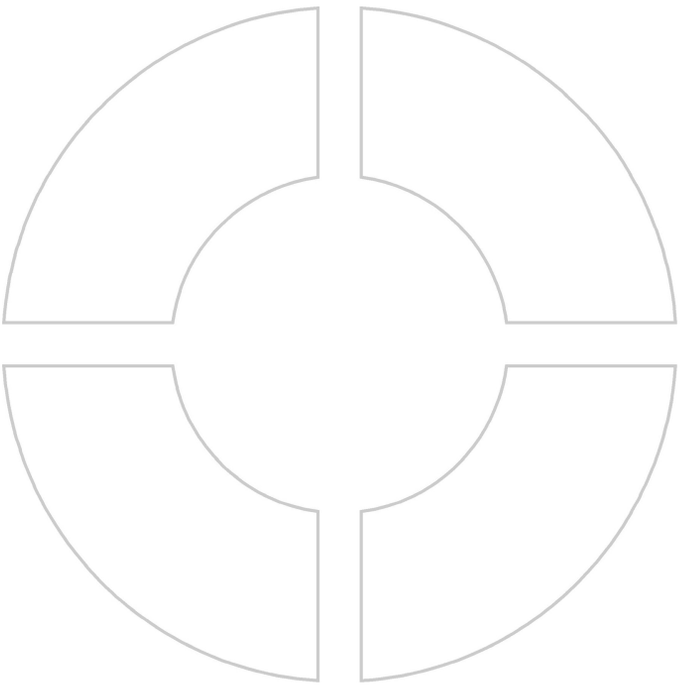
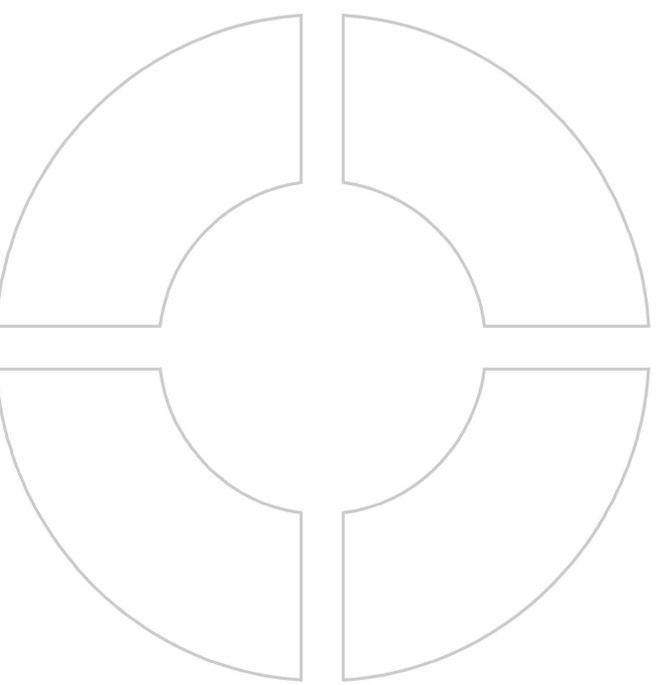




Description of products

The products of the AGRUSAN piping system program are made of PP-R (Polypropylene-Random-Copolymere). Apart from its thermal resistance, this type of material is especially resistant to extractions.

Further advantages of PP-R

- low specific weight - 9 times lighter than iron
- physiological non-toxicity (acc. to ÖNORM B 5014 and KTW-guidelines)
- high internal creep strength
- high heat ageing stability
- very good chemical resistance
- high abrasion resistance
- smooth inner surface of pipes
- no deposits, therefore no "overgrowth"
- less frictional resistance
- non - conductive
- good thermal insulation properties
- good weldability
- easy and safe installation
- easy and safe connection of pipes
- corrosion resistant
- reduced flow stream noises in comparison with metallic pipelines

The pipes and fittings are joined by homogenous socket welding according to DVS 2207, part 11 and ASTM D 2657, electric socket fusion, as well as by unions.

Characteristics of Polypropylene (PP - R)

	Property	Standard	Unit	PP-R
	Specific density at 23°C	ISO 1183	g/cm^3	0,91
	Melt flow index MFR 190/5 MFR 230/2,16 MFR 230/5 MFI range	ISO 1133 ISO1872/1873	g/10min	 0,25 1,25
Mechanical Properties	Tensile stress at yield	ISO 527-2	MPa	25
	Elongation at yield	ISO 527-2	%	13,5
	Elongation at break	ISO 527	%	>300
	Impact strength unnotched at +23°C Impact strength unnotched at 0°C Impact strength unnotched at -20°C	ISO 179	kJ/m^2	no break no break 40
	Impact strength notched at +23°C Impact strength notched at 0°C Impact strength notched at -20°C	ISO 179	kJ/m^2	25 3,5 2
	Ball indentation hardness acc. Rockwell	ISO 2039-1	MPa	45
	Flexural strength (3,5% flexural stress)	ISO 178	MPa	20
	Modulus of elasticity	ISO 527	MPa	900
Thermal Properties	Vicat-Softening point VST/B/50	ISO 306	°C	65
	Heat deflection temperature HDT/B	ISO 75	°C	70
	Linear coefficient of thermal expansion	DIN 53752	$K^{-1} \times 10^{-4}$	1,6
	Thermal conductivity at 20 °C	DIN 52612	W/(mxK)	0,24
	Flammability	UL94 DIN 4102	--	94-HB B2
Electrical Properties	Specific volume resistance	VDE 0303	OHM cm	$>10^{16}$
	Specific surface resistance	VDE 0303	OHM	$>10^{13}$
	relative dielectric constant at 1 MHz	DIN 53483	--	2,3
	Dielectric strength	VDE 0303	kV/mm	70
	Physiologically non-toxic	EEC 90/128	--	Yes
	FDA	--	--	Yes
	UV stabilized	--	--	No
	Colour	--	--	red

Chemical resistance of PP - R to the most commonly used aggressive liquids

General information

Polypropylene displays excellent resistance to non - oxidating acids even at higher temperatures, whereas it is quickly destroyed by oxidizing acids. Some media may cause stress cracking, especially with mechanical stresses being applied at the same time.

Sulphuric acid (H_2SO_4)

Diluted sulphuric acid (up to a concentration of about 50 %) only insignificantly changes the mechanical properties of polypropylene even on long-time reaction at temperatures up to 50°C. At higher temperatures and/or higher concentrations the mechanical properties of PP-R deteriorate, stress cracking is significantly accelerated. With simultaneously imposed mechanical stresses a limited working life may be expected.

Nitric acid (HNO_3)

Concentrated nitric acid reacts with PP-R, thus leading to a quick oxidative degeneration of the material. On reaction of concentrated nitric acid and its fumes PP-R changes its colour and cracks occur of the surfaces. With concentrations higher than 10 % the mechanical properties deteriorate very quickly, with concentration rates only significantly affecting this process now. Simultaneously applied mechanical stresses exercise an important influence on stress cracking.

Remark:
Direct contact between copper and PP-R (especially at higher temperatures) deteriorates the physical properties of PP-R, due to the accelerated thermal oxidation, the heat ageing is accelerated. In general it is recommended not to use PP-R piping systems in connection with copper pipe systems.

Hydrochloric acid (HCl)

Diluted hydrochloric acid (up to about 5 %) at temperatures of up to 100°C does not substantially influence the mechanical properties of PP-R. With a concentration higher than approximately 10 % continuous damage to the material will occur. Furthermore, concentrated hydrochloric acid (above 32%) causes stress cracking especially at higher temperatures. Moreover, when the material contacts with concentrated hydrochloric acid at higher operating temperatures and/or operating pressures discolourisations into dark brown or even black as well as with embrittlement of the material will occur. Diffusion of hydrochloric acid fumes (hydrochloric acid gas) caused by the pipe material may be possible.

Phosphoric acid (H_3PO_4)

Phosphoric acid does not react with PP-R and up to now diffusion has not been proved. PP-R is excellently resistant to this medium. For example, phosphoric acid with a concentration of about 80% and a temperature of 60°C having reacted on PP-R for one year could not cause any changes in the material.

Hydrofluoric acid (HF)

PP-R is resistant to hydrofluoric acid even with a concentration of about 60% and shows no significant changes of mechanical properties. However, upon long-term reaction with concentrations higher than 60% stress cracking may be possible.

Permissible operating pressure for AGRUSAN Piping Systems

These data apply to water (untreated).
The given values represent the loads on pipes and pipe connections of potable water installations likely to be exerted within an operating period of 50 years. The calculated lifetime is witnessed by the results of the internal pressure tests performed of pipes by the raw material suppliers as well as by long term testing of pipes as their ageing stability in fresh, oxygen saturated water of moderate temperature.

AGRUSAN piping system SDR 6 / PN 20 / S - 2,5		
Operating temperature [°C]	Operating period [years]	Permissible operating pressure [bar]
20	50	20,4
30	50	17,3
40	50	14,5
50	50	12,2
60	50	10,1
70	25	8,0
80	25	5,1
95	10	3,4

AGRUSAN piping system SDR 7,4 / PN 16 / S - 3,2		
Operating temperature [°C]	Operating period [years]	Permissible operating pressure [bar]
20	50	16,3
30	50	13,8
40	50	11,6
50	50	9,7
60	50	8,0
70	25	6,4
80	25	4,0
95	10	2,7

AGRUSAN piping system SDR 11 / PN 10 / S - 5		
Operating temperature [°C]	Operating period [years]	Permissible operating pressure [bar]
20	50	10,2
30	50	8,6
40	50	7,2
50	50	6,1
60	50	5,0
70	25	4,0
80	25	2,5
95	10	1,6

For the design and operation of AGRUSAN systems the different operating pressures of the fitting components DA90-PN16 and DA110-PN10 have to be taken in consideration.

Therefore by combination of two different pressure ratings the lower component pressure rating has to be taken into account for the design of the system.

Remark:

PP - R and copper
Direct contact between copper and PP-R (especially at higher temperatures) deteriorates the physical properties of PP-R, due to the accelerated thermal oxidation, the heat ageing is accelerated. In general it is recommended not to use PP-R piping systems in connection with copper pipe systems.

Permissible system operating pressure for AGRUSAN pipes (acc. DIN 8077 - safety factor 1,5 - valid for untreated water and included the system reduction coefficient

Transport

Normally, the pipes are delivered in standard length of 5,0m. The pipes are wrapped in black polyethylene film and are additionally protected at both ends.

For the transport of the pipes consider the following:

- The loading areas should be free of sharp objects (such as stones, metal pieces, ...)
- The pipes should be supported on the loading area by at least 3/4 of their length, in order to prevent them from too strong deflection during transport.

Storage

The pipes should be stored horizontally on an even area, free of sharp objects. The pipes should be piled not higher than 1,0 m and secured against lateral rolling. Principally, it is recommended to store the AGRUSAN pipes and fittings in the black protective covering till usage. If the agrusan pipes are exposured to sunlight they should be protected against UV-radiation.

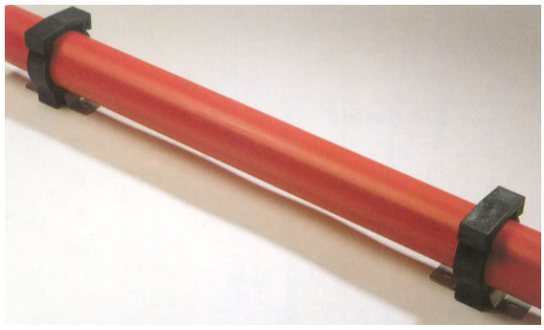
Installation

The installation of AGRUSAN piping systems differences considerably from the installation procedures for metal pipelines. Therefore it is recommended to provide training facilities for every mechanical engineer as to the correct techniques for installing and welding the AGRUSAN products.

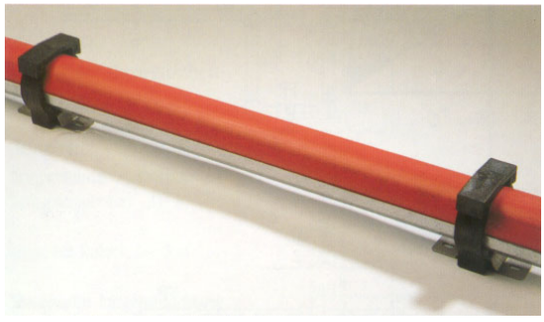
During installation at temperatures of about 0°C avoid flexing of pipes during handling as well as mechanical and impact loading of the pipes. Installations below temperatures of 0°C are not recommended.

Installation Guidelines

Support distances (based on DVS 2210 / Part 1)



recommended pipe support > OD 40mm



recommended pipe support OD20 - OD40mm

For the suspension of the pipes standard pipe cups may be applied. Especially with non-buried pipes it is recommended to use metal support shells for straight pipe lengths, but also take care of the required points of restraint and sliding points.
Points of restraint should be provided close to branches and butterfly valves. Points of restraints, which have not been specified, should be chosen in a way to make use of changes of directions in straight runs of pipes, in order to allow for the absorption of thermal expansions.

Support distances depend on the mechanical properties of the pipe material, pipe dimensions, weight of the flow medium, operating temperature and arrangement of the pipes.

The support distances given in the tables refer to a flow medium with a density of 1 g/cm³ and to horizontally laid pipes.

For the calculation of the support distances a maximum pipe deflection of 2,5 mm between the two pipe clips has been taken as a basis.

At vertical laying the support distance may be increased by 30%.

For liquids with other density values the support distances have to be adapted as follows:

Approximate values for support distance		
Compressed air		+30%
Liquids	1,25 g/cm³	-10%
Liquids	1,50 g/cm³	-15%
Liquids	1,75 g/cm³	-20%

We recommend the usage of agru pipe clips or agru pipeholders.

For pipe-dimensions Ø20 to 40 mm we recommend to install the pipes with continuous pipe supports (see picture). So the support distances can be increased to a usual measure (1,5 - 2,0 m).

Support distances of **AGRUSAN** pipes				
OD [mm]	Support distances L in [mm]			
	20°C*	40°C*	60°C*	70°C*
20	600	550	510	490
25	680	640	600	570
32	810	770	720	680
40	940	890	810	790
50	1060	1020	940	890
63	1230	1190	1110	1060
75	1320	1230	1150	1110
90	1400	1320	1230	1190
110	1570	1490	1360	1280

* ...operating temperature

Installation Guidelines

Thermal expansion (Change of length)

Under thermal influences AGRUSAN pipes expand according to the values shown in the diagram (page 8).

This effect only appears on exposed piping systems.

Remark:
At a below wall installation in which the pipe is restrained by brickwork, no change of length appears because of complete restrained conditions.

For the calculation of the change of length use the following formula:

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

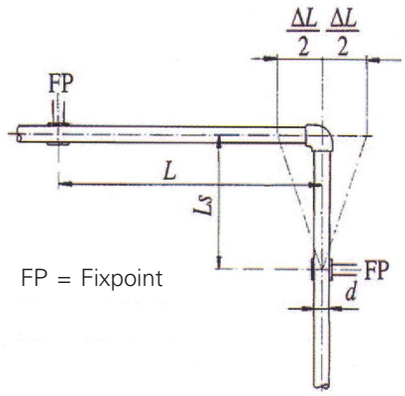
ΔL ...change of length (mm)

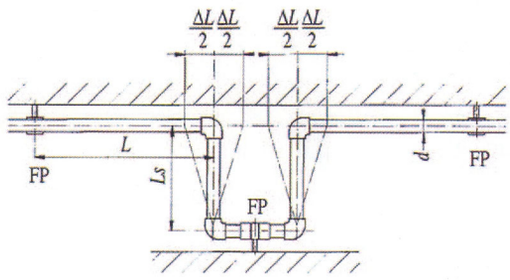
α ...thermal expansion coefficient for PP = 0,15 mm/(m.K)

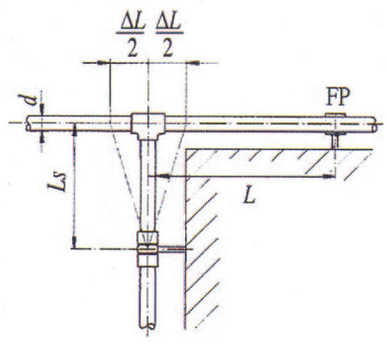
ΔT ...temperature difference (°K)

L ...length of pipe (m)

The lowest and the highest temperatures of the pipe wall (installation, operation) are important for the determination of ΔT. Usually, calculation with rational approximations media or ambient temperature are taken as a basis.







Calculation of length of expansion loop (based on DVS 2210 / part 1)

Changes of length are caused by changes of operating temperatures. With above ground piping systems attention has to be paid to the fact that any axial movements will be compensated sufficiently. In most cases changes of direction in the run of the pipe may be used for the absorption of the changes of length with the help of expansion loop. In this way the path geometry that considers a length Ls absorbs completely the variation L.

The minimum length of expansion loop is expressed by:

$$L_s = C \times \sqrt{d \times \Delta L}$$

L_s ...length of expansion loop (mm)

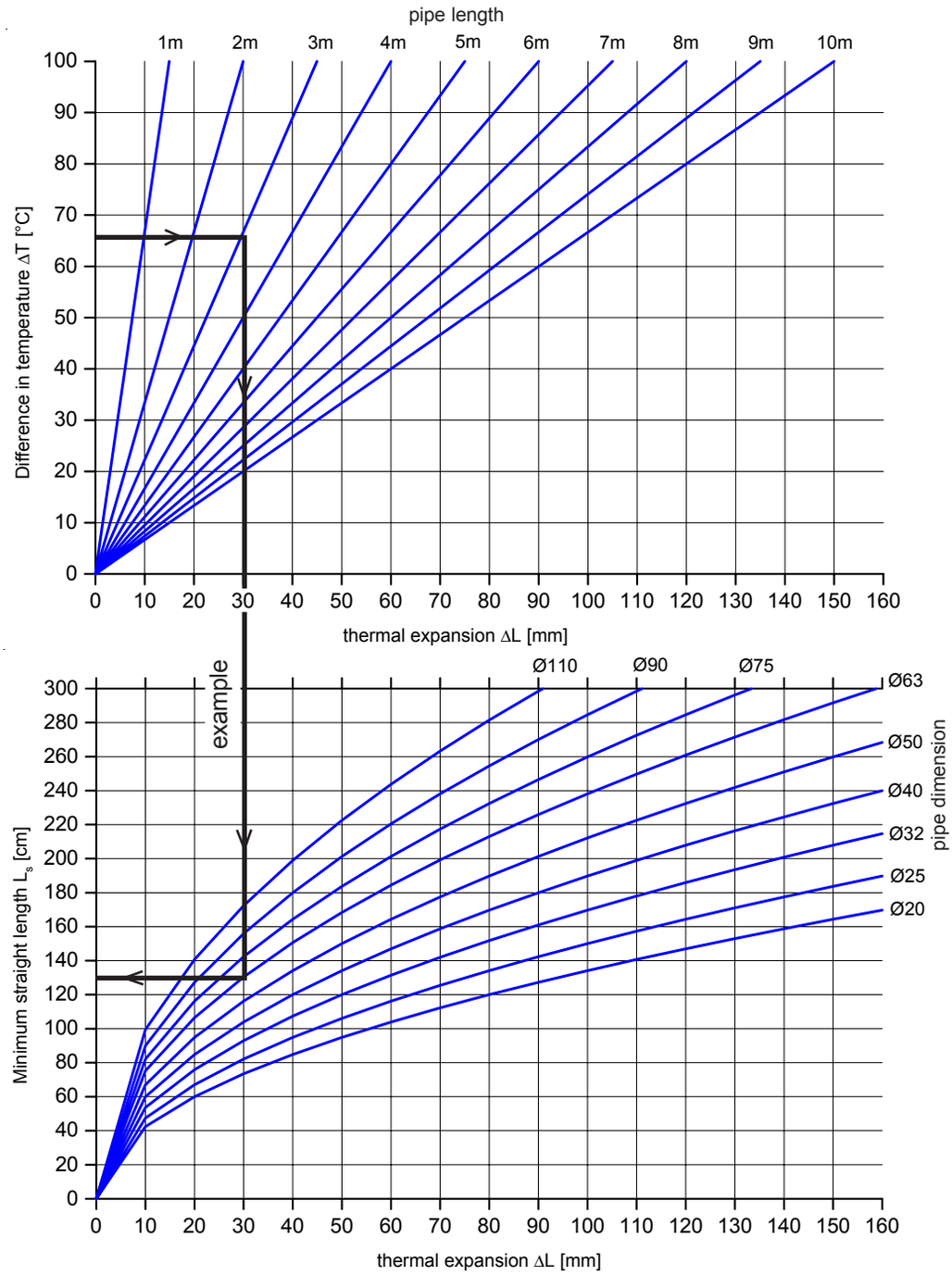
d ...pipe outside diameter (mm)

ΔL ...change of length (mm)

C ...material-dependant constant for PP = 30

Example

Table of theoretical thermal expansion and design of expansion loop



Example:
Difference in temperature (operating and installation temperatures) ΔT: 67°C

Length of pipe: L = 3m

Theoretical longitudinal expansion
ΔL: 30,0 mm

If you want to know the minimum length of the expansion loop for a 63mm pipe, you only have to look at the 63mm-graph in above diagram.

Minimum length of expansion loop:
L_s = 132 cm

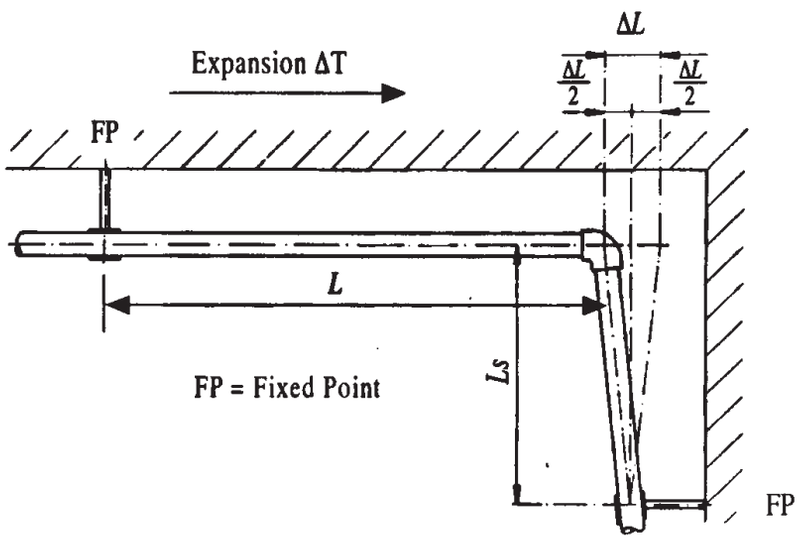
Prestressing method

On applying this method use the equation ΔL/2, as due to prestressing a part of the change of length is compensated by ΔL/2.
This method allows to install the pipe in a prestressed form whereby calculated expansions during a installation are compensated.

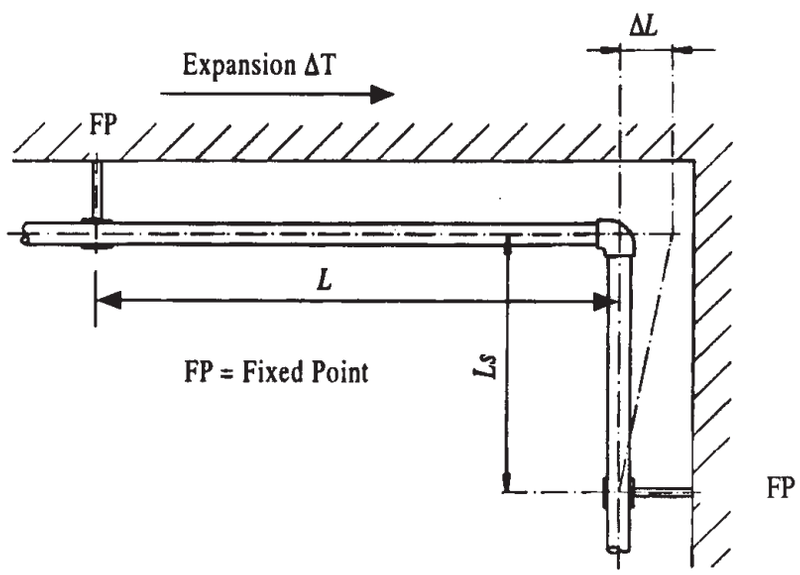
Advantages of the prestressing method:

The straight lengths of elbows, expansion loops and branches will become shorter.

Visually perfect appearance installation during operation,as the thermal expansion movements will hardly be noticed.



Standard method for compensation of change in length



Isulation requirements

For insulation purpose national requirements (codes, standards) should be adapted whereby special recommendations must also be considered as listed below.

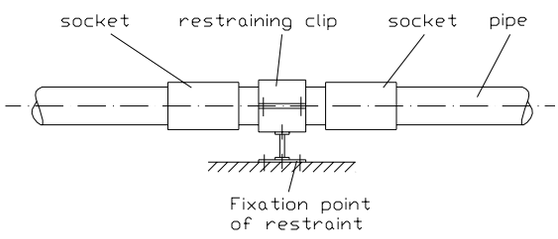
a) Covered installations

- Cold water pipes have to be installed with thin-walled insulation.
- Hot water pipes have to be insulated during installation; in particular, this refers to elbows and branches, which have to be adequately covered, in order to provide sufficient space for expansion.

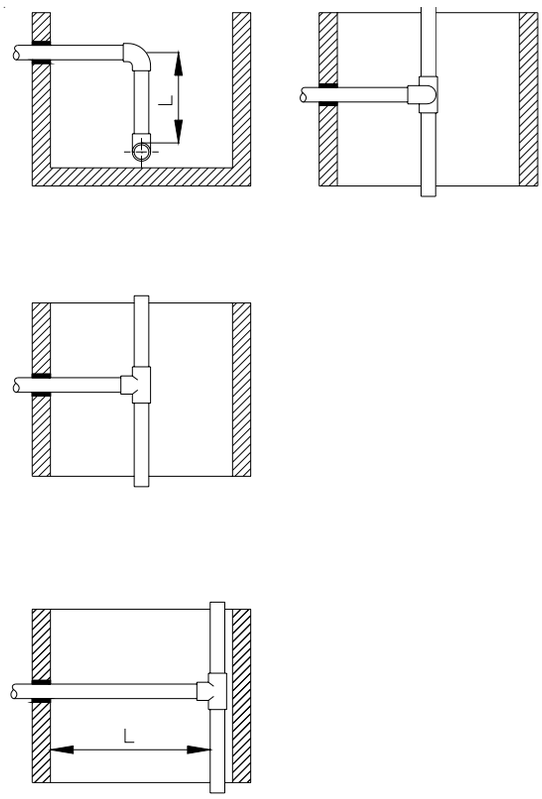
b) Non-covered installations

- Cold water pipes are not required to be encased (except for wall ducts)
- Hot water pipes have to be insulated (minimum 8mm thick)
- Above all, it is necessary to consider the guidelines for the calculation of the
  - length of expansion bend
  - support distances

Example for construction of a restraint point:



c) Installation in shafts and wall ducts



For installation in shafts and wall ducts the guidelines for insulation - as stated for non-covered installation - are recommended.

Pressure test (acc. DIN 1988, part 2)

After installation, the piping system has to be subject to a pressure test prior to initial operation. Particularly at larger projects it is recommended to record the results of the pressure tests. Pressure tests should only commence a minimum of 1 hour after the last weld was done.

1. Preliminary test (at 20°C)

For the preliminary, test a pressure of PN + 5 bar is applied, which may be restored twice within 30 minutes at intervals of 10 minutes. Followed by another test period of 30 minutes the pressure must not decrease more than 0,6bar.

2. Main test (at 20°C)

The main test has to be performed immediately after the preliminary test. The testing period will last for 2 hours. The pressure taken after the preliminary test (PN + 5 bar) must not have dropped more than 0,2bar after 2hours (Temperature changes should be avoided during pressure testing).

After the pressure test it is necessary to adjust the operating pressure.

Pressure test setup and test record

Water installation systems in buildings equipped with the AGRUSAN piping system. Ø 20 - 110 mm, up to 100m long, should be tested in one system. The final inspection (pressure test) is important, because it points out possile loose points in the system (flange connections which are not tightened).

Filling of the piping system and preparations for the test

- The AGRUSAN piping system has to be filled with cold water and vented completely.
- The test pump has to be installed at the lowest point of the piping system.
- For testing use a suitable manometer allowing for pressure changes readings amounting to 0,1 bar.
- The manometer has to be placed at the lowest point of the pipeline.

Basics for the design of AGRUSAN systems

Calculation of piping systems (in accordance with ÖNORM B 2531 / part 1 and part 2)

Each AGRUSAN piping system should be calculated according to the relevant guidelines; it is necessary to consider the following criterias:

Hydrostatic pressure

- hydrostatic pressure of medium as supplied
- changes of hydrostatic pressure according to the level of outlet
- hydrostatic pressure losses in instruments, valves, etc.
- necessary yield hydrostatic pressure
- permissible hydrostatic pressure up to the tapping point

Throughput and load values

- specific throughput of tapping points
- simultaneous tapping of water

Flow speed

- with regard to economic aspects the flow speed should reach at least 1,0 m/s, however it should not exceed 2,0 m/s because of the increasing flow stream noises. A higher flow speed (max. 3,0 m/s) should be chosen only in rare cases.

Determination of nominal pipe width

The determination of the required nominal pipe width is based on 3 methods:

1. Formular

$$ID = 20 \times \sqrt{\frac{10 \times Q}{\pi \times v}}$$

ID = required inside diameter of pipe (mm)

Q = conveyed quantity (dm³/s)

v = flow speed (m/s)

This equation may be used for the initial design of piping systems.

2. Method of approximation by Kelting

3. Method by Prantl - Colebrook

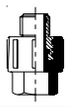
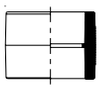
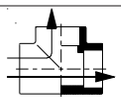
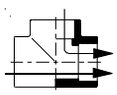
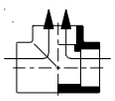
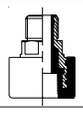
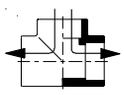
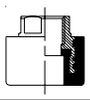
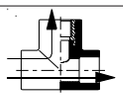
On applying this method of calculation also the hydrostatic pressure losses of the used fittings have to be taken into consideration.

Direct contact between copper and PP-R (especially at higher temperatures) deteriorates the physical properties of PP-R, due to the accelerated thermal oxidation, the heat ageing is accelerated. In general it is recommended not to use PP-R piping systems in connection with copper pipe systems.

Pipe datas

SDR 6 / S - 2,5					
OD [mm]	DR	ID [mm]	s [mm]	Weight [kg/m]	Water volume [dm³/m]
20	1/2"	13,2	3,4	0,172	0,136
25	3/4"	16,6	4,2	0,266	0,216
32	1"	21,2	5,4	0,434	0,353
40	1 1/4"	26,6	6,7	0,671	0,556
50	1 1/2"	33,4	8,3	1,041	0,866
63	2"	42,0	10,5	1,653	1,385
75	2 1/2"	50,0	12,5	2,339	1,963
90	3"	60,0	15,0	3,360	2,827
110	4"	73,4	18,3	5,02	4,231

- In the following table you will find the resistance coefficients (ξ) of typical standard AGRUSAN fittings (20 - 110mm; 1/2" - 4") - valid for water.

Type of fitting	ξ	Type of fitting		ξ
Elbow 90° 	2.0	Adapter union with male thread 	reduced	0.85
Elbow 45° 	0.6	Adapter elbow with female thread 		2.2
Socket 	0.25	Tee (separation) 	equal reduced	1.8 3.6
Reducer up to 2 dimensions 	0.6	Tee (union) 	equal reduced	1.3 2.6
Reducer up to 3 dimensions 	0.85	Tee (reverse direction) 	equal reduced	4.2 9.0
Adaptor union with male thread 	0.4	Tee (reverse direction) 	equal reduced	2.2 5.0
Adapter union with female thread 	0.4	Tee with female thread 		0.8

- Use the following equation for the calculation of pressure losses in fittings.

$$\Delta p_{fitt} = \xi \times \frac{\rho}{2 \times 10^5} \times v^2$$

ξ ...coefficient of resistance

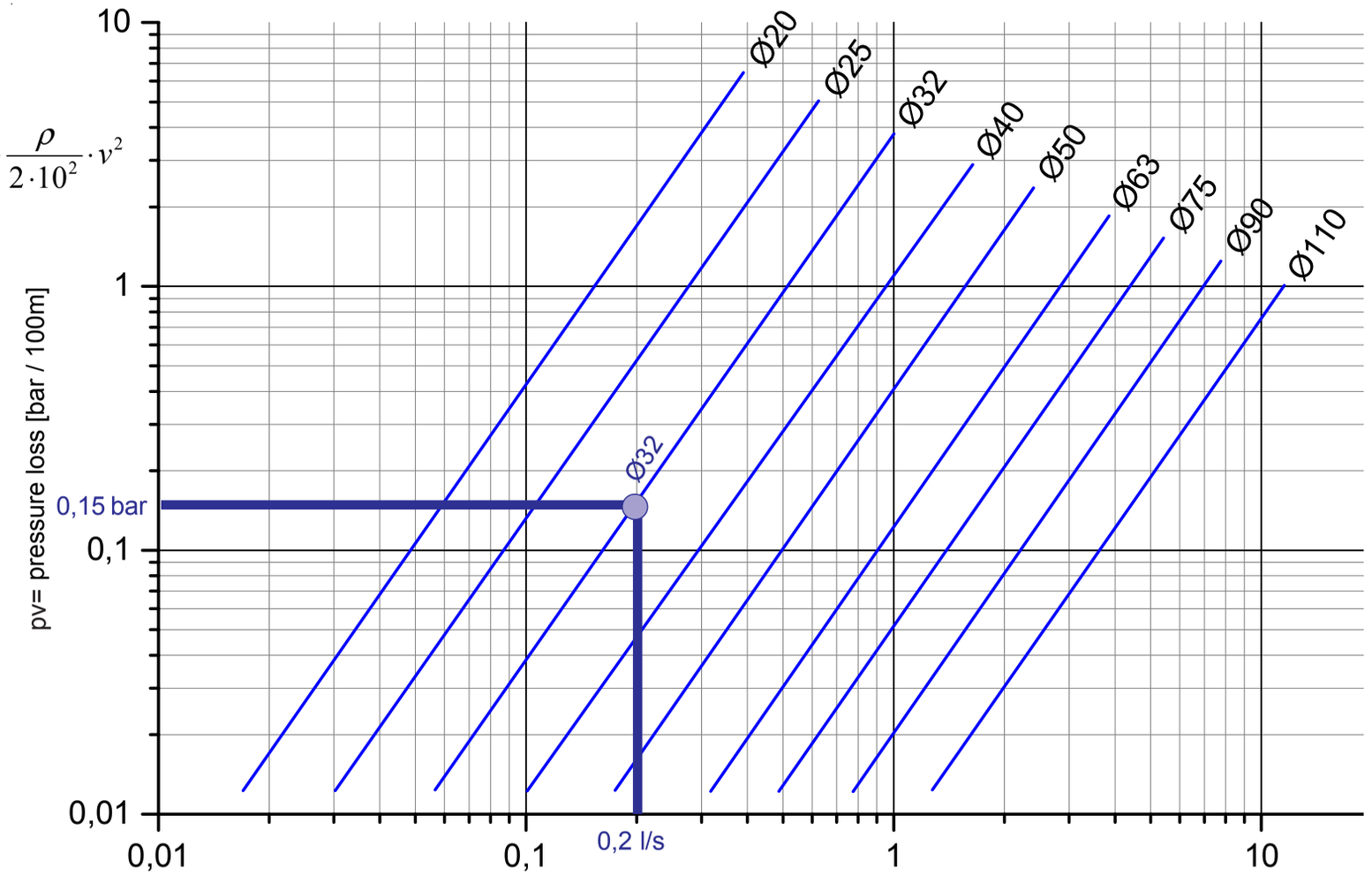
ρ ...density of the flowing medium (g/cm³)

v ...flow speed (m/s)

Pressure drop

Diagram for the calculation of pressure drop in straight AGRUSAN pipes (valid for water at a temperature of approx. 10°C)

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



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

(acc. DVS 2210-1)

pv	...pressure loss (bar)		
λ	...pipe frictional index (in most cases 0,02 is sufficient)		
L	...length of pipe (m)	ρ	...medium density (kg/m³)
di	...inside diameter of pipe (mm)	v	...flow velocity (m/s)

General Information

The welding area has to be protected from unfavourable weather conditions (e.g. moisture, wind, intensive UV-radiation, temperatures <0°C).

Appropriate measures (e.g. preheating, tent-covering, heating) may be necessary to ensure that the required pipe wall temperature will be maintained. Welding operations may be performed at any outside temperatures, provided, that it does not interfere with the welder´s manual skill.

If necessary, the weldability has to be proved by performing sample welding seams under the given conditions.

If pipe areas should be disproportionately warmed up as a consequence of intensive UV-radiation, it is necessary to take care for the equalization of temperature by covering the welding area in good time.
On applying any of these methods, keep the welding area clear of flexural stresses (e.g. careful storage, use of dollies).

The joining areas of the parts to be welded must not be damaged or contaminated.

Immediately before starting the welding process, the joining areas have to be cleaned.

Application limits for different kinds of joints

If possible, all joints have to be executed so as to avoid any kind of stresses. Stresses which may arise from differences in temperature between laying and operating conditions must be kept as low as possible by taking appropriate measures.

Adhesive connections

With polyolefines adhesive connections are not applicable due to their proper chemical resistance.

Welded connections

General information for welding of AGRUSAN systems:

- Use suitable welding devices
- Employ well - trained personal
- Comply with welding guidelines
  - The welding areas of fittings and pipies should be clean

Heating element socket welding
(acc. welding guideline DVS 2207/Part 11 for PP)

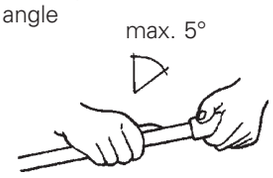
Welding method

In heating element socket welding, pipe and fittings are lap-welded. The pipe end and fitting socket are heated up to welding temperature by means of a socket-like and spigot-like heating element and afterwards, they are joined.

The dimensions of pipe end, heating element and fitting socket are coordinated so that a joining pressure builds up on joining (see schematic sketch).

Heating element socket welding may be manually performed up to pipe outside diameters of 40 mm. Above 40mm, the use of a welding device is recommended because of increasing joining forces.

After alignment the parts only can be adjusted in an angle of max 5°.

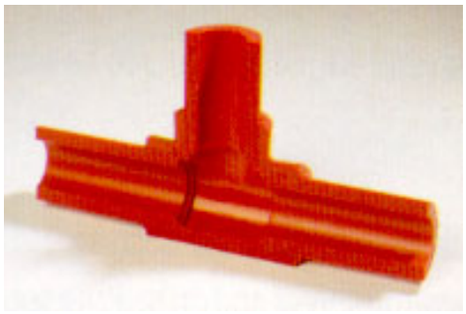


The guidelines of the DVS are to be adhered to during the whole welding process!

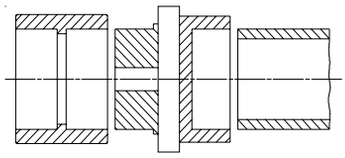
Welding parameters

Welding temperature (T)
PP-R 250 - 270°C

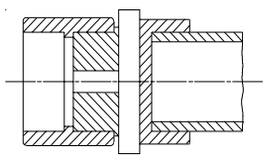
Reference values for heating element socket welding of AGRUSAN fittings made of PP-R at an outside temperature of about 20°C and with moderate winds (see enclosed table).



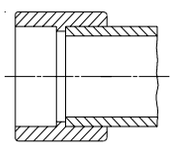
schematic sketch of the welding process



preparation of the welding



alignment and pre-heating



joining and cooling

AGRUSAN fittings for socket welding comply with DIN 16962.

OD [mm]	Preheating time [sec.]	Joining time [sec.]	Cooling time [min.]
20	5	4	2
25	7	4	2
32	8	6	4
40	12	6	4
50	12	6	4
63	24	8	6
75	30	8	6
90	40	8	6
110	50	10	8

Electro socket welding

Check:
The clamping device has to be loosened and the pipe ends must be inserted until the markings are directly visible on the socket ends.

Performing the welding process

Observe the operating instructions for the welding device. Only the most significant steps of the welding procedure are described as follows.

Both plug-type socket connections should be turned upwards (however the axial position of the socket must not be changed) and connected with the welding cable. Position welding cable so as to prevent its weight from twisting the welding socket.

After the welding equipment has been properly connected, this is shown on the display.

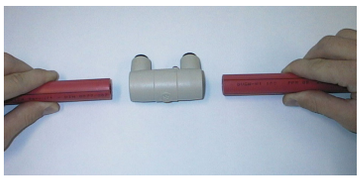
The welding parameters are recorded by means of a reading pencil or a scanner. An audio signal will acknowledge the data input.

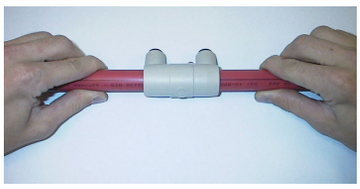
After the welding parameters have been recorded in, the trademark, dimension and outside temperature are shown on the display. These values now have to be acknowledged. Then, for control purposes, you will be asked, whether the pipe worked.

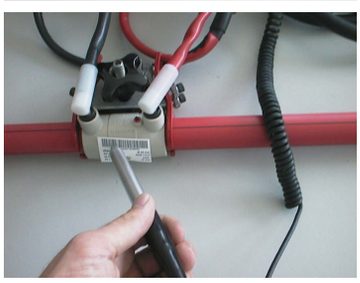
The welding process is started by pressing the green start key on the fusion equipment. The display shows the desired and the actual welding time as well as the welding voltage.

During the whole welding process (including cooling time) the clamping device shall remain installed. The end of the welding process is indicated by an audio signal.

After the cooling time has finished, the clamping device may be removed. The recommended cooling time must be provided! If a welding process is interrupted (e.g. in cas of a power failure), it is not permissible to reweld the same socket.







Visual control and documentation

Visual weld control is performed by the welding indicator on the socket.
Moreover, all welding parameters are stored internally by the welding device and can be printed to produce a welding record.

Threaded connections

a) Threaded parts with plastic inserts

- The thread should be sealed with PTFE tape of a jointing compound which will not cause stress cracking in plastics.
- Take care not too overtighten. Usually hand tight plus 1/2 - 1 extra turns will be sufficient.
- On mounting of metal threads take care to insert them straight into the plastic thread.
- In some cases, the neglection of these instructions might damage the plastic thread.

b) Threaded parts with metal inserts

- When connecting to valves etc., do not insert them too far (consider threaded length - ref. supply program).
- The thread can be sealed with hemp or teflon pipe joint compound (non petroleum base).
- In some cases, the neglection of these instructions might cause bursting or destruction of the metal inserts.

Flange connections

Flange connections have to be tightened by means of a torque key according to the torque values given in the table.

On choosing the sealing material special attention has to be paid to its chemical and thermal suitability.

Remark:

When tightening a threaded connection the torque must not exceed 40 Nm.

OD [mm]	Quantity of bolts	Thread	Torque [Nm]
20	4	M12	15
25	4	M12	15
32	4	M12	15
40	4	M16	25
50	4	M16	35
63	4	M16	35
75	4	M16	40
90	8	M16	40
110	8	M16	40

Range of Applications

The AGRUSAN piping system is designed for a continuous operating temperature of **60°C** at a maximum operating pressure of **10bar.**

For applications, such as heating systems, the AGRUSAN piping system may also be used at higher operating temperatures (related to the permissible operating temperature - see page 4).

The specified properties allows AGRUSAN for the following applications:

- Cold and hot water supply
- Heating system installations

In all application areas noted the above AGRUSAN piping system program may be used both for new installations and the refurbishment of existing piping systems.

REMARK !

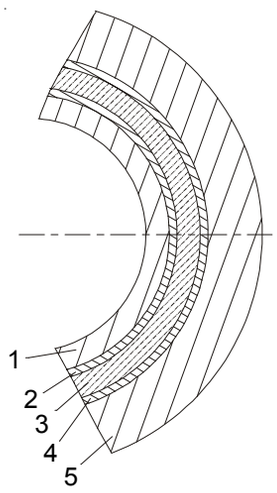
Before applying the AGRUSAN piping system for the transport of aggressive media it is necessary to check the chemical resistance. (Chemical resistance checks are provided on request by our technical department).

PE-RT - natural - heating pipe

The PE-RT - natural - piping system is designed for wall and floor heating with a maximum continuous operating temperature of **65°C** at **4 bar** maximum operating pressure. This pipe has a special 5-layer-structure with an inside oxygen barrier which provides an optimum protection of this layer against damages and abrasion. Furthermore, there is no negative influence at socket fusion.

Schematic structure:

1 - Basic material
2 - Adhesive
3 - EVOH barrier
4 - Adhesive
5 - Basic material



Joining methods:

- Heating element socket welding:

Temperature: 250-270°C

	17x2,0	10x1,5
Preheating time	4 sec	3 sec
Adjusting time	4 sec	4 sec
Cooling time	6 sec	6 sec
Cooling time total	2 min	2 min

Mentioned values are reference values in accordance to DVS 2207 part1 for PE-HD

- Clamped joint:

Standard adaptors - Eurokonus

Material properties PE-RT

Specific density at 23°C	
ISO 1183	0,933 g/cm³
Melt index	
ISO 1133 190°C/2,16kg	0,7 g/10min
ISO 1133 190°C/5,00kg	2,2 g/10min
Tensile stress at yield	
ISO 527	16,5 MPa
Elongation at yield	
ISO 527	13 %
Elongation at break	
ISO 527	>800 %
E-modulus	
ISO 527	~ 580 MPa
Linear coefficient of thermal exp.	
DIN 53752	1,95 10^{-4}/K

Permissible operating pressures for PE-RT piping system:

PE-RT - pipe 17x2,0 & 10x1,5

20°C	8,7 bar
30°C	8,3 bar
40°C	7,3 bar
50°C	6,5 bar
55°C	6,0 bar
60°C	5,0 bar
65°C	4,0 bar

Mentioned values are valid for 50 years life time and medium water.

Installation guidelines for PE-RT :

Minimum bending radius: 5xOD

17x2,0 = 85mm
10x1,5 = 50mm

Standards ans Specifications

DIN 8077	PP pipes - Dimensions
DIN 8078	Pipes made of PP-R (type 3) - General quality requiremens, testing
DIN EN 12108	Plastic piping systems - Recommended practice and techniques for the installation inside building structures of pressure piping systems for hot and cold water intended for human consumption.
ÖNORM EN 12202	Plastic piping systems for hot and cold water - Polypropylene (PP)
ÖNORM EN ISO 15874-1	Plastic piping systems for hot and cold water installations - Polypropylene (PP)

Internal Quality Control

Based on our long-standing experience in the production of pipes and fittings out of polyolefines and owing to a consistently performed internal control, the quality or our products considerably exceed the minimum requirements of the relevant international standards. In the AGRU quality control system all AGRUSAN products are continuously inspected in accordance with the relevant standards.

The internal quality control comprises:

Control of documents for material delivered by raw material supplier:

- meltflow index
- density
- moisture content

Incoming control of raw material:

- meltflow index
- moisture content
- colour

Production control:

- colour
- marking
- surface condition
- dimensions
- X-ray investigation (only for fittings)

Quality control:

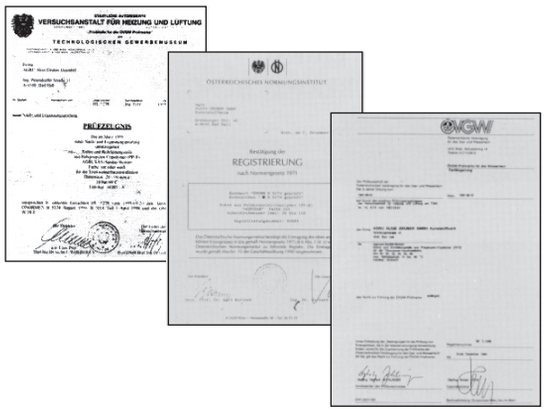
- internal pressure test
- dimensions
- heat reversion
- impact test

Final inspection:

- visual control
- packaging

External Quality Control

In addition to internal control AGRUSN products are continuously checked and registered by 3rd party institutes.



Marking

Pipes

During production the pipes are continuously marked at distances of 3 feet (1000mm) by durable printing.

Fittings for socket welding

The marking of fittings includes the serial number, the dimensions, the moulding-material-identification and the trademark.