REHAU®
Unlimited Polymer Solutions

RAUFUSION PP-R PLUMBING SYSTEM

Technical Information

RAUFUSION PP-R PLUMBING SYSTEM

This Technical Information RAUFUSION PP-R PLUMBING SYSTEM is valid from **January 2017**.

Our current technical document can be found at **www.rehau.com** for download.

All measurements and weights are of approximation values.
Errors and changes are excepted.

TABLE OF CONTENTS

1 INFORMATION AND SAFETY ADVICES

Notes on this Technical Information

Validity
This technical information is valid for South East Asia including Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

Navigation
At the beginning of this document you can find a detailed content page which lists the individual chapters and their respective page numbers.

Definitions
- Supply lines or piping consist of pipes and their joints (e.g. fittings, threads or similar). This applies to drinking water and heating piping and all other pipes in this Technical Information.
- Piping systems, installations, systems, etc. consist of the pipes and the necessary components.
- Connection components consist of fittings with the corresponding pipes and valves, as well as seals and threaded connections.

Explanation of symbols

 Safety Information

 Legal information

 Important information, which needs to be taken into account

 Information in the internet

 Your benefits/advantages

Latest technical information
For safe usage of REHAU products, please check regularly if a newer version of the technical information is available to you. The date of issue of your technical information can be found on the back cover in the bottom right hand corner. The latest technical information manuals are available from the REHAU sales office, appointed wholesalers as well as from our website: www.rehau.com.

Safety advice and operating instructions
- Please read these safety instructions and technical information carefully and completely for your own safety and other's before beginning the installations.
- Please keep this copy for your future reference.
- If you have any questions or need further clarifications on the safety instructions and/or the individual installation instructions, please contact your nearest REHAU sales office.
- Failure to observe the safety information/instructions can result in damage to property and persons.

 When installing this pipe system, please observe all applicable national and international regulations on installation, accident prevention and safety together with the information contained in this manual.

Also observe the applicable laws, standards, guidelines and regulations (e.g. DIN, EN, ISO, DVGW, TRGI, VDE, VDI, SPAN and Singapore CP, SS Singapore plumbing code, other codes valid in the region) as well as regulations on environmental protection, provisions of professional associations and regulations of the local public utility companies.

Any applications not described in this manual - i.e. non-standard applications - must be discussed with our Technical Applications Department. For more detailed advice, please contact your REHAU sales office.

The design and installation information related solely to the specific REHAU product. Occasionally, references are made to parts of applicable standards and directives. Always observe the current version of any guidelines, standards or directives.

Further standards, directives and guidelines related to the design, installation and operation of drinking water, heating or buildings services systems should also be referred to, but these do not form part of this Technical Information.

General safety measures

- Keep your workplace tidy and free of obstructions.
- Ensure there is always sufficient light.
- Keep children, pets and unauthorized persons away from tools and installation areas. This is especially important when carrying out refurbishment/repair work in occupied areas.
- Only use those components in the corresponding piping system, which have been generally approved by REHAU. Using components which are not part of the system or tools which do not originate from the respective REHAU installation system can lead to accidents or other hazards.

Trades qualifications

- Only authorized and trained persons are allowed to install REHAU systems.
- Work on electrical systems and cables shall only be carried out by qualified, competent and authorized specialists.

Work clothing

- Wear eye protection, adequate work clothing, protective shoes, safety helmets, and a hairnet if you have long hair.
- Do not wear loose clothing or jewellery as these can be caught by moving parts.
- A safety helmet must be worn especially when carrying out installation work at face level or overhead.

Follow the installation instructions

- Read carefully and observe at all times the Operating Manual for the REHAU installation tool which is being used.
- Incorrect handling of tools can cause burns, cuts and crushing or sever limbs.
- Incorrect handling of tools can damage jointing components and cause leaks.
- The REHAU pipe cutters have a sharp blade. Store and handle them in such a way that the REHAU pipe cutters will not create any risk of injury.
- When cutting the pipe to the desired length, keep a safety distance between the holding hand and the tool (pipe cutter).
- When cutting, do not reach into the cutting zone of the tool or near its moving parts.
- The pipe fusion tool is designed be heated up to 260°C to melt the PP-R pipe for fusion. Avoid skin contact with the exposed metal when the machine is running. Wait for the machine to cool down prior to carrying out maintenance work or moving the machine to new location.
- Always observe the relevant heating and cooling times of different pipe sizes to achieve a proper weld for the pipes and fittings.
- Always disconnect the power from a tool prior to carrying out maintenance work, changing over any parts or when moving the tool to a new location on site.

Operating parameter

If the operating parameters are exceeded, the pipes and joints may become over melted, causing a blockage of the joints. Not adhering to the operating parameters is thus not allowed.

2 OVERVIEW

2.1 Benefits at a glance

RAUFUSION pipe

- Long service life and highly resistant to aggressive elements
- Corrosion resistance of RAUFUSION pipes: No pitting
- No tendency to deposits or encrustation
- High impact toughness of RAUFUSION pipe material
- Good resistance to abrasion
- Good heat insulating properties, minimal insulation required
- Noise absorption abilities providing with sound insulating characteristics
- Lighter weight
- Easy and flexible installation methods
- Cost effective piping network
- Pipe size from 20 to 160 mm
- S5, S3.2, S2.5 sizes available - PN10, PN16, PN20

RAUFUSION engineering features

- 4 stripes located 90º apart for easy identification and installation
- No bottle necks reducing flow of fittings joints
- Shallower installation for concealed fitting
- Deep multi point rib design tested to resist extreme torque for threaded fittings
- Special nickel coating on brass fittings to enhance wear and corrosion resistance.
- No O-ring or solvent required to join pipes and fittings.

REHAU fittings

- 3 types of RAUFUSION fittings for water services, i.e. PP-R fittings, PP-R brass fittings and PP-R PE-X fittings
- RAUFUSION fittings for water services are tested according to DIN EN 12164, DIN EN 12165 and DIN EN 12168 standards, RAUFUSION fittings are made to comply with DIN 8077, DIN 8078 and ISO 15874.

Universal tools RAUTOOL from REHAU

- Suitable for all pipe dimensions from 20mm to 160 mm
- RF 63 - Suitable for pipe dimensions from 20mm to 63mm
- RF 125 - Suitable for pipe dimensions from 75mm to 110mm
- RF 125 Station kit - Suitable for pipe dimensions from 20mm to 110mm
- RF 160 Station kit - Suitable for pipe dimensions from 50mm to 160mm.

3 MATERIAL

3.1 PP-R materials

Polypropylene Random Copolymer (PP-R)

The Polypropylene Random Copolymer (PP-R), one of the 3 general types of polypropylene is used for RAUFUSION system and is engineered to meet the requirements of ISO 15874 and DIN8077/8078. Polypropylene random copolymers are thermoplastic resins produced through the polymerization of propylene, with ethylene links introduced in the polymer chain. The resins possess a broad range of characteristics and are used in a wide range of applications.

Properties	Test method	Unit	Values
Melt Index 230/2.16	ISO 1133	g/10min	0.25
Density	ISO 1183	g/cm3	0.9
Vicat softening temperature	ISO 306	C	>130 C
Thermal conductivity (20°C)	DIN 52612	W/mK	0.24
Thermal expansion factor	Dilatometer	Mm/mK	0.15
Elongation	ASTM D 638	%	>400
Tensile strength at yield	ASTM D 638	MPa	26.5
Flexular modulus	ASTM D 790	MPa	833

Tab. 3-1 Technical data of pipes (approximate value)

3.2 Material testing at REHAU

At REHAU, all types of pipes are subjected to constant quality assurance and pass through numerous short and long-term tests to ensure the quality of the REHAU pipes. Several standard tests conducted in the REHAU test laboratory are described in the following pages. For polymer pipe materials subjected to thermal and mechanical loads, it must be observed that deformation and the strength depend on the temperature and exposure time.

To determine the permissible conditions for long-term loads, it is necessary to investigate the mechanical behaviour over a long period and at different temperatures. This also applies to pipes subjected to internal pressure. RAUFUSION pipes are fully tested to comply with international code EN ISO 15874: 2013 for hot water and cold water installation.

3.2.1 Internal pressure resistance test

REHAU conducts comprehensive pressure tests to ensure that pipes are produced to the highest standard possible. In the internal pressure resistance test, pipes are filled with water and pressurized. Three types of pressure tests are conducted, as shown in the table Tab 3-2.

Pressure tested	Time tested	Ambient temperature
16 MPa Hoop stress	1 hour	20°C
3.5 MPa Hoop stress	1000 hours	95°C
1.9 MPa Hoop stress	8760 hours	110°C

Tab. 3-2 Internal pressure resistance tests

For the internal pressure resistance test, pipes are filled with water and pressurized to 1.9 MPa. The pipes are then placed in an environment with an ambient temperature of 110°C for 8760 hours.

Fig. 3-2 Internal pressure resistance test

\\Fig. 3-3 Longitudinal resistance test apparatus

3.2.2 Longitudinal reversion test

RAUFUSION pipes are tested to ensure that after expansion due to heating, the pipes will revert to not more than 2% of their original length. The pipes are measured before being heated in an air oven up to 135°C. The pipes are left to cool and then measured again. Both measurements are compared and the difference is calculated.

3.2.3 Impact resistance test

In an impact resistance test, the pipe is first conditioned to a temperature of 0°C. Then the pipe is placed on the test machine and a pendulum swings down and strikes the pipe.

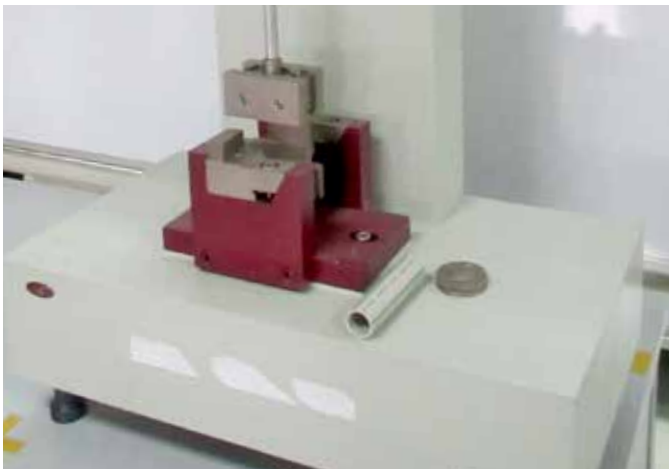


Fig. 3-4 Impact resistance test apparatus

Fig. 3-5 Melt mass flow rate test apparatus

3.2.4 Melt mass flow rate test

In a melt mass flow rate test, the test specimen is melted to ensure that the melted mass does not exceed 0.5 g for 10 minutes. Test specimens of 2.16 kg are heated to 230°C when conducting this test. RAUFUSION pipes and RAUFUSION compound are tested to comply with ISO 15874.

4 TRANSPORT AND STORAGE

4.1 Handling the pipes and system components

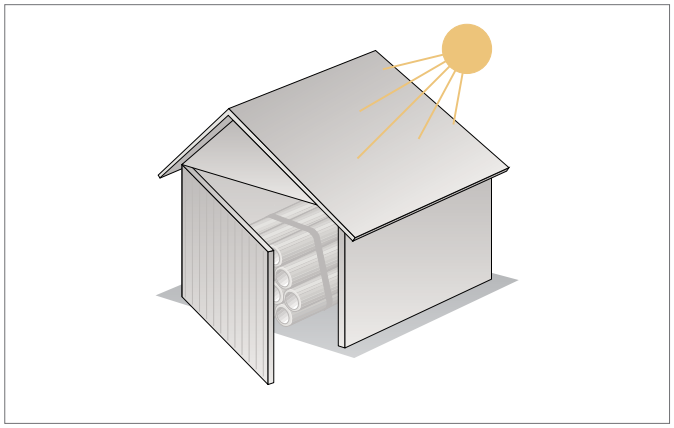


Fig. 4-1 Protect pipes and fittings against sunlight

- Store and transport pipes and components protected against UV radiation.
- When laying pipes in areas where UV-radiation (e.g. sunlight, neon light) can occur, cover the piping fully with UV-proof material.

Avoid damaging the pipes and system components:

- Load and unload with due care
- Only transport in a fashion suitable for the material
- Do not drag over floors or concrete surfaces
- Store on a flat surface with no sharp edges
- Protect against mechanical damage
- Protect against dirt, drilling dust, mortar, grease, oil, paint, solvents, chemicals, humidity, etc.
- Protect against sunlight, e.g. with an opaque file or similar material
- Protect against long sunlight exposure during the construction phase
- Only unpack shortly before laying
- Note the hygienic requirements (e.g. sealing of pipe ends, protection of the fittings, compliance with VDI 6023 – Hygiene-conscious planning, execution, operation and installation of drinking water systems)

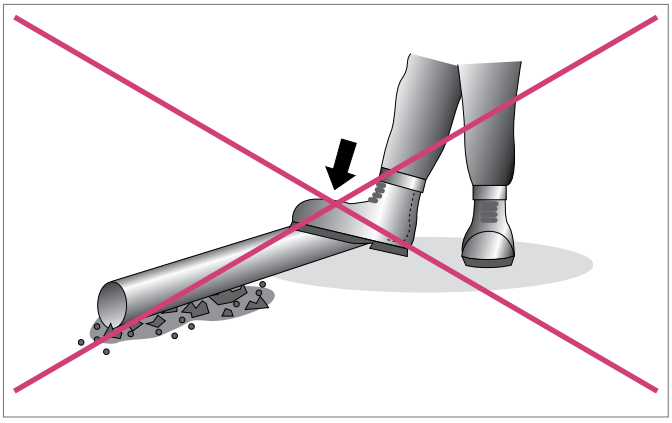


Fig. 4-2 Do not store pipes on sharp-edged surfaces

5 PIPES

5.1 Applications

- Potable hot and cold water installations (5°C – 70°C)
- Industrial piping systems: The use of PP-R piping systems to carry mediums other than water is generally possible but shall be checked and confirmed by REHAU prior to installation. Especially in case of certain aggressive chemicals the application of PP-R can be limited. The chemical tables in ISO TR 10358 can be used as reference.
- Compressed air piping system: Only approved oils and additives in the air should be used to preserve the integrity of the PP-R piping system. Please contact REHAU prior to usage.
- Chilled water piping system (from 5°C to 70°C): Special precautionary measures are necessary in applications where chilled water below 5°C shall be transported. Please contact REHAU prior to installation.

5.2 Types

Magenta, Grey and Green are the primary colours of REHAU. These colours denote a symbol of quality, innovation and service; recognisable throughout the world. The distinct REHAU colours are represented in the RAUFUSION PP-R 3 pipes series. They represents REHAU'S distinct design, engineering and commitment to the products reliability and innovation.

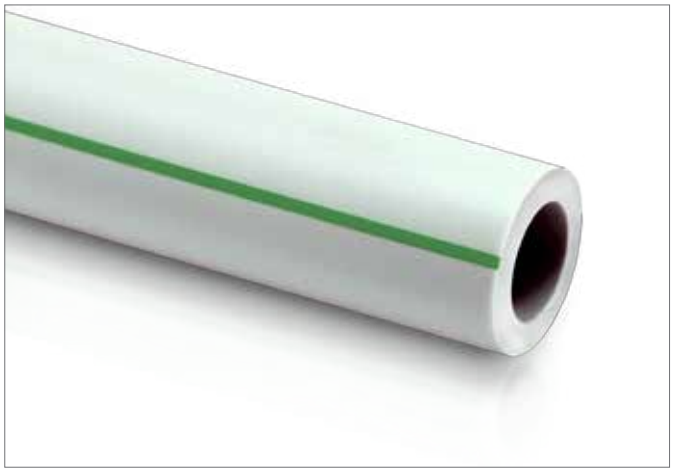


Fig. 5-1 RAUFUSION PN 10 pipe

5.2.1 S5 / SDR 11 / PN 10

Applications	:	Potable cold water piping, industrial piping
Standards	:	DIN 8077/ 78, ISO 15874
Operating temperature	:	5°C to 70°C
Operating pressure	:	ISO Class 1 (60°C) = 6 bar
		ISO Class 2 (70°C) = 4 bar
		Cold Water (20°C) = 12.9 bar
Pipe defining features	:	Light grey with 4 green stripes
Pipe length per unit	:	4 meters

Outside Diameter/ Nominal Diameter (mm)	Pipe Thickness (mm)	Inner Diameter (mm)	Volume (litre /m)
20	1.9	16.2	0.206
25	2.3	20.4	0.327
32	2.9	26.2	0.539
40	3.7	32.6	0.835
50	4.6	40.8	1.307
63	5.8	51.4	2.075
75	6.8	61.4	2.961
90	8.2	73.6	4.254
110	10	90.0	6.362
160	14.6	130.8	13.437

Tab. 5-1 Dimensions for PN10 PP-R

Fig. 5-2 RAUFUSION PN 16 pipe

5.2.2 S3.2 / SDR 7.4 / PN16

Applications	:	Potable hot and cold water piping, industrial piping Standards
	:	DIN 8077/ 78, ISO 15874
Operating temperature	:	5°C to 70°C
Operating pressure	:	ISO Class 1 (60°C) = 8 bar
		ISO Class 2 (70°C) = 6 bar
		Cold Water (20°C) = 20.4 bar
Pipe defining features	:	Light grey with 4 grey stripes
Pipe length per unit	:	4 meters

Outside Diameter/ Nominal Diameter (mm)	Pipe Thickness (mm)	Inner Diameter (mm)	Volume (litre /m)
20	2.8	14.4	0.163
25	3.5	18	0.254
32	4.4	23.2	0.423
40	5.5	29	0.661
50	6.9	36.2	1.029
63	8.6	45.8	1.647
75	10.3	54.4	2.324
90	12.3	65.4	3.359
110	15.1	79.8	5.001
125	17.1	90.8	6.478
160	21.9	116.2	10.609

Tab. 5-2 Dimensions for PN16 PP-R

Fig. 5-3 RAUFUSION PN 20 pipe

5.2.3 S2.5 / SDR 6 / PN20

Applications	:	Potable cold and hot water piping, industrial piping, compressed air piping, chilled water piping
Standards	:	DIN 8077/ 78, ISO 15874
Operating temperature:		5°C to 70°C
Operating pressure	:	ISO Class 1 (60°C) = 10 bar
		ISO Class 2 (70°C) = 8 bar
		Cold Water (20°C) = 25.7 bar
Pipe defining features	:	Light grey with 4 magneta stripes
Pipe length per unit	:	4 meters

Outside Diameter/ Nominal Diameter (mm)	Pipe Thickness (mm)	Inner Diameter (mm)	Volume (litre /m)
20	3.4	13.2	0.137
25	4.2	16.6	0.216
32	5.4	21.2	0.353
40	6.7	26.6	0.556
50	8.4	33.2	0.866
63	10.5	42.0	1.385
75	12.5	50.0	1.963
90	15.0	60.0	2.827
110	18.4	73.2	4.208

Tab. 5-3 Dimensions for PN20 PP-R

Local approval

Local approvals may vary. When using the REHAU plumbing installation system, please consult your REHAU Sales Office.

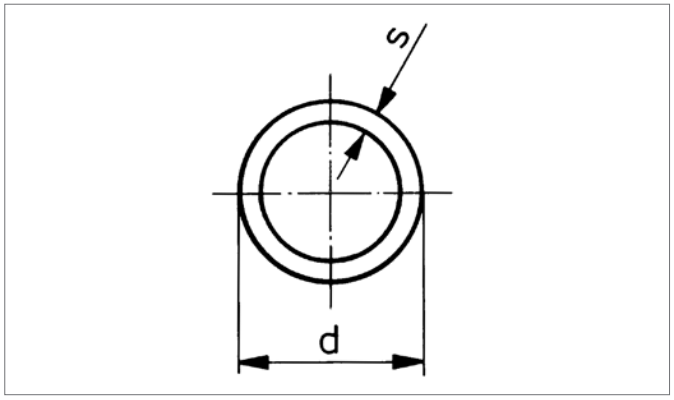


Fig. 5-4 Diameter/Wall thickness

5.3 Regression curve

The diagram below shows the pipe lifespan depending on fluid pressure and temperature.

For PP-R:

$$\log t = -55.725 - \frac{9484.1 \log \sigma}{T} + \frac{25502.2}{T} + 6.39 \log \sigma$$

(Left hand side of graph)

$$\log t = -19.98 + \frac{9507}{T} - 4.11 \log \sigma$$

(Right hand side of graph)

Where

t = Time to fracture (hours)
T = Temperature of fluid (K)
σ = Hydrostatic pressure (MPa)

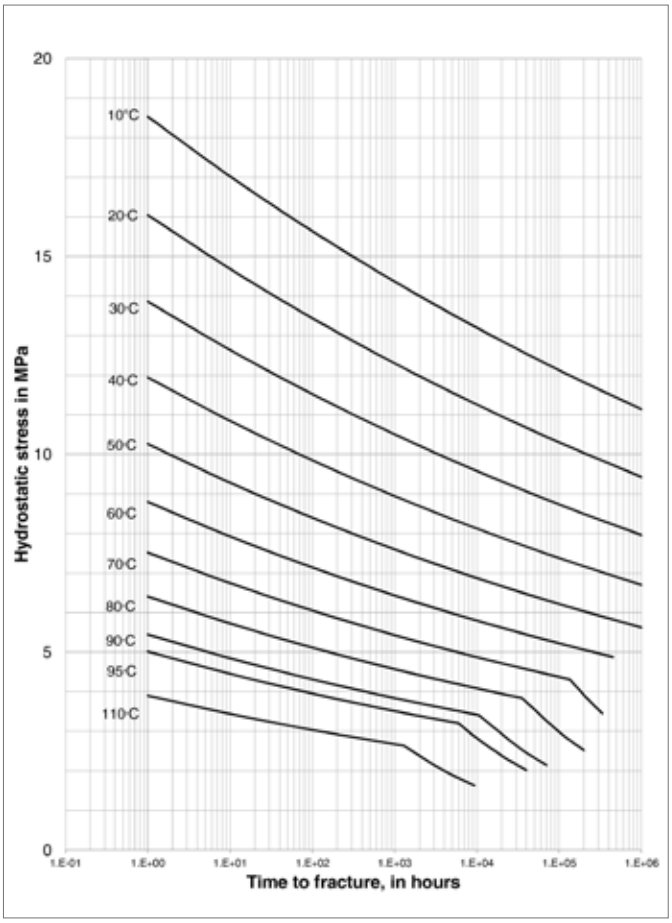


Fig. 5-5 Service life graph Tested to DIN 8088 evaluated according to ISO 9080

The formula used to calculate pressure from hoop stress diagram is listed as below:

$$P = \frac{20 \times s \times R}{(d - s) \times SF}$$

Where

P = maximum working pressure (bar)
d = outer diameter (mm)
s = thickness (mm)
R = hydrostatic stress (MPa)
SF = safety factor coefficient (1.5 for hot water, 1.25 ~ 1.4 for cold water)

6 FITTINGS

6.1 Fitting types

RAUFUSION pipes can be connected to other pipe system materials. RAUFUSION fittings consist of three types:

6.1.1 Socket fusion fittings

RAUFUSION socket fusion fittings are made of PP-R and are the primary fittings in connecting PP-R pipes. Socket fusion fittings are jointed to pipes via socket fusion/welding method. The pipes and fittings are heated via RAUTOOL RF 63 and RF 125 and are fused together. No O'rings or solvent required to seal the joint hence increasing the stability and resistance of the joint. RAUFUSION fittings are manufactured to be joined using RAUTOOL RF. REHAU is not liable for the security and integrity of RAUFUSION joints not joined using RAUTOOL RF.

Fig. 6-1 RAUFUSION socket fusion fitting

6.1.2 PP-R – PE-X adaptor

RAUFUSION PP-R – PE-X adaptors are made from PP-R and Dezincification Resistance Brass (DZR Brass) complying with EN 12420. RAUFUSION pipes can be connected to REHAU's proprietary PE-X system, RAUTITAN system. RAUTITAN PE-X pipes are joined using compression sleeve method which further enhances joints' stability. RAUFUSION to RAUTITAN adaptors are available for RAUTITAN PE-X sizes 16mm to 40mm. The PP-R – PE-X adaptor mechanical characteristics adhere to the same pressure and temperature rating as RAUFUSION fittings. Pressure and temperature rating of the PP-R – PE-X adaptor is according to this technical information and not according to our PE-X system technical information.

Fig. 6-2 RAUFUSION PP-R - PE-X fitting

6.1.3 PP-R – Metal adaptor

Transition between PP-R and other pipe materials are possible adaptor fittings with threaded metal insert or RAUFUSION Union Adaptors. RAUFUSION fittings are available for both male and female thread connections types. RAUFUSION metal fittings are nickel coated to enhance its corrosion and wear resistance. For pipes ranges from 63mm to 160mm, flange fittings are available to be connected to large size metal pipes. RAUFUSION fittings comply to thread standards ISO 7 and ISO 228.

Fig. 6-3 RAUFUSION PP-R - Metal fitting

6.2 Connection to fittings

Equipment or sanitary wares can be easily connected with RAUFUSION adaptor unions

RAUFUSION fittings sizes	RAUFUSION Metal Adapter		Fittings Threads
	Fitting types	Connection types	
20mm	Wall mounted elbow (90°)	Female	ISO 7, DIN 2999 (DIN 10226-1 and 10226-3)
20mm – 32mm	Elbow (90°)	Male/ Female	ISO 7, DIN 2999 (DIN 10226-1 and 10226-3)
20mm – 32mm	Tee	Male/ Female	ISO 7, DIN 2999 (DIN 10226-1 and 10226-3)
20mm – 63mm	Coupling	Male/ Female	ISO 7, DIN 2999 (DIN 10226-1 and 10226-3)
20mm – 63mm	Adaptor union	Male/ Female	ISO 7, DIN 2999 (DIN 10226-1 and 10226-3)

Table 6.1 RAUFUSION fittings with sanitary wares

6.3 Installation notes for connection components

- Avoid over-tightening threaded joints
- Using pipe wrenches may cause damage to the fittings
- Do not apply excessive hemp to threaded joints. The thread tips must be visible
- Do not subject fittings to deformation, e.g. by hammer blows
- Only use BSP threads (British Standard pipe threads) according to ISO 7-1 and DIN 2999 (DIN 10226-1 and 10226-3) standards. Other thread types are not permitted
- Make sure that the connection components are free of inadmissible stress during assembly and when in operation. Make sure that the piping has sufficient scope of movement (e.g. from deflection legs).
- Do not use dirty or damaged system components, pipes, fittings, or seals
- When flat-sealed joints (or similar) are opened, check that the sealing surface is undamaged before reconnecting and insert a new seal if necessary

Observe the following instructions when installing threaded fittings:

- Only use sealants approved for portable water installation (e.g. DVGW certified sealants)
- Avoid contact of sealant with the plastic components of the system
- Screw the threaded joints together so that the thread-end remains visible
- Check that different thread types are capable of being combined according to ISO 7-1and DIN 2999 (DIN 10226-1 and 10226-3) before screwing them together, e.g. tolerances, free movement. Other thread types are not permitted
- If using long threads, ensure the maximum possible screwing depth and sufficient thread depth in opposing parts with inside threads

The threads of threaded fitting adapters are according to:

- Thread according to ISO 7-1 and DIN 2999 (DIN 10226-1 and 10226-3):
  - Rp = cylindrical female thread
  - R = conical male thread
- Thread according to ISO 228:
  - G = cylindrical thread, non-sealing thread

Aligning the fittings

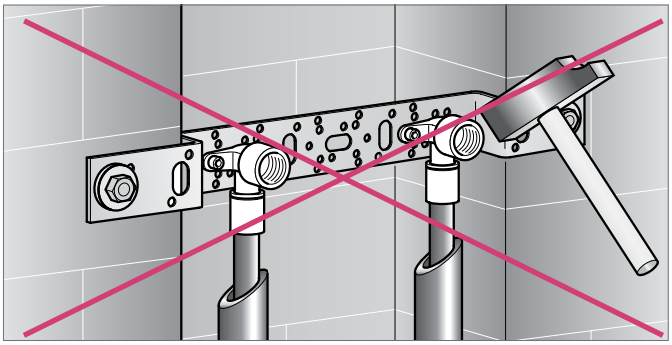


Fig. 6-4 Do not align using a hammer

- Ensure that the employed sealants, cleaning agents, building foams, etc. do not contain any components which cause stress cracking, e.g. ammonia, ammonia-bearing, aromatic and oxy-genated solvents (e.g. ketone and ether), chlorinated hydrocarbons.
- Protect fittings and pipes against dirt, drilling dust, mortar, grease, oil, paint, lacquers, adhesive/protective primers, solvents, etc. which may damage the PP-R material.
- In aggressive environments (e.g. farming, encased in concrete, seawater atmosphere, cleaning agents), protect piping and fittings against corrosion adequately and in such a way that they are sealed against diffusion (e.g. to aggressive gasses, fermentation gases).
- Protect systems against damage (e.g. during construction phase, at vehicles area, machines or farming, and from damage caused by animals).

7 INSTALLATION TOOLS: RAUTOOL

- Before using tools, read and observe the information in the operating instructions completely.
- If these operating instructions are no longer present with the tool or are not longer available, order a copy or download them from the REHAU web site.
- Do not use damaged tools or partially functioning tools; send these for repair to your REHAU Sales Office or replace with a new tool.

Operating instructions can be downloaded online from www.rehau.com. The scope of delivery of installation tools RAUTOOL can be seen from the product book.

- RAUTOOL installation tools are specially designed to work with REHAU programs
- Development and supervision directly from REHAU
- RAUTOOL installation tools are continuously improved and further developed
- Flexible and good tool handling
- Compact design

7.1 Fusion tools list

7.1.1 Pipe cutters

Check the blade of the pipe cutters regularly for damage and replace the blade or the cutters as necessary. Damaged or blunt blades can cause burrs or notches on the pipe, which can affect proper welding.

- If the pipe was cut improperly, please cut it again to ensure square and burr-free cut.

When cutting the pipes, observe the following:

- Use the correct pipe cutters for the corresponding pipe type only
- Cut the pipe square and without burrs
- Pipe cutters must be in good working condition

7.1.2 Socket fusion machine

Fig. 7-1 RAUTOOL RF 63

Fig. 7-2 RAUTOOL RF 125

Fig. 7-3 RAUTOOL RF 160

7.2 RAUTOOL check and maintenance

- Always ensure that the RAUTOOL are clean and free from impurities before using. Ensure that the protective telfon coating on the heating bushes is in good condition and not scratched or removed. If the heating bushes are not completely coated with telfon coating replace with new heating bushes.
- When securing the heating bushes onto RAUTOOL, ensure that the bushes are properly tighten onto the welding plate for a full surface contact between the welding plate and the bushes
- Ensure that RAUTOOL is connected to electrical supply as stated on the data plate of RAUTOOL. Connection to the incorrect power supply may damage RAUTOOLS and may even cause harm to users.
- Do not use pliers or unsuitable tools to tighten or loosen the heating bush as this may cause damage to the heating bush's protective coating.
- Do not use water to cool RAUTOOLS as this may damage the heating resistances of the plate and may cause electric shock
- Do not attempt to open or repair RAUTOOLS without proper training and certification by REHAU
- Check the operating temperature (260°C +/- 5°C) of RAUTOOLS periodically using suitable measuring instruments. Too high or too low temperature will cause improper jointing

Fig. 7-3 Check if the operating temperature sufficient.

8 INSTALLATION TECHNIQUES

RAUFUSION pipes are printed with the heating time on every 10cm interval along the pipe.

8.1 Socket fusion installation (20mm to 160mm)

1) Fix the heating bushes

Attach the correct size heating bushes on the heating tool. Maximum two set of bushes can be attached at the same time. Use RAUTOOL RF 63 for sizes 20mm to 63mm connections and RAUTOOL RF 125 for sizes 75mm to 110 mm connections. Alternatively, the RAUTOOL RF 160 station kit can be used for sizes 50mm to 160mm connections.

Fig. 8-1 Fix the heating bushes

2) Check the tools

Turn on the socket machine. Use suitable measurement tool to check the temperature of the machine. The pipes and fittings are ready for welding when the temperature of the machines reaches the range of 255°C and 265°C. The machine must be properly calibrated to ensure that the machine is heated to the correct temperature.

Fig. 8-2 Check the tools

3) Clean the heating tools, pipes and fittings

Clean the heating bush with a clean cloth and suitable cleaner e.g. industrial alcohol or acetone. Do this before every welding. Make sure that the pipe and the fitting are properly cleaned and free from dirt and dust. Impurity can affect the welding quality and lead to weakened joints.

Fig. 8-3 Clean the heating bushes

4) Cut the pipe

When cutting the pipe, observe the following:

- Use the correct pipe cutters for the corresponding pipe size only
- Cut the pipe at right angles to the pipe axis and without burrs
- Pipe cutters must be in good working conditions

Fig. 8-4 Cut the pipes

5) Mark the pipe

Mark the insertion depth for the corresponding pipe sizes as shown in the Table 8-1.

Fig. 8-5 Mark the pipes

6) Heat the pipe and the fitting

Push the pipe and fitting slowly and without twisting into the heating bushes. Ensure that the pipe and fitting are properly aligned when pushing into the heating bushes. The pipe should be only pushed in up to the marked insertion depth. This step is important to ensure that the end of the pipe is not melted thus reducing the bore and restricting flow.

Fig. 8-6 Heat the pipe and fittings

The pipes and fitting should only be heated to the period as specified in Table 8-1. Correct heating time should be observed to ensure that the pipe or fitting is not over melted thus restricting water flow or melted insufficiently and thus not allowing for a homogeneous joint. Pull out the pipes and fittings without twisting when the heating time has elapsed.

7) Join pipe and fitting

Push the pipe into the fitting so that the welding beads of pipe and fitting touch each other. Correct the alignment of the pipe and fitting by a maximum of 15°. Observe the proper jointing time as shown in Table 8-1 to ensure a proper joint. The alignment of the joint can only be done during this stage. Do no twist or align the joint after this period.

Fig. 8-7 Align the pipe and fitting

Fig. 8-8 Join the pipe and fitting

The pipe should be left to cool for the corresponding period in table 8-1 before apply any stress on the joint.

Pipe Diameter	Insertion depth (mm)	Heating time (sec)	Joining time (sec)	Cooling time (sec)
20	14	5	4	120
25	16	6	4	180
32	18	8	6	240
40	20	12	6	240
50	23	18	6	300
63	26	25	8	360
75	28	30	8	480
90	31	40	10	480
110	33	50	10	480
125	36	58	10	600
160	43	80	15	900

Tab. 8-1 PP-R pipe fusion / welding table

9 PLANNING AND DESIGN

§ RAUFUSION system for water services must be planned, calculated, installed and operated according to national water services installation standards/regulations and other relevant standards. The complete RAUFUSION system is designed for installation in new buildings, and for carrying out renovations and repairs. It is suitable for drinking water systems in buildings for residential, industrial and commercial use such as hospitals, schools, kindergartens, sports halls, churches, aged care facilities, supermarkets and services stations, as well as industrial premises, etc.

For continuous operation, the following parameters must not be exceeded:
- Continuous operating temperature Maximum 70°C,
- Continuous operating pressure according to this technical information,
- Minimum designed service life - 50 years

For operating parameters higher than specified as above, please consult your REHAU Sales Office.

The following maximum allowable working pressure for PP-R pipes applies: (according to DIN 8077 with a safety factor of 1.5)

9.1 Operating parameters for pipes according to DIN 8077

Temperature in °C	Years of Service	Pipe Series (S)		
		5	3.2	2.5
		Standard Dimension Ratio (SDR)		
		11	7.4	6
		Allowable working pressure in bar		
10	1	17.6	27.8	35.0
	5	16.6	26.4	33.2
	10	16.1	25.5	32.1
	25	15.6	24.7	31.1
	50	15.2	24.0	30.3
	100	14.8	23.4	29.5
20	1	15.0	23.8	30.0
	5	14.1	22.3	28.1
	10	13.7	21.7	27.3
	25	13.3	21.1	26.5
	50	12.9	20.4	25.7
	100	12.5	19.8	24.9
30	1	12.8	20.2	25.5
	5	12.0	19.0	23.9
	10	11.6	18.3	23.1
	25	11.2	17.7	22.3
	50	10.9	17.3	21.8
	100	10.6	16.9	21.2

Temperature in °C	Years of Service	Pipe Series (S)		
		5	3.2	2.5
		Standard Dimension Ratio (SDR)		
		11	7.4	6
		Allowable working pressure in bar		
50	1	9.2	14.5	18.3
	5	8.5	13.5	17.0
	10	8.2	13.1	16.5
	25	8.0	12.6	15.9
	50	7.7	12.2	15.4
	100	7.4	11.8	14.9
60	1	7.7	12.2	15.4
	5	7.2	11.4	14.3
	10	6.9	11.0	13.8
	25	6.7	10.5	13.3
	50	6.4	10.1	12.7
70	1	6.5	10.3	13.0
	5	6.0	9.5	11.9
	10	5.9	9.3	11.7
	25	5.1	8.0	10.1
	50	4.3	6.7	8.5
80	1	5.5	8.6	10.9
	5	4.8	7.6	9.6
	10	4.0	6.3	8.0
	25	3.2	5.1	6.4
95	1	3.9	6.1	7.7
	5	2.5	4.0	5.0
	(10) 1)	(2.1)1)	(3.4)1)	(4.2)1)

Tab 9-1 Operating parameters for RAUFUSION pipes according to DIN 8077

1) The bracketed values apply where testing can be shown to have been carried out for longer than one year at 110°C

9.2 Potable water criteria

The drinking water must comply with the currently valid limits of the following standards:
- DIN 2000
- German drinking water ordinance
- Council directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

In locations with highly corrosive water composition, e.g. in volcanic areas, installations using bore/well water etc., the suitability of RAUFUSION pipe system must be checked with REHAU. In some cases, the available water quality may void the REHAU warranty unless appropriate water treatment is provided.

Nonetheless, there is no fundamentally ideal material for every application. Thus, different influential factors can lead to corrosion in drinking water installation, regardless of the materials used. In some specific cases, corrosion can happen even with water qualities within the permitted range of the drinking water ordinance. The chlorine concentration and the hydrogen carbonate concentration of the water have considerable influence on how aggressive the corrosion is. High chloride concentration combined with low hydrogen carbonate concentration can negatively influence the corrosion behaviour. However, the interaction under the following factors, according to DIN EN 12502-1:2005 (D), also influence the corrosion resistance:

- Material properties (chemical composition, surface integrity)
- Water quality (physical and chemical properties, solid matter)
- Planning and execution (geometry, mix installation, connections)
- Leak testing and initial start-up (purging, drainage, disinfection)
- Operating conditions (temperature, temperature changes, flow conditions)

The application of water after-treatment (e.g. water softening), in principle, changes the corrosive-chemical behaviour of the water. To avoid corrosion damage as a result of incorrect use and operation of a water treatment system, we explicitly recommend that you have your individual situation examined beforehand by an expert or the system manufacturer. The most practical way of evaluating the likelihood of corrosion due to water quality is to test the water which is to be distributed to the area.

According to The Guidelines for Drinking Water Quality 2011, by World Health Organization, the free chlorine content in water intended for human consumption shall not exceed the range of 0.2 to 1 ppm. Higher chlorination may affect the properties and life time of the PP-R system negatively. In case of chlorination exceeding the afore mentioned levels, REHAU will not be liable for any damages to the system.

It is the responsibility of the system designer that the above-mentioned factors and parameters are taken into account when it comes to corrosion protection and sediment formation in actual application. Our Technical Application Department for RAUFUSION application area provides support when needed. If the drinking water quality is outside the limits of the drinking water guidelines, evaluation and approval is definitely required from our Technical Application Department if the RAUFUSION system is intended to be used.

In this case, please contact your local REHAU Sales Office.

1) The limit values for maximum disinfection agent concentrations detailed in the drinking water ordinance are not to be interpreted as permanent, lasting application concentrations. They represent the temporary maximum values defined under hygienic and toxicological aspects. Top priority of the drinking water ordinance is the principle of minimization, that is, nothing should be mixed into the water. Only if a chemical additive is required due to contamination may the minimum amount required be mixed in.

9.3 Copper ion leach out

Under certain operating conditions and certain water qualities it is possible that copper ions leach out from copper pipes, fittings or other components which may be present up-stream in the system or within a circulation loop. These copper ions may affect the PP-R material negatively. Thus copper components shall be avoided in the system completely.

9.4 Pipe sizing

For best water flow to the usage of the more common sanitary appliances, REHAU provides a list of recommended pipe sizes. Hydraulic calculations are required to determine the correct pipe size.

Appliance	Flow rate (litre /min)	Pressure (bar)	Recommended Pipe Size (OD/DN)
Basin	6	1.0	20
Kitchen tap	8	1.0	20
WC	8	1.0	20
Shower (sprinkler)	9	1.0	25
Washing machine	15	1.0	20
Urinals	18	1.0	20
Bathtub	12	1.0	25

Tab. 9-2 Recommended RAUFUSION pipe sizes connected to appliances

Room type	Appliances	Flow Rate (litre /min)	Recommended Pipe Size (based on max flow rate) (OD/(DN)
Kitchen	Kitchen tap Dishwasher	14	25
Laundry room	Washing machine Tap	14	25
Powder room	Basin WC	14	25
Common bathroom	Basin Shower WC	23	32
Master bathroom	Basin Shower Bath tub WC	23	32

Tab. 9-3 Recommended RAUFUSION pipe sizes branching into rooms

Copper pipe (DN in mm or inches)	Recommended PP-R pipe (DN in mm)
15 or ½"	20
20 or ¾"	25
25 or 1"	32
32 or 1¼"	40
40 or 1½"	50
50 or 2"	63
65 or 2½"	75
80 or 3"	90
100 or 5"	110 or 125
125 or 5"	160

Tab. 9-4 Recommended PP-R pipe size with relation to copper pipe size

10 INSULATION

10.1 Thermal insulation

Thermal insulation may be required to reduce heat loss through the pipe. In hot water installations, while PP-R pipes are polymeric in nature and its thermal conductivity is more than 100 times lower compared to metallic pipes, it cannot be assumed that no insulation is required. The required insulation thickness of pipes depends on length of the pipe, flow rate and specific heat capacity of the fluid.

Insulation Thickness	None	9.5mm	12.7mm	19.0mm	25.4mm	31.8mm
Nominal Pipe Diameter	Linear Density of Heat Loss W/m					
20	29.0	10.7	9.4	7.8	6.9	6.2
25	33.7	12.4	10.8	8.9	7.8	7.0
32	39.2	14.6	12.6	10.3	8.9	8.0
40	44.9	17.0	14.6	11.8	10.2	9.0
50	50.7	19.8	17.1	13.7	11.7	10.3
63	57.9	23.3	20.0	16.0	13.6	12.0
75	62.7	26.3	22.6	18.1	15.3	13.4
90	68.3	29.8	25.7	20.5	17.3	15.1
110	74.2	34.2	29.5	23.6	19.9	17.3
125	88.9	37.7	32.2	25.3	21.1	18.3
160	98.5	44.8	38.4	30.4	25.3	21.9

Tab. 10-1 may be used to aid heat loss calculation for RAUFUSION PN 20 pipes.

The heat losses are calculated based on:

- ISO 12241 (Thermal insulation for building equipment and industrial installations – calculation rules)
- Horizontal pipe installation indoors in still air
- Laminar air flow over pipe/insulation
- Internal heat transfer coefficient larger than 1000 W/m2K
- Water temperature of 65°C
- Ambient temperature of 25°C
- Emissivity of:
  - 0.77 for copper (strongly oxidized)
  - 0.93 for polymer piping
  - 0.90 for insulation
- Thermal conductivity of:
  - 380 W/mK for copper pipes
  - 0.24 W/mk for PP-R pipes
  - 0.04 W/mK for insulation

11 PIPE SUPPORT AND FIXING

11.1 Pipe brackets and clips

Use only pipe brackets and clips with the following properties:
- Suitable for plastic pipes
- Improved acoustic properties through rubber lining
- Correct size (to allow easy gliding of pipe without pulling the rubber lining out)
- Free of burrs

11.2 Anchor points

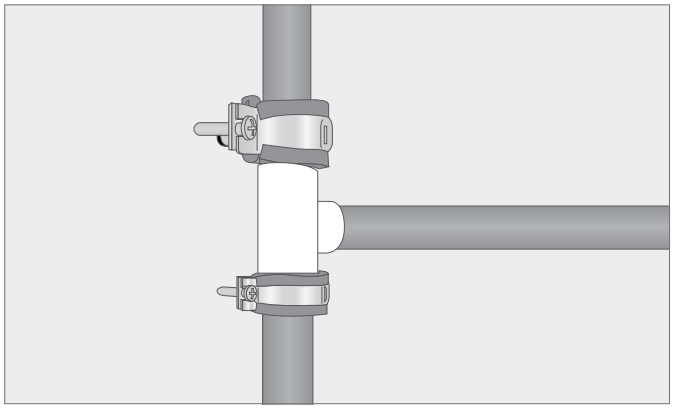


Fig. 11-1 Anchor point made by pipe clamps

- Observe the instruction and guideline from the pipe bracket/clip manufacturer
- Adapt the guideline values for design and installation of pipe brackets and clip (as per Table 11-1) to the building requirements and bracket/clip manufacturer's recommendations
- Anchor points can be used to restrict the thermal linear expansion into one direction
- Long pipe run can be divided into several sections by adding several anchor points
- Anchor points can be fixed at tees, elbows or connectors. Anchor points can be fixed by installing a pipe bracket directly before each fitting

11.3 Spacing of brackets and clips

Choose the correct pipe spacing intervals according to the guideline values (see Table 11-1).

11.4 Exposed installation

When installing pipe at exposed areas or installing long pipe run.
- Install anchor points at 6m intervals
- Ensure that there is sufficient space for piping to expand

Nominal Pipe Diameter DN	Spans in mm at Pipe Wall Temperature of						
	20°C	30°C	40°C	50°C	60°C	70°C	80°C
20	700	675	650	625	600	575	550
25	800	775	750	725	700	675	650
32	950	925	900	875	850	800	750
40	1100	1075	1050	1000	950	925	875
50	1250	1225	1200	1150	1100	1050	1000
63	1450	1425	1400	1350	1300	1250	1200
75	1550	1500	1450	1400	1350	1300	1250
90	1650	1600	1550	1500	1450	1400	1350
110	1850	1800	1750	1700	1600	1500	1400
125	2000	1950	1900	1800	1700	1600	1500
160	2250	2200	2100	2000	1900	1800	1700

Tab. 11-1 Recommended spacing of pipe bracket/clip for RAUFUSION pipes PN 10, PN 16 and PN 20

12 THERMAL EXPANSION AND CONTRACTION

12.1 Guidelines

Due to physical laws, all piping materials expand when heated and contract when cooled. This effect, which occurs regardless of the piping material, must be taken into account in the installation of water services, heating installation. This also applies to RAUFUSION piping systems.

The thermal expansion and contraction occur mainly due to the different installation, ambient and operating temperatures. During installation, appropriate pipe routing with provisions for movement (e.g. at changes of direction) and corresponding space for piping expansion must always be taken into account. Additional deflection legs e.g. U-expansion bends or lyre loops are usually only necessary for larger changes in length.

12.2 Calculation of linear thermal expansion

The thermal change in length is calculated with the following equation:

ΔL = Length change in mm

α = Coefficient of linear thermal expansion in

L = Length of piping in m

ΔT = Temperature difference in K

The coefficient of linear thermal expansion must be selected according to the installed pipe type.

Determining the pipe length

The pipe length L is the actual installed pipe length on site between anchor points, expansion bends or loops. Sometimes it may be necessary to divide the pipe run into several sections by adding anchor points or expansion bends and loops to keep the thermal expansion low.

Determining the temperature difference

In determining the temperature difference, the installation temperature as well as the minimum and maximum temperatures of the pipe wall during operation (e.g. thermal disinfection) and when the system is out of service must be taken into account in the calculation.

Pipe Type	Coefficient of Linear Thermal	Material Constant C
	$\Delta L = \alpha \cdot L \cdot \Delta T$	$L_{BS} = C \cdot \ d_a \cdot \Delta L$
RAUFUSION	0.15	20

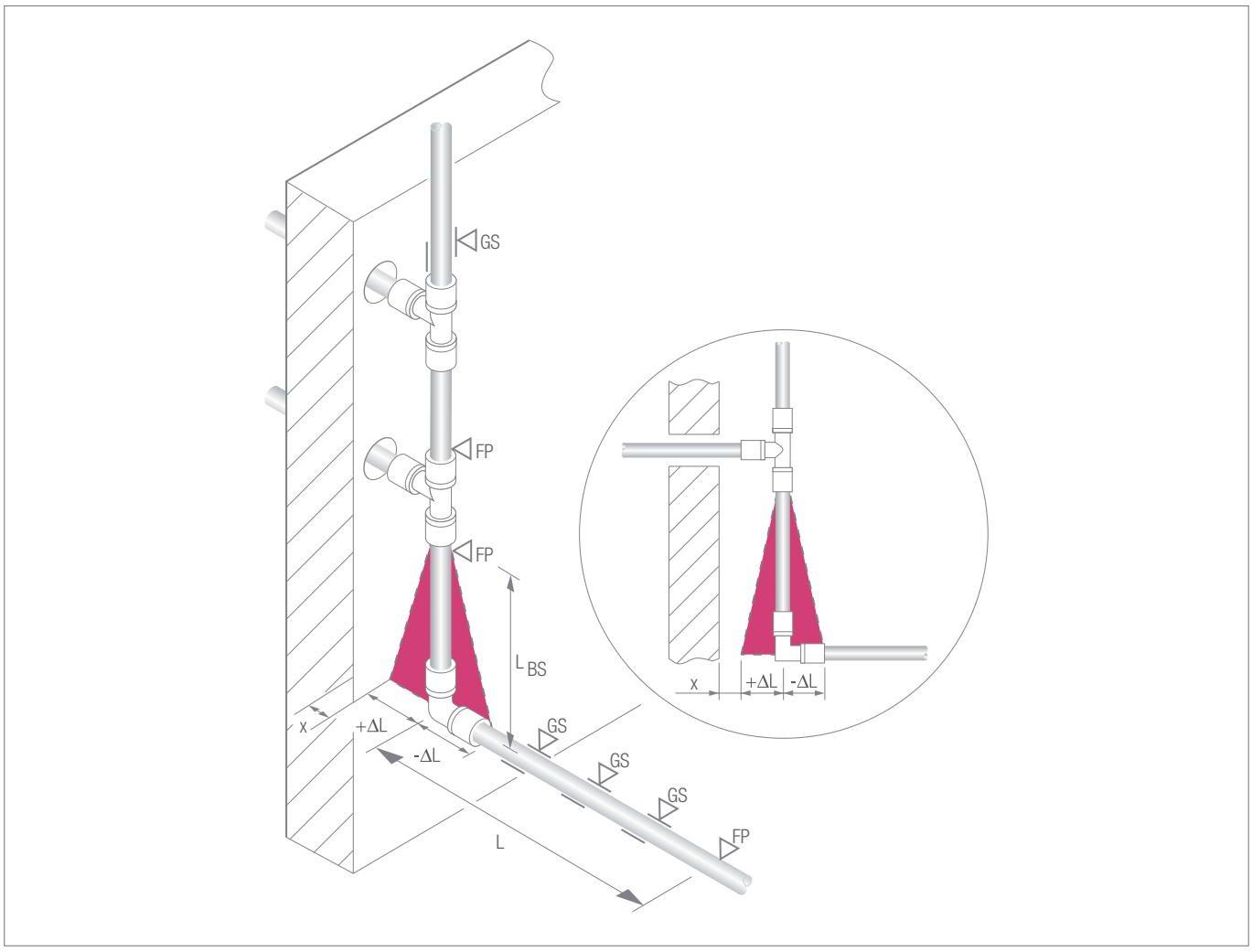
Tab. 12-1 Coefficient of linear thermal expansion (approximate values) and material constants for deflection leg calculation (approximate values)

13 DEFLECTION LEGS

Thermal length changes can be accommodated by deflection legs. RAUFUSION pipes are particularly suitable for this due to their flexibility.

A deflection leg is the freely moveable pipe length, which can take up the required thermal length changes. The length of the deflection leg is influenced mainly by the material (material constant C).

Deflection legs result mostly from changes in direction of the piping. For long piping lengths, additional deflection legs must be installed in the piping to compensate the thermal length changes.



GS - sliding support / bracket
FP - fixed anchor point

13.1 Calculation of deflection leg length

The minimum length of deflection length (L_{BS}) is calculated by the following formula:

$L_{BS} = C \cdot \sqrt{(d_a \cdot \Delta L)}$

where

L_{BS} = Length of deflection leg
d_a = Outside pipe diameter in mm
ΔL = Length change in mm
C = Material constant of piping material

For approximate values for material constant C, see Table 12-1. Do not fit pipe brackets close to the deflection legs so it will not be prevented from bending.

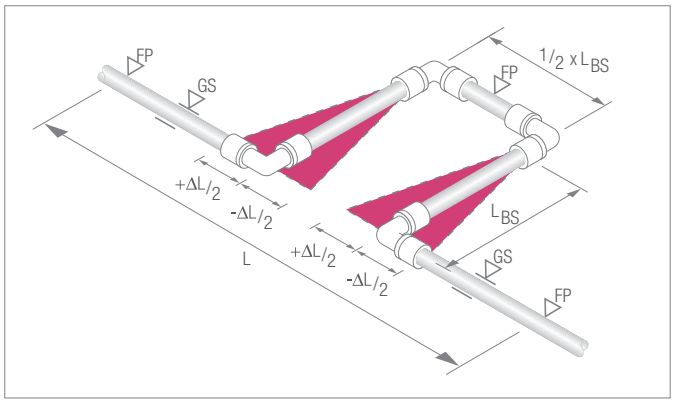


Fig. 13-2 U expansion bends

L_{BS} = Length of deflection leg
ΔL = Thermal length change
L = Pipe length
FP = Anchor point
GS = Sliding point

13.2 Calculation examples

The pipe length L, for which the thermal length change is to be accommodated at a deflection leg, is 7 m.
The temperature difference between the minimum and maximum values (installation temperature and subsequent operating temperature) is 50 K.
The installed pipe outer diameter is 20 mm.
What length of deflection leg is required for RAUFUSION pipe?

Calculation of deflection leg length with RAUFUSION pipes

$\Delta L = \alpha \cdot L \cdot \Delta T$
$\Delta L = 0.15 \frac{mm}{mm} \; 7m \cdot 50k$
$\Delta L = 52.5mm$

$L_{BS} = C \cdot \sqrt{d_a \cdot \Delta L}$
$L_{BS} = 20 \cdot \sqrt{20mm \cdot 52.5mm}$
$L_{BS} = 648$ mm

Assessment of the results

The required deflection leg length for RAUFUSION is shorter compared to metal pipe system due to the flexible pipe material. For metallic pipe materials, a substantially larger deflection leg is required for the same operating parameters during installation due to the significantly higher material constant (C).

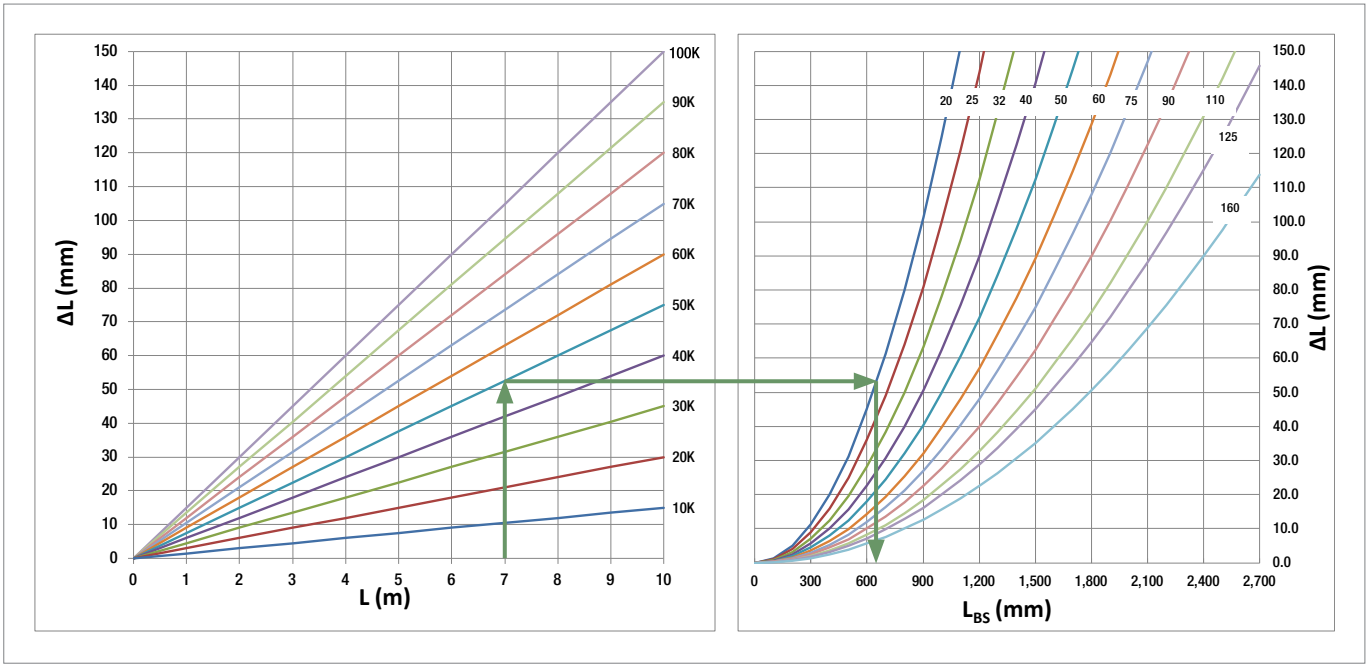


Fig.13-3 Linear expansion and deflection leg length of RAUFUSION PP-R pipes size 20 - 125 mm

14 FIRE SAFETY

Every service penetration reacts differently in the event of fire. Because of this test results are only applicable to the tested wall or floor construction, installed pipes and the applied fire stops. A fire safety engineer responsible for a particular building can at his discretion accept test results from a different test setup, if he deems the construction in question to be achieving a better fire rating than the one that was tested.

RAUFUSION is made of PP-R which compiles to the requirements of the fire classification B2 DIN 4102 (normal flammable). REHAU recommends to put fire protection measures in place in accordance to local codes and practices. REHAU cannot accept responsibility or liability for the correct manufacture or installation of fire protection systems.

15 INSTALLATION ADVICES

15.1 Exposure to excessive heat

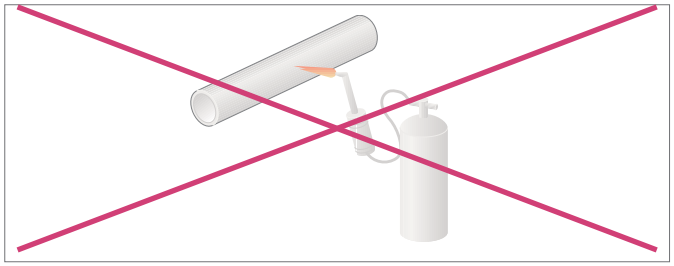


Fig. 15-1 Protect piping against exposure to excessive heat

During construction, maintenance or repair work in close proximity care must be taken not to expose RAUFUSION pipe systems to a naked flame (soldering), flood lights or other localized heat sources, as this can result in permanent damage or a significant reduction in performance life.

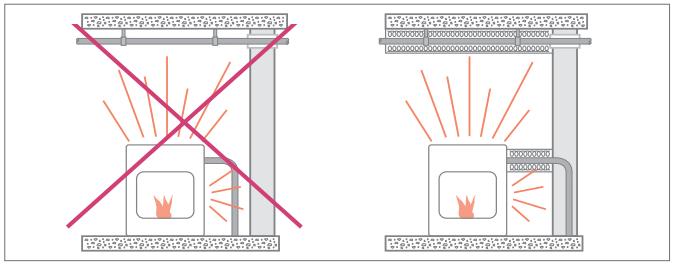


Fig. 15-2 Protection against temperature-induced stress

Piping close to devices with high temperature emissions must be insulated sufficiently and permanently protected against inadmissible heating. Adhere to the maximum allowable operating parameters (e.g. operating temperature, pressure and duration).

15.2 External installation

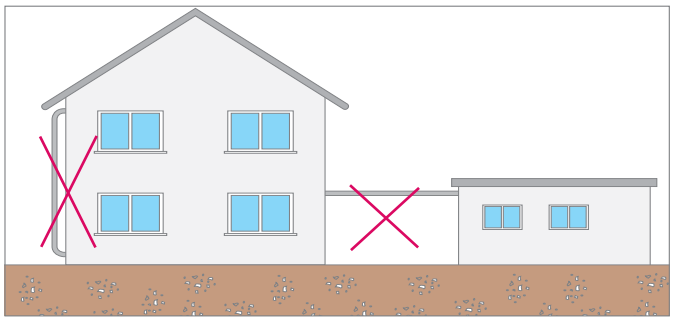


Fig. 15-3 All external installations, in-ground and above ground, to be adequately protected

All external installations, in-ground and above ground, shall follow the applicable national plumbing installation standards and must be protected as required by these codes.

RAUFUSION system is an indoor system, which must not be installed externally, except for the below installations:

- In-ground installations after water meter of the building premises
- Short pipe length after connection from water meter before going below the ground
- Connection to an externally located water heater
- Connection to garden taps within the premises

For each of the excepted external installation, adequate protection is required.

15.2.1 External installation below ground

RAUFUSION pipe can be installed in the ground without protection. Adequate protection is to be provided if the pipe is in risk of:

- Mechanical damage
- Chemical damage
- Contamination

In-ground installations of RAUFUSION, system with jointings must be protected against:
- Mechanical damage
- Corrosion
- Chemical damage
- Contamination

For below ground installation of RAUFUSION system, proper bedding and backfill materials have to be observed. To lay RAUFUSION system below ground, please ensure the following:

- The pipe bedding, compacted pipe overlay and compacted pipe side support materials are compacted sand or fine-grain soil with no hard object and sharp edges.
- The pipe bedding, compacted pipe overlay and compacted pipe side support materials are at least 75mm deep and are without any hard object and sharp edges.
- The backfill material is free from builder's waste, concrete pieces, rocks, or hard matters larger than 25mm and broken up so that it contains no soil lumps larger than 75mm.
- The depth of cover is suitable according to the ground loading. Proper corrosion protection of the fittings can be achieved by using a recognized corrosion protection system, such as the butyl-tape based DEKOTEC N15/PE5 system or equivalent.

Chemical damage

If chemical damage is likely to occur, the RAUFUSION must be adequately protected using a suitable conduit, e.g. PVC pipes or equivalent.
When using a Corrosion Protection System, always ensure the following:

- The corrosion protection system is chemically compatible with all system components
- It's fully suitable for the given ground conditions, e.g. damp soil
- The system includes an approved cavity filler/mastique which can be applied to profile the joint, allowing smooth application of the protection tape without any cavities between the tape and fitting
- Mechanical protection is provided to avoid any damage to the corrosion protection tape e.g. by backfill material
- In addition to complete coverage of the joint itself, the corrosion protection system has to cover at least 150mm of the pipe on each side of the joint

15.3 Installation in areas exposed to UV-radiation

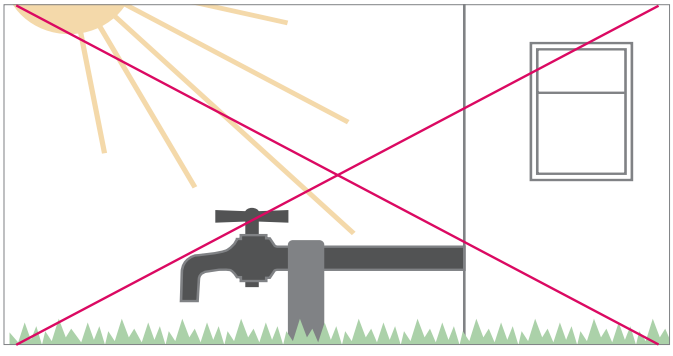


Fig. 15-4 Unprotected installation in areas exposed to UV-radiation is not permitted, example: outdoors

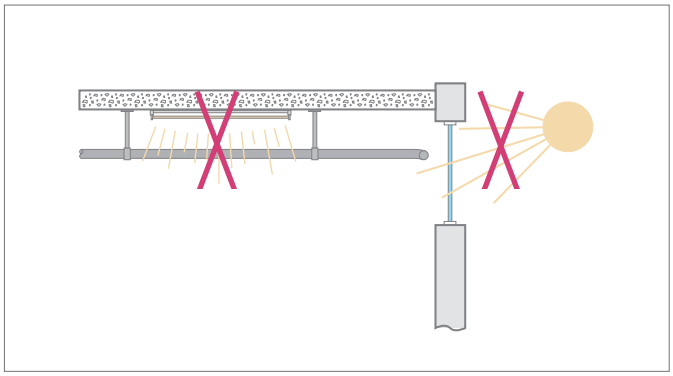


Fig. 15-5 Unprotected installation in areas exposed to UV-radiation is not permitted, example: indoors

- Store and transport pipes with protection against UV-radiation
- Protect piping from UV-rays in areas where UV radiation can occur (e.g. sunlight,) using UV protection methods such as UV resistance paint, pipe insulation, pipe sleeves or etc.

15.4 Installation in combination with bitumen and sheets and coatings

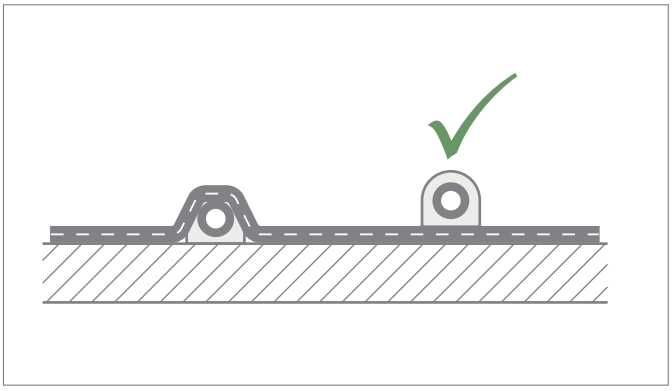


Fig. 15-6 Only install pipes on top of bitumen sheet

Do not lay pipes under bitumen sheeting. Installation under bitumen sheeting can lead to damage to the piping or to the bitumen sheeting.

- Allow the bitumen sheets or bituminous coatings that contain solvents to dry completely before laying the pipes
- Adhere to the setting time specified by the manufacturer
- Before laying the pipes, ensure that the pipes nor the drinking water are not adversely affected
- Protect the pipe adequately from heating while laying the pipes near flaming bitumen sheets

15.5 Installation in areas with asphalt screed

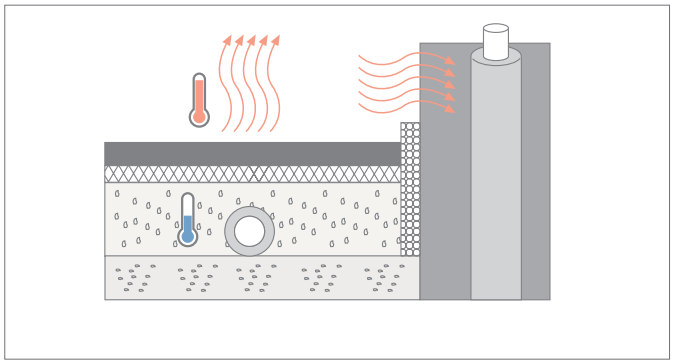


Fig. 15-7 Installation under hot asphalt screed

Hot asphalt screeds are laid at a temperature of approximately 250°C. To protect the piping from overheating, proper steps need to be taken. Since these depend on the structural condition and cannot be influenced by REHAU, these must be coordinated with and approved by the planner.

The following measures must at least be taken to protect the piping (e.g. pipes, fittings, joints) from exposure to high temperatures. At any point, none of the piping insulation shall exceed 100°C:

- Lay pipes directly onto subfloor
- Embed pipes completely in insulation granules

Use insulation granules made from volcanic pearlite (this material can also be used for levelling purposes and has good acoustic and thermal insulation properties). There is no limit on the maximum thickness for the layer of insulation granules:

- Cover the pipes with at least 10mm of compacted material
- For layers of 40mm thickness and more, mechanically compact the material manually before placing the thermal insulation cover on top

Always agree with the contractor laying the hot asphalt screed on the suitable insulation and protective measures to prevent any damage to the pipes due to excessive heat.

15.6 Potential equalization

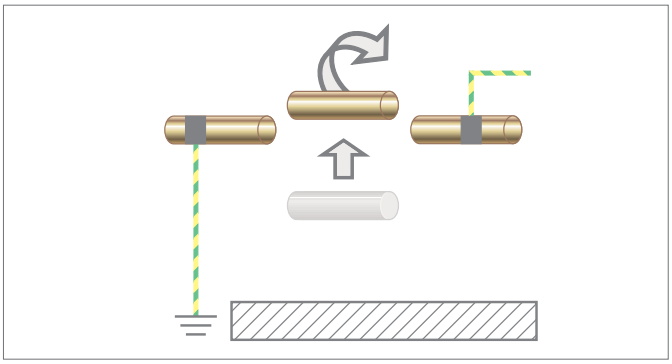


Fig. 15-8 Potential equalization while replacing pipes

RAUFUSION piping must not be used as an earthing conductor for electrical units. After replacement of existing metallic pipe with RAUFUSION system, the function of potential equalization and the effectiveness of the electrical safety devices must be verified by an electrician.

16 CONNECTION TO WATER HEATERS

16.1 Electrical instantaneous water heaters

Electrical instantaneous water heaters can be combined with RAUFUSION system according to the manufacturer's specifications. Please observe the operating parameter limits set by respective water heater's manufacturer (maximum pressure and maximum temperature during operation as well as in case of malfunction) and the maximum operating parameters of the RAUFUSION system.

16.2 Instantaneous gas water heaters

Not all gas instantaneous water heaters are suitable for direct connection to plastic pipes. With these units, inadmissibly high pressures and temperatures can arise if malfunction occurs.

Always observe the manufacturer's specification of the equipment.

Approval for connection of instantaneous gas water heaters to RAUFUSION system can only be issued by the equipment manufacturer.

16.3 Hot water tanks

RAUFUSION system for drinking water can be used for hot water tanks with a maximum water temperature of 70°C in continuous operation.

Electrical instantaneous water heaters, instantaneous gas water heaters and other water heaters must be approved by the respective manufacturer. The installed pipe type and its field of application must be observed.

16.4 Solar water heaters

RAUFUSION system can be used together with solar water heater systems that have a maximum water temperature of 70°C in continuous operation.

Suitable measures must be taken (e.g. mixer for regulating hot water temperature) to ensure that the hot water temperature does not exceed 70°C.

For this reason, RAUFUSION system is only suitable for distribution of regulated hot water temperature (maximum 70°C) from the mixer outlet.

16.5 Uncontrolled heat sources

RAUFUSION pipes must not be used together with uncontrolled heat sources. Installation of a tempering valve is required.

Should there be any doubt on the suitability of the water heaters to RAUFUSION system, please contact your nearest REHAU Sales Office for further advice.

17 PRESSURE TESTING AND PURGING OF DRINKING WATER PIPES

Pressure testing of water services installation system has to be done according to applicable national water services installation standards.

17.1 Guidelines for pressure test

The successful execution and documentation of a pressure test is a prerequisite for any warranty claims from the REHAU guarantee and the liability agreement with the German Central Association for Plumbing, Heating and Air Conditioning (ZVSHK).

According to DIN EN 806-4, a pressure test must be conducted on the completed but not yet concealed piping before commissioning.

Statements on the system's leak-tightness derived from the pressure test (constant, decreasing, increasing) can only be asserted in a limited capacity.

- The leak-tightness of the system can only be checked by performing a visual examination of unconcealed lines.
- Micro leaks can only be located by performing a visual examination (water outlet or leak detection agent) at high pressure.

Subdividing the piping system into smaller test sections increases the examination accuracy.

17.2 Leak test of drinking water installations with water

17.2.1 Preparing for pressure test with water

1. Piping needs to be accessible and shall not be concealed.
2. Dismount safety devices and meters as necessary and replace with pipes or pipe stoppers.
3. Fill the piping at the lowest point of the system with filtered drinking water until free of air.
4. Vent the extraction points until water escapes without air.
5. Use a pressure testing device with a measurement precision of 100 hPa (0.1 bar) for the pressure test.
6. Connect the pressure testing device to the lowest point on the drinking water installation.
7. Close all extraction points carefully.
8. Ensure that the temperature remains as constant as possible during the pressure test.
9. Prepare the pressure test record and note the system data.

The pressure test can be heavily influenced by temperature fluctuations in the piping system, e.g. a temperature change of 10 K can cause a pressure change of 0.5 to 1 bar.
Due to the pipe material properties (e.g. pipe elongation when there is increased pressurisation), the pressure can fluctuate during the pressure test.

17.2.2 Pressure test for installations with RAUFUSION only and installations with RAUFUSION pipes mixed with metal pipes (Applicable to piping system consisting of pipe sizes d63mm or less)

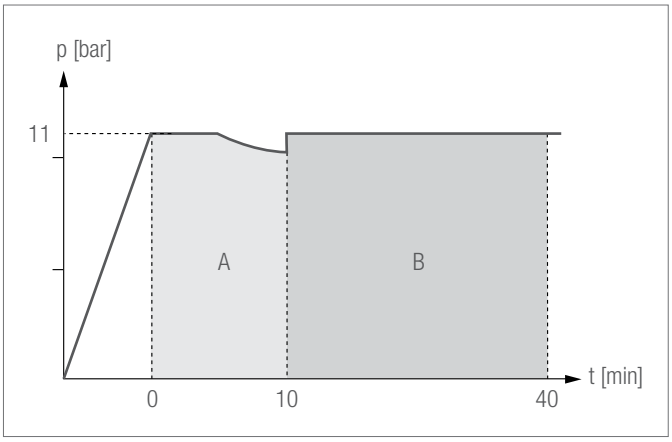


Fig. 17-1 Pressure test diagram for RAUFUSION pipe system of d63mm or less.

A Adaptation time (if necessary restore the pressure)
B Pressure test for installations with RAUFUSION pipes only and installations with RAUFUSION pipes mixed with metal pipes
P Pressure of the lowest pressure rating pipe used
S5 – 4.4 bar
S3.2 – 6.6 bar
S2.5 – 8.8 bar

1. Pressurize the drinking water installation slowly as indicated in Figure 17-1 respective to the lowest pressure rating of the pipes used.
2. If the difference between ambient temperature and water temperature is higher than 10 k than the pressure test can only begin after a waiting time of 30 minutes to achieve the temperature balance between the room and the water installation.
3. After 10 minutes, control the test pressure and if necessary restore the pressure.
4. Note down the test pressure in the pressure test record.
5. After a test period of 30 more minutes, note down the test pressure in the pressure test record.
6. Perform visual checks for leaks on the entire drinking water installation, especially on the connection area.

If there is a drop in test pressure:

- Repeat a thorough visual inspection of the installation, extraction points and joints.
- After resolving the cause of the drop in pressure, repeat the pressure test (steps 1 - 6).

7. If no leaks are found during the visual check, then the pressure test can be ended.

17.2.3 Pressure test for installations with RAUFUSION and installations with RAUFUSION pipes mixed with metal pipes. (Applicable to piping system consisting of pipe sizes larger than d63mm).

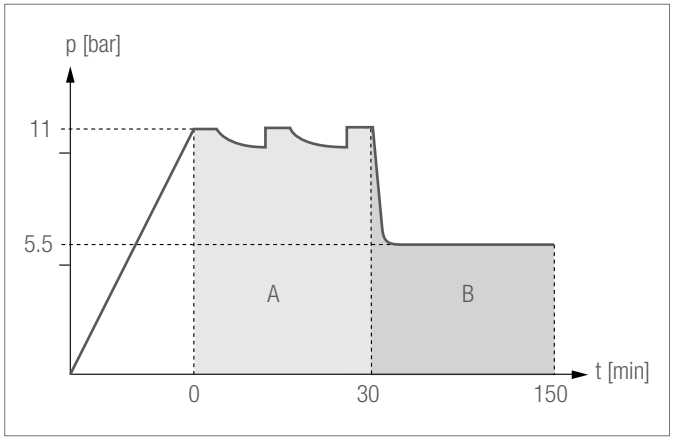


Fig. 17-2 Pressure test diagram for RAUFUSION pipe system of more than d63mm

A Adaptation time (if necessary restore the pressure)
B Pressure test for installations with RAUFUSION pipes only and installations with RAUFUSION pipes mixed with metal pipes
P Pressure of the lowest pressure rating pipe used
S5 – 4.4 bar
S3.2 – 6.6 bar
S2.5 – 8.8 bar

1. Pressurize the drinking water installation slowly as indicated in Figure 17-2 respective to the lowest pressure rating of the pipes used.
2. The test pressure has to be maintained at the pressure during 30 minutes. If necessary restore the test pressure regularly.
3. After 30 minutes, note down the test pressure in the pressure test record.
4. Check the entire drinking water installation, particularly the joints, for leaks by visual inspection.
5. Decrease slowly the test pressure from the starting pressure to 0.5 times the starting pressure and note it down in the pressure test record.
6. After a waiting time of 2 hours, note down the test pressure in the pressure test record.
7. Check the entire drinking water installation, particularly the joints, for leaks by visual inspection.

If there is a drop in test pressure:
- Repeat a thorough visual inspection of the piping, extraction points and joints.
- After resolving the cause of the drop in pressure, repeat the pressure test (steps 1 - 7).

8. If no leaks are found during the visual check, then the pressure test can be ended.

17.2.4 Completion of the pressure test with water

After completion of the pressure test:
1. Confirm the pressure test in the pressure test record by the executing company and the client.
2. Dismount the pressure test unit.
3. After the pressure test, thoroughly rinse out the drinking water pipes for hygiene purposes (see section 17.3).
4. Reinstall all removed safety devices and meters.

17.3 Purging drinking water pipes

According to DIN EN 806-4, dirt from the storage and construction phase has to be flushed out. For that all extraction points have to be opened in a defined order and for several minutes.

According to DIN EN 806-4, the time-consuming purging of the piping with a mixture of air and water is an alternative to a purge with drinking water.

For hygiene reasons or if frost can occur we recommend to fully drain drinking water installation, if this one cannot be immediately put into operation. Purge the drained system thoroughly before commissioning.

According to DIN EN 806-4, the purge of the installation has to be periodically repeated for hygiene reasons if water has to stay in the piping a long time before commissioning.

18 STANDARDS, REGULATIONS AND GUIDELINES

§ Observe the applicable national and international laying, installation, accident prevention and safety regulations when installing piping systems, as well as the instructions in this Technical Information.

Also observe the applicable laws, standards, guidelines and regulations (e.g. DIN, EN, ISO, DVGW, TRGI, VDE and VDI) as well as regulations on environmental protection, provisions of professional associations and regulations of the local public utility companies. Areas of application not contained in this Technical Information (special applications) require consultation with our Applications Department. For extensive advice, consult your REHAU Sales Office.

The planning and installation instructions are directly connected with the respective REHAU product. References are made to excerpts from generally applicable standards and regulations. Observe the respectively valid issues of the guidelines, standards and regulations.

Further standards, regulations and guidelines with regard to the planning, installation and operation of drinking water, heating and building technology systems must also be taken into account but are not a part of this Technical Information.

The following standards, regulations and guidelines are referred to in the Technical Information (the current version is always valid):

DIN 1988
Codes of practice for drinking water installations (TRWI)

DIN 2000
Central drinking water supply - Guidelines regarding requirements for drinking water, planning, construction, operation and maintenance of plants

DIN 4102
Fire behaviour of building materials and components

DVS 2210-1
Industrial Pipelines Made of Thermoplastics Planning and Execution Above-Ground Pipe Systems

DIN 4725
Warm water surface heating systems - Systems and components

DIN 49019
Conduits for electrical installation

DIN 49073
Metal boxes and boxes of insulating material for recessed mounting for accommodation of accessories and socket outlets

DIN 50916-2
Testing of copper alloys; stress corrosion and cracking test using ammonia; testing of components

DIN 50930-6
Corrosion of metals – Corrosion of metallic under corrosion load by water inside of tubes, tanks and apparatus - Part 6: Influence of the composition of drinking water.

DIN EN 12164
Copper and copper alloys - Rod for free machining purposes

DIN EN 12165
Copper and copper alloys - Wrought and unwrought forging stock

DIN EN 12168
Copper and copper alloys - Hollow rod for free machining purposes

DIN EN 12502-1
Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems

DIN EN 13163 to DIN EN 13171
Thermal insulation products for buildings

DIN EN 13501
Fire classification of construction products and building elements

DIN EN 60529
Degrees of protection provided by enclosures

DIN EN 806
Codes of practice for drinking water installations

DIN EN ISO 6509
Corrosion of metals and alloys - Determination of dezincification resistance of brass

DIN EN ISO 7730
Ergonomics of the thermal environment

DIN V 4108-6
Thermal protection and energy-economy in buildings

DIN VDE 0100
(Summary)
Electrical systems in building
Setting up high-voltage current systems
Setting up low-voltage current systems

DIN VDE 0100-701
Low-voltage electrical installations - Requirements for special installations or locations - Part 701: Locations containing a bath or shower

DIN VDE 0298-4
Application of cables and cords in power installations

DIN VDE 0604-3
Trunking mounted on walls and ceilings for electrical installations; skirting board ducts

DVGW GW 393
Extensions (pipe connectors) from copper materials for gas and drinking water installations - Requirements and testing

DVGW W 270
Reproduction of micro-organisms on materials for the drinking water area

DVGW W 291
Cleaning and disinfection of water distribution systems

DVGW W 534
Pipe connectors and connections in the drinking water installation

DVGW W 551
Drinking water heating and drinking water pipe systems

ISO 228
Pipe threads where pressure-tight joints are not made on the threads

ISO 7
Pipe threads where pressure-tight joints are not made on the threads

DIN 2999 Pipe threads where pressure-tight joints are not made on the threads

DIN 10226-1
Pipe threads where pressure tight joints are made on the threads: Taper external threads and parallel internal threads- Dimensions, tolerances and designation

DIN 10226-3
Pipe threads where pressure tight joints are made on the threads: Verification by means of limit gauges

DIN 2429-2 Symbolic representation of pipework components on engineering drawings; functional representation

DIN 8077 Polypropylene (PP) pipes - PP-H 100, PP-B 80, PP-R 80 – Dimensions

DIN 8078 Polypropylene (PP) pipes - PP-H (Type 1), PP-B (Type 2), PP-R (Type 3) - General quality requirements and testing

DIN 8078 suppl. 1 Pipes of polypropylene (PP); chemical resistance of pipes and fittings

DIN 16962-10 Pipe joint assemblies and fittings for types 1 to 3 polypropylene (PP) pressure pipes; injection-moulded fittings for butt welding; dimensions

DIN 16962-12 Pipe joints and components of polypropylene (PP) for pipes under pressure, PP-H100, PP-B 80 and PP-R 80 - Part 12: Flange adapters, flanges, sealing rings for socket welding; dimensions

DIN 16962-13 Pipe joint assemblies and fittings for type 1 and type 2 polypropylene (PP) pressure pipes; pipe couplings; dimensions

DIN 16962-4 Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes; adaptors for fusion jointing, flanges and sealing elements; dimensions

DIN 16962-5 Pipe joints and components of polypropylene (PP) for pipes under pressure, PP-H100, PP-B 80 and PP-R 80 - Part 5: General quality requirements, testing

DIN 16962-6 Pipe joints and elements for polypropylene (PP) pressure pipelines, types 1 and 2; injection moulded elbows for socket-welding, dimensions

DIN 16962-7 Pipe joints and elements for polypropylene (PP) pressure pipelines, types 1 and 2; injection moulded Tee pieces for socket-welding, dimensions

DIN 16962-8 Pipe joints and elements for polypropylene (PP) pressure pipelines, types 1 and 2; injection moulded sockets and caps for socket-welding, dimensions

DIN 16962-9 Pipe joint assemblies and fittings for types 1 and 2 polypropylene (PP) pressure pipes; injection moulded reducers and nipples for socket welding; dimensions

DVS 2207-6 Welding of thermoplastics - Non-contact heated tool butt welding of pipes, pipeline components and sheets - Methods, equipment, parameters

DVS 2207-11 Welding of thermoplastics - Heated tool welding of pipes, pipeline, components and sheets out of PP

DVS 2208-1 Welding of thermoplastics - machines and devices for the heated tool welding of pipes, piping parts and panels

ISO 3213 Polypropylene (PP) pipes - Effect of time and temperature on expected strength

ISO 7279 Polypropylene (PP) fittings for pipes under pressure; sockets for fusion using heated tools; metric series; dimensions of sockets

ISO 9623 PE/metal and PP/metal adaptor fittings for pipes for fluids under pressure - Design lengths and size of threads - metric series

EN ISO 15494 Plastics piping systems for industrial applications - Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system;metric series (ISO 15494:2003)

EN ISO 15874-1 :Plastics piping systems for hot and cold water installations - Polypropylene (PP) - Part 1: General (ISO 15874-1:2003).

EN ISO 15874-2 :Plastics piping systems for hot and cold water installations - Polypropylene (PP) - Part 2: Pipes (ISO 15874-2:2003).

EN ISO 15874-3 :Plastics piping systems for hot and cold water installations - Polypropylene (PP) -Part 3: Fittings

EN ISO 15874-5: Plastics piping systems for hot and cold water installations - Polypropylene (PP) - Part 5: Fitness for purpose of the system

EN ISO 15874-7: Plastics piping systems for hot and cold water installations - Polypropylene (PP) - Part 7: Guidance for the assessment of conformity

EN 12107 :Plastics piping systems - Injection-moulded thermoplastics fittings, valves and ancillary equipment - Determination of long-term hydrostatic strength of components. thermoplastics materials for injection moulding of piping

EN 12293 :Plastics piping systems - Thermoplastics pipes and fittings for hot and cold water - Test method for the resistance of mounted assemblies to temperature cycling

EN 12294 :Plastics piping systems — Systems for hot and cold water - Test method for leaktightness under vacuum

EN 12295 :Plastics piping systems - Thermoplastics pipes and associated fittings for hot and cold water - Test method for resistance of joints to pressure cycling

EN 1254-3 :Copper and copper alloys - Plumbing fittings - Part 3: Fittings with compression ends for use with plastics pipes.

EN 578 :Plastics piping systems -Plastics pipes and fittings -Determination of the opacity

EN 681-1 :Elastomeric seals - Materials requirements for pipe joint seals used in water and drainage applications - Part 1: Vulcanized rubber.

EN 681-2 :Elastomeric seals - Materials requirements for pipe joint seals used in water and drainage applications - Part 2: Thermoplastic elastomers.

EN 712 :Thermoplastics piping systems -End-load bearing mechanical joints between pressure pipes and fittings-Test method for resistance to pull-out under constant longitudinal force

EN 713 :Plastics piping systems -Mechanical joints between fittings and polyolefin pressure pipes -Test method for leaktightness under internal pressure of assemblies subjected to bending

EN 743 :Plastics piping and ducting systems -Thermoplastics pipes -Determination of the longitudinal reversion

EN 921 :Plastics piping systems -Thermoplastics pipes -Determination of resistance to internal pressure at constant temperature

EN ISO 3126 :Plastics piping systems — Plastics components — Measurement of dimensions (ISO 3126:2003)

EN ISO 9080:Plastics piping and ducting systems -Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation (ISO 9080:2003)

ENV 12108: Plastics piping systems - Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption

ISO 1043-1: Plastics - Symbols and abbreviated terms - Part 1: Basic polymers and their special characteristics

ISO 10508 :Thermoplastics pipes and fittings for hot and cold water systems

ISO 1133 :Plastics -Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

ISO 4065: Thermoplastics pipes - Universal wall thickness table

ISO 472 : Plastics – Vocabulary

ISO 9854-1 :Thermoplastics pipes for the transport of fluids -Determination of pendulum impact strength by the Charpy method -Part 1: General test method

ISO 9854-2 :Thermoplastics pipes for the transport of fluids -Determination of pendulum impact strength by the Charpy method -Part 2: Test conditions for pipes of various materials.

APPENDIX A

PRESSURE TABLE S5 / SDR 11 / PN 10

Calculation based on the Colebrook White equation as below.

$$h_f = f_D \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

where

h_f is the head loss due to friction (m);

L is the length of the pipe (m);

D is the hydraulic diameter of the pipe (for a pipe of circular section, this equals the internal diameter of the pipe) (m);

V is the average velocity of the fluid flow, equal to the volumetric flow rate per unit cross-sectional wetted area (m/s);

g is the local acceleration due to gravity (m/s^2).

APPENDIX A

PRESSURE TABLE S5 / SDR 11 / PN 10

COLD WATER @ 20^{0}C

Cold water @ 20°C

S5 / SDR 11 / PN10	20 x 1.9		25 x 2.3		32 x 2.9		40 x 3.7		50 x 4.6	
Peak Flow Rate,Qs (l/s)	Do (mm) = 20.00 Di (mm) = 16.20		Do (mm) = 25.00 Di (mm) = 20.40		Do (mm) = 32.00 Di (mm) = 26.20		Do (mm) = 40.00 Di (mm) = 32.60		Do (mm) = 50.00 Di (mm) = 40.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01										
0.02										
0.06	0.1007	0.291								
0.07	0.1313	0.340								
0.08	0.1653	0.388	0.0555	0.245						
0.09	0.2028	0.437	0.0679	0.275						
0.10	0.2435	0.485	0.0815	0.306	0.0249	0.185				
0.12	0.3347	0.582	0.1118	0.367	0.0341	0.223	0.0121	0.144		
0.14	0.4384	0.679	0.1461	0.428	0.0445	0.260	0.0158	0.168		
0.16	0.5544	0.776	0.1845	0.490	0.0561	0.297	0.0199	0.192	0.0069	0.122
0.18	0.6822	0.873	0.2267	0.551	0.0689	0.334	0.0244	0.216	0.0084	0.138
0.20	0.8219	0.970	0.2727	0.612	0.0828	0.371	0.0293	0.240	0.0101	0.153
0.30	1.6903	1.455	0.5576	0.918	0.1683	0.556	0.0594	0.359	0.0204	0.229
0.40	2.8321	1.941	0.9301	1.224	0.2796	0.742	0.0983	0.479	0.0338	0.306
0.50	4.2378	2.426	1.3865	1.530	0.4155	0.927	0.1457	0.599	0.0499	0.382
0.60	5.9014	2.911	1.9244	1.836	0.5750	1.113	0.2013	0.719	0.0688	0.459
0.70	7.8185	3.396	2.5421	2.142	0.7575	1.298	0.2647	0.839	0.0903	0.535
0.80	9.9859	3.881	3.2383	2.448	0.9627	1.484	0.3358	0.958	0.1144	0.612
0.90			4.0118	2.754	1.1900	1.669	0.4144	1.078	0.1410	0.688
1.00			4.8618	3.059	1.4392	1.855	0.5005	1.198	0.1701	0.765
1.20			6.7889	3.671	2.0023	2.226	0.6944	1.438	0.2355	0.918
1.40					2.6503	2.597	0.9170	1.677	0.3103	1.071
1.60					3.3818	2.968	1.1676	1.917	0.3944	1.224
1.80					4.1960	3.339	1.4458	2.156	0.4875	1.377
2.00					5.0919	3.710	1.7513	2.396	0.5896	1.530
2.20							2.0838	2.636	0.7005	1.683
2.40							2.4430	2.875	0.8201	1.836
2.60							2.8288	3.115	0.9484	1.989
2.80							3.2410	3.355	1.0853	2.142
3.00							3.6794	3.594	1.2306	2.295
3.20							4.1438	3.834	1.3844	2.448
3.40									1.5465	2.601
3.60									1.7170	2.754
3.80									1.8958	2.907
4.00									2.0829	3.059
4.20									2.2782	3.212
4.40									2.4817	3.365
4.60									2.6933	3.518
4.80									2.9131	3.671
5.00									3.1409	3.824
5.20									3.3769	3.977
5.40										

Cold water @ 20°C

S5 / SDR 11 / PN10	63 x 5.8		75 x 6.8		90 x 8.2		110 x 10.0		160 x 14.6	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 51.40		Do (mm) = 75.00 Di (mm) = 61.40		Do (mm) = 90.00 Di (mm) = 73.60		Do (mm) = 110.00 Di (mm) = 90.00		Do (mm) = 160.00 Di (mm) = 130.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.20	0.0034	0.096								
0.30	0.0068	0.145	0.0029	0.101	0.0013	0.071				
0.40	0.0113	0.193	0.0048	0.135	0.0021	0.094	0.0008	0.063		
0.50	0.0166	0.241	0.0071	0.169	0.0030	0.118	0.0012	0.079	0.0002	0.037
0.60	0.0229	0.289	0.0098	0.203	0.0042	0.141	0.0016	0.094	0.0003	0.045
0.70	0.0300	0.337	0.0129	0.236	0.0054	0.165	0.0021	0.110	0.0004	0.052
0.80	0.0379	0.386	0.0162	0.270	0.0069	0.188	0.0026	0.126	0.0005	0.060
0.90	0.0467	0.434	0.0200	0.304	0.0084	0.212	0.0032	0.141	0.0006	0.067
1.00	0.0562	0.482	0.0241	0.338	0.0101	0.235	0.0039	0.157	0.0007	0.074
1.20	0.0777	0.578	0.0332	0.405	0.0140	0.282	0.0054	0.189	0.0009	0.089
1.40	0.1022	0.675	0.0436	0.473	0.0183	0.329	0.0070	0.220	0.0012	0.104
1.60	0.1297	0.771	0.0553	0.540	0.0232	0.376	0.0089	0.252	0.0015	0.119
1.80	0.1601	0.867	0.0682	0.608	0.0286	0.423	0.0109	0.283	0.0018	0.134
2.00	0.1934	0.964	0.0823	0.675	0.0345	0.470	0.0132	0.314	0.0022	0.149
2.20	0.2295	1.060	0.0975	0.743	0.0409	0.517	0.0156	0.346	0.0026	0.164
2.40	0.2684	1.157	0.1140	0.811	0.0477	0.564	0.0182	0.377	0.0031	0.179
2.60	0.3100	1.253	0.1316	0.878	0.0551	0.611	0.0210	0.409	0.0035	0.193
2.80	0.3544	1.349	0.1503	0.946	0.0629	0.658	0.0239	0.440	0.0040	0.208
3.00	0.4014	1.446	0.1701	1.013	0.0711	0.705	0.0271	0.472	0.0045	0.223
3.20	0.4511	1.542	0.1911	1.081	0.0798	0.752	0.0304	0.503	0.0051	0.238
3.40	0.5035	1.639	0.2131	1.148	0.0890	0.799	0.0339	0.534	0.0057	0.253
3.60	0.5585	1.735	0.2363	1.216	0.0986	0.846	0.0375	0.566	0.0063	0.268
3.80	0.6161	1.831	0.2605	1.283	0.1087	0.893	0.0413	0.597	0.0069	0.283
4.00	0.6764	1.928	0.2858	1.351	0.1192	0.940	0.0453	0.629	0.0076	0.298
4.20	0.7392	2.024	0.3122	1.418	0.1301	0.987	0.0494	0.660	0.0082	0.313
4.40	0.8046	2.120	0.3397	1.486	0.1415	1.034	0.0537	0.692	0.0089	0.327
4.60	0.8725	2.217	0.3682	1.554	0.1533	1.081	0.0582	0.723	0.0097	0.342
4.80	0.9430	2.313	0.3977	1.621	0.1655	1.128	0.0628	0.755	0.0104	0.357
5.00	1.0161	2.410	0.4284	1.689	0.1782	1.175	0.0676	0.786	0.0112	0.372
5.20	1.0917	2.506	0.4600	1.756	0.1913	1.222	0.0725	0.817	0.0120	0.387
5.40	1.1698	2.602	0.4927	1.824	0.2048	1.269	0.0776	0.849	0.0129	0.402
5.60	1.2504	2.699	0.5264	1.891	0.2188	1.316	0.0828	0.880	0.0137	0.417
5.80	1.3335	2.795	0.5612	1.959	0.2331	1.363	0.0882	0.912	0.0146	0.432

Cold water @ 20°C

S5 / SDR 11 / PN10	63 x 5.8		75 x 6.8		90 x 8.2		110 x 10.0		160 x 14.6	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 51.40		Do (mm) = 75.00 Di (mm) = 61.40		Do (mm) = 90.00 Di (mm) = 73.60		Do (mm) = 110.00 Di (mm) = 90.00		Do (mm) = 160.00 Di (mm) = 130.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
6.00	1.4191	2.892	0.5970	2.026	0.2479	1.410	0.0938	0.943	0.0156	0.447
6.20	1.5072	2.988	0.6338	2.094	0.2631	1.457	0.0995	0.975	0.0164	0.461
6.40	1.5977	3.084	0.6716	2.161	0.2787	1.504	0.1054	1.006	0.0174	0.476
6.60	1.6908	3.181	0.7104	2.229	0.2947	1.551	0.1114	1.037	0.0184	0.491
6.80	1.7863	3.277	0.7503	2.297	0.3111	1.598	0.1176	1.069	0.0194	0.506
7.00	1.8843	3.374	0.7911	2.364	0.3280	1.645	0.1239	1.100	0.0205	0.521
7.50	2.1400	3.614	0.8977	2.533	0.3718	1.763	0.1404	1.179	0.0232	0.558
8.00	2.4110	3.855	1.0105	2.702	0.4182	1.880	0.1578	1.258	0.0260	0.595
8.50			1.1295	2.871	0.4672	1.998	0.1761	1.336	0.0290	0.633
9.00			1.2547	3.040	0.5186	2.115	0.1954	1.415	0.0322	0.670
9.50			1.3861	3.208	0.5725	2.233	0.2156	1.493	0.0354	0.707
10.00			1.5235	3.377	0.6289	2.350	0.2366	1.572	0.0388	0.744
10.50			1.6671	3.546	0.6877	2.468	0.2586	1.650	0.0424	0.781
11.00			1.8168	3.715	0.7490	2.586	0.2815	1.729	0.0462	0.819
11.50			1.9725	3.884	0.8127	2.703	0.3053	1.808	0.0500	0.856
12.00					0.8789	2.821	0.3300	1.886	0.0540	0.893
12.50					0.9474	2.938	0.3555	1.965	0.0581	0.930
13.00					1.0184	3.056	0.3819	2.043	0.0624	0.967
13.50					1.0918	3.173	0.4093	2.122	0.0669	1.005
14.00					1.1675	3.291	0.4374	2.201	0.0714	1.042
14.50					1.2457	3.408	0.4665	2.279	0.0761	1.079
15.00					1.3262	3.526	0.4964	2.358	0.0809	1.116
15.50					1.4091	3.643	0.5272	2.436	0.0859	1.154
16.00					1.4944	3.761	0.5589	2.515	0.0910	1.191
16.50					1.5821	3.878	0.5914	2.594	0.0962	1.228
17.00					1.6721	3.996	0.6248	2.672	0.1016	1.265
17.50							0.6590	2.751	0.1070	1.302
18.00							0.6941	2.829	0.1128	1.340
18.50							0.7300	2.908	0.1185	1.377
19.00							0.7668	2.987	0.1244	1.414
19.50							0.8045	3.065	0.1304	1.451
20.00							0.8429	3.144	0.1365	1.488

PRESSURE TABLE S3.2 / SDR 7.4 / PN16
COLD WATER @ 20^{0}C

Cold water @ 20°C

S3.2 / SDR 7.4 / PN16	20 x 2.8		25 x 3.5		32 x 4.4		40 x 5.5		50 x 6.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 20.00 Di (mm) = 14.40		Do (mm) = 25.00 Di (mm) = 18.00		Do (mm) = 32.00 Di (mm) = 23.20		Do (mm) = 40.00 Di (mm) = 29.00		Do (mm) = 50.00 Di (mm) = 36.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.06	0.1758	0.368								
0.07	0.2295	0.430	0.0797	0.275						
0.08	0.2893	0.491	0.1003	0.314						
0.09	0.3551	0.553	0.1230	0.354	0.0370	0.213				
0.10	0.4268	0.614	0.1476	0.393	0.0443	0.237				
0.12	0.5872	0.737	0.2026	0.472	0.0607	0.284	0.0211	0.182		
0.14	0.7700	0.860	0.2652	0.550	0.0793	0.331	0.0275	0.212	0.0097	0.136
0.16	0.9746	0.982	0.3351	0.629	0.1000	0.378	0.0347	0.242	0.0121	0.155
0.18	1.2004	1.105	0.4121	0.707	0.1228	0.426	0.0425	0.273	0.0149	0.175
0.20	1.4473	1.228	0.4961	0.786	0.1476	0.473	0.0511	0.303	0.0178	0.194
0.30	2.9865	1.842	1.0174	1.179	0.3011	0.710	0.1037	0.454	0.0361	0.291
0.40	5.0171	2.456	1.7010	1.572	0.5011	0.946	0.1720	0.606	0.0597	0.389
0.50	7.5240	3.070	2.5407	1.965	0.7456	1.183	0.2552	0.757	0.0883	0.486
0.60	10.4977	3.684	3.5325	2.358	1.0333	1.419	0.3529	0.908	0.1219	0.583
0.70			4.6735	2.751	1.3630	1.656	0.4645	1.060	0.1601	0.680
0.80			5.9615	3.144	1.7340	1.892	0.5898	1.211	0.2030	0.777
0.90			7.3949	3.537	2.1457	2.129	0.7285	1.363	0.2504	0.874
1.00			8.9723	3.930	2.5975	2.366	0.8804	1.514	0.3022	0.972
1.20					3.6199	2.839	1.2233	1.817	0.4189	1.166
1.40					4.7985	3.312	1.6173	2.120	0.5525	1.360
1.60					6.1314	3.785	2.0616	2.422	0.7029	1.555
1.80							2.5554	2.725	0.8697	1.749
2.00							3.0983	3.028	1.0526	1.943
2.20							3.6898	3.331	1.2516	2.138
2.40							4.3295	3.634	1.4664	2.332
2.60							5.0171	3.936	1.6969	2.526
2.80									1.9429	2.721
3.00									2.2044	2.915
3.20									2.4814	3.109
3.40									2.7736	3.303
3.60									3.0810	3.498
3.80									3.4036	3.692
4.00									3.7412	3.886
4.20										

Cold water @ 20°C

S3.2 / SDR 7.4 / PN16	63 x 8.6		75 x 10.3		90 x 12.3		110 x 15.1	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 45.80		Do (mm) = 75.00 Di (mm) = 54.40		Do (mm) = 90.00 Di (mm) = 65.40		Do (mm) = 110.00 Di (mm) = 79.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.18	0.0049	0.109						
0.20	0.0059	0.121	0.0026	0.086				
0.30	0.0118	0.182	0.0052	0.129	0.0022	0.089	0.0009	0.060
0.40	0.0195	0.243	0.0086	0.172	0.0036	0.119	0.0014	0.080
0.50	0.0288	0.303	0.0127	0.215	0.0053	0.149	0.0021	0.100
0.60	0.0396	0.364	0.0175	0.258	0.0073	0.179	0.0028	0.120
0.70	0.0520	0.425	0.0229	0.301	0.0095	0.208	0.0037	0.140
0.80	0.0658	0.486	0.0289	0.344	0.0120	0.238	0.0047	0.160
0.90	0.0810	0.546	0.0356	0.387	0.0148	0.268	0.0057	0.180
1.00	0.0977	0.607	0.0429	0.430	0.0178	0.298	0.0069	0.200
1.20	0.1351	0.728	0.0592	0.516	0.0245	0.357	0.0095	0.240
1.40	0.1779	0.850	0.0779	0.602	0.0322	0.417	0.0125	0.280
1.60	0.2259	0.971	0.0988	0.688	0.0409	0.476	0.0158	0.320
1.80	0.2791	1.093	0.1219	0.774	0.0504	0.536	0.0194	0.360
2.00	0.3373	1.214	0.1472	0.860	0.0608	0.595	0.0234	0.400
2.20	0.4004	1.335	0.1746	0.947	0.0720	0.655	0.0277	0.440
2.40	0.4685	1.457	0.2041	1.033	0.0842	0.714	0.0324	0.480
2.60	0.5415	1.578	0.2358	1.119	0.0971	0.774	0.0374	0.520
2.80	0.6193	1.700	0.2694	1.205	0.1109	0.834	0.0426	0.560
3.00	0.7018	1.821	0.3051	1.291	0.1255	0.893	0.0482	0.600
3.20	0.7891	1.942	0.3428	1.377	0.1410	0.953	0.0541	0.640
3.40	0.8812	2.064	0.3826	1.463	0.1572	1.012	0.0603	0.680
3.60	0.9778	2.185	0.4243	1.549	0.1742	1.072	0.0668	0.720
3.80	1.0792	2.307	0.4680	1.635	0.1921	1.131	0.0736	0.760
4.00	1.1851	2.428	0.5136	1.721	0.2107	1.191	0.0807	0.800
4.20	1.2957	2.549	0.5613	1.807	0.2301	1.250	0.0881	0.840
4.40	1.4109	2.671	0.6108	1.893	0.2503	1.310	0.0958	0.880
4.60	1.5306	2.792	0.6623	1.979	0.2713	1.369	0.1038	0.920
4.80	1.6548	2.914	0.7157	2.065	0.2930	1.429	0.1121	0.960
5.00	1.7836	3.035	0.7710	2.151	0.3155	1.488	0.1206	1.000
5.20	1.9169	3.156	0.8282	2.237	0.3388	1.548	0.1295	1.040
5.40	2.0547	3.278	0.8873	2.323	0.3628	1.607	0.1386	1.080
5.60	2.1970	3.399	0.9483	2.409	0.3876	1.667	0.1480	1.120
5.80	2.3437	3.521	1.0112	2.495	0.4131	1.727	0.1577	1.160

Cold water @ 20°C

S3.2 / SDR 7.4 / PN16	125 x 17.1		160 x 21.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 125.00 Di (mm) = 90.80		Do (mm) = 160.00 Di (mm) = 116.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.18				
0.20				
0.30				
0.40	0.0008	0.062		
0.50	0.0011	0.077	0.0003	0.047
0.60	0.0015	0.093	0.0005	0.057
0.70	0.0020	0.108	0.0006	0.066
0.80	0.0025	0.124	0.0008	0.075
0.90	0.0031	0.139	0.0010	0.085
1.00	0.0037	0.154	0.0012	0.094
1.20	0.0051	0.185	0.0016	0.113
1.40	0.0067	0.216	0.0021	0.132
1.60	0.0085	0.247	0.0026	0.151
1.80	0.0105	0.278	0.0032	0.170
2.00	0.0126	0.309	0.0039	0.189
2.20	0.0150	0.340	0.0046	0.207
2.40	0.0175	0.371	0.0054	0.226
2.60	0.0202	0.402	0.0062	0.245
2.80	0.0229	0.432	0.0071	0.264
3.00	0.0259	0.463	0.0080	0.283
3.20	0.0291	0.494	0.0090	0.302
3.40	0.0324	0.525	0.0100	0.321
3.60	0.0359	0.556	0.0110	0.339
3.80	0.0396	0.587	0.0121	0.358
4.00	0.0434	0.618	0.0133	0.377
4.20	0.0474	0.649	0.0145	0.396
4.40	0.0515	0.680	0.0158	0.415
4.60	0.0557	0.710	0.0171	0.434
4.80	0.0601	0.741	0.0184	0.453
5.00	0.0647	0.772	0.0198	0.471
5.20	0.0695	0.803	0.0212	0.490
5.40	0.0744	0.834	0.0227	0.509
5.60	0.0794	0.865	0.0242	0.528
5.80	0.0846	0.896	0.0258	0.547

Cold water @ 20°C

S3.2 / SDR 7.4 / PN16	63 x 8.6		75 x 10.3		90 x 12.3		110 x 15.1	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 45.80		Do (mm) = 75.00 Di (mm) = 54.40		Do (mm) = 90.00 Di (mm) = 65.40		Do (mm) = 110.00 Di (mm) = 79.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
6.00	2.4949	3.642	1.0760	2.581	0.4394	1.786	0.1676	1.200
6.20	2.6506	3.763	1.1426	2.667	0.4664	1.846	0.1779	1.240
6.40	2.8107	3.885	1.2111	2.754	0.4942	1.905	0.1884	1.280
6.60			1.2815	2.840	0.5227	1.965	0.1992	1.320
6.80			1.3537	2.926	0.5520	2.024	0.2103	1.360
7.00			1.4278	3.012	0.5820	2.084	0.2216	1.400
7.50			1.6211	3.227	0.6601	2.233	0.2512	1.500
8.00			1.8258	3.442	0.7429	2.381	0.2825	1.600
8.50			2.0420	3.657	0.8302	2.530	0.3154	1.700
9.00			2.2695	3.872	0.9219	2.679	0.3501	1.799
9.50					1.0182	2.828	0.3864	1.899
10.00					1.1189	2.977	0.4243	1.999
10.50					1.2241	3.126	0.4639	2.099
11.00					1.3337	3.275	0.5051	2.199
11.50					1.4477	3.423	0.5479	2.299
12.00					1.5661	3.572	0.5924	2.399
12.50					1.6889	3.721	0.6385	2.499
13.00					1.8160	3.870	0.6861	2.599
13.50							0.7354	2.699
14.00							0.7863	2.799
14.50							0.8388	2.899
15.00							0.8928	2.999
15.50							0.9484	3.099
16.00							1.0056	3.199
16.50							1.0644	3.299
17.00							1.1248	3.399
17.50							1.1867	3.499
18.00							1.2502	3.599
18.50							1.3152	3.699
19.00							1.3818	3.799
19.50							1.4499	3.899
20.00							1.5196	3.999

Cold water @ 20°C

S3.2 / SDR 7.4 / PN16	125 x 17.1		160 x 21.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 125.00 Di (mm) = 90.80		Do (mm) = 160.00 Di (mm) = 116.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
6.00	0.0900	0.927	0.0274	0.566
6.20	0.0953	0.957	0.0291	0.585
6.40	0.1009	0.988	0.0308	0.604
6.60	0.1067	1.019	0.0325	0.622
6.80	0.1126	1.050	0.0343	0.641
7.00	0.1187	1.081	0.0362	0.660
7.50	0.1345	1.158	0.0409	0.707
8.00	0.1511	1.235	0.0459	0.754
8.50	0.1688	1.313	0.0513	0.802
9.00	0.1872	1.390	0.0569	0.849
9.50	0.2065	1.467	0.0627	0.896
10.00	0.2266	1.544	0.0688	0.943
10.50	0.2479	1.622	0.0751	0.990
11.00	0.2697	1.699	0.0817	1.037
11.50	0.2925	1.776	0.0885	1.084
12.00	0.3160	1.853	0.0957	1.132
12.50	0.3404	1.930	0.1031	1.179
13.00	0.3660	2.008	0.1106	1.226
13.50	0.3921	2.085	0.1185	1.273
14.00	0.4190	2.162	0.1265	1.320
14.50	0.4467	2.239	0.1349	1.367
15.00	0.4753	2.316	0.1434	1.414
15.50	0.5051	2.394	0.1524	1.462
16.00	0.5353	2.471	0.1614	1.509
16.50	0.5664	2.548	0.1707	1.556
17.00	0.5982	2.625	0.1802	1.603
17.50	0.6313	2.703	0.1900	1.650
18.00	0.6648	2.780	0.2000	1.697
18.50	0.6991	2.857	0.2102	1.744
19.00	0.7343	2.934	0.2209	1.792
19.50	0.7702	3.011	0.2317	1.839
20.00	0.8074	3.089	0.2426	1.886

PRESSURE TABLE S3.2 / SDR 7.4 / PN 16
HOT WATER @ 60°C

Hot water @ 60°C

S3.2 / SDR 7.4 / PN16	20 x 2.8		25 x 3.5		32 x 4.4		40 x 5.5		50 x 6.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 20.00 Di (mm) = 14.40		Do (mm) = 25.00 Di (mm) = 18.00		Do (mm) = 32.00 Di (mm) = 23.20		Do (mm) = 40.00 Di (mm) = 29.00		Do (mm) = 50.00 Di (mm) = 36.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.01										
0.02										
0.03	0.0426	0.184								
0.04	0.0702	0.246	0.0243	0.157	0.0073	0.095				
0.05	0.1036	0.307	0.0358	0.196	0.0107	0.118	0.0037	0.076		
0.06	0.1427	0.368	0.0492	0.236	0.0147	0.142	0.0051	0.091		
0.07	0.1871	0.430	0.0644	0.275	0.0192	0.166	0.0067	0.106	0.0023	0.068
0.08	0.2369	0.491	0.0814	0.314	0.0243	0.189	0.0084	0.121	0.0029	0.078
0.09	0.2919	0.553	0.1001	0.354	0.0298	0.213	0.0103	0.136	0.0036	0.087
0.10	0.3520	0.614	0.1206	0.393	0.0359	0.237	0.0124	0.151	0.0043	0.097
0.12	0.4873	0.737	0.1664	0.472	0.0494	0.284	0.0170	0.182	0.0059	0.117
0.14	0.6423	0.860	0.2189	0.550	0.0648	0.331	0.0223	0.212	0.0078	0.136
0.16	0.8167	0.982	0.2777	0.629	0.0820	0.378	0.0282	0.242	0.0098	0.155
0.18	1.0102	1.105	0.3428	0.707	0.1011	0.426	0.0347	0.273	0.0120	0.175
0.20	1.2225	1.228	0.4141	0.786	0.1219	0.473	0.0418	0.303	0.0145	0.194
0.30	2.5609	1.842	0.8608	1.179	0.2515	0.710	0.0858	0.454	0.0296	0.291
0.40	4.3510	2.456	1.4539	1.572	0.4224	0.946	0.1436	0.606	0.0494	0.389
0.50	6.5848	3.070	2.1895	1.965	0.6331	1.183	0.2144	0.757	0.0735	0.486
0.60	9.2576	3.684	3.0654	2.358	0.8827	1.419	0.2980	0.908	0.1020	0.583
0.70			4.0800	2.751	1.1706	1.656	0.3942	1.060	0.1346	0.680
0.80			5.2322	3.144	1.4963	1.892	0.5026	1.211	0.1712	0.777
0.90			6.5213	3.537	1.8594	2.129	0.6232	1.363	0.2119	0.874
1.00			7.9465	3.930	2.2598	2.366	0.7558	1.514	0.2565	0.972
1.20					3.1710	2.839	1.0566	1.817	0.3575	1.166
1.40					4.2287	3.312	1.4044	2.120	0.4739	1.360
1.60					5.4318	3.785	1.7988	2.422	0.6054	1.555
1.80							2.2393	2.725	0.7519	1.749
2.00							2.7257	3.028	0.9133	1.943
2.20							3.2578	3.331	1.0895	2.138
2.40							3.8354	3.634	1.2803	2.332
2.60							4.4583	3.936	1.4857	2.526
2.80									1.7056	2.721
3.00									1.9400	2.915
3.20									2.1889	3.109
3.40									2.4521	3.303
3.60									2.7296	3.498
3.80									3.0215	3.692
4.00									3.3277	3.886
4.20										

Hot water @ 60°C

S3.2 / SDR 7.4 / PN 16	63 x 8.6		75 x 10.3		90 x 12.3		110 x 15.1	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 45.80		Do (mm) = 75.00 Di (mm) = 54.40		Do (mm) = 90.00 Di (mm) = 65.40		Do (mm) = 110.00 Di (mm) = 79.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.07								
0.08	0.0010	0.049						
0.09	0.0012	0.055						
0.10	0.0014	0.061	0.0006	0.043				
0.12	0.0019	0.073	0.0009	0.052	0.0004	0.036		
0.14	0.0025	0.085	0.0011	0.060	0.0005	0.042	0.0002	0.028
0.16	0.0032	0.097	0.0014	0.069	0.0006	0.048	0.0002	0.032
0.18	0.0039	0.109	0.0017	0.077	0.0007	0.054	0.0003	0.036
0.20	0.0047	0.121	0.0021	0.086	0.0009	0.060	0.0003	0.040
0.30	0.0096	0.182	0.0042	0.129	0.0018	0.089	0.0007	0.060
0.40	0.0160	0.243	0.0070	0.172	0.0029	0.119	0.0011	0.080
0.50	0.0238	0.303	0.0104	0.215	0.0043	0.149	0.0017	0.100
0.60	0.0329	0.364	0.0144	0.258	0.0060	0.179	0.0023	0.120
0.70	0.0433	0.425	0.0189	0.301	0.0078	0.208	0.0030	0.140
0.80	0.0550	0.486	0.0240	0.344	0.0099	0.238	0.0038	0.160
0.90	0.0679	0.546	0.0297	0.387	0.0123	0.268	0.0047	0.180
1.00	0.0821	0.607	0.0358	0.430	0.0148	0.298	0.0057	0.200
1.20	0.1141	0.728	0.0497	0.516	0.0205	0.357	0.0079	0.240
1.40	0.1509	0.850	0.0656	0.602	0.0270	0.417	0.0104	0.280
1.60	0.1924	0.971	0.0835	0.688	0.0343	0.476	0.0132	0.320
1.80	0.2384	1.093	0.1034	0.774	0.0424	0.536	0.0163	0.360
2.00	0.2890	1.214	0.1252	0.860	0.0513	0.595	0.0197	0.400
2.20	0.3442	1.335	0.1489	0.947	0.0610	0.655	0.0233	0.440
2.40	0.4038	1.457	0.1745	1.033	0.0714	0.714	0.0273	0.480
2.60	0.4678	1.578	0.2020	1.119	0.0826	0.774	0.0315	0.520
2.80	0.5362	1.700	0.2313	1.205	0.0945	0.834	0.0361	0.560
3.00	0.6091	1.821	0.2625	1.291	0.1071	0.893	0.0408	0.600
3.20	0.6862	1.942	0.2955	1.377	0.1205	0.953	0.0459	0.640
3.40	0.7678	2.064	0.3303	1.463	0.1346	1.012	0.0512	0.680
3.60	0.8536	2.185	0.3670	1.549	0.1494	1.072	0.0569	0.720
3.80	0.9438	2.307	0.4054	1.635	0.1650	1.131	0.0627	0.760
4.00	1.0383	2.428	0.4457	1.721	0.1812	1.191	0.0689	0.800
4.20	1.1371	2.549	0.4877	1.807	0.1982	1.250	0.0753	0.840
4.40	1.2401	2.671	0.5316	1.893	0.2158	1.310	0.0819	0.880
4.60	1.3474	2.792	0.5772	1.979	0.2342	1.369	0.0889	0.920
4.80	1.4590	2.914	0.6246	2.065	0.2533	1.429	0.0960	0.960

Hot water @ 60°C

S3.2 / SDR 7.4 / PN 16	125 x 17.1		160 x 21.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 125.00 Di (mm) = 90.80		Do (mm) = 160.00 Di (mm) = 116.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.07				
0.08				
0.09				
0.10				
0.12				
0.14				
0.16	0.0001	0.025		
0.18	0.0002	0.028		
0.20	0.0002	0.031	0.0001	0.019
0.30	0.0004	0.046	0.0001	0.028
0.40	0.0006	0.062	0.0002	0.038
0.50	0.0009	0.077	0.0003	0.047
0.60	0.0013	0.093	0.0004	0.057
0.70	0.0016	0.108	0.0005	0.066
0.80	0.0021	0.124	0.0006	0.075
0.90	0.0025	0.139	0.0008	0.085
1.00	0.0031	0.154	0.0009	0.094
1.20	0.0042	0.185	0.0013	0.113
1.40	0.0056	0.216	0.0017	0.132
1.60	0.0071	0.247	0.0022	0.151
1.80	0.0087	0.278	0.0027	0.170
2.00	0.0106	0.309	0.0032	0.189
2.20	0.0125	0.340	0.0038	0.207
2.40	0.0147	0.371	0.0045	0.226
2.60	0.0170	0.402	0.0052	0.245
2.80	0.0193	0.432	0.0059	0.264
3.00	0.0219	0.463	0.0067	0.283
3.20	0.0246	0.494	0.0075	0.302
3.40	0.0274	0.525	0.0084	0.321
3.60	0.0304	0.556	0.0092	0.339
3.80	0.0336	0.587	0.0102	0.358
4.00	0.0369	0.618	0.0112	0.377
4.20	0.0403	0.649	0.0122	0.396
4.40	0.0439	0.680	0.0133	0.415
4.60	0.0474	0.710	0.0144	0.434
4.80	0.0513	0.741	0.0156	0.453

Hot water @ 60°C

S3.2 / SDR 7.4 / PN 16	63 x 8.6		75 x 10.3		90 x 12.3		110 x 15.1	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 45.80		Do (mm) = 75.00 Di (mm) = 54.40		Do (mm) = 90.00 Di (mm) = 65.40		Do (mm) = 110.00 Di (mm) = 79.80	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
5.00	1.5748	3.035	0.6737	2.151	0.2731	1.488	0.1035	1.000
5.20	1.6948	3.156	0.7247	2.237	0.2936	1.548	0.1112	1.040
5.40	1.8191	3.278	0.7774	2.323	0.3147	1.607	0.1191	1.080
5.60	1.9476	3.399	0.8318	2.409	0.3366	1.667	0.1273	1.120
5.80	2.0803	3.521	0.8880	2.495	0.3591	1.727	0.1358	1.160
6.00	2.2172	3.642	0.9460	2.581	0.3824	1.786	0.1445	1.200
6.20	2.3584	3.763	1.0057	2.667	0.4063	1.846	0.1535	1.240
6.40	2.5037	3.885	1.0671	2.754	0.4309	1.905	0.1627	1.280
6.60			1.1303	2.840	0.4562	1.965	0.1722	1.320
6.80			1.1952	2.926	0.4822	2.024	0.1819	1.360
7.00			1.2619	3.012	0.5089	2.084	0.1919	1.400
7.50			1.4361	3.227	0.5785	2.233	0.2179	1.500
8.00			1.6212	3.442	0.6523	2.381	0.2455	1.600
8.50			1.8170	3.657	0.7304	2.530	0.2746	1.700
9.00			2.0236	3.872	0.8127	2.679	0.3053	1.799
9.50					0.8992	2.828	0.3375	1.899
10.00					0.9898	2.977	0.3712	1.999
10.50					1.0847	3.126	0.4064	2.099
11.00					1.1836	3.275	0.4431	2.199
11.50					1.2868	3.423	0.4814	2.299
12.00					1.3941	3.572	0.5211	2.399
12.50					1.5055	3.721	0.5624	2.499
13.00					1.6210	3.870	0.6051	2.599
13.50							0.6494	2.699
14.00							0.6951	2.799
14.50							0.7424	2.899
15.00							0.7911	2.999
15.50							0.8413	3.099
16.00							0.8930	3.199
16.50							0.9461	3.299
17.00							1.0008	3.399
17.50							1.0569	3.499
18.00							1.1145	3.599
18.50							1.1736	3.699
19.00							1.2341	3.799
19.50							1.2961	3.899
20.00							1.3596	3.999

Hot water @ 60°C

S3.2 / SDR 7.4 / PN 16	125 x 17.1		160 x 21.9	
Peak Flow Rate, Qs (l/s)	Do (mm) = 125.00 Di (mm) = 90.80		Do (mm) = 160.00 Di (mm) = 116.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
5.00	0.0552	0.772	0.0167	0.471
5.20	0.0594	0.803	0.0180	0.490
5.40	0.0636	0.834	0.0192	0.509
5.60	0.0680	0.865	0.0206	0.528
5.80	0.0725	0.896	0.0219	0.547
6.00	0.0771	0.927	0.0233	0.566
6.20	0.0818	0.957	0.0248	0.585
6.40	0.0867	0.988	0.0263	0.604
6.60	0.0917	1.019	0.0277	0.622
6.80	0.0969	1.050	0.0292	0.641
7.00	0.1022	1.081	0.0308	0.660
7.50	0.1160	1.158	0.0350	0.707
8.00	0.1305	1.235	0.0393	0.754
8.50	0.1461	1.313	0.0440	0.802
9.00	0.1623	1.390	0.0488	0.849
9.50	0.1792	1.467	0.0539	0.896
10.00	0.1970	1.544	0.0592	0.943
10.50	0.2158	1.622	0.0647	0.990
11.00	0.2351	1.699	0.0704	1.037
11.50	0.2552	1.776	0.0764	1.084
12.00	0.2761	1.853	0.0827	1.132
12.50	0.2978	1.930	0.0892	1.179
13.00	0.3206	2.008	0.0958	1.226
13.50	0.3438	2.085	0.1027	1.273
14.00	0.3678	2.162	0.1098	1.320
14.50	0.3926	2.239	0.1171	1.367
15.00	0.4181	2.316	0.1247	1.414
15.50	0.4448	2.394	0.1326	1.462
16.00	0.4718	2.471	0.1406	1.509
16.50	0.4997	2.548	0.1488	1.556
17.00	0.5283	2.625	0.1572	1.603
17.50	0.5580	2.703	0.1658	1.650
18.00	0.5882	2.780	0.1747	1.697
18.50	0.6191	2.857	0.1838	1.744
19.00	0.6507	2.934	0.1933	1.792
19.50	0.6831	3.011	0.2028	1.839
20.00	0.7167	3.089	0.2125	1.886

PRESSURE TABLE S2.5 / SDR 6 / PN20
COLD WATER @ 20^{0}C

Cold water @ 20°C

S2.5 / SDR 6 / PN20	20 x 3.4		25 x 4.2		32 x 5.4		40 x 6.7		50 x 8.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 20.00 Di (mm) = 13.20		Do (mm) = 25.00 Di (mm) = 16.60		Do (mm) = 32.00 Di (mm) = 21.20		Do (mm) = 40.00 Di (mm) = 26.60		Do (mm) = 50.00 Di (mm) = 33.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.05	0.1939	0.365								
0.06	0.2656	0.438	0.0897	0.277						
0.07	0.3470	0.512	0.1169	0.323						
0.08	0.4377	0.585	0.1473	0.370	0.0462	0.227				
0.09	0.5376	0.658	0.1806	0.416	0.0566	0.255				
0.10	0.6464	0.731	0.2169	0.462	0.0679	0.283	0.0232	0.180		
0.12	0.8903	0.877	0.2980	0.554	0.0931	0.340	0.0318	0.216	0.0111	0.139
0.14	1.1684	1.023	0.3902	0.647	0.1217	0.397	0.0415	0.252	0.0145	0.162
0.16	1.4800	1.169	0.4933	0.739	0.1536	0.453	0.0522	0.288	0.0183	0.185
0.18	1.8243	1.315	0.6070	0.832	0.1887	0.510	0.0641	0.324	0.0224	0.208
0.20	2.2008	1.461	0.7311	0.924	0.2269	0.567	0.0770	0.360	0.0269	0.231
0.30	4.5534	2.192	1.5027	1.386	0.4637	0.850	0.1566	0.540	0.0544	0.347
0.40	7.6656	2.923	2.5165	1.848	0.7729	1.133	0.2601	0.720	0.0901	0.462
0.50	11.5162	3.654	3.7639	2.310	1.1515	1.416	0.3863	0.900	0.1336	0.578
0.60			5.2395	2.772	1.5974	1.700	0.5345	1.080	0.1844	0.693
0.70			6.9392	3.234	2.1093	1.983	0.7041	1.260	0.2425	0.809
0.80			8.8602	3.696	2.6858	2.266	0.8947	1.440	0.3076	0.924
0.90					3.3261	2.550	1.1059	1.620	0.3796	1.040
1.00					4.0295	2.833	1.3374	1.799	0.4583	1.155
1.20					5.6233	3.400	1.8602	2.159	0.6359	1.386
1.40					7.4632	3.966	2.4618	2.519	0.8395	1.617
1.60							3.1407	2.879	1.0687	1.848
1.80							3.8963	3.239	1.3232	2.079
2.00							4.7276	3.599	1.6026	2.310
2.20							5.6340	3.959	1.9066	2.541
2.40									2.2350	2.772
2.60									2.5876	3.003
2.80									2.9643	3.234
3.00									3.3650	3.465
3.20									3.7894	3.696
3.40									4.2374	3.927
3.60										

Cold water @ 20°C

S2.5 / SDR 6 / PN20	63 x 10.5		75 x 12.5		90 x 15.0		110 x 18.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 42.00		Do (mm) = 75.00 Di (mm) = 50.00		Do (mm) = 90.00 Di (mm) = 60.00		Do (mm) = 110.00 Di (mm) = 73.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.16	0.0060	0.115						
0.18	0.0074	0.130	0.0032	0.092				
0.20	0.0088	0.144	0.0039	0.102				
0.30	0.0178	0.217	0.0078	0.153	0.0033	0.106	0.0013	0.071
0.40	0.0294	0.289	0.0128	0.204	0.0054	0.141	0.0021	0.095
0.50	0.0435	0.361	0.0190	0.255	0.0080	0.177	0.0031	0.119
0.60	0.0599	0.433	0.0261	0.306	0.0110	0.212	0.0043	0.143
0.70	0.0786	0.505	0.0342	0.357	0.0143	0.248	0.0056	0.166
0.80	0.0996	0.577	0.0433	0.407	0.0181	0.283	0.0070	0.190
0.90	0.1227	0.650	0.0533	0.458	0.0223	0.318	0.0086	0.214
1.00	0.1480	0.722	0.0642	0.509	0.0269	0.354	0.0104	0.238
1.20	0.2048	0.866	0.0887	0.611	0.0371	0.424	0.0143	0.285
1.40	0.2699	1.011	0.1167	0.713	0.0487	0.495	0.0188	0.333
1.60	0.3429	1.155	0.1481	0.815	0.0617	0.566	0.0238	0.380
1.80	0.4238	1.299	0.1829	0.917	0.0762	0.637	0.0294	0.428
2.00	0.5125	1.444	0.2209	1.019	0.0919	0.707	0.0354	0.475
2.20	0.6088	1.588	0.2622	1.120	0.1090	0.778	0.0420	0.523
2.40	0.7126	1.732	0.3066	1.222	0.1274	0.849	0.0490	0.570
2.60	0.8239	1.877	0.3542	1.324	0.1470	0.920	0.0565	0.618
2.80	0.9427	2.021	0.4050	1.426	0.1679	0.990	0.0645	0.665
3.00	1.0688	2.165	0.4588	1.528	0.1901	1.061	0.0730	0.713
3.20	1.2022	2.310	0.5157	1.630	0.2136	1.132	0.0819	0.760
3.40	1.3428	2.454	0.5756	1.732	0.2382	1.203	0.0914	0.808
3.60	1.4907	2.598	0.6386	1.833	0.2641	1.273	0.1012	0.855
3.80	1.6457	2.743	0.7045	1.935	0.2913	1.344	0.1116	0.903
4.00	1.8079	2.887	0.7735	2.037	0.3196	1.415	0.1223	0.950
4.20	1.9772	3.032	0.8454	2.139	0.3491	1.485	0.1336	0.998
4.40	2.1536	3.176	0.9202	2.241	0.3798	1.556	0.1453	1.046
4.60	2.3370	3.320	0.9980	2.343	0.4117	1.627	0.1574	1.093
4.80	2.5274	3.465	1.0788	2.445	0.4448	1.698	0.1700	1.141
5.00	2.7249	3.609	1.1624	2.546	0.4791	1.768	0.1830	1.188
5.20	2.9293	3.753	1.2490	2.648	0.5145	1.839	0.1964	1.236
5.40	3.1407	3.898	1.3384	2.750	0.5511	1.910	0.2103	1.283
5.60			1.4307	2.852	0.5888	1.981	0.2246	1.331
5.80			1.5259	2.954	0.6277	2.051	0.2393	1.378

Cold water @ 20°C

S2.5 / SDR 6 / PN20	63 x 10.5		75 x 12.5		90 x 15.0		110 x 18.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 42.00		Do (mm) = 75.00 Di (mm) = 50.00		Do (mm) = 90.00 Di (mm) = 60.00		Do (mm) = 110.00 Di (mm) = 73.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
6.00			1.6240	3.056	0.6678	2.122	0.2545	1.426
6.20			1.7249	3.158	0.7090	2.193	0.2701	1.473
6.40			1.8287	3.259	0.7513	2.264	0.2861	1.521
6.60			1.9354	3.361	0.7948	2.334	0.3026	1.568
6.80			2.0448	3.463	0.8395	2.405	0.3195	1.616
7.00			2.1571	3.565	0.8852	2.476	0.3367	1.663
7.50			2.4502	3.820	1.0045	2.653	0.3818	1.782
8.00					1.1309	2.829	0.4295	1.901
8.50					1.2642	3.006	0.4797	2.020
9.00					1.4045	3.183	0.5325	2.139
9.50					1.5517	3.360	0.5879	2.257
10.00					1.7057	3.537	0.6458	2.376
10.50					1.8666	3.714	0.7062	2.495
11.00					2.0344	3.890	0.7692	2.614
11.50							0.8346	2.733
12.00							0.9026	2.851
12.50							0.9730	2.970
13.00							1.0459	3.089
13.50							1.1213	3.208
14.00							1.1991	3.327
14.50							1.2794	3.446
15.00							1.3621	3.564
15.50							1.4473	3.683
16.00							1.5349	3.802
16.50							1.6249	3.921

PRESSURE TABLE S2.5 / SDR 6 / PN20
HOT WATER @ 60^{0}C

Hot water @ 60°C

S2.5 / SDR 6 / PN20	20 x 3.4		25 x 4.2		32 x 5.4		40 x 6.7		50 x 8.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 20.00 Di (mm) = 13.20		Do (mm) = 25.00 Di (mm) = 16.60		Do (mm) = 32.00 Di (mm) = 21.20		Do (mm) = 40.00 Di (mm) = 26.60		Do (mm) = 50.00 Di (mm) = 33.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.03	0.0644	0.219	0.0217	0.139						
0.04	0.1063	0.292	0.0357	0.185	0.0112	0.113				
0.05	0.1570	0.365	0.0526	0.231	0.0165	0.142	0.0056	0.090		
0.06	0.2163	0.438	0.0724	0.277	0.0226	0.170	0.0077	0.108	0.0027	0.069
0.07	0.2840	0.512	0.0948	0.323	0.0295	0.198	0.0101	0.126	0.0035	0.081
0.08	0.3599	0.585	0.1199	0.370	0.0373	0.227	0.0127	0.144	0.0044	0.092
0.09	0.4437	0.658	0.1475	0.416	0.0458	0.255	0.0156	0.162	0.0054	0.104
0.10	0.5355	0.731	0.1777	0.462	0.0551	0.283	0.0187	0.180	0.0065	0.116
0.12	0.7421	0.877	0.2456	0.554	0.0760	0.340	0.0257	0.216	0.0090	0.139
0.14	0.9793	1.023	0.3232	0.647	0.0998	0.397	0.0337	0.252	0.0117	0.162
0.16	1.2463	1.169	0.4104	0.739	0.1264	0.453	0.0426	0.288	0.0148	0.185
0.18	1.5428	1.315	0.5070	0.832	0.1558	0.510	0.0525	0.324	0.0182	0.208
0.20	1.8686	1.461	0.6128	0.924	0.1880	0.567	0.0632	0.360	0.0219	0.231
0.30	3.9274	2.192	1.2772	1.386	0.3890	0.850	0.1301	0.540	0.0448	0.347
0.40	6.6899	2.923	2.1616	1.848	0.6545	1.133	0.2178	0.720	0.0748	0.462
0.50	10.1454	3.654	3.2610	2.310	0.9825	1.416	0.3258	0.900	0.1116	0.578
0.60			4.5722	2.772	1.3718	1.700	0.4534	1.080	0.1548	0.693
0.70			6.0933	3.234	1.8215	1.983	0.6002	1.260	0.2045	0.809
0.80			7.8229	3.696	2.3308	2.266	0.7660	1.440	0.2604	0.924
0.90					2.8994	2.550	0.9505	1.620	0.3225	1.040
1.00					3.5269	2.833	1.1537	1.799	0.3907	1.155
1.20					4.9572	3.400	1.6151	2.159	0.5451	1.386
1.40					6.6200	3.966	2.1494	2.519	0.7233	1.617
1.60							2.7559	2.879	0.9249	1.848
1.80							3.4342	3.239	1.1497	2.079
2.00							4.1839	3.599	1.3976	2.310
2.20							5.0047	3.959	1.6684	2.541
2.40									1.9620	2.772
2.60									2.2782	3.003
2.80									2.6170	3.234
3.00									2.9784	3.465
3.20									3.3622	3.696
3.40									3.7685	3.927
3.60										

Hot water @ 60°C

S2.5 / SDR 6 / PN20	63 x 10.5		75 x 12.5		90 x 15.0		110 x 18.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 42.00		Do (mm) = 75.00 Di (mm) = 50.00		Do (mm) = 90.00 Di (mm) = 60.00		Do (mm) = 110.00 Di (mm) = 73.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
0.08	0.0015	0.058						
0.09	0.0018	0.065	0.0008	0.046				
0.10	0.0021	0.072	0.0009	0.051				
0.12	0.0029	0.087	0.0013	0.061	0.0005	0.042		
0.14	0.0038	0.101	0.0017	0.071	0.0007	0.050	0.0003	0.033
0.16	0.0048	0.115	0.0021	0.081	0.0009	0.057	0.0003	0.038
0.18	0.0059	0.130	0.0026	0.092	0.0011	0.064	0.0004	0.043
0.20	0.0071	0.144	0.0031	0.102	0.0013	0.071	0.0005	0.048
0.30	0.0146	0.217	0.0063	0.153	0.0027	0.106	0.0010	0.071
0.40	0.0242	0.289	0.0105	0.204	0.0044	0.141	0.0017	0.095
0.50	0.0360	0.361	0.0156	0.255	0.0065	0.177	0.0025	0.119
0.60	0.0498	0.433	0.0216	0.306	0.0090	0.212	0.0035	0.143
0.70	0.0657	0.505	0.0284	0.357	0.0118	0.248	0.0046	0.166
0.80	0.0835	0.577	0.0360	0.407	0.0150	0.283	0.0058	0.190
0.90	0.1032	0.650	0.0445	0.458	0.0185	0.318	0.0071	0.214
1.00	0.1248	0.722	0.0538	0.509	0.0224	0.354	0.0086	0.238
1.20	0.1736	0.866	0.0747	0.611	0.0310	0.424	0.0119	0.285
1.40	0.2298	1.011	0.0987	0.713	0.0409	0.495	0.0157	0.333
1.60	0.2931	1.155	0.1257	0.815	0.0520	0.566	0.0199	0.380
1.80	0.3636	1.299	0.1556	0.917	0.0643	0.637	0.0246	0.428
2.00	0.4411	1.444	0.1886	1.019	0.0779	0.707	0.0298	0.475
2.20	0.5255	1.588	0.2244	1.120	0.0926	0.778	0.0354	0.523
2.40	0.6169	1.732	0.2631	1.222	0.1084	0.849	0.0414	0.570
2.60	0.7151	1.877	0.3047	1.324	0.1254	0.920	0.0479	0.618
2.80	0.8202	2.021	0.3491	1.426	0.1436	0.990	0.0547	0.665
3.00	0.9320	2.165	0.3963	1.528	0.1628	1.061	0.0620	0.713
3.20	1.0507	2.310	0.4463	1.630	0.1832	1.132	0.0697	0.760
3.40	1.1760	2.454	0.4991	1.732	0.2048	1.203	0.0779	0.808
3.60	1.3081	2.598	0.5547	1.833	0.2274	1.273	0.0864	0.855
3.80	1.4469	2.743	0.6131	1.935	0.2511	1.344	0.0954	0.903
4.00	1.5924	2.887	0.6742	2.037	0.2759	1.415	0.1047	0.950
4.20	1.7445	3.032	0.7380	2.139	0.3019	1.485	0.1145	0.998
4.40	1.9033	3.176	0.8046	2.241	0.3289	1.556	0.1246	1.046
4.60	2.0687	3.320	0.8740	2.343	0.3570	1.627	0.1352	1.093

Hot water @ 60°C

S2.5 / SDR 6 / PN20	63 x 10.5		75 x 12.5		90 x 15.0		110 x 18.4	
Peak Flow Rate, Qs (l/s)	Do (mm) = 63.00 Di (mm) = 42.00		Do (mm) = 75.00 Di (mm) = 50.00		Do (mm) = 90.00 Di (mm) = 60.00		Do (mm) = 110.00 Di (mm) = 73.20	
	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)	Head loss (kPa/m)	Velocity (m/s)
4.80	2.2407	3.465	0.9460	2.445	0.3862	1.698	0.1462	1.141
5.00	2.4194	3.609	1.0208	2.546	0.4164	1.768	0.1575	1.188
5.20	2.6047	3.753	1.0982	2.648	0.4478	1.839	0.1693	1.236
5.40	2.7965	3.898	1.1784	2.750	0.4802	1.910	0.1815	1.283
5.60			1.2613	2.852	0.5137	1.981	0.1940	1.331
5.80			1.3469	2.954	0.5482	2.051	0.2069	1.378
6.00			1.4351	3.056	0.5838	2.122	0.2203	1.426
6.20			1.5261	3.158	0.6205	2.193	0.2340	1.473
6.40			1.6197	3.259	0.6582	2.264	0.2481	1.521
6.60			1.7160	3.361	0.6970	2.334	0.2626	1.568
6.80			1.8150	3.463	0.7369	2.405	0.2775	1.616
7.00			1.9167	3.565	0.7778	2.476	0.2927	1.663
7.50			2.1825	3.820	0.8846	2.653	0.3326	1.782
8.00					0.9980	2.829	0.3748	1.901
8.50					1.1180	3.006	0.4195	2.020
9.00					1.2445	3.183	0.4665	2.139
9.50					1.3775	3.360	0.5158	2.257
10.00					1.5170	3.537	0.5676	2.376
10.50					1.6629	3.714	0.6216	2.495
11.00					1.8153	3.890	0.6781	2.614
11.50							0.7368	2.733
12.00							0.7979	2.851
12.50							0.8613	2.970
13.00							0.9271	3.089
13.50							0.9952	3.208
14.00							1.0655	3.327
14.50							1.1382	3.446
15.00							1.2132	3.564
15.50							1.2906	3.683
16.00							1.3702	3.802
16.50							1.4521	3.921
17.00								

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