50,4
16	960	57,6
18	1080	64,8
20	1200	72

18. SYMBOLS

A behavior of polypropylene pipes and fittings under the influence of selected chemical compound is categorized in the following way:

T – resistant: material for pipes and fittings was thoroughly examined and passed all tests positively.

T/N – conditionally resistant: behavior of pipe and fitting material should be checked every time for a given operating parameters of the system – next detailed examinations are necessary.

N – non–resistant: changes of pipe and fitting material under the influence of transported substance or chemical compound were found. Polypropylene pipes should not be used for transportation of this substance or compound.

(-) no data available: there are no data concerning chemical resistance of polypropylene to a given compound or chemical product.

In the column entitled" Concentration", the following descriptions of the composition of examined substances is used:

Numeric value in % – concentration of the solution of examined substance,
All – all concentrations of examined substance have been checked,
A – water solution of the substance, with the content of the substance < 10%,
B – water solution of the substance, with the content of the substance > 10%,
C – saturated water solution (at the temperature of 20°C),
D – transported liquid is at least technically pure,
E – commercial composition of examined substance.

19. CHEMICAL RESISTANCE OF PIPES AND FITTINGS

TABLE1.

Chemical resistance of pipes and fittings made of type 3 polypropylene to selected chemical substances.

Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
1	Acetic acid (aqueous solution)	D	T	T/N	N
2	Acetic acid (aqueous solution)	do 40%	T	T	–
3	Acetone	D	T	T	–
4	Air	D	T	T	T
5	Ammonia water	C	T	T	–
6	Ammonium (in gas)	D	T	T	–
7	Ammonium (in liquid)	D	T	–	–
8	Ammonium chloride (sal–ammoniac)	C	T	T	–
9	Ammonium fluoride	B	T	T	–
10	Aniline (amino benzene)	D	T/N	T/N	–
11	Aniline chloride	C	T	T	–
12	Apple acid	B	T	T	–
13	Apple juice	E	T	T	T
14	Aqua regia (HCl/HNO3)	75% / 75%	N	N	N
15	Arsenic acid (aqueous solution)	10%	T	T	–
16	Arsenic acid (aqueous solution)	80%	T	T	T/N
17	Beer	E	T	T	T
18	Benzaldehyde (benzoic aldehyde)	C	T	T	–
19	Benzoic acid	C	T	T	–
20	Benzol	D	T/N	N	N
21	Borax (sodium tetra borate)	B	T	T	–
22	Boric acid (orto)	C	T	T	T
23	Bromine (bromine water)	C	T/N	N	N
24	Bromine (vapors)	all	T/N	N	N
25	Butadiene (in gas)	D	T/N	N	N
26	Butane (in gas)	D	T	T	–
27	Butane acid (butyric acid, aqueous solution)	20%	T	–	–
28	Butanol (butyl alcohol)	D	T	T/N	T/N
29	Butylene (butane, in liquid)	D	T/N	–	–
30	Butyric acid (aqueous solution)	20%	T	–	–
31	Calcium carbonate	C	T	T	T
32	Calcium hydroxide	C	T	T	–
33	Camphor oil	D	N	N	N
34	Carbolineum	E	T	–	–
35	Carbon dioxide (in gas)	all	T	T	–
36	Chloramine	B	T	–	–
37	Chloric acid (aqueous solution)	1%	T	T/N	N
38	Chloric acid (aqueous solution)	10%	T	T/N	N

Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
39	Chloric acid (aqueous solution)	20%	T	N	N
40	Chlorinated lime	all	T	T	–
41	Chlorinated portable water	D	T	T	T
42	Chlorine (in gas, dry)	D	N	N	N
43	Chlorine (in gas, damp)	0,5%	T/N	N	N
44	Chlorine (in gas, damp)	1 %	N	N	N
45	Chlorine (sin liquid)	D	N	N	N
46	Chlorine (chlorine water)	C	T/N	N	N
47	Chloroacetic acid, (mono)	B	T	T	–
48	Chloroacetic acid, (mono)	85%	T	T	–
49	Chlorobenzol	D	T/N	–	–
50	Chloroform	D	T/N	N	N
51	Chloromethane (in gas, methyl chloride)	D	N	N	N
52	Chlorosulfonic acid	D	N	N	N
53	Chromic acid (aqueous solution)	40%	T/N	T/N	N
54	Chromic alum	C	T	T	–
55	Citric acid	A	T	T	T
56	Copra (coconut oil)	D	T	–	–
57	Corn oil	D	T	T/N	–
58	Crezol	90%	T	T	–
59	Crezol	> 90%	T	–	–
60	Crude oil	E	T	N	N
61	Cupric chloride	C	T	T	–
62	Cupric sulfate	C	T	T	–
63	Cuprous cyanide	C	T	T	–
64	Cyclohexanol (cyclohexyl acid)	D	T	T/N	–
65	Decaline (decahydronaphthalene)	D	T/N	N	N
66	Dextrin	B	T	T	–
67	Dextrose (grape sugar. D–glucose)	20%	T	T	T
68	Dichloric acid (aqueous solution)	50%	T	T	–
69	Dichlorobenzol	D	T/N	–	–
70	Dichloromethane (methylene chloride)	D	T/N	N	N
71	Diesel oil	E	T	T/N	–
72	Dimethylamine (in gas)	100%	T	–	–
73	Distilled water	E	T	T	T
74	Engine oil	D	T	T/N	–
75	Ethanol (ethyl alcohol)	D	T	T	T
76	Ethylene dichloride (1,1– and 1,2–)	D	T/N	–	–
77	Ethylene Glycol	D	T	T	T
78	Etylobenzene	D	T/N	N	N
79	Fatty acid	D	T	T/N	–

Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
80	Ferric and ferrous chlorides	C	T	T	–
81	Fluorine (dry)	D	T/N	–	–
82	Formaldehyde (methanol, aqueous solution)	40%	T	T	–
83	Fructose	B	T	T	T
84	Fruit juices and beverages	E	T	T	T
85	Furfural alcohol	D	T	T/N	–
86	Gelatin	B	T	T	T
87	Glucose (aqueous solution)	20%	T	T	T
88	Glyceryn	D	T	T	T
89	Glycol acid (aqueous solution)	30%	T	T/N	–
90	Hexane	D	T	T/N	–
91	Heptane	D	T	T/N	N
92	Hydrochloric acid (aqueous solution)	do 20%	T	T	–
93	Hydrochloric acid (aqueous solution)	20% do 36%	T	T/N	T/N
94	Hydrofluoric acid (aqueous solution)	40%	T	T	–
95	Hydrofluoric acid (aqueous solution)	70 %	T	T/N	–
96	Hydrogen	D	T	T	–
97	Hydrogen chloride (in gas damp)	D	T	T	–
98	Hydrogen chloride (in gas dry)	D	T	T	–
99	Hydrogen peroxide (aqueous solution)	30%	T	T/N	–
100	Hydrogen sulfide	D	T	T	–
101	Hydroquinone	B	T	–	–
102	Illuminating gas	E	T	–	–
103	Isooctane	D	T	T/N	N
104	Isopropanol (isopropyl alcohol)	D	T	T	T
105	Kerosene	D	T	T/N	–
106	Ksylol (all isomers)	D	T/N	N	N
107	Lactic acid	90%	T	T	–
108	Lanolin	E	T	T/N	–
109	Linseed oil	E	T	T	T
110	Liquid grease	E	T/N	–	–
111	Machine oil	D	T	T/N	N
112	Magnesium chloride	C	T	T	T
113	Mazout (diesel oil)	E	T	T/N	–
114	Menthol	D	T	T/N	–
115	Mercury	D	T	T	–
116	Mercury salt	C	T	T	–

Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
117	Methanol (methyl alcohol)	D	T	T	–
118	Methanol (methyl alcohol)	5%	T	T	T/N
119	Methyloamine (aqueous solution)	32%	T	–	–
120	Milk	E	T	T	T
121	Mineral water	E	T	T	T
122	Molasses	E	T	T	T
123	Natural gas	D	T	–	–
124	Natural gas	D	T	–	–
125	Natural oil	D	T	T	–
126	Nickel salts (aqueous solution)	C	T	T	–
127	Nitric acid (aqueous solution)	10%	T	T/N	N
128	Nitric acid (aqueous solution)	10% do 50%	T/N	N	N
129	Nitric acid (aqueous solution)	> 50%	N	N	N
130	Nitrobenzene	D	T	T/N	–
131	Nitrotoulene	D	T	T/N	N
132	Oils and fats (plant and animal subst.)	D	T	T/N	–
133	Oleic acid	D	T	T/N	–
134	Oleum (fuming sulfuric acid)	D	N	N	N
135	Olive oil	D	T	T	T/N
136	Oxalic acid	C	T	T	N
137	Painter's naphtha	D	T	T/N	N
138	Paraffin oil	D	T	T/N	N
139	Paraffins	E	T	T	–
140	Petrol	E	T/N	N	N
141	Petrol – benzoyl (mixture)	80% / 20% (obj.)	T/N	N	N
142	Petrol benzene	D	T	T/N	–
143	Phentol (aqueous solution)	5%	T	T	–
144	Phentol (aqueous solution)	90%	T	–	–
145	Phosphates (inorganic)	C	T	T	–
146	Phosphorous acid (orto)	85%	T	T	T
147	Photographic emulsion (film emulsion)	E	T	T	–
148	Photographic developer (aqueous solution)	E	T	T	–
149	Photographic fixer (aqueous solution)	E	T	T	–
150	Picric oil	C	T	–	–
151	Potassium fluoride	C	T	T	–
152	Potassium lye (aqueous solution)	50%	T	T	T
153	Potassium cyanide	B	T	T	–
154	Potassium carbonate (potash)	C	T	T	–
156	Propane (in gas)	D	T	–	–

Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
157	Propanol (propyl alcohol)	D	T	T	–
158	Propionic acid (aqueous solution)	> 50%	T	T	–
159	Propylene glycol	D	T	T	–
160	Pyridine	D	T/N	T/N	–
161	Ricinus oil	D	T	T	–
162	Sea water	E	T	T	T
163	Silicone oil	D	T	T	T
164	Silver nitrate	C	T	T	T/N
165	Silver salts	C	T	T	–
166	Soda (sodium Carbonate)	50%	T	T	T/N
167	Sodium bicarbonate	do 60%	T	T	T
168	Sodium bicarbonate (aqueous solution)	50 %	T	T	T/N
169	Sodium bicarbonate (aqueous solution)	C	T	T	T
170	Sodium chlorite (aqueous solution)	2% do 20%	T	T/N	N
171	Sodium chlorine (table salt)	A	T	T	T
172	Sodium hypochlorite (aqueous solution)	10%	T	–	–
173	Sodium nitrate	C	T	T	–
174	Sodium nitrate	C	T	T	–
175	Sodium silicate (aqueous glass)	B	T	T	–
176	Sodium sulfate	C	T	T	–
177	Sodium sulfate	C	T	T	–
178	Sodium sulfate	40%	T	T	–
179	Sodium thiosulfate	C	T	T	–
180	Soya oil	D	T	T/N	–
181	Starch	all	T	T	–
182	Starch syrup	all	T	T	–
183	Succinic acid	C	T	T	–
184	Sucrose syrup	E	T	T	–
185	Sulfur Dioxide (in gas)	D	T	T	–
186	Sulfur dioxide (aqueous solution)	all	T	T	–
187	Sulfur acid (aqueous solution)	10%	T	T	T
188	Sulfur acid (aqueous solution)	10% do 80%	T	T	–
189	Sulfur acid (aqueous solution)	80% do D	T/N	N	–
190	Tannic acid (tannin, aqueous solution)	10%	T	N	–
191	Tanning extract (plant preparation)	E	T	N	–
192	Tartaric acid	10%	T	T	–
193	Teast	all	T	–	–
194	Tetrachloroethane	D	T/N	N	N
195	Tetrahydronaphthalene	D	N	N	N
196	Tiophene	D	T	T/N	–
197	Toulene	D	T/N	N	N

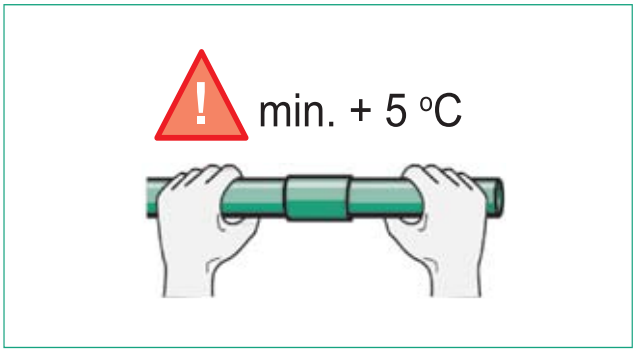
Item	Transported substance	Concentration	At the temperature of:		
		%	20°C	60°C	100°C
198	Transformer oil	D	T/N	N	–
199	Trichloroacetic aldehyde	D	T	T	–
200	Trichloroethylene	D	N	N	N
201	Turpentine	D	N	N	N
202	Tyclohexane	D	T	–	–
203	Urea (carbamide)	C	T	T	–
204	Vaseline oil	D	T	T/N	–
205	Vinegar	E	T	T	T
206	Vodka (all types)	E	T	T	–
207	Washing agents	A	T	T	–
208	Wine	E	T	T	–

Assembly **Instructions**

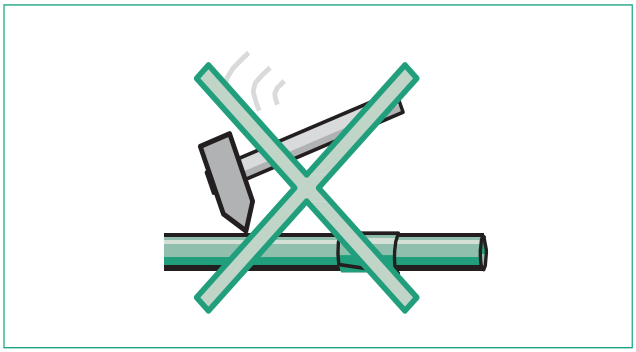
20. ASSEMBLY INSTRUCTIONS

20.1 General

Only components not damaged or contaminated, either during storage or transport may be used for installation works.



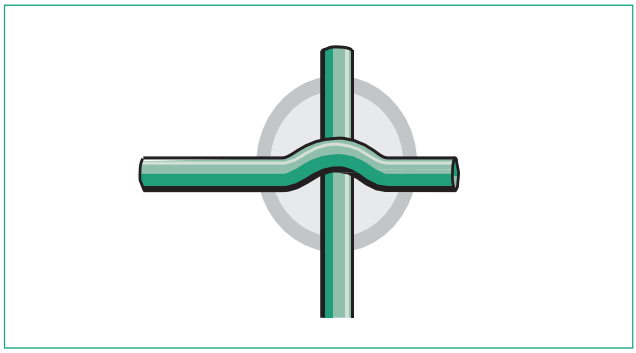
A minimum temperature level for plastic piping installation is, with regard to welding, +5 °C. At lower temperatures it is difficult to provide working conditions for high quality pipe joints.



Components of plastic piping systems must be protected against damage during transport and installation.

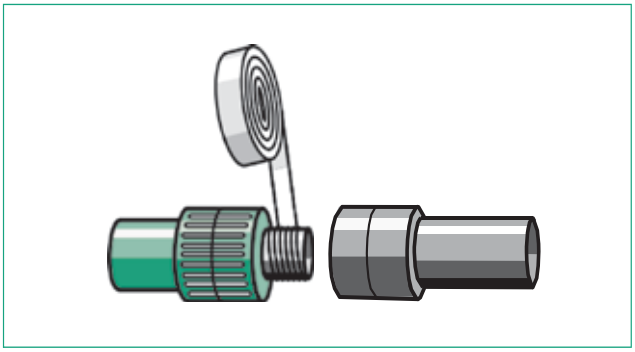
Pipe bending should be done at +15 °C. For pipes of diameter range 16 – 32 mm a minimum bending radius equals to eight diameters (D).

Components must not be exposed to naked flames.

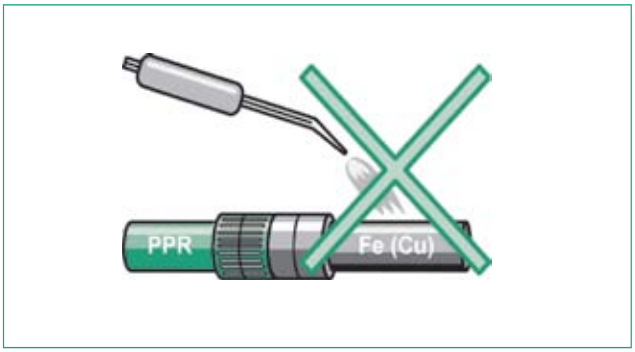


Pipeline cross overs should be made with the use of components specially designed for this purpose.

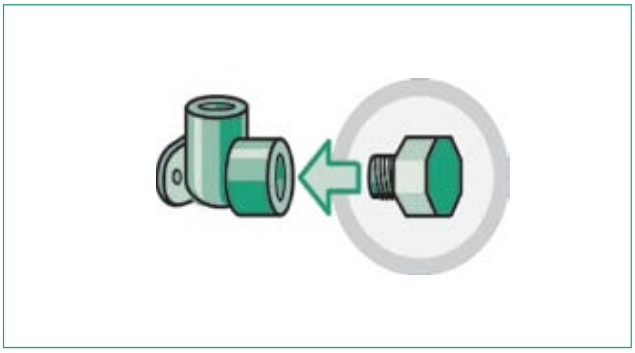
Connecting of plastic parts is done by polyfusion welding, or by the use of electric fittings and butt welding techniques. A high-quality homogeneous joint is the result. An exact working process and appropriate tools must be used in connecting procedures.



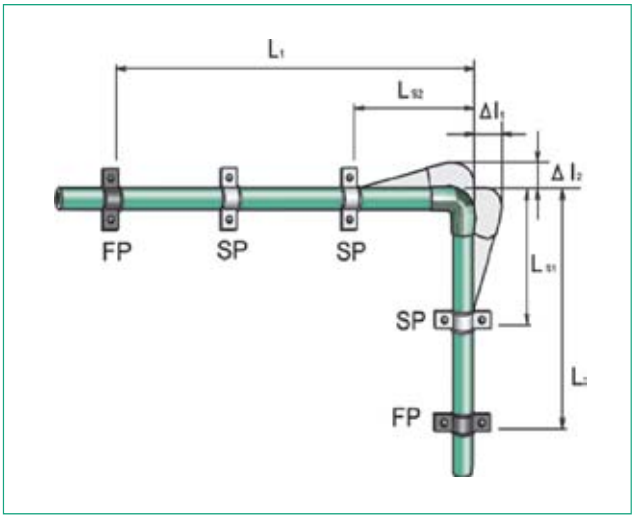
Threaded fittings must be used for screw-type joints. Threads should never be cut directly into plastic components. Threads are sealed with a special PTFE tape or sealing compounds.



Brazing or soldering of metal fittings should not take place close to a joint between metal and plastic systems because of potential hazard of heat transfer to the fitting.



It is recommended to use plastic plugs for blanking elbows or wall mounting groups (plastic plugs are designated only for temporary use). For long term blanking has to be used plugs with metal thread.



$\Delta l = \Delta \cdot L \cdot \Delta t$ [mm]
Δl linear change [mm]
Δ is thermal expansion coefficient of expansion [mm/m °C]

for AQUATerra PPR design purposes $\Delta = 0{,}12$
for AQUATerra STABI PLUS, FIBER, respectively
$\Delta = 0{,}05$
L design distance (distance of two neighbouring fixed points in the line) [m]
Δt installation and service temperature difference [°C]

$Ls = k \cdot \sqrt{\Delta(D. \Delta l)}$ [mm]

Ls compensating length [mm]
k material constant, for PPR k = 20
D pipe outside diameter [mm]
Δl linear change [mm]

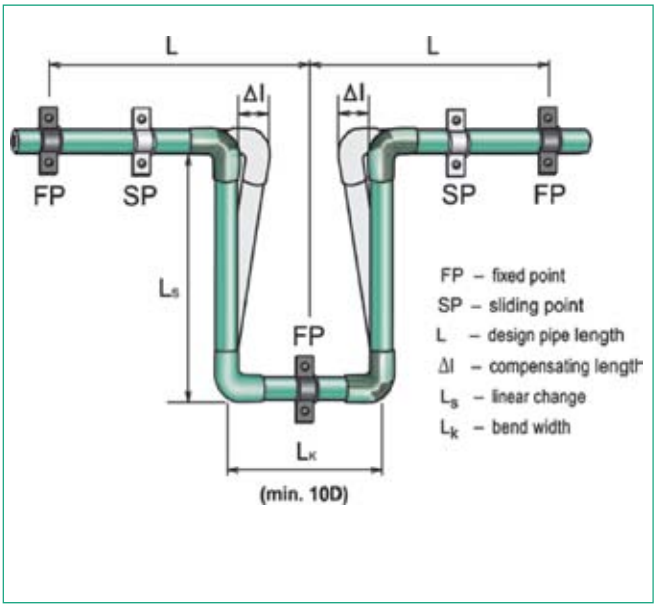
If pipeline linear changes are not compensated in a suitable way, i.e. if the pipes cannot contract and expand, additional thrust and tensile forces are concentrated in the pipes shortening their service life.

21. COMPENSATION OF THERMAL EXPANSION

21.1 Linear expansion and contraction

The difference of temperature during installation and under service conditions, i.e. a medium flows through the system at a different temperature to that prevailing during the installation period, results in linear changes – expansion or contraction (Δ).

21.2 Expansion u-bend



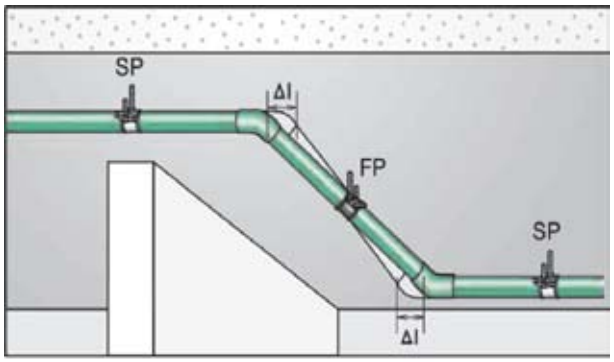
Lk = 2 . ΔI + 150 [mm] and also Lk ≥10.D

In polypropylene applications material flexibility is used for linear compensations. Pipe bends are also used for these purposes. A suitable compensation technique is the one where the pipeline is deflected perpendicularly to the original route and a free compensating length (marked as Ls) is left at the normal line. The value of Ls compensating length will depend on calculated route extension (shortening), pipe material and diameter.

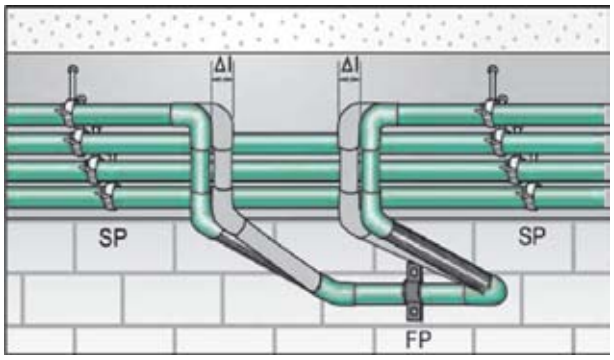
The values of ΔI linear change and Ls compensating length can also be taken from the graphs shown on pages 24, 25 and 26.

TABLE OF COMPENSATION PIPE

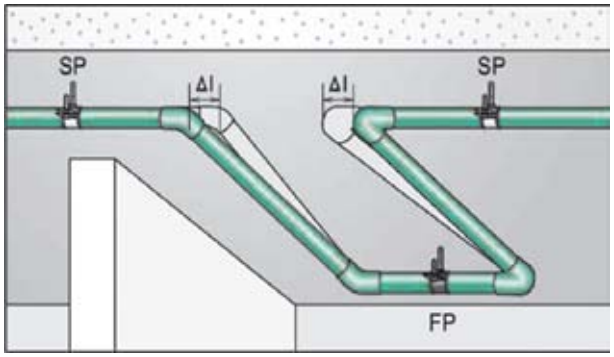
Pipe Diameter (mm)	Distances of all fixed L-points (m)	
	Plain Pipes, FIBER, Aluminum	PPR
20	27	9
25	30	10
32	36	12
40	42	14



Example of compensations by change of path.



By changing the height of the pipeline.



Expansion U-bend.

21.3 Examples given for aquaterra PPR pipinga

1) Data input:

Parameter	Symbol	Value	Unit
Linear change	Δl	?	mm
Thermal expansion coefcient	a	0,12	mm/m°C
Pipe length	L	10	m
Operating temperature inside the pipe	^{t}p	60	°C
Temperature at installation	^{t}m	20	°C
Difference between operating and installation temperature levels Δt= ^{t}p-^{t}m	Δt	40	°C

Solution: $\Delta l = \alpha \cdot L \cdot \Delta t$ [mm]

$\Delta l = 0{,}12 \cdot 10 \cdot 40 = 48$ mm

2) Data input:

Parameter	Symbol	Value	Unit
Compensating length	Δl	?	mm
Compensating length	k	20	-
External pipe diameter	D	40	mm
Linear change as calculated above	Δl	48	mm

Solution: $Ls = k \cdot \sqrt{(D \cdot \Delta l)}$ [mm]

$Ls = 20 \cdot \sqrt{(40 \cdot 48)} = 876$ mm

3) Data input:

Parameter	Symbol	Value	Unit
Expansion U-bend width			
External pipe diameter	D	40	mm
Linear change as calculated above	Δl	48	mm

Solution: $Lk = 2 \cdot \Delta l + 150$ [mm]

$Lk = 2 \cdot 48 + 150 = 246$ mm

$Lk > 10\ D$

$246 \text{ mm} < 10 \cdot 40 \Rightarrow Lk = 400$ mm

Pipe pre-stressing can be also used for the purposes of linear expansion compensation; the compensating length may be made shorter in this way. The pre-stressing orientation is opposite to the expected linear change and its value equals to Examples given for AQUATerra PPR Piping about one half.

Linear expansion AQUATerra PPR piping
Examples: L = 10 m, Δt = 40 °C

4) Data input:

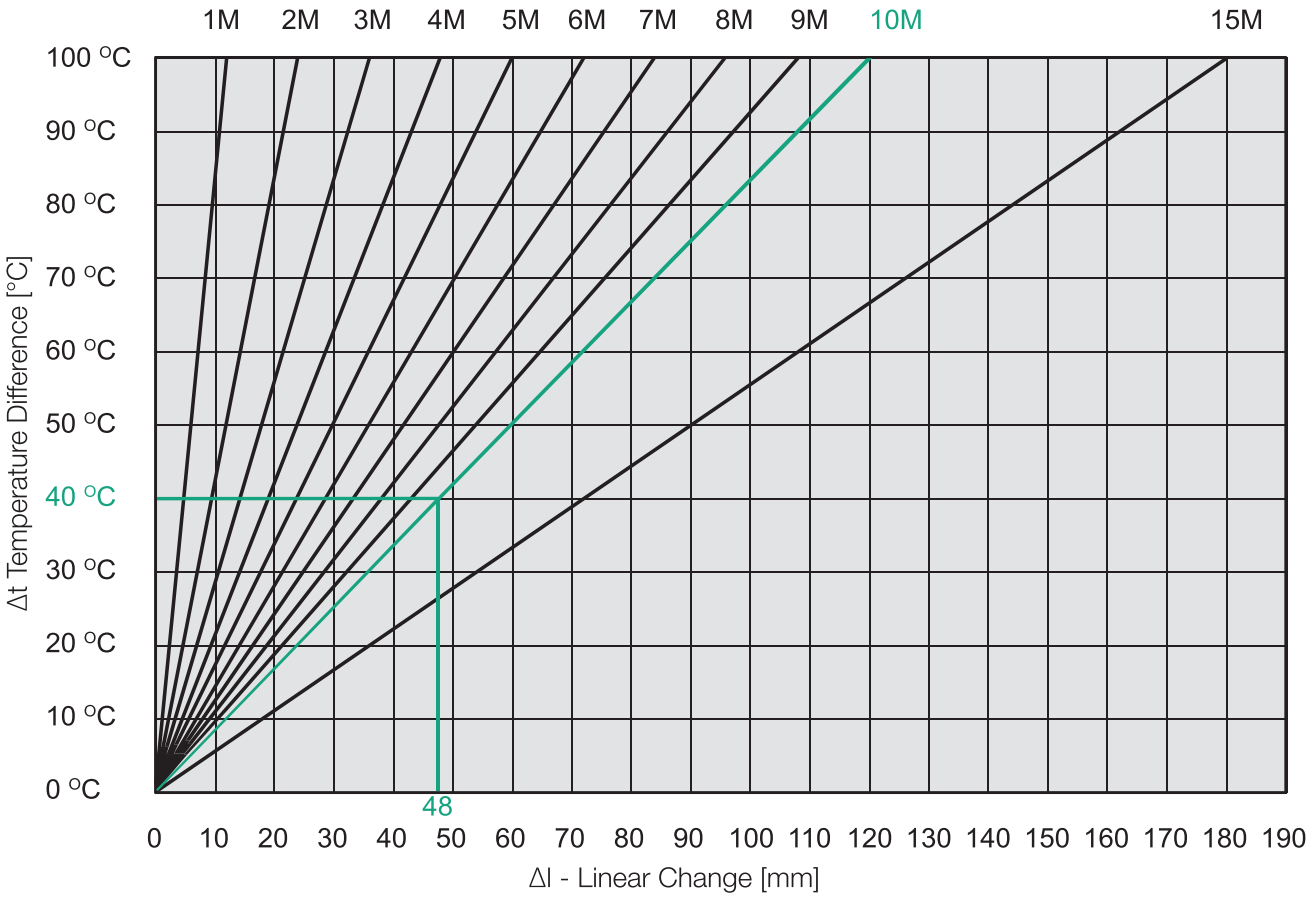
Parameter	Symbol	Value	Unit
Compensating Length	Δl	?	mm
PPR material constant	k	20	-
External pipe diameter	D	40	mm
Linear change as calculated above	Δl	48	mm

Solution: $Lsp = k \cdot \sqrt{(D \cdot l / 2)}$ [mm]

$Lsp = 20 \cdot \sqrt{(40 \cdot 24)} = 620$ mm

The calculated free length (Lsp) is assumed length without any sustaining or suspending elements (within this length) obstructing the expansion. The free length (Lsp) should not exceed maximum spacing distance between supporting elements corresponding to the pipe diameter and media temperature as shown in Chapter 10, Part 10.3.

CALCULATION OF PIPE LENGTH L

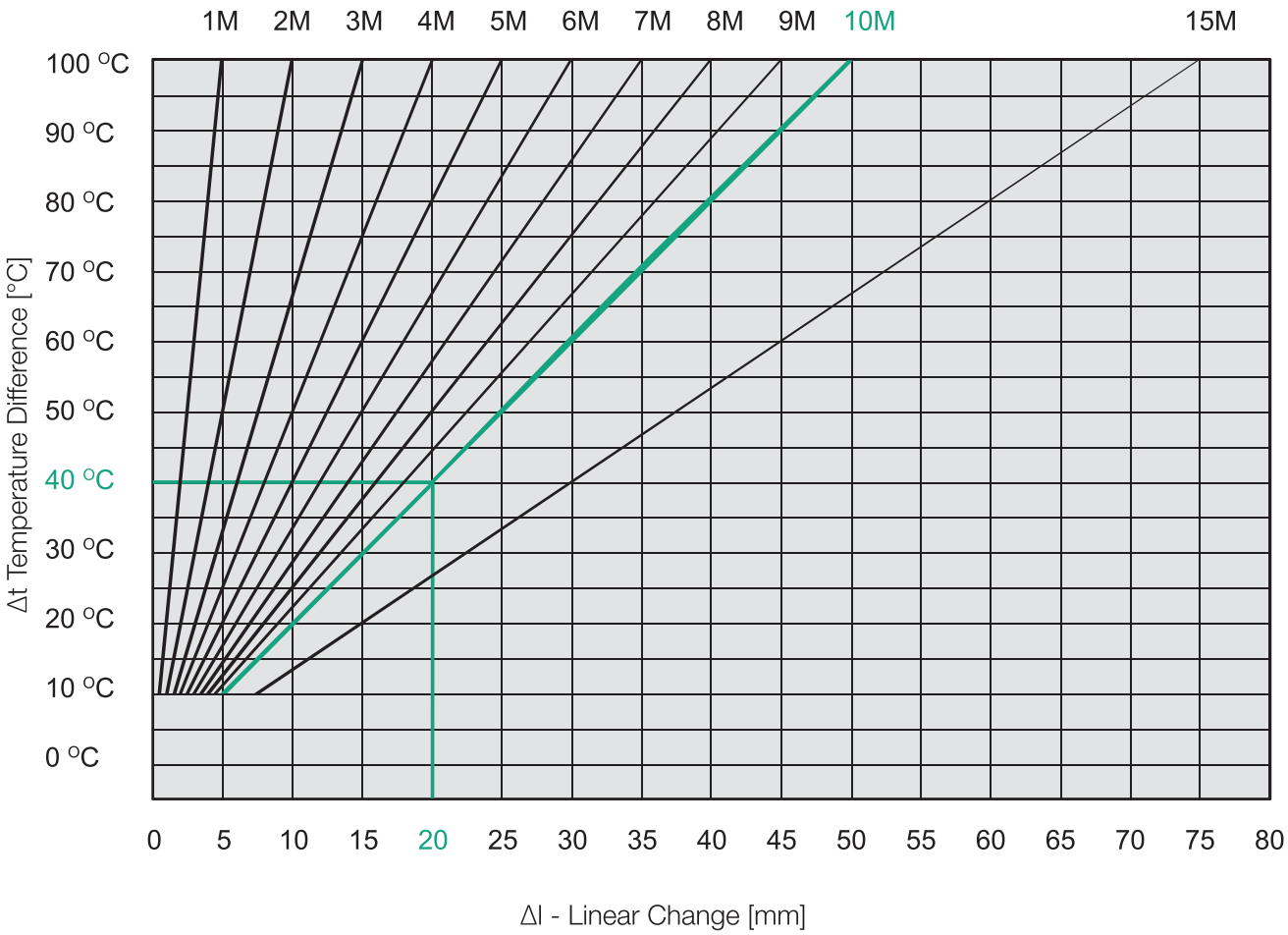


Temperature difference ΔI								
Pipe Length	**10 °C**	**20 °C**	**30 °C**	**40 °C**	**50 °C**	**60 °C**	**70 °C**	**80 °C**
Linear change ΔI [mm]								
1 m	1	2	4	5	6	7	8	10
2 m	1	5	7	10	12	14	17	19
3 m	2	7	11	14	18	22	25	29
4 m	2	10	14	19	24	29	34	38
5 m	3	12	18	24	30	36	42	48
6 m	3	14	22	29	36	43	50	58
7 m	4	17	25	34	42	50	59	67
8 m	4	19	29	38	48	58	67	77
9 m	5	22	32	43	54	65	76	86
10 m	5	24	36	48	60	72	84	96
15 m	8	36	54	72	90	108	126	144

Rounded to whole numbers.

Linear expansion AQUATerra PPR Aluminum, FIBER COMPOSITE
Examples: L = 10 m, Δt = 40 °C

CALCULATION OF PIPE LENGTH L



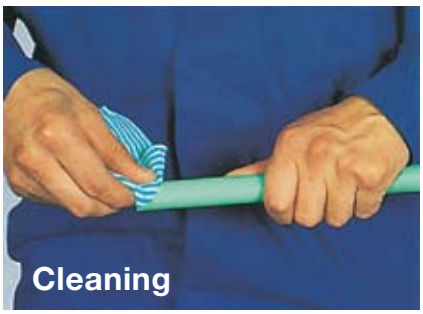
Temperature difference Δl								
Pipe Length	**10 °C**	**20 °C**	**30 °C**	**40 °C**	**50 °C**	**60 °C**	**70 °C**	**80 °C**
Linear change Δl [mm]								
1 m	1	1	2	2	3	3	4	4
2 m	1	2	3	4	5	6	7	8
3 m	2	3	5	6	8	9	11	12
4 m	2	4	6	8	10	12	14	16
5 m	3	5	8	10	13	15	18	20
6 m	3	6	9	12	15	18	21	24
7 m	4	7	11	14	18	21	25	28
8 m	4	8	12	16	20	24	28	32
9 m	5	9	13	18	23	27	32	36
10 m	5	10	15	20	25	30	35	40
15 m	8	15	23	30	38	45	53	60

Rounded to whole numbers.

22. INSTALLATION GUIDE

22.1 Phases of welding

1. Pipes should be cut down to required length, at 90°C to the axis, using appropriate tools (pipe shears or cutters).



2. Before welding, pipes and fittings must be cleaned (to remove dust, grease, etc.) and dried.

3. Mark the required depth of pipe insertion into the fitting (for a given outer pipe diameter - see the table).

5. Simultaneously insert the pipe end and slide the fitting over corresponding heating tips of the welder (heated up to 260 - 280° C earlier) Keep the required heating time - see heating time values for different system dimensions.

5. After heating, remove both elements from heating tips and push the pipe into the fitting flange up to the depth marked earlier. The welding time depends on the outer diameter of the pipe. Good welds should have a double, uniform fin of material pushed out to the surface, along the circumference connected elements.

6. It is recommended to keep the connection fixed for the next 10 - 20 seconds, allowing the weld to cool down partially and achieve the initial strength. It is now possible to make other connections of the system. Full load of the weld is allowed only when the connection has cooled down completely.

22.2 Welding process parameters

Pipe diameter [mm]	Welding depth [mm]	Heating time* [s]	Welding time [s]	Cooling time [mm]
20	14	5	4	2
25	15	7	4	2
32	16	8	6	4
40	18	12	6	4
50	20	18	6	4
63	24	24	8	6
75	26	30	10	8
90	29	40	10	8
110	32.5	50	10	8
125	35	60	12	9
160	40	70	14	10

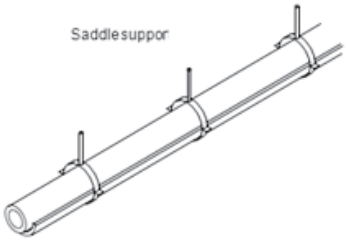
Note:
Values presented in the table refer to PN 16, PN 20 pipes and faser composite PN20, PN25 & PN32 pipes.

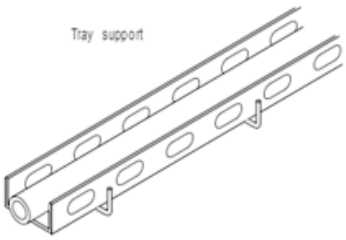
23. DISTANCE BETWEEN SUPPORTS

Pipes can be installed on trays or saddles that provide support. Thus, when there are long sections on view, the expansion will enable the movement of the pipe on the tray but prevent the unsightly effect that expansion can cause.

The recommended distances are:

Diameter	Single LayerPPR				Three-layer FASER			
	Distance for tray support		Distance pipe-tray support		Distance for tray support		Distance pipe-tray support	
	Water < 30 ºC	Water > 30 ºC	Water < 30 ºC	Water > 30 ºC	Water < 30 ºC	Water > 30 ºC	Water < 30 ºC	Water > 30 ºC
20	1500	1000	500	200	1950	1300	650	260
25	1500	1200	500	300	1950	1560	650	390
32	1500	1200	750	400	1950	1560	975	520
40	1500	1200	750	600	1950	1560	975	780
50 / 63 / 75	1500	1500	750	750	1950	1950	975	975
90 / 110 / 125	2000	2000	1000	1000	2600	2600	1300	1300
160	2500	2500	1250	1250	3250	3250	1625	1625





When there is a riser with shunts,it is very important that this can absorb the expansion without loading tension on the shunts. According to ENV
12108, there commended distance between two guide clamps or between a guide and an anchor are:

L* (mm)								
Eternal Diameter (mm)	Single layer PPR				Three-layer FASER			
	Pipes that allow changes in length		Pipes that do not allow changes in length		Pipes that allow changes in length		Pipes that do not allow changes in length	
	Cold Water	Hot Water	Cold Water	Hot Water	Cold Water	Hot Water	Cold Water	Hot Water
16	750	400	600	250	975	520	780	325
20	800	500	700	300	1040	650	910	390
25	850	600	800	350	1105	780	1040	455
32	1000	650	900	400	1300	845	1170	520
40	1100	800	1100	500	1430	1040	1430	650
50	1250	1000	1250	600	1625	1300	1625	780
63	1400	1200	1400	750	1820	1560	1820	975
75	1500	1300	1500	900	1950	1690	1950	1170
90	1650	1450	1650	1100	2145	1885	2145	1430
110	1900	1600	1850	1300	2470	2080	2405	1690
125	2100	1850	2000	1400	2730	2405	2600	1820
160	2500	2300	2300	1800	3250	2990	2990	2340

* For vertical pipes, multiply by 1.3

24. HANDLING AND STORAGE

Resistance to ultraviolet light (UV)

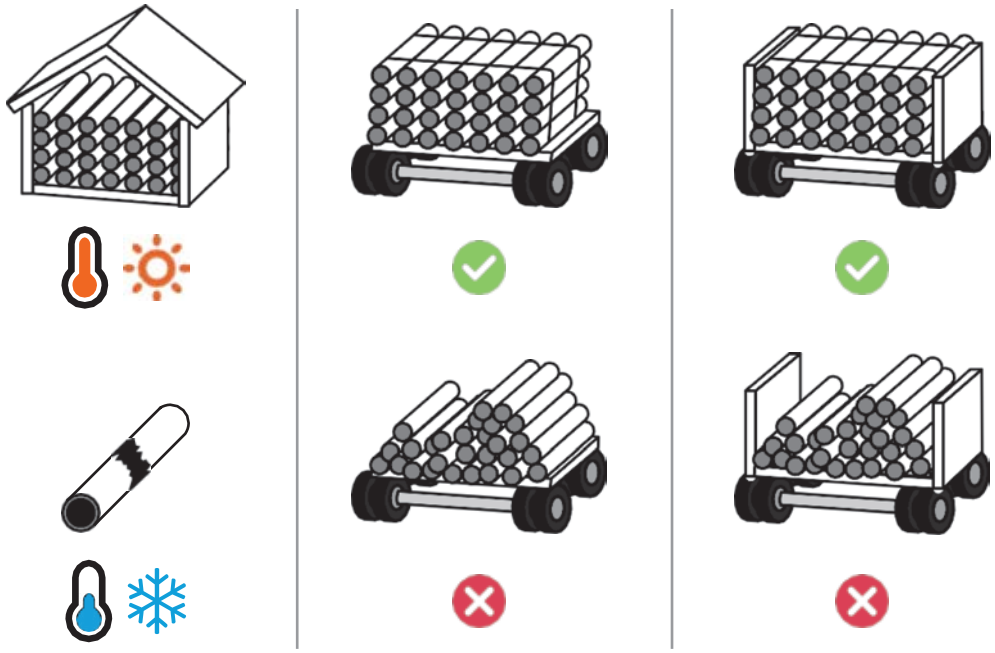
PPR must not be exposed to solar radiation. Even though stabilised against this radiation, continuous exposure causes degradation of the material, accelerating its ageing.

Strength at low temperatures

At temperatures below0ºC, PPR becomesf ragile because it is a crystalline material.Therefore it is important to avoid any type of impact, especially during transport and handling. However, when installed, its plasticity is capable of absorbing changes in volume due to freezing of liquids flowing inside.

Arrangement of pipes

It is important to try to keep the pipes horizontal and to avoid their curvature as far as possible to prevent deformations that may make subsequent installation difficult



Bending

Because of the plasticity of the pipes, they allow a certain amount of bending.The maximum radius of curvature is 8 times the its diameter.If it is necessary to bend them, you can use hot air heaters, never direct heat, because this could destroy the molecular structure of the pipe.

Threaded components

In threaded female terminals, avoid conical caps because the threads can deteriorate.To ensure seal integrity,Teflon or similar can be used in suitable amounts.

25. ANTI – LEGIONELLA TREATMENTS

AQUATERRA pipes do not encourage the growth of any type of micro-organism or known bacteria because of their properties. However, in those cases where disinfection is necessary, AQUATERRA pipes do not present any problem provided disinfection is performed in accordance with current legislation.

According to current regulation for the control and prevention of Legionella (UNE100030) and Royal Decree RD863/2003 the following disinfection methods are recommended:

Chemical route in tanks

For cold drinking water, maximum concentrations in tanks of between 20 and 30 ppm of residual free chlorine for a maximum of between 3 hours and 1 hour respectively for water at pH 7.

Chemical route in pipes

Disinfection with 50 mg/l free chlorine for more than 12 hours can be performed twice a year, or 150 mg/l of oxygen peroxide for 24 hours can be used; in both cases, 30 ºC must never be exceeded.

Thermal route

For domestic hot water (ACS). 70 ºC or over for 2 hours.

It is very important to take into account that two methods should never be used together (combination of high temperatures with high concentrations of chlorine if this could damage the installation.

In some places, the use of chlorine dioxide as a disinfectant is very common due to its low price and its high disinfectant effect. However, its use is not recommended because of the high oxidation potential ends up by affecting the installation (metal or plastic).

Recycling - Ecology

AQUATERRA PPR pipes are manufactured with 100% virgin materials (the standard does not authorize the use of recycled materials for drinking water) and are also 100% recyclable.

They are also very environmentally friendly materials because their contamination is purely visual.

Unitary linear resistance of flow for Aquaterra type pipes

26. UNITARY LINEAR RESISTANCE OF FLOW FOR AQUATERRA TYPE PIPES

Table 1. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 10 polypropylene at the temperature of 20°C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m]² v [m/s]	Nominal pressure PN 10 Temperature 20°C								
		Pipe cross-section Dz x e [mm x mm]								
		20 x 1.9	25 x 2.3	32 x 2.9	40 x 3.7	50 x 4.6	63 x 5.8	75 x 6.8	90 x 8.2	110 x 10
0.01	R	0.1								
	V	0.1								
0.02	R	0.1	0.1							
	V	0.1	0.1							
0.03	R	0.2	0.1							
	V	0.2	0.1							
0.04	R	0.5	0.2	0.0						
	V	0.2	0.1	0.1						
0.05	R	0.7	0.3	0.1						
	V	0.2	0.2	0.1						
0.06	R	1.0	0.3	0.1	0.0					
	V	0.3	0.2	0.1	0.1					
0.07	R	1.3	0.4	0.1	0.1					
	V	0.3	0.2	0.1	0.1					
0.08	R	1.7	0.6	0.2	0.1					
	V	0.4	0.2	0.2	0.1					
0.09	R	2.0	0.7	0.2	0.1					
	V	0.4	0.3	0.2	0.1					
0.10	R	2.4	0.8	0.3	0.1					
	V	0.5	0.3	0.2	0.1					
0.12	R	3.4	1.1	0.4	0.1	0.0				
	V	0.6	0.4	0.2	0.1	0.1				
0.14	R	4.4	1.5	0.5	0.2	0.1				
	V	0.7	0.4	0.3	0.2	0.1				
0.16	R	5.6	1.9	0.6	0.2	0.1				
	V	0.8	0.5	0.3	0.2	0.0				
0.18	R	6.8	2.3	0.7	0.2	0.1				
	V	0.9	0.6	0.3	0.2	0.0				
0.20	R	8.2	2.7	0.9	0.3	0.1	0.0			
	V	1.0	0.6	0.4	0.2	0.2	0.1			
0.30	R	16.9	5.6	1.8	0.6	0.2	0.1	0.0		
	V	1.5	0.9	0.6	0.4	0.2	0.1	0.1		
0.40	R	28.4	9.3	2.9	1.0	0.3	0.1	0.1		
	V	1.9	1.2	0.8	0.5	0.3	0.2	0.1		
0.50	R	42.5	13.9	4.3	1.5	0.5	0.2	0.1		
	V	2.4	1.5	0.9	0.8	0.4	0.2	0.2		
0.60	R	59.1	19.3	6.0	2.0	0.7	0.2	0.1	0.0	
	V	2.9	1.8	1.1	0.7	0.5	0.3	0.2	0.1	
0.70	R	78.3	25.5	7.9	2.7	0.9	0.3	0.1	0.1	
	V	3.4	2.1	1.3	0.8	0.5	0.3	0.2	0.2	
0.80	R	100.0	32.4	10.0	3.4	1.2	0.4	0.2	0.1	
	V	3.9	2.5	1.5	1.0	0.6	0.4	0.3	0.2	

q [dm³/s]	R [hPa/m]² v [m/s]	Nominal pressure PN 10 Temperature 20°C								
		Pipe cross-section Dz x e [mm x mm]								
		20 x 1.9	25 x 2.3	32 x 2.9	40 x 3.7	50 x 4.6	63 x 5.8	75 x 6.8	90 x 8.2	110 x 10
0.90	R	124.2	40.2	12.4	4.2	1.4	0.5	0.2	0.1	
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2	
1.00	R	150.8	48.7	15.0	5.0	1.7	0.6	0.2	0.1	0.0
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.3	0.2	0.2
1.20	R	211.5	68.0	20.8	7.0	2.4	0.8	0.3	0.1	0.1
	V	5.8	3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2
1.40	R		90.3	27.6	9.2	3.1	1.0	0.4	0.2	0.1
	V		4.3	2.6	1.7	1.1	0.7	0.5	0.3	0.2
1.60	R		115.5	35.2	11.7	4.0	1.3	0.6	0.2	0.1
	V		4.9	3.0	1.9	1.2	0.8	0.5	0.4	0.3
1.80	R		143.7	43.6	14.5	4.9	1.6	0.7	0.3	0.1
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3
2.00	R			52.9	17.5	5.9	1.9	0.8	0.4	0.1
	V			3.8	2.4	1.5	1.0	0.7	0.5	0.3
2.20	R			63.1	20.9	7.0	2.3	1.0	0.4	0.2
	V			4.1	2.6	1.7	1.1	0.8	0.5	0.3
2.40	R			74.1	24.5	8.2	2.7	1.2	0.5	0.2
	V			4.5	2.9	1.8	1.2	0.8	0.6	0.4
2.60	R			85.9	28.3	9.5	3.1	1.3	0.6	0.2
	V			4.9	3.1	2.0	1.3	0.9	0.6	0.4
2.80	R			98.6	32.5	10.9	3.6	1.5	0.6	0.2
	V			5.3	3.4	2.1	1.4	1.0	0.7	0.4
3.00	R				36.9	12.3	4.0	1.7	0.7	0.3
	V				3.6	2.3	1.5	1.0	0.7	0.5
3.20	R				41.5	13.9	4.5	1.9	0.8	0.3
	V				3.8	2.5	1.5	1.1	0.8	0.5
3.40	R				46.4	15.5	5.0	2.2	0.9	0.3
	V				4.1	2.6	1.6	1.2	0.8	0.5
3.60	R				51.6	17.2	5.6	2.4	1.0	0.4
	V				4.3	2.8	1.7	1.2	0.9	0.6
3.80	R				57.0	19.0	6.2	2.7	1.1	0.4
	V				4.6	2.9	1.8	1.3	0.9	0.6
4.00	R				62.7	20.9	6.8	3.0	1.2	0.5
	V				4.8	3.1	1.9	1.4	0.9	0.6
4.20	R				68.6	22.8	4.7	3.2	1.3	0.5
	V				5.0	3.2	2.0	1.4	1.0	0.7
4.40	R					24.9	8.1	3.5	1.4	0.5
	V					3.4	2.1	1.5	1.0	0.7
4.60	R					27.0	8.7	3.6	1.5	0.6
	V					3.5	2.2	1.6	1.1	0.7
4.80	R					29.2	9.4	4.1	1.7	0.6
	V					3.7	2.3	1.6	1.1	0.8
5.00	R					31.5	10.2	4.4	1.8	0.7
	V					3.8	2.4	1.7	1.2	0.8
5.20	R					33.8	10.9	4.7	1.9	0.7
	V					4.0	2.5	1.8	1.2	0.8
5.40	R					36.3	11.7	5.0	2.1	0.8
	V					4.1	2.6	1.8	1.3	0.8
5.60	R					38.8	12.5	5.4	2.2	0.8
	V					4.8	2.7	1.9	1.3	0.9
5.80	R					41.4	13.4	5.7	2.4	0.9
	V					4.4	2.8	2.0	1.4	0.9
6.00	R					44.1	14.2	6.1	2.5	0.9
	V					4.6	2.9	2.0	1.4	0.9

q [dm³/s]	R [hPa/m]² v [m/s]	Nominal pressure PN 10 Temperature 20°C								
		Pipe cross-section Dz x e [mm x mm]								
		20 x 1.9	25 x 2.3	32 x 2.9	40 x 3.7	50 x 4.6	63 x 5.8	75 x 6.8	90 x 8.2	110 x 10
6.20	R					46.8	15.1	6.5	2.7	1.0
	V					4.7	3.0	2.1	1.5	1.0
6.40	R					49.7	16.0	6.8	2.8	1.1
	V					4.9	3.1	2.2	1.5	1.0
6.60	R					52.6	16.9	7.2	3.0	1.1
	V					5.1	3.2	2.2	1.6	1.0
6.80	R						17.9	7.6	3.1	1.2
	V						3.3	2.3	1.6	1.1
7.00	R						18.9	8.1	3.3	1.2
	V						3.4	2.4	1.7	1.1
7.50	R						21.4	9.1	3.8	1.4
	V						3.6	2.6	1.8	1.2
8.00	R						24.1	10.3	4.2	1.6
	V						3.9	2.7	1.9	1.3
9.00	R						30.0	12.2	5.3	2.0
	V						4.3	3.1	2.1	1.4
10.00	R						36.5	15.5	6.4	2.4
	V						4.8	3.4	2.4	1.6

Table 2. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 16 and PN20 polypropylene at the temperature of 20°C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][3] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.01	R	0.1										
	V	0.1										
0.02	R	0.2	0.1									
	V	0.1	0.1									
0.03	R	0.5	0.1	0.0								
	V	0.2	0.1	0.1								
0.04	R	0.9	0.3	0.1								
	V	0.3	0.2	0.1								
0.05	R	1.3	0.5	0.1	0.0							
	V	0.3	0.2	0.1	0.1							
0.06	R	1.8	0.6	0.2	0.1							
	V	0.4	0.2	0.1	0.1							
0.07	R	2.3	0.8	0.3	0.1							
	V	0.4	0.3	0.2	0.1							
0.08	R	2.9	1.0	0.3	0.1	0.0						
	V	0.5	0.3	0.2	0.1	0.1						
0.09	R	3.6	1.2	0.4	0.1	0.1						
	V	0.6	0.4	0.2	0.1	0.1						
0.10	R	4.3	1.5	0.5	0.2	0.1						
	V	0.6	0.4	0.2	0.2	0.1						
0.12	R	5.9	2.0	0.6	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.14	R	7.8	2.7	0.8	0.3	0.1						
	V	0.9	0.6	0.3	0.2	0.1						
0.16	R	9.8	3.4	1.1	0.4	0.1	0.0					
	V	1.0	0.6	0.4	0.3	0.2	0.1					
0.18	R	12.1	4.2	1.3	0.4	0.2	0.1					
	V	1.1	0.7	0.4	0.3	0.2	0.1					
0.20	R	14.6	5.0	1.6	0.5	0.2	0.1	0.0				
	V	1.2	0.8	0.5	0.3	0.2	0.1	0.1				
0.30	R	30.3	10.3	3.2	1.1	0.4	0.1	0.1				
	V	1.8	1.2	0.7	0.5	0.3	0.2	0.1				
0.40	R	51.1	17.2	5.3	1.8	0.6	0.2	0.1	0.0			
	V	2.5	1.6	1.0	0.6	0.4	0.2	0.2	0.1			
0.50	R	76.9	25.8	7.9	2.7	0.9	0.3	0.1	0.1			
	V	3.1	2.0	1.2	0.8	0.5	0.3	0.2	0.2			
0.60	R	107.5	36.0	10.9	3.7	1.2	0.4	0.2	0.1			
	V	3.7	2.4	1.4	0.9	0.6	0.4	0.3	0.2			
0.70	R	143.0	47.7	14.4	4.9	1.6	0.5	0.2	0.1			
	V	4.3	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.80	R	183.3	60.9	18.4	6.2	2.0	0.7	0.3	0.1			
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.4	0.2			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m]³ v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.90	R	278.2	75.6	22.7	7.6	2.5	0.8	0.4	0.2	0.0		
	V	6.1	3.5	2.2	1.4	0.9	0.6	0.4	0.3	0..2		
1.00	R		91.9	27.6	9.2	3.1	1.0	0.4	0.2	0.1		
	V		3.9	2.4	1.5	1.0	0.6	0.4	0.3	0.2		
1.20	R		128.9	38.5	12.8	4.2	1.4	0.6	0.3	0.1		
	V		4.7	2.9	1.8	1.2	0.7	0.5	0.4	0.2		
1.40	R		171.9	51.1	17.0	5.6	1.8	0.8	0.3	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.60	R			65.4	21.7	7.1	2.3	1.0	0.4	0.2	0.1	
	V			3.9	2.5	1.6	1.0	0.7	0.5	0.3	0.2	
1.80	R			81.4	26.9	8.8	2.9	1.3	0.5	0.2	0.1	
	V			4.3	2.8	1.8	1.1	0.8	0.5	0.4	0.3	
2.00	R			99.1	32.7	10.7	3.5	1.5	0.6	0.2	0.1	
	V			4.8	3.1	1.9	1.2	0.9	0.6	0.4	0.3	
2.20	R			118.4	38.9	12.7	4.1	1.8	0.8	0.3	0.1	
	V			5.3	3.4	2.1	1.4	1.0	0.7	0.4	0.3	
2.40	R				45.8	14.9	4.8	2.1	0.9	0.3	0.1	0.0
	V				3.7	2.3	1.5	1.0	0.7	0.5	0.4	0.2
2.60	R				53.1	17.2	5.6	2.4	1.0	0.4	0.1	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.80	R				60.9	19.8	6.4	2.8	1.2	0.4	0.2	0.0
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
3.00	R				69.3	22.4	7.3	3.1	1.3	0.5	0.2	0.1
	V				4.6	2.9	1.8	1.3	0.9	0.6	0.5	0.3
3.20	R				78.1	25.3	8.2	3.5	1.5	0.5	0.2	0.1
	V				4.9	3.1	2.0	1.4	1.0	0.6	0.5	0.3
3.40	R				87.5	28.3	9.1	3.9	1.6	0.6	0.3	0.1
	V				5.2	3.3	2.1	1.5	1.0	0.7	0.5	0.3
3.60	R					31.4	10.1	4.4	1.8	0.7	0.3	0.1
	V					3.5	2.2	1.6	1.1	0.7	0.6	0.3
3.80	R					34.7	11.2	4.8	2.0	0.7	0.3	0.1
	V					3.7	2.3	1.7	1.2	0.8	0.6	0.4
4.00	R					38.2	12.3	5.3	2.2	0.8	0.3	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
4.20	R					41.8	13.4	5.8	2.4	0.9	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.8	0.6	0.4
4.40	R					45.6	14.6	6.3	2.6	1.0	0.4	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.60	R					49.6	15.9	6.8	2.8	1.0	0.5	0.1
	V					4.5	2.8	2.0	1.4	0.9	0.7	0.4
4.80	R					53.7	17.2	7.4	3.1	1.1	0.5	0.1
	V					4.7	2.9	2.1	1.5	1.0	0.7	0.5
5.00	R					57.9	18.5	8.0	3.3	1.2	0.5	0.2
	V					4.9	3.1	2.2	1.5	1.0	0.8	0.5
5.20	R					62.3	19.9	8.6	3.5	1.3	0.6	0.2
	V					5.1	3.2	2.3	1.6	1.0	0.8	0.5
5.40	R						21.4	9.2	3.8	1.4	0.6	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
5.60	R						22.9	9.8	4.0	1.5	0.7	0.2
	V						3.4	2.4	1.7	1.1	0.9	0.5
5.80	R						24.4	10.5	4.3	1.6	0.7	0.2
	V						3.6	2.5	1.8	1.2	0.9	0.5
6.00	R						26.0	11.1	4.6	1.7	0.8	0.2
	V						3.7	2.6	1.8	1.2	0.9	0.6

q [dm³/s]	R [hPa/m]³ v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
6.20	R						27.6	11.8	4.9	1.8	0.8	0.2
	V						3.8	2.7	1.9	1.2	1.0	0.6
6.40	R						29.3	12.5	5.2	1.9	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
6.60	R						31.0	13.3	5.5	2.0	0.9	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
6.80	R						32.8	14.0	5.8	2.1	1.0	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
7.00	R						34.6	14.8	6.1	2.2	1.1	0.3
	V						4.3	3.0	2.1	1.4	1.1	0.7
7.50	R						39.4	16.8	9.6	2.5	1.2	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
8.00	R						44.4	18.9	7.8	2.9	1.4	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
9.00	R						55.4	23.6	9.6	3.5	1.8	0.5
	V						5.5	3.9	2.7	1.8	1.4	0.8
10.00	R							28.7	11.7	4.3	2.2	0.6
	V							4.3	3.0	2.0	1.5	0.9

Table 3. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 16 and PN20 polypropylene at the temperature of 60◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.01	R	0.0										
	V	0.1										
0.02	R	0.2	0.1	0.0								
	V	0.1	0.1	0.1								
0.03	R	0.4	0.2	0.1								
	V	0.2	0.1	0.1								
0.04	R	0.7	0.2	0.1								
	V	0.3	0.2	0.1								
0.05	R	1.1	0.4	0.1	0.0							
	V	0.3	0.2	0.1	0.1							
0.06	R	1.4	0.5	0.2	0.1							
	V	0.4	0.2	0.1	0.1							
0.07	R	1.9	0.7	0.2	0.1							
	V	0.4	0.3	0.2	0.1							
0.08	R	2.4	0.8	0.3	0.1							
	V	0.5	0.3	0.2	0.1							
0.09	R	3.0	1.0	0.3	0.1							
	V	0.6	0.4	0.2	0.1							
0.10	R	3.6	1.2	0.4	0.1	0.0						
	V	0.6	0.4	0.2	0.2	0.1						
0.12	R	5.0	1.7	0.5	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.14	R	6.5	2.2	0.7	0.2	0.1						
	V	0.9	0.6	0.3	0.2	0.1						
0.16	R	8.3	2.8	0.9	0.3	0.1						
	V	1.0	0.6	0.4	0.3	0.2						
0.18	R	10.3	3.5	1.1	0.4	0.1	0.0					
	V	1.1	0.7	0.4	0.3	0.2	0.1					
0.20	R	12.5	4.2	1.3	0.4	0.2	0.1					
	V	1.2	0.8	0.5	0.3	0.2	0.1					
0.30	R	26.3	8.8	2.7	0.9	0.3	0.1	0.0				
	V	1.8	1.2	0.7	0.5	0.3	0.2	0.1				
0.40	R	44.9	14.9	4.5	1.5	0.5	0.2	0.1				
	V	2.5	1.6	1.0	0.6	0.4	0.2	0.2				
0.50	R	68.1	22.5	6.7	2.3	0.7	0.2	0.1	0.0			
	V	3.1	2.0	1.2	0.8	0.5	0.3	0.2	0.2			
0.60	R	96.0	31.5	9.4	3.1	1.0	0.3	0.2	0.1			
	V	3.7	2.4	1.4	0.9	0.6	0.4	0.3	0.2			
0.70	R	128.6	42.1	12.5	4.2	1.4	0.5	0.2	0.1			
	V	4.3	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.80	R	165.8	54.1	16.0	5.3	1.7	0.6	0.3	0.1			
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.4	0.2			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.90	R	207.6	67.5	19.9	6.6	2.2	0.7	0.3	0.1	0.0		
	V	5.5	3.5	2.2	1.4	0.9	0.6	0.4	0.3	0.2		
1.00	R		82.4	24.2	8.0	2.6	0.9	0.4	0.2	0.1		
	V		3.9	2.4	1.5	1.0	0.6	0.4	0.3	0.2		
1.20	R		116.5	34.1	11.2	3.6	1.2	0.5	0.2	0.1		
	V		4.7	2.9	1.8	1.2	0.7	0.5	0.4	0.2		
1.40	R		156.4	45.6	14.9	4.8	1.6	0.7	0.3	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.60	R			58.7	19.1	6.2	2.0	0.9	0.4	0.1	0.1	
	V			3.9	2.5	1.6	1.0	0.7	0.5	0.3	0.2	
1.80	R			73.4	23.8	7.7	2.5	1.1	0.4	0.2	0.1	
	V			4.3	2.8	1.8	1.1	0.8	0.5	0.4	0.3	
2.00	R			89.7	29.1	9.3	3.0	1.3	0.5	0.2	0.1	
	V			4.8	3.1	1.9	1.2	0.9	0.6	0.4	0.3	
2.20	R			107.6	34.8	11.2	3.6	1.5	0.6	0.2	0.1	
	V			5.3	3.4	2.1	1.4	1.0	0.7	0.4	0.3	
2.40	R				41.0	13.1	4.2	1.8	0.7	0.3	0.1	0.0
	V				3.7	2.3	1.5	1.0	0.7	0.5	0.4	0.2
2.60	R				47.7	15.3	4.9	2.1	0.9	0.3	0.1	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.80	R				55.0	17.5	5.6	2.4	1.0	0.4	0.2	0.0
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
3.00	R				62.7	20.0	6.4	2.7	1.1	0.4	0.2	0.1
	V				4.6	2.9	1.8	1.3	0.9	0.6	0.5	0.3
3.20	R				70.9	22.5	7.2	3.1	1.3	0.5	0.2	0.1
	V				4.9	3.1	2.0	1.4	1.0	0.6	0.5	0.3
3.40	R				79.6	25.3	8.0	3.4	1.4	0.5	0.2	0.1
	V				5.2	3.3	2.1	1.5	1.0	0.7	0.5	0.3
3.60	R					28.2	8.9	3.8	1.6	0.6	0.3	0.1
	V					3.5	2.2	1.6	1.1	0.7	0.6	0.3
3.80	R					31.2	9.9	4.2	1.7	0.6	0.3	0.1
	V					3.7	2.3	1.7	1.2	0.8	0.6	0.4
4.00	R					34.4	10.9	4.6	1.9	0.7	0.3	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
4.20	R					37.7	11.9	5.1	2.1	0.8	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.8	0.6	0.4
4.40	R					41.2	13.0	5.5	2.3	0.8	0.4	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.60	R					44.8	14.1	6.0	2.5	0.9	0.5	0.1
	V					4.5	2.8	2.0	1.4	0.9	0.7	0.4
4.80	R					48.6	15.3	6.5	2.7	1.0	0.5	0.1
	V					4.7	2.9	2.1	1.5	1.0	0.7	0.5
5.00	R					52.6	16.6	7.0	2.9	1.0	0.5	0.2
	V					4.9	3.1	2.2	1.5	1.0	0.8	0.5
5.20	R					56.6	17.8	7.6	3.1	1.1	0.6	0.2
	V					5.1	3.2	2.3	1.6	1.0	0.8	0.5
5.40	R						19.1	8.1	3.3	1.2	0.6	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
5.60	R						20.5	8.7	3.5	1.3	0.7	0.2
	V						3.4	2.4	1.7	1.1	0.9	0.5
5.80	R						21.9	9.3	3.8	1.4	0.7	0.2
	V						3.6	2.5	1.8	1.2	0.9	0.5
6.00	R						23.4	9.9	4.0	1.5	0.8	0.2
	V						3.7	2.6	1.8	1.2	0.9	0.6

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
6.20	R						24.9	10.5	4.3	1.6	0.8	0.2
	V						3.8	2.7	1.9	1.2	1.0	0.6
6.40	R						26.4	11.2	4.5	1.6	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
6.60	R						28.0	11.8	4.8	1.7	0.9	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
6.80	R						29.6	12.5	5.1	1.8	1.0	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
7.00	R						31.3	13.2	5.4	1.9	1.0	0.3
	V						4.3	3.0	2.1	1.4	1.1	0.7
7.50	R						35.7	15.0	6.1	2.2	1.2	0.3
	V						4.6	3.3	2.3	1.5	1.2	0.7
8.00	R						40.4	17.0	6.9	2.5	1.4	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
9.00	R						50.6	21.3	8.6	3.1	1.7	0.5
	V						5.5	3.9	2.7	1.8	1.4	0.8
10.00	R							26.0	10.5	3.8	2.1	0.6
	V							4.3	3.0	2.0	1.5	0.9

Table 4. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 16 and PN20 polypropylene at the temperature of 70◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.01	R	0.0										
	V	0.1										
0.02	R	0.1	0.0									
	V	0.1	0.1									
0.03	R	0.2	0.1									
	V	0.2	0.1									
0.04	R	0.3	0.1	0.0								
	V	0.2	0.2	0.1								
0.05	R	0.5	0.2	0.1								
	V	0.3	0.2	0.1								
0.06	R	0.8	0.2	0.1								
	V	0.4	0.2	0.1								
0.07	R	1.0	0.3	0.1								
	V	0.4	0.3	0.2								
0.08	R	1.4	0.4	0.1	0.0							
	V	0.5	0.3	0.2	0.1							
0.09	R	1.7	0.6	0.0	0.1							
	V	0.6	0.4	0.0	0.1							
0.10	R	2.1	0.7	0.2	0.1							
	V	0.6	0.4	0.2	0.2							
0.12	R	3.0	1.0	0.3	0.1							
	V	0.7	0.5	0.3	0.2							
0.14	R	4.1	1.4	0.4	0.1	0.0						
	V	0.9	0.6	0.3	0.2	0.1						
0.16	R	5.4	1.8	0.5	0.2	0.1						
	V	1.0	0.6	0.4	0.2	0.2						
0.18	R	6.9	2.2	1.1	0.2	0.1						
	V	1.1	0.7	0.6	0.3	0.2						
0.20	R	8.5	2.8	0.8	0.3	0.1	0.0					
	V	1.2	0.8	0.5	0.3	0.2	0.1					
0.30	R	19.0	6.2	1.8	0.6	0.2	0.1					
	V	1.8	1.2	0.7	0.5	0.3	0.2					
0.40	R	33.8	11.1	3.3	1.1	0.3	0.1	0.0				
	V	2.5	1.6	1.0	0.6	0.4	0.2	0.2				
0.50	R	52.9	17.3	5.1	1.7	0.5	0.2	0.1				
	V	3.1	2.0	1.2	0.8	0.5	0.3	0.2				
0.60	R	76.1	24.9	7.3	2.4	0.8	0.2	0.1	0.0			
	V	3.7	2.4	1.4	0.9	0.6	0.4	0.3	0.2			
0.70	R	103.6	33.9	10.0	3.2	1.0	0.3	0.1	0.1			
	V	4.3	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.80	R	135.3	44.3	13.0	4.2	1.3	0.4	0.2	0.1			
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.3	0.2			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.90	R	171.3	56.1	16.5	5.4	1.7	0.5	0.2	0.1			
	V	5.5	3.5	2.2	1.4	0.9	0.6	0.4	0.3			
1.00	R		69.3	20.3	6.6	2.1	0.7	0.3	0.1	0.0		
	V		3.9	2.4	1.5	1.0	0.6	0.4	0.3	0.2		
1.20	R		99.8	29.3	9.5	3.0	1.0	0.4	0.2	0.1		
	V		4.7	2.9	1.8	1.2	0.7	0.5	0.4	0.2		
1.40	R		135.8	39.9	12.9	4.1	1.3	0.5	0.2	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.60	R			52.1	16.9	5.4	1.7	0.7	0.3	0.1	0.1	
	V			3.9	2.5	1.6	1.0	0.7	0.5	0.3	0.2	
1.80	R			65.9	21.4	6.8	2.2	0.9	0.4	0.1	0.1	
	V			4.3	2.8	1.7	1.1	0.8	0.5	0.4	0.3	
2.00	R			81.4	26.4	8.4	2.7	1.1	0.5	0.2	0.1	
	V			4.8	3.1	1.9	1.2	0.9	0.6	0.4	0.3	
2.20	R			98.4	32.0	10.2	3.2	1.4	0.5	0.2	0.1	
	V			5.3	3.4	2.1	1.3	1.0	0.7	0.4	0.3	
2.40	R				38.1	12.1	3.8	1.6	0.6	0.2	0.1	0.0
	V				3.7	2.3	1.5	1.0	0.7	0.5	0.4	0.2
2.60	R				44.7	14.2	4.5	1.9	0.8	0.3	0.1	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.80	R				51.8	16.5	5.2	2.2	0.9	0.3	0.2	0.0
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
3.00	R				59.5	19.0	6.0	2.5	1.0	0.4	0.2	0.1
	V				4.6	2.9	1.8	1.3	0.9	0.6	0.5	0.3
3.20	R				67.7	21.6	6.8	2.9	1.2	0.4	0.2	0.1
	V				4.9	3.1	2.0	1.4	1.0	0.6	0.5	0.3
3.40	R				76.4	24.3	7.7	3.2	1.3	0.5	0.2	0.1
	V				5.2	3.3	2.1	1.5	1.0	0.7	0.5	0.3
3.60	R					27.3	8.6	3.6	1.5	0.5	0.3	0.1
	V					3.5	2.2	1.6	1.1	0.7	0.6	0.3
3.80	R					30.4	9.6	4.0	1.6	0.6	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
4.00	R					33.7	10.6	4.5	1.8	0.7	0.3	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
4.20	R					37.1	11.7	4.9	2.0	0.7	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.8	0.6	0.4
4.40	R					40.8	12.9	5.4	2.2	0.8	0.4	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.60	R					44.6	14.0	5.9	2.4	0.9	0.4	0.1
	V					4.5	2.8	2.0	1.4	0.9	0.7	0.4
4.80	R					48.5	15.3	6.4	2.6	0.9	0.5	0.1
	V					4.7	2.9	2.1	1.4	1.0	0.7	0.5
5.00	R					52.6	16.6	7.0	2.8	1.0	0.5	0.2
	V					4.9	3.1	2.2	1.5	1.0	0.8	0.5
5.20	R					56.9	18.0	7.6	3.1	1.1	0.6	0.2
	V					5.1	3.2	2.3	1.6	1.0	0.8	0.5
5.40	R						19.4	8.2	3.3	1.2	0.6	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
5.60	R						20.8	8.8	3.5	1.3	0.7	0.2
	V						3.4	2.4	1.7	1.1	0.9	0.5
5.80	R						22.3	9.4	3.8	1.4	0.7	0.2
	V						3.6	2.5	1.7	1.2	0.9	0.5
6.00	R						23.9	10.1	4.1	1.5	0.8	0.2
	V						3.7	2.6	1.8	1.2	0.9	0.6

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
6.20	R						25.5	10.8	4.3	1.6	0.8	0.2
	V						3.8	2.7	1.9	1.2	1.0	0.6
6.40	R						27.2	11.5	4.6	1.7	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
6.60	R						28.9	12.2	4.9	1.8	0.9	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
6.80	R						30.7	12.9	5.2	1.9	1.0	0.3
	V						4.2	2.9	2.1	1.4	1.1	0.6
7.00	R						32.5	13.7	5.5	2.0	1.0	0.3
	V						4.3	3.0	2.1	1.4	1.1	0.7
7.50	R						37.3	15.7	6.3	2.3	1.2	0.3
	V						4.6	3.3	2.3	1.5	1.2	0.7
8.00	R						42.5	17.9	7.2	2.6	1.4	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
9.00	R						53.8	22.7	9.1	3.3	1.7	0.5
	V						5.5	3.9	2.7	1.8	1.4	0.8
10.00	R							28.0	11.3	4.1	2.1	0.6
	V							4.3	3.0	2.0	1.5	0.9

Table 5. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 16 and PN20 polypropylene at the temperature of 80◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.01	R	0.0										
	V	0.1										
0.02	R	0.1	0.0									
	V	0.1	0.1									
0.03	R	0.2	0.1									
	V	0.2	0.1									
0.04	R	0.3	0.1	0.0								
	V	0.2	0.2	0.1								
0.05	R	0.5	0.2	0.1								
	V	0.3	0.2	0.1								
0.06	R	0.8	0.2	0.1								
	V	0.4	0.2	0.1								
0.07	R	1.0	0.3	0.1								
	V	0.4	0.3	0.2								
0.08	R	1.3	0.4	0.1	0.0							
	V	0.5	0.3	0.2	0.1							
0.09	R	1.7	0.6	0.0	0.1							
	V	0.6	0.4	0.0	0.1							
0.10	R	2.1	0.7	0.2	0.1							
	V	0.6	0.4	0.2	0.2							
0.12	R	3.0	1.0	0.3	0.1							
	V	0.7	0.5	0.3	0.2							
0.14	R	4.1	1.3	0.4	0.1	0.0						
	V	0.9	0.6	0.3	0.2	0.1						
0.16	R	5.4	1.8	0.5	0.2	0.1						
	V	1.0	0.6	0.4	0.2	0.2						
0.18	R	6.8	2.2	1.1	0.2	0.1						
	V	1.1	0.7	0.6	0.3	0.2						
0.20	R	8.4	2.8	0.8	0.3	0.1	0.0					
	V	1.2	0.8	0.5	0.3	0.2	0.1					
0.30	R	18.9	6.2	1.8	0.6	0.2	0.1					
	V	1.8	1.2	0.7	0.5	0.3	0.2					
0.40	R	33.6	11.0	3.2	1.1	0.3	0.1	0.0				
	V	2.5	1.6	1.0	0.6	0.4	0.2	0.2				
0.50	R	52.5	17.2	5.1	1.6	0.5	0.2	0.1				
	V	3.1	2.0	1.2	0.8	0.5	0.3	0.2				
0.60	R	75.6	24.8	7.3	2.4	0.8	0.2	0.1	0.0			
	V	3.7	2.4	1.4	0.9	0.6	0.4	0.3	0.2			
0.70	R	103.0	33.7	9.9	3.2	1.0	0.3	0.1	0.1			
	V	4.3	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.80	R	134.5	44.1	12.9	4.2	1.3	0.4	0.2	0.1			
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.3	0.2			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.90	R	170.2	55.8	16.4	5.3	1.7	0.5	0.2	0.1			
	V	5.5	3.5	2.2	1.4	0.9	0.6	0.4	0.3			
1.00	R		68.9	20.2	6.6	2.1	0.7	0.3	0.1	0.0		
	V		3.9	2.4	1.5	1.0	0.6	0.4	0.3	0.2		
1.20	R		99.1	29.1	9.5	3.0	1.0	0.4	0.2	0.1		
	V		4.7	2.9	1.8	1.2	0.7	0.5	0.4	0.2		
1.40	R		135.0	39.6	12.9	4.1	1.3	0.5	0.2	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.60	R			51.7	16.8	5.4	1.7	0.7	0.3	0.1	0.1	
	V			3.9	2.5	1.6	1.0	0.7	0.5	0.3	0.2	
1.80	R			65.5	21.3	6.8	2.1	0.9	0.4	0.1	0.1	
	V			4.3	2.8	1.7	1.1	0.8	0.5	0.4	0.3	
2.00	R			80.9	26.3	8.4	2.6	1.1	0.4	0.2	0.1	
	V			4.8	3.1	1.9	1.2	0.9	0.6	0.4	0.3	
2.20	R			97.8	31.8	10.1	3.2	1.3	0.5	0.2	0.1	
	V			5.3	3.4	2.1	1.3	1.0	0.7	0.4	0.3	
2.40	R				37.8	12.1	3.8	1.6	0.6	0.2	0.1	0.0
	V				3.7	2.3	1.5	1.0	0.7	0.5	0.4	0.2
2.60	R				44.4	14.1	4.5	1.9	0.8	0.3	0.1	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.80	R				51.5	16.4	5.2	2.2	0.9	0.3	0.2	0.0
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
3.00	R				59.1	18.8	5.9	2.5	1.0	0.4	0.2	0.1
	V				4.6	2.9	1.8	1.3	0.9	0.6	0.5	0.3
3.20	R				67.2	21.4	6.8	2.8	1.1	0.4	0.2	0.1
	V				4.9	3.1	2.0	1.4	1.0	0.6	0.5	0.3
3.40	R				75.9	24.2	7.6	3.2	1.3	0.5	0.2	0.1
	V				5.2	3.3	2.1	1.5	1.0	0.7	0.5	0.3
3.60	R					27.1	8.6	3.6	1.5	0.5	0.3	0.1
	V					3.5	2.2	1.6	1.1	0.7	0.6	0.3
3.80	R					30.2	9.5	4.0	1.6	0.6	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
4.00	R					33.5	10.6	4.5	1.8	0.7	0.3	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
4.20	R					36.9	11.6	4.9	2.0	0.7	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.8	0.6	0.4
4.40	R					40.5	12.8	5.4	2.2	0.8	0.4	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.60	R					44.3	14.0	5.9	2.4	0.9	0.4	0.1
	V					4.5	2.8	2.0	1.4	0.9	0.7	0.4
4.80	R					48.2	15.2	6.4	2.6	0.9	0.5	0.1
	V					4.7	2.9	2.1	1.4	1.0	0.7	0.5
5.00	R					52.3	16.5	7.0	2.8	1.0	0.5	0.2
	V					4.9	3.1	2.2	1.5	1.0	0.8	0.5
5.20	R					56.6	17.8	7.5	3.0	1.1	0.6	0.2
	V					5.1	3.2	2.3	1.6	1.0	0.8	0.5
5.40	R						19.2	8.1	3.3	1.2	0.6	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
5.60	R						20.7	8.7	3.5	1.3	0.7	0.2
	V						3.4	2.4	1.7	1.1	0.9	0.5
5.80	R						22.2	9.4	3.8	1.4	0.7	0.2
	V						3.6	2.5	1.7	1.2	0.9	0.5
6.00	R						23.8	10.0	4.0	1.5	0.8	0.2
	V						3.7	2.6	1.8	1.2	0.9	0.6

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
6.20	R						25.4	10.7	4.3	1.6	0.8	0.2
	V						3.8	2.7	1.9	1.2	1.0	0.6
6.40	R						27.0	11.4	4.6	1.7	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
6.60	R						28.7	12.1	4.9	1.8	0.9	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
6.80	R						30.5	12.9	5.2	1.9	1.0	0.3
	V						4.2	2.9	2.1	1.4	1.1	0.6
7.00	R						32.3	13.6	5.5	2.0	1.0	0.3
	V						4.3	3.0	2.1	1.4	1.1	0.7
7.50	R						37.1	15.6	6.3	2.3	1.2	0.3
	V						4.6	3.3	2.3	1.5	1.2	0.7
8.00	R						42.2	17.8	7.2	2.6	1.3	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
9.00	R						53.5	22.5	9.1	3.3	1.7	0.5
	V						5.5	3.9	2.7	1.8	1.4	0.8
10.00	R							27.8	11.2	4.1	2.1	0.6
	V							4.3	3.0	2.0	1.5	0.9

Table 6. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 16 and PN20 polypropylene at the temperature of 95◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.01	R	0.0										
	V	0.1										
0.02	R	0.1	0.0									
	V	0.1	0.1									
0.03	R	0.2	0.1									
	V	0.2	0.1									
0.04	R	0.3	0.1	0.0								
	V	0.2	0.2	0.1								
0.05	R	0.5	0.2	0.1								
	V	0.3	0.2	0.1								
0.06	R	0.7	0.2	0.1								
	V	0.4	0.2	0.1								
0.07	R	1.0	0.3	0.1								
	V	0.4	0.3	0.2								
0.08	R	1.3	0.4	0.1	0.0							
	V	0.5	0.3	0.2	0.1							
0.09	R	1.7	0.6	0.0	0.1							
	V	0.6	0.4	0.0	0.1							
0.10	R	2.1	0.7	0.2	0.1							
	V	0.6	0.4	0.2	0.2							
0.12	R	3.0	1.0	0.3	0.1							
	V	0.7	0.5	0.3	0.2							
0.14	R	4.1	1.3	0.4	0.1	0.0						
	V	0.9	0.6	0.3	0.2	0.1						
0.16	R	5.3	1.7	0.5	0.2	0.1						
	V	1.0	0.6	0.4	0.2	0.2						
0.18	R	6.7	2.2	1.1	0.2	0.1						
	V	1.1	0.7	0.6	0.3	0.2						
0.20	R	8.3	2.7	0.8	0.3	0.1	0.0					
	V	1.2	0.8	0.5	0.3	0.2	0.1					
0.30	R	18.7	6.1	1.8	0.6	0.2	0.1					
	V	1.8	1.2	0.7	0.5	0.3	0.2					
0.40	R	33.3	10.9	3.2	1.0	0.3	0.1	0.0				
	V	2.5	1.6	1.0	0.6	0.4	0.2	0.2				
0.50	R	52.0	17.0	5.0	1.6	0.5	0.2	0.1				
	V	3.1	2.0	1.2	0.8	0.5	0.3	0.2				
0.60	R	74.9	24.5	7.2	2.3	0.7	0.2	0.1	0.0			
	V	3.7	2.4	1.4	0.9	0.6	0.4	0.3	0.2			
0.70	R	101.9	33.4	9.8	3.2	1.0	0.3	0.1	0.1			
	V	4.3	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.80	R	133.1	43.6	12.8	4.2	1.3	0.4	0.2	0.1			
	V	4.9	3.1	1.9	1.2	0.8	0.5	0.3	0.2			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
0.90	R	168.5	55.2	16.2	5.3	1.7	0.5	0.2	0.1			
	V	5.5	3.5	2.2	1.4	0.9	0.6	0.4	0.3			
1.00	R		68.2	20.0	6.5	2.1	0.7	0.3	0.1	0.0		
	V		3.9	2.4	1.5	1.0	0.6	0.4	0.3	0.2		
1.20	R		98.1	28.8	9.4	3.0	0.9	0.4	0.2	0.1		
	V		4.7	2.9	1.8	1.2	0.7	0.5	0.4	0.2		
1.40	R		133.6	39.2	12.7	4.1	1.3	0.5	0.2	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.60	R			51.2	16.6	5.3	1.7	0.7	0.3	0.1	0.1	
	V			3.9	2.5	1.6	1.0	0.7	0.5	0.3	0.2	
1.80	R			64.8	21.1	6.7	2.1	0.9	0.4	0.1	0.1	
	V			4.3	2.8	1.7	1.1	0.8	0.5	0.4	0.3	
2.00	R			80.0	26.0	8.3	2.6	1.1	0.4	0.2	0.1	
	V			4.8	3.1	1.9	1.2	0.9	0.6	0.4	0.3	
2.20	R			96.8	31.5	10.0	3.2	1.3	0.5	0.2	0.1	
	V			5.3	3.4	2.1	1.3	1.0	0.7	0.4	0.3	
2.40	R				37.4	11.9	3.8	1.6	0.6	0.2	0.1	0.0
	V				3.7	2.3	1.5	1.0	0.7	0.5	0.4	0.2
2.60	R				43.9	14.0	4.4	1.9	0.8	0.3	0.1	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.80	R				51.0	16.2	5.1	2.2	0.9	0.3	0.2	0.0
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
3.00	R				58.5	18.6	5.9	2.5	1.0	0.4	0.2	0.1
	V				4.6	2.9	1.8	1.3	0.9	0.6	0.5	0.3
3.20	R				66.6	21.2	6.7	2.8	1.1	0.4	0.2	0.1
	V				4.9	3.1	2.0	1.4	1.0	0.6	0.5	0.3
3.40	R				75.1	23.9	7.6	3.2	1.3	0.5	0.2	0.1
	V				5.2	3.3	2.1	1.5	1.0	0.7	0.5	0.3
3.60	R					26.8	8.5	3.6	1.4	0.5	0.3	0.1
	V					3.5	2.2	1.6	1.1	0.7	0.6	0.3
3.80	R					29.9	9.4	4.0	1.6	0.6	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
4.00	R					33.1	10.5	4.4	1.8	0.6	0.3	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
4.20	R					36.5	11.5	4.9	2.0	0.7	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.8	0.6	0.4
4.40	R					40.1	12.6	5.3	2.1	0.8	0.4	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.60	R					43.8	13.8	5.8	2.3	0.9	0.4	0.1
	V					4.5	2.8	2.0	1.4	0.9	0.7	0.4
4.80	R					47.7	15.0	6.3	2.6	0.9	0.5	0.1
	V					4.7	2.9	2.1	1.4	1.0	0.7	0.5
5.00	R					51.8	16.3	6.9	2.8	1.0	0.5	0.2
	V					4.9	3.1	2.2	1.5	1.0	0.8	0.5
5.20	R					56.0	17.7	7.4	3.0	1.1	0.6	0.2
	V					5.1	3.2	2.3	1.6	1.0	0.8	0.5
5.40	R						19.0	8.0	3.2	1.2	0.6	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
5.60	R						20.5	8.6	3.5	1.3	0.7	0.2
	V						3.4	2.4	1.7	1.1	0.9	0.5
5.80	R						22.0	9.3	3.7	1.4	0.7	0.2
	V						3.6	2.5	1.7	1.2	0.9	0.5
6.00	R						23.5	9.9	4.0	1.5	0.8	0.2
	V						3.7	2.6	1.8	1.2	0.9	0.6

q [dm³/s]	R [hPa/m][5] v [m/s]	Nominal pressure PN 16 and Faser PN20 SDR 7.4 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x2.8	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.03	90x12.3	110x15.1	125x17.1	160x21.9
6.20	R						25.1	10.6	4.3	1.5	0.8	0.2
	V						3.8	2.7	1.9	1.2	1.0	0.6
6.40	R						26.8	11.3	4.5	1.7	0.9	0.2
	V						3.9	2.8	1.9	1.3	1.0	0.6
6.60	R						28.5	12.0	4.8	1.8	0.9	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
6.80	R						30.2	12.7	5.1	1.9	1.0	0.3
	V						4.2	2.9	2.1	1.4	1.1	0.6
7.00	R						32.0	13.5	5.4	2.0	1.0	0.3
	V						4.3	3.0	2.1	1.4	1.1	0.7
7.50	R						36.7	15.5	6.2	2.3	1.2	0.3
	V						4.6	3.3	2.3	1.5	1.2	0.7
8.00	R						41.8	17.6	7.1	2.6	1.3	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
9.00	R						52.9	22.3	9.0	3.3	1.7	0.5
	V						5.5	3.9	2.7	1.8	1.4	0.8
10.00	R							27.5	11.1	4.0	2.1	0.6
	V							4.3	3.0	2.0	1.5	0.9

Table 7. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 20 and PN25 polypropylene at the temperature of 20◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][4] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.01	R	0.1	0.1									
	V	0.1	0.1									
0.02	R	0.3	0.1	0.0								
	V	0.2	0.1	0.1								
0.03	R	0.8	0.2	0.1								
	V	0.2	0.1	0.1								
0.04	R	1.3	0.5	0.1	0.0							
	V	0.3	0.2	0.1	0.1							
0.05	R	1.9	0.7	0.2	0.1							
	V	0.4	0.2	0.1	0.1							
0.06	R	2.7	0.9	0.3	0.1							
	V	0.4	0.3	0.2	0.1							
0.07	R	3.5	1.2	0.4	0.1	0.0						
	V	0.5	0.3	0.2	0.1	0.1						
0.08	R	4.4	1.5	0.5	0.2	0.1						
	V	0.6	0.4	0.2	0.1	0.1						
0.09	R	5.4	1.8	0.6	0.2	0.1						
	V	0.7	0.4	0.3	0.2	0.1						
0.10	R	6.5	2.2	0.7	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.12	R	8.9	3.0	0.9	0.3	0.1	0.0					
	V	0.9	0.6	0.3	0.2	0.1	0.1					
0.14	R	11.7	3.9	1.2	0.4	0.2	0.1					
	V	1.0	0.7	0.4	0.3	0.2	0.1					
0.16	R	14.8	4.9	1.5	0.5	0.2	0.1					
	V	1.2	0.7	0.5	0.3	0.2	0.1					
0.18	R	18.3	6.1	1.9	0.6	0.2	0.1					
	V	1.3	0.8	0.5	0.3	0.2	0.1					
0.20	R	22.1	7.3	2.3	0.8	0.3	0.1	0.0				
	V	1.5	0.9	0.6	0.4	0.2	0.1	0.1				
0.30	R	45.6	15.1	4.6	1.6	0.6	0.2	0.1	0.0			
	V	2.2	1.4	0.9	0.5	0.4	0.2	0.2	0.1			
0.40	R	76.8	25.2	7.7	2.6	0.9	0.3	0.1	0.1			
	V	2.9	1.9	1.1	0.7	0.5	0.3	0.2	0.1			
0.50	R	115.3	37.7	11.5	3.9	1.3	0.4	0.2	0.1			
	V	3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2			
0.60	R	161.2	52.5	16.0	5.4	1.9	0.6	0.3	0.1			
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.70	R	214.2	69.5	21.1	7.1	2.4	0.8	0.3	0.1	0.0		
	V	5.1	3.2	2.0	1.3	0.8	0.5	0.4	0.3	0.1		
0.80	R		88.7	26.9	9.0	3.1	1.0	0.4	0.2	0.1		
	V		3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2		

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][4] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.90	R		110.2	33.3	11.1	3.8	1.2	0.5	0.2	0.1		
	V		4.2	2.6	1.6	1.0	0.7	0.5	0.3	0.2		
1.00	R		133.8	40.4	13.4	4.6	1.5	0.6	0.3	0.1		
	V		4.6	2.8	1.8	1.2	0.7	0.5	0.4	0.2		
1.20	R		187.4	56.3	18.6	6.4	2.1	0.9	0.4	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.40	R			74.7	24.7	8.4	2.7	1.2	0.5	0.2	0.1	
	V			4.0	2.5	1.6	1.0	0.7	0.5	0.3	0.3	
1.60	R			95.6	31.5	10.7	3.4	1.5	0.6	0.2	0.1	
	V			4.5	2.9	1.9	1.2	0.8	0.6	0.4	0.3	
1.80	R			118.9	39.0	13.3	4.2	1.8	0.8	0.3	0.1	
	V			5.1	3.2	2.1	1.3	0.9	0.6	0.4	0.3	
2.00	R				47.3	16.1	5.1	2.2	0.9	0.4	0.1	0.0
	V				3.6	2.3	1.4	1.0	0.7	0.5	0.4	0.2
2.20	R				56.4	19.1	6.1	2.6	1.1	0.4	0.2	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.40	R				66.2	22.4	7.1	3.1	1.3	0.5	0.2	0.1
	V				4.3	2.8	1.7	1.2	0.9	0.6	0.4	0.3
2.60	R				76.8	25.9	8.3	3.6	1.5	0.6	0.2	0.1
	V				4.7	3.0	1.9	1.3	0.9	0.6	0.5	0.3
2.80	R				88.1	29.7	9.4	4.1	1.7	0.6	0.3	0.1
	V				5.0	3.2	2.0	1.4	1.0	0.7	0.5	0.3
3.00	R					33.7	10.7	4.6	1.9	0.7	0.3	0.1
	V					3.5	2.2	1.5	1.1	0.7	0.5	0.3
3.20	R					38.0	12.0	5.2	2.2	0.8	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
3.40	R					42.4	13.5	5.8	2.4	0.9	0.4	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
3.60	R					47.2	14.9	6.4	2.7	1.0	0.4	0.1
	V					4.2	2.6	1.8	1.3	0.9	0.7	0.4
3.80	R					52.1	16.5	7.1	2.9	1.1	0.5	0.1
	V					4.4	2.7	1.9	1.3	0.9	0.7	0.4
4.00	R					57.3	18.1	7.8	3.2	1.2	0.5	0.2
	V					4.6	2.9	2.0	1.4	1.0	0.7	0.4
4.20	R					62.7	19.8	8.5	3.5	1.3	0.6	0.2
	V					4.9	3.0	2.1	1.5	1.0	0.8	0.5
4.40	R					58.4	21.6	9.2	3.8	1.5	0.6	0.2
	V					5.1	3.2	2.2	1.6	1.0	0.8	0.5
4.60	R						23.4	10.0	4.2	1.6	0.7	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
4.80	R						25.3	10.8	4.5	1.7	0.8	0.2
	V						3.5	2.4	1.7	1.1	0.9	0.5
5.00	R						27.3	11.6	4.8	1.8	0.8	0.2
	V						3.6	2.6	1.8	1.2	0.9	0.6
5.20	R						29.3	12.5	5.2	2.0	0.9	0.3
	V						3.8	2.7	1.8	1.2	1.0	0.6
5.40	R						31.5	13.4	5.6	2.1	1.0	0.3
	V						39	2.8	1.9	1.3	1.0	0.6
5.60	R						33.6	14.3	6.0	2.2	1.0	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
5.80	R						35.9	15.3	6.4	2.4	1.1	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
6.00	R						38.2	16.3	6.8	2.5	1.2	0.3
	V						4.3	3.1	2.1	1.4	1.1	0.7

q [dm³/s]	R [hPa/m]⁴ v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 20°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
6.20	R						40.6	17.3	7.2	2.7	1.3	0.4
	V						4.5	3.2	2.2	1.5	1.1	0.7
6.40	R						43.1	18.3	7.6	2.9	1.4	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
6.60	R						45.6	19.4	8.1	3.0	1.4	0.4
	V						4.8	3.4	2.3	1.6	1.2	0.7
6.80	R						48.2	20.5	8.5	3.2	1.5	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
7.00	R						50.9	21.6	9.0	3.4	1.6	0.5
	V						5.1	3.6	2.5	1.7	1.3	0.8
7.50	R							24.5	10.2	3.8	1.9	0.5
	V							3.8	2.7	1.8	1.4	0.8
8.00	R							27.6	11.5	4.3	2.1	0.6
	V							4.1	2.8	1.9	1.5	0.9
9.00	R							34.4	14.3	5.3	2.7	0.8
	V							4.6	3.2	2.1	1.6	1.0
10.00	R							41.8	17.4	6.5	3.3	1.0
	V							5.1	3.5	2.4	1.8	1.1

Table 8. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 20 and PN25 polypropylene at the temperature of 60◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][6] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.01	R	0.1	0.0									
	V	0.1	0.1									
0.02	R	0.3	0.1	0.0								
	V	0.2	0.1	0.1								
0.03	R	0.6	0.2	0.1								
	V	0.2	0.2	0.1								
0.04	R	1.1	0.4	0.1	0.0							
	V	0.3	0.2	0.1	0.1							
0.05	R	1.6	0.5	0.2	0.1							
	V	0.4	0.2	0.2	0.1							
0.06	R	2.2	0.7	0.2	0.1							
	V	0.4	0.3	0.2	0.1							
0.07	R	2.8	0.9	0.3	0.1							
	V	0.5	0.3	0.2	0.2							
0.08	R	3.6	1.2	0.4	0.2	0.0						
	V	0.6	0.4	0.2	0.2	0.1						
0.09	R	4.4	1.5	0.5	0.2	0.1						
	V	0.7	0.4	0.3	0.2	0.1						
0.10	R	5.3	1.8	0.6	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.12	R	7.4	2.5	0.8	0.3	0.1						
	V	0.9	0.6	0.3	0.2	0.2						
0.14	R	9.8	3.2	1.0	0.3	0.1	0.0					
	V	1.0	0.7	0.4	0.3	0.2	0.1					
0.16	R	12.4	4.1	1.3	.04	0.2	0.1					
	V	1.2	0.7	0.5	0.3	0.2	0.1					
0.18	R	15.4	5.1	1.6	0.5	0.2	0.1					
	V	1.3	0.8	0.5	0.3	0.2	0.1					
0.20	R	18.6	6.1	1.9	0.6	0.2	0.1	0.0				
	V	1.5	0.9	0.6	0.4	0.2	0.2	0.1				
0.30	R	39.2	12.7	3.9	1.3	0.5	0.2	0.1				
	V	2.2	1.4	0.9	0.5	0.4	0.2	0.2				
0.40	R	66.8	21.6	6.5	2.2	0.8	0.2	0.1	0.0			
	V	2.9	1.9	1.1	0.7	0.5	0.3	0.2	0.1			
0.50	R	101.3	32.5	9.8	3.3	1.1	0.4	0.2	0.1			
	V	3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2			
0.60	R	142.7	45.6	13.7	4.5	1.5	0.5	0.2	0.1			
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.70	R	191.4	60.8	18.2	6.0	2.0	0.7	0.3	0.1	0.0		
	V	5.1	3.2	2.0	1.3	0.8	0.5	0.4	0.3	0.2		
0.80	R		78.1	23.3	7.6	2.6	0.8	0.4	0.2	0.1		
	V		3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2		

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][6] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.90	R		97.5	28.9	9.5	3.2	1.0	0.4	0.2	0.1		
	V		4.2	2.6	1.6	1.0	0.7	0.5	0.3	0.2		
1.00	R		119.3	35.2	11.5	3.9	1.2	0.5	0.2	0.1		
	V		4.6	2.8	1.8	1.2	0.7	0.5	0.4	0.2		
1.20	R		168.3	49.5	16.1	5.4	1.7	0.7	0.3	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.40	R			66.1	21.5	7.2	2.3	1.0	0.4	0.2	0.1	
	V			4.0	2.3	1.6	1.0	0.7	0.5	0.3	0.3	
1.60	R			85.3	27.5	9.2	2.9	1.3	0.5	0.2	0.1	
	V			4.5	2.9	1.9	1.2	0.8	0.6	0.4	0.3	
1.80	R			106.6	34.3	11.5	2.6	1.6	0.7	0.2	0.1	
	V			5.1	3.2	2.1	1.3	0.9	0.6	0.4	0.3	
2.00	R				41.8	14.0	4.4	1.9	0.8	0.3	0.1	0.0
	V				3.6	2.3	1.4	1.0	0.7	0.5	0.4	0.2
2.20	R				50.0	16.7	5.2	2.2	0.9	0.4	0.2	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.40	R				59.1	19.6	6.2	2.6	1.1	0.4	0.2	0.1
	V				4.3	2.8	1.7	1.2	0.9	0.6	0.4	0.3
2.60	R				68.7	22.7	7.1	3.0	1.3	0.5	0.2	0.1
	V				4.7	3.0	1.9	1.3	0.9	0.6	0.5	0.3
2.80	R				79.1	26.1	8.2	3.5	1.5	0.5	0.3	0.1
	V				5.0	3.2	2.0	1.4	1.0	0.7	0.5	0.3
3.00	R					29.7	9.3	4.0	1.7	0.6	0.3	0.1
	V					3.5	2.2	1.5	1.1	0.7	0.5	0.3
3.20	R					33.6	10.5	4.5	1.9	0.7	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
3.40	R					37.6	11.7	5.0	2.1	0.8	0.4	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
3.60	R					42.1	13.1	5.5	2.3	0.9	0.4	0.1
	V					4.2	2.6	1.8	1.3	0.9	0.7	0.4
3.80	R					46.6	14.4	6.1	2.6	1.0	0.5	0.1
	V					4.4	2.7	1.9	1.3	0.9	0.7	0.4
4.00	R					51.3	15.9	6.7	2.8	1.0	0.5	0.2
	V					4.6	2.9	2.0	1.4	1.0	0.7	0.4
4.20	R					56.3	17.4	7.4	3.1	1.1	0.6	0.2
	V					4.9	3.0	2.1	1.5	1.0	0.8	0.5
4.40	R					61.5	19.0	8.0	3.4	1.2	0.6	0.2
	V					5.1	3.2	2.2	1.6	1.0	0.8	0.5
4.60	R						20.7	8.7	3.6	1.4	0.7	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
4.80	R						22.4	9.4	3.9	1.5	0.8	0.2
	V						3.5	2.4	1.7	1.1	0.9	0.5
5.00	R						24.2	10.2	4.3	1.6	0.8	0.2
	V						3.6	2.6	1.8	1.2	0.9	0.6
5.20	R						26.0	11.0	4.6	1.7	0.9	0.3
	V						3.8	2.7	1.8	1.2	1.0	0.6
5.40	R						28.0	11.8	4.9	1.8	1.0	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
5.60	R						30.0	12.6	5.3	1.9	1.0	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
5.80	R						32.1	13.4	5.6	2.1	1.1	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
6.00	R						34.2	14.3	6.0	2.2	1.2	0.3
	V						4.3	3.1	2.1	1.4	1.1	0.7

q [dm³/s]	R [hPa/m][6] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 60°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
6.20	R						36.4	15.2	6.4	2.3	1.3	0.4
	V						4.5	3.2	2.2	1.5	1.1	0.7
6.40	R						38.6	16.2	6.7	2.5	1.3	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
6.60	R						40.9	17.1	7.1	2.6	1.4	0.4
	V						4.8	3.4	2.3	1.6	1.2	0.7
6.80	R						43.3	18.1	7.5	2.8	1.5	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
7.00	R						45.8	19.1	8.0	2.9	1.6	0.5
	V						5.1	3.6	2.5	1.7	1.3	0.8
7.50	R							21.9	9.1	3.3	1.8	0.5
	V							3.8	2.7	1.8	1.4	0.8
8.00	R							24.7	10.2	3.8	2.1	0.6
	V							4.1	2.8	1.9	1.5	0.9
9.00	R							30.9	12.8	4.7	2.6	0.8
	V							4.6	3.2	2.1	1.6	1.0
10.00	R							37.7	15.6	5.7	3.3	0.9
	V							5.1	3.5	2.4	1.8	1.1

Table 8. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 20 and PN25 polypropylene at the temperature of 70◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][7] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.01	R	0.1	0.0									
	V	0.1	0.1									
0.02	R	0.3	0.1	0.0								
	V	0.2	0.1	0.1								
0.03	R	0.6	0.2	0.1								
	V	0.2	0.1	0.1								
0.04	R	1.0	0.3	0.1	0.0							
	V	0.2	0.1	0.1	0.1							
0.05	R	1.5	0.5	0.2	0.1							
	V	0.4	0.2	0.1	0.1							
0.06	R	2.1	0.7	0.2	0.1							
	V	0.4	0.3	0.2	0.1							
0.07	R	2.7	0.9	0.3	0.1							
	V	0.5	0.3	0.2	0.1							
0.08	R	3.5	1.2	0.4	0.1	0.0						
	V	0.6	0.4	0.2	0.1	0.1						
0.09	R	4.3	1.4	0.4	0.2	0.1						
	V	0.7	0.4	0.3	0.2	0.1						
0.10	R	5.2	1.7	0.5	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.12	R	7.2	2.4	0.7	0.3	0.1						
	V	0.9	0.6	0.3	0.2	0.1						
0.14	R	9.5	3.1	1.0	0.3	0.1	0.0					
	V	1.0	0.7	0.4	0.3	0.2	0.1					
0.16	R	12.1	4.0	1.2	0.4	0.1	0.1					
	V	1.2	0.7	0.5	0.3	0.2	0.1					
0.18	R	14.9	4.9	1.5	0.5	0.2	0.1					
	V	1.3	0.8	0.5	0.3	0.2	0.1					
0.20	R	18.1	5.9	1.8	0.6	0.2	0.1	0.0				
	V	1.5	0.9	0.6	0.4	0.2	0.2	0.1				
0.30	R	38.2	12.4	3.8	1.3	0.4	0.1	0.1				
	V	2.2	1.4	0.9	0.5	0.4	0.2	0.2				
0.40	R	65.2	21.0	6.3	2.1	0.7	0.2	0.1	0.0			
	V	2.9	1.9	1.1	0.7	0.5	0.3	0.2	0.1			
0.50	R	99.1	31.7	9.5	3.2	1.1	0.4	0.2	0.1			
	V	3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2			
0.60	R	140.1	44.6	13.3	4.4	1.5	0.5	0.2	0.1			
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.70	R	187.6	59.5	17.7	5.8	2.0	0.6	0.3	0.1	0.0		
	V	5.1	3.2	2.0	1.3	0.8	0.5	0.4	0.3	0.2		
0.80	R		76.4	22.7	7.4	2.5	0.8	0.4	0.2	0.1		
	V		3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2		

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][7] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.90	R		95.7	28.2	9.2	3.1	1.0	0.4	0.2	0.1		
	V		4.2	2.6	1.6	1.0	0.7	0.5	0.3	0.2		
1.00	R		116.8	34.4	11.2	3.8	1.2	0.5	0.2	0.1		
	V		4.6	2.8	1.8	1.2	0.7	0.5	0.4	0.2		
1.20	R		165.1	48.4	15.7	5.3	1.7	0.7	0.3	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.40	R			64.9	20.9	7.0	2.2	1.0	0.4	0.2	0.1	
	V			4.0	2.3	1.6	1.0	0.7	0.5	0.3	0.3	
1.60	R			83.6	26.9	9.0	2.8	1.2	0.5	0.2	0.1	
	V			4.5	2.9	1.9	1.2	0.8	0.6	0.4	0.3	
1.80	R			104.5	33.5	11.2	3.5	1.5	0.6	0.2	0.1	
	V			5.1	3.2	2.1	1.3	0.9	0.6	0.4	0.3	
2.00	R				40.9	13.6	4.3	1.8	0.8	0.3	0.1	0.0
	V				3.6	2.3	1.4	1.0	0.7	0.5	0.4	0.2
2.20	R				49.1	16.3	5.1	2.2	0.9	0.3	0.2	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.40	R				57.9	19.1	6.0	2.6	1.1	0.4	0.2	0.1
	V				4.3	2.8	1.7	1.2	0.9	0.6	0.4	0.3
2.60	R				67.4	22.2	7.0	3.0	1.2	0.5	0.2	0.1
	V				4.7	3.0	1.9	1.3	0.9	0.6	0.5	0.3
2.80	R				77.5	25.6	8.0	3.4	1.4	0.5	0.3	0.1
	V				5.0	3.2	2.0	1.4	1.0	0.7	0.5	0.3
3.00	R					29.2	9.1	3.9	1.6	0.6	0.3	0.1
	V					3.5	2.2	1.5	1.1	0.7	0.5	0.3
3.20	R					33.0	10.2	4.3	1.8	0.7	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
3.40	R					37.0	11.5	4.9	2.0	0.8	0.4	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
3.60	R					41.2	12.8	5.4	2.3	0.8	0.4	0.1
	V					4.2	2.6	1.8	1.3	0.9	0.7	0.4
3.80	R					45.6	14.1	6.0	2.5	0.9	0.5	0.1
	V					4.4	2.7	1.9	1.3	0.9	0.7	0.4
4.00	R					50.3	15.5	6.6	2.7	1.0	0.5	0.2
	V					4.6	2.9	2.0	1.4	1.0	0.7	0.4
4.20	R					55.2	17.0	7.2	3.0	1.1	0.6	0.2
	V					4.9	3.0	2.1	1.5	1.0	0.8	0.5
4.40	R					60.3	18.6	7.8	3.3	1.2	0.6	0.2
	V					5.1	3.2	2.2	1.6	1.0	0.8	0.5
4.60	R						20.3	8.5	3.6	1.3	0.7	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
4.80	R						22.0	9.2	3.8	1.4	0.7	0.2
	V						3.5	2.4	1.7	1.1	0.9	0.5
5.00	R						23.7	10.0	4.1	1.5	0.8	0.2
	V						3.6	2.6	1.8	1.2	0.9	0.6
5.20	R						25.6	1.7	4.5	1.6	0.9	0.3
	V						3.8	2.7	1.8	1.2	1.0	0.6
5.40	R						27.5	11.5	4.8	1.8	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
5.60	R						29.4	12.3	5.1	1.9	1.0	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
5.80	R						31.4	13.2	5.5	2.0	1.1	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
6.00	R						33.5	14.0	5.8	2.1	1.2	0.3
	V						4.3	3.1	2.1	1.4	1.1	0.7

q [dm³/s]	R [hPa/m][7] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 70°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
6.20	R						35.7	14.9	6.2	2.3	1.2	0.4
	V						4.5	3.2	2.2	1.5	1.1	0.7
6.40	R						37.9	15.9	6.6	2.4	1.3	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
6.60	R						40.1	16.8	7.0	2.6	1.4	0.4
	V						4.7	3.4	2.3	1.6	1.2	0.7
6.80	R						42.5	17.8	7.4	2.7	1.5	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
7.00	R						44.9	18.5	7.8	2.9	1.6	0.5
	V						5.1	3.6	2.5	1.7	1.3	0.8
7.50	R							21.4	8.9	3.2	1.8	0.5
	V							3.8	2.7	1.8	1.4	0.8
8.00	R							24.2	10.0	3.7	2.1	0.6
	V							4.1	2.8	1.9	1.5	0.9
9.00	R							30.3	12.5	4.6	2.6	0.8
	V							4.6	3.2	2.1	1.6	1.0
10.00	R							37.0	15.3	5.5	3.2	0.9
	V							5.1	3.5	2.4	1.8	1.1

Table 10. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 20 and PN25 polypropylene at the temperature of 80◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.01	R	0.1	0.0									
	V	0.1	0.1									
0.02	R	0.3	0.1	0.0								
	V	0.2	0.1	0.1								
0.03	R	0.6	0.2	0.1								
	V	0.2	0.1	0.1								
0.04	R	1.0	0.3	0.1	0.0							
	V	0.3	0.2	0.1	0.1							
0.05	R	1.5	0.5	0.2	0.1							
	V	0.4	0.2	0.1	0.1							
0.06	R	2.0	0.7	0.2	0.1							
	V	0.4	0.3	0.2	0.1							
0.07	R	2.7	0.9	0.3	0.1							
	V	0.5	0.3	0.2	0.1							
0.08	R	3.4	1.1	0.4	0.1	0.0						
	V	0.6	0.4	0.2	0.1	0.1						
0.09	R	4.2	1.4	0.4	0.1	0.1						
	V	0.7	0.4	0.3	0.2	0.1						
0.10	R	5.0	1.7	0.5	0.2	0.1						
	V	0.7	0.5	0.3	0.2	0.1						
0.12	R	7.0	2.3	0.7	0.2	0.1						
	V	0.9	0.6	0.3	0.2	0.1						
0.14	R	9.2	3.0	0.9	0.3	0.1						
	V	1.0	0.7	0.4	0.3	0.2						
0.16	R	11.8	3.9	1.2	0.4	0.1	0.0					
	V	1.2	0.7	0.5	0.3	0.2	0.1					
0.18	R	14.6	4.8	1.5	0.5	0.2	0.1					
	V	1.3	0.8	0.5	0.3	0.2	0.1					
0.20	R	17.7	5.8	1.8	0.6	0.2	0.1	0.0				
	V	1.5	0.9	0.6	0.4	0.2	0.1	0.1				
0.30	R	37.4	12.1	3.4	1.2	0.4	0.1	0.1				
	V	2.2	1.4	0.9	0.5	0.4	0.2	0.2				
0.40	R	64.0	20.5	6.2	2.1	0.7	0.2	0.1	0.0			
	V	2.9	1.9	1.1	0.7	0.5	0.3	0.2	0.1			
0.50	R	97.6	31.1	9.3	3.1	1.1	0.3	0.2	0.1			
	V	3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2			
0.60	R	137.7	43.7	13.0	4.3	1.5	0.5	0.2	0.1			
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.70	R	184.6	58.4	17.3	5.7	1.9	0.6	0.3	0.1	0.0		
	V	5.1	3.2	2.0	1.3	0.8	0.5	0.4	0.3	0.2		
0.80	R		75.3	22.2	7.3	2.5	0.8	0.3	0.1	0.1		
	V		3.7	2.3	1.4	0.9	0.6	0.4	0.3	0.2		

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.90	R		94.1	27.7	9.0	3.1	1.0	0.4	0.2	0.1		
	V		4.2	2.6	1.6	1.0	0.7	0.5	0.3	0.2		
1.00	R		114.9	33.7	11.0	3.7	1.2	0.5	0.2	0.1		
	V		4.6	2.8	1.8	1.2	0.7	0.5	0.4	0.2		
1.20	R		162.5	47.7	15.4	5.2	1.6	0.7	0.3	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.40	R			63.8	20.5	6.9	2.2	0.9	0.4	0.1	0.1	
	V			4.0	2.5	1.6	1.0	0.7	0.5	0.3	0.3	
1.60	R			82.2	26.4	8.8	2.8	1.2	0.5	0.2	0.1	
	V			4.5	2.9	1.9	1.2	0.8	0.6	0.4	0.3	
1.80	R			102.8	32.9	11.0	3.5	1.5	0.6	0.2	0.1	
	V			5.1	3.2	2.1	1.3	0.9	0.6	0.4	0.3	
2.00	R				40.3	13.3	4.2	1.8	0.7	0.3	0.1	0.0
	V				3.6	2.3	1.4	1.0	0.7	0.5	0.4	0.2
2.20	R				48.3	16.0	5.0	2.1	0.9	0.3	0.2	0.0
	V				4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.40	R				56.9	18.8	5.8	2.5	1.0	0.4	0.2	0.1
	V				4.3	2.8	1.7	1.2	0.9	0.6	0.4	0.3
2.60	R				66.2	21.8	6.8	2.9	1.2	0.5	0.2	0.1
	V				4.7	3.0	1.9	1.3	0.9	0.6	0.5	0.3
2.80	R				76.3	25.2	7.8	3.3	1.4	0.5	0.3	0.1
	V				5.0	3.2	2.0	1.4	1.0	0.7	0.5	0.3
3.00	R					28.7	8.9	3.8	1.6	0.6	0.3	0.1
	V					3.5	2.2	1.5	1.1	0.7	0.5	0.3
3.20	R					32.4	10.0	4.3	1.8	0.7	0.3	0.1
	V					3.7	2.3	1.6	1.1	0.8	0.6	0.4
3.40	R					36.3	11.2	4.8	2.0	0.7	0.4	0.1
	V					3.9	2.5	1.7	1.2	0.8	0.6	0.4
3.60	R					40.5	12.5	5.3	2.2	0.8	0.4	0.1
	V					4.2	2.6	1.8	1.3	0.9	0.7	0.4
3.80	R					44.9	13.9	5.8	2.4	0.9	0.5	0.1
	V					4.4	2.7	1.9	1.3	0.9	0.7	0.4
4.00	R					49.5	15.3	6.4	2.7	1.0	0.5	0.1
	V					4.6	2.9	2.0	1.4	1.0	0.7	0.4
4.20	R					54.3	16.8	7.0	2.9	1.1	0.6	0.2
	V					4.9	3.0	2.1	1.5	1.0	0.8	0.5
4.40	R					59.3	18.5	7.7	3.2	1.2	0.6	0.2
	V					5.1	3.2	2.2	1.6	1.0	0.8	0.5
4.60	R						19.9	8.4	3.5	1.3	0.7	0.2
	V						3.3	2.3	1.6	1.1	0.8	0.5
4.80	R						21.6	9.1	3.8	1.4	0.7	0.2
	V						3.5	2.4	1.7	1.1	0.9	0.5
5.00	R						23.3	9.8	4.1	1.5	0.8	0.2
	V						3.6	2.6	1.8	1.2	0.9	0.6
5.20	R						25.1	10.5	4.4	1.6	0.9	0.3
	V						3.8	2.7	1.8	1.2	1.0	0.6
5.40	R						27.0	11.3	4.7	1.7	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
5.60	R						28.9	12.1	5.0	1.8	1.0	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
5.80	R						30.9	13.0	5.4	2.0	1.1	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
6.00	R						32.9	13.8	5.7	2.1	1.2	0.3
	V						4.3	3.1	2.1	1.4	1.1	0.7

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 80°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
6.20	R						35.1	14.7	6.1	2.2	1.2	0.4
	V						4.5	3.2	2.2	1.5	1.1	0.7
6.40	R						37.3	15.6	6.4	2.4	1.3	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
6.60	R						39.5	16.5	6.8	2.5	1.4	0.4
	V						4.8	3.4	2.3	1.6	1.2	0.7
6.80	R						41.8	17.5	7.2	2.6	1.5	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
7.00	R						44.2	18.5	7.6	2.8	1.6	0.5
	V						5.1	3.6	2.5	1.7	1.3	0.8
7.50	R							21.1	8.7	3.2	1.8	0.5
	V							3.8	2.7	1.8	1.4	0.8
8.00	R							23.8	9.8	3.6	2.1	0.6
	V							4.1	2.8	1.9	1.5	0.9
9.00	R							29.8	12.3	4.4	2.6	0.8
	V							4.6	3.2	2.1	1.6	1.0
10.00	R							36.4	15.0	5.4	3.2	0.9
	V							5.1	3.5	2.4	1.8	1.1

Table 11. Values of unitary linear resistance of flow R for calculation of pressure losses in pipes made of PN 20 and PN25 polypropylene at the temperature of 95◦C (according to the Colebrook - White formula).

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.01	R	0.0										
	V	0.1										
0.02	R	0.1	0.0									
	V	0.1	0.1									
0.03	R	0.3	0.1									
	V	0.2	0.1									
0.04	R	0.5	0.2	0.0								
	V	0.3	0.2	0.1								
0.05	R	0.8	0.3	0.1								
	V	0.4	0.2	0.1								
0.06	R	1.2	0.4	0.1								
	V	0.4	0.3	0.2								
0.07	R	1.6	0.5	0.1								
	V	0.5	0.3	0.2								
0.08	R	2.1	0.7	0.2	0.1							
	V	0.6	0.4	0.2	0.1							
0.09	R	2.6	0.8	0.2	0.1							
	V	0.7	0.4	0.3	0.2							
0.10	R	3.2	1.0	0.3	0.1							
	V	0.7	0.5	0.3	0.2							
0.12	R	4.6	1.5	0.4	0.1							
	V	0.9	0.6	0.3	0.2							
0.14	R	6.3	2.0	0.6	0.2	0.1						
	V	1.0	0.6	0.4	0.3	0.2						
0.16	R	8.2	2.6	0.8	0.2	0.1						
	V	1.2	0.7	0.5	0.3	0.2						
0.18	R	10.4	3.3	1.6	0.3	0.1						
	V	1.3	0.8	0.7	0.3	0.2						
0.20	R	12.9	4.1	1.2	0.4	0.1	0.0					
	V	1.5	0.9	0.6	0.4	0.2	0.1					
0.30	R	28.9	9.2	2.7	0.9	0.3	0.1					
	V	2.2	1.4	0.9	0.5	0.3	0.2					
0.40	R	51.4	16.3	4.8	1.5	0.5	0.2	0.1				
	V	2.9	1.8	1.1	0.7	0.5	0.3	0.2				
0.50	R	80.3	25.5	7.5	2.4	0.8	0.2	0.1				
	V	3.7	2.3	1.4	0.9	0.6	0.4	0.3				
0.60	R	115.7	36.8	10.8	3.5	1.1	0.4	0.1	0.1			
	V	4.4	2.8	1.7	1.1	0.7	0.4	0.3	0.2			
0.70	R	157.5	50.1	14.7	4.7	1.5	0.5	0.2	0.1			
	V	5.1	3.2	2.0	1.3	0.8	0.5	0.4	0.2			
0.80	R	205.7	65.4	19.2	6.2	2.0	0.6	0.3	0.1			
	V	5.8	3.7	2.3	1.4	0.9	0.6	0.4	0.3			

The hPa/m unit is equivalent to the quantity expressed in %.

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
0.90	R	260.3	82.8	24.4	7.8	2.5	0.8	0.3	0.1			
	V	6.6	4.2	2.6	1.6	1.0	0.6	0.5	0.3			
1.00	R		102.2	30.1	9.7	3.1	1.0	0.4	0.2	0.1		
	V		4.6	2.8	1.8	1.1	0.7	0.5	0.4	0.2		
1.20	R		147.1	43.3	13.9	4.5	1.4	0.6	0.2	0.1	0.0	
	V		5.5	3.4	2.2	1.4	0.9	0.6	0.4	0.3	0.2	
1.40	R		200.2	58.9	19.0	6.1	1.9	0.8	0.3	0.1	0.1	
	V		6.5	4.0	2.5	1.6	1.0	0.7	0.5	0.3	0.3	
1.60	R			77.0	24.8	7.9	2.5	1.1	0.4	0.2	0.1	
	V			4.5	2.9	1.8	1.2	0.8	0.6	0.4	0.3	
1.80	R			97.4	31.3	10.0	3.2	1.3	0.5	0.2	0.1	
	V			5.1	3.2	2.1	1.3	0.9	0.6	0.4	0.3	
2.00	R			120.3	38.7	12.4	3.9	1.6	0.7	0.2	0.1	0.0
	V			5.7	3.6	2.3	1.4	1.0	0.7	0.5	0.4	0.2
2.20	R			145.5	46.8	15.0	4.8	2.0	0.8	0.3	0.2	0.0
	V			6.2	4.0	2.5	1.6	1.1	0.8	0.5	0.4	0.2
2.40	R				55.7	17.8	5.7	2.4	1.0	0.3	0.2	0.1
	V				4.3	2.7	1.7	1.2	0.8	0.6	0.4	0.3
2.60	R				65.4	20.9	6.7	2.8	1.1	0.4	0.2	0.1
	V				4.7	3.0	1.9	1.3	0.9	0.6	0.5	0.3
2.80	R				75.8	24.3	7.7	3.2	1.3	0.5	0.3	0.1
	V				5.0	3.2	2.0	1.4	1.0	0.7	0.5	0.3
3.00	R				87.0	27.9	8.9	3.7	1.5	0.5	0.3	0.1
	V				5.4	3.4	2.2	1.5	1.1	0.7	0.5	0.3
3.20	R				99.0	31.7	10.1	4.2	1.7	0.6	0.3	0.1
	V				5.8	3.7	2.3	1.6	1.1	0.8	0.6	0.4
3.40	R				111.8	35.8	11.4	4.8	1.9	0.7	0.4	0.1
	V				6.1	3.9	2.5	1.7	1.2	0.8	0.6	0.4
3.60	R					40.2	12.8	5.3	2.1	0.8	0.4	0.1
	V					4.1	2.6	1.8	1.3	0.9	0.7	0.4
3.80	R					44.7	14.2	6.0	2.4	0.9	0.5	0.1
	V					4.3	2.7	1.9	1.3	0.9	0.7	0.4
4.00	R					49.6	15.8	6.6	2.6	1.0	0.5	0.1
	V					4.6	2.9	2.0	1.4	0.9	0.7	0.4
4.20	R					54.7	17.4	7.3	2.9	1.1	0.6	0.2
	V					4.8	3.0	2.1	1.5	1.0	0.8	0.5
4.40	R					60.0	19.1	8.0	3.2	1.2	0.6	0.2
	V					5.0	3.2	2.2	1.6	1.0	0.8	0.5
4.60	R					65.6	20.9	8.7	3.5	1.3	0.7	0.2
	V					5.3	3.3	2.3	1.6	1.1	0.8	0.5
4.80	R					71.4	22.7	9.5	3.8	1.4	0.7	0.2
	V					5.5	3.5	2.4	1.7	1.1	0.9	0.5
5.00	R					77.5	24.6	10.3	4.1	1.5	0.8	0.2
	V					5.7	3.6	2.5	1.8	1.2	0.9	0.6
5.20	R					83.8	26.6	11.1	4.5	1.6	0.9	0.3
	V					5.9	3.8	2.6	1.8	1.2	1.0	0.6
5.40	R						28.7	12.0	4.8	1.8	0.9	0.3
	V						3.9	2.8	1.9	1.3	1.0	0.6
5.60	R						30.9	12.9	5.2	1.9	1.0	0.3
	V						4.0	2.9	2.0	1.3	1.0	0.6
5.80	R						33.1	13.9	5.6	2.0	1.1	0.3
	V						4.2	3.0	2.1	1.4	1.1	0.6
6.00	R						35.5	14.8	6.0	2.2	1.1	0.3
	V						4.3	3.1	2.1	1.4	1.1	0.7

q [dm³/s]	R [hPa/m][8] v [m/s]	Nominal pressure PN 20 plain pipe and PN 25 Faser Pipe SDR6 Temperature 95°C										
		Pipe cross-section Dz x e [mm x mm]										
		20x3.4	25x4.2	32x5.4	40x6.7	50x8.3	63x10.5	75x12.5	90x15.0	110x18.4	125x20.08	160x26.6
6.20	R						37.9	15.8	6.4	2.3	1.2	0.4
	V						4.5	3.2	2.2	1.5	1.1	0.7
6.40	R						40.4	16.9	6.8	2.5	1.3	0.4
	V						4.6	3.3	2.3	1.5	1.2	0.7
6.60	R						42.9	18.0	7.2	2.6	1.4	0.4
	V						4.8	3.4	2.3	1.6	1.2	0.7
6.80	R						45.6	19.1	7.7	2.8	1.5	0.4
	V						4.9	3.5	2.4	1.6	1.2	0.8
7.00	R						48.3	20.2	8.1	3.0	1.6	0.5
	V						5.1	3.6	2.5	1.7	1.3	0.8
7.50	R						55.4	23.2	9.3	3.4	1.8	0.5
	V						5.4	3.8	2.7	1.8	1.4	0.8
8.00	R						63.1	26.4	10.6	3.9	2.0	0.6
	V						5.8	4.1	2.8	1.9	1.5	0.9
9.00	R						79.8	33.4	13.4	4.9	2.6	0.8
	V						6.5	4.6	3.2	2.1	1.6	1.0
10.00	R							41.2	16.6	6.0	3.2	0.9
	V							5.1	3.5	2.4	1.8	1.1

SKZ

Das Kunststoff-Zentrum

Test report no.: 113980/14

Customer/production site: Aquagas Plastic Industries, Dubai Investment Park 2, P.O. Box 56790, DUBAI, UNITED ARAB EMIRATES

Model name: AQUATERRA

Summary of test results: see paragraph 5

This test report comprises 8 pages.

Dr. Anton Zahn — Martin Schulz

TZW

AquaGas Plastic Industries L.L.C., P.O. Box 56790, DUBAI, UAE

Testing according to the „Guideline for the Hygienic Assessment of Organic Materials in Contact with Drinking Water (KTW Guideline)" of Umweltbundesamt (UBA) (Bundesgesundheitsblatt current version)

Dear Mr. Faisal,

The results are given in the adjacent test certificate.

Additionally, please find attached our invoice.

Best regards

TECHNOLOGIEZENTRUM WASSER

WRAS APPROVED MATERIAL

Aquagas Plastic Industries LLC, PO Box 56790, Dubai, UAE

WATER REGULATIONS ADVISORY SCHEME LTD. (WRAS) MATERIAL APPROVAL

POLYPROPYLENE – COMPONENTS

Yours faithfully

Certification made simple™

Certificate of Registration

Presented to

AQUAGAS Plastic Industries L.L.C.

P.O. Box 56790, Dubai Investment Park - 2, Dubai, United Arab Emirates

(ISO Certified Company)

Management Standard Certifications:

ISO 14001:2015 Environmental Management System

Legal Status: Limited Liability Company

Scope of Certification: Manufacturer of "AQUATERRA" PPR Pipes and Fittings and "PPTERRA" Pipes and Fittings

Signed for and on behalf of ISO Certification Body

ISO

Certifying companies worldwide

ATTESTATION OF CONFORMITY

ISSUED TO: AQUA GAS PLASTIC INDUSTRIES LLC, P.O. Box 56790, Dubai Investment Park 2, Dubai, UAE

PRODUCT(S) DESCRIPTION: PPR Pipe SDR 6 PN 20 "AQUA TERRA" 20 mm to 160 mm

MANUFACTURED BY: AQUA GAS PLASTIC INDUSTRIES LLC, P.O. Box 56790, Dubai Investment Park 2, Dubai, UAE

ATTESTATION

Dubai Central Laboratory Department hereby attests that the product(s) described above conforms to the requirements of the applicable standard specifications / requirements.

This attestation is based solely on the review and verification of the validity and authenticity of the Product Conformity Certificate as per Evaluation Report as mentioned above. This attestation shall not be used when the Product Conformity Certificate becomes invalid at any time.

DVGW CERT

DVGW-Baumusterprüfzertifikat

DVGW type examination certificate

Zertifikatinhaber: Aquagas Plastic Industries, Dubai Investment Park 2, UAE- Dubai

Vertreiber: Aquagas Plastic Industries, Dubai Investment Park 2, UAE- Dubai

Modell: AQUATERRA

DAkkS

UNITED ARAB EMIRATES — MINISTRY OF INFRASTRUCTURE DEVELOPMENT

ZAYED

Supplier Certificate

AQUAGAS PLASTIC INDUSTRIES L L C

NSF International

789 N. Dixboro Road, Ann Arbor, MI 48105 USA

RECOGNIZES

Aqua Gas Plastic Industries- AQUATERRA

United Arab Emirates

AS COMPLYING WITH NSF/ANSI 14, 61 AND ALL APPLICABLE REQUIREMENTS. PRODUCTS APPEARING IN THE NSF OFFICIAL LISTING ARE AUTHORIZED TO BEAR THE NSF MARK.


Aquaterra

AQUAGAS
Plastic Industries L.L.C.

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