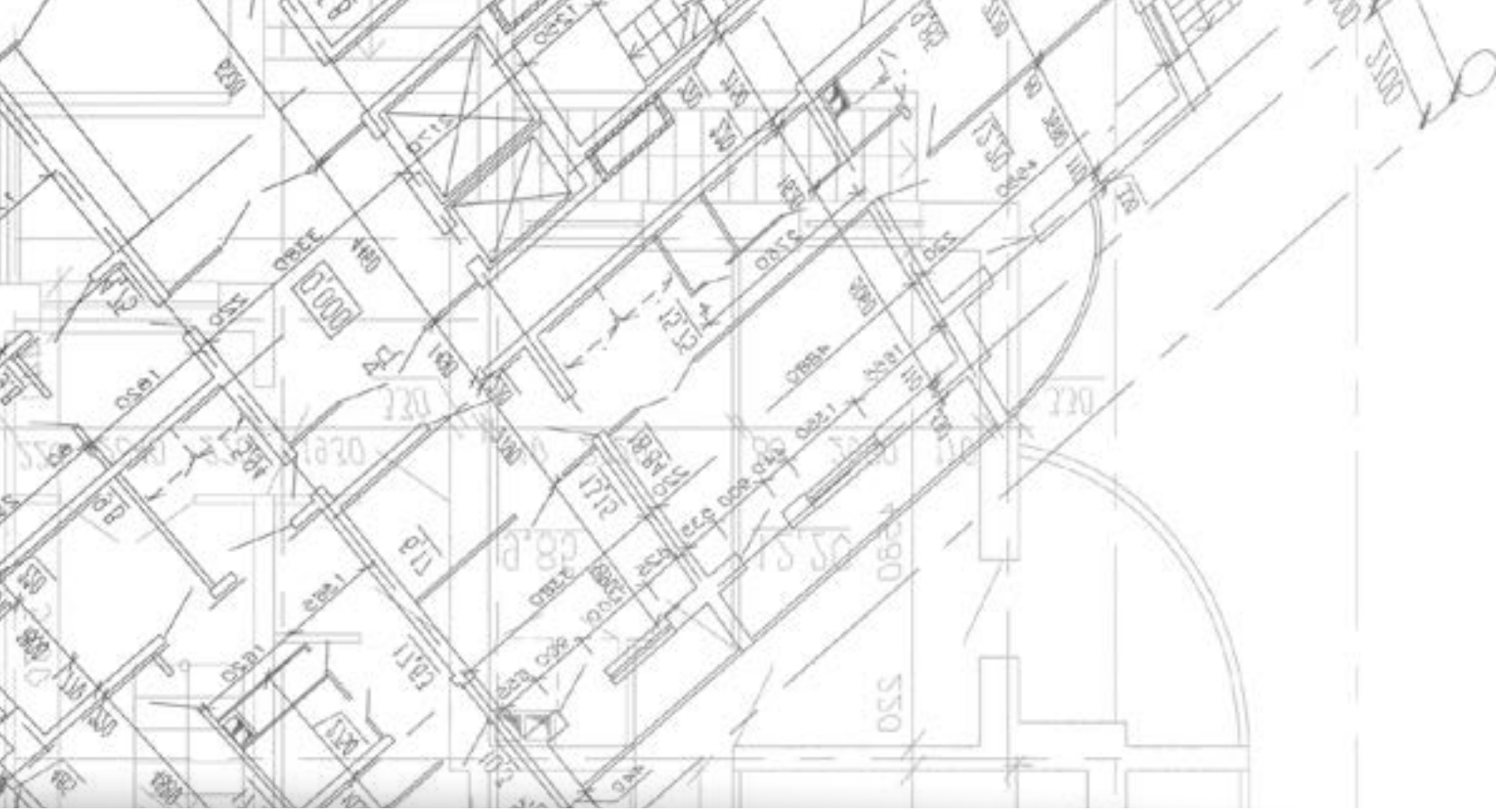
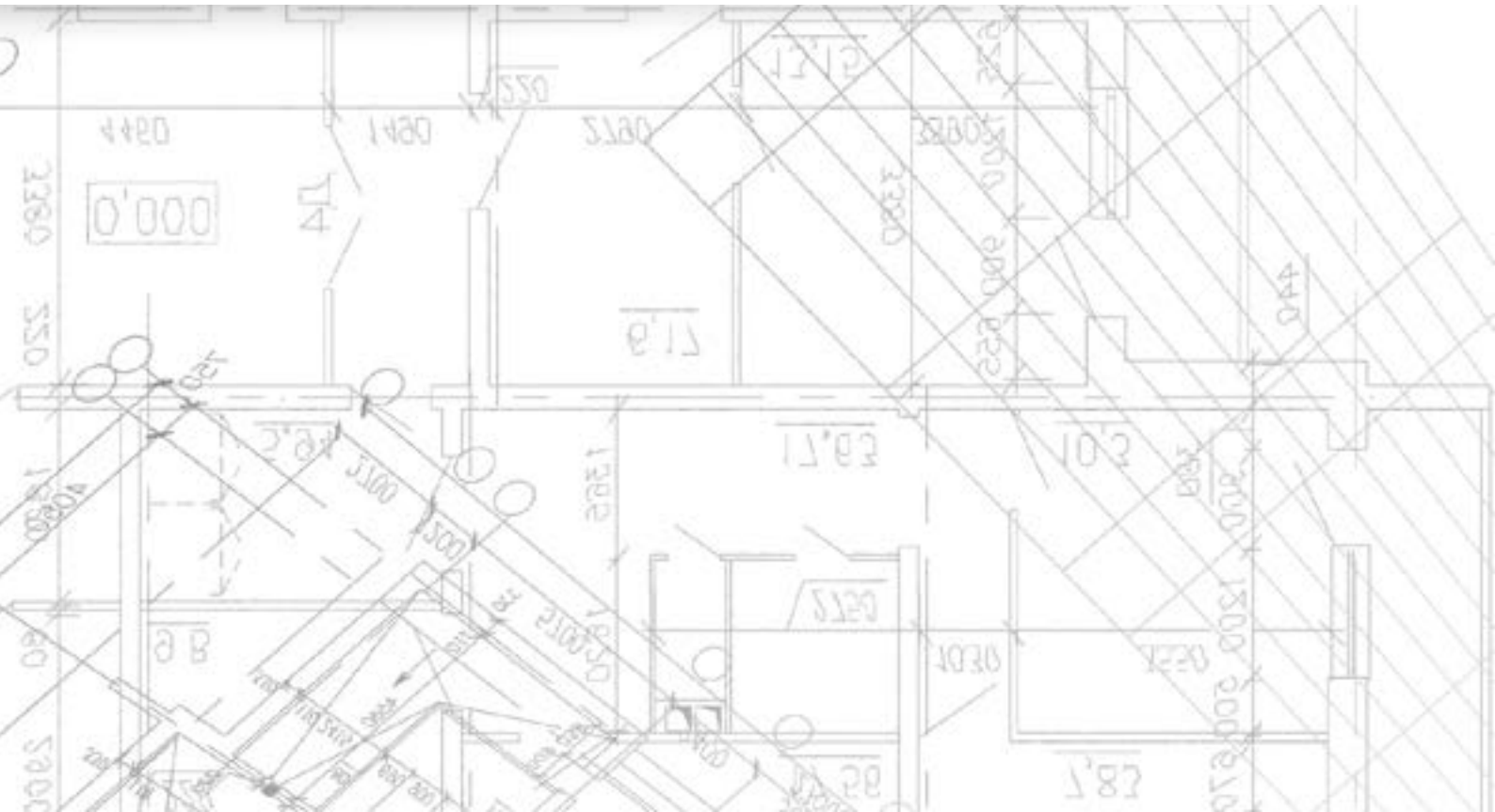


REPOLEN®

PPR AND PE-100 TECHNICAL MANUAL



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COMPANY

REBOCA, SL is a company with 100% Spanish capital, which was founded in 1981 having as its main activity the recovery and recycling of plastic materials.

After some time, the company began to diversify its product range, entering the drip irrigation fittings and piping market. Little by little, the offer of fittings was extended, until in 1985, REBOCA, SL begins to manufacture piping for the supply of pressurised water.

This represents a major growth for the company since the service to clients is not only provided in terms of piping, but also in relation to all fittings necessary for the installation assembly, both of irrigation and pressurised water.

While the company grows in this sense, it abandons the recovery and recycling of materials, in order to be able to focus its efforts on piping manufacture.

In 1992, the random polypropylene (PP-R), piping and fittings for the pressurised hot and cold water pipeline, for heating, cooling, hot water system, sanitary water and water for human consumption REPOLEN product range was added to our catalogue.

In 1994 an entire line of piping and fittings made in high-density polyethylene (PE-100) for pressurised cold water pipelines, sanitary water and water for human consumption, recycled water, gas, hydrocarbons; joined by polyfusion with socket system was added, obtaining a complete range of products easy to install and with the same connection technique. This made it possible to complete the offer for installations.

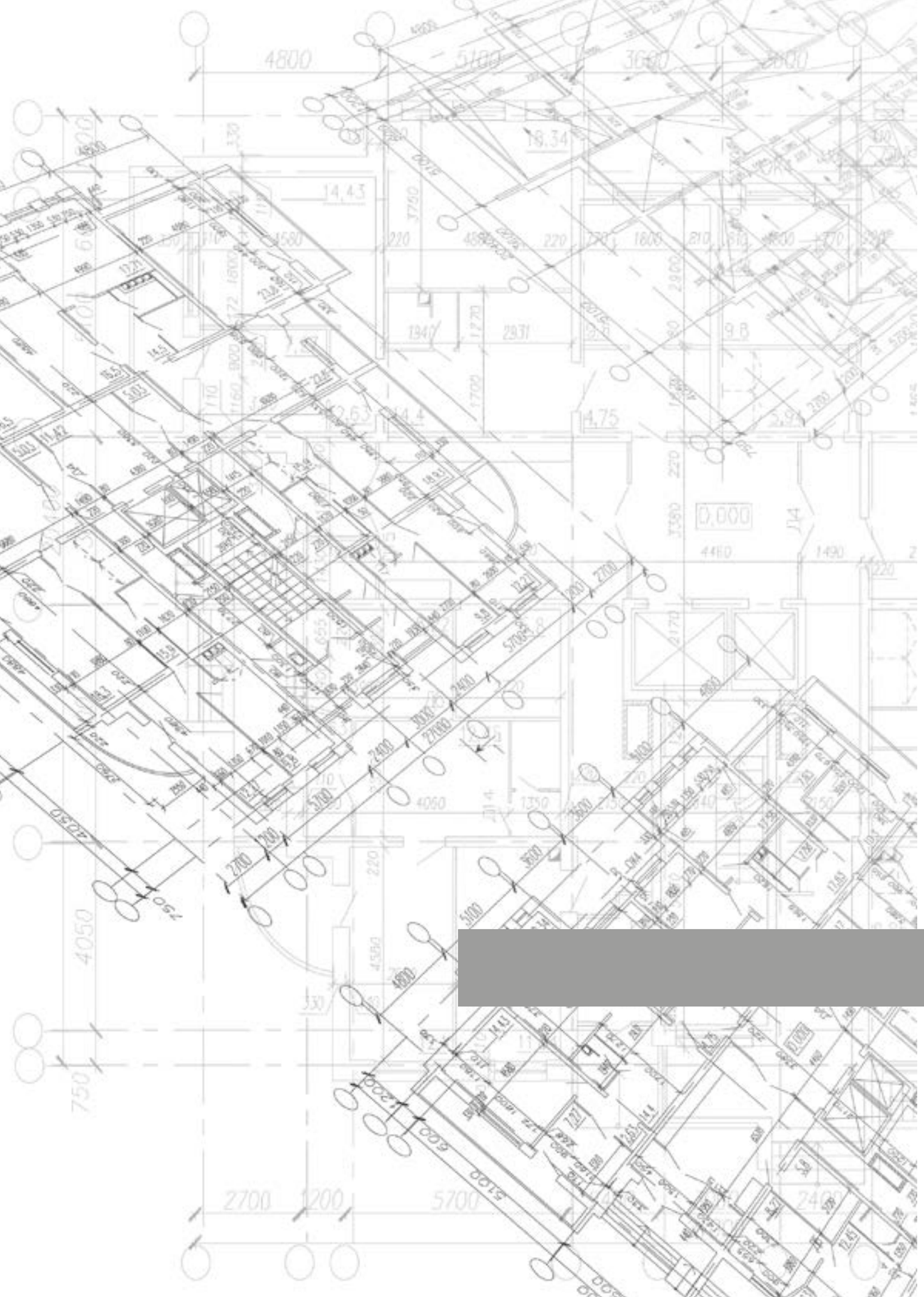
Since then and until now, REBOCA, S.L. has been working on PE-32 and PE-40 pipe manufacture for irrigation and pressure, PE-100 for pressurised cold water and PP-R for pressurised cold and hot water, as well as the necessary fittings.

- In January 2001, the Company Registration Certificate according to UNE-EN ISO 9001 was granted by AENOR. At the end of March of the same year, the AENOR N mark was granted for PP-R pipe manufacture in our facilities in L'Ollería (Valencia).
- In December of the same year, the AENOR N mark for PE-100 pipe manufacture was obtained.
- In June 2002 the AENOR N mark for PE-40 and PE-32 pipes for microirrigation was obtained.
- The PP-R fittings are certified in 2007.
- In 2009 the REPOLEN PP-R system is certified.
- In 2010, DNV certification for PE-100 and PP-R and AENOR N certification for PE-100 and PP-R batteries and manifolds were obtained.
- In 2011, the AENOR N mark for PE-100 gas pipes is obtained.
- In 2013, the AENOR N certification for PE-RT (temperature resistant polyethylene) pipes for heating water and radiant floor was obtained.
- In 2015, the Faser multilayer (PP-R / PP-R with fibre glass / PP-R) pipe for pressurised hot water, cooling and hot water system certification was obtained.

Currently and by exclusive decision of REBOCA, S.L. and under commercial criteria, the following certifications are maintained:

- PP-R pipes
- PP-R Fittings
- REPOLEN system in PP-R
- PE-100 pipes for water
- PE-100 pipes for gas
- PE-40 Pipes
- PE-RT pipes
- Faser Multilayer Tubes

One of the main concerns of REBOCA, S.L. has been and continues to be to offer our clients products with the highest quality, for this purpose we have been adapting our facilities and our products catalogue to their needs.



QUALITY

2.1 Applicable standards
2.2 Reference documents
2.3 Quality control laboratory
2.4 Certificates

2.1 APPLICATION STANDARDS

- UNE IN 1555: Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE)
- UNE IN 12201: Plastics piping systems for water supply Polyethylene (PE)
- UNE IN ISO 15874: Plastics piping systems for hot and cold water installations Polypropylene (PP)
- UNE 53394 IN: Plastics. Code for the installation and handling of polyethylene (PE) pipes for water piping under pressure. Recommended Techniques
- UNE 53943: Plastic networks to centralise water meters. Polyethylene (PE), polypropylene (PP) and polybutylene (PB) networks with butt welded joints
- RP 001.01: Specific AENOR N marking regulations for polyethylene (PE) pipes for water supply and sanitation under pressure.
- RP 001.52: Specific AENOR N marking regulations for plastic piping systems for hot and cold water installations.
- RP 001.72: Specific regulations for the AENOR certificate of conformity for polypropylene (PP-R) and fibreglass (FV) piping systems for hot and cold water installations inside the structure of buildings.
- RP 01.73: Specific AENOR N marking regulations for polyethylene (PE) fittings for the supply of gaseous fuels.

2.2 REFERENCE DOCUMENTS

- CTE: Technical Building Code
- RITE: Regulation of Thermal Installations in Buildings
- ISO 9001: Quality management systems. Requirements
- ISO 14001: Environmental management systems. Requirements with guidance for use
- UNE 53943: Plastic networks to centralise water meters. Polyethylene (PE), polypropylene (PP) and polybutylene (PB) networks with butt welded joints
- UNE 53959 IN: Plastics. Thermoplastics pipes and fittings for the transport of liquids under pressure. Calculation of head losses
- UNE-EN 476: General requirements for components used in discharge pipes, drains and sewers for gravity systems
- UNE-EN 752: Drain and sewer systems outside buildings
- UNE-EN 805: Water supply - Requirements for systems and components outside buildings
- UNE-EN 806: Specifications for installations inside buildings conveying water for human consumption
- UNE-EN 1295: Structural design of buried pipelines under various conditions of loading.
- UNE-EN 1610: Installation and testing of sewage connections and networks.
- UNE-EN 12666: Plastics piping systems for non-pressure underground drainage and sewerage Polyethylene (PE)
- UNE-EN 13244: Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage Polyethylene (PE)
- UNE-EN 13476: Plastics piping systems for non-pressure underground drainage and sewerage Structured-wall piping systems of unplasticised poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE)
- UNE-EN 13689: Guidance on the classification and design of plastics piping systems used for renovation
- UNE-EN 14409: Plastics piping systems for renovation of underground water supply networks
- UNE-EN 50086: Conduit systems for cable management
- UNE-EN ISO 15494: Plastics piping systems for industrial applications. Polybutene (PB), polyethylene (PE), and polypropylene (PP). Specifications for components and the system. Metric Series
- UNE-ENV 12108: Plastics piping systems Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption
- Polyethylene piping. Technical Manual. ASETUB

QUALITY CONTROL LABORATORY 2.3

- Equipment for the control of the fluidity index
- Equipment for controlling the contents of fibre glass, ashes, carbon black, etc.
- Dimensional inspection equipment (inner and outer caliper, circrometer, micrometer, magnifying glass)
- Equipment for water tightness control
- Equipment for longitudinal shrinkage control
- Equipment for resistance to cracking control
- Equipment for tensile test control
- Equipment for impact resistance control
- Equipment for internal pressure resistance control

CERTIFICATES 2.4

Company Certificates

AENOR

IQNET

Product Certificates

AENOR THERMO-WELDABLE PPR SYSTEM

AENOR PPR PIPING

AENOR PPR FITTINGS

Product Certificates

AENOR PE 100 PIPELINES

AENOR GAS PIPELINES

Product compliance certificates

AENOR FASER PIPELINES

WARRANTIES

The REPOLEN® system used in hydro-sanitary installations, following the guidelines indicated in the Technical Manual, is covered by an insurance policy contracted by REBOCA, S.L. TRANSFORMADOS PLASTICOS; with the company GROUPAMA; Policy no. 63,132,771 for a value of 1,202,040 euros.

The conditions governing this warranty are:

- Send the warranty certificate within 10 days of completion of the installation.
- The pipes and fittings must be installed following the instructions, warnings, and recommendations contained in the REPOLEN® Technical Manual.
- Insurance coverage will be for 10 years from the date of production marked on the pipe and fittings. Within this time frame, damages up to 1,202,040 euros, caused both to objects or people, by the breakage of a REPOLEN® pipe or fitting with manufacturing defects, will be compensated.

The warranty is not valid in the following cases:

The connection between the pipe and the fitting, with heat source with temperature and pressure limits, even if accidental, is not compatible with the features of the material used by the REPOLEN® system.

- Failure to follow the instructions for use, warnings, and recommendations in the REPOLEN® Technical Manual.
- Use of obviously defective materials (cracked pipes and fittings, etc.)
- Use of components not manufactured by REPOLEN® / REBOCA, S.L. for the execution of the installation
- Incorrect or defective welding due to the use of unsuitable fittings.

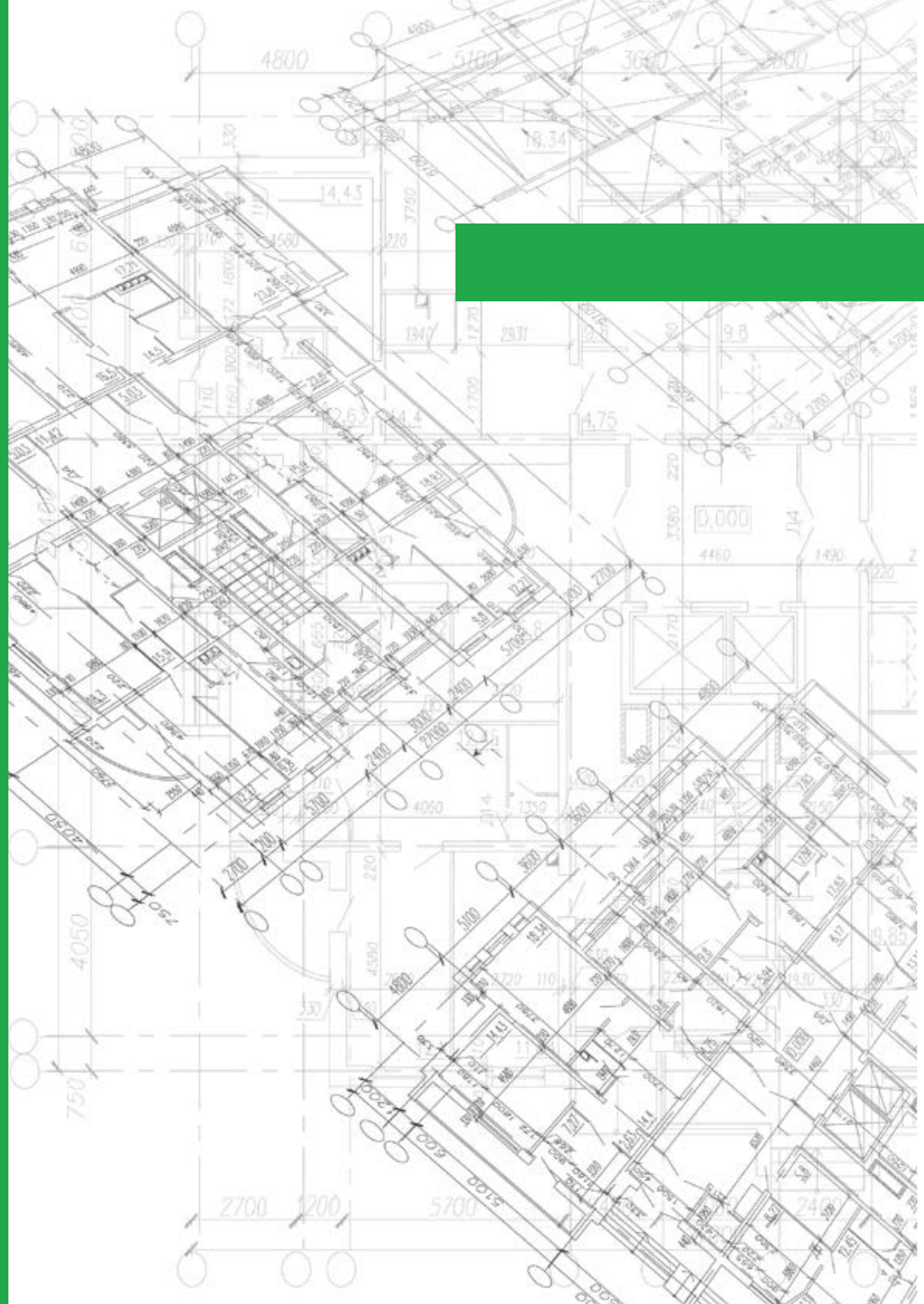
Instructions for Claiming Warranty Intervention:

In the event of damage attributable to the pipe or fitting, and only for the reasons described above, you must inform REBOCA, S.L. by registered letter of the type of damage and send the damaged piece of pipe or the fitting, as well as a copy of the Warranty Certificate, which must include:

- Place and date of installation.
- Name and address of the installer.
- Marking of the pipe or fitting, if possible on the product or on the container.

After receiving the above in our Company, within a reasonable time frame, our company will make the necessary arrangements and transfer the documentation received to the Insurance Company.

Any payment made by REBOCA, S.L. to carry out the procedures with the Insurance Company will be borne by the claimant, if the reasons for the breakage are not those foreseen within the warranty.



PPR

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18 Physico-chemical properties 4.2
19 Chemical resistance 4.3
19 Regression curves 4.4

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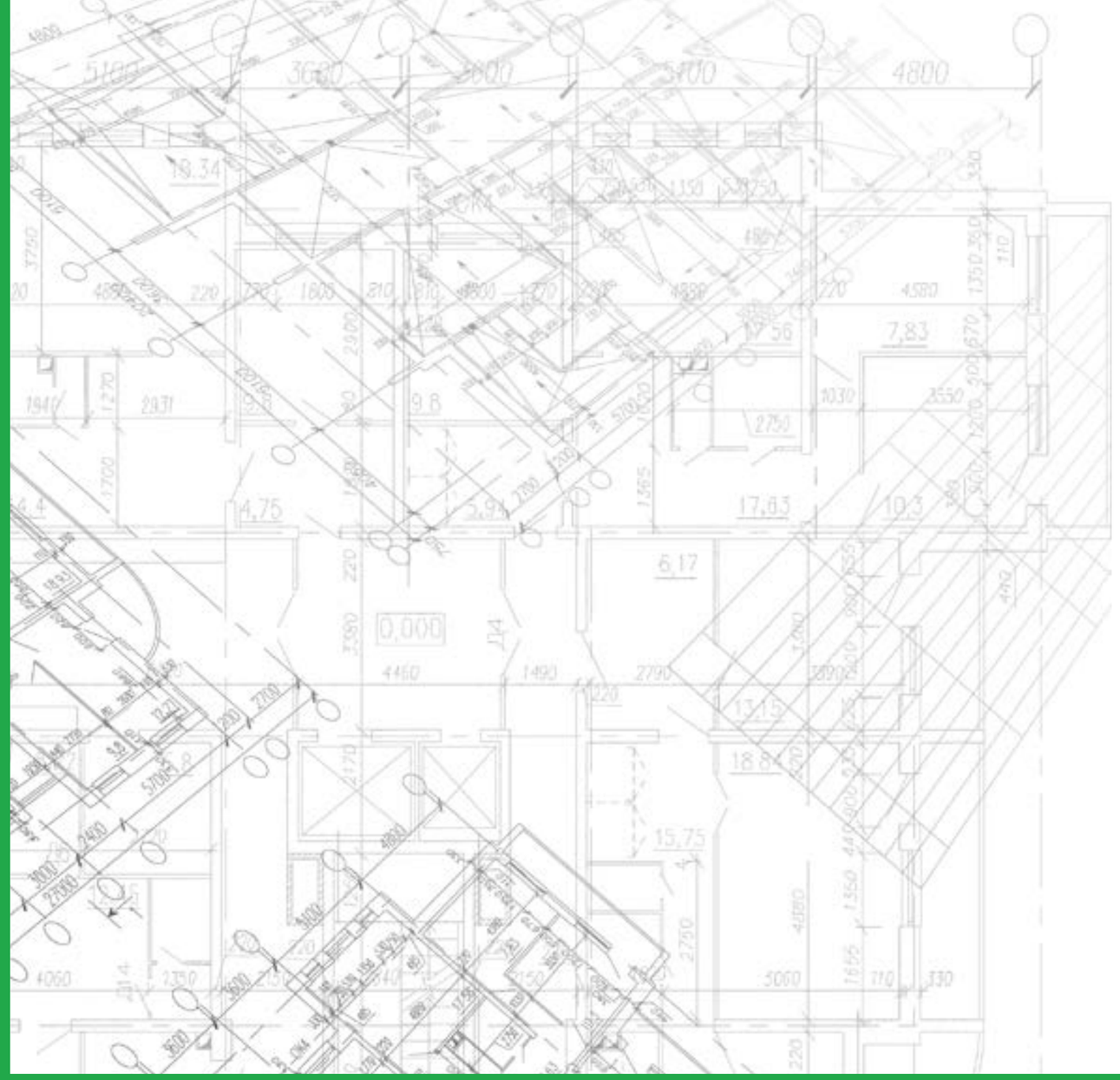
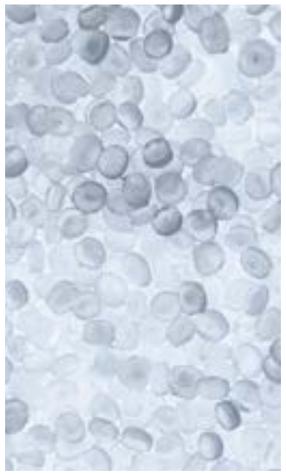


MATERIAL PROPERTIES

4.1 Types of polypropylenes
4.2 Physico-chemical properties
4.3 Chemical resistance
4.4 Regression curves

4.1 TYPES OF POLYPROPYLENES



Polypropylene is a polymer formed by monomeric high molecular weight chains of propylene, which gives excellent mechanical properties, making it suitable for both hot and cold water installations.

Depending on the type of monomers and their molecular arrangement, three types of polypropylene can be identified:

- PP-H (polypropylene Homopolymer). It only has propylene monomers. It is not suitable for human consumption water, nor for pressurised cold water use. It is therefore used for transporting hot water, sewerage drain, industrial fluids, etc.
- PP-B (polypropylene block). It has propylene and ethylene monomers arranged by blocks in polymer chains. It is very resistant to impact, even at low temperatures but does not have much pressure resistance. It is not suitable for human consumption water. It is used little and basically for drainage.
- PP-R (polypropylene random). The propylene and ethylene monomers are randomly arranged in the chains, providing very good mechanical properties, especially under pressure with or without temperature. Suitable for human consumption water.

4.2 PHYSICAL MECHANICAL PROPERTIES

REPOLEN® piping and fittings are manufactured with type 3 Polypropylene Random Copolymer, a very high molecular weight propylene and ethylene copolymer with a random arrangement of monomers, with excellent mechanical resistance up to 100ºC and an exceptional chemical resistance that makes it the best system for transporting food liquids and other hot fluids under pressure.

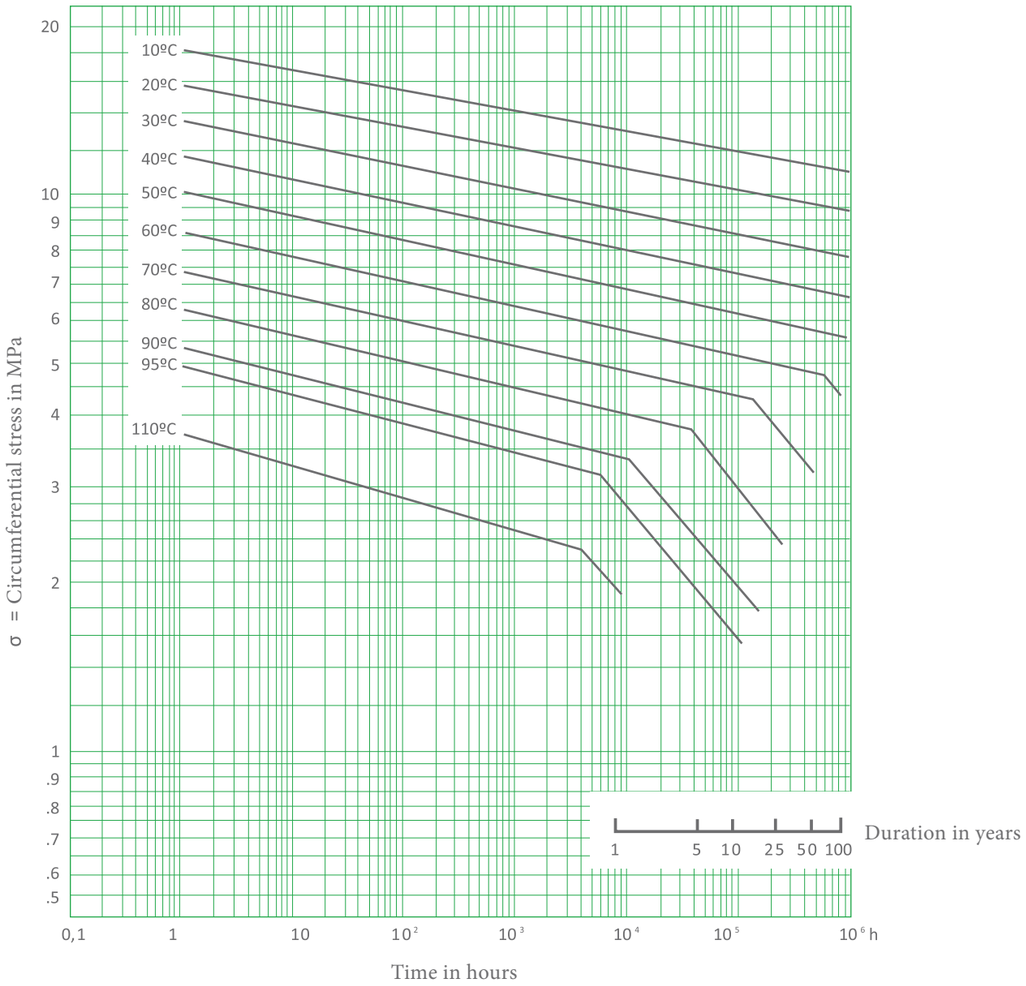
It also has a high resistance, which ensures easy handling for installation and transport even at temperatures below 0 º C.

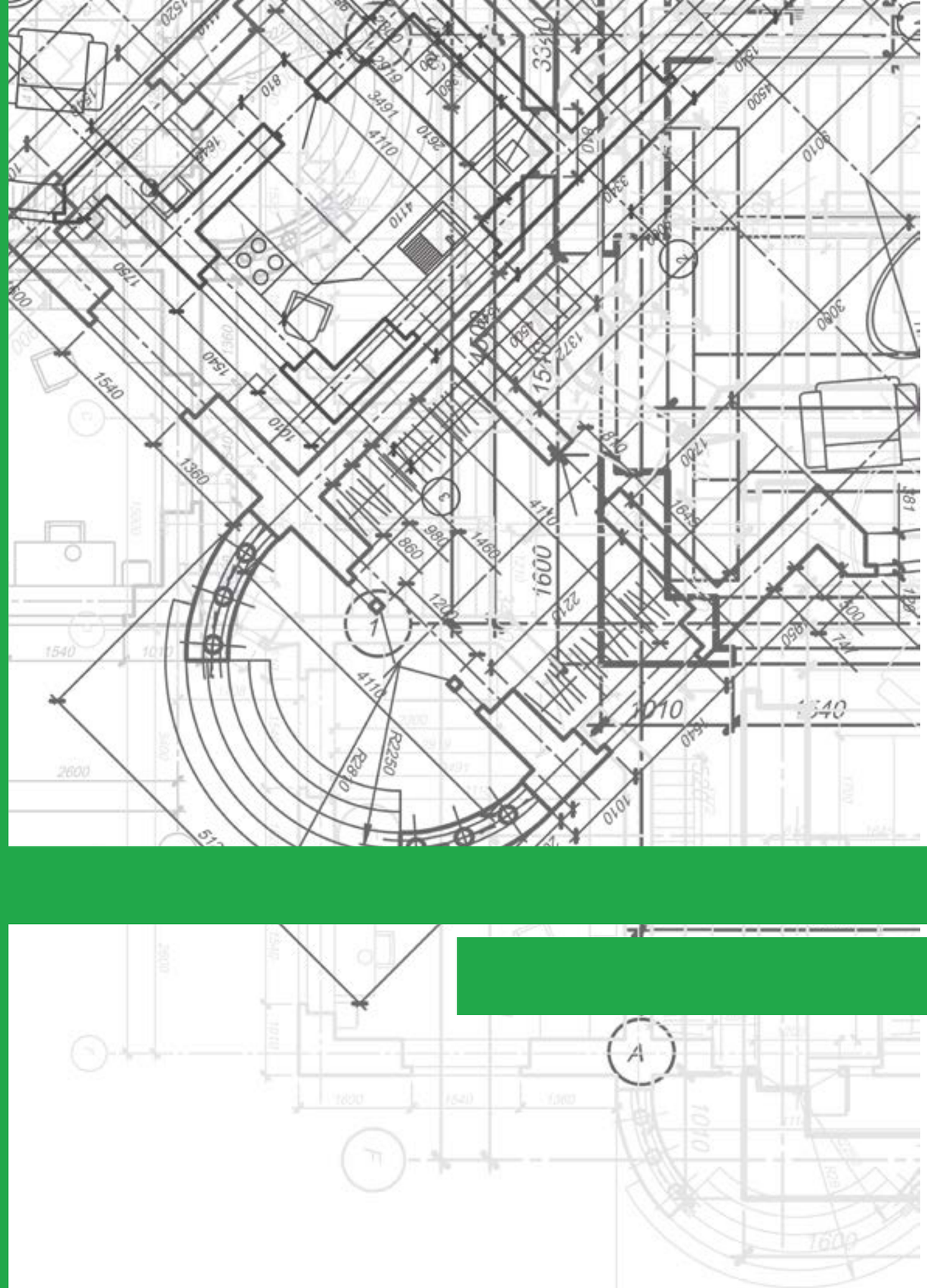
PROPERTY	VALUE	UNITS	TEST PROCEDURE
Fluidity Index (230ºC; 2.16 kg)	0.3	gr/10 min	ISO 1133
Fluidity Index (230ºC; 5 kg)	1.2	gr/10 min	ISO 1133
Density at 23ºC	905	Kg/m3	ISO 1183
Elastic Flexural Modulus	815	MPa	ISO 178
Charpy impact resistance with notch, 23ºC	> 9	kJ/m2	ISO 179
Tensile strength at the Yield point	34	MPa	ISO 527-2
Tensile strength at the breaking point	27	MPa	ISO 527-2
Elongation at the breaking point	> 520	%	ISO 527-2
VICAT, 9.8 N	70	ºC	ISO 306
HDT 0.45 MPa	45	ºC	ISO 75
Long-term hydrostatic resistance after 50 years and 20ºC (97.5 % LCL), MRS	> 8.0	MPa	ISO TR 9080
Fire Classification. Multilayer Faser pipe. Halogen free	B2	---	DIN 4102

CHEMICAL RESISTANCE 4.3

Due to the nature of PP, pipes made of this material have very high chemical resistance properties, being resistant to both acids and alkalis, as well as to a large range of industrial substances. For further information, see Annex I

REGRESSION CURVES 4.4

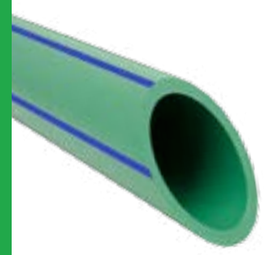




PRODUCT RANGE

5.1 Single-layer PPR pipes according to UNE-EN ISO 15874
5.2 Three-layer FASER pipes according to UNE-EN ISO 15874
5.3 Fittings

5.1 SINGLE-LAYER PPR PIPES ACCORDING TO



S5 SDR11 PN10 application classes/design pressure: 4/6; 2/4; 1/6				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
20	16.2	1.9 – 2.2	0.11	0.21
25	20.4	2.3 – 2.7	0.17	0.33
32	26.2	2.9 – 3.3	0.27	0.54
40	32.6	3.7 – 4.2	0.42	0.83
50	40.8	4.6 – 5.2	0.67	1.31
63	51.4	5.8 – 6.5	1.04	2.07
75	61.4	6.8 – 7.6	1.45	2.97
90	73.6	8.2 – 9.2	2.09	4.25
110	90	10 – 11.1	3.11	6.36
125	102.7	11.4 – 12.7	3.28	8.2
160	130.8	14.6 – 16.2	6.6	13.44

S3.2 SDR7.4 PN16 application classes/design pressure: 5/6; 4/10; 2/6; 1/8				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
16	11.6	2.2 – 2.6	0.09	0.1
20	14.4	2.8 – 3.2	0.15	0.16
25	18	3.5 – 4	0.23	0.25
32	23.2	4.4 – 5	0.36	0.42
40	29	5.5 – 6.2	0.57	0.66
50	36.2	6.9 – 7.7	0.9	1.03
63	45.8	8.6 – 9.6	1.4	1.65
75	54.4	10.3 – 11.5	2	2.32
90	65.4	12.3 – 13.7	2.85	3.36
110	79.8	15.1 – 16.8	4.19	5
125	90.8	17.1 – 19	5.52	6.47
160	116.2	21.9 – 24.2	8.69	10.6

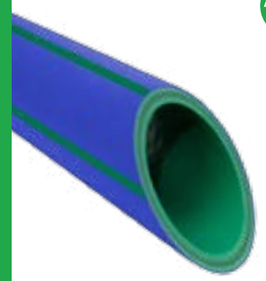
S2.5 SDR6 PN20 application classes/design pressure: 5/6; 4/10; 2/8; 1/10				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
16	10.6	2.7 – 3.1	0.11	0.09
20	13.2	3.4 – 3.9	0.17	0.14
25	16.6	4.2 – 4.8	0.26	0.22
32	21.2	5.4 – 6.1	0.42	0.35
40	26.6	6.7 – 7.5	0.66	0.56
50	334	8.3 – 9.3	1.03	0.87
63	42	10.5 – 11.7	1.65	1.38
75	50	12.5 – 13.9	2.3	1.96
90	60	15 – 16.6	3.31	2.83
110	73.4	18.3 – 20.3	4.9	4.21
125	83.4	20.8 – 23	6.42	5.46

Service pressures

Period of operation		Pressure (mbar)		
Temp.	Years of service	S5 SDR11 single layer	S3.2 SDR7.4 single layer	S2.5 SDR6 single layer
10°C	1	17,6	27,8	35
	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	30,3
20°C	1	15	23,8	30
	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
30°C	1	12,8	20,2	25,5
	5	12	19	23,9
	10	11,6	18,3	23,1
	25	11,2	17,7	22,3
	50	10,9	17,3	21,8
40°C	1	10,8	17,1	21,5
	5	10,1	16	20,2
	10	9,8	15,6	19,6
	25	9,4	15	18,8
	50	9,2	14,5	18,3
50°C	1	9,2	14,5	18,3
	5	8,5	13,5	17
	10	8,2	13,1	16,5
	25	8	12,6	15,9
	50	7,7	12,2	15,4
60°C	1	7,7	12,2	15,4
	5	7,2	11,5	14,3
	10	6,9	11	13,8
	25	6,7	10,5	13,3
	50	6,4	10,1	12,7
70°C	1	6,5	10,3	13
	5	6	9,5	11,9
	10	5,9	9,3	11,7
	25	5,1	8	10,1
	50	4,3	6,7	8,5
80°C	1	5,5	8,6	10,9
	5	4,8	7,6	9,6
	10	4	6,3	8
	25	3,2	5,1	6,4
90°C	1	---	6,1	7,7
	5	---	4	5

Period of operation			Pressure (mbar)		
Temperature			Years of service	S3.2 SDR7.4 single layer	S2.5 SDR6 single layer
Permanent at 70°C with 30 days a year at	75°C		5	9,41	11,54
			10	9,11	11,16
			25	8,26	9,64
			45	7,16	8,38
	80°C		5	9,1	11,16
			10	8,8	10,8
			25	7,86	9,17
			42,5	6,9	8,08
	85°C		5	8,49	10,44
			10	8,21	10,08
			25	7,19	8,4
			37,5	6,52	7,63
	90°C		5	7,8	9,6
			10	7,5	9,27
			25	6,33	7,4
			35	5,83	6,83
Permanent at 70°C with 60 days a year a	75°C		5	9,36	11,47
			10	9,06	11,1
			25	8,1	9,45
			45	7,02	8,22
	80°C		5	8,9	10,92
			10	8,61	10,56
			25	7,43	8,68
			40	6,63	7,77
	85°C		5	8,23	10,11
			10	7,95	9,77
			25	6,54	7,65
			35	6,03	7,06
	90°C		5	7,53	9,27
			10	7,27	8,95
			25	5,57	6,53
			30	5,33	6,25
Permanent at 70°C with 90 days a year at	75°C		5	9,31	11,42
			10	9,01	11,05
			25	7,95	9,29
			45	6,89	8,08
	80°C		5	8,77	10,76
			10	8,48	10,41
			25	7,11	8,31
			37,5	6,44	7,23
	85°C		5	8,07	9,92
			10	7,8	9,58
			25	6,11	7,15
			32,5	5,73	6,72
	90°C		5	7,38	9,08
			10	7,13	8,77
			25	5,12	6,01

5.2 THREE-LAYER FASER PIPES ACCORDING TO



AENOR CC

FASER CLIMA S5 SDR 11 application classes / design pressure: 4/6; 2/4; 1/6					
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Layer thickness FV (mm)	Weight (kg/m)	Capacity (l/m)
32	26.2	2.9 – 3.3	> 0.7	0.26	0.54
40	32.6	3.7 – 4.2	> 0.9	0.43	0.83
50	40.8	4.6 – 5.2	> 1.2	0.87	1.31
63	51.4	5.8 – 6.5	> 1.5	1.04	2.07
75	61.4	6.8 – 7.6	> 1.7	1.38	2.97
90	73.6	8.2 – 9.2	> 2.1	2.14	4.25
110	90	10 – 11.1	> 2.5	3.22	6.36
125	102.7	11.4 – 12.7	> 2.9	4.12	8.2
160	130.8	14.6 – 16.2	> 3.7	4.44	13.44

AENOR CC

FASER-CT S4 SDR 9 application classes / design pressure: 5/4; 4/8; 2/4; 1/6					
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Layer thickness FV (mm)	Weight (kg/m)	Capacity (l/m)
32	24,8	3,6 - 4,1	> 0,9	0,328	0,483
40	31	4,5 - 5,1	> 1,12	0,511	0,754
50	38,8	5,6 - 6,3	> 1,4	0,791	1,182
63	48,8	7,1 - 8	> 1,77	1,261	1,869
75	58,2	8,4 - 9,4	> 2,1	1,771	2,659
90	69,8	10,1 - 11,3	> 2,52	2553	3,825
110	88,4	12,3 - 13,7	> 3,07	3,789	5,725
125	97	14 - 15,5	> 3,5	4,886	7,386
160	124,2	17,9 - 19,8	> 4,47	7,987	12,109

AENOR CC

FASER S3.2 SDR7.4 application classes/design pressure: 5/6; 4/10; 2/6; 1/8					
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Layer thickness FV (mm)	Weight (kg/m)	Capacity (l/m)
20	14.4	2.8 – 3.2	> 0.7	0.16	0.16
25	18	3.5 – 4	> 0.9	0.25	0.25
32	23.2	4.4 – 5	> 1.1	0.39	0.42
40	29	5.5 – 6.2	> 1.4	0.61	0.66
50	36.2	6.9 – 7.7	> 1.8	0.95	1.03
63	45.8	8.6 – 9.6	> 2.2	1.49	1.65
75	54.4	10.3 – 11.5	> 2.6	2.11	2.32
90	65.4	12.3 – 13.7	> 3.07	3.03	3.36
110	79.8	15.1 – 16.8	> 3.77	4.53	5
125	90.8	17.1 – 19	> 4.26	6.21	6.47
160	116.2	21.9 – 24.2	> 5.47	9.75	10.6

Service pressures

Period of operation		Pressure (bar)		
Temperature	Years of service	S5 SDR11 Faser Climate	S4 SDR9 Repolen Faser	S3,2 SDR7,4 Repolen Faser
Permanent at 70ºC with 30 days a year at 75ºC	5	9,38	12,9	14,27
	10	9,08	12,6	13,79
	25	7,82	12,2	11,74
	45	6,77	12	10,18
Permanent at 70ºC with 30 days a year at 80ºC	5	8,88	11,7	13,5
	10	8,46	11,4	12,8
	25	7,38	11,1	11,14
	42,5	6,49	10,9	9,79
Permanent at 70ºC with 30 days a year at 85ºC	5	8,17	10,7	12,42
	10	7,82	10,4	11,87
	25	6,7	10,1	10,14
	37,5	6,07	10	9,18
Permanent at 70ºC with 30 days a year at 90ºC	5	7,5	9,8	11,39
	10	7,19	9,5	10,94
	25	5,85	9,2	8,86
	35	5,39	9,1	8,16
Permanent at 70ºC with 60 days a year a 75ºC	5	9,26	12,3	14,11
	10	8,9	12,1	13,57
	25	7,62	11,7	11,58
	45	6,6	11,5	10,05
Permanent at 70ºC with 60 days a year a 80ºC	5	8,61	11,4	13,12
	10	8,24	11,2	12,54
	25	6,93	10,8	10,56
	40	6,18	10,7	9,41
Permanent at 70ºC with 60 days a year a 85ºC	5	7,91	10,4	12,03
	10	7,56	10,2	11,52
	25	6,05	9,9	9,22
	35	5,57	9,8	8,48
Permanent at 70ºC with 60 days a year a 90ºC	5	7,25	9,5	11,04
	10	6,4	9,3	9,76
	25	5,12	9,1	7,81
	30	4,9	9	7,46
Permanent at 70ºC with 90 days a year at 75ºC	5	9,17	12,2	14,02
	10	8,79	12	13,38
	25	7,45	11,6	11,33
	45	6,45	11,4	9,82
Permanent at 70ºC with 90 days a year at 80ºC	5	8,46	11,3	12,9
	10	8,11	11	12,35
	25	6,6	10,7	10,05
	37,5	5,98	10,6	9,09
Permanent at 70ºC with 90 days a year at 85ºC	5	7,76	10,3	11,81
	10	7,03	10,1	10,72
	25	5,63	9,8	8,58
	32,5	5,28	9,7	8,03
Permanent at 70ºC with 90 days a year at 90ºC	5	6,96	9,4	10,59
	10	5,88	9,2	8,96
	25	4,7	8,9	7,17

Period of operation		Pressure (bar)		
Temp.	Years of service	S5 SDR11 Faser Climate	S4 SDR 9 Repolen Faser	S3.2 SDR7.4 Repolen Faser
10ºC	1	27,8	28,8	30,2
	5	26,2	27,9	28,2
	10	25,6	27,5	27,7
	25	24,7	27,1	26,9
	50	24,1	26,7	26,1
	100	23,5	26,3	25,2
15ºC	1	25,7	26,9	29,4
	5	24,2	26	27,4
	10	23,6	25,7	26,9
	25	22,8	25,2	26,1
	50	22,2	24,9	25,3
	100	21,6	24,5	24,5
20ºC	1	23,8	25	28,6
	5	22,3	24,2	26,8
	10	21,7	23,9	26,1
	25	21	23,5	25,3
	50	20,4	23,1	24,5
	100	19,9	22,8	23,7
30ºC	1	20,2	21,7	24,3
	5	18,9	20,9	22,8
	10	18,4	20,6	22
	25	17,8	20,2	21,3
	50	17,3	19,9	20,7
	100	6,8	19,7	20
40ºC	1	17,1	18,6	20,5
	5	16	18	19,2
	10	15,6	17,7	18,7
	25	15	17,3	18
	50	14,6	17,1	17,5
	100	14,1	16,8	16,8
50ºC	1	14,5	15,9	17,5
	5	13,5	15,3	16,2
	10	13,1	15,1	15,7
	25	12,6	14,7	15,2
	50	12,2	14,5	14,7
	100	11,9	14,3	14,1
60ºC	1	12,2	13,5	14,7
	5	11,4	13	13,7
	10	11	12,7	13,2
	25	10,6	12,4	12,6
	50	10,3	12,2	12,1
70ºC	1	10,3	11,3	12,4
	5	9,6	10,9	11,4
	10	9,2	10,7	11,1
	25	8	10,4	9,6
	50	6,8	10,2	8,1
75ºC	1	9,4	10,4	11,7
	5	8,7	9,9	10,8
	10	8	9,7	10
	25	6,4	9,5	8
	50	5,4	9,3	6,7
80ºC	1	8,6	9,5	10,4
	5	7,7	9	9,2
	10	6,5	8,9	7,8
	25	5,2	8,6	6,2
90ºC	1	7,2	7,8	8,7
	5	5,1	7,4	6
	10	4,3	7,3	5,1

5.3 FITTINGS

TERMOFUSION

Cap

Sleeve

Male/female reducer

Female/female reducer

Smooth female tee

Reduced female center tee

Male center tee

90° elbow female / female

45° elbow female / female

Tee female thread

* Available in SS 316

Male thread tee

* Available in SS 316

90° elbow female thread

* Available in SS 316

TERMOFUSION

90° elbow male thread

* Available in SS 316

Female thread sleeve

* Available in SS 316

Male thread sleeve

Straight coupling female loose nut

90° female thread elbow wall

* Available in SS 316

90° male thread elbow wall

* Available in SS 316

Universal connector

Thread connector

Flange collar with gasket

Long flange collar

Flat flange steel, coated p.P.

KEYS AND VALVES

Tap with trim

Tap body

Tap moulding with trim

Tap trim

Long shaft tap with knob

Moulding for long-staff tap trim

Tap trim with knob long handle

Flush valve extension

Brass locking tap

Brass tap lock moulding kit

Inclined tap

KEYS AND VALVES

Inclined tap body

Detachable ball tap with neck flange

Brass ball valve tap

* Available in SS 316

PP-H ball valve female thread

PP-H ball valve with flange neck

ELECTRO-WELDABLE

Electro-weldable sleeve

Electro-weldable 90° elbow

Electro-weldable 45° elbow

Electro-weldable tee

Electro-weldable reducer

FITTINGS

Weldable branch female outlet

Weldable branch female thread outlet

* Available in SS 316

Weldable branch outlet male thread

Insert with thread

* Available in SS 316

Insert with splint

Insert

Plate for batteries

Curved branch

Pipe Saving

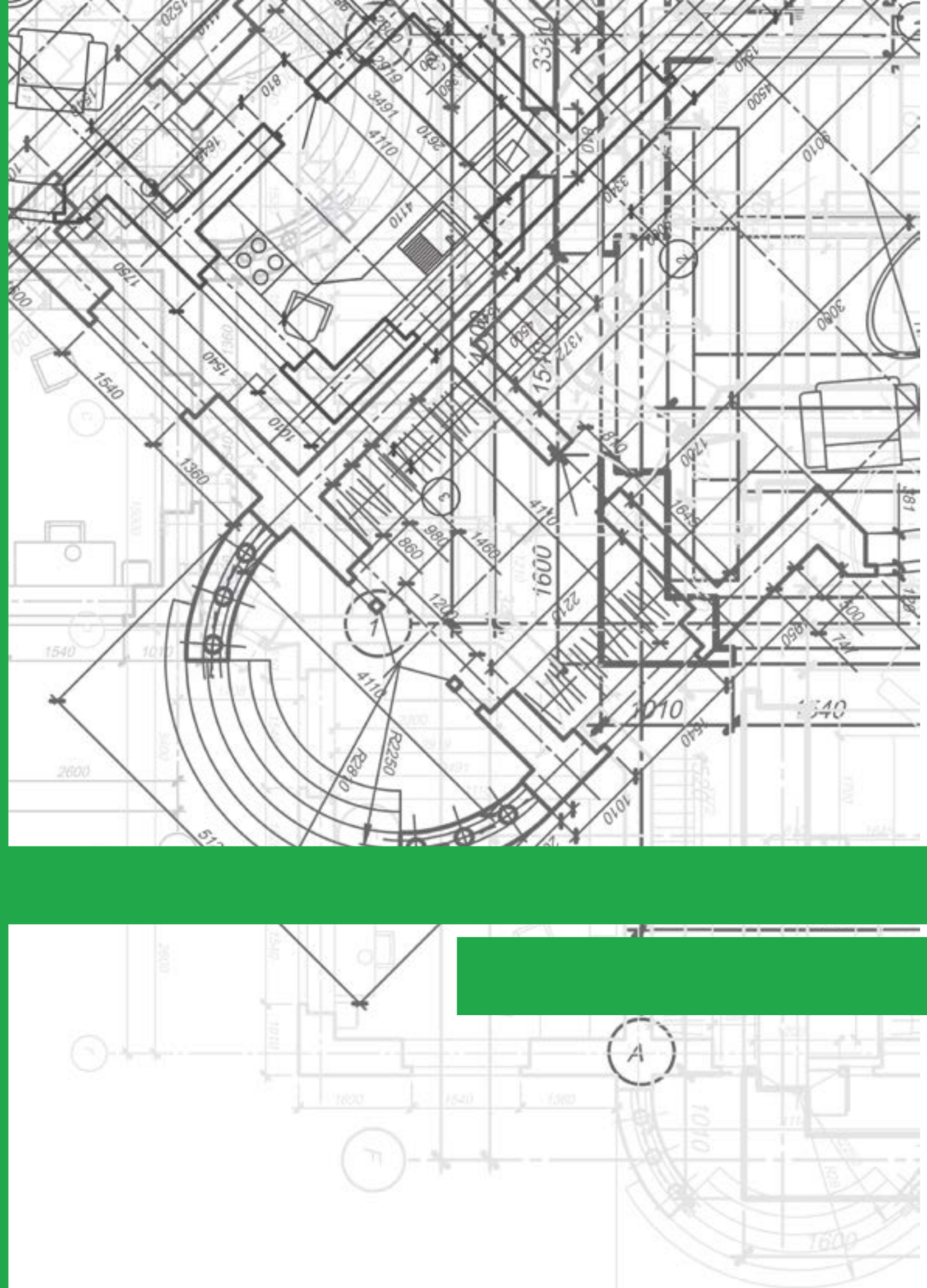
Manifold

Female / female cross

90° elbow male/female

45° elbow male/female

Repair plug



SYSTEM FEATURES

6.1 Main advantages
6.2 Application fields
6.3 Marking and traceability
6.4 Handling and storage
6.5 Antilegionella treatments
6.6 Recycling - Environment

6.1 MAIN ADVANTAGES

- High resistance to long-term internal pressure and high temperatures.
- Non-toxic. Suitable for the use with drinking water. Does not add odour, colour or taste of any kind, making it especially suitable for the transport of large quantities of food products, 100 % recyclable.
- High resistance to chemical corrosion of both acids and alkalis. Fully reliable in saline environments (sea water, etc.)
- Interior with mirror finish, which means total absence of fouling and very low pressure drop.
- Low thermal conductivity coefficient. Low heat loss. Minimal condensation.
- Electrical insulator. High resistance to eddy currents.
- Very easy to assemble. Much lighter than other traditional materials.
- Highly resistant to abrasion.
- Excellent behaviour to antilegionella treatments according to standard.
- Very low noise transmission level.
- Very low celerity (wave propagation velocity).
- Resistant to cold. Given the material's plasticity, it is capable of absorbing most of the volume increase in cases of freezing.
- Acoustic insulation. Thanks to the low celerity of the material (wave propagation velocity), it features an excellent damping effect against the transmission of noise during fluids' passage.

6.2 APPLICATION FIELDS

REPOLEN systems are designed to provide solutions in all those applications that require the transport of pressurised cold and hot water, both for human consumption and domestic or industrial use.

In addition to its basic applications, the system's great features make it possible for it to be used in endlessly different applications.

The great difference between the REPOLEN and the REPOLEN FASER systems lies in the difference in lineal expansion, which makes it possible for it to adapt to the possibilities of each installation.

Some of the most common uses are:

Hydrosanitary installations: Connections, meters and manifold panels, pillars, distribution, branches, boilers, accumulators, return lines.

Air conditioning both with fan coils and radiant floor.

Heating in even high-temperature boilers, radiant floor, radiators, etc.

Thermal waters, swimming pools, geothermal installations.

Facilities sensitive to disinfection against legionella, such as hospitals, schools, institutional buildings, hotels, sports facilities, etc.

Recycled water installations where even solids may be washed away.

Compressed air systems.

Installations for the transport of industrial liquids: industrial refrigeration, chemical industries, food industries, ...

MARKING AND TRACEABILITY 6.3

Pipes marking is done in accordance with the UNE EN ISO 15874 standard and the requirements of the AENOR Special Regulations, RP.001.52, and RP.001.72. The purpose of pipe marking is to provide the necessary information to the installer, the user and the manufacturer, if necessary. The marking includes:

- Trademark: REPOLEN
- Reference to the AENOR mark (Product Certificate or Certificate of Conformity) and contract number
- Material it is made of
- Nominal diameter and thickness
- Application class and nominal pressure (see below)
- Manufacturing period
- Reference standard
- Symbol for suitability for food use
- Reference to 100% national manufacture

The manufacturing period is unique for each pipe production, enabling complete traceability of the finished product. Knowing this number makes it possible to make a complete tracking, from the entry of raw material to the delivery at our clients' home

As for the application class, according to the standard, pipes are marked with the design pressure (not nominal or working pressure) for a given application class. The design pressure is defined as the maximum pressure in relation to the circumstances for which the system has been designed. According to the standard, these pressures are 4, 6, 8 and 10 bar.

With regard to the application class, the standard distinguishes between 4 classes:

Application class	Design temperature (ºC) DT	Time to DT (years)	Maximum temperature (ºC) Tmax	Time to Tmax (years)	Malfunctioning temperature Tmal (ºC)	Time to Tmal (years)	Typical field of application
1	60	49	80	1	95	100	Hot water supply (60ºC)
2	70	49	80	1	95	100	Hot water supply (70ºC)
4	20 followed by 40 followed by 60	2.5 20 25	70	2.5	100	100	Heating by radiant floor and low-temperature radiators
5	20 followed by 40 followed by 80	14 25 10	90	1	100	100	High temperature radiators

However, in order to facilitate the use of the pipes, they are also marked with the theoretical nominal pressure if they were to work at 20ºC for 50 years.

Even if it is not marked on the pipe, it is advisable to know the SDR and the S:

- SDR is the relation between the outer diameter and the thickness of the pipe, according to the equation:

$$SDR = \varphi \text{ ext} / \text{thickness}$$

- S is a dimensionless number that classifies the piping according to ISO 4065 standard and indicates the relationship between the tangential tension (σ) and the working pressure (P) at a given temperature, according to:

$$S = \sigma / P$$

6.4 HANDLING AND STORAGE

Resistance to ultraviolet rays (UV)

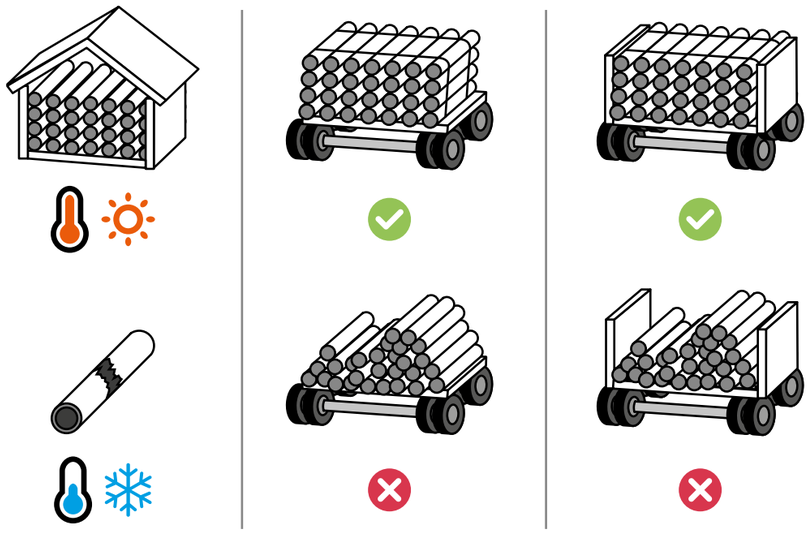
PPR should not be exposed to solar radiation. Even when stabilised against this radiation, its continuous exposure causes material degradation, thus accelerating its ageing.

Resistance to low temperatures

At temperatures below 0ºC, PPR, being a crystalline material, becomes fragile. It is therefore important, especially during transport and handling, to avoid any kind of impact. However, once installed, its plasticity is capable of absorbing volume variations due to the freezing of the liquids flowing inside.

Arrangement of the pipes

It is important to try to ensure that the pipes are always horizontal and to try to avoid, as far as possible, their curvature in order to prevent deformations that make subsequent installation difficult.



Bending

Thanks to the plasticity of the pipes, they allow a certain curvature. The maximum radius of curvature is 8 times its diameter. If bending is necessary, hot air heaters can be used, never direct torch, as this could destroy the molecular structure of the pipe.

Threading

Conical plugs should be avoided in the female threaded terminals, as they could deteriorate the threads. Teflon or similar can be used in appropriate quantities to ensure tightness.

ANTILEGIONELLA TREATMENTS 6.5

Due to their characteristics, Repolen piping do not favour the cultivation of any type of microorganism or known bacteria. However, in cases where disinfection is required, Repolen pipes do not present any problems as long as the disinfection is carried out in accordance with current standards.

In accordance with the current standards, for the control and prevention of Legionella (UNE 100030) and with Royal Decree RD863/2003, the following disinfection methods are recommended:

- Chemical use in reservoirs

For cold water for human consumption, maximum concentrations of 20 to 30 ppm of free residual chlorine for a maximum of between 3 and 1 hour respectively for water at pH7 inside the reservoirs.

- Chemical use in pipings

Disinfection with 50 mg/l of free chlorine for more than 12 hours can be carried out twice a year, or 150 mg/l of oxygen peroxide can be used for 24 hours; in both cases, the temperature should never exceed 30°C.

- Thermal way

For domestic hot water (hot water system). 70ºC or more for 2 hours

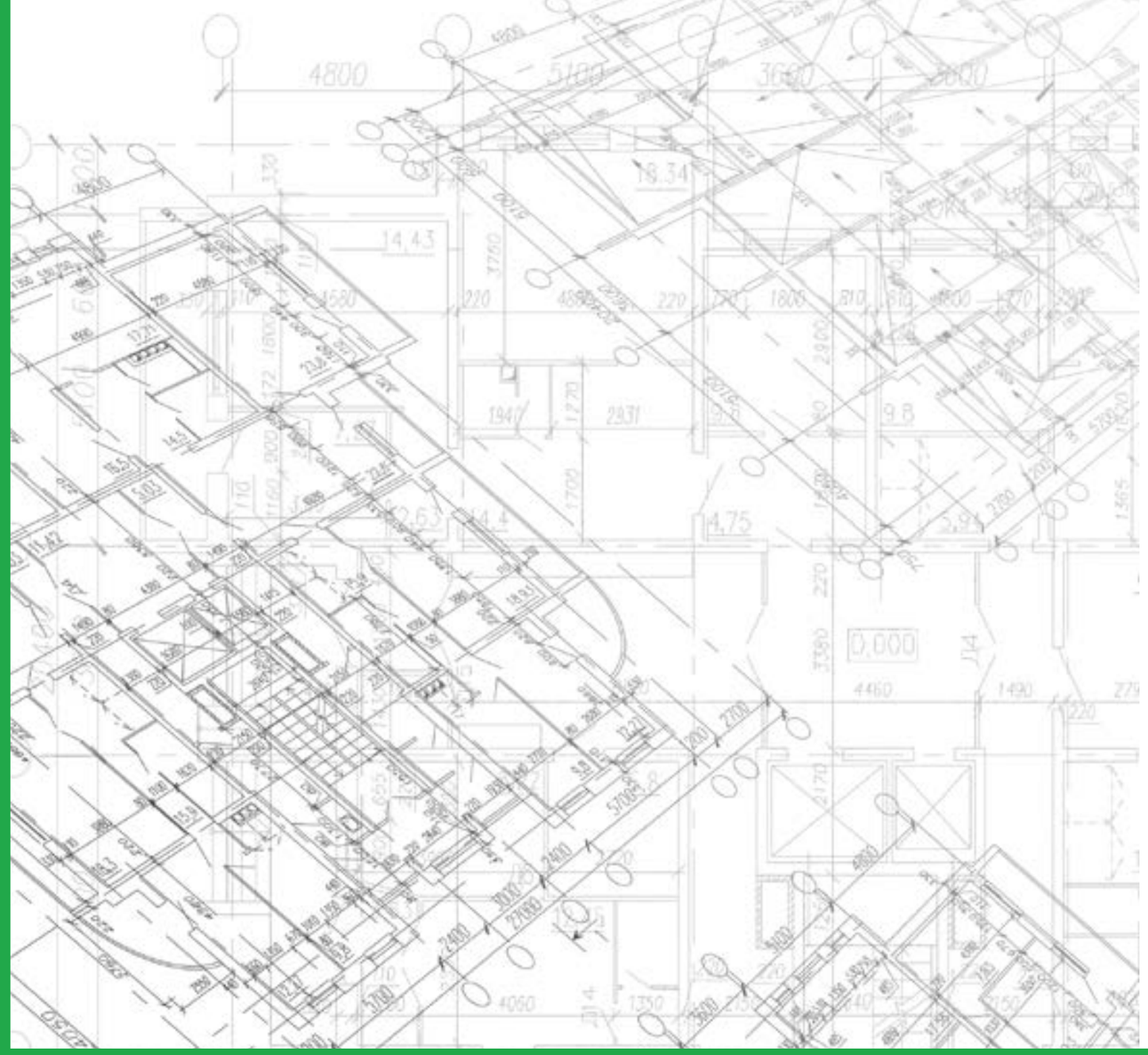
It is very important to note that the two methods should never be used together (the combination of high temperatures with high concentrations of chlorine can damage installations)

In some places chlorine dioxide is widely used as a disinfectant, due to its low price and its high disinfectant effect. However, its use is not recommended since its high oxidation potential may eventually affect the installations (metallic or plastic).

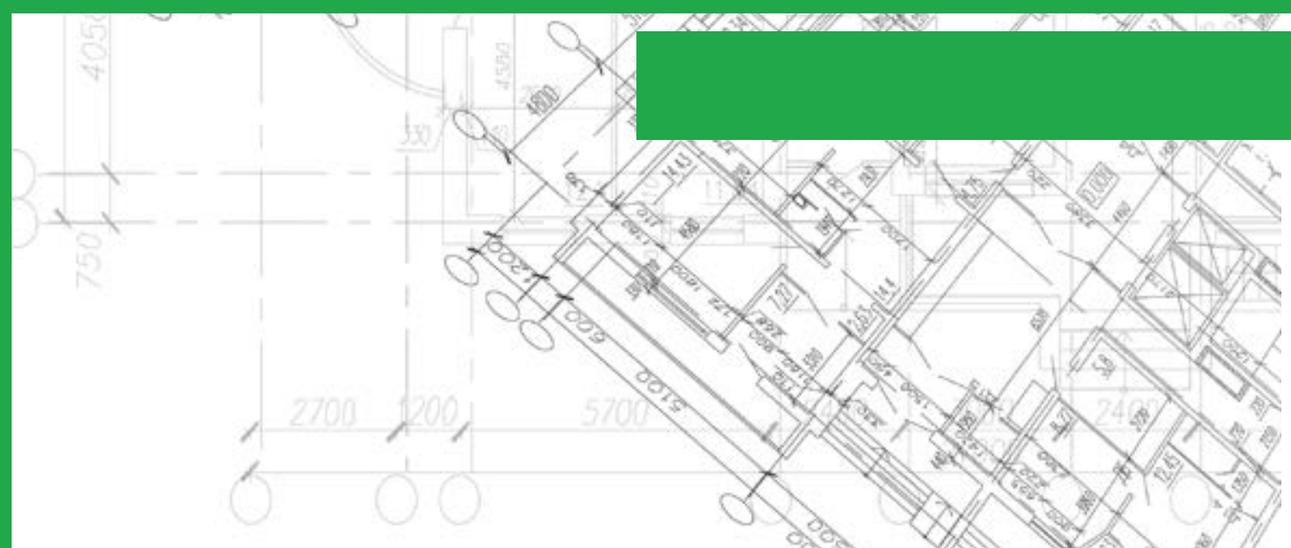
RECYCLING - ENVIRONMENT 6.6

PPR REPOLEN's piping are made of 100% virgin materials (the standards do not authorise the use of recycled materials for drinking water) and they are also 100% recyclable.

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



INSTALLATION CRITERIA



7.1 Expansion calculation
7.2 Distance between supports
7.3 Insulation
7.4 Hydraulic start-up test
7.5 Water hammer
7.6 Pressure drop
7.7 Peak flow rate
7.8 Installations sizing
7.9 On-site recommendations

7.1 EXPANSION CALCULATION

REPOLEN PP-R and PPR FASER pipings are subject to thermal expansion in exactly the same way as other construction materials. This makes it necessary to compensate for this lineal expansion when calculating the installation. Built-in piping absorbs this lineal expansion towards the inside.

There are several formulas according to ENV 12108. The calculation equation is as follows:

$$\Delta L = L * \lambda * \Delta T$$

where: ΔL is the increase in length of the pipe due to the effect of lineal expansion, in millimetres

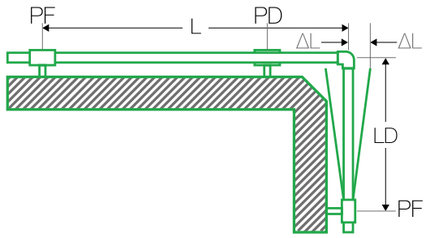
L is the length of the pipe on which the lineal expansion is calculated, in metres

λ is the lineal expansion coefficient, in mm/m°C. Depends on the material

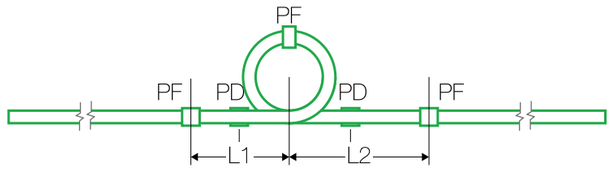
λPPR = 0.15 mm/m°C

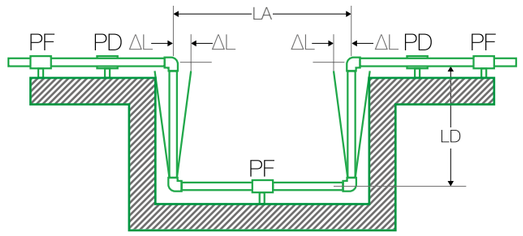
λfaser = 0.03 mm/m°C

ΔT, is the temperature difference between the transported fluid and the ambient temperature



These lineal expansions are to be calculated between fixed points or changes of direction. If there is little lineal expansion and the installation can absorb it, it is best to allow mobility at the ends. If this mobility cannot be allowed and there is little lineal expansion, dilating sleeves can be used. The most common is to make bows, either in loop (if the pipe allows, it is not very frequent) or in U shape.





Clamps marked as PF fix the pipe (anchoring), making its mobility not possible, while the PD, if available, only provide support (guide).

The equation used for the bow calculations is:

$$LB = 2 * LD + LA = k * \sqrt{D * \Delta L}$$

where: LB is the total flexible arm

LD is the length of the transverse arm

LA is the length of the longitudinal arm $LA = 0.5 * LD$

k is a material-specific constant, which for PPR is 20

D is the nominal diameter of the pipe

Example: A 8 m long pipe with a 25 mm diameter will be installed to transport water at 70°C in an environment with a temperature of 25°C, approximately.

Installations with single-layer PPR

$$\Delta L = 8 * 0.15 * (70 - 25) = 54 \text{ mm}$$

We'll have to compensate 54 mm

For calculating the bow:

$$LB = 20 * \sqrt{25 * 54} = 734.85 \cong 735 \text{ mm}$$

$$LB = 2 * LD + 0.5 * LD \Rightarrow LD = \frac{735}{2.5} = 294 \text{ mm}$$

$$LA = 294 * 0.5 = 147 \text{ mm}$$

That is, the bow will have two transversal arms of 294 mm each and one longitudinal arm of 147 mm

Installations with PPR REPOLEN

$$\Delta L = 8 * 0.03 * (70 - 25) = 10.8 \text{ mm}$$

We'll have to compensate 10.8mm

For calculating the bow:

$$LB = 20 * \sqrt{25 * 10.8} = 328.63 \cong 329 \text{ mm}$$

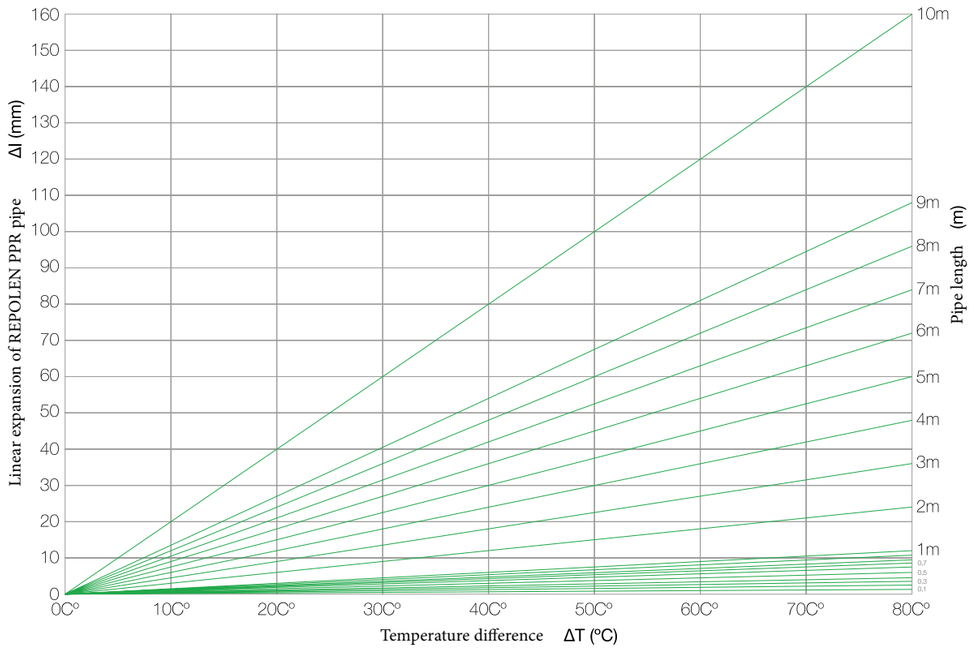
$$LB = 2 * LD + 0.5 * LD \Rightarrow LD = \frac{329}{2.5} = 131.6 \cong 132 \text{ mm}$$

$$LA = 132 * 0.5 = 66 \text{ mm}$$

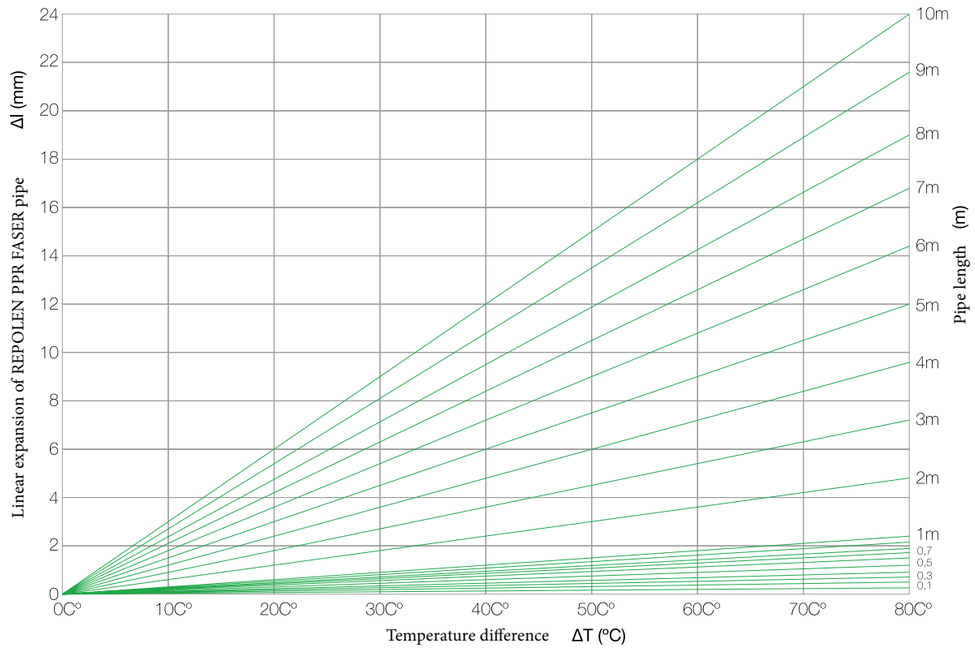
That is, the bow will have two transversal arms of 132 mm each one and one longitudinal of 66 mm

To make calculation easier, lineal expansion tables are included:

λ = 0,15mm/m°C								
Piping length (m)	Temperature difference ΔTee (°C)							
	10	20	30	40	50	60	70	80
	Lineal expansion of PPR REPOLEN piping Δl (mm)							
0,1	0,15	0,3	0,45	0,6	0,75	0,9	1,05	1,2
0,2	0,3	0,6	0,9	1,2	1,5	1,8	2,1	2,4
0,3	0,45	0,9	1,35	1,8	2,25	2,7	3,15	3,6
0,4	0,6	1,2	1,8	2,4	3	3,6	4,2	4,8
0,5	0,75	1,5	2,25	3	3,75	4,5	5,25	6
0,6	0,9	1,8	2,7	3,6	4,5	5,4	6,3	7,2
0,7	1,05	2,1	3,15	4,2	5,25	6,3	7,35	8,4
0,8	1,2	3,6	3,6	4,8	6	7,2	8,4	9,6
0,9	1,35	2,7	4,05	5,4	6,75	8,1	9,45	10,8
1	1,5	3	4,5	6	7,5	9	10,5	12
2	3	6	9	12	15	18	21	24
3	4,5	9	13,5	18	22,5	27	31,5	36
4	6	12	18	24	30	36	42	48
5	7,5	15	22,5	30	37,5	45	52,5	60
6	9	18	27	36	45	54	63	72
7	10,5	21	31,5	42	52,5	63	73,5	84
8	12	24	36	48	60	72	84	96
9	13,5	27	40,5	54	67,5	81	94,5	108
10	20	40	60	80	100	120	140	160



λ = 0,03 mm/m°C								
Piping length (m)	Temperature difference ΔTee (°C)							
	10	20	30	40	50	60	70	80
	Lineal expansion of REPOLEN piping PPR FASER Δl (mm)							
0,1	0,03	0,06	0,09	0,12	0,15	0,18	0,21	0,24
0,2	0,06	0,12	0,18	0,24	0,3	0,36	0,42	0,48
0,3	0,09	0,18	0,27	0,36	0,45	0,54	0,63	0,72
0,4	0,12	0,24	0,36	0,48	0,6	0,72	0,84	0,96
0,5	0,15	0,3	0,45	0,6	0,75	0,9	1,05	1,2
0,6	0,18	0,36	0,54	0,72	0,9	1,08	1,26	1,44
0,7	0,21	0,42	0,63	0,84	1,05	1,26	1,47	1,68
0,8	0,24	0,44	0,72	0,96	1,2	1,44	1,68	1,92
0,9	0,27	0,54	0,81	1,08	1,35	1,62	1,89	2,16
1	0,3	0,6	0,9	1,2	1,5	1,8	2,1	2,4
2	0,6	1,2	1,8	2,4	3	3,6	4,2	4,8
3	0,9	1,8	2,7	3,6	4,5	5,4	6,3	7,2
4	1,2	2,4	3,6	4,8	6	7,2	8,4	9,6
5	1,5	3	4,5	6	7,5	9	10,5	12
6	1,8	3,6	5,4	7,2	9	10,8	12,6	14,4
7	2,1	4,2	6,3	8,4	10,5	12,6	14,7	16,8
8	2,4	4,8	7,2	9,6	12	14,4	16,8	19,2
9	2,7	5,4	8,1	10,8	13,5	16,2	18,9	21,6
10	3	6	9	12	15	18	21	24



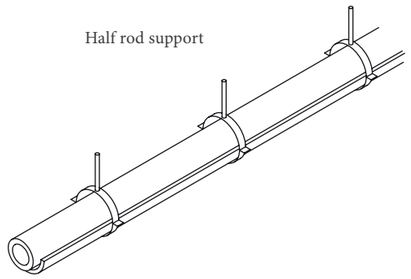
7.2 DISTANCE BETWEEN SUPPORTS

Piping can be installed on trays or half rods, in a way that they can be used as support. As a result, when there are long sections exposed, the lineal expansions will ensure the piping movement on the tray but they will avoid the unsightly effect that lineal expansions may cause.

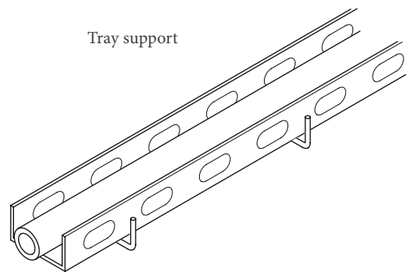
The recommended distances are:

Diameter	PPR single layer				Three-layer FASER			
	Distance for tray clamping		Distance for pipe-tray clamping		Distance for tray clamping		Distance for pipe-tray clamping	
	Water < 30ºC	Water > 30ºC	Water < 30ºC	Water > 30ºC	Water < 30ºC	Water > 30ºC	Water < 30ºC	Water > 30ºC
16 / 20	1500	1000	500	200	1950	1300	650	260
25	1500	1200	500	300	1950	1560	650	390
32	1500	1200	750	400	1950	1560	975	520
40	1500	1200	750	600	1950	1560	975	780
50 / 63 / 75	1500	1500	750	750	1950	1950	975	975
90 / 110 / 125	2000	2000	1000	1000	2600	2600	1300	1300
160	2500	2500	1250	1250	3250	3250	1625	1625

Half rod support



Tray support



It is very important that a riser with branches can absorb the lineal expansions without loading tension on the branches. According to the ENV 12108, the recommended distance between two guiding clamps or between a guiding and an anchoring clamp is:

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

* For vertical pipes, multiply by 1.3

INSULATION 7.3

The thermal conductivity coefficient of PPR is 0.24 W/mK. If we compare it with copper (384 W/mK) or iron (58 W/mK), we will understand that with PPR REPOLEN pipes the problem of condensation is almost non-existant.

However, according to RITE, all installations containing fluids refrigerated below room temperature or above 40ºC must carry an insulator with a thickness (conductivity of the 0.04 W/mK isolator), must conform with the figures in the following tables in order to avoid condensation:

Maximum temperature of the fluid (ºC)						
Outer diameter of the pipe to be lined (mm)	Hot fluids inside the building			Hot fluids outside the building		
	40 < T < 60	60 < T < 100	100 < T < 180	40 < T < 60	60 < T < 100	100 < T < 180
φ < 35	25	25	30	35	35	40
35 < φ < 60	30	30	40	40	40	50
60 < φ < 90	30	30	40	40	40	50
90 < φ < 140	30	40	50	40	50	60
140 < φ	35	40	50	45	50	60

Maximum temperature of the fluid (ºC)						
Outer diameter of the pipe to be lined (mm)	Cold fluids inside the building			Cold fluids outside the building		
	40 < T < 60	60 < T < 100	100 < T < 180	- 10 < T < 0	0 < T < 10	T > 10
φ < 35	30	20	20	50	40	40
35 < φ < 60	40	30	20	60	50	40
60 < φ < 90	40	30	30	60	50	50
90 < φ < 140	50	40	30	70	60	50
140 < φ	50	40	30	70	60	50

If piping networks operation is continuous through the whole year, 5mm must be added to the insulation thicknesses indicated in the tables.

For pipes with an outer diameter equal or less than 20 mm and a length of less than 5 m, from their connection to the general up to the terminal, which are embedded in partitions or floors, or within internal conduits, the insulation thickness should reach 10 mm.

If insulators with a different thermal conductivity than that given as a reference are used, the thickness is calculated using the following equation:

$$d = {}^{D}/_{2} * \left\{ e^{\left({}^{\lambda}/_{\lambda ref} * \ln {}^{(D + 2 * dref)}/_{D}\right)} - 1 \right\}$$

where: d is the thickness of the new insulator

D is the outer diameter of the pipe to be lined

λ is the thermal conductivity of the new insulator (W/mK)

λref is the thermal conductivity of the insulator for which the tables were calculated (0.04 W/mK)

dref is the thickness given by the tables for the referenced insulating material

Example: You want to line a pipe with a 75 mm diameter that will run inside a building that will carry water at a temperature of 80ºC, and you would like to use an insulator with a thermal conductivity of 0.037 W/mK:

D = 75 mm λ = 0.037 W/mK λref = 0.04 W/mK

According to the table, if we match row 60 < D < 90 with column 60 < T < 100, dref = 30mm

$$d = {}^{75}/_{2} * \left\{ e^{\left({}^{0.037}/_{0.04} * \ln {}^{(75 + 2 * 30)}/_{75}\right)} - 1 \right\} = 27.1 \text{ mm}$$

7.4 START UP HYDRAULIC TEST

Make sure that the installation is in good condition, without possible tensions or breaks.

The test will be performed on sections of less than 100 lineal meters. If there are larger sections, they must be divided.

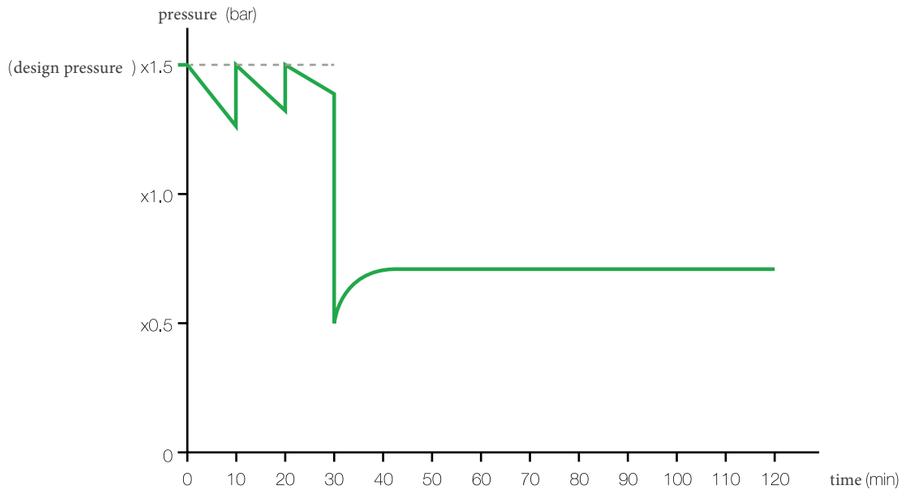
The test will be carried out with clean water at room temperature. Slowly fill the entire installation making sure that there are no air pockets left that may cause water hammers. To do this, bleed the instalation until there is no air.

According to the ENV 12108, apply 1.5 times the design pressure (Pd) of the installation. After 10 minutes, pump again until reaching said pressure (1.5 Pd); after 20 minutes pump again up to 30 minutes, checking for possible leaks or defects. For hot water it will be 2 times the Pd. In both cases with a minimum of 6 bar.

From minute 30 on, two methods can be used:

Method A

Reduce the pressure to 0.5 times the design pressure by means of the bleeding tap. Close it. If the pressure stabilises above 0.5 Pd and remains stable for 90 minutes, the installation is considered correct. This is the recommended method for cold water (according to RITE).



Method B

Take two pressure readings at 30 and 60 minutes. The pressure difference must be less than 0.6 bar. Maintain the pressure for 2 hours, checking the installation for leaks or dampness and, if the pressure drop is less than 0.2 bar after that time, the installation is considered correct.

WATER HAMMER 7.5

When a liquid is flowing through a piping at a constant speed and at a given time any element on the installation is operated (a valve is closed or opened, variation of a pump's speed, etc) an overpressure is caused, resulting in an unbalance in the fluidity speed of the liquid that alters flows and pressures in the different points of the pipeline. This overpressure is called water hammer and must be added to the working or service pressure.

Pressure and flow rate variations that result in a water hammer spread throughout the liquid mass in a wave-like motion. Wave propagation velocity is called celerity and is according to the water modulus of elasticity whose value varies according to the temperature and modulus of elasticity of the piping material.

The lower the value of the modulus of elasticity of the piping material, the lower the celerity and the overpressure value that can take place in the piping. It is therefore advisable to use polyethylene piping, due to their low modulus of elasticity, so as in the same operating conditions, they result in pressures that are much lower than those that would be produced with the use of classic materials, which are considerably more rigid.

Calculation of the overpressure by water hammer can be done using Michaud's equation:

$$\Delta H = \pm \frac{2 * L * v}{g * T}$$

for

$$T > \frac{2 * L}{a}$$

If: ΔF= increase of pressure or height, or water hammer (overpressure in m.w.c.)

a = wave propagation velocity or celerity in m/s

v = water velocity in a constant speed of m/s

L = piping length in m

g = acceleration of gravity in m/s^2

T = stopping manoeuvre time in s

The celerity is calculated with the equation:

$$a = \frac{9900}{\sqrt{48.3 + K_c * D_m / e}} \qquad K_c = \frac{10^{10}}{E}$$

If : Kc = dimensionless indicator

E = piping modulus of elasticity in kg/m^2 (10^8 for PE)

In the case of very long pipelines, the water hammer does not reach its maximum value at the closing end (or point of change of direction), but at a generic point inside the pipe. In this case the Allievi equation is used:

$$\Delta H = \pm \frac{a * v}{g} \quad \text{if} \quad T < \frac{2 * L}{a}$$

The water hammer can be mitigated in different ways:

- Check valves. They are installed in the impulsions to protect in group of pumping and the emptying of the piping through the pump. They can also be placed on the pipeline operating pressure.
- Flywheel. Or pumping group stop delayer. By means of a flywheel attached to the motor shaft.
- Air tank. A tank attached to the piping in which there is water and air under pressure. This air absorbs the pressure variations in the pipeline. Requires maintenance as air dissolves in water over time.
- Surge tank. A vertical tank attached to the piping and higher than the equivalent pressure the piping can withstand.
- Air release valves. Prevents cavitation at high points in the installation.
- Safety valves. If there is a possibility of cavitation leading to strong overpressure.

7.6 PRESSURE DROP

REPOLEN piping have significantly lower pressure drops than piping made of other materials, such as copper thanks to its very low roughness coefficient, 0.007 for PPR, 0.011 for clean copper, 0.025 for clean brass. It should be considered that plastic materials do not rust, no foulings are produced, so that the roughness of the pipe virtually does not vary (depending on the use given to the pipe, fluid transported, disinfection treatments, etc.). For example, iron piping start from a roughness of 0.25, which over time can even reach 4.

Pressure drops in installations are due to the rubbing of the liquid against the walls of the pipe and to those coming from obstacles in the installation (tees, elbows, reducers, branches, etc).

The pressure drops of REPOLEN pipes with a water temperature of 10ºC are indicated in the following tables. At higher temperatures, losses are slightly lower.

REPOLEN SDR 6

The first value corresponds to the pressure drop in mm/m.w.c. and the second to the average speed in m/s.

Flow rate		φ - REPOLEN SDR 6										
l/s	kg/h	16x2.7	20x3.4	25x4.2	32x5.4	40x6.7	50x8.4	63x10.5	75x12.5	90x15	110x18.4	125x20.8
0.02	70	10	2	0.9								
		0.22	0.14	0.09								
0.04	140	33	8	3	1							
		0.44	0.29	0.18	0.11							
0.05	180	52	13	4	2							
		0.57	0.37	0.23	0.14							
0.06	220	73	19	6	2							
		0.7	0.45	0.28	0.17							
0.08	290	118	30	10	4	1.5	0.5					
		0.92	0.59	0.37	0.23	0.15	0.09					
0.1	360	164	42	15	6	2	0.7					
		1.11	0.71	0.45	0.28	0.18	0.11					
0.12	430	234	61	21	8	3	1.07	0.33				
		1.36	0.88	0.55	0.34	0.22	0.14	0.09				
0.14	510		83	29	11	4	1.44	0.45				
			1.04	0.66	0.4	0.26	0.16	0.1				
0.16	580		104	37	14	5	1.8	0.56				
			1.18	0.75	0.46	0.29	0.19	0.12				
0.18	655		129	45	18	6	2.02	0.7				
			1.34	0.84	0.52	0.33	0.21	0.13				
0.2	730		156	55	22	7.5	2.69	0.84				
			1.49	0.94	0.58	0.37	0.24	0.15				
0.23	830		290	69	27	9	3.3	1				
			1.65	1.07	0.66	0.42	0.27	0.17				
0.25	900		353	85	33	11	4.1	1.3				
			1.83	1.2	0.74	0.47	0.3	0.19				

Flow rate		φ - REPOLEN SDR 6										
l/s	kg/h	16x2.7	20x3.4	25x4.2	32x5.4	40x6.7	50x8.4	63x10.5	75x12.5	90x15	110x18.4	125x20.8
0.3	1080			110	43	15	5.3	1.6				
				1.39	0.85	0.54	0.35	0.22				
0.35	1280			149	59	20	7.1	2.2				
				1.65	1.01	0.64	0.41	0.26				
0.4	1430			270	71	24	8	2.7				
				1.85	1.13	0.72	0.46	0.29				
0.45	1605				87	30	10	3.4				
					1.27	0.81	0.52	0.32				
0.5	1805				107	36	13	4.2				
					1.43	0.91	0.58	0.36				
0.55	2005				135	44	15	5				
					1.55	1.01	0.65	0.4				
0.65	2155				172	50	17	5.7				
					1.7	1.08	0.69	0.43				
0.7	2530				225	66	23	7.6				
					1.98	1.27	0.82	0.51				
0.75	2705					74	26	8.5				
						1.36	0.87	0.54				
0.8	2280					83	29	9.5				
						1.45	0.93	0.58				
0.85	3005					89	31	10				
						1.51	0.97	0.61				
0.9	3255					103	36	11				
						1.63	1.05	0.66				
1	3600					143	43	14	7.9	2.8		
						1.8	1.16	0.73	0.5	0.35		
1.2	4320					198	59	19	9.2	3.9		
						2.16	1.4	0.87	0.61	0.42		
1.3	4680						66	22	10.6	4.5		
							1.49	0.93	0.66	0.46		
1.4	5040						76	25	12.1	5.1		
							1.62	101	0.71	0.5		
1.6	5760						14	32	15.3	6.4		
							1.85	1.16	0.81	0.57		
1.8	6480						141	40	18.8	7.9		
							2.08	1.32	0.92	0.64		
2	7200						170	48	22.7	9.5	3.7	
							2.31	1.46	102	0.71	0.48	
2.2	7920							57	26.9	11.3	4.4	
								1.6	1.12	0.78	0.52	
2.4	8640							66	31.4	13.1	5.1	
								1.74	1.22	0.85	0.57	
2.6	9360							76	36.1	15.1	5.9	3.1
								1.88	1.32	0.92	0.62	0.48

Flow rate		φ - REPOLEN SDR 6										
l/s	kg/h	16x2.7	20x3.4	25x4.2	32x5.4	40x6.7	50x8.4	63x10.5	75x12.5	90x15	110x18.4	125x20.8
2.8	10080							87	41.2	17.3	6.7	3.6
								2.02	1.43	0.99	0.67	0.51
3	10800							111.3	46.6	19.5	7.5	4.1
								2.17	1.53	1.06	0.71	0.55
3.5	12600							149	61.4	25.7	9.9	5.3
								2.53	1.78	1.24	0.83	0.64
4	14400								77.9	32.6	12.6	6.7
									2.04	1.41	0.95	0.73
4.5	16200								96.2	40.2	15.5	8.3
									2.29	1.59	1.07	0.82
5	18000								116.2	48.5	18.7	10
									2.55	1.77	1.19	0.92
6	21600								161.1	67.2	25.9	13.9
									3.06	2.12	1.43	1.1
7	25200									88.6	34.2	18.3
										2.48	1.66	1.28
8	28800									112.7	43.4	23.2
										2.83	1.9	1.46
9	32400									139.3	53.6	28.7
										3.18	2.14	1.65
10	36000										64.8	34.7
											2.38	1.83
11	39600										77	41.1
											2.61	2.01
12	43200										90	48.1
											2.85	2.2
13	46800										104	55.6
											3.09	2.38
15	54000											71.9
												2.75
17	61200											92.1
												3.11

REPOLEN SDR 7.4

The first value corresponds to the pressure drop in mm/m.w.c. and the second to the average speed in m/s.

Flow rate		φ - REPOLEN SDR 7.4								
l/s	kg/h	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
0.1	360	16.9	5.2								
		0.39	0.24								
0.15	540	33.8	10.21								
		0.59	0.35								
0.2	720	55.4	16.7								
		0.79	0.47								
0.25	864	81.4	24.5								
		0.98	0.59								
0.3	1080	111.6	33.6	11.7							
		1.18	0.71	0.45							
0.35	1260	145.9	43.9	15.3							
		1.38	0.83	0.53							
0.4	1440	184.2	55.3	19.2	6.7						
		1.57	0.95	0.61	0.39						
0.45	1620	226.3	67.9	23.6	8.3						
		1.77	1.06	0.68	0.44						
0.5	1800	272.2	81.5	28.3	9.9						
		1.96	1.18	0.76	0.49						
0.55	1980	321.7	96.3	33.4	11.7						
		2.16	1.3	0.83	0.53						
0.6	2160		112.2	38.9	13.6						
			1.42	0.91	0.58						
0.65	2340		129	44.7	15.6	5.2					
			1.54	0.98	0.63	0.4					
0.7	2520		147	50.9	17.8	6					
			1.66	1.06	0.68	0.439					
0.75	2700		165.9	57.4	20	6.7					
			1.77	1.14	0.73	0.46					
0.8	2880		185.9	64.3	22.4	7.5					
			1.89	1.21	0.78	0.49					
0.85	3060		206.8	71.5	24.9	8.3					
			2.01	1.29	0.83	0.52					
0.9	3240		228.7	79.1	27.6	9.2					
			2.13	1.36	0.87	0.55					
1	3600			95.2	33.1	11.1	4.9				
				1.51	0.97	0.61	0.43				
1.2	4320			131.2	45.6	15.2	6.7				
				1.82	1.17	0.73	0.52				
1.4	5040			172.3	59.9	20	8.8	3.7			
				2.12	1.36	0.86	0.61	0.42			

Flow rate		φ - REPOLEN SDR 7.4									
l/s	kg/h	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
1.6	5760				75.8	25.2	11.1	4.7			
					1.55	0.98	0.69	0.48			
1.8	6480				9.3	31.1	13.6	5.7			
					1.75	1.1	0.78	0.54			
2	7200				112.5	20	16.4	6.9			
					1.94	1.22	0.87	0.6			
2.2	7920				133.2	44.3	19.4	8.2			
					2.14	1.35	0.95	0.66			
2.4	8640					51.6	22.7	9.05			
						1.47	1.04	0.72			
2.6	9360					69.5	26.1	11			
						1.59	1.13	0.78			
2.8	10080					67.9	29.8	12.5	4.6		
						1.71	1.21	0.84	0.56		
3	10800					76.7	33.6	14.1	5.4	2.9	
						1.84	1.3	0.9	0.6	0.46	
3.5	12600					100.9	44.2	18.6	7.1	3.8	
						21.4	1.52	1.05	0.7	0.54	
4	14400					128	56	23.5	8.9	4.8	
						2.45	1.73	1.21	0.8	0.62	
4.5	16200					158	69.1	29	11	5.9	
						2.76	1.95	1.36	0.9	0.69	
5	18000						83.4	35	13.3	7.1	2.2
							2.17	1.51	1	0.77	0.47
5.5	19800						98.9	41.5	15.7	8.4	2.6
							2.38	1.66	1.11	0.85	0.52
6	21600						115.6	48.4	18.4	9.8	3
							2.6	1.81	1.21	0.93	0.57
6.5	23400							55.9	20.6	11.3	3.5
								1.96	1.29	1	0.61
7	25200							63.8	24.2	12.9	4
								2.11	1.41	1.08	0.66
7.5	27000							72.2	27.3	14.6	4.5
								2.26	1.51	1.16	0.71
8	28800							81	30.7	16.3	5
								2.41	1.61	1.24	0.75
9	32400							100	97.9	20.2	6.2
								2.71	1.81	1.39	0.85
10	36000								45.8	24.4	7.5
									2.01	1.54	0.94
11	39600								54.3	28.9	8.9
									2.21	1.7	1.04
12	43200								63.5	33.8	10.4
									2.41	1.85	1.13

Flow rate		φ - REPOLEN SDR 7.4									
l/s	kg/h	25x3.5	32x4.4	40x5.5	50x6.9	63x8.6	75x10.3	90x12.3	110x15.1	125x17.1	160x21.9
13	46800								73.3	39	12
									2.61	2.01	1.23
14	50400									44.5	13.6
										2.16	1.32
15	54000									50.4	15.4
										2.32	141
16	57600									56.6	17.1
										2.47	1.5
17	61200									63.1	19.3
										2.63	1.6
20	72000										25.9
											1.89
30	108000										53.8
											2.83

REPOLEN SDR 9

The first value corresponds to the pressure drop in mm/m.w.c. and the second to the average speed in m/s.

Flow rate		φ - REPOLEN SDR 9					
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2
0.1	360	3,78	1,33				
		0,21	0,13				
0,15	540	7,49	2,63				
		0,31	0,2				
0.2	720	12,22	4,28	1,49	0,51		
		0,41	0,26	0,17	0,11		
0.3	1080	24,51	8,55	2,97	1,01		
		0,62	0,4	0,25	0,16		
0.4	1440	40,33	14,03	4,86	1,65		
		0,83	0,53	0,34	0,21		
0.5	1800	59,45	20,65	7,14	2,42		
		1,04	0,66	0,42	0,27		
0,6	2160	81,74	28,35	9,79	3,31		
		1,24	0,79	0,51	0,32		
0.7	2520	107,07	37,09	12,79	4,32		
		1,45	0,93	0,59	0,37		
0.8	2880	135,36	46,85	16,14	5,44		
		1,66	1,06	0,68	0,43		
0.9	3240	166,52	57,6	19,83	6,68		
		1,86	1,19	0,76	0,48		
1	3600	200,51	69,3	23,84	8,03		
		2,07	1,32	0,85	0,53		

Flow rate		φ - REPOLEN SDR 9					
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2
1,1	3960	237,25	81,95	28,18	9,48		
		2,28	1,46	0,93	0,59		
1.2	4320	276,7	95,53	32,82	11,04		
		2,48	1,59	1,01	0,64		
1.3	4680	318,82	110,02	37,78	12,7		
		2,69	1,72	1,1	0,7		
1.4	5040	363,57	125,4	43,05	14,46		
		2,9	1,85	1,18	0,75		
1,5	5400	410,9	141,67	48,61	16,32		
		3,11	1,99	1,27	0,8		
1.6	5760	460,8	158,82	54,47	18,28		
		3,31	2,12	1,35	0,86		
1,7	6120	513,22	176,82	60,63	20,34		
		3,52	2,25	1,44	0,91		
1.8	6480	568,14	195,68	67,07	22,49		
		3,73	2,38	1,52	0,96		
1,9	6840	625,54	215,39	73,8	24,74		
		3,93	2,52	1,61	1,02		
2	7200	685,38	235,93	80,81	27,08	11,71	
		4,14	2,65	1,69	1,07	0,75	
2.2	7920		279,49	95,68	32,05	13,84	
			2,91	1,86	1,18	0,83	
2.4	8640		326,3	111,66	37,38	16,14	
			3,18	2,03	1,28	0,9	
2.6	9360		376,33	128,72	43,07	18,59	
			3,44	2,2	1,39	0,98	
2.8	10080		429,51	146,85	49,11	21,19	
			3,71	2,37	1,5	1,05	
3	10800		485,81	166,04	55,51	23,95	10,07
			3,97	2,54	1,6	1,13	0,78
3.5	12600			218,56	73	31,47	13,22
				2,96	1,87	1,32	0,91
4	14400			277,42	92,6	39,89	16,75
				3,38	2,14	1,5	1,05
4.5	16200			342,49	114,25	49,2	20,64
				3,81	2,41	1,69	1,18
5	18000				137,91	59,36	24,89
					2,67	1,88	1,31
6	21600				191,11	82,2	34,45
					3,21	2,26	1,57
7	25200				251,96	108,31	45,36
					3,74	2,63	1,83
8	28800					137,6	57,59
						3,01	2,09

Flow rate		φ - REPOLEN SDR 9					
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2
9	32400					169,99	71,12
						3,38	2,35
10	36000					205,44	85,92
						3,76	2,6
11	39600						101,95
							2,87
12	43200						119,22
							3,14
13	46800						137,68
							3,4
14	50400						157,34
							3,66

REPOLEN SDR 11

The first value corresponds to the pressure drop in mm/m.w.c. and the second to the average speed in m/s.

Flow rate		φ - REPOLEN SDR 11							
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2	110x10	125x11.4	160x14.6
0.1	360	2.9								
		0.19								
0.16	576	6.5								
		0.3								
0.2	720	9.4								
		0.37								
0.25	864	13.8								
		0.46								
0.3	1080	18.9	6.7							
		0.56	0.36							
0.35	1260	24.7	8.8							
		0.65	0.42							
0.4	1440	31.1	11.1	3.8						
		0.74	0.48	0.31						
0.45	1620	38.1	13.6	4.7						
		0.83	0.6	0.34						
0.5	1800	45.8	16.3	5.6						
		0.93	0.6	0.38						
0.55	1980	54.1	19.2	6.6						
		1.02	0.66	0.42						
0.6	2160	63	22.3	7.7						
		1.11	0.72	0.46						

Flow rate		φ - REPOLEN SDR 11								
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2	110x10	125x11.4	160x14.6
0.65	2340	72.1	25.7	8.9	3					
		1.21	0.78	0.5	0.31					
0.7	2520	82.5	29.2	10.1	3.4					
		1.3	0.84	0.54	0.34					
0.75	2700	93.1	33	11.4	3.8					
		1.39	0.9	0.57	0.36					
0.8	2880	104.2	36.9	12.7	4.3					
		1.48	0.96	0.61	0.39					
0.85	3060	116	41	14.1	4.7					
		1.58	1.02	0.65	0.41					
0.9	3240		45.3	15.6	5.2					
			1.08	0.69	0.43					
1	3600		54.5	18.8	6.3	2.7				
			1.2	0.76	0.48	0.34				
1.2	4320		75.2	25.8	8.6	3.7				
			1.44	0.92	0.58	0.41				
1.4	5040		98.7	33.9	11.3	4.9	2.1			
			1.68	1.07	0.67	0.47	0.33			
1.6	5760			42.9	14.3	6.1	2.6			
				1.22	0.77	0.54	0.38			
1.8	6480			52.8	21.1	9.1	3.8			
				1.38	0.96	0.68	0.47			
2	7200			63.6	25	9.1	3.8			
				1.53	1.06	0.68	0.47			
2.2	7920			73.2	25	10.7	4.5			
				1.68	1.06	0.74	0.52			
2.4	8640				29.2	12.5	5.3			
					1.16	0.81	0.56			
2.6	9360				33.6	14.4	6.0			
					1.25	0.9	0.6			
2.8	10080				38.3	16.4	6.9	2.7		
					1.35	0.9	0.7	0.4		
3	10800				43.3	18.5	7.8	3	1.6	
					1.45	1.01	0.71	0.47	0.37	
3.5	12600				57	24.4	10.3	3.9	2.1	
					1.69	1.18	0.9	0.55	0.43	
4	14400				72.2	30.9	13	5	2.7	
					1.93	1.4	0.9	0.6	0.5	
4.5	16200					38.1	16	6.1	3.3	
						1.5	1.1	0.7	0.5	
5	18000					46	19.3	7.4	4	1.2
						1.69	1.18	0.79	0.61	0.37
5.5	19800					54.5	22.9	8.8	4.8	1.5
						1.86	1.29	0.86	0.67	0.41

Flow rate		φ - REPOLEN SDR 11								
l/s	kg/h	32x2.9	40x3.7	50x4.6	63x5.8	75x6.8	90x8.2	110x10	125x11.4	160x14.6
6	21600					63.6	26.7	10.2	5.6	1.7
						2	1.4	0.9	0.7	0.4
7	25200						35.2	13.4	7.3	23
							1.6	1.1	0.9	0.5
8	28800						44.7	17.1	9.3	2.9
							1.9	1.3	1	0.6
9	32400							21.1	11.5	3.5
								1.4	1.1	0.7
10	36000							25.4	13.8	4.2
								1.57	1.22	0.74
11	39600							30.1	16.4	5
								1.73	1.34	0.82
12	43200							35.2	19.2	5.9
								1.89	1.46	0.89
13	46800							40.7	22.1	6.8
								2.04	1.58	0.97
14	50400								25.3	7.7
									1.71	1.04
15	54000								28.6	8.8
									1.83	1.12
16	57600								32.1	9.8
									1.95	1.19
17	61200									11
										1.27
18	64800									12.1
										1.34
19	68400									13.4
										1.41
20	72000									14.7
										1.49
25	90000									21.9
										1.86
30	108000									30.25
										2.23

The pressure drop stipulated for the fittings is:

Description	Scheme	Resistance coefficient (r)
Sleeve		0.25
Sleeve Thread - Female		0.5
Sleeve Thread - Male		0.7
One diameter reducer		0.4
Two diameter reducer		0.5
Three diameter reducer		0.6
Four diameter reducer		0.7
Five diameter reducer		0.8
Six diameter reducer		0.9
90º Elbow		1.2
90º Elbow Thread - Male		1.6
90º Elbow Thread - Female		1.4
45º Elbow		0.6
Divergent Flow Tee		1.8
Convergent Flow Tee		1.3
Opposition Tee with Divergent Flow		2.2
Opposition Tee with Convergent Flow		4.2
Reducing tee	The result will be the sum of the tee with the reducer	
Female thread tee		1.6
Tee Thread - Male		1.8

Example

Assume an installation with 10 linear meters of REPOLEN pipe and a 25 x 4.2 mm diameter, in which there are 4 sleeves, 3 90º elbows, 2 tees and a female threaded sleeve, which is intended to transport 0.35 l/s of water at 10ºC.

The total pressure drop will be the pressure drop of the piping, plus that of the fittings:

$$H = Ht + Ha$$

where: H is the total pressure drop in mm.w.c.
Ht is the pressure drop of the piping in mm.w.c.
Ha is the pressure drop of the fittings in mm.w.c.

For calculating the pressure drop of the piping it is necessary to consult the previous tables, so we see that for the chosen pipe and 0.35 l/s, we have a water velocity of 1.65 m/s and a pressure drop of 149 mm.w.c. Since we have 10 linear meters:

$$Ht = 149 * 10 = 1490 \text{ mm.w.c.}$$

The pressure drop of various fittings is calculated by the equation:

$$Ha = \Sigma r * v^2 * \gamma / 2 * g$$

where: r is the coefficient of resistance of the fitting
v is the velocity of the transported fluid in m/s
γ is the specific weight of the fluid transported. Being water is 1 kg/l
g is the acceleration of gravity, 9.8 m/s

$$Ha = (4 * 0.25 + 3 * 1.2 * 2 * 1.8 + 0.5) * 1.65^2 * 1/2 * 9.8 = 8.7 * 2.72 * 0.05 = 1.183 \text{ m.c.a.} = 1183 \text{ mm.w.c.}$$

$$H = 1490 + 1183 = 2673 \text{ mm.w.c.}$$

7.7 PEAK FLOW RATE

Determination of peak flow rate Vs from the sum of flows ΣVR for residential buildings
acc. to DIN 1988 Teil 3 VS = 0.682 - (ΣVR)0.45 - 0.7 [l / s]

ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS
0,03	0,00	1,02	0,55	2,02	0,80	3,02	0,98	4,02	1,14	5,10	1,28	10,10	1,79	15,10	2,17
0,04	0,02	1,04	0,55	2,04	0,80	3,04	0,98	4,04	1,14	5,20	1,29	10,20	1,80	15,20	2,18
0,06	0,05	1,06	0,56	2,06	0,80	3,06	0,99	4,06	1,14	5,30	1,30	10,30	1,81	15,30	2,19
0,07	0,07	1,08	0,57	2,08	0,81	3,08	0,99	4,08	1,14	5,40	1,32	10,40	1,82	15,40	2,19
0,08	0,08	1,10	0,57	2,10	0,81	3,10	0,99	4,10	1,15	5,50	1,33	10,50	1,82	15,50	2,20
0,09	0,09	1,12	0,58	2,12	0,82	3,12	1,00	4,12	1,15	5,60	1,34	10,60	1,83	15,60	2,21
0,10	0,10	1,14	0,58	2,14	0,82	3,14	1,00	4,14	1,15	5,70	1,35	10,70	1,84	15,70	2,21
0,13	0,13	1,16	0,59	2,16	0,82	3,16	1,00	4,16	1,16	5,80	1,36	10,80	1,85	15,80	2,22
0,15	0,15	1,18	0,59	2,18	0,83	3,18	1,01	4,18	1,16	5,90	1,38	10,90	1,86	15,90	2,23
0,20	0,19	1,20	0,60	2,20	0,83	3,20	1,01	4,20	1,16	6,00	1,39	11,00	1,87	16,00	2,23
0,22	0,21	1,22	0,61	2,22	0,84	3,22	1,01	4,22	1,16	6,10	1,40	11,10	1,87	16,10	2,24
0,24	0,22	1,24	0,61	2,24	0,84	3,24	1,02	4,24	1,17	6,20	1,41	11,20	1,88	16,20	2,25
0,26	0,23	1,26	0,62	2,26	0,84	3,26	1,02	4,26	1,17	6,30	1,42	11,30	1,89	16,30	2,25
0,28	0,24	1,28	0,62	2,28	0,85	3,28	1,02	4,28	1,17	6,40	1,43	11,40	1,90	16,40	2,26
0,30	0,26	1,30	0,63	2,30	0,85	3,30	1,03	4,30	1,17	6,50	1,44	11,50	1,91	16,50	2,27
0,32	0,27	1,32	0,63	2,32	0,86	3,32	1,03	4,32	1,18	6,60	1,45	11,60	1,91	16,60	2,27
0,34	0,28	1,34	0,64	2,34	0,86	3,34	1,03	4,34	1,18	6,70	1,47	11,70	1,92	16,70	2,28
0,36	0,29	1,36	0,64	2,36	0,86	3,36	1,04	4,36	1,18	6,80	1,48	11,80	1,93	16,80	2,29
0,38	0,30	1,38	0,65	2,38	0,87	3,38	1,04	4,38	1,19	6,90	1,49	11,90	1,94	16,90	2,29
0,40	0,31	1,40	0,65	2,40	0,87	3,40	1,04	4,40	1,19	7,00	1,50	12,00	1,95	17,00	2,30
0,42	0,32	1,42	0,66	2,42	0,88	3,42	1,05	4,42	1,19	7,10	1,51	12,10	1,95	17,10	2,31
0,44	0,33	1,44	0,66	2,44	0,88	3,44	1,05	4,44	1,19	7,20	1,52	12,20	1,96	17,20	2,31
0,46	0,34	1,46	0,67	2,46	0,88	3,46	1,05	4,46	1,20	7,30	1,53	12,30	1,97	17,30	2,32
0,48	0,35	1,48	0,67	2,48	0,89	3,48	1,06	4,48	1,20	7,40	1,54	12,40	1,98	17,40	2,33
0,50	0,36	1,50	0,68	2,50	0,89	3,50	1,06	4,50	1,20	7,50	1,55	12,50	1,99	17,50	2,33
0,52	0,37	1,52	0,68	2,52	0,89	3,52	1,06	4,52	1,20	7,60	1,56	12,60	1,99	17,60	2,34
0,54	0,38	1,54	0,69	2,54	0,90	3,54	1,06	4,54	1,21	7,70	1,57	12,70	2,00	17,70	2,35
0,56	0,39	1,56	0,69	2,56	0,90	3,56	1,07	4,56	1,21	7,80	1,58	12,80	2,01	17,80	2,35
0,58	0,39	1,58	0,70	2,58	0,90	3,58	1,07	4,58	1,21	7,90	1,59	12,90	2,02	17,90	2,36
0,60	0,40	1,60	0,70	2,60	0,91	3,60	1,07	4,60	1,22	8,00	1,60	13,00	2,02	18,00	2,36
0,62	0,41	1,62	0,71	2,62	0,91	3,62	1,08	4,62	1,22	8,10	1,61	13,10	2,03	18,10	2,37
0,64	0,42	1,64	0,71	2,64	0,92	3,64	1,08	4,64	1,22	8,20	1,62	13,20	2,04	18,20	2,38
0,66	0,43	1,66	0,72	2,66	0,92	3,66	1,08	4,66	1,22	8,30	1,63	13,30	2,05	18,30	2,38
0,68	0,43	1,68	0,72	2,68	0,92	3,68	1,09	4,68	1,23	8,40	1,64	13,40	2,05	18,40	2,39
0,70	0,44	1,70	0,73	2,70	0,93	3,70	1,09	4,70	1,23	8,50	1,65	13,50	2,06	18,50	2,40
0,72	0,45	1,72	0,73	2,72	0,93	3,72	1,09	4,72	1,23	8,60	1,66	13,60	2,07	18,60	2,40
0,74	0,46	1,74	0,74	2,74	0,93	3,74	1,09	4,74	1,23	8,70	1,67	13,70	2,07	18,70	2,41
0,76	0,46	1,76	0,74	2,76	0,94	3,76	1,10	4,76	1,24	8,80	1,67	13,80	2,08	18,80	2,41
0,78	0,47	1,78	0,74	2,78	0,94	3,78	1,10	4,78	1,24	8,90	1,68	13,90	2,09	18,90	2,42
0,80	0,48	1,80	0,75	2,80	0,94	3,80	1,10	4,80	1,24	9,00	1,69	14,00	2,10	19,00	2,43
0,82	0,48	1,82	0,75	2,82	0,95	3,82	1,11	4,82	1,24	9,10	1,70	14,10	2,10	19,10	2,43
0,84	0,49	1,84	0,76	2,84	0,95	3,84	1,11	4,84	1,25	9,20	1,71	14,20	2,11	19,20	2,44
0,86	0,50	1,86	0,76	2,86	0,95	3,86	1,11	4,86	1,25	9,30	1,72	14,30	2,21	19,30	2,44
0,88	0,50	1,88	0,77	2,88	0,96	3,88	1,12	4,88	1,25	9,40	1,73	14,40	2,12	19,40	2,45
0,90	0,51	1,90	0,77	2,90	0,96	3,90	1,12	4,90	1,25	9,50	1,74	14,50	2,13	19,50	2,46
0,92	0,52	1,92	0,77	2,92	0,96	3,92	1,12	4,92	1,26	9,60	1,75	14,60	2,14	19,60	2,46
0,94	0,52	1,94	0,78	2,94	0,97	3,94	1,12	4,94	1,26	9,70	1,76	14,70	2,15	19,70	2,47
0,96	0,53	1,96	0,78	2,96	0,97	3,96	1,13	4,96	1,26	9,80	1,76	14,80	2,15	19,80	2,47
0,98	0,54	1,98	0,79	2,98	0,97	3,98	1,13	4,98	1,26	9,90	1,77	14,90	2,16	19,90	2,48
1,00	0,54	2,00	0,79	3,00	0,98	4,00	1,13	5,00	1,27	10,00	1,78	15,00	2,17	20,00	2,49

* This table is valid when the flow rate VR of the individual intake points is less than 0.5 l/s.

Determination of peak flow rate Vs from the sum of flows ΣVR for residential buildings
acc. to DIN 1988 Teil 3 VS = 1.7 - (ΣVR)0.21 - 0.7 [l / s]

ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS	ΣVR	VS
1,00	1,00	5,10	1,69	10,10	2,06	15,10	2,31	22,40	2,57	142,20	4,12	262,40	4,78	382,40	5,23
1,05	1,02	5,20	1,70	10,20	2,07	15,20	2,31	24,80	2,64	144,80	4,13	264,80	4,79	384,80	5,23
1,10	1,03	5,30	1,71	10,30	2,07	15,30	2,31	27,20	2,70	147,20	4,15	267,20	4,81	387,20	5,24
1,15	1,05	5,40	1,72	10,40	2,08	15,40	2,32	29,60	2,76	149,60	4,17	269,60	4,81	389,60	5,25
1,20	1,07	5,50	1,73	10,50	2,09	15,50	2,32	32,00	2,82	152,00	4,18	272,00	4,82	392,00	5,26
1,25	1,08	5,60	1,74	10,60	2,09	15,60	2,33	34,40	2,87	154,40	4,20	274,40	4,83	394,40	5,26
1,30	1,10	5,70	1,75	10,70	2,10	15,70	2,33	36,80	2,92	156,80	4,21	276,80	4,84	396,80	5,27
1,35	1,11	5,80	1,76	10,80	2,10	15,80	2,34	39,20	2,97	159,20	4,23	279,20	4,85	399,20	5,28
1,40	1,12	5,90	1,77	10,90	2,11	15,90	2,34	41,60	3,02	161,60	4,25	281,60	4,86	401,60	5,29
1,45	1,14	6,00	1,78	11,00	2,11	16,00	2,34	44,00	3,06	164,00	4,26	284,00	4,87	404,00	5,29
1,50	1,15	6,10	1,79	11,10	2,12	16,10	2,35	46,40	3,11	166,40	4,28	286,40	4,88	406,40	5,30
1,55	1,16	6,20	1,79	11,20	2,12	16,20	2,35	48,80	3,15	168,80	4,29	288,80	4,89	408,80	5,31
1,60	1,18	6,30	1,80	11,30	2,13	16,30	2,35	51,20	3,19	171,20	4,31	291,20	4,90	411,20	5,32
1,65	1,19	6,40	1,81	11,40	2,13	16,40	2,36	53,60	3,22	173,60	4,32	293,60	4,91	413,60	5,32
1,70	1,20	6,50	1,82	11,50	2,14	16,50	2,36	56,00	3,26	176,00	4,34	296,00	4,92	416,00	5,33
1,75	1,21	6,60	1,83	11,60	2,14	16,60	2,37	58,40	3,29	178,40	4,35	298,40	4,93	418,40	5,34
1,80	1,22	6,70	1,83	11,70	2,15	16,70	2,37	60,80	3,33	180,80	4,36	300,80	4,93	420,80	5,35
1,85	1,23	6,80	1,84	11,80	2,15	16,80	2,37	63,20	3,36	183,20	4,38	303,20	4,94	423,20	5,35
1,90	1,25	6,90	1,85	11,90	2,16	16,90	2,38	65,60	3,39	185,60	4,36	305,60	4,95	425,60	5,36
2,00	1,27	7,00	1,86	12,00	2,16	17,00	2,38	68,00	3,42	188,00	4,41	308,00	4,96	428,00	5,37
2,10	1,29	7,10	1,87	12,10	2,17	17,10	2,39	70,40	3,45	190,40	4,42	310,40	4,97	430,40	5,38
2,20	1,31	7,20	1,87	12,20	2,17	17,20	2,39	72,80	3,48	192,80	4,43	312,80	4,98	432,80	5,38
2,30	1,32	7,30	1,88	12,30	2,18	17,30	2,39	75,20	3,51	195,20	4,45	315,20	4,99	435,20	5,39
2,40	1,34	7,40	1,89	12,40	2,18	17,40	2,40	77,60	3,54	197,60	4,46	317,60	5,00	437,60	5,40
2,50	1,36	7,50	1,90	12,50	2,19	17,50	2,40	80,00	3,57	200,00	4,47	320,00	5,01	440,00	5,40
2,60	1,38	7,60	1,90	12,60	2,19	17,60	2,40	82,40	3,59	202,40	4,49	322,40	5,02	442,40	5,41
2,70	1,39	7,70	1,91	12,70	2,20	17,70	2,41	84,80	3,62	204,80	4,50	324,80	5,03	444,80	5,42
2,80	1,41	7,80	1,92	12,80	2,20	17,80	2,41	87,20	3,64	207,20	4,51	327,20	5,04	447,20	5,42
2,90	1,43	7,90	1,92	12,90	2,21	17,90	2,42	89,60	3,67	209,60	4,52	329,60	5,04	452,00	5,43
3,00	1,44	8,00	1,93	13,00	2,21	18,00	2,42	92,00	3,69	212,00	4,54	332,00	5,05	454,40	5,44
3,10	1,46	8,10	1,94	13,10	2,22	18,10	2,42	94,40	3,72	214,40	4,55	334,40	5,06	456,80	5,44
3,20	1,47	8,20	1,94	13,20	2,22	18,20	2,43	96,80	3,74	216,80	4,56	336,80	5,07	459,20	5,45
3,30	1,48	8,30	1,95	13,30	2,23	18,30	2,43	99,20	3,76	219,20	4,57	339,20	5,08	461,60	5,46
3,40	1,50	8,40	1,96	13,40	2,23	18,40	2,43	101,60	3,79	221,60	4,58	341,60	5,09	464,00	5,47
3,50	1,51	8,50	1,96	13,50	2,24	18,50	2,44	104,00	3,81	224,00	4,60	344,00	5,10	466,40	5,47
3,60	1,52	8,60	1,97	13,60	2,24	18,60	2,44	106,40	3,83	226,40	4,61	346,40	5,10	468,80	5,48
3,70	1,54	8,70	1,98	13,70	2,25	18,70	2,44	108,80	3,85	228,80	4,62	348,80	5,11	471,20	5,49
3,80	1,55	8,80	1,98	13,80	2,25	18,80	2,45	111,20	3,87	231,20	4,63	351,20	5,12	473,60	5,49
3,90	1,56	8,90	1,99	13,90	2,25	18,90	2,45	113,60	3,89	233,60	4,64	353,60	5,13	476,00	5,50
4,00	1,57	9,00	2,00	14,00	2,26	19,00	2,45	116,00	3,91	236,00	4,66	356,00	5,14	478,40	5,51
4,10	1,59	9,10	2,00	14,10	2,26	19,10	2,46	118,40	3,93	238,40	4,67	358,40	5,15	480,80	5,51
4,20	1,60	9,20	2,01	14,20	2,27	19,20	2,46	120,80	3,95	240,80	4,68	360,80	5,15	483,20	5,52
4,30	1,61	9,30	2,02	14,30	2,27	19,30	2,47	123,20	3,97	243,20	4,69	363,20	5,16	485,60	5,52
4,40	1,62	9,40	2,02	14,40	2,28	19,40	2,47	125,60	3,99	245,60	4,70	365,00	5,17	488,00	5,53
4,50	1,63	9,50	2,03	14,50	2,28	19,50	2,47	128,00	4,01	248,00	4,71	368,00	5,18	490,40	5,54
4,60	1,64	9,60	2,03	14,60	2,29	19,60	2,48	130,40	4,03	250,40	4,72	370,40	5,19	492,40	5,54
4,70	1,65	9,70	2,04	14,70	2,29	19,70	2,48	132,80	4,05	252,80	4,76	372,80	5,19	492,80	5,55
4,80	1,66	9,80	2,05	14,80	2,29	19,80	2,48	135,20	4,06	255,20	4,74	375,20	5,20	495,20	5,56
4,90	1,67	9,90	2,05	14,90	2,30	19,90	2,49	137,60	4,08	257,60	4,75	377,60	5,21	497,60	5,56
5,00	1,68	10,00	2,06	15,00	2,30	20,00	2,49	140,00	4,10	260,00	4,77	380,00	5,22	500,00	5,57

* This table is valid when the flow rate VR of the individual intake points is less than 0.5 l/s.

7.8 INSTALLATIONS SIZING

According to CTE HS4, the flow rates to be taken into consideration are:

Equipment	Minimum instantaneous flow rate (l/s)		Nominal diameter of the coupling submain	
	Cold water	Hot water (Hot Water System)	Steel pipe (“)	Copper or plastic pipe (mm)
Bathtub < 1.4 m	0.2	0.15	¾	20
Bathtub > 1.4 m	0.3	0.2	¾	20
Bidet	0.1	0.065	½	12
Shower	0.2	0.1	½	12
Domestic sink	0.2	0.1	½	12
Non-domestic sink	0.3	0.2	¾	20
Isolated tap	0.15	0.1	---	---
Garage tap	0.2	---	---	---
Toilet with cistern	0.1	---	½	12
Toilet with flushometer	1.25	---	1 – 1 ½	25 – 40
Toilet	0.1	0.065	½	12
Laundry room	0.2	0.1	---	---
Domestic washing machine	0.2	0.15	¾	20
Industrial washing machine (> 8 kg)	0.6	0.4	1	25
Washbasin	0.05	0.03	½	12
Domestic dishwasher	0.15	0.1	½ (thread to ¾)	12
Industrial dishwasher (20 services)	0.25	0.2	¾	20
Urinal with cistern	0.04	---	½	12
Urinal with timed tap	0.15	---	½	12
Landfill	0.2	---	¾	20

- The minimum pressures will be:
  100 kPa for common taps
  150 kPa for flushometers and heaters
- The pressure at any point of consumption must not exceed 500 kPa.
- The minimum supply diameters are:

Section under consideration	Steel pipe (“)	Copper or plastic pipe (mm)
Supply to private toilet: Bathroom, toilet, kitchen	¾	20
Supply to specific branch: Housing, flat, commercial premises	¾	20
Column (riser or downward)	¾	50
Main Distributor	1	25
Supply of air conditioning equipment	< 50 kW	12
	50 – 250 kW	20
	250 – 500 kW	25
	> 500 kW	32

- The temperature at the Hot Water System points of consumption must be between 50 and 65ºC.
- The installations will be sized by dividing the installation into sections and always taking into account the most unfavourable section (the one with the greatest pressure loss).
- The calculation speed must be between 0.5 and 3.5 m/s (for plastic piping).

For the Hot Water System, the drive circuit is calculated in the same way as for cold water. For the return circuit, the flow rate will be estimated so that in the most distant tap, the temperature loss is a maximum of 3ºC from the outlet of the accumulator or exchanger.

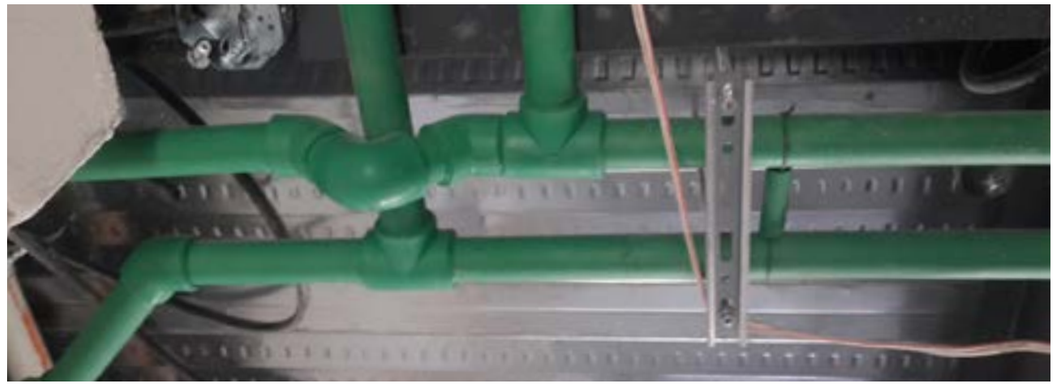
In any case, no less than 250 l/h will be recirculated in each column. It must be considered that at least 10% of the supply water is recirculated. The minimum internal diameter of the return piping must be 16 mm.

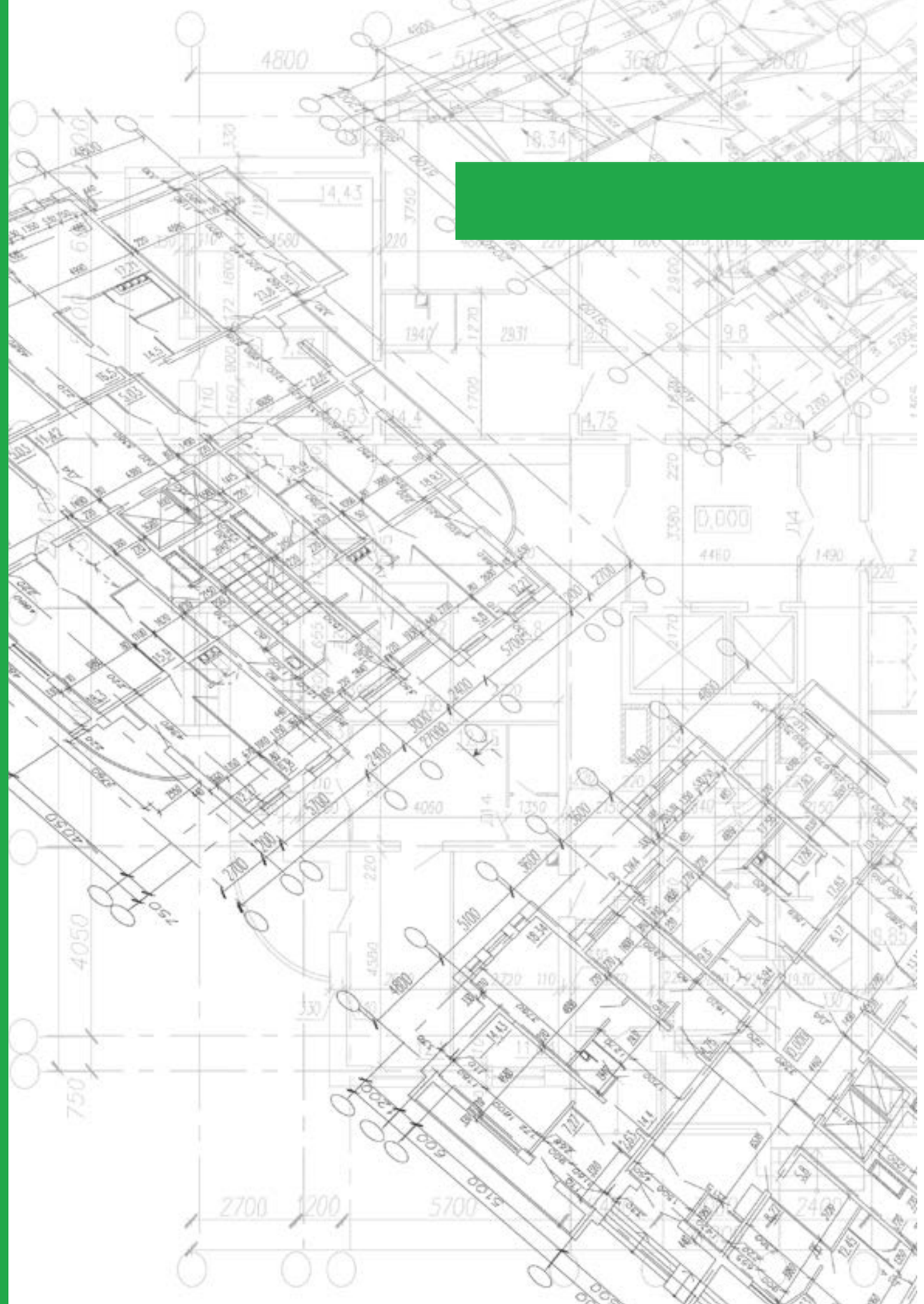
The diameters on the recirculated flow rate are:

Piping diameter (“)	Recirculated flow rate (l/h)
½	14
¾	300
1	600
1 ¼	1100
1 ½	1800
2	3300

ON-SITE RECOMMENDATIONS 7.9

- Take into account the environmental conditions when welding, avoiding currents that could cause undesirable cooling
- PPR REPOLEN pipes must never be exposed to direct sunlight, as they are not protected against ultraviolet radiation.
- In case of low temperatures, check the condition of the pipes’ ends, in case any unintended impact could have occurred during handling or transport.
- PPR REPOLEN pipes can be installed in direct contact with any traditional building material.
- Take special care with regard to lineal expansions, both in recessed installations and in exposed installations, to allow for movement and to place the fasteners where necessary and advisable.
- In the case of buried installations, they must be placed at a 0.8 m depth if traffic will not run over them and at 1 m if it may run over them.





CONNECTION SYSTEMS

8.1 Thermofusion or socket welding connection
8.2 Butt weld connection
8.3 Electrofusion connection
8.4 Flanged systems
8.5 Installation of branch systems
8.6 System repair

The main connection system are:

- Thermofusion or socket welding (recommended option)
- Electrofusion
- Butt or mirror welding
- Others: flanged fittings, threads, etc.

- For most of these systems, there are a series of common points to keep in mind:

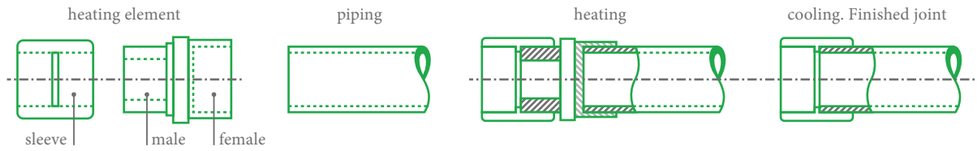
- It is essential to maintain the cleanliness of the elements to be connected. Such cleaning should never be done using chemicals. Wiping off any dirt with a clean cloth would be enough.
- The cuts of the parts to be joined must be as parallel as possible to each other and as perpendicular as possible to the length of the pipe. If there is any burr, it is advisable to remove it before connecting the parts.
- In processes where temperature is involved, it is important to ensure that materials with similar melting points are to be connected.
- It is necessary to consider the environmental conditions where the connection is going to take place, since extreme temperatures could distort machine data in automatic welds, or even affect the elements to be joined. In the same way, it is necessary to avoid air currents that can make the connection difficult, since it may accelerate the partial cooling of the different elements.

8.1 THERMOFUSION OR SOCKET WELDING

The process consists of connecting a pipe and a fitting by applying heat on the external part of the pipe and the internal part of the fitting. To do this, the pipe is inserted into the heating matrix while another heating matrix is inserted into the fitting.

Once the corresponding time has elapsed (see time table), the matrices are removed and the pipe is inserted into the fitting, keeping the pressure for the indicated time.

This type of welding guarantees a perfect pipe - fitting connection. The end result is a single part, eliminating the risk of leakage.



Welding instructions

- Check the temperature of the matrices (275 - 285ºC). It is necessary to avoid air currents that could cool the matrix on one side. The temperature difference does not guarantee a good weld.
- Clean the pipe and fitting with a clean cloth
- Mark the depth at which the pipe should enter
- Insert the pipe and fitting while exerting a light pressure on them and allowing the material to melt slowly
- Count the time indicated in the enclosed table according to the diameter of the pipe
- Remove the pipe and fitting and insert the pipe into the fitting, maintaining the pressure for the time indicated in the table.
- During this time, small alignment corrections can be made.
- When the bench welder is used (large diameters), the procedure is almost the same, except that the pressure is exerted by the bench.
- A good weld will produce a uniform bead all around the welded perimeter (see butt weld bead).
- Wait about two hours before doing hydraulic tests.

Steps for manual welding

Check the length of the pipe to be inserted in the accessory

Mark the measured length on the pipe

Apply the matrices to the pipe and fitting

Insert the pipe into the fitting

Steps for machine welding

Level the fitting on the machine

Apply the matrices to the pipes and fittings

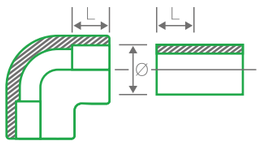
Remove the matrices

Insert the pipe into the fitting

Nominal diameter (mm)	Warm-up time (s)	Assembly time (s)	Cooling time (sec)
16	5	4	20
20	5	4	20
25	7	4	25
32	8	6	25
40	12	6	35
50	18	6	35
63	25	8	40
75	30	8	40
90	40	10	50
110	50	10	60
125	60	10	65
140	65	12	90
160	70	12	100

Note: It is recommended to wait at least a couple of hours before testing for leaks.

Working depth table	
Nominal diameter (mm)	Minimum depth (mm)
16	13
20	14.5
25	16
32	18
40	20.5
50	23.5
63	27.5
75	30
90	33
110	37
125	40
140	39.8
160	43.2



L = Length
∅ = Coupling diameter

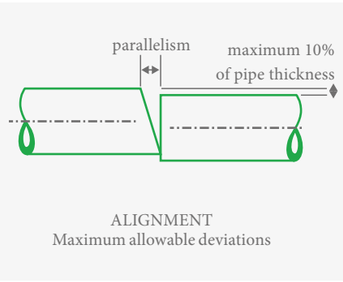
Special care of the heating matrices

- It is important to keep them in good condition, preventing them from suffering any impact or scratches.
- Always keep them clean. If there is any material attached left, remove it while they are still hot using a clean cloth.
- If they are used for more than one material, cleaning when finished is especially important.
- If they are damaged, replace them with new ones. The matrices have a Teflon coating which ensures a homogeneous distribution of heat. If the Teflon is damaged, the matrix will not heat evenly in all its parts and correct welding cannot be guaranteed.

The procedure consists of heating two pipes (or a pipe with a fitting of the same outer diameter and thickness as the pipe) by means of a heating plate, and then apply pressure to achieve the connection of both elements.
It is usually used for large diameters. It is very important that it is always carried out between equal thicknesses and diameters.

Welding instructions

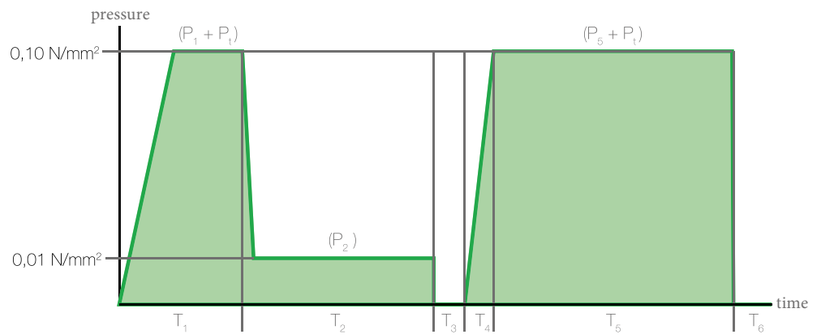
- Place the elements aligned on the welding machine.
- Face the pipes (using the blade of the machine itself) to properly clean the surfaces and even them out.
- Remove the facing tool and the burrs without touching the surfaces to be connected.
- Ensure the surfaces are parallel to each other.
- Check that the heating plate is clean and at the correct temperature.
- Follow the pressure curve indicated by the machine manufacturer.
- A first P1 pressure is exerted for a T1 time to create the initial height cord (h).
- After this time, lower the pressure to ensure full heating P2 (preset welding pressure = 1.5 bar).
- After the heating time T2, move back the elements and remove the heating plate and quickly connect the ends T3.
- Increase the pressure progressively until it reaches the pressure indicated by the manufacturer P1 - T4.
- Maintain this pressure for the time indicated until the weld is cold T5.
- Wait about two hours before doing hydraulic tests.



ALIGNMENT
Maximum allowable deviations

h = Initial cord height in a $^*T_1$ time

Final cord



8.3 ELECTROFUSION CONNECTION

The system consists of passing a low voltage current through metal coils inside the fittings, embedded in the polypropylene, causing the Joule heating effect that welds the fitting with the pipe previously inserted in it.

Check the length of the pipe to be inserted into the fitting.

Mark the measured length on the pipe.

Scrap the surface to be welded (best with automatic scraper).

Insert the pipe into the fitting without forcing it (the pipe must be inserted without forcing it but play-free).

Connect the machine terminals to the fitting.

Read fitting label code.

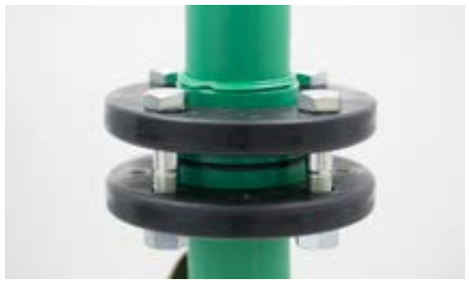
Wait for welding process to finish (indicators outlet).

FLANGED SYSTEMS 8.4

Reboca, S.L. has flanged systems that enable the connection between pipes. REPOLEN flanges are PN16.

Remember that the tightening of the screws must always be done crosswise and gradually, in order to ensure a perfect coupling of the gasket.

Measure	PN	Thickness (mm)	Outer diameter (mm)	Internal diameter (mm)	No. of holes
32	16	16,8	117	42,5	4
40	16	18	141,5	51	4
50	16	18	151	62,5	4
63	16	19,5	165	78	4
75	16	19,5	188,5	93	4
90	16	19,5	199	113	8
110	16	19,5	224,5	134	8
125	16	25	250	168	8
140	16	25	250	159	8
160 PPR	16	19,5	285	191,5	8
160 PE	16	19,5	285	179,5	8
200	16	24	341,5	236	12
250	16	30	404,5	288,5	12
315	16	34	462,5	338	12



8.5 INSTALLATION OF BRANCH SYSTEMS

The REPOLEN socket system makes it easy to modify existing installations.

Make a hole in the pipe where you want to make the new intake with the corresponding drill.

Cut the edges that may remain carefully so as not to damage the pipe.

Apply the heating matrices both to the pipe and to the branch to be grafted, proceeding in the same way as with any socket weld.

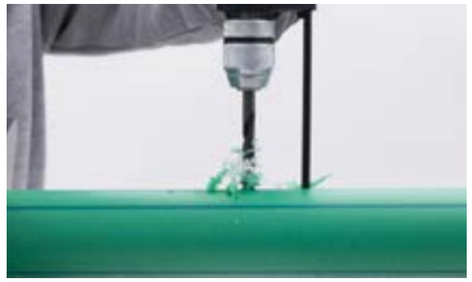
Remove the matrices and insert the branch into the hole.

Level the outlet before the weld cools down.

SYSTEM REPAIR 8.6

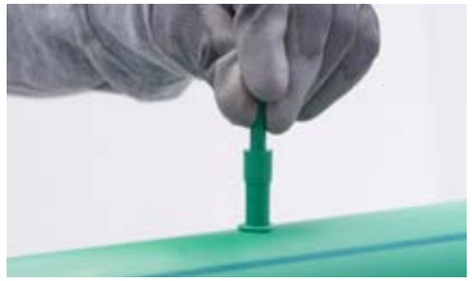
If a small breakage, an unintentional hole, etc. occurs on an already finished installation, a repair plug, with the appropriate matrix, would be enough to solve it.

Depending on the size of the hole, apply a 6 or 10 mm drill bit.



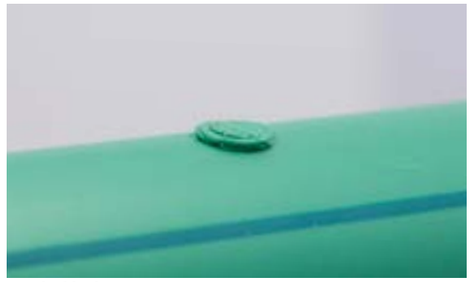
The hole has to be round.

Apply the repair matrices, both to the hole and to the repair plug.

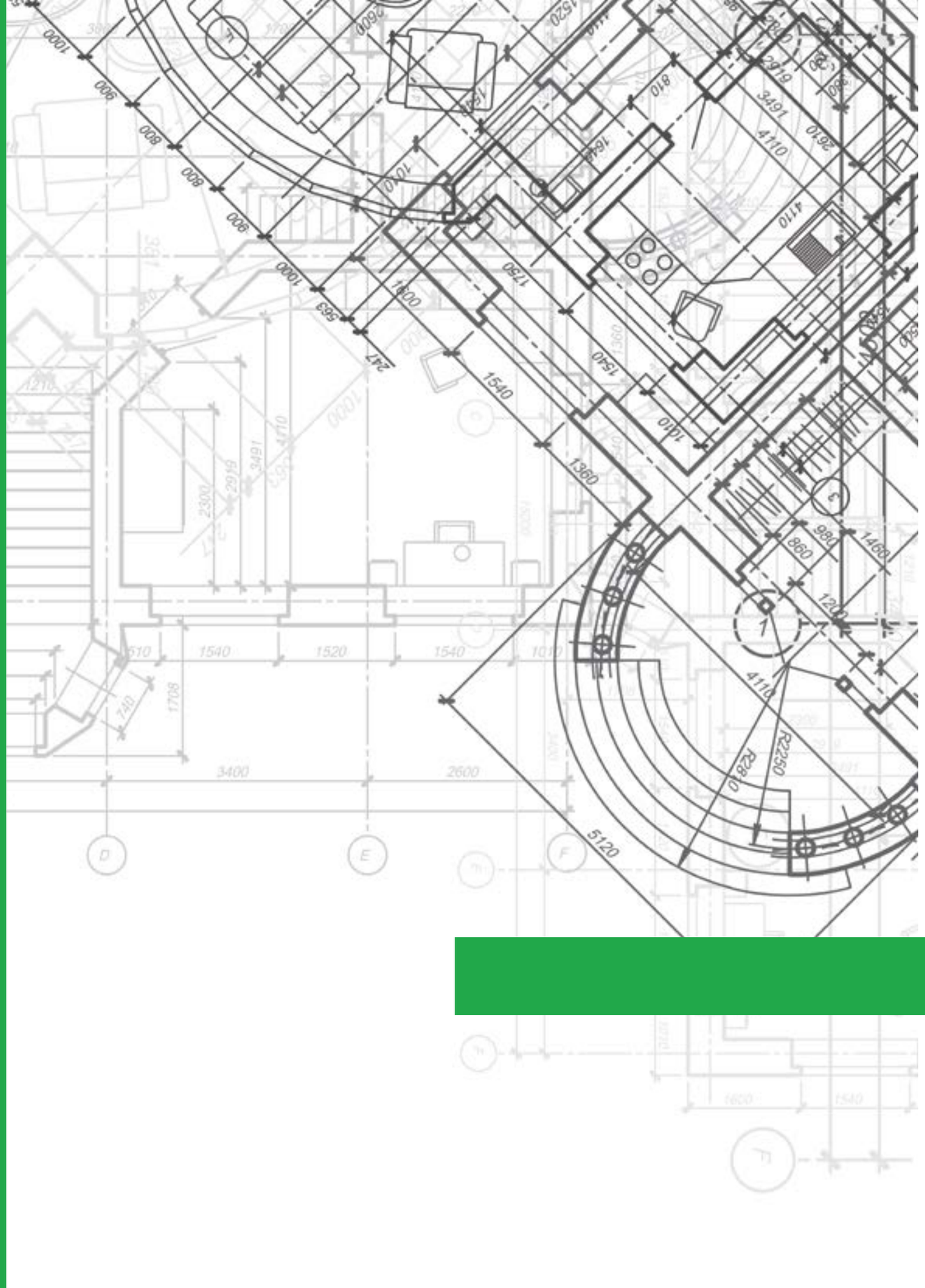


Insert the plug into the hole taking care not to insert it too much so as not to create turbulence in the water flow.

Cut off excess plug.



Finished look.



ANNEXES

9.1 CHEMICAL RESISTANCE TABLE

+	Resists with insignificant variations	cold sat.	Cold saturation
/	Resists with variations under certain conditions	e	Boiling
-	Does not resist	a	Aqueous solution

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Oil No. 3 according to ASMT D380-59	100	+	/	-
Camphor oil		-		
Animal oil		+	+	
Peanut oil	100	+	+	/
Coconut oil		+	+	
Fish liver oil		+		
Flaxseed oil	100	+	+	+
Corn oil	100	+	/	
Animal oil	100	+	/	
Vegetable oil	100	+	/	
Olive oil	100	+	+	+
Palm kernel oil		+	/	
Silicone oil	100	+	+	+
Soybean oil	100	+	/	
Vaseline oil		+	/	-
Fine spindle oil	100	+	-	
Transformer oil	100	+	/	
Lubricating oils	100	/		
Mineral oils (without aromatic components)	100	+	/	-
Machine oils	100	+	/	-
Engine oils	100	+	/	-
Acetaldehyde	100	/	-	
	a. 40	+	+	
Ammonium acetate	aq. any	+	+	+
Amyl acetate	100	/	-	
Butyl acetate	100	/	-	-
Ethyl acetate	100	+	/	
Methyl acetate	100	+	+ e	
Lead acetate	aq. sat. cold	+	+	
Vinyl acetate	100	+	/	
Sodium acetate	aq. sat. cold	+	+	+
Acetophenone	100	+	/	
Acetone	100	+	+ e	
Acetic acid (glacial)	100	+	/	-

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Acetic Acid	70	+	+	
	50	+	+	
	30	+	+	
	10	+	+	+
Battery acid	d = 1,28	+	+	
Adipic acid	a.	+	+	
Anthraquinon-sulfonic acid	aq. (susp)	+		
Arsenic Acid	aq. 80	+	+	
	aq. dil.	+	+	
Benzoic acid	100	+	+	
	aq. any	+	+	+
Boric acid	100	+	+	+
	aq. sat. cold	+	+	+
Bromhydric acid	conc.	+		
Bromic acid	conc.	+		
Butyric acid	aq. 20	+		
	100	+		
Citric acid	aq. any	+	+	+
Hydrochloric acid	36	+	+	
	10	+	+	+
Chloric acid	aq. 1	+	/	-
Chloroacetic acid	(di) 100	+	/	
	(mono) 100	+	+	
	(tri) 100	+	+	
Chlorosulfuric acid	100	-	-	-
Chromic acid	50	+	+	
	20	+	+	
Diglycolic acid	a. 30	+	+	
	aq. sat. cold	+		
Stearic acid	100	+	/	
Hydrofluoric acid	70	+		
	40	+	+	

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Formic acid	100	+	/	
	a. 85	+	/	
	a. 50	+	/	
	a. 2n (~9)	+	+	
Phosphoric acid	85	+	+	+
	60	+	+	
	up to 30	+	+	
Phthalic acid	a. 50	+	+	
Glycolic acid	100	+		
Palm kernel fatty acid	100	/	-	
Lactic acid	a. 90	+	+	+
	a. 50	+	+	+
	a. 20	+	+	+
	a. 10	+	+	+
Maleic acid	100	+	+	
	aq. sat. cold	+	+	
Malic acid	aq. sat. cold	+	+	
Nitric acid	68	-	-	
	50	/	-	
	up to 30	+	/	
Oleic acid	100	+	/	-
Oxalic acid	a. 50	+	/	
	a. 30	+	+	+
	aq. sat. cold	+	/	
Perchloric acid	a. 2n	+	+	
Picric acid	1	+		
Propionic acid	a. 50	+	+	
Prussic acid	aq. any	+	+	
Silichofluoric acid	a. up to 32	+		
Succinic acid	100	+	+	
	aq. sat. cold	+	+	
Sulphuric acid	98	/	-	
	85	+	/	
	50	+	+	
	10	+	+	+
Fatty acids (C6)	100	+	+	
Tartaric acid	a. 10	+	+	
	aq. sat. cold	+	+	
Acrylonitrile	100	+		
Dinonyl adipate	100	+		
Dioctyl adipate	100	+		
Water (drinking, dest.)		+	+	+
Bromine water	cold sat.	-	-	-
Chlorine water	cold sat.	/	-	

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Sea water		+	+	+
Soda water		+	+	
Mineral water		+	+	+
Hydrogen peroxide	30	+	/	
	10	+	+	
	4	+	+	
Aqua regia		/	-	
Camphor	100	+		
Allyl alcohol	96	+	+	
Amyl alcohol	100	+	+	+
Benzyl alcohol	100	+	/	
Wax alcohol	100	/	-	
Copra alcohol	100	+	/	
Ethyl alcohol	100	+		
	96	+	+	+
Ethyl alcohol (in fermentation)	usual	+		
Ethyl alcohol + acetic acid (in fermentation)	usual	+		
Furfuryl alcohol	100	+	/	
Methoxybutyl alcohol	100	+		
Propartyl alcohol	a. 7	+	+	
Starch	100	+	+	
	in solution	+	+	
Tar		+	/	
Alum (of all kinds)		+	+	
Ammonia	a. 30	+	+	
	a. 15	+		
	a. 10	+	+	
	gaseous 100	+	+	
	liquid 100	+		
Acetic anhydride	100	+	/	-
Sulphur dioxide	any	+	+	+
Aniline	100	+	+	
Anisole		/	/	
Antifreeze		+	+	+
Antiformin (benzaldoxime)	a. 2	+	+	
Salted herring		+		
Rum aroma		+		
Asphalt		+	/	
Aspirin		+		
Sugar (dry)	100	+	+	+
Sugar (in solution)	aq. any	+	+	+
Sulphur	100	+	+	+
Chrome baths		+	+	

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Benzene	100	/	-	
Benzaldehyde	100	+		
	aq. sat. cold	+		
Sodium benzoate	aq. sat. cold	+	+	
Carbon dioxide	(wet) any	+	+	
	(dry) 100	+	+	
Sodium bisulfite	aq. sat. cold	+	+	
Moth balls		+		
Potassium borate	aq. 1	+	+	
Borax	aq. sat. cold	+	+	+
Potassium bromate	aq. sat. cold	+	+	+
Bromine	(liquid) 100	-		
	(vapours) High	-	-	
	(vapours) Low	/	-	
Potassium bromide	aq. sat. cold	+	+	+
Butadiene	100	/	-	
Butane	(gaseous) 100	+	+	
	(liquid) 100	+		
Butanediol	a. 100	+	+	
Butanol	100	+	/	/
Butanetriol	a. 100	+	+	
Butylphenol	cold sat.	+		
Butylphenone	100	-		
Butylglycol	100	+		
Butynediol	100	+		
Butyraldehyde	100	/		
Butoxyl		+		
Cocoa	ready to be consumed	+	+	+
	powder	+		
Coffee	eady to be consumed	+	+	+
	grain and ground	+		
Cinnamon		+		
Sodium hydrogencarbonate (sodium bicarbonate)	aq. sat. cold	+	+	+
Ammonium carbonate	aq. any	+	+	+
Calcium carbonate	aq. sat. cold	+	+	+
Potassium carbonate	aq. sat. cold	+	+	
Sodium carbonate	a. 10	+	+	+
	aq. sat. cold	+	+	
Beeswax		+	/	
Encaustic wax	100	+	/	
Beer		+		
Potassium cyanide	100	+		
	aq. sat. cold	+	+	

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Cyclohexane	100	+		
Cyclohexanol	100	+	/	
Cyclohexanone	100	+	/	
Clophenes		+	/	-
Chloramine	aq. any	+		
Potassium chlorate	aq. sat. cold	+	+	+
Sodium chlorate	aq. sat. cold	+	+	
Aniline hydrochloride	sat. a.	+	+	-
Phenylhydrazine hydrochloride	a.	+	/	
Sodium chlorite	sat. a.	+	/	
Chlorine	gaseous, dry 100	-	-	-
	gaseous, wet 10	/	-	-
	liquid 100	-		
Chlorobenzene	100	+		
Chloroethanol	100	+	+	
Chloroform	100	/	-	-
Ammonium chloride	aq. any	+	+	+
Antimony chloride	a. 90	+		
Benzoyl chloride	100	/		
Lime chloride	aqueous	+	+	
Calcium chloride	a. 50	+	+	+
	a. 10	+	+	+
	aq. sat. cold	+	+	+
Ethyl chloride	100	/		
Ethylene chloride	100	/		
Hydrogen chloride (gaseous, dry and wet)	any	+	+	
Methylene chloride	100	/	- e	
Methyl chloride	100	/	-	
Sulphuryl chloride	100	-		
Thionyl chloride	100	-		
Tricyanogen chloride	100	+		
Stannous chloride	aq. sat. cold	+	+	
Potassium chloride	100	+	+	+
Sodium chloride	aq. sat. cold	+	+	+
	a. 10	+	+	+
	a. 50	+		
Coca-Cola		+		
Calendering glue		+	+	
Apple compote		+	+	+
Cognac		+		
Shoe polish		+	/	
Cresols	100	+	/	
	in solution	+		

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Potassium chromate	a. 40	+	+	+
Crotonaldehyde	100	+		
CY3 (machine oil)		+	/	-
Shampoo		+	+	
Sauerkraut (ready to be served)		+	+	+
Decalin	100	/	/	
Dextrin	aq. sat. cold	+		
Dichlorobenzene	100	/		
Dichloroethane	100	+		
Dichloroethylene	100	+		
Potassium dichromate	aq. sat. cold	+	+	+
Diethanolamine	100	+		
Diisobutylketone	100	+	-	-
Dimethylamine	100	+		
Dimethylformamide	100	+	+	
Dioxane	100	/	/	-
Light DTE (turbine oil)		-	-	
Cold cuts		+	+	
False fir needles essence	100	+	+	
Wild spruce needles essence		+	+	
Bitter almonds essence		+		
Carnation essence		+	/	
Lemon rind essence		+		
Orange peel essence		+		
Lemon essence		+		
Mint essence		+		
Nail polish		+	/	
Yeast spices		+	+	
Whale sperm		+		
Amylacetic ester	100	/	-	
Butylacetic ester	100	/	-	
Monoloroacetic acid ethyl ester	100	+	+	
Methylacetic ester	100	+	+ e	
Dichloroacetic acid methyl ester	100	+	+	
Monochloroacetic acid methyl ester	100	+	+	
Isopropyl ester	100	/	-	
Petroleum ester	100	+	/	
Dibutyl ether	100	/	-	
Ethyl ether	100	/		
Ethylbenzene	100	/	-	
Ethylene glycol	100	+	+	+
Acetic ester	100	+	/	
Ethylhexanol	100	+		

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Cellulose tanning extracts	usual	+		
Vegetable tanning extracts	usual	+		
Phenol	hot sat. a.	+	+	
	comerc.	+	+	
Fluorine (dry)	100	-		
Ammonium fluoride	a. up to 20	+	+	
Formaldehyde	a. 30/40	+	+	
	a. 10	+	+	
Ammonium phosphate	aq. any	+	+	+
Tricesyl phosphate	100	+	/	
Trioctyl phosphate		+		
Sodium phosphates	hot sat. a.	+	+	+
Phosgene	100	/	/	
Frigen 113	100	-		
Fructose		+	+	+
Butyl phthalate	100	+	/	/
Dibutyl phthalate	100	+	/	/
Dihexyl phthalate	100	+	/	
Dinonyl phthalate	100	+		
Dioctyl phthalate	100	+	/	
Fuel oils	100	+	/	
Roasting gas (dry)	any	+	+	
Lighting gas (benzene free)		+		
Soft drinks		+		
Diesel	100	/		
Crude petrol	100	/	-	
Normal petrol	100	/	-	
Super petrol	100	/	-	
Petrol boiling point 100-140°C	100	/	-	
Gelatine	aq. any	+	+	
Gin		+		
Glycerine.	100	+	+	+
	aq. any	+	+	+
Glycocole	a. 10	+		
Glycol	100	+	+	+
	any	+	+	+
Glucose	hot sat. a.	+	+	+
Glucose (grape sugar)	hot sat. a.	+	+	
Flour	100	+		
Heptane	100	/	/	
Hexane	100	+	/	
Hexanetriol	100	+	+	+
Chloral hydrate	any	/	-	
Hydrazine hydrate		+		

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Hydrogen	100	+	+	-
Hydroquinone	100	+		
Barium hydroxide	aq. any	+	+	
Sodium hydroxide	100	+	+	
Calcium hypochlorite	aq. any	+	+	
Sodium hypochlorite	a. 20	+	/	
	a. 10	+	+	
	a. 6	+	+	+
Isobutyric aldehyde	100	/		
Isooctane	100	+	/	
Isopropanol	100	+	+	+
	aq. any	+	+	
Soap	liquid	+	+	
	bar	+	+	
Jelly		+	+	+
Tomato juice		+	+	
Tomato ketchup		+	+	
Lanolin (wool grease)		+	/	
Milk		+	+	+
Pulses		+	+	+
Bisulphite bleach SO2 content	hot sat. a.	+	+	
Whitewash bleach, 12.5% active chlorine		+	/	-
Yeast	aq. any	+		
Liqueurs		+		
Brake fluid	100	+		
Lysol		+	/	
Fruit salad		+	-	
Mayonnaise		+		
Pork lard		+	+	/
Butter		+	+	
Margarine		+	+	
Molasses	usual	+	+	
Beet molasses		+	+	+
Menthol	100	+		
Mercury	100	+	+	
Jam		+	+	+
Methanol	100	+	+ e	
	a. 50	+	+	
Methylamine	100	+		
	a. 32	+		
Methyl bromide	100	-	-	
Methyl ethyl ketone	100	+	/	
Chromic mixture		-	-	
Mixture of naphthene and liquid paraffin 8,5°E	100	+	/	-

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Mixture of liquid paraffins 12-15°E		+	/	
Honey		+	+	
Morpholine		+	+	
Mustard		+		
Mowilith D		+		
Naphthalene	100	+		
Cream		+		
Ammonium nitrate	aq. any	+	+	+
Calcium nitrate	a. 50	+	+	
Silver nitrate	a. 20	+	+	+
Potassium nitrate	100	+	+	
	aq. sat. cold	+	+	
Sodium nitrate	aq. sat. cold	+	+	
Nitrobenzene	100	+	+	
or Nitrotoluene		+	/	
Octylcresol	100	/	-	
Oleum	any	-	-	-
Urine		+	+	
Phosphorus oxychloride	100	+	/	
Ethyl oxide	100	/ e		
Oxygen	any	+	/	
Ozone	50 pphm	+	/	
Sodium palmitate	5	+	+	+
Paraffin	100	+	+	-
	liquid 100	+	/	-
Toothpastes		+	+	
Pectin	aq. sat. cold	+	+	
Phosphorus pentoxide	100	+		
Sodium perborate	aq. sat. cold	+	+	+
Potassium perchlorate	a. 1	+	+	
Perchlorethylene	100	/	-	
Perfume		+		
Potassium permanganate	aq. sat. cold	+	+	
Potassium persulphate	100	+		
	aq. any	+	+	
Fish	pickled	+	+	+
Petroleum	100	+	/	
Paprika		+	+	
Pepper		+	+	
Pyridine	100	/	/	
Caustic Potash	55	+	+	+
	25	+	+	+
	2n	+	+	+
Dairy products		+	+	+

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Dishwashing products		+	+	+
Propane	gaseous 100	+	+	
	liquid 100	+		
i-Propanol + n-Propanol	100	+	+	
Propylene glycol	a. 100	+	+	
Pudding		+	+	+
Furniture polish		+	/	-
Kerosene	100	/	/	-
Cheese		+		
Quinine		+		
Nail polish remover		+	/	
Horseradish		+		
Cottage cheese		+		
Photographic developers	ready to be used	+		
	commercial	+	+	
Rum		+	+	
Sagrotan		+	/	
Common salt	aq. any	+	+	
Fertilizing salt	sat. a.	+	+	
Fixing salt in solution	any	+	+	
Aluminium salts	aq. any	+	+	+
Barium salts	aq. any	+	+	+
Zinc salts	aq. sat. cold	+	+	
Copper salts	aq. sat. cold	+	+	
Chromium salts (bivalent and trivalent)	aq. sat. cold	+	+	
Iron salts	aq. sat. cold	+	+	+
Mercury salts	aq. sat. cold	+	+	
Nickel salts	aq. sat. cold	+	+	
Silver salts	aq. sat. cold	+	+	
Magnesium salts	aq. sat. cold	+	+	+
Dibutyl sebacate	100	+		
Beef tallow	100	+	+	
	sulphur emission	+		
Shell-Dromus	a. 0,5	+	/	/
Soluble silicate		+	+	
Silicone emulsion		+	+	+
Viscose solution for spinning		+	+	
Soap solution	any	+	+	
Iodine solution	50	+	+	
Caustic soda	52	+	+	+
	30	+	+	+
	2n	+	+	+
Fat-free buttermilk		+		
Ammonium sulphate	aq. any	+	+	+

PRODUCT	CONCENT.	TEMPERATURE		
	%	20°C	60°C	100°C
Dimethyl sulphate	100	/	-	
	a. 50	/	/	
Hydrazine sulphate	10	+	+	
Hydroxylamine sulphate	a. 12	+	+	
Potassium sulphate	aq. sat. cold	+	+	
Sodium sulphate (Glauber salt)	aq. sat. cold	+	+	
Sodium sulphide	a. 40	+	+	
	aq. sat. cold	+	+	
Fatty alcohol sulphanate		+	/	
Ammonium sulphide	aq. any	+	+	
Carbon sulphide	100	+		
Hydrogen sulphide	(dry) 100	+	+	
	aq. any	+	+	
Tea	consumption	+	+	+
	leaves	+	+	
Tetrachloroethane	100	/	-	
Tetrachloroethylene	100	/	-	
Carbon tetrachloride	100	-	-	
Tetraethyl lead	100	+		
Tetrahydrofuran	100	/	-	
Tetrahydonaphthalene	100	-	-	
Ink		+	+	
Tincture of iodine	usual	+		
Thiophene	100	/	-	
Sodium thiosulphate	aq. sat. cold	+	+	
Toluene	100	/	-	
Turpentine	100	-	-	-
Trichloroethylene	100	/	/	
Antimony trichloride	100	+	+	
Phosphorus trichloride	100	+		
Trielanolamine	100	+		
Urea	aq. sat. cold	+	+	
Vanilla		+	+	
Nitrous vapours	conc.	+	-	-
Vaseline		+	/	
Wine		+	+	
Whisky		+		
White spirit	100	/	-	
p-Xylene	100	-	-	
Potassium iodide	aq. sat. cold	+	+	
Lemon juice		+	+	
Apple juice		+	+	
American pineapple juice		+	+	
Fruit juice		+	+	+

PE-100

80 **Material properties** **10**

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86 Sewerage, sanitation and other applications
87 PE-100 Pipes UNE-EN 15501 (Gas) 11.2
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MATERIAL PROPERTIES

10.1 What is Polyethylene. Types of polyethylene
10.2 Physico-chemical properties
10.3 Gas permeability of PE pipes
10.4 Chemical resistance
10.5 Bacterial resistance

10.1 WHAT IS POLYETHYLENE. TYPES OF POLYETHYLENE

Polyethylene is a polymer made up of ethylene monomers which, depending on the polymerisation process used, are arranged into chains that may be more or less intertwined and more or less long. Their length and this intertwining will define the properties it will have.

When cooled, polymer chains can be arranged into crystalline structures (crystallisation) or maintain the disordered "ball" structure (amorphous structure). Depending on the grade of each of these structures, polyethylenes of different densities are obtained:

- Low-density polyethylene: Density between 0.915 - 0.930 g/cm3 and a degree of crystallinity of 40% to 55%. It is also called high pressure, because it is obtained in reactors that work at high pressures (up to 1000 atm). They have very branched molecules.
- Medium-density polyethylene: Density between 0.930 - 0.940 g/cm3 and a degree of crystallinity between 50 and 60%. Molecules with little branching.
- High-density polyethylene: Density between 0.940 - 0.965 g/cm3 and a crystallinity degree of 60 - 80%. It is also called low pressure because it is obtained in reactors that work at a much lower pressure than the previous ones (from 30 to 40 atm). Molecules with short branches.

The properties of polyethylene depend mainly on density, molecular weight (length of chains) and molecular weight distribution.

The REPOLEN system uses high-density polyethylene, PE-100, with a bimodal distribution of molecular weights.

10.2 PHYSICO-CHEMICAL PROPERTIES

The higher the percentage of crystallinity, the higher: Tensile strength; modulus of elasticity (rigidity); hardness; resistance to solvents; impermeability to gases and vapours, etc. On the contrary, the lower: Impact resistance; translucency; and stress cracking. On the other hand, the higher the molecular weight, the higher the tensile strength and internal pressure, but the lower the fluidity of the melt. In summary, the most important properties of the PE-100 used to manufacture REPOLEN pipes and fittings are:

PROPERTY	VALUE	UNITS	TEST PROCEDURE
Fluidity index (190ºC; 21.6 kg)	7	g/10 min	ISO 1133
Fluidity index (190ºC; 5 kg)	0.27	g/10 min	ISO 1133
Density at 23ºC	962	Kg/m3	ISO 1183
Tensile strength at the breaking point	38	MPa	ISO 527-2
Elongation at the breaking point	> 600	%	ISO 527-2
Elastic Flexural Modulus	1000	MPa	ISO 178
Oxidation induction time (210ºC)	> 20	Min	UNE EN 728
VICAT softening temperature (10 N)	128	ºC	ISO 306
Long-term hydrostatic resistance after 50 years and 20ºC (97.5 % LCL), MRS	> 10.0	MPa	ISO TR 9080

PE PIPES GAS PERMEABILITY 10.3

The coefficient of permeability depends on the type of plastic and gas. Polyethylene is also influenced by its basic density. In the table the values of these coefficients for the most used gases can be seen on the table.

Gas	P (cm3 / m bar)
Nitrogen	0.018
Air	0.029
Carbon Monoxide	0.036
Natural Gas	0.056
Methane	0.056
Argon	0.066
Oxygen	0.072
Ethane	0.089
Helium	0.15
Hydrogen	0.22
Carbon Dioxide	0.28
Sulphur Dioxide	0.43

CHEMICAL RESISTANCE 10.4

Due to their molecular structure, they have excellent resistance to a great variety of chemical agents. In the same way, they feature a very good resistance to electrochemical corrosions, due to the effect of sea water; urban and industrial discharges, etc.

For further information, please refer to Annex I.

BACTERIAL RESISTANCE 10.5

Due to their characteristics, PE pipes do not favour the cultivation of any type of microorganism, bacteria or known fungus. The mirror finish also helps prevent the formation of fouling that can become a very suitable medium for the appearance of undesirable organisms.

PRODUCT RANGE

11.1 PE-100 pipes UNE-EN 12201
- Human consumption
- Reclaimed water
- Sewerage, sanitation and other applications

11.2 PE-100 Pipes UNE-EN 15501 (Gas)
11.3 PE-100 pipes Cables, electricity and telecommunications
11.4 Thermofusion fittings
11.5 Electroweldable fittings and transitions
11.6 Compression fittings
11.7 Butt welded accesories

11.1 PE-100 pipes UNE-EN 12201

For human consumption water: Black with blue stripes
For reclaimed water: Black with purple stripes
For sewerage, sanitation and other applications: Black with brown stripes
Calculated with a safety coefficient C = 1.25

S8 SDR17 PN10				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
32	28	2 – 2.3	0,19	0,62
40	35.2	2.4 – 2.8	0,29	0,97
50	44	3 – 3.4	0,45	1,52
63	55.4	3.8 – 4.3	0,72	2,41
75	66	4.5 – 5.1	1,02	3,42
90	79.1	54 – 6.1	1,47	4,91
110	96.8	6.6 – 7.4	2,19	7,36
125	110.2	7.4 – 8.3	2,79	9,54
140	123.4	8.3 – 9.3	3,5	11,96
160	141	9.5 – 10.6	4,57	15,61

S5 SDR11 PN16				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
20	16	2 – 2.3	0,11	0,2
25	20.4	2.3 – 2.7	0,17	0,33
32	26	3 – 3.4	0,28	0,53
40	32.6	3.7 – 4.2	0,42	0,83
50	40.8	4.6 – 5.2	0,66	1,31
63	51.4	5.8 – 6.5	1,02	2,07
75	61.4	6.8 – 7.6	1,46	2,96
90	73.6	8.2 – 9.2	2,1	4,25
110	90	10 – 11.1	3,14	6,36
125	102.2	11.4 – 12.7	4,13	8,2
140	114.6	12.7 – 14.1	5,14	10,31
160	130.8	14.6 – 16.2	6,75	13,44

S4 SDR9 PN20				
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)	Capacity (l/m)
20	15.4	2.3 – 2.7	0,14	0,19
25	19	3 – 3.4	0,21	0,28
32	24.8	3.6 – 4.1	0,33	0,48
40	31	4.5 – 5.1	0,51	0,75
50	38.8	5.6 – 6.3	0,79	1,18
63	48.8	7.1 – 8	1,27	1,87
75	58.2	8.4 – 9.4	1,75	2,66
90	69.8	0.1 – 11.3	2,52	3,83
110	85.4	12.3 – 13.7	3,74	5,73

E-100 UNE-EN 15501 PIPES 11.2

For gas
Black with orange strip
Calculated with a safety coefficient C = 2

SDR11			
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)
16	10	3 – 3.4	0,12
20	14	3 – 3.4	0,16
25	19	3 – 3.4	0,21
32	26	3 – 3.4	0,28
40	32.6	3.7 – 4.2	0,43
50	40.8	4.6 – 5.2	0,67
63	51.4	5.8 – 6.5	1,06

PE-100 WIRING PIPES 11.3

For housing electrical or telecommunication wires
Black with red stripes

PN6			
Nominal diameter (mm)	Internal diameter (mm)	Thickness (mm)	Weight (kg/m)
75	69.2	2.9 – 3.3	0,67
90	83	3.5 – 4	0,98
110	101.6	4.2 – 4.8	1,44
160	147.6	6.2 - 7	3,07

11.4 FITTINGS

TERMOFUSION

Cap

Sleeve

Male/female reducer

Female/female reducer

Smooth female tee

Reduced female center tee

Male center tee

90º elbow female / female

45º elbow female / female

Tee female thread

* Available in SS 316

Male thread tee

* Available in INOX 316

90º elbow female thread

* Available in SS 316

90º elbow male thread

* Available in SS 316

Female thread sleeve

* Available in SS 316

Male thread sleeve

* Available in INOX 316

Straight coupling female loose nut

90º female thread elbow wall

* Available in SS 316

90º male thread elbow wall

* Available in SS 316

Universal connector

Thread connector

Flange collar with gasket

Long flange collar

Flat flange steel coated P.P.

KEYS AND VALVES

Tap with trim

Tap body

Tap moulding with trim

Tap trim

Long shaft tap with knob

Moulding for long-staff tap trim

Tap trim with knob long handle

Flush valve extension

Brass locking tap

Brass tap lock moulding kit

Inclined tap

Inclined tap body

Detachable ball tap with neck flange

PP-H ball valve with flange neck

FITTINGS

Weldable branch female outlet

Weldable branch female thread outlet

* Available in SS 316

Weldable branch outlet male thread

Insert with thread

* Available in SS 316

Insert with splint

Weldable branch male outlet

Victaulic type weldable branch

Insert

Plate for batteries

Curved branch

Pipe Saving

90º elbow male/female

45º elbow male/female

Repair plug

ELECTROFUSION TRANSITIONS AND BUTT

Electro-weldable PE sleeve

Electro-weldable PE 90° elbow

Electro-weldable 45° elbow PE

Electro-weldable tee PE

Electro-weldable reducer PE

Simple electro-weldable intake

Transition sleeve flange

Reducing electro-weldable tee PE

Electro-weldable plug PE

Female Transition Racord

Male Transition Racord

Female Transition Sleeve

Male Transition Sleeve

90º female elbow transition

90º male elbow transition

Female Transition Sleeve

45º male elbow transition

45º female elbow transition

Flange collar PE100

90º elbow PEAD butt N

45º elbow PEAD butt N

90º tee PEAD butt N

COMPRESSION FITTINGS

Sleeve

End plug

Reducing coupling

90º Elbow

Tee - 3 necks

Tee - 1 reducing neck

Male thread coupling

Female thread coupling

90° elbow male thread

90º elbow female thread

Male thread branch tee

Female thread branch tee

PP Nut

Fixing cone

Bushing

SYSTEM FEATURES

12.1 Main advantages
12.2 Application fields
12.3 Marking and traceability
12.4 Storage, handling and transport

12.1 MAIN ADVANTAGES

- Leak-tight system.
- Easy handling and installation, thanks in part to its reduced weight.
- Low maintenance cost.
- Multiple connection systems.
- 100% recyclable.
- Resistant to high energy radiation.
- Ultraviolet protection. Suitable for outdoor use.
- Highly resistant to abrasion.
- Absorbs vibrations and ground movements (Seismic hazards). Also passage of heavy vehicles.
- Electrical insulator. It does not need cathodic guards, nor against galvanic currents.
- Low thermal conductivity.
- Internal mirror shine and very low roughness coefficient: Minimal pressure drop.
- Highly corrosion resistant.
- High chemical resistance to both acids and alkalis.
- 100 % non-toxic.
- Very low noise transmission level.
- Flexibility. Possibility of cold bending.
- High impermeability to gases.
- Low celerity (wave propagation velocity).
- High resistance to temperatures below 0ºC.

- Some properties of PE pipes are:

PROPERTY OF THE PIPE		VALUE	UNITS
Lineal thermal expansion coefficient		0.22	mm/m ºC
Thermal conductivity		0.37	Kcal/m ºC
Poisson coefficient		0.4	υ
Dielectric constant		2.5	---
Hydraulic roughness	k	0.003	mm
	N (Manning)	0.008	---
	C (Hazen-Williams)	150	---
Shore D hardness		65	---
Carbon black content		2 – 2.5	mass
Carbon black dispersion		< 3	---
Volatile substances content		< 350	mg/kg
Water content		< 300	mg/kg

APPLICATION FIELDS 12.2

Drinking water pipes

Pressure supply

Sanitation

Irrigation

Recycled waters

Gas pipeline

Drainage

Underwater sewage systems

Compressed air

Protection of communication wires

Diesel at low temperature

Chemical industries

Transport of solids

Rehabilitation of existing pipelines

Installations without trench opening

Food industry

12.3 MARKING AND TRACEABILITY

The marking of the pipes is done in accordance with the UNE EN 12201 standard and the requirements of the AENOR Special Regulations, RP.001.01. in the case of water, and the UNE EN 1555 standard and the AENOR Special Regulations RP.001.05 in the case of gaseous fuels. The purpose of pipe marking is to provide the necessary information to the installer, the user and the manufacturer, if necessary. The marking includes:

- Trademark: REPOLEN.
- Reference to the AENOR mark (Product Certificate) and contract number.
- Material it is made of.
- Nominal diameter and thickness.
- Nominal pressure and SDR.
- Intended use: W for drinking water; P for pressurised sewage and sewerage; W/P for mixed use; and GAS for gaseous fuels.
- Manufacturing period.
- Reference standard.
- Symbol of suitability for food use, if applicable.
- Reference to 100% national manufacture.

The manufacturing period is unique for each pipe production, enabling complete traceability of the finished product. Knowing this number, it is possible to make a complete tracking from the entry of raw material, until the delivery at our clients' home.

Although the most used reference is the nominal pressure (PN), it is convenient to know the SDR and the S:

- SDR is the relation between the outer diameter and the thickness of the pipe, according to the equation:

$$SDR = \varphi \text{ ext} / \text{thickness}$$

- S is a dimensionless number that classifies the piping according to ISO 4065 standard and indicates the relationship between the tangential tension (σ) and the working pressure (P) at a certain temperature, according:

$$S = \sigma / P$$

STORAGE, HANDLING AND TRANSPORT 12.4

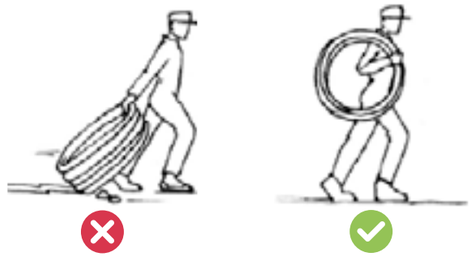
PE pipes can be stored indoors or outdoors, thanks to the protection against solar radiation given by the carbon black.

The rolls can be stored horizontally on top of each other up to a height of 1.5 m and vertically only one height.

The bars can be stacked on flat and clean horizontal surfaces, having the necessary supports to prevent deformation and up to a maximum height of 1.5 m.

PE-100 pipes must be stored in such a way that they cannot come into contact with fuels, solvents, aggressive paints, etc. It is also advisable to avoid contact or proximity to surfaces that can reach 50ºC or more

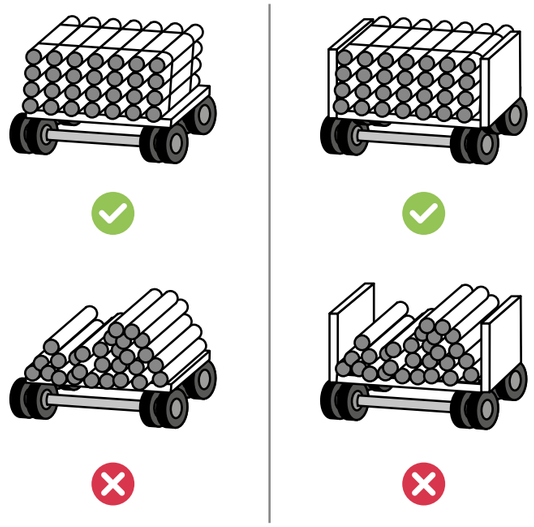
PE-100 is a resistant and flexible material, but it is necessary to avoid dragging on rough surfaces and contact with sharp-edged objects.

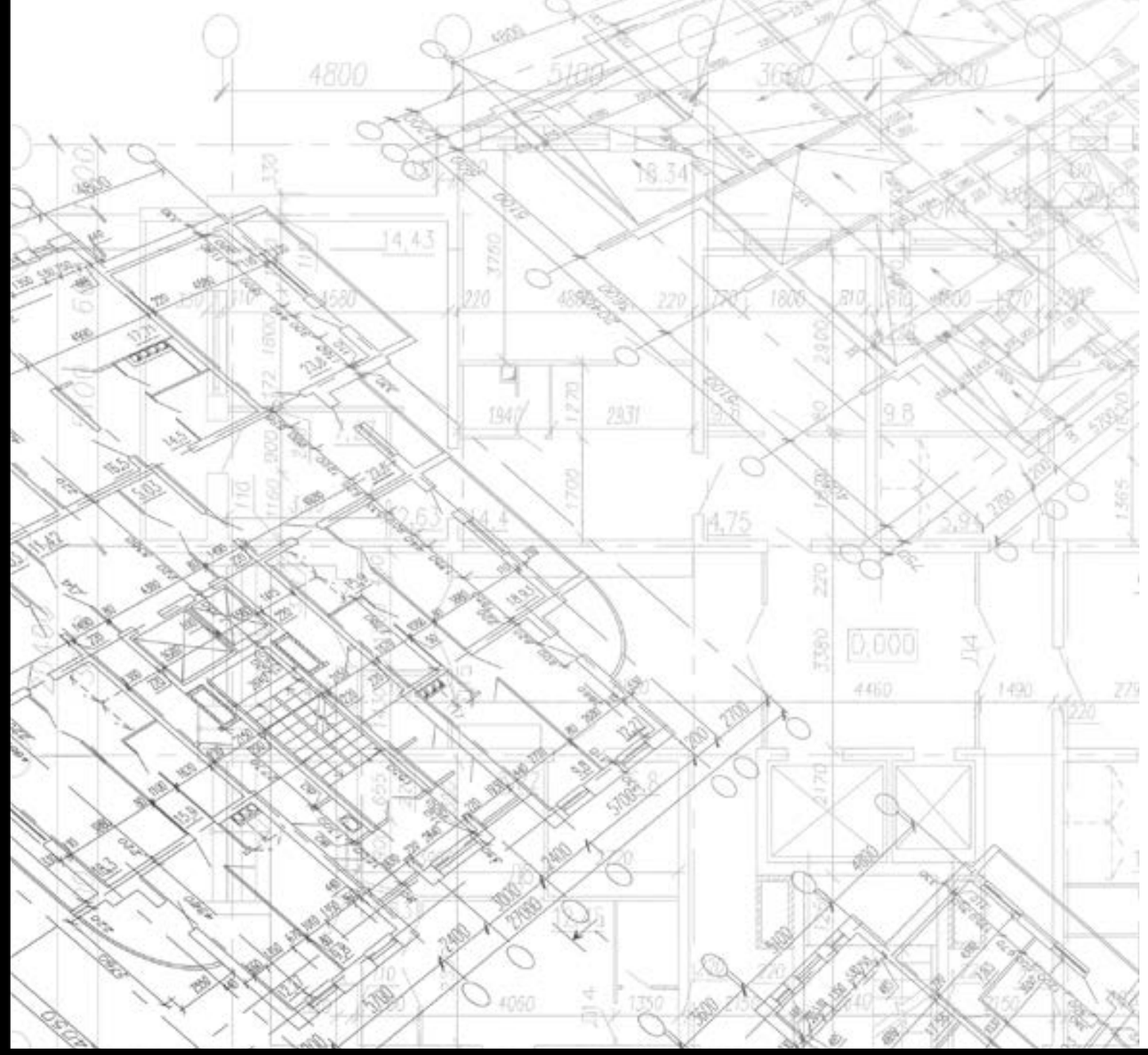


If, for any reason, a pipe with a damaged piece or with bends is detected, the damaged piece must be removed before installation

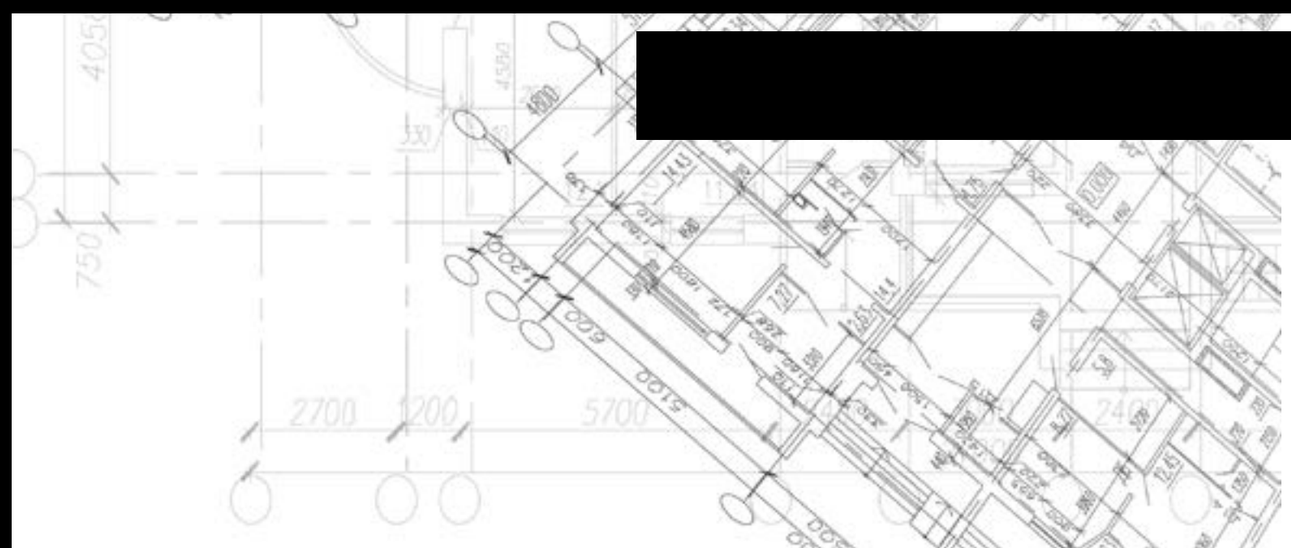
For transport, it is important to do it on a horizontal plane free of nails or protrusions that could damage the piping. Care must be taken in the correct stacking of the pipes. Do not place heavy loads on top that could deform the pipes.

When getting them off the lorry, they should NEVER be thrown, but accompany them when unloading and subsequent stacking





INSTALLATION CRITERIA



13.1 Buried Installations
13.2 Non-buried installations
13.3 Flexibility. Curvature
13.4 Pressure drop
13.5 Water hammer
13.6 Hydraulic start-up test

13.1 BURIED INSTALLATIONS

In general, the following can be established:

- Polyethylene pipings are flexible, susceptible to permanent deformation due to the load and the time of application of the load. These deformations shall be limited by applying the corresponding calculations (UNE 53-331).
- If there are steep slopes in the route, pipe laying should preferably be carried out in the ascending direction, having anchorage points in mind.
- When pipe laying has to be interrupted, the ends should be plugged to prevent the ingress of foreign bodies.
- If there is a risk of flooding of the trench, points of attachment of the piping to the bed should be provided to prevent it from floating and to maintain the layout.
- The layout must follow a meandering path.

Buried installation techniques can be: With conventional trenches, plough with mole drain and push plough. For trenching, a series of factors must be taken into account:

Type of soil

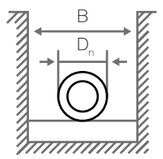
- Group 1: Non cohesive. Gravel and loose sand are included in this group. Percentage of fines (φ < 0.06 mm), less than 5%.
- Group 2: Not very cohesive. Gravel and clayey or silty sands are included. Percentage of fines between 5 and 15 %.
- Group 3: Medium cohesive. Gravel and clayey or silty sands are included. Percentage of fines between 15 and 40 %.
- Group 4: Cohesives. Includes clays, silts and soils with mixtures of organic components. It is not recommended for use without special precautions such as geotextiles, etc.

Trench type

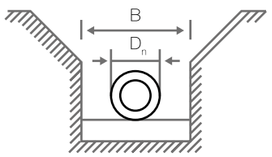
Narrow trench | Wide trench | Low embankment | Embanked trench | Two pipeline trench

Trench section

The walls, whenever possible, should be vertical.



If this is not possible, it is recommended to make a section like the one in the following drawing, bearing in mind that the upper generatrix of the pipe must be inside the section of vertical walls.



Trench depth

It must protect the pipes from the loads they have to support, both fixed and mobile. To calculate these overloads, the information included in UNE 53331 IN standard must be taken into account. But as a general rule, the following is acceptable:

	Depth above the upper generator (m)	
Facility	Under roadway or with traffic	1.00
	Under pavement or without traffic	0.80

Trench width

This obviously depends on the diameter of the piping, the depth of the trench and the type of soil. There should be enough space on both sides of the pipe to facilitate compaction of the filling, such as:

DN (mm)	Minimum trench width (OD + x), meters		
	Piped trench	Trench without shoring	
		β > 60º	β < 60º
< 225	OD + 0.40	OD + 0.40	
225 < DN < 350	OD + 0.5	OD + 0.50	OD + 0.40
350 < DN < 700	OD + 0.70	OD + 0.70	OD + 0.40
700 < DN < 1200	OD + 0.85	OD + 0.85	OD + 0.40
DN > 1200	OD + 1.0	OD + 1.0	OD + 0.40

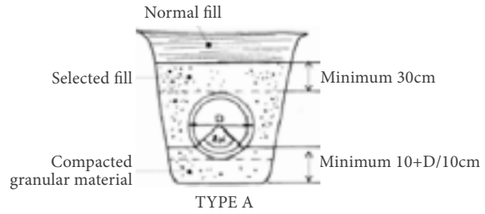
Bed

If the terrain is even, it will be excavated to the ground level. If stones, foundations, rocks, etc. remain uncovered, they must be excavated below ground level for later filling of the bed. This additional excavation can be from 15 to 30 cm, and its filling will be done with the contribution of soil from the excavation, which is easily compactable and free of stones, or with loose sand.

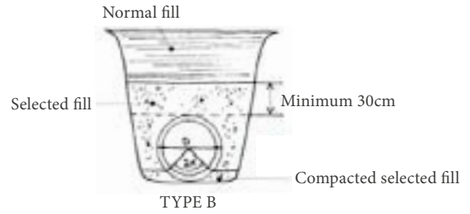
Types of support

Two types of supports are considered:

- Type A Support: Consists of a continuous bed of compacted granular material on which the pipe rests. It must be evenly compacted across its entire length and wrap the pipe according to a 2α support angle, recommended 120º.
- Type B support: The pipe rests directly on the bottom of the trench or on the natural ground in the case of an installation under embankment. To be used only on sandy grounds free from lumps and stones.



TYPE A



TYPE B

Fill

The filling is carried out once the piping has been laid and tested. It must be calculated and carried out in such a way as to limit the deformation of the pipe. For this purpose, the material used must be chosen taking into account the mechanical criteria of resistance to loads, stability in its conditions of use, ease of installation and subsequent compaction.

Compacting

The compaction of the filler will depend on: The soil characteristics, the soil cover, the life time of the installation and the water table. The compaction equipment used will depend on the type of filling to be compacted.

The filling will be made by 10 cm successive layers, if possible with soil free of stones from the excavation itself, up to 30 cm the pipe generator getting 95% of the Normal Proctor in compaction. Care must be taken to balance the compaction on both sides of the pipe as to equalise the pressure on it. The rest of the filling can be done mechanically and with unsorted soil from the excavation.

13.2 NON-BURIED INSTALLATIONS

In non-buried installations it is very important to take into account issues such as lineal expansion, since the deformations that the pipe may undergo will be visible, causing a snaking effect that may lead to misunderstandings regarding the strength of the pipe.

The lineal expansion coefficient of polyethylene is considered to be 0.2 mm/m°C for practical purposes. There are several formulas according to ENV 12108. The calculation equation is as follows:

$$\Delta L = L * \lambda * \Delta T$$

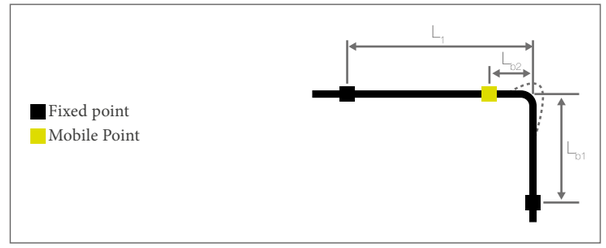
where: ΔL is the increase in length that the pipe will have due to the lineal expansion, in millimetres.
L is the length of the pipe on which the lineal expansion is calculated in metres
λ is the lineal expansion coefficient, in mm/m°C.
ΔT, is the temperature difference between the transported fluid and the ambient temperature

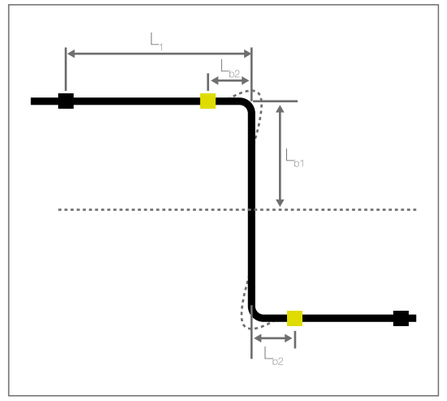
To make calculations easier, an expansion table is included:

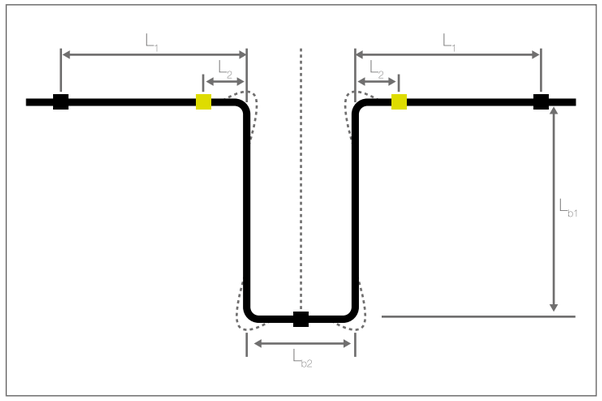
λ = 0,2mm/m°C								
Piping length (m)	Lineal expansion of REPOLEN PE-100 piping Δl (mm) Temperature difference ΔTee (°C)							
	10	20	30	40	50	60	70	80
0.1	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6
0.2	0.4	0.8	1.2	1.6	2	2.4	2.8	3.2
0.3	0.6	1.2	1.8	2.4	3	3.6	4.2	4.8
0.4	0.8	1.6	2.4	3.2	4	4.8	5.6	6.4
0.5	1	2	3	4	5	6	7	8
0.6	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6
0.7	1.4	2.8	4.2	5.6	7	8.4	9.8	11.2
0.8	1.6	3.2	4.8	6.4	8	9.6	11.2	12.8
0.9	4.8	3.6	5.4	7.2	9	10.8	12.6	14.4
1	2	4	6	8	10	12	14	16
2	4	8	12	16	20	24	28	32
3	6	12	18	24	30	36	42	48
4	8	16	24	32	40	48	56	64
5	10	20	30	40	50	60	70	80
6	12	24	36	48	60	72	84	96
7	14	28	42	56	70	84	98	112
8	16	32	48	64	80	96	112	128
9	18	36	54	72	90	108	126	144
10	20	40	60	80	100	120	140	160

Among the compensation systems employed, are:

- Compensators. There are different types of compensators on the market.
- Address changes: in "L", "Z" or "U".







The equations used for the calculation are:

$$L_{b1} = \sqrt{\frac{3 * DN * \Delta L1 * E_{50}}{0.15 * \sigma_s}}$$

$$L_{b2} = \sqrt{\frac{3 * DN * \Delta L_{b1} * E_{50}}{0.15 * \sigma_s}}$$

L_{b1} y L_{b2} can be seen in the drawings.
DN is the nominal diameter of the pipe, in mm.
ΔL_1 is the increase in length of the L_1, in mm.
E_{50} is the long term modulus of elasticity at 20°C (E_{50} = 150 N/mm2).
σ_s is the design tension of PE100, in N/mm^2 σ_s = MRS / C.
MRS is the minimum tension required (10 MPa for PE100).
C is the design coefficient (1.25 for water and 2 for gas).
ΔL_{b1} is the increase in length of the stretch $L_{b1.}$

Example:

A 90 mm diameter and 5 m length pipe is to be installed to carry water under an estimated maximum temperature difference of 25°C.

$$\Delta L_1 = \alpha * \Delta T * L = 0.2 * 25 * 5 = 25 \text{ mm} \qquad \sigma_s = \frac{MRS}{C} = \frac{10}{1.25} = 8$$

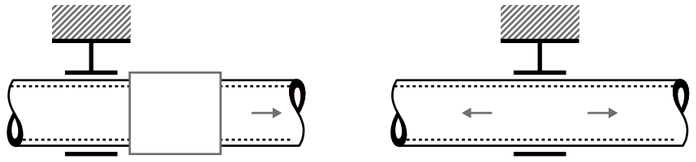
$$L_{b1} = \sqrt{\frac{3 * DN * \Delta L1 * E_{50}}{0.15 * \sigma_s}} = \sqrt{\frac{3 * 90 * 25 * 150}{0.15 * 8}} = 918.56 \text{ mm} = 0.92 \text{ m}$$

$$\Delta L_{b1} = \alpha * \Delta T * L = 0.2 * 25 * 0.92 = 4.6 \text{ mm}$$

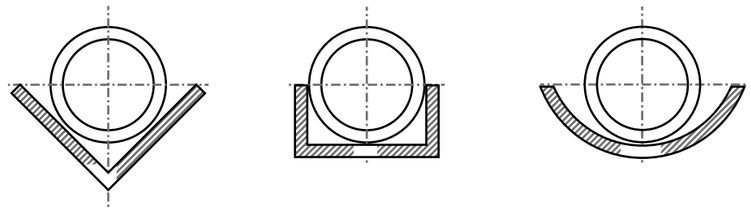
$$L_{b2} = \sqrt{\frac{3 * DN * \Delta L_{b1} * E_{50}}{0.15 * \sigma_s}} = \sqrt{\frac{3 * 90 * 25 * 150}{0.15 * 8}} = 176.21 \text{ mm} = 0.18 \text{ m}$$

The exposed installations must be installed on supports, to prevent serpentine effects, memory of the pipe due to being rolled up, etc.

Concerning lineal expansions, fixed points and moving points have already been discussed. In both cases, clamps that hold the pipe are installed. The former do not allow movement and the latter allow movement to absorb expansion.



Depending on where the installation is going to be placed, it may be advisable to place it on tiles or profiles. In all cases, the fastening or supporting elements of the pipes must be free of sharp edges that could damage the pipes.



As a guideline, a table with the recommended distance between supports is included. These values are for 20ºC, in case of reaching higher temperatures, the following reducer factors should be applied:

- From 20 to 35ºC, coefficient = 0.9
- From 35 to 40ºC, coefficient = 0.85

diameter	20	25	32	40	50	63	75	90	110	125	140	160	180	200	225	250	280	315	355	400	450	500
PN10	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	1.6	1.7	1.9	2.1	2.2	2.4	2.6	2.8	3.0	3.3	3.5	3.8	4.1
PN16	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.1	3.4	3.6	3.9	4.2	4.5
PN20	0.3	0.4	0.5	0.6	0.7	0.9	1.02	1.2	1.5	1.6	1.8	2.0	2.3	2.6	2.8	3.0	3.3	3.7	3.9	4.3	4.6	4.9

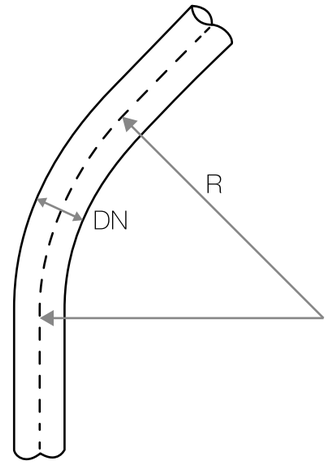
The good flexibility of PE enables installations with a certain cold curvature without the need for fittings. The estimated calculations are based on the following equations:

For low nominal pressures	For high nominal pressuresaltas
$R_c = R_m^2 / (0.28 * e)$	$R_c = (0.5 * OD)^2 /$

where:
- R_c is the curvature ratio in mm
- R_m is the medium ratio of the piping in mm
- e is the thickness of the pipe in mm
- OD is the outer diameter of the pipe in mm
- ε is the elongation of the superior fibres, in percentage, and mustn't be higher than 2.5 % in the long term

In general, you can use the following table with the values calculated at 20ºC. If the installation is done at 0ºC it is multiplied by 2.5; and between 0 and 20ºC a linear extrapolation is done:

PN	10	30 x DN
	16	20 x DN
	20	20 x DN



13.4 PRESSURE DROP

Polyethylene piping have a smooth internal surface to prevent fouling formation and result in reduced pressure drop.

To calculate the pressure drop in polyethylene piping, the Connor or Colebrook abacus can be used, which relate the pressure drop to speed, internal diameter and flow rate. In any case, UNE 53959 IN can also be consulted.

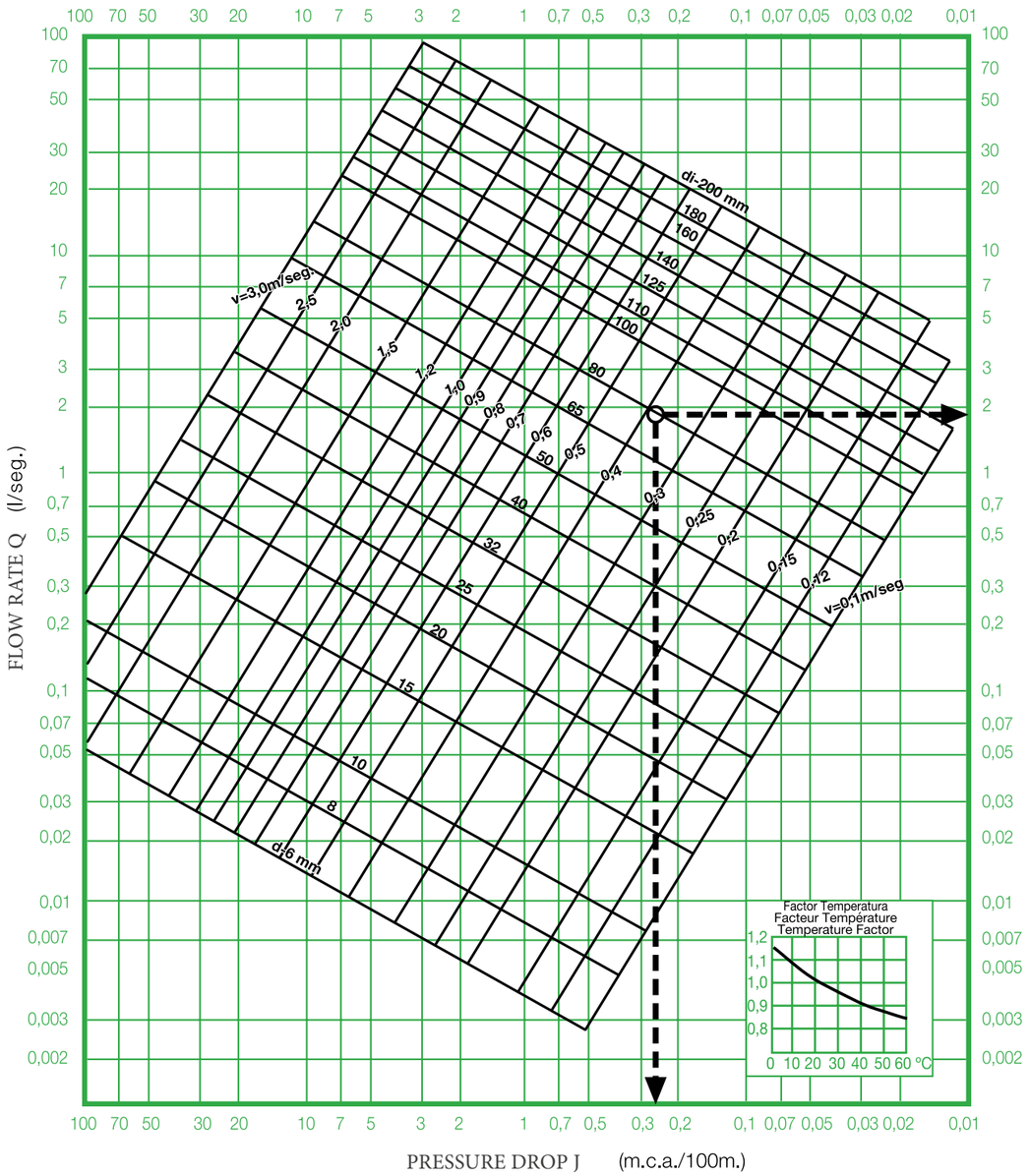
The following coefficients are accepted depending on the equation used for the calculation:

k = 0.003 mm (absolute roughness, Colebrook formula)

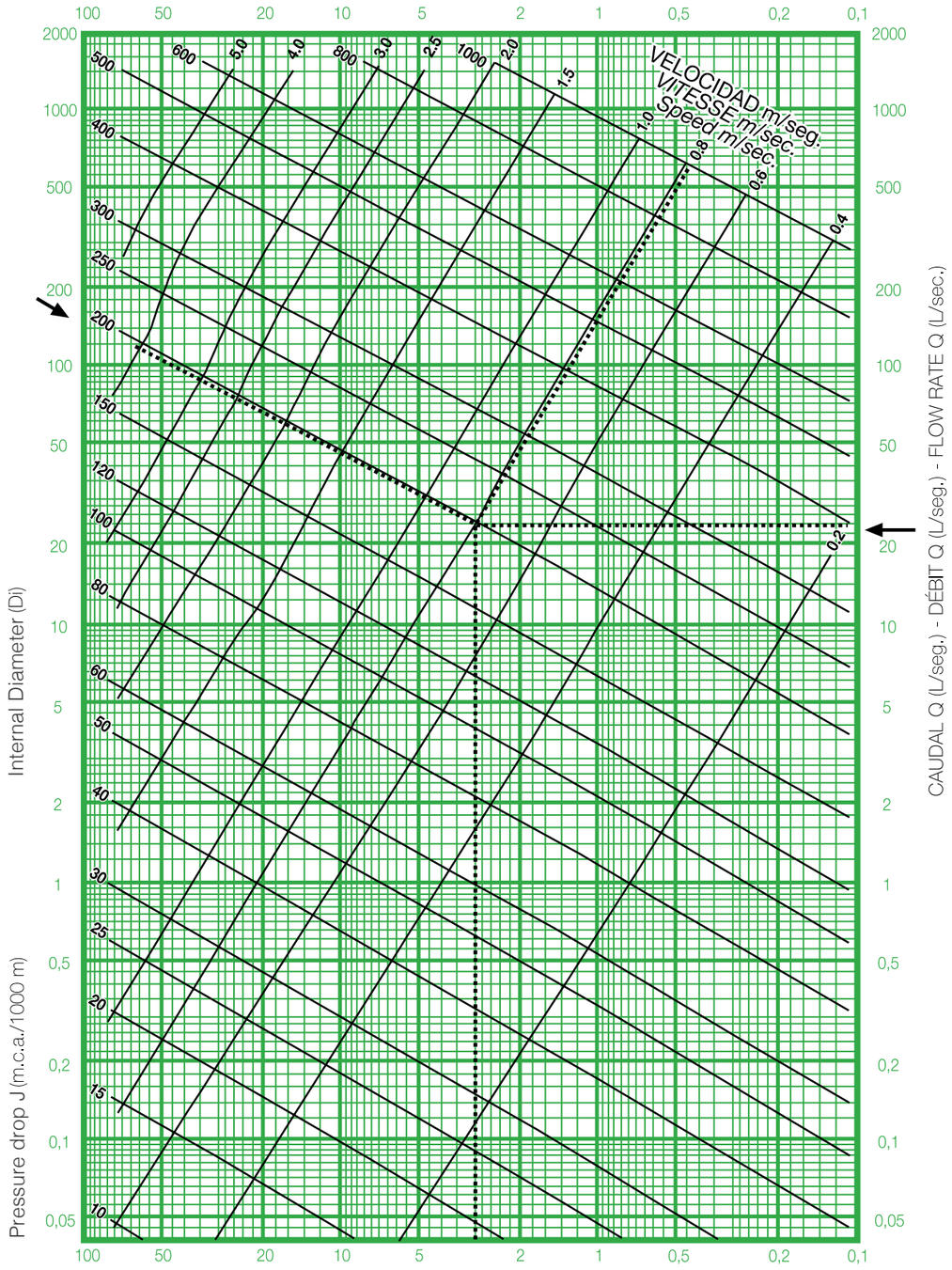
n = 0.008 (Manning formula)

C = 150 (Hazen Wiliams formula)

Connor Graph



Colebrok Graph



13.5 WATER HAMMER

When a liquid is flowing through a piping at a constant speed and at a given time any element on the installation is operated (a valve is closed or opened, variation of a pump's speed, etc) an overpressure is caused, resulting in an unbalance in the fluidity speed of the liquid that alters flows and pressures in the different points of the pipeline. This overpressure is called water hammer and must be added to the working or service pressure.

Pressure and flow rate variations that result in a water hammer spread throughout the liquid mass in a wave-like motion. Wave propagation velocity is called celerity and is according to the water modulus of elasticity whose value varies according to the temperature and modulus of elasticity of the piping material.

The lower the value of the modulus of elasticity of the piping material, the lower the celerity and the overpressure value that can take place in the piping. It is therefore advisable to use polyethylene piping, due to their low modulus of elasticity, so as in the same operating conditions, they result in pressures that are much lower than those that would be produced with the use of classic materials, which are considerably more rigid.

Calculation of the overpressure by water hammer can be done using Michaud's equation:

$$\Delta H = \pm \frac{2 * L * v}{g * T}$$

for

$$T > \frac{2 * L}{a}$$

If: ΔF= increase of pressure or height, or water hammer (overpressure in m.w.c.)

a = wave propagation velocity or celerity in m/s

v = water velocity in a constant speed of m/s

L = piping length in m

g = acceleration of gravity in m/s2 T = stop operation time in s

T = stopping manoeuvre time in s

The celerity is calculated with the equation:

$$a = \frac{9900}{\sqrt{48.3 + K_c * D_m / e}} \qquad K_c = \frac{10^{10}}{E}$$

If Kc = dimensionless indicator

E = piping modulus of elasticity in kg/M² (10^8 for PE)

In the case of very long pipelines, the water hammer does not reach its maximum value at the closing end (or point of change of direction), but at a generic point inside the pipe. In this case the Allievi equation is used:

$$\Delta H = \pm \frac{a * v}{g} \quad \text{if} \quad T < \frac{2 * L}{a}$$

The water hammer can be mitigated in different ways:

- Check valves. They are installed in the impulsions to protect in group of pumping and the emptying of the piping through the pump. They can also be placed on the pipeline operating pressure
- Flywheel. Or pumping group stop delayer. By means of a flywheel attached to the motor shaft
- Air tank. A tank attached to the piping in which there is water and air under pressure.
- This air absorbs the pressure variations in the pipeline. Requires maintenance as air dissolves in water over time.
- Surge tank. A vertical tank attached to the piping and higher than the equivalent pressure the piping can withstand.
- Air release valves. Prevents cavitation at high points in the installation
- Safety valves. If there is a possibility of cavitation leading to strong overpressure

HYDRAULIC START-UP TEST 13.6

Internal pressure test (hydrostatic pressure)

The hydrostatic pressure tests will be carried out in piping sections of less than 500 m in length, and will be carried out as the assembly is completed in each section, without waiting to have the entire work completed. The pressure difference between the highest and lowest point shall not exceed 10% of the test pressure.

The internal hydrostatic pressure for the trench test must never exceed 1.4 times the maximum working pressure of the piping at the lowest point of the section. The pressure shall be raised slowly, not exceeding 1 kg/cm2 per minute.

Before starting the test, all the pipeline fittings must be placed in their final position and the piping will be conveniently anchored in all the changes of direction as well as in the fixed points. The anchoring must be designed to withstand the maximum thrust developed during hydrostatic testing. The trench must be partially filled, in order to avoid piping movements, always leaving the connections uncovered.

Start by slowly filling the section to be tested with water, leaving open all the elements for air outlet, which will then be closed successively from bottom to top, once it has been verified that there is no air in the pipeline. If possible, the water will enter from the lower part, which will make the air release from the upper part easier. If this is not possible, filling will be done even slower to avoid air remaining in the piping.

At the highest point of the pipeline, a bleeder valve will be placed to expel the air and to check that the whole section to be tested is properly communicated.

Once the entire section has been filled, an initial inspection will be carried out to check that all the connections are leak-tight.

The equipment necessary for the pressure test must have the appropriate elements to regulate the pressure increase. It must be placed at the lowest point of the piping to be tested and must be fitted with pre-calibrated pressure gauges. The pressure will be raised but it mustn't exceed 1 bar/min

The ends of the section to be tested will be conveniently closed and easily detachable in order to be able to continue assembling the piping once the test is finished

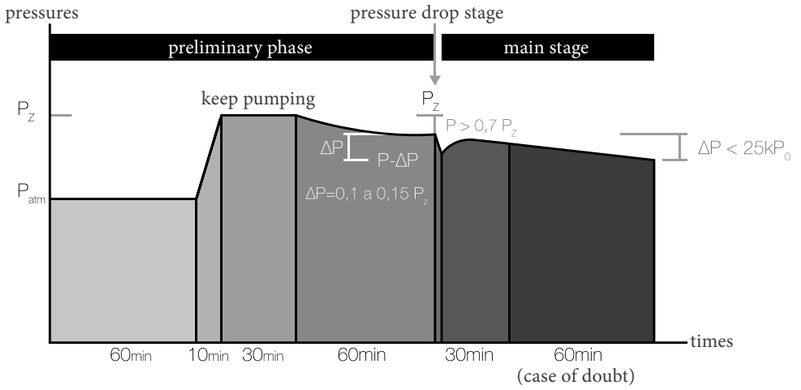
Once the pressure testing has been obtained, a 30-minute pause will be made. The test will be considered satisfactory when during this time the pressure gauge does not indicate descent above √(p⁄5), being p the pressure testing in trench in bar. When the pressure gauge drop is higher, leaks will be corrected and a new test will be carried out until a satisfactory result is obtained.

Various methods can be used to repair leaks or damaged sections. In general, the best way is to cut the damaged section and replace it with a prefabricated unit or fittings. When failure or damage occurs in a welded joint, the original weld must be completely eliminated before being re-welded.

Tests according to UNE-EN 805

As an option, the test can be performed according to the UNE-EN 805 standard. This test is longer as it consists of three stages, following the attached chart:

- Preliminary or Relaxation Stage
- Pressure Drop Stage
- Main Stage



CONNECTION SYSTEMS

14.1 Thermofusion or socket welding connection
14.2 Butt weld connection
14.3 Electrofusion connection
14.4 Flanged systems
14.5 Mechanical systems
14.6 Installation of branch systems
14.7 System repair

The main connection system are:

- Thermofusion or socket welding (recommended option).
- Electrofusion.
- Butt or mirror welding.
- Others: Flanged fittings, threads, victaulic system, etc.

For most of these systems, there are a series of common points to keep in mind:

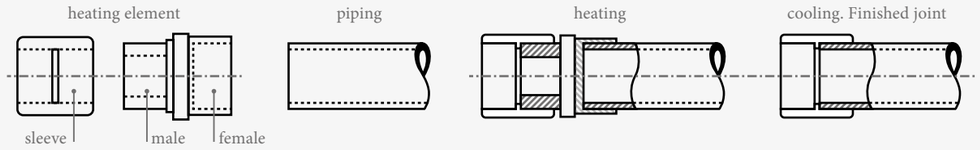
- It is essential to maintain the cleanliness of the elements to be connected. Such cleaning should never be done using chemicals. Wiping off any dirt with a clean cloth would be enough.
- The cuts of the parts to be joined must be as parallel as possible to each other and as perpendicular as possible to the length of the pipe. If there is any burr, it is advisable to remove it before connecting the parts.
- In processes where temperature is involved, it is important to ensure that materials with similar melting points are to be connected.
- It is necessary to take into account the environmental conditions where the connection is going to take place, since extreme temperatures could distort machine data in automatic welds, or even affect the elements to be connected. In the same way, it is necessary to avoid air currents that can make the connection difficult, since it may accelerate the partial cooling of the different elements.

14.1 THERMOFUSION OR SOCKET WELDING

The process consists of connecting a pipe and a fitting by applying heat on the external part of the pipe and the internal part of the fitting. To do this, the pipe is inserted into the heating matrix while another heating matrix is inserted into the fitting.

Once the corresponding time has elapsed (see time table), the matrices are removed and the pipe is inserted into the fitting, keeping the pressure for the indicated time.

This type of welding guarantees a perfect pipe - fitting connection. The end result is a single part, eliminating the risk of leakage.

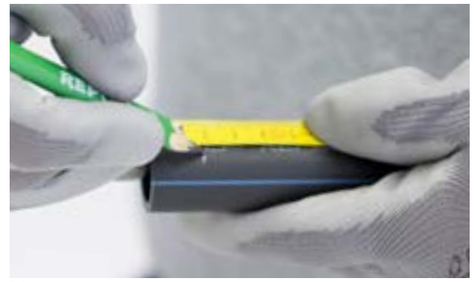


Welding instructions

- Check the temperature of the matrices (235 - 245 ºC). It is necessary to avoid air currents that could cool the matrix on one side. The temperature difference does not guarantee a good weld.
- Clean the pipe and fitting with a clean cloth.
- Mark the depth at which the pipe should enter.
- Insert the pipe and fitting while exerting a light pressure on them and allowing the material to melt slowly.
- Count the time indicated in the enclosed table according to the diameter of the pipe.
- Remove the pipe and fitting and insert the pipe into the fitting, maintaining the pressure for the time indicated in the table.
- During this time, small alignment corrections can be made.
- When the bench welder is used (large diameters), the procedure is almost the same, except that the pressure is exerted by the bench.
- A good weld will produce a uniform bead all around the welded perimeter (see butt weld bead).
- Wait about two hours before doing hydraulic tests.

Steps for manual welding

Check the length of the pipe to be inserted in the accessory


Mark the measured length on the pipe

Apply the matrices to the pipe and fitting

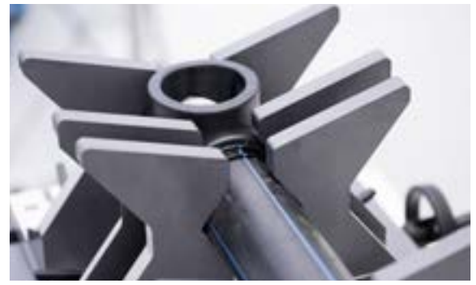
Insert the pipe into the fitting

Steps for machine welding

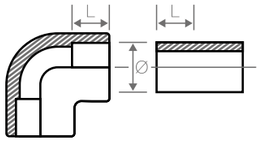
Level the fitting on the machine

Apply the matrices to the pipes and fittings

Remove the matrices


Insert the pipe into the fitting

Working depth table	
Nominal diameter (mm)	Minimum depth (mm)
16	13.3
20	14.5
25	16
32	18.1
40	20.5
50	23.5
63	27.4
75	30
90	33
110	37
125	40



L = Length
∅ = Coupling diameter

	Warm-up time (s)				
Nominal Diameter (mm)	PN10	PN16	PN20	Assembly time (s)	Cooling time (s)
16	---	3	5	4	10
20	---	3	5	4	10
25	---	4	6	4	15
32	---	5	7	6	15
40	---	7	10	6	25
50	9	11	15	6	25
63	12	14	20	8	40
75	18	20	25	8	40
90	25	30	35	8	50
110	35	45	45	10	60
125	40	50	50	10	65

Note: It is recommended to wait at least a couple of hours before testing for leaks.

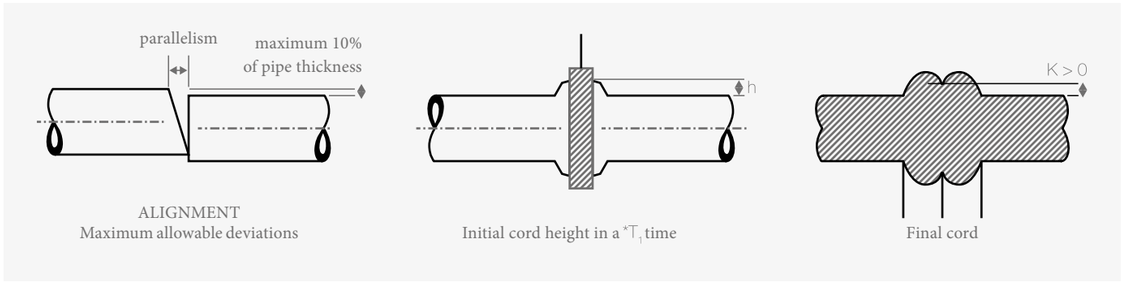
Special care of the heating matrices

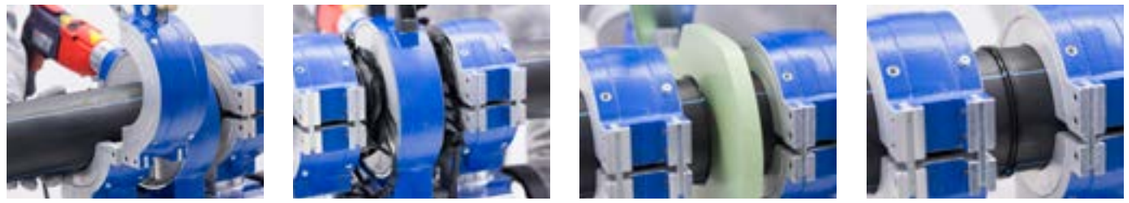
- It is important to keep them in good condition, preventing them from suffering any impact or scratches.
- Always keep them clean. If there is any material attached left, remove it while they are still hot using a clean cloth.
- If they are used for more than one material, cleaning when finished is especially important.
- If they are damaged, replace them with new ones. The matrices have a Teflon coating which ensures a homogeneous distribution of heat. If the Teflon is damaged, the matrix will not heat evenly in all its parts and correct welding cannot be guaranteed.

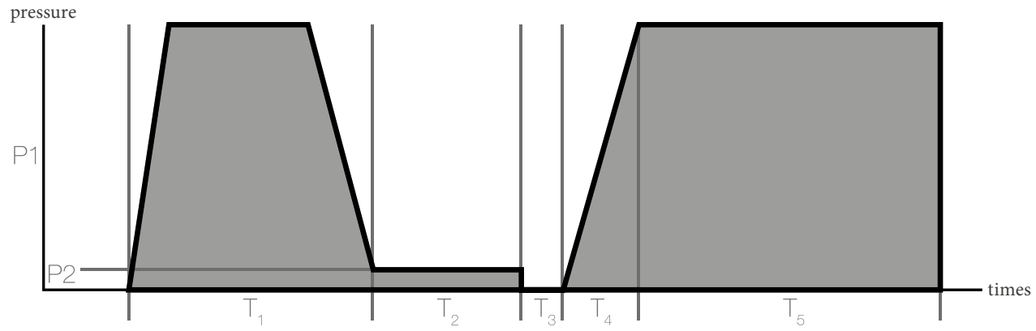
The procedure consists of heating two pipes (or a pipe with an fitting of the same outer diameter and thickness as the pipe) by means of a heating plate (approximately 210 - 225ºC), and then use pressure to achieve the connection of the two elements.
It is usually used for large diameters. It is very important to carry this out using equal thicknesses and diameters.

Welding instructions

- Place the elements aligned on the welding machine.
- Face the pipes (using the blade of the machine itself) to properly clean the surfaces and even them out.
- Remove the facing tool and the burrs without touching the surfaces to be connected.
- Ensure the surfaces are parallel to each other.
- Check that the heating plate is clean and at the correct temperature.
- Follow the pressure curve indicated by the machine manufacturer
- A first P1 pressure is exerted for a T1 time to create the initial height cord (h).
- After this time, lower the pressure to ensure full heating P2 (preset welding pressure = 1.5 bar).
- After the heating time T2, move back the elements and remove the heating plate and quickly connect the ends T3.
- Increase the pressure progressively until it reaches the pressure indicated by the manufacturer P1 - T4.
- Maintain this pressure for the time indicated until the weld is cold T5.
- Wait about two hours before doing hydraulic tests.







14.3 ELECTROFUSION CONNECTION

The system consists of passing a low voltage current through metal coils inside the fittings, embedded in the polypropylene, causing the Joule heating effect that welds the fitting with the pipe previously inserted in it.

Check the length of the pipe to be inserted into the fitting

Mark the measured length on the pipe

Scrap the surface to be welded (best with automatic scraper)

Insert the pipe into the fitting without forcing it (the pipe must be inserted without forcing it but play-free)

Connect the machine terminals to the fitting

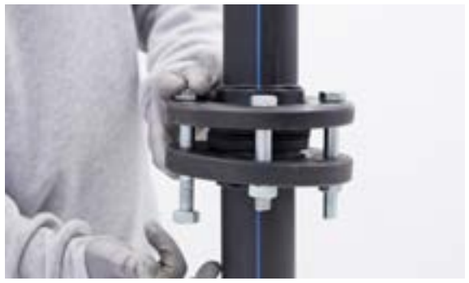
Read fitting label code

Wait for welding process to finish (indicators outlet)

FLANGED SYSTEMS 14.4

Reboca, S.L. has flanged systems that enable the connection between pipes. REPOLEN flanges are PN16.

Remember that the screws tightening must always be done crosswise and gradually, to ensure a perfect coupling of the gasket.



MECHANICAL SYSTEMS 14.5

It consists in using mechanical fittings, normally threaded. It is usually used for small diameters and thicknesses.

The assembly steps are:

- Cut the pipe perpendicularly
- Disassemble the fitting to be connected
- Insert the pipe by butt pressure
- Retighten the fitting thread

14.6 INSTALLATIONS OF BRANCH SYSTEMS

The REPOLEN socket system makes it easy to repair and modify existing installations.

Make a hole in the pipe where you want to make the new intake with the corresponding drill

Cut the edges that may remain carefully so as not to damage the pipe

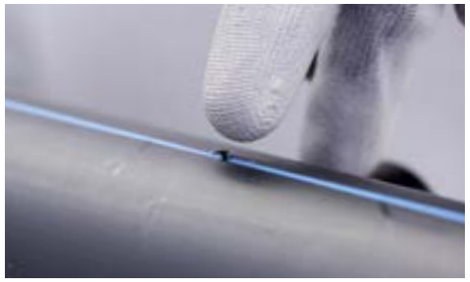
Apply the heating matrices both to the pipe and to the branch to be grafted, proceeding in the same way as with any socket weld

Remove the matrices and insert the branch into the hole

Level the outlet before the weld cools down

SYSTEM REPAIR 14.7

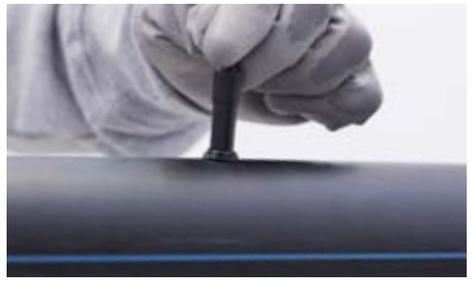
If a small breakage, an unintentional hole, etc. occurs on an already finished installation, a repair plug, with the appropriate matrix, would be enough to solve it.



Depending on the size of the hole, apply a 6 or 10 mm drill bit

The hole has to be round

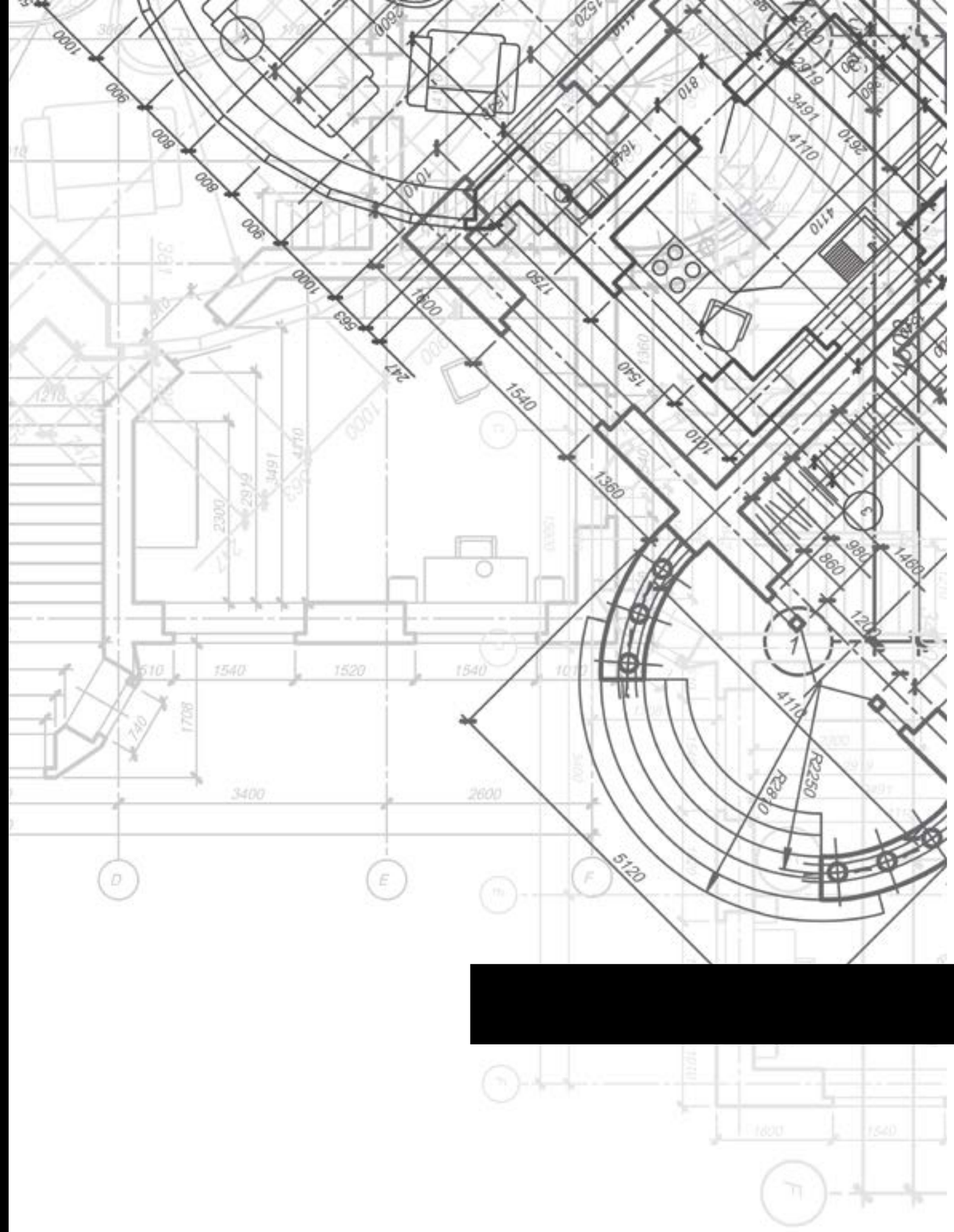
Apply the repair matrices, both to the hole and to the repair plug



Insert the plug into the hole taking care not to insert it too much so as not to create turbulence in the water flow

Cut off excess plug

Finished look



ANNEXES

9.1 CHEMICAL RESISTANCE TABLE

+	Resists with insignificant variations	cold sat.	Cold saturation
/	Resists with variations under certain conditions	e	Boiling
-	Does not resist	a	Aqueous solution

PRODUCT	CONCENTRATION	TEMPERATURE	
		20ºC	60ºC
Coconut oil		+	/
Flaxseed oil	100	+	+
Corn oil	100	+	/
Paraffin oil	100	+	+
Castor oil	100	+	+
Silicone oil	100	+	+
Diesel	100		
Heating oil	100	+	/
Fine spindle oil	100	/	/
Engine oils	100	+	/
Animal oil		+	/
Ethereal oils		/	/
Mineral oils	100	+	/
Vegetable oil		+	/
Acetaldehyde	100	+	/
Ammonium acetate		+	+
Amyl acetate	100	+	/
Butyl acetate	100	+	/
Ethyl acetate	100	/	/
Methoxybutyl acetate	100	+	/
Lead acetate	Saturated	+	+
Acetone	100	+	+
Acetic Acid	1 - 10	+	+
	10 - 60	+	/
	80 - 100	+	/
Adipic acid		+	+
Aminoacetic Acid		+	+
Aromatic Acids		+	+
Arsenic Acid	100	+	+
Benzenesulfonic acid		+	+
Benzoic acid	Aqueous Sol.	+	+
Boric acid	Sol.	+	+
Bromhydric acid	10 - 50	+	+
Butyric acid		+	/
Carbonic acid (dry / wet)	100	+	+
Hydrocyanic acid	saturated	+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20ºC	60ºC
Citric acid	saturated	+	+
Hydrochloric acid	10 - 35	+	+
	concentrated	+	+
Chlorous acid	concentrated	+	+
Chlorosulfuric acid	100	-	-
Cresylic acid	50	+	+
Chromic acid	50	+	/
	80	+	-
Dichloroacetic acid	50	+	+
	100	+	/
Stearic acid	100	+	/
Ethylenediaminetetraacetic acid		+	+
Fluoric acid		+	+
Hydrofluoric acid	40 - 40	+	/
Fluorosilicic acid	32	+	+
	Conc. Sol.	+	+
Formic acid	10 - 80	+	+
	100	+	/
Phosphoric acid	0 - 30	+	+
	30 - 90	+	+
	95	+	/
Phthalic acid	50	+	+
Gallic acid	saturated	+	/
Glycolic acid	30	+	+
	55	+	+
	70	+	+
Hypochlorous acid	conc	+	/
Lactic acid	10 - 80	+	+
	90 - 100	+	/
Maleic acid		+	+
Malic acid	50	+	+
Methylsulfuric acid		+	/
Monochloroacetic acid		+	+
Nicotinic acid		+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20ºC	60ºC
Nitric acid	0 - 30	+	+
	30 - 50	+	/
	70	+	/
	98 - 98	-	-
Oleic acid	conc	+	/
Oxalic acid	diluted	+	+
	saturated	+	+
Perchloric acid	20	+	+
	50	+	/
	70	+	-
Picric acid		+	+
Propionic acid	50	+	+
	100	+	/
Salicylic acid		+	+
Selenic acid		+	+
Silicic acid		+	+
Sodium Acid	saturated	+	+
Succinic acid	50	+	+
Hydrogen sulphide		+	+
Sulphochromic acid		-	-
Sulphuric acid	0 - 50	+	+
	70	+	/
	80	+	-
	96	/	-
	98	/	-
	oleum	-	-
Sulphuric acid	10	+	+
Tannic acid	10	+	+
Tartaric acid	10	+	+
	saturated	+	/
Trichloroacetic acid	50	+	+
	100	+	-
Fatty acids with more than 4 carbon atoms		+	/
Acrylonitrile	100	+	+
Chlorine water	2	+	+
Sea water		+	+
Hydrogen peroxide	30	+	/
	90	+	-
Aqua regia		-	-

PRODUCT	CONCENTRATION	TEMPERATURE	
		20ºC	60ºC
Camphor		+	/
	crystals	+	/
	oil	-	-
Allyl alcohol	96	+	+
Amyl alcohol	100	+	-
Benzyl alcohol		+	+
Butyl alcohol		+	+
Ethyl alcohol	100	+	+
Furfuryl alcohol	100	+	/
Isobutyl alcohol		+	+
Isopropyl alcohol		+	+
Methyl alcohol		+	+
Glycolic Alcohol		+	/
Propyl alcohol		+	+
Starch	saturated	+	+
Chromium Alums	saturated	+	+
Ammonia	dry gas 100	+	+
	liquid	+	
	solution	+	+
Acetic anhydride		+	/
Carbon dioxide	dry 100	+	+
	wet	+	+
Phosphoric anhydride		+	+
Phthalic anhydride		+	+
Sulphuric anhydride		/	-
Sulphur dioxide	wet	+	+
Aniline	100	+	/
Arsenic		+	+
Aspirin		+	+
Sulphur	colloidal	+	+
Galvanic baths		+	+
Benzene	100	/	-
Benzine	100	/	-
Benzaldehyde		+	/
Sodium benzoate	saturated	+	+
Potassium bicarbonate	saturated	+	+
Sodium bicarbonate	saturated	+	+
Potassium dichromate	saturated	+	+
Sodium dichromate	saturated	+	+
Sodium bisulphate	saturated	+	+
Sodium bisulfite	saturated	+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Paper whiteners and dyes		+	+
Potassium borate	saturated	+	+
Sodium borate	conc.	+	+
Borax	solution	+	+
Potassium bromate	10	+	+
Bromine	(liquid) 100	-	
Bromochloromethane		-	-
Ammonium bromide		+	+
Calcium bromide		+	+
Potassium bromide	saturated	+	+
Butadiene		-	-
Butanediol	10 - 100	+	+
Butylene Glycol		+	+
Coffee		+	+
Cinnamon		+	+
	oil	-	-
Ammonium carbonate		+	+
Calcium carbonate		+	+
Barium carbonate	saturated	+	+
Bismuth carbonate	saturated	+	+
Magnesium carbonate	saturated	+	+
Potassium carbonate		+	+
Sodium carbonate	solution	+	+
Beeswax		+	/
Beer		+	+
Ketones	100	+	/
Copper cyanide		+	+
Mercury cyanide	saturated	+	+
Potassium cyanide	saturated	+	+
Sodium cyanide	saturated	+	+
Cyclohexane		+	+
Cyclohexanol		+	/
Cyclohexanone		+	/
Calcium chlorate	saturated	+	+
Barium chlorate	saturated	+	+
Potassium chlorate	saturated	+	+
Sodium chlorate	saturated	+	+
Sodium chlorite	50	+	+
Chlorine	wet gas	/	-
	dry gas	/	-
	liquid 100	-	-
Chlorobenzene		/	-
Chloroethanol		+	+
Chloroform	100	/	-

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Aluminium chloride	solution	+	+
Amyl chloride	100	/	-
Ammonium chloride	solution	+	+
Antimony chloride	saturated	+	+
Barium chloride	saturated	+	+
Benzoyl chloride		/	/
Calcium chloride	solution	+	+
Zinc chloride	solution	+	+
Copper chloride	solution	+	+
Tin chloride	saturated	+	+
Ferrous chloride	saturated	+	+
	solution	+	+
Ferric chloride	solution	+	+
Magnesium chloride	solution	+	+
Mercuric chloride	sublimated	+	+
	solution	+	+
Methylene chloride	100	/	/
Nickel chloride	saturated	+	+
Potassium chloride	solution	+	+
Sodium chloride	solution	+	+
Sulphuryl chloride		-	-
Thionyl chloride		-	-
Creosote		+	+
Cresol		+	+
Potassium chromate	saturated	+	+
Shampoo		+	+
Decalin	100	/	-
Disinfectants		+	-
Synthetic detergents	solution	+	+
Dextrin	saturated	+	+
Dextrose	saturated	+	+
Methyl dichloroacetate		+	+
Dichloroethane		/	/
Dichloroethylene		-	-
Potassium dichromate	saturated	+	+
Sodium dichromate	saturated	+	+
Diethylene glycol		+	/
Diisobutylketone		+	-
Diethanolamine		+	/
Dimethylformamide		+	/
Dioxane	100	+	+
Carbon dioxide	saturated cold	+	+
	wet 100	+	+
	dry 100	+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Emulsifiers		+	+
Acrylic Emulsions		+	+
Photographic emulsions		+	+
Epichlorohydrin		+	+
Turpentine Essence		/	/
Whale sperm		+	/
Aliphatic esters	100	+	/
Ethanol	10	+	+
	95	+	+
	96	+	+
	100	+	/
Ether	100	/	/
Petroleum Ether		+	/
Dibutyl ether		/	-
Diethyl ether		/	/
Ethyl ether		/	-
Isopropyl ether		/	-
Ethylbenzene		/	-
Ethylene glycol		+	+
Tanning extracts	commercial	+	+
Orange extracts		+	+
Vanilla extracts		+	+
Phanacetin		+	+
Phenylsulfonate		+	+
Phenol		+	+
Potassium ferricyanide	saturated	+	+
Sodium ferricyanide	saturated	+	+
Fluorine		-	-
Ammonium fluoride	20	+	+
	70	+	+
Aluminium fluoride		+	+
Copper Fluoride	saturated	+	+
Potassium fluoride	saturated	+	+
Sodium fluoride	saturated	+	+
Formaldehyde	10 - 30	+	+
	30 - 40	+	/
Phosphine	100	+	+
Ammonium phosphate		+	+
Tri-b-chloroethylene phosphate		+	+
Tributyl phosphate		+	+
Tricesyl phosphate	100	+	/
Disodium phosphate		+	+
Sodium phosphate		+	+
Trisodium phosphate	saturated	+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Yellow phosphorus	100	+	+
Fructose	saturated	+	+
Dibutyl phthalate	100	+	/
Furfural	100	/	-
Natural gas		+	+
Nitrous gases		+	+
Diesel		+	-
Petroleum jelly		+	+
Glycerine.	solution	+	+
Glycol	concentrated	+	+
Butyl glycolate		+	+
Glucose		+	+
Heptane		/	-
Hexachlorobenzene		+	+
Hexane	100	+	/
Hexanol	100	/	-
Chloral hydrate	solution	+	+
Hydrazine hydrate		+	+
Aromatic hydrocarbons		/	-
Hydrogen	100	+	+
Hydroquinone		+	+
Hydrosulphite	10	+	+
Ammonium hydroxide	p.c. 0.88	+	+
Calcium hydroxide	saturated	+	+
Barium hydroxide	saturated	+	+
Magnesium hydroxide	saturated	+	+
Potassium hydroxide	concentrated	+	+
	20	+	+
	50	+	+
Sodium hydroxide	30	+	+
	concentrated	+	+
Calcium hypochlorite	15% Active Cl	+	+
Sodium hypochlorite		+	+
Iodine		+	+
Isooctane		+	/
Isopropanol		+	+
Syrups	usual	+	+
Kerosene		/	/
Lanolin		+	+
Latex		+	+
Milk		+	+
Bleach	15% act.	+	+
Yeast		+	+
Hydraulic Liquid		+	/

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Margarine		+	+
Molasses		+	+
Menthol		+	/
Mercury		+	+
Jam		+	+
Ammonium metaphosphate	saturated	+	+
Methanol	100	+	+
	50	+	+
4-methyl-2-pentanol		+	/
Methylcyclohexane		/	-
Methyl ethyl ketone		+	-
Methylglycol		+	+
Methoxybutanol		+	/
Sulphochromic mixture		+	-
Methyl monochloroacetate		+	+
Carbon monoxide		+	+
Morpholine		+	+
Naphtha		+	/
Naphthalene		+	-
Ammonium nitrate	saturated	+	+
Calcium nitrate		+	+
Magnesium nitrate	saturated	+	+
Mercury nitrate	saturated	+	+
Nickel nitrate	saturated	+	+
Silver nitrate		+	+
Lead nitrate		+	+
Ferric nitrate	saturated	+	+
Potassium nitrate	saturated	+	+
Sodium nitrate	solution	+	+
Nitrobenzene		+	/
o-dichlorobenzene		/	-
Oleum		-	-
o-nitrotoluene		+	/
Phosphorus oxychloride		+	/
Carbon Oxide		+	+
Zinc oxide		+	+
Oxygen	100	+	/
Ozone	100	/	-
p-dochlorobenzene		/	-
Phosphorus pentoxide	100	+	+
Potassium perborate	saturated	+	+
Sodium perborate		+	+
Potassium perchlorate	saturated	+	+
Perchlorethylene	100	/	-

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Potassium permanganate	6	+	+
	20	+	+
Sodium peroxide	10	+	
	saturated	/	
Ammonium persulphate	saturated	+	+
Potassium persulphate		+	+
Petroleum		+	/
Pyridine		+	/
Tetraethyl lead	100	/	/
Polyglycols		+	+
Caustic Potash		+	+
Propane	gas	+	+
Propylene glycol		+	/
Pseudocoumene		/	/
Fruit pulp		+	+
p-Xylene	100	/	-
Resorcinol		+	+
Photographic developers		+	+
Common salt	saturated	+	+
Brine	saturated	+	+
Tallow		+	+
Cider		+	+
Sodium silicate	solution	+	+
Caustic soda		+	+
Aluminium sulphate	solution	+	+
Ammonium sulphate	saturated	+	+
Barium sulphate	saturated	+	+
Calcium sulphate		+	+
Zinc sulphate	saturated	+	+
Copper sulphate	saturated	+	+
Ferrous sulphate		+	+
Magnesium sulphate	saturated	+	+
Nickel sulphate	saturated	+	+
Potassium sulphate	concentrated	+	+
Sodium sulphate	concentrated	+	+
Barium Sulfite	saturated	+	+
Potassium sulphite	concentrated	+	+
Sodium sulphite	saturated	+	+
Dimethyl sulfoxide		+	+
Ammonium sulphide	saturated	+	+
Barium sulphide	saturated	+	+
Calcium sulphide		+	+
Carbon sulphide	100	/	-
Hydrogen sulphide		+	+

PRODUCT	CONCENTRATION	TEMPERATURE	
		20°C	60°C
Potassium sulphide	concentrated	+	+
Sodium sulphide	25	+	+
	saturated	+	+
Talcum	100	+	+
Tea		+	+
Tetrabromoethane		-	-
Tetrachloroethane		/	-
Tetrachloroethylene	100	/	-
Carbon tetrachloride	100	+	/
Tetrahydrofuran	100	+	/
Tetraline	100	+	/
Tincture of iodine		+	/
Ammonium thiocyanate	saturated	+	+
Thiophene		/	/
Sodium thiosulphate	saturated	+	+
Toluene	100	/	-
Trichloroethylene	100	-	-
Antimony trichloride		+	+
Phosphorus trichloride	100	+	/
Trielanolamine	100	+	-
Urea	33	+	+
Vaseline		/	/
Vinegar	commercial	+	+
Wine		+	+
White spirit		/	/
Apple juice		+	+
Orange juice		+	+
Tomato juice		+	+
Grape juice		+	+
Carrot juice		+	+

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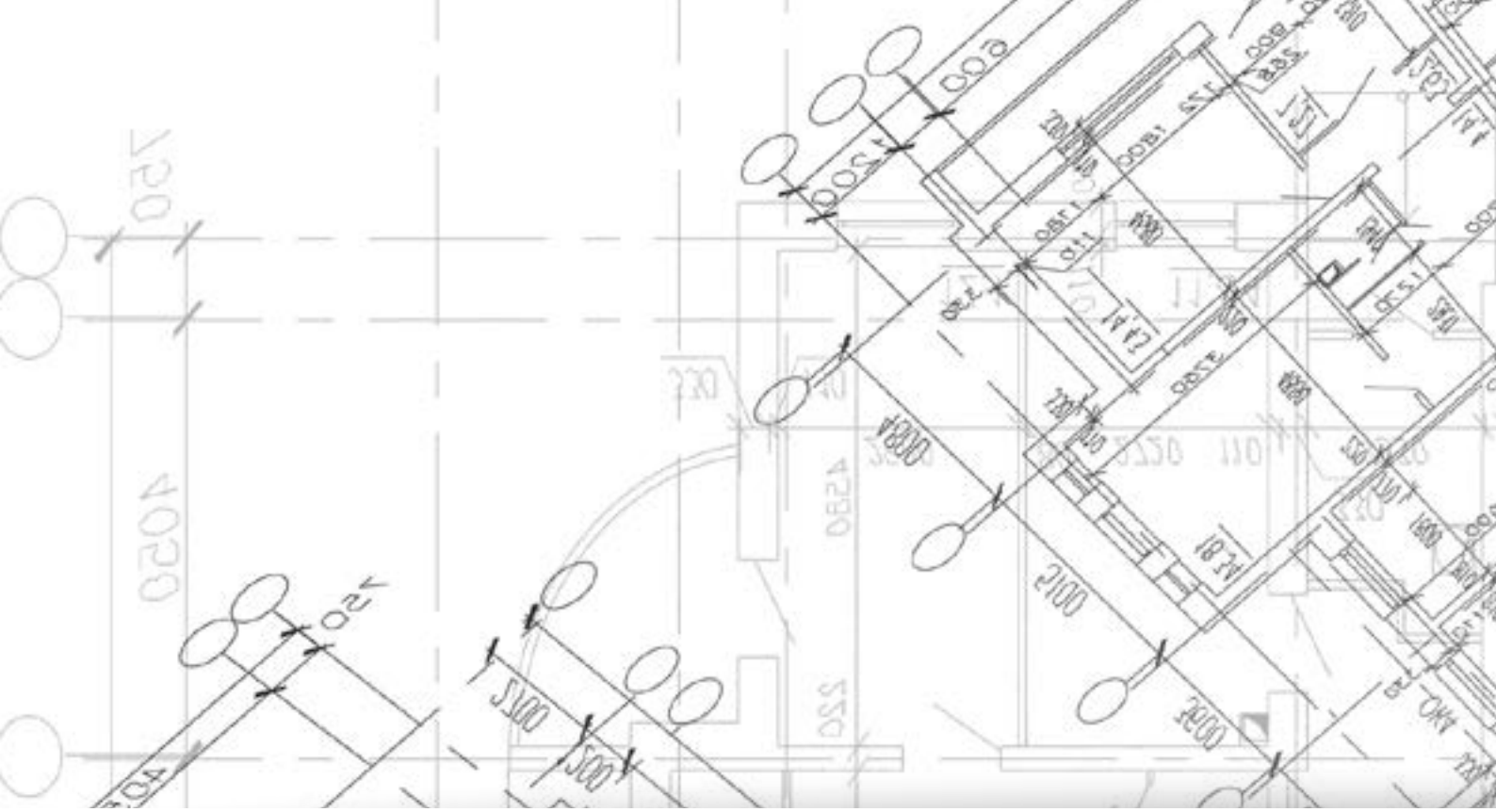

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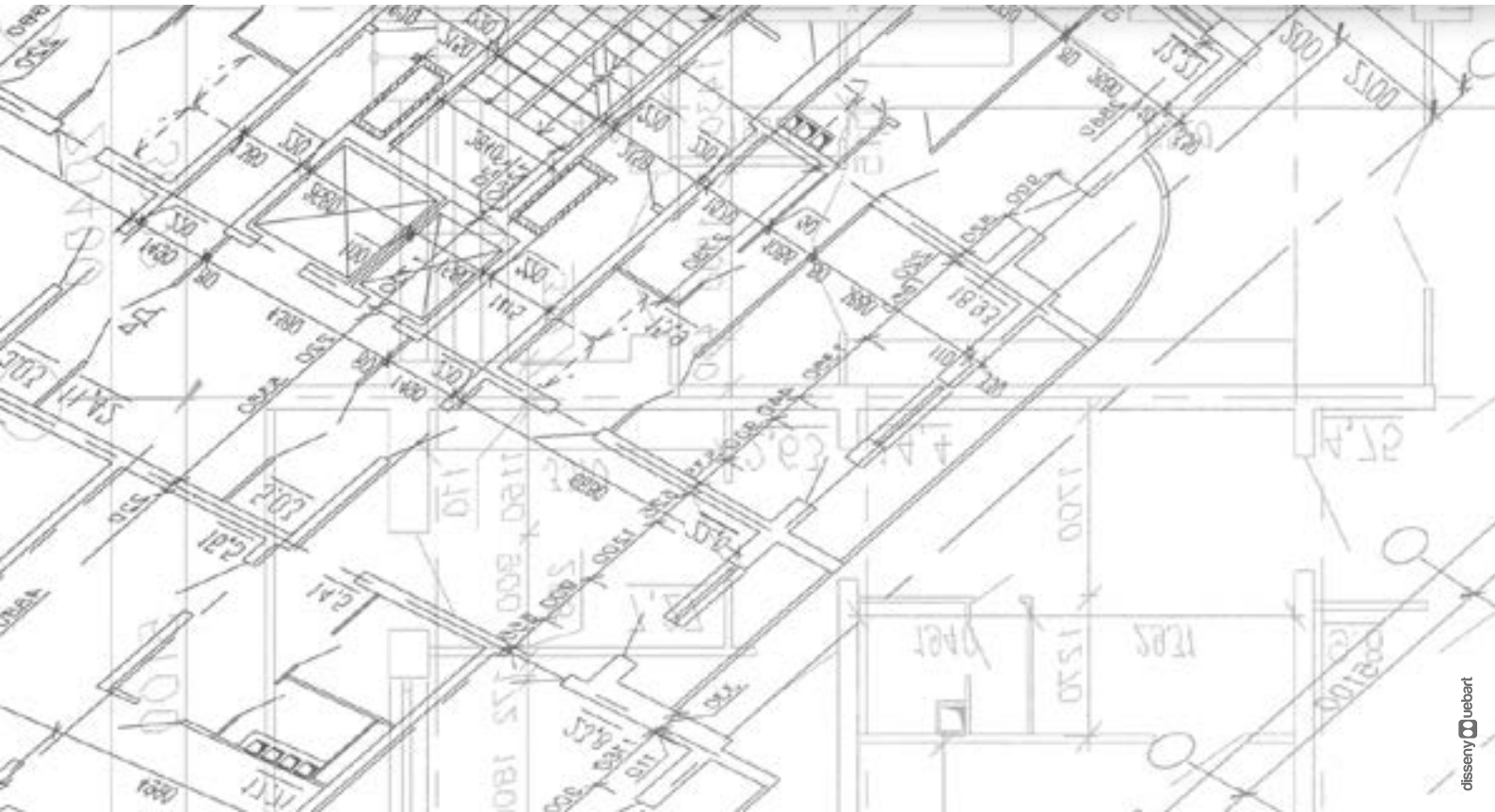

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