aquatherm grey pipe

Potable water and heating installations

aquatherm

CONTENTS

CHAPTER 1
Pipe material

THE AQUATHERM GREY PIPE-CONNECTION PIPE

aquatherm grey pipe- connection pipe

The aquatherm grey pipe system offers three types of connection pipes:

- aquatherm grey pipe-PB connection pipe (grey) in coils Ø 16 - 25 mm, produced from the high-flexible material polybutene (PB)

  aquatherm grey pipe-multi layer metal composite pipe (white) in coils Ø 16 - 20 mm and in 4 m length Ø 16 - 40 mm made of PE-X for various applications

- aquatherm grey pipe PE-RT - Heizkörperanschlussrohr (rot) im Ring ø 16-20 mm, aus dem hochflexiblen temperaturbeständigen Polyethylen (PE-RT)

Potable water installation

aquatherm grey pipe - The allrounder!

The aquatherm grey pipe-system is applicable in the field of:

- **potable water installations**
- **heating installations**
- **underfloor heating installation**

The aquatherm grey pipe-PB pipe is particularly bendable, thus easy and flexible to install.

The crucial advantage of the aquatherm grey pipe-system is that it can be processed completely (!) in the house installation.

Surplus pipes which result after an installation, e.g. an underfloor heating, must no more disposed, but can be processed without problems also for radiator connection or potable water application.

This does not only save the plumber´s time and money, but also works with a system, which considers optimally the modern requirements of an environmentally conscious, ecologically thinking final consumer.

Heating installation

Underfloor heating installation

PIPE MATERIAL

Advantages of the aquatherm grey pipe-connection pipe

The advantages of the aquatherm grey pipe-connection pipes in the field of floor connection are:

- Oxygen barrier due to EVOH-coating
- Hygienically neutral
- Microbiologically impeccable
- Corrosion resistant
- Very flexible
- Low friction loss

aquatherm grey pipe-PB potable water and radiator connection pipes made from PB (polybutene) features by their high creep behaviour, which means, temperature and pressure resistance.

The high heat resistance makes polybutene the ideal pipe material for hot water and heating installations. In the field of small dimensioned connection pipes, polybutene is convincing by its high flexibility.

Classification of service conditions

aquatherm grey pipe-PB-connection pipes are applicable in all classes mentioned in ISO 10508.

aquatherm grey pipe-PB-connection pipes				
Classification acc. to ISO 10508				
Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Hot water supply (60°)	Hot water supply (70°)	Low temperature underfloor heating	Underfloor heating and low temperature radiators	High temperature radiators

Registration

aquatherm grey pipe-PB-potable water and radiator connection pipes inclusive sliding sleeve connections are certified under registration-no. DW-8501 AU2075 by the DVGW and under no. 3V207 PB by DIN CERTCO.

DVGW product

DIN GEPRÜFT
DIN CERTCO Registiernummer
3V098 PB
Prüfungsgrundlage: DIN 4726: 1993-09; DIN 4727: 1988-09

PIPE MATERIAL

Quality requirements

aquatherm grey pipe-PB potable water and heating connection pipes are produced from the high-flexible and heat-stabilized material polybutene resp. polybutene with fibre composite. The physical and chemical characteristics are adjusted to the special demands of the potable water and heating sector. SHT-connection pipes correspond to the quality requirements of DIN 16968, DIN 4727 and DIN 4726. Separation by means of heat exchanger is not necessary according to DIN 4726 if using aquatherm grey pipe pipes for heating a system. The connection pipes have an oxygen barrier.

aquatherm grey pipe-corrugated pipes are made from polyethylene (PE). These types of protection pipes are compressable and can be pushed back before connecting without problems.

Marking / colour

Connection pipe

Colour: grey with transparent shining oxygen barrier

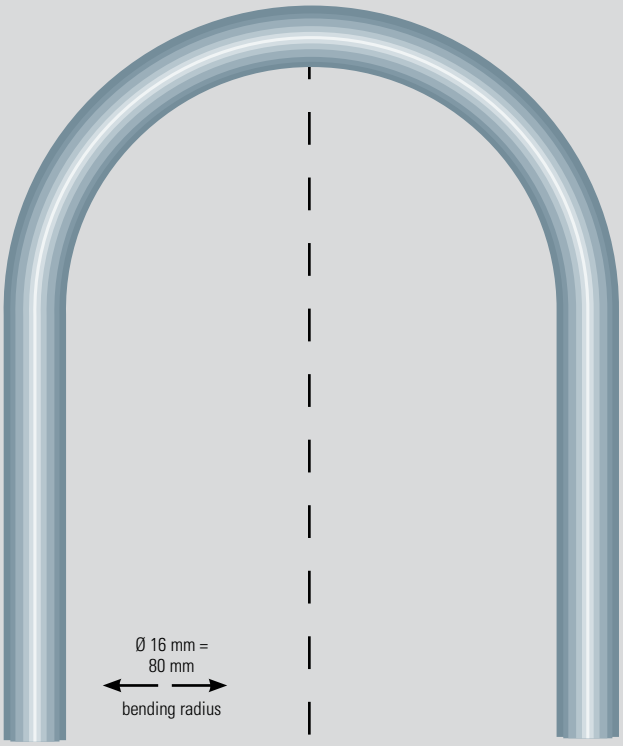
Marking:
AQUATHERM GREY PIPE 16 X 2.0 MM – – – ART.-NO.77000
– – – PB 125 – – – DIN 16969/DIN 16968 – – – DVGW AU2075 – OXYGEN-TIGHT – – – DIN 4726
– – – DIN CERTCO 3V207 PB – – – 0484/98 – – –
DATE OF MANUFACTURING/TIME– – MACHINE-NO. – – –CHARGE-NR.
– – – MTR.-MARKING – – – MADE IN
GERMANY

Each pipe coil is additionally printed with the continuous number of meters and the coils include a package insert with the marking data.

Corrugated pipe

Colour: green

Marking:
AQUATHERM GREY PIPE – – – ART.-NO.77012



FITTINGS

Brass fittings

Material:
aquatherm grey pipe-fittings with threads and inserts made from dezincification resistant brass

Material designation:
PPSU = Polyphenylene sulphone / Brass

Characteristics:
All fittings of the aquatherm grey pipe-system are – due to the latest European Potable Water Standard – made from a dezincification resistant brass. This type of brass has been developed especially for the application in areas with aggressive water. aquatherm applies this standard brass for all metal fittings and connection pieces.

Fittings made of PPSU

Material:
aquatherm grey pipe-system fittings made from the plastic PPSU (PPSU = Polyphenylene sulphone)

Characteristics:
The advantages of complementary aquatherm grey pipe-system fittings are:

- High heat resistant
- High impact rate
- Low stress cracking susceptibility
- Chemical resistant
- Hygienical harmlessness
- No corrosion
- No o-ring application
- No diminished cross-section
- Reduction of metal influences to potable water
- Considerable weight reduction compared to brass fittings
- Environmentally friendly production, as the material PPSU is recyclable

These favourable characteristics of the aquatherm grey pipe offer multiple fields of applications.

The material PPSU is applied for the aviation and space industry as well as for medicine technique. Especially regarding the safeness with food contact, particularly with potable water, the aquatherm grey pipe system fittings made from PPSU are first choice in the field of potable water technique.

Even high temperature- and pressure stability are optimum for the field of heating technique.

Brass fittings

Fittings made of PPSU

CONNECTION TECHNIQUE

aquatherm grey pipe-tools

The aquatherm grey pipe-connection by means of sliding sleeves is very simple. For the permanent connection the following tools are required:

- **an expanding tool (Art.-No. 50800)**
- **an assembly tool (Art.-No. 50802)**

Both tools are equipped with interchangeable false jaws for the dimensions Ø 16 mm, 20 mm, 25 mm, 32 mm and 40 mm.

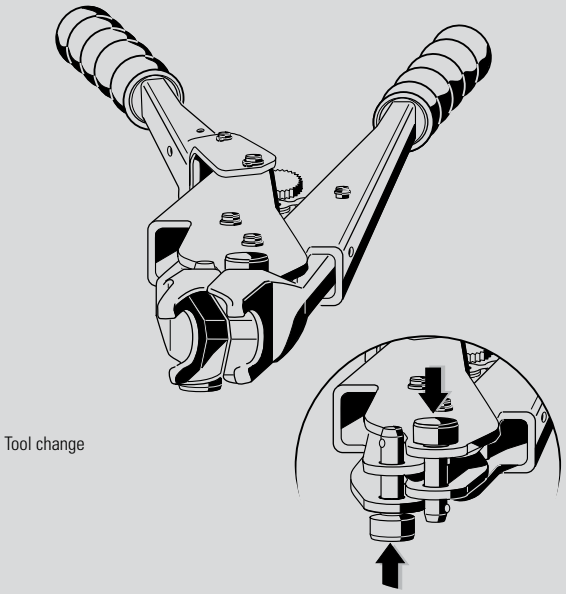
aquatherm grey pipe-tools

Tool change

The interchangeable false jaw of the expanding tool is screwed off; then the required dimension is fixed.

When using the multi-layer metal composite pipe (Art.-No. 77070 / 77072 and 77050-77058), the false jaws Art.-No. 50857-50864 have to be applied.

Only remove the bolts to change both inserts of the SHT-assembly tool. After inserting the new dimension the fastening bolts have to be inserted that way, that the bolt heads turn to the outside.



Tool change

1. Compressing the corrugated pipe

The PE-corrugated pipe is compressable and can be adjusted with the red resp. blue end sleeve. It is not necessary to cut the corrugated pipe before connecting it.

2. Put the sliding sleeve onto the pipe

Before expanding the connection pipe, the SHT-sleeve has to be slided onto the pipe. This sleeve is identical on both sides - inside and outside. It does not make any difference which side is pushed onto the pipe resp. onto the fitting.

3. Expanding of the connection pipe

For expanding of the pipe end, the tool must be opened totally for inserting it into the pipe end. Then the expanding tool is compressed - the aquatherm grey pipe-connection pipe is bulge formed. For an easy pipe assembly with the fitting, the tool must be opened again, turned slightly and compressed for the even expansion of the pipe end.

4. Pressing

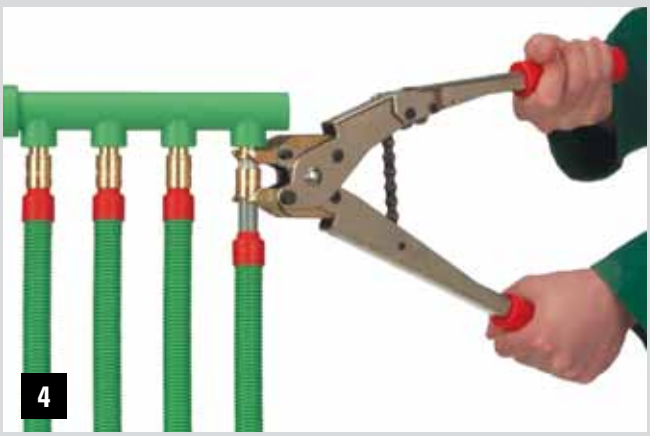
The expanded pipe end is pushed on the corrugated part of the pipe supporting body at the manifold branch resp. the fitting up to the stop.

Now the assembly tool is put on. By compressing the tool the sleeve presses the plastic pipe onto the supporting body. That quick and safe a permanent connection is installed. Then the compressed corrugated pipe is pushed with the end sleeve up to the fitting.

Attention!

If the temperatures are below 0° C, the pipe must be warmed up by hand before expanding it. White discolourations are unproblematic. The EVOH-oxygen tight coating is only expanded lightly neither without influencing the tightness of the pipe connection nor the oxygen barrier.

The sliding sleeve must be kept away from the expanding area as otherwise the tool and pipe might be damaged.



CONNECTION TECHNIQUE

Sliding sleeve

The sliding sleeve technology is an interlocking connection.

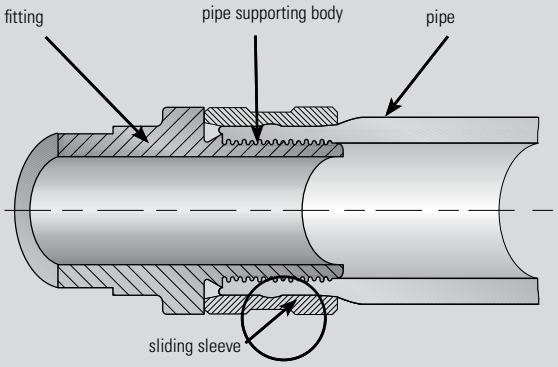
The permanent tight connection results from pressing the aquatherm grey pipe-sliding sleeve onto the aquatherm grey pipe-pipe with the aquatherm grey pipe-fitting.

The sliding sleeve connection technology must be utilized with the original aquatherm grey pipe pipes, fittings and tools only.

Sliding sleeve technique

Especially for flexible floor connection the sliding sleeve technique grants important advantages.

Whether in the field of radiator connection or potable water on-wall installation, with the sliding sleeve technique you create permanent connections between low dimensioned connection pipes, nickel-plated brass fittings and plastic fittings without great expenses of tools and assembly.



Permanent safety

Sliding sleeve technique

EXAMPLES: POTABLE WATER APPLICATION

IPre-wall installation

The SHT-program provides you with all necessary elements for a perfect installation.

Installation type:
Connecting back-plate elbow

Installation type:
Single connecting / Twin connecting back plate elbow

Installation type:
Connecting elbow for concealed flushing box

EXAMPLES: HEATING APPLICATION

Examples: heating application

The complete solution for radiator connection with the aquatherm grey pipe-distribution blocks.

The compact block is equipped at all sides with sliding sleeve connections. The connection to the radiator is made by radiator valves twin with euroconus thread 16 x 2.0 mm corner or passage.

A compact insulation for the distribution block is available.

Installation type:
Connection out of the floor via direct connection to the connecting bend

Installation type:
Connection out of the floor via distribution block and connecting bend

Installation type:
Connection out of the wall via distribution block and radiator connection set

CONNECTION TECHNIQUE

Branching

The aquatherm grey pipe System offers 4 different possibilities of connection from the riser to the floor distribution:

a) central PP-R manifold
b) PP-R adapter
c) transition pieces with male thread
d) Euroconus adapter 3/4'' nut

a) Branch to the PP-R manifold:

The central manifold is assembled by fusion welding with the following elements:

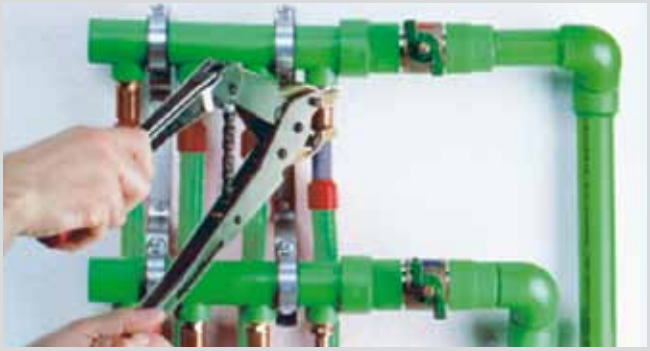
- aquatherm grey pipe-four-port-manifold (Art.-No. 78004)
- aquatherm grey pipe-ball valve (Art.-No. 78000)
- fusiotherm®-manifold end piece (Art.-No. 30804)
- fusiotherm®-end cap (Art.-No. 14112)

The distribution pipe has 4 branches, each for screwing in sliding sleeve connections (Art.-No. 78010 Ø 16 mm resp. 78012 Ø 20 mm) or blind plugs (Art.-No. 78020).

b) Branch via PP-R-adapter:

The aquatherm grey pipe-adapter from PP-R and brass:

- Art.-No. 78300: 20/16 x 2.0 mm
- Art.-No. 78302: 20/20 x 2.0 mm
- Art.-No. 78304: 25/20 x 2.0 mm
- Art.-No. 78306: 25/25 x 2.3 mm
- Art.-No. 78308: 32/25 x 2.3 mm
- Art.-No. 78310: 32/32 x 2.9 mm
- Art.-No. 78312: 40/32 x 2.9 mm



VERBINDUNGSTECHNIK

c) Branch via male transition pieces:

The aquatherm grey pipe-transition pieces

- Art.-No. 79200: 16 x 2.0 mm x 1/2" M
- Art.-No. 79202: 20 x 2.0 mm x 1/2" M
- Art.-No. 79203: 20 x 2.0 mm x 3/4" M
- Art.-No. 79204: 25 x 2.3 mm x 3/4" M
- Art.-No. 79205: 25 x 2.3 mm x 1/2" M
- Art.-No. 79206: 32 x 2.9 mm x 3/4" M
- Art.-No. 79208: 32 x 2.9 mm x 1" M
- Art.-No. 79207: 40 x 3,5 mm x 11/4" M

can be screwed in all commercial fittings with female thread. This enables the transition of the aquatherm grey pipe-system to all metallic and plastic pipe systems.

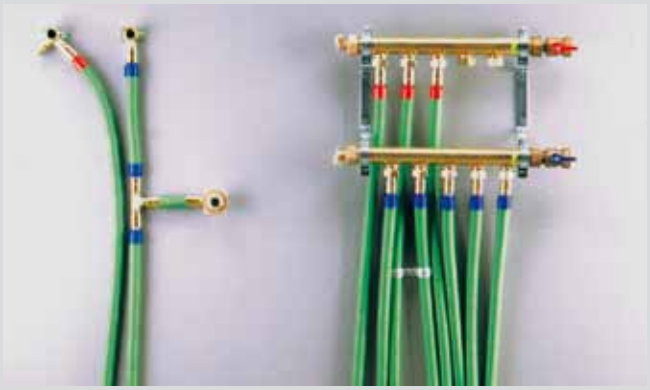
d) Branch via manifold with euroconus:

The floor distribution can be realized even with all non-system connection manifolds with euroconus connections.

The SHT-euroconus adapter:

- Art.-No. 79220: 16 x 2.0 mm
- Art.-No. 79222: 20 x 2.0 mm

with 3/4" nut and sliding sleeve connection only have to be screwed in customary manifolds or screwed connections only.



PLANNING

Laws / Regulations / Standards

The following laws, decrees, guidelines and standards have to be considered when planning and completing the aquatherm grey pipe system for potable water and radiator connections:

Planning and execution:

- EnEV Decree for Energy Saving
- DIN 1961 VOB and C
- DIN 4102 Fire protection
- DIN 4108 Standard for thermal insulation in the field of structural engineering
- DIN 4109 standard for the elimination of noise in the field of structural engineering
- DIN 4701 Calculation of building´s heat demand
- DIN 18380 Water heating plants
- DIN 1988 Standard for potable water installations
- DIN 18381 Installation of gas, water and VOB Part C sewage installation of waste water pipes inside buildings

- DIN 16928 Pipe connections, fittings, installation
- aquatherm Technical information

Systemspecific standards

General quality requirements, dimensions

- DIN 16968 Polybutene (PB) pipes general quality requirements and test
- DIN 16969 Polybutene (PB) pipes PB 125 dimensions
- DVGW-working sheets
- SKZ-guidelines
- DIN EN ISO 9000 f.

Hygiene

- **KTW-recommendations of the federal public health office health assessment**
  of plastics and nonmetallic materials within the framework of the law for foods and commodity goods for potable water applications

- **DVGW-working sheet W 270**
  Increase of microorganism on materials used for potable water applications - test and evaluation

Local regulations and codes of practice must be observed. The same goes for regulations regarding the use of chemicals.

Calculation Basis

To determine the pipe diameter the following data are required:

- minimum gauge pressure of supply or pressure in flow direction behind pressure reducing or boosting valve
- geodetic variations
  loss of pressure due to apparatus i.e. water meter, filter, softening installations, etc.
- minimum pressure of flow of the water point applied
- pipe friction pressure factor of the applied pipe material
- coefficients of loss for fittings and connection elements used

Calculation guide / Software

The calculation of the aquatherm grey pipe potable water and radiator connection system can be done with the assistance of planning software “liNear”, which can be ordered directly with - or without - training at aquatherm.

For our Dendrit customers:

aquatherm® naturally still offers you qualified support with your Dendrit-software!

In both cases please call our aquatherm-information service:

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PLANNING

Thermal insulation of hot 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.

Extract from § 12 addendum 5 of the EnEV

Central heating pipes, line 1 – 4 installed in heated
rooms or building parts between heated rooms of the one user, where heat output can be controlled by open stop valves do not require a minimum thickness of the insulation.

This even applies to hot water pipes up to an inner diameter of 22 mm in flats, which are neitherin the circulation nor have an additional electric heating.

Applying material with thermal conductivities different to 0.035 W/(mK) the minimum thickness of the insulation has to be converted correspondingly.

For the conversion and the thermal conductivity of the insulation the ways and values of calculation described in the technical regulations must be applied.

The minimum insulation acc. to the table for heating distributions and heating pipes can be reduced as far as the same limit of heat output even for further insulation demands in consideration of the insulating effect of the pipe walls are guaranteed.

Extract from § 12 addendum 5 of the EnEV

Line	Type of pipe/fitting	Minimum thickness of insulation referred to thermal conductivity of 0.035 W/(mK)
1	inner diameter up to 22 mm	20 mm
2	inner diameter more than 22 mm up to 35 mm	30 mm
3	inner diameter more than 35 mm up to 100 mm	same as inner diameter
4	inner diameter more than 100 mm	100 mm
5	pipes and fittings after line 1 – 4 in wall- and ceiling openings, in crossing area of pipes, at pipe connections, at central supply manifolds	1/2 of the requirements of line 1 to 4
6	pipes of central heating after line 1-4, which have been installed after introduction of this decree between heated rooms of various users	1/2 of the requirements of line 1 to 4
7	pipes after line 6 in floor construction	6 mm

PLANNING / INSULATION

Thermal insulation of cold water pipes

As stipulated in

- **DIN 1988, Part 2**

potable water systems have to be protected against heat gain and condensation. Standard values for the minimum insulation thicknesses have to be taken from the following table.

The insulation thicknesses are suitable for all pipe materials and thus for aquatherm grey pipe-pipe.

The values correspond to the German Industry Standard (DIN).

Standard values for the minimum insulation thicknesses for the insulation of potable water systems (cold)

Type of the installation	Insulation thickness at λ = 0.040 W/(mK)*
Open installed pipe, in a unheated room (i. e. basement)	4 mm
Open installed pipe, in a heated room	9 mm
Pipe in a duct, without hot water pipes	4 mm
Pipe in a duct, beside hot water pipes	13 mm
Pipe in a pipe chase riser	4 mm
Pipe in a pipe chase, beside hot water pipes	13 mm
Pipe on a concrete floor	4 mm

*) The insulation thicknesses, applied to a diameter of d = 20 mm, for other coefficients of thermal conduction have to be calculated correspondingly.

PLANNING / INSULATION

Pipe insulation

The Decree for Energy Saving (EnEV) regulates the thermal insulation of pipes and fittings in Germany. Acc. to this decree aquatherm grey pipe-pipes and fittings have to
be insulated against loss of heat.

The insulation thickness depends on the respective installation. The minimum thickness of insulation refers to a thermal conductivity group (WLG035)

Installing insulation of different material with differing
thermal conductivity, the thickness of insulation must be converted and determined acc. to the technical regulations.

Thermal conductivity of W / (mK)	**0,030 W / (mK)**		**0,0350 W / (mK)**		**0,040 W / (mK)**	
Diameter	**Insulation acc. EnEV in mm**					
	50 %	100 %	50 %	100 %	50 %	100 %
16 mm	8	15	10	20	13	27
20 mm	8	15	10	20	13	26
25 mm	8	15	10	20	13	25
32 mm	12	23	15	30	19	39
40 mm	12	23	15	30	19	38

Support intervals for aquatherm grey pipe**-multi layer metal composite pipe**

Table to determine support intervals for aquatherm grey pipe-multi layer metal composite pipe in conjunction with temperature and outside diameter.

Difference in temperature Δ T [K]	**Pipe diameter d (mm)**				
	16	**20**	**25**	**32**	**40**
	Support intervals in cm				
0	130	155	170	195	220
20	100	120	130	150	170
30	100	120	130	150	170
40	100	110	120	140	160
50	100	110	120	140	160
60	80	100	110	130	150
70	70	90	100	120	140

PLANNING

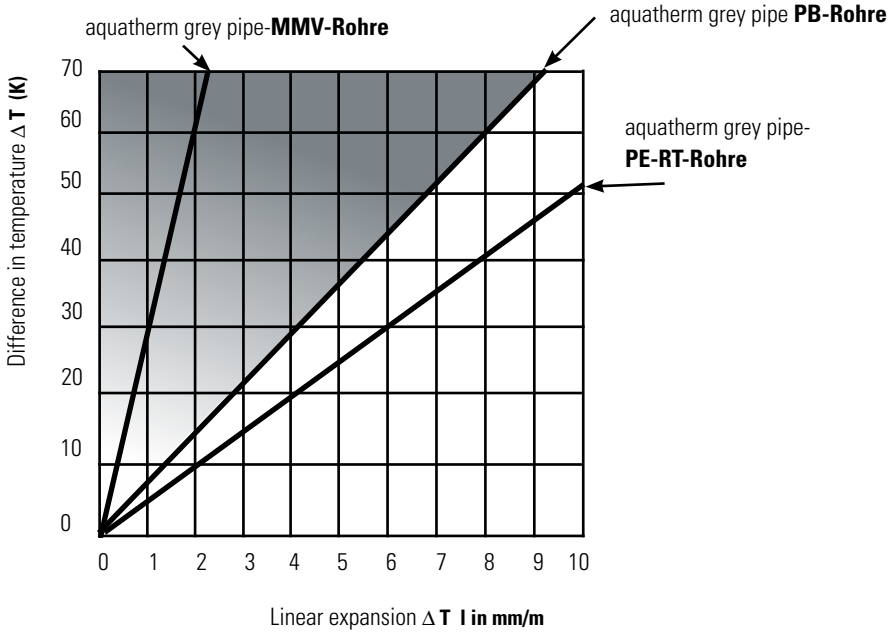
Linear expansion chart for aquatherm grey pipe-PB-potable water & radiator connection pipe and MMC-pipe

The linear expansion of the aquatherm grey pipe-PB-potable water & radiator connection pipe and MMC-pipe can be taken from the following tables. These tables facilitate a simple and quick determination of linear expansion.

Pipe lenght	Difference in temperature ΔT																							
	10K			20K			30K			40K			50K			60K			70K			80K		
	linear expansion ΔL [mm]																							
Typ	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR	PB	PE-RT	MVR
1m	1,30	1,95	0,30	2,60	3,90	0,60	3,90	5,85	0,90	5,20	7,80	1,20	6,50	9,75	1,50	7,80	11,70	1,80	9,10	13,65	2,10	10,40	15,60	2,40
2m	2,60	3,90	0,60	5,20	7,80	1,20	7,80	11,70	1,80	10,40	15,60	2,40	13,00	19,50	3,00	15,60	23,40	3,60	18,20	27,30	4,20	20,80	31,20	4,80
3m	3,90	5,85	0,90	7,80	11,70	1,80	11,70	17,55	2,70	15,60	23,40	3,60	19,50	29,25	4,50	23,40	35,10	5,40	27,30	40,95	6,30	31,20	46,80	7,20
4m	5,20	7,80	1,20	10,40	15,60	2,40	15,60	23,40	3,60	20,80	31,20	4,80	26,00	39,00	6,00	31,20	46,80	7,20	36,40	54,60	8,40	41,60	62,40	9,60
5m	6,50	9,75	1,50	13,00	19,50	3,00	19,50	29,25	4,50	26,00	39,00	6,00	32,50	48,75	7,50	39,00	58,50	9,00	45,50	68,25	10,50	52,00	78,00	12,00
6m	7,80	11,70	1,80	15,60	23,40	3,60	23,40	35,10	5,40	31,20	46,80	7,20	39,00	58,50	9,00	46,80	70,20	10,80	54,60	81,90	12,60	62,40	93,60	14,40
7m	9,10	13,65	2,10	18,20	27,30	4,20	27,30	40,95	6,30	36,40	54,60	8,40	45,50	68,25	10,50	54,60	81,90	12,60	63,70	95,55	14,70	72,80	109,20	16,80
8m	10,40	15,60	2,40	20,80	31,20	4,80	31,20	46,80	7,20	41,60	62,40	9,60	52,00	78,00	12,00	62,40	93,60	14,40	72,80	109,20	16,80	83,20	124,80	19,20
9m	11,70	17,55	2,70	23,40	35,10	5,40	35,10	52,65	8,10	46,80	70,20	10,80	58,50	87,75	13,50	70,20	105,30	16,20	81,90	122,85	18,90	93,60	140,40	21,60
10m	13,00	19,50	3,00	26,00	39,00	6,00	39,00	58,50	9,00	52,00	78,00	12,00	65,00	97,50	15,00	78,00	117,00	18,00	91,00	136,50	21,00	104,00	156,00	24,00
20m	26,00	39,00	6,00	52,00	78,00	12,00	78,00	117,00	18,00	104,00	156,00	24,00	130,00	195,00	30,00	156,00	234,00	36,00	182,00	273,00	42,00	208,00	312,00	48,00
30m	39,00	58,50	9,00	78,00	117,00	18,00	117,00	175,50	27,00	156,00	234,00	36,00	195,00	292,50	45,00	234,00	351,00	54,00	273,00	409,50	63,00	312,00	468,00	72,00
40m	52,00	78,00	12,00	104,00	156,00	24,00	156,00	234,00	36,00	208,00	312,00	48,00	260,00	390,00	60,00	312,00	468,00	72,00	364,00	546,00	84,00	416,00	624,00	96,00
50m	65,00	97,50	15,00	130,00	195,00	30,00	195,00	292,50	45,00	260,00	390,00	60,00	325,00	487,50	75,00	390,00	585,00	90,00	455,00	682,50	105,00	520,00	780,00	120,00

Graph of linear expansion dependent on temperature:

aquatherm grey pipe-**pipes,**
aquatherm grey pipe-**multilayer metal composite pipes.**
aquatherm grey pipe-**PE-RT pipes**



PLANNING

Pipe friction factor 20° C

Pipe friction factor R and calculated flow rate v in dependence on volumetric current V̇

aquatherm grey pipe **potable water and radiator connection pipe / Multi-layer metal composite pipe**

Roughness: 0.0070 mm
Temperature: 20° C
Density: 998.20 kg/m3
Viscosity: 0.47 *E-6 m2/s

V= volumetric current (l/s) R= pressure gradient mbar/m V= flow rate

d x s ▶		PB & PE-RT			Multi-layer PE-X				
V̇	d_i	16mm	20mm	25mm	16mm	20mm	25mm	32mm	40mm
0,01	R	0,20	0,05	0,02	0,20	0,05	0,02	0,01	0,00
	v	0,09m/s	0,05m/s	0,03m/s	0,09m/s	0,05m/s	0,03m/s	0,02m/s	0,01m/s
0,02	R	0,64	0,17	0,05	0,64	0,17	0,06	0,02	0,01
	v	0,18m/s	0,10m/s	0,06m/s	0,18m/s	0,10m/s	0,07m/s	0,04m/s	0,02m/s
0,03	R	1,27	0,33	0,10	1,27	0,33	0,13	0,04	0,01
	v	0,27m/s	0,15m/s	0,09m/s	0,27m/s	0,15m/s	0,10m/s	0,06m/s	0,04m/s
0,04	R	2,07	0,53	0,17	2,07	0,53	0,21	0,06	0,02
	v	0,35m/s	0,20m/s	0,12m/s	0,35m/s	0,20m/s	0,13m/s	0,08m/s	0,05m/s
0,05	R	3,05	0,78	0,25	3,05	0,78	0,30	0,09	0,03
	v	0,44m/s	0,25m/s	0,15m/s	0,44m/s	0,25m/s	0,17m/s	0,10m/s	0,06m/s
0,06	R	4,18	1,07	0,34	4,18	1,07	0,41	0,12	0,04
	v	0,53m/s	0,30m/s	0,18m/s	0,53m/s	0,30m/s	0,20m/s	0,12m/s	0,07m/s
0,07	R	5,46	1,39	0,44	5,46	1,39	0,53	0,15	0,05
	v	0,62m/s	0,35m/s	0,21m/s	0,62m/s	0,35m/s	0,23m/s	0,14m/s	0,08m/s
0,08	R	6,89	1,75	0,55	6,89	1,75	0,67	0,19	0,06
	v	0,71m/s	0,40m/s	0,24m/s	0,71m/s	0,40m/s	0,27m/s	0,16m/s	0,09m/s
0,09	R	8,47	2,15	0,68	8,47	2,15	0,82	0,23	0,07
	v	0,80m/s	0,45m/s	0,28m/s	0,80m/s	0,45m/s	0,30m/s	0,17m/s	0,11m/s
0,10	R	10,19	2,58	0,81	10,19	2,58	0,98	0,28	0,08
	v	0,88m/s	0,50m/s	0,31m/s	0,88m/s	0,50m/s	0,33m/s	0,19m/s	0,12m/s
0,12	R	14,05	3,55	1,12	14,05	3,55	1,35	0,38	0,11
	v	1,06m/s	0,60m/s	0,37m/s	1,06m/s	0,60m/s	0,40m/s	0,23m/s	0,14m/s
0,16	R	23,40	5,88	1,84	23,40	5,88	2,23	0,63	0,19
	v	1,41m/s	0,80m/s	0,49m/s	1,41m/s	0,80m/s	0,53m/s	0,31m/s	0,19m/s
0,18	R	28,87	7,24	2,27	28,87	7,24	2,74	0,77	0,23
	v	1,59m/s	0,90m/s	0,55m/s	1,59m/s	0,90m/s	0,60m/s	0,35m/s	0,21m/s
0,20	R	34,86	8,72	2,73	34,86	8,72	3,30	0,92	0,28
	v	1,77m/s	0,99m/s	0,61m/s	1,77m/s	0,99m/s	0,66m/s	0,39m/s	0,23m/s
0,30	R	72,35	17,94	5,57	72,35	17,94	6,75	1,88	0,56
	v	2,65m/s	1,49m/s	0,92m/s	2,65m/s	1,49m/s	0,99m/s	0,58m/s	0,35m/s
0,40	R	122,10	30,07	9,30	122,10	30,07	11,27	3,12	0,93
	v	3,54m/s	1,99m/s	1,22m/s	3,54m/s	1,99m/s	1,33m/s	0,78m/s	0,47m/s
0,50	R	183,82	45,00	13,86	183,82	45,00	16,82	4,64	1,37
	v	4,42m/s	2,49m/s	1,53m/s	4,42m/s	2,49m/s	1,66m/s	0,97m/s	0,58m/s
0,60	R	257,32	62,68	19,24	257,32	62,68	23,35	6,43	1,90
	v	5,31m/s	2,98m/s	1,84m/s	5,31m/s	2,98m/s	1,99m/s	1,17m/s	0,70m/s
0,70	R	342,47	83,06	25,41	342,47	83,06	30,86	8,47	2,50
	v	6,19m/s	3,48m/s	2,14m/s	6,19m/s	3,48m/s	2,32m/s	1,36m/s	0,82m/s
0,80	R	439,19	106,10	32,37	439,19	106,10	39,33	10,76	3,17
	v	7,07m/s	3,98m/s	2,45m/s	7,07m/s	3,98m/s	2,65m/s	1,55m/s	0,94m/s
0,90	R	547,43	131,78	40,10	547,43	131,78	48,75	13,31	3,91
	v	7,96m/s	4,48m/s	2,75m/s	7,96m/s	4,48m/s	2,98m/s	1,75m/s	1,05m/s
1,00	R	667,13	160,08	48,60	667,13	160,08	59,10	16,10	4,72
	v	8,84m/s	4,97m/s	3,06m/s	8,84m/s	4,97m/s	3,31m/s	1,94m/s	1,17m/s
1,20	R		224,49	67,87		224,49	82,58	22,40	6,54
	v		5,97m/s	3,67m/s		5,97m/s	3,98m/s	2,33m/s	1,40m/s
1,40	R		299,21	90,12		299,21	109,72	29,66	8,64
	v		6,96m/s	4,28m/s		6,96m/s	4,64m/s	2,72m/s	1,64m/s
1,60	R		384,19	115,34		384,19	140,49	37,86	11,00
	v		7,96m/s	4,90m/s		7,96m/s	5,30m/s	3,11m/s	1,87m/s
1,80	R		479,37	143,49		479,37	174,87	46,98	13,62
	v		8,95m/s	5,51m/s		8,95m/s	5,97m/s	3,50m/s	2,10m/s
2,00	R			174,56			212,82	57,03	16,50
	v			6,12m/s			6,63m/s	3,89m/s	2,34m/s

PLANUNG

Pipe friction factor 20° C

Pipe friction factor R and calculated flow rate v in dependence on volumetric current V̇

aquatherm grey pipe **potable water and radiator connection pipe / Multi-layer metal composite pipe**

Roughness: 0.0070 mm
Temperature: 20° C
Density: 998.20 kg/m3
Viscosity: 0.47 *E-6 m2/s

V= volumetric current (l/s) R= pressure gradient mbar/m V= flow rate

d x s ▶		PB & PE-RT			Multi-layer PE-X				
V̇	d_i	16mm	20mm	25mm	16mm	20mm	25mm	32mm	40mm
2,20	R			208,53			254,34	67,98	19,63
	v			6,73m/s			7,29m/s	4,27m/s	2,57m/s
2,40	R			245,39			299,40	79,85	23,01
	v			7,34m/s			7,95m/s	4,66m/s	2,81m/s
2,60	R			285,14			348,01	92,61	26,64
	v			7,95m/s			8,62m/s	5,05m/s	3,04m/s
2,80	R			327,76			397,07	106,28	30,52
	v			8,57m/s			9,28m/s	5,44m/s	3,27m/s
3,00	R							120,83	34,65
	v							5,83m/s	3,51m/s
3,20	R							136,28	39,02
	v							6,22m/s	3,74m/s
3,40	R							152,62	43,64
	v							6,61m/s	3,98m/s
3,60	R							169,84	48,49
	v							6,99m/s	4,21m/s
3,80	R							187,95	53,59
	v							7,38m/s	4,44m/s
4,00	R							206,94	58,94
	v							7,77m/s	4,68m/s
4,20	R							226,81	64,52
	v							8,16m/s	4,91m/s
4,40	R							247,56	70,34
	v							8,55m/s	5,14m/s
4,60	R							269,19	76,40
	v							8,94m/s	5,38m/s
4,80	R								79,09
	v								5,61m/s
5,00	R								85,52
	v								5,85m/s
5,20	R								91,77
	v								6,08m/s
5,40	R								98,25
	v								6,31m/s
5,60	R								104,33
	v								6,55m/s
5,80	R								110,72
	v								6,78m/s
6,00	R								116,47
	v								7,02m/s
6,20	R								122,73
	v								7,25m/s
6,40	R								129,40
	v								7,48m/s
6,60	R								136,44
	v								7,72m/s
6,80	R								138,74
	v								7,95m/s
7,00	R								146,75
	v								8,18m/s
7,50	R								168,17
	v								8,77m/s

PLANNING

Pipe friction factor 60° C

Pipe friction factor R and calculated flow rate v in dependence on volumetric current V̇

aquatherm grey pipe **potable water and radiator connection pipe / Multi-layer metal composite pipe**

Roughness: 0.0070 mm
Temperature: 60° C
Density: 983.20 kg/m3
Viscosity: 0.47 *E-6 m2/s

V= volumetric current (l/s) R= pressure gradient mbar/m V= flow rate

d x s ▶		PB & PE-RT			Mehrschichtverbundrohre MVR				
V̇	d_i	16mm	20mm	25mm	16mm	20mm	25mm	32mm	40mm
0,01	R	0,15	0,04	0,01	0,15	0,04	0,02	0,00	0,00
	v	0,09m/s	0,05m/s	0,03m/s	0,09m/s	0,05m/s	0,03m/s	0,02m/s	0,01m/s
0,02	R	0,50	0,13	0,04	0,50	0,13	0,05	0,01	0,00
	v	0,18m/s	0,10m/s	0,06m/s	0,18m/s	0,10m/s	0,07m/s	0,04m/s	0,02m/s
0,03	R	1,01	0,26	0,08	1,01	0,26	0,10	0,03	0,01
	v	0,27m/s	0,15m/s	0,09m/s	0,27m/s	0,15m/s	0,10m/s	0,06m/s	0,04m/s
0,04	R	1,67	0,43	0,13	1,67	0,43	0,16	0,05	0,01
	v	0,35m/s	0,20m/s	0,12m/s	0,35m/s	0,20m/s	0,13m/s	0,08m/s	0,05m/s
0,05	R	2,48	0,63	0,20	2,48	0,63	0,24	0,07	0,02
	v	0,44m/s	0,25m/s	0,15m/s	0,44m/s	0,25m/s	0,17m/s	0,10m/s	0,06m/s
0,06	R	3,41	0,86	0,27	3,41	0,86	0,33	0,09	0,03
	v	0,53m/s	0,30m/s	0,18m/s	0,53m/s	0,30m/s	0,20m/s	0,12m/s	0,07m/s
0,07	R	4,49	1,13	0,35	4,49	1,13	0,43	0,12	0,04
	v	0,62m/s	0,35m/s	0,21m/s	0,62m/s	0,35m/s	0,23m/s	0,14m/s	0,08m/s
0,08	R	5,69	1,43	0,45	5,69	1,43	0,54	0,15	0,05
	v	0,71m/s	0,40m/s	0,24m/s	0,71m/s	0,40m/s	0,27m/s	0,16m/s	0,09m/s
0,09	R	7,02	1,76	0,55	7,02	1,76	0,67	0,19	0,06
	v	0,80m/s	0,45m/s	0,28m/s	0,80m/s	0,45m/s	0,30m/s	0,17m/s	0,11m/s
0,10	R	8,48	2,12	0,66	8,48	2,12	0,80	0,22	0,07
	v	0,88m/s	0,50m/s	0,31m/s	0,88m/s	0,50m/s	0,33m/s	0,19m/s	0,12m/s
0,12	R	11,77	2,93	0,91	11,77	2,93	1,11	0,31	0,09
	v	1,06m/s	0,60m/s	0,37m/s	1,06m/s	0,60m/s	0,40m/s	0,23m/s	0,14m/s
0,16	R	19,82	4,90	1,52	19,82	4,90	1,84	0,51	0,15
	v	1,41m/s	0,80m/s	0,49m/s	1,41m/s	0,80m/s	0,53m/s	0,31m/s	0,19m/s
0,18	R	24,56	6,05	1,87	24,56	6,05	2,27	0,63	0,19
	v	1,59m/s	0,90m/s	0,55m/s	1,59m/s	0,90m/s	0,60m/s	0,35m/s	0,21m/s
0,20	R	29,77	7,32	2,26	29,77	7,32	2,74	0,76	0,23
	v	1,77m/s	0,99m/s	0,61m/s	1,77m/s	0,99m/s	0,66m/s	0,39m/s	0,23m/s
0,30	R	62,83	15,28	4,68	62,83	15,28	5,69	1,56	0,46
	v	2,65m/s	1,49m/s	0,92m/s	2,65m/s	1,49m/s	0,99m/s	0,58m/s	0,35m/s
0,40	R	107,34	25,89	7,89	107,34	25,89	9,59	2,62	0,77
	v	3,54m/s	1,99m/s	1,22m/s	3,54m/s	1,99m/s	1,33m/s	0,78m/s	0,47m/s
0,50	R	163,16	39,08	11,85	163,16	39,08	14,41	3,92	1,15
	v	4,42m/s	2,49m/s	1,53m/s	4,42m/s	2,49m/s	1,66m/s	0,97m/s	0,58m/s
0,60	R	230,23	54,84	16,56	230,23	54,84	20,15	5,46	1,59
	v	5,31m/s	2,98m/s	1,84m/s	5,31m/s	2,98m/s	1,99m/s	1,17m/s	0,70m/s
0,70	R	308,49	73,13	22,00	308,49	73,13	26,79	7,23	2,10
	v	6,19m/s	3,48m/s	2,14m/s	6,19m/s	3,48m/s	2,32m/s	1,36m/s	0,82m/s
0,80	R	397,91	93,94	28,16	397,91	93,94	34,31	9,23	2,68
	v	7,07m/s	3,98m/s	2,45m/s	7,07m/s	3,98m/s	2,65m/s	1,55m/s	0,94m/s
0,90	R	498,46	117,26	35,05	498,46	117,26	42,72	11,46	3,32
	v	7,96m/s	4,48m/s	2,75m/s	7,96m/s	4,48m/s	2,98m/s	1,75m/s	1,05m/s
1,00	R	610,15	143,08	42,65	610,15	143,08	52,01	13,92	4,02
	v	8,84m/s	4,97m/s	3,06m/s	8,84m/s	4,97m/s	3,31m/s	1,94m/s	1,17m/s
1,20	R		202,19	59,99		202,19	73,22	19,50	5,61
	v		5,97m/s	3,67m/s		5,97m/s	3,98m/s	2,33m/s	1,40m/s
1,40	R		271,24	80,17		271,24	97,90	25,96	7,45
	v		6,96m/s	4,28m/s		6,96m/s	4,64m/s	2,72m/s	1,64m/s
1,60	R		350,21	103,16		350,21	126,05	33,30	9,52
	v		7,96m/s	4,90m/s		7,96m/s	5,30m/s	3,11m/s	1,87m/s
1,80	R		439,08	128,97		439,08	157,66	41,52	11,84
	v		8,95m/s	5,51m/s		8,95m/s	5,97m/s	3,50m/s	2,10m/s
2,00	R			157,57			192,71	50,61	14,39
	v			6,12m/s			6,63m/s	3,89m/s	2,34m/s

PLANNING

Pipe friction factor 60° C

Pipe friction factor R and calculated flow rate v in dependence on volumetric current $\dot{V}$

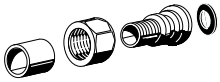
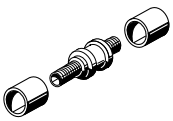
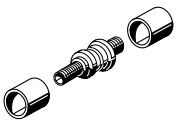
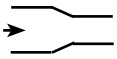
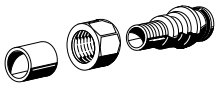
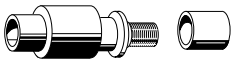
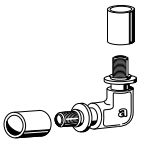
aquatherm grey pipe **potable water and radiator connection pipe / Multi-layer metal composite pipe**

Roughness:	0.0070 mm
Temperature:	**60° C**
Density:	983.20 kg/m3
Viscosity:	0.47 *E-6 m2/s

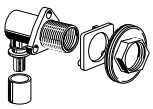
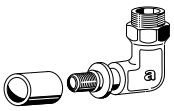
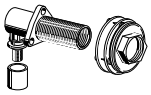
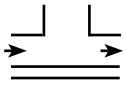
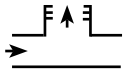
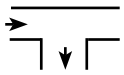
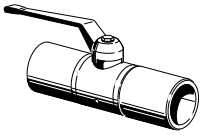
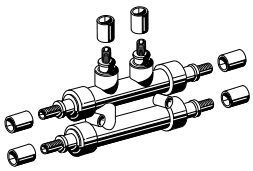
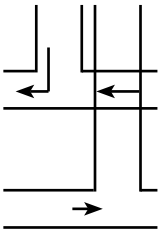
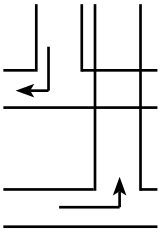
V= Durchfluss (l/s) R= Druckgefälle mbar/m V= Geschwindigkeit

d x s ▶		PB & PE-RT			Mehrschichtverbundrohre MVR				
$\dot{V}$	d_i	16mm	20mm	25mm	16mm	20mm	25mm	32mm	40mm
2,20	R			188,98			231,20	60,56	17,18
	v			6,73m/s			7,29m/s	4,27m/s	2,57m/s
2,40	R			223,17			273,14	71,37	20,21
	v			7,34m/s			7,95m/s	4,66m/s	2,81m/s
2,60	R			260,16			318,50	83,05	23,47
	v			7,95m/s			8,62m/s	5,05m/s	3,04m/s
2,80	R			299,93			365,45	95,59	26,96
	v			8,57m/s			9,28m/s	5,44m/s	3,27m/s
3,00	R							108,98	30,68
	v							5,83m/s	3,51m/s
3,20	R							123,23	34,64
	v							6,22m/s	3,74m/s
3,40	R							138,34	38,82
	v							6,61m/s	3,98m/s
3,60	R							154,31	43,24
	v							6,99m/s	4,21m/s
3,80	R							171,13	47,89
	v							7,38m/s	4,44m/s
4,00	R							188,80	52,77
	v							7,77m/s	4,68m/s
4,20	R							207,33	57,87
	v							8,16m/s	4,91m/s
4,40	R							226,71	63,21
	v							8,55m/s	5,14m/s
4,60	R							246,94	68,78
	v							8,94m/s	5,38m/s
4,80	R								72,29
	v								5,61m/s
5,00	R								78,25
	v								5,85m/s
5,20	R								84,19
	v								6,08m/s
5,40	R								90,35
	v								6,31m/s
5,60	R								96,37
	v								6,55m/s
5,80	R								102,67
	v								6,78m/s
6,00	R								108,69
	v								7,02m/s
6,20	R								115,12
	v								7,25m/s
6,40	R								121,90
	v								7,48m/s
6,60	R								128,99
	v								7,72m/s
6,80	R								133,69
	v								7,95m/s
7,00	R								141,53
	v								8,18m/s
7,50	R								162,32
	v								8,77m/s

Coefficient of Loss ζ aquatherm grey pipe-fittings

Fitting	Picture	Symbol	Comment	ζ–Value
aquatherm grey pipe- transition joint with seal				0,50
aquatherm grey pipe- coupling				0,50
aquatherm grey pipe- reducing coupling			Reduction by 1 Dimens. by 2 Dimens. by 3 Dimens.	0,40 0,50 0,60
Euroconusadapter				0,50
Adapter on aquatherm green pipe-pipes				0,80
aquatherm grey pipe- elbow				1,50
aquatherm grey pipe - elbow 45 °				0,50
aquatherm grey pipe- connecting back plate elbow				1,50
aquatherm grey pipe- connecting back plate elbow, twin			Supply	1,80
			Transition	2,00

Coefficient of Loss ζ aquatherm grey pipe-fittings

Fittings	Picture	Symbol	Comment	ζ–Value
aquatherm grey pipe- connecting elbow for concealed flushing box connections				1,50
transition elbow for concealed installation				1,50
aquatherm grey pipe- elbow dry construction				1,50
aquatherm grey pipe- tee			Passage in case of seperation of flow	0,50
			Seperation of flow	1,50
Reducing tee	The ζ-value results from the addition of tee and the value 0.5.			
aquatherm grey pipe- four-port manifold			Seperation of flow	1,10
Ball valve for **aquatherm grey pipe** four-port manifold				0,50
aquatherm grey pipe- distribution block			Reduced 20 mm passage in case of separation of flow	1,00
			20 mm passage in case of separation of flow	0,25
			16 mm branch in case of separation of flow	0,80
			16 mm branch in case of conjunction of flow	1,60
			Reduced 16 mm branch in case of separation of	2,20

PLANNING / INSTALLATION PRINCIPLES

Pressure test / Test control

Acc. to the Technical rules for potable water installations

DIN 1988

all pipelines have to be (while still visible) hydraulically pressure tested. The test pressure has to be 1.5 times of the working pressure. When carrying out the pressure test the material properties of plastic-pipes lead to an expansion of the pipe. This influences the test result.

A further influence of the test result can be caused by the coefficient of thermal expansion of plastic-pipes. Different temperatures of pipe and test medium lead
to alterations of pressure.

A temperature change of 10 K corresponds to a pressure difference of 0.5 to 1 bar. Therefore the highest possible constant temperature of the test medium has to be ascertained at the hydraulic pressure test of installations with fusiotherm- and/or aquatherm grey pipe-pipes.

The hydraulic pressure test requires a preliminary, principal and final test.

For the preliminary test a test pressure of 1.5 times of the highest possible operating pressure has to be produced. This test pressure has to be re-established twice within 30 minutes within an interval of 10 minutes. After a test time of a further 30 minutes the test pressure must not drop more than 0.6 bar and no leakage should have appeared.

The preliminary test is followed directly by the principal test. Test time is 2 hours. On doing so the test pressure taken from the preliminary test may not fall more than 0.2 bar.

After completion of the preliminary and principal tests the final test must be conducted, which has to be effected with a test pressure of alternate 10 and 1 bar
in a rhythm of at least 5 minutes. Between each test course the pressure has to be removed.

No leakage must appear at any point of the tested installation.

Measuring of the test pressure

Measuring has to be done with a manometer allowing a perfect reading of a pressure change of 0.1 bar.

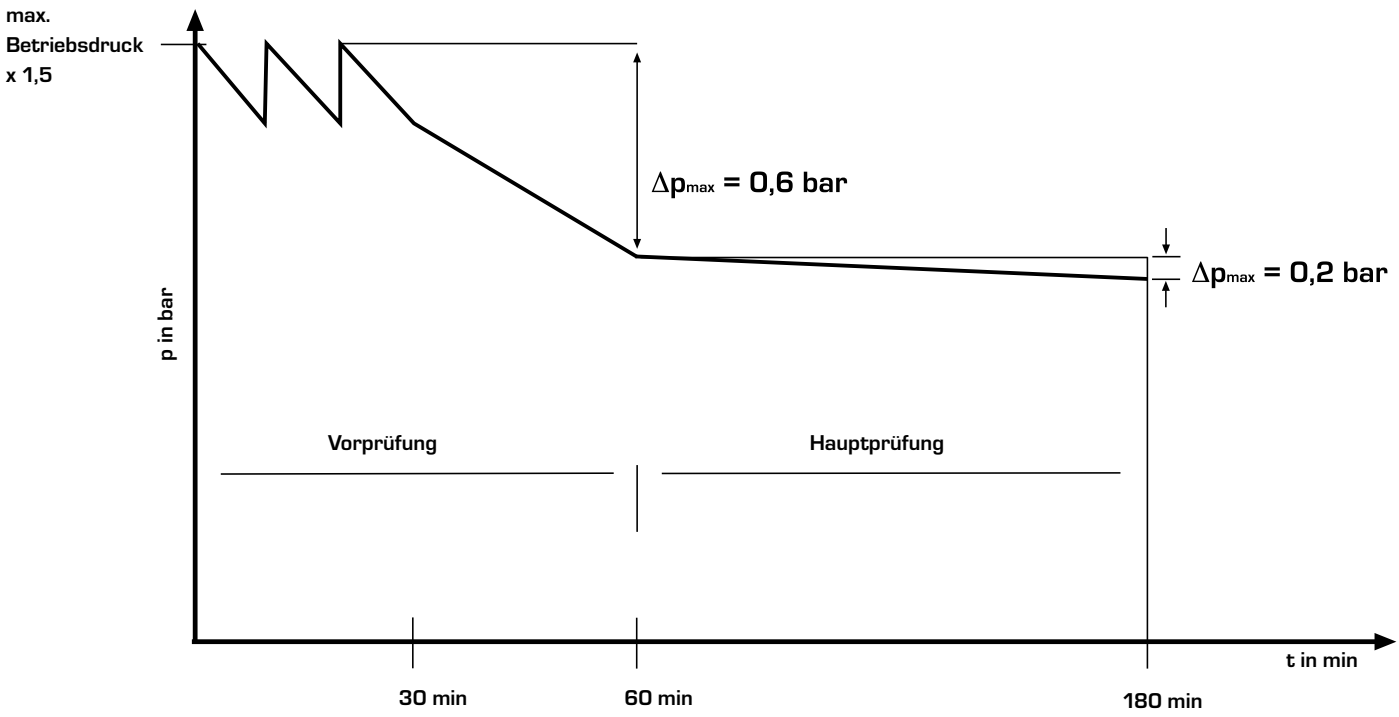
The manometer has to be placed at the deepest point of the installation.

Test record

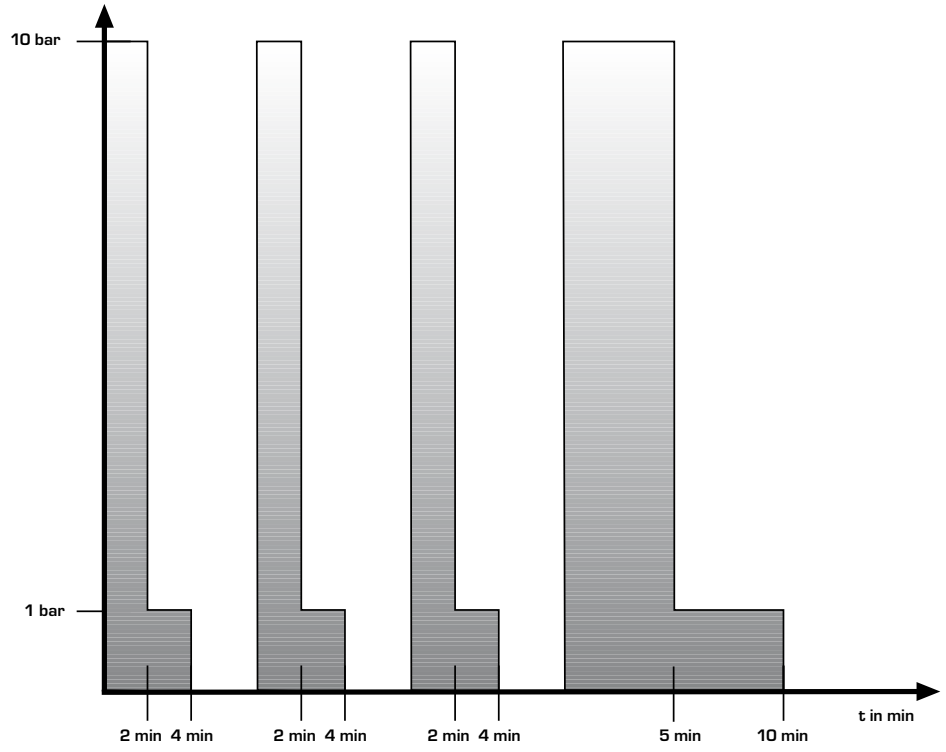
A record of the hydraulic pressure test has to be prepared and signed by the client and contractor stating place and date.

PLANNING / INSTALLATION PRINCIPLES

Preliminary- and principal test



Final Test



PLANNING / INSTALLATION PRINCIPLES

Description of the installation

Place: _____

Object: _____

_____

_____

Pipe-lengths:
Ø 16 mm _____ m
Ø 20 mm _____ m
Ø 25 mm _____ m
Ø 32 mm _____ m
Ø 40 mm _____ m

Highest point: _____ m
(over manometer)

Start of the test: _____
End of the test: _____
Test period: _____

Client: _____

_____

_____

_____

Contractor: _____

_____

_____

_____

Place: _____

Date: _____

_____

Stamp / Signature:

Preliminary test

Test pressure: 15 bar

Pressure drop after 1. re-establishment: _____ bar
(Test start)

Pressure drop after 2. re-establishment: _____ bar

Pressure drop after 30 minutes: _____ bar
(max. 0,6 bar)

Result preliminary test: _____

Principal test

Working pressure: _____ bar
(Result preliminary test)

Pressure after 1 hour: _____ bar
(Test start)

Pressure after 2 hours: _____ bar

Pressure drop: _____ bar
(max. 0,2 bar)

Result principle test:

Final test*

1. Working pressure 10 bar: _____ bar
at least 5 minutes, then
Working pressure 1 bar: _____ bar
at least 5 minutes
2. Working pressure 10 bar: _____ bar
at least 5 minutes, then
Working pressure 1 bar: _____ bar
at least 5 minutes
3. Working pressure 10 bar: _____ bar
at least 5 minutes, then
Working pressure 1 bar: _____ bar
at least 5 minutes
4. Working pressure 10 bar: _____ bar
at least 5 minutes, then
Working pressure 1 bar: _____ bar
at least 5 minutes

* Unpressurize the pipe between each cycle.

CALCULATION

Rate per hour

Apart from material costs the labour costs and the rate per hour resulting from them are the basis for the calculation. The rate per hour supposed for the calculation example of

0.70 EUR/min.

is a realistic value for a handicraft business with 15 - 30 employees.

This rate results from the annual costs for a plumber plus general business costs, profit, etc.

The rate per hour for plumbers and workers results in costs for single- and groupminutes, from which - by means of calculation tables - the installation costs for different works can be determined.

Installation times / Assembly costs

The adjusted times of assembly for potable water and heating installations carried out with the aquatherm grey pipe-connection pipe are described as "1 man minute" and are valid for the following building groups:

- **one-familiy and multifamily houses**
- **building blocks**
- **community owned and functional buildings**

For all building groups	Installation times in min/ per m
ø 16 mm	6.0 Minuten
ø 20 mm	8.0 Minuten
ø 25 mm	10.0 Minuten
ø 32 mm	12.0 Minuten
ø 40 mm	14.0 Minuten

The installation time per minute refers to 1 meter completely installed pipe inclusive fitting connection and fastening.

Due to this the following prices for assembly are resulting in the supposed rate of 0.64 Euro/min. for one meter completely installed pipe (plus material costs):

Dimension	Install. time x supposed rate	Assembly costs/m
16 mm	6,0 min. x 0,7 EUR/min	4,.0
20 mm	8,0 min. x 0,7 EUR/min	5.60
25 mm	10,0 min. x 0,7 EUR/min	7.00
32 mm	12,0 min. x 0,7 EUR/min	8.40
40 mm	14,0 min. x 0,7 EUR/min	9.80

Rate of surcharge for fittings and fastenings

Many tenders include surcharges on the pipe sums for fittings and connection pieces as well as for fastening material. All aquatherm grey pipe-connection pipes require the same fittings and connection pieces. That's why an uniform percentage on the pipe sum of:

150 % for fittings
15 % for fastening

can be added to the price.

These rates of surcharge base on standard buildings and probably differ in case of comfort buildings due to the installation of luxury bath rooms, swimming pools, saunas, etc.

This model calculation is based on different acceptances, which individually differ in practical appliances. For this reason, the user has to check his individual case. Excluding all claims and sequence damage, aquatherm vouches only for intention and gross negligence.

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