ECOLINE

Technical Catalog

CONTENT:

GENERAL INTRODUCTION
OUR HISTORY

ECOLINE has been manufacturing pre-insulated pipelines since 1980, becoming now one of the most experienced European manufacturers.
Each of our Clients, for almost forty years, has been sure to find in our company the maximum reliability and expertise, which are part of our history. Owners and staff are committed to pass on to new generations the same values at the origins of our company: we are willing to demonstrate our Customers they can trust on us as we always aim to providing a service beyond their expectations.

Reliability, short delivery times, flexibility and innovation are our strengths to solve quickly unforeseen events in the building site.
As a matter of fact, we can rely on a well stocked warehouse, high skilled staff able to quickly realize customized fittings and a technical team able to develop appropriate designing solutions according to every single problem to solve.
Our main achievement is to keep on providing support to our Customers with the reliability we are known for almost forty years.

GENERAL INTRODUCTION
OUR PRODUCTION SITES

In the current site of Vescovato, near Cremona, 100 km from Milan, covering an area of 60,000 square metres [10,000 of which are roofed], are manufactured all types of accessories for building district heating networks. Every year more than 300,000 metres of piping and 50,000 accessories are produced. In the new site of Casalromano, near Mantua, about 100 km from Milan, on an area of 50,000 square metres [5,000 of which are roofed], are manufactured PE, PEX, stainless steel flexible preinsulated pipes in rolls, both in UNO or DUO, using latest technology systems, thus ensuring the best performances as required by our Customers.

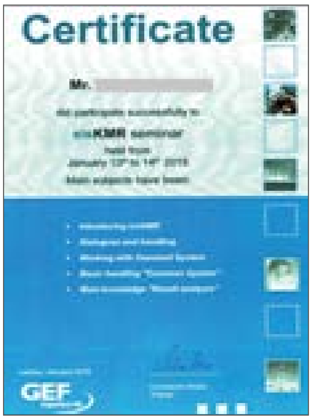
ECOLINE and **ECOTECH** sites and their warehouses

GENERAL INTRODUCTION
QUALITY AND CERTIFICATIONS

High quality levels have been reached through the years ensuring finished products complying with the European standards EN 253/448/488/489. Compliance with additional standards has been reached in the last few years:

- Standard EN 13941, about design and installation pre-insulated bonded pipe systems for district heating;
- Standard EN 14419, about Surveillance systems for pre-insulated bonded pipe systems for district heating.

ECOLINE can carry out the stress-analysis tests of buried pre-insulated pipeline networks according to standard EN 13491, using the specific software sisKMR (always available in the latest updated version) and relying on highly experienced technical staff. Our constant commitment has been recognized by TUV: the production of all materials, stress-analysis calculation and on site assistance comply with the requirements of ISO 9001 [Quality Systems]. Since January 2012, we have obtained also DET NORSKE VERITAS certification of compliance for the products manufactured in the **ECOLINE** site in Vescovato, with the guide lines EUROHEAT & POWER EHP/001, and, since June 2012 the certification of compliance of the environmental system with the standard UNI EN ISO 14001.



SUPPORT AND SERVICE

Other services our staff can provide are:

- Technical inspection of the network
  - laying conditions;
  - stress-analysis;
- Material computation;
- Training of the staff in charge of pipeline laying and insulation restoration of the joint areas;
- Training of the Customer's staff in charge of pipeline laying supervision;
- Constant technical support in case of pipeline path changes;
- Stress-analysis check due to thermal expansion;
- Surveillance system design;
- Supply of installation procedures;
- Supply of detailed layout.

Today like 40 years ago, **ECOLINE** has retained its customers mainly providing several supporting services, first of all the possibility to have a well stocked warehouse with all the components from DN 20 to DN 500 [for larger DN we have raw materials stocked at our suppliers' sites].
Today like 40 years ago, the real order to perform can be defined only after opening excavations and this is one of the main advantages we can propose: the possibility to solve quickly such emergencies with EUROHEAT AND POWER certified components.
If not strictly necessary, don't use products such as foamed bends on site: they are one of the most vulnerable parts of a line and they don't comply with standards EN 448.

ECOTHERM® SYSTEM

Products

ECOTHERM® PREINSULATED BONDED PIPELINES SYSTEM

Ecotherm® system is a set of pipelines, special parts and accessories suitable to build up district heating/cooling networks. **ECOLINE** indeed produces pre-insulated pipelines able to transport fluids with temperature between -200°C / +300°C. The pre-insulated pipeline systems for district heating/cooling networks are used for temperatures between 0°C and 140°C. The transported fluid is generally cool, hot, heated water or low pressure steam.

The pipelines are suitable also for transporting other types of fluids. The insulation is made of high-quality polyurethane foam. The pipelines can be rigid or flexible. The applied material is generally carbon steel [P 235/355]. The features and operational limitations are listed in the tables below. It is possible to supply, on request, other types of service pipe: seamless steel pipes, high-quality steel, stainless steel, galvanized steel, PEX, copper, etc.

SERVICE PIPE
Welded steel according to the requirements of the Standard UNI EN 253. They are supplied in class P235GH or P265GH and, on request, P355NH. All the steel pipes, during their manufacturing, are hydro tested.

INSULATION
Rigid polyurethane foam according to the Standard EN 253. Thermal conductivity coefficient is ≤0,027 W/m°K, at an average temperature of 50°C.
Core Density: ≥ 60 Kg/m3
PUR Compression: ≥0,3MPa

CASING PIPE
High density polyethylene complying with the standard EN253 (CORONA treatment).

SURVEILLANCE SYSTEM
In the insulation are inserted 2 copper cables, with a section of 1,5 mm^2 (a copper cable and a tinned copper one), suitable for the realization of the leak detecting system.
On request, as an alternative, it is possible to provide the system pipelines with Brandes leak detecting system.

ASSEMBLED PIPE
Available in 6 metres lenght for diameters between ¾ " to 2";in 6 or 12 metres lenght for larger diameters. Free service pipe ends: 150/200 mm. Maximum temperature 155°C. For higher temperatures, refer to the other systems until temperatures of 300° are reached.

FIELDS OF APPLICATION

HEATING

COOLING

GEOTHERMAL ENERGY

SANITARY WATER

FIREPROOF NETWORK

CONDITIONING

GREEN HOUSE

THERMAL PLANTS

PROCESS PLANTS

STEAM TRANSPORT

DISTRICT HEATING NETWORKS

District Heating represents a form of long distance heat transport and distribution, starting from one or more centralized points of production [power plants]. A district heating system is therefore composed by three essential elements:

1. **heat production system;**
2. **heat transport system;**
3. **heat consumption system.**

Heat produced in power plants is transferred through appropriate heat exchangers to the vector fluid which, through buried pipelines [called 'flow' pipelines], is transported inside the thermal power plants of the buildings, where it is used for heating the secondary circuits of the buildings themselves. The fluid, once cooled, is transported through the return pipelines to the production power plant, where it is heated again in order to be insert again in the network. Heat generation in a District Heating system can occur exploiting different sources. In particular, among the factors which have made successful district heating/cooling the favourite option for saving energy in the new directive 27/2012 about energy efficiency. It allows to exploit in an integrated way excess heat produced during some producing processes as source of heating. Therefore the thermal energy in a district heating system can arrive for example:

- **from incineration (waste-to-energy plant) of the solid urban waste**
- **from thermoelectric generation (combined heat and power production)**
- **from fuels and biofuels refining processes**
- **from different production industrial processes**

Moreover, district heating can use different types of renewable sources:

- **biomass**
- **geothermy at high and low enthalpy [using heating pumps]**
- **thermal solar**

The possibility to integrate a lot of different heat sources on the territory, makes District Heating the best solution to manage the urban heating in a successful and efficient way.

ECOLINE takes care of the transport phase, producing the pipelines which allow the heat transport to users and all the accessories necessary to build up the distribution system. As better explained in the products section of this catalogue, pipelines are realized with the "Bonded" construction system. In detail, it is a preinsulated pipelines system consisting of:

- service pipe: it is the pipe in which is transported the fluid;
- outer casing: it is the pipe in which is inserted the service pipe;
- insulation: realized through injection of rigid polyurethane foam between the carrier pipe and the outer casing.

District Heating system designing can be divided approximately into the following macro steps:

- heat generation system designing;
- heat distribution network designing;
- heat transfer system designing to the users

The aim of this section of **ECOLINE** catalogue is to provide the designers the necessary recommendations for a correct design of the a District Heating system distribution network.
Executive design of a heat distribution network is divided in the following macro steps:

- horizontal - altimetric definition of the line
- hydraulic designing;
- mechanical designing;
- surveillance system designing;
- features definition of the applied materials for building the network [Tender Specifications];
- work computation.

In the following pages of this catalogue, in particular, are provided recommendations for hydraulic and mechanical designing of a district heating distribution network, referring to simplified schemes and using some base assumptions. More articulated and complex system designing needs specific analyses performed by the designer of the works.
ECOLINE Technical Department is available to propose its competence in order to support the designers/Clients during evaluation of specific detailed elements of the developing system.

BONDED PIPE SYSTEM

PRE-INSULATED PIPES PRODUCTION

ECOLINE manufactures pre-insulated pipes according to the Standard EN253, injecting polyurethane foam, within the crawl space created between the steel service pipe in an high-density polyethylene casing.

MAIN FEATURES OF THE MATERIALS

Service pipe

- Welded steel pipe according to the European Standard EN 10217-1,2,3 or 5;
- Steel class = P235TR1, P235TR2, P235GH, P355NH;
- Yield strength
  min 235 N/mm^2 [P235];
  min. 355 N/mm^2 [P355];
- Tensile strength
  360÷500 N/mm^2 [P235];
  490÷650 N/mm^2 [P355];
- Ultimate elongation
  23-25% [P235];
  20-22% [P355];
- Welding factor = 1
- Available certification according to the EN 10204 3.1;
- Prepared ends according to UNI ISO 6761;
- Sandblasted external surface.

Insulation

- Rigid polyurethane foam according to the European Standard EN 253;
- CCOT > 160 °C for 30 years;
- Applied blowing agent: Cyclopentane;
- Thermal conductivity ≤ 0,027 W/m°C [at 50°];
- Compressive strength ≥ 0,3 MPa.

Surveillance system wires[1]

- With 2 copper cables (one bare copper, one tinned copper) of 1,5 mm2, inserted in the insulation;
- The system is complying with the European Standard EN 14419.

Outer casing

- High density polyethylene pipe according to EN253
- Elongation at break → 350%;
- MFI variation ≤ 0,5 g/10 m.
- Corona treatment on the internal surface.

Assembled pipe

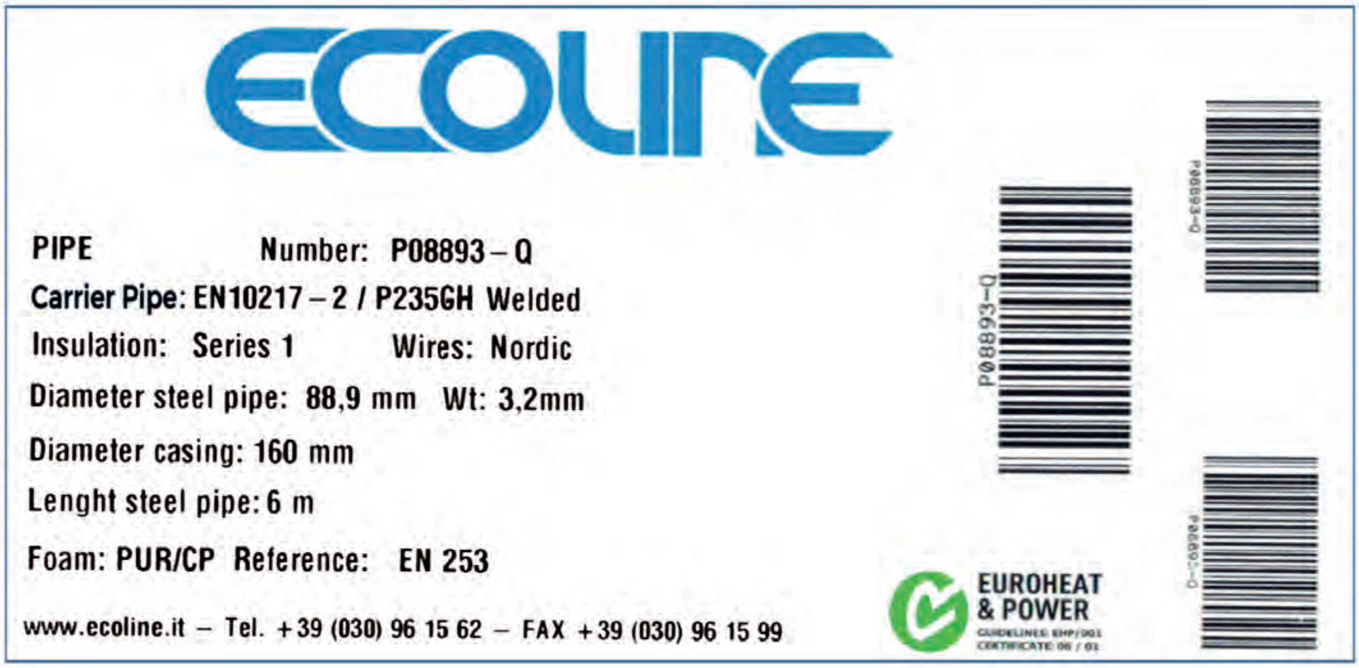
- Pre-insulated pipe in accordance with EN253 available in 6 metres lenght until DN 150, included, and in 12 metres bars start- ing from DN 25, included..
- Cut back insulation for 150÷200 mm.
  Max. operating temperature = 155 °C

[1] For alternative systems, contact our offices

PIPES FEATURES

MATERIAL IDENTIFICATION METHOD

All the pre-insulated pipes are identified by a label and specific bar-code.



STRAIGHT PIPELINES

PIPES FEATURES

SERIES 1

Steel pipe			PEHD casing	Weight Preinsulated pipe	Water volume	Total weight	Available lengths	
DN	De [mm]	WT [mm]	D [mm]	[kg/m]	[l/m]	[kg/m]	L=6 m.	L=12 m.
20	26,9	2,0	90	2,5	0,4	2,9	x	
25	33,7	2,3	90	3,0	0,7	3,7	x	x
32	42,4	2,6	110	4,1	1,1	5,2	x	x
40	48,3	2,6	110	4,5	1,5	6,0	x	x
50	60,3	2,9	125	6,0	2,4	8,4	x	x
65	76,1	2,9	140	8,0	3,9	11,8	x	x
80	88,9	3,2	160	10,0	5,5	15,4	x	x
100	114,3	3,6	200	13,0	9,0	21,8	x	x
125	139,7	3,6	225	17,0	14,0	30,7	x	x
150	168,3	4,0	250	21,0	20,0	40,6	x	x
200	219,1	4,5	315	31,0	34,7	65,0		x
250	273,0	5,0	400	44,0	54,4	97,3		x
300	323,9	5,6	450	57,0	77,0	132,5		x
350	355,6	5,6	500	64,0	93,2	155,4		x
400	406,4	6,3	560	81,0	122,0	200,6		x
450	457,0	6,3	630	94,0	155,3	246,3		x
500	508,0	6,3	710	108,0	193,0	297,3		x
600	610,0	7,1	800	140,0	278,5	413,1		x
700	711,0	8,0	900	180,0	380,0	552,6		x
800	813,0	8,8	1000	222,0	497,0	709,4		x

Note: For the calculation of the mass of the pipe filled with water, the mass of water at an average temperature of about 50 °C with the conversion factor l = 0,98kg, is considered

PIPES FEATURES

SERIES 2

Steel pipe			PEHD casing	Weight Preinsulated pipe	Water volume	Total weight	Available lengths	
DN	De [mm]	WT [mm]	D [mm]	[kg/m]	[l/m]	[kg/m]	L=6 m.	L=12 m.
20	26,9	2,0	110	2,9	0,4	3,3	x	
25	33,7	2,3	110	3,4	0,7	4,1	x	x
32	42,4	2,6	125	4,4	1,1	5,5	x	x
40	48,3	2,6	125	4,8	1,5	6,3	x	x
50	60,3	2,9	140	6,5	2,4	8,9	x	x
65	76,1	2,9	160	8,0	3,9	11,8	x	x
80	88,9	3,2	180	10,0	5,5	15,4	x	x
100	114,3	3,6	225	14,5	9,0	23,3	x	x
125	139,7	3,6	250	17,5	14,0	31,2	x	x
150	168,3	4,0	280	22,5	20,0	42,1	x	x
200	219,1	4,5	355	33,0	34,7	67,0		x
250	273,0	5,0	450	47,5	54,4	100,8		x
300	323,9	5,6	500	61,0	77,0	136,5		x
350	355,6	5,6	560	69,2	93,2	160,6		x
400	406,4	6,3	630	88,0	122,0	207,6		x
450	457,0	6,3	710	103,0	155,3	255,3		x
500	508,0	6,3	800	120,0	193,0	309,3		x
600	610,0	7,1	900	155,0	278,5	428,1		x
700	711,0	8,0	1000	196,0	380,0	568,6		x
800	813,0	8,8	1100	240,0	497,0	727,4		x

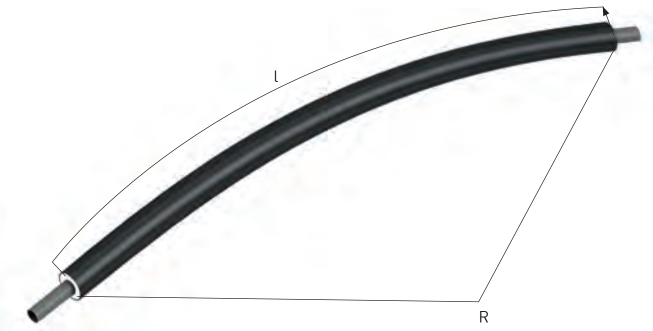
PIPES FEATURES

SERIES 3

Steel pipe			PEHD casing	Weight Preinsulated pipe	Water volume	Total weight	Available lengths	
DN	De [mm]	WT [mm]	D [mm]	[kg/m]	[l/m]	[kg/m]	L=6 m.	L=12 m.
20	26,9	2,0	125	3,2	0,4	3,6	x	
25	33,7	2,3	125	3,7	0,7	4,4	x	x
32	42,4	2,6	140	4,8	1,1	5,9	x	x
40	48,3	2,6	140	5,2	1,5	6,7	x	x
50	60,3	2,9	160	7,0	2,4	9,4	x	x
65	76,1	2,9	180	8,4	3,9	12,2	x	x
80	88,9	3,2	200	10,5	5,5	15,9	x	x
100	114,3	3,6	250	15,5	9,0	24,3	x	x
125	139,7	3,6	280	18,8	14,0	32,5	x	x
150	168,3	4,0	315	24,2	20,0	43,8	x	x
200	219,1	4,5	400	36,0	34,7	70,0		x
250	273,0	5,0	500	51,7	54,4	105,0		x
300	323,9	5,6	560	66,5	77,0	142,0		x
350	355,6	5,6	630	77,0	93,2	168,4		x
400	406,4	6,3	710	97,5	122,0	217,1		x
450	457,0	6,3	800	114,5	155,3	266,8		x
500	508,0	6,3	900	134,0	193,0	323,3		x
600	610,0	7,1	1000	171,0	278,5	444,1		x
700	711,0	8,0	1100	214,0	380,0	586,6		x
800	813,0	8,8	1200	260,0	497,0	747,4		x

CURVED PIPES

Bended pipes
In some individual cases, in order to optimise the laying activities, it can be necessary to use bended or bent on-site pipes, instead of the prefabricated lbows. Bended pipes can be used also in different installing conditions, such as changes of levels or other, provided that the relating requirements are respected. Pipes with diameter up to DN 80, included, can be easily bent on site [see the chapter about the laying systems].
For greater than DN80 diameters, **ECOLINE** in its own sites can manufacture bends at the required angle in multiples of 1° on 12 m bars. Applied materials for the construction of bended pipes are the same used for straight pipes. Bended pipes maintain mechanical strength features within the allowable limits for stress analyses tests and consequently the possibility to be used also for PN25 plants.
They are appropriately identified by the bending angle written on the label.
Placement of the surveillance system wires is stated according to the final position of the bended pipe inside the laying route.



Steel pipe	Max. bending angle	Bended pipe radius	Effective radius	Straight end lengths	Tolerance on the angle (±)
De x WT (mm)	(°)	(m)	(m)	(m)	(°)
114,3x3,6	38	16,4	18,1	0,56	3,8
139,7x3,6	43	14,3	16	0,63	3,1
168,3x4,0	45	13,4	15,3	0,67	2,6
219,1x4,5	41	14,3	16,8	0,89	2
273,0x5,0	36	15,7	19,2	1,02	1,6
323,9x5,6	29	18,9	23,8	1,21	1,4
355,6x5,6	25,5	21,7	27	1,16	1,2
406,4x6,3	19	27,4	36,2	1,47	1,1
457,2x6,3	14	37	49,1	1,48	0,9
508,0x6,3	9	58,9	76,4	1,38	0,8
609,6x7,1	4,8	100	143,3	1,81	0,7

ELBOWS

Elbows
Two different types of elbows can be supplied, according to the dimensions, design type and requirements of the Customer:

- Derived from a steel pipe of the same quality of the one used for pre-insulated pipes, cold-bent with bending radius
  R = 2,5D
- Derived from forged according to EN 10253-2, with bending radius R = 1,5D.

On request, it is anyway possible to manufacture bends with different bending radii.
Available angles for standard bends are 45° and 90°.
On request, bends with different bending angles can be manufactured, in multiples of 15° or with angles required for specific purposes.

Note: if bends with angles different from 90° are used, make sure that the necessary technical verifications have been performed. In case of doubts, do not hesitate to contact our offices for further details.

Insulation

- Rigid polyurethane foam according to the European standard EN 253;
- CCOT >160°C for 30 years;
- Applied blowing agent: cyclopentane;
- Thermal conductivity ≤ 0,027 W/m°C [a 50 °C];
- Compressive strength ≥ 0,3 MPa.

Surveillance system wires

- Preparation for the surveillance system with 2 copper cables (one bare copper, the other tinned copper) of 1,5 mm2, inserted in the insulation in the position at 11,05, about 15 mm from the service pipe;
- The system is in accordance with the European Standard EN 14419-

For alternative systems, contact our offices

Outer casing

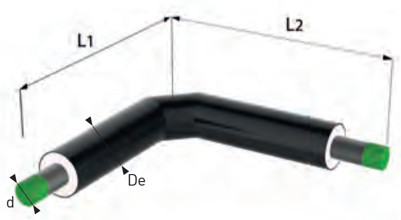
- It consists of a high density polyethylene pipe according to EN253;
- Elongation at break: → 350%;
- MFI variation ≤ 0,5 g/10 m.
- Corona treatment on the internal surface.

Assembled bend

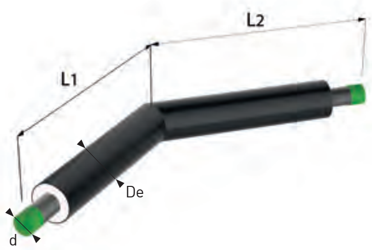
- Pre-insulated bends in accordance with EN448; available angles: 45° and 90°;
- Upon request, can be manufactured bends with different angles, in multiples of 15° or with required angles for specific purposes;
- Ends without insulation for 150÷200 mm. Corona treatment on the internal surface;
- Max. operating temperature = 155 °C.

WARNINGS: bend dimensions can be slightly modified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, contact our TECHNICAL DEPARTEMENT for data confirmation.

90°



45°

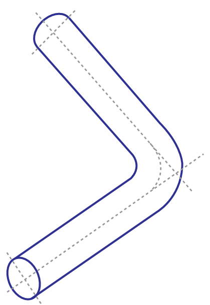


ELBOWS

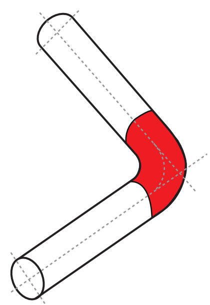
PRE-INSULATED 90° ELBOWS

Steel pipe		SERIES 1 HDPE casing	SERIES 2 HDPE casing	SERIES 3 HDPE casing	STD L1=L2	Longer Length L1=L2	Asymmetric L1 L2	
DN	d [mm]	De [mm]	De [mm]	De [mm]	L1=L2 [mm]	L1=L2 [mm]	L1 [mm]	L2 [mm]
20	26,9	90	110	125	440	1000	440	1500
25	33,7	90	110	125	440	1000	440	1500
32	42,4	110	125	140	495	1000	495	1500
40	48,3	110	125	140	495	1000	495	1500
50	60,3	125	140	160	530	1000	530	1500
65	76,1	140	160	180	550	1000	550	1500
80	88,9	160	180	200	580	1000	580	1500
100	114,3	200	225	250	680	1000	680	1500
125	139,7	225	250	280	690	1000	690	1500
150	168,3	250	280	315	840	1000	840	1500
200	219,1	315	355	400	860	1000	860	1500
250	273,0	400	450	500	1000			
300	323,9	450	500	560	1200			
350	355,6	500	560	630	880			
400	406,4	560	630	710	960			
450	457,0	630	710	800	1020			
500	508,0	710	800	900	1085			
600	610,0	800	900	1000	1210			
700	711,0	900	1000	1100	1500			
800	813,0	1000	1100	1200	2000			

BENT
Steel bends of the same quality of the pipes and cold-bent fordiameters up to DN 300, included.



FORGED
Forged steel bends according to the European Standard EN 10253-2 min. class P235GH, extended at the ends using steel sockets of the same quality of the pipes, for bigger diameters than DN300.

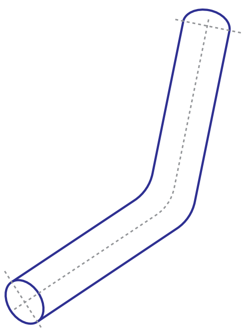


ELBOWS

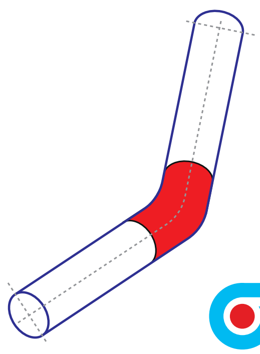
PRE-INSULATED 45° ELBOWS

Steel pipe		SERIES 1 HDPE casing	SERIES 2 HDPE casing	SERIES 3 HDPE casing	STD L1=L2	Longer Length L1=L2	Asymmetric L1 L2	
DN	d [mm]	De [mm]	De [mm]	De [mm]	L1=L2 [mm]	L1=L2 [mm]	L1 [mm]	L2 [mm]
20	26,9	90	110	125	420	1000	420	1500
25	33,7	90	110	125	420	1000	420	1500
32	42,4	110	125	140	465	1000	465	1500
40	48,3	110	125	140	465	1000	465	1500
50	60,3	125	140	160	490	1000	490	1500
65	76,1	140	160	180	510	1000	510	1500
80	88,9	160	180	200	530	1000	530	1500
100	114,3	200	225	250	610	1000	610	1500
125	139,7	225	250	280	610	1000	610	1500
150	168,3	250	280	315	760	1000	760	1500
200	219,1	315	355	400	760	1000	760	1500
250	273,0	400	450	500	875			
300	323,9	450	500	560	1050			
350	355,6	500	560	630	585			
400	406,4	560	630	710	650			
450	457,0	630	710	800	670			
500	508,0	710	800	900	700			
600	610,0	800	900	1000	740			
700	711,0	900	1000	1100	1500			
800	813,0	1000	1100	1200	2000			

BENT
Steel bends of the same quality of the pipes and bent for diameters up to DN 300, included.



FORGED
Forged steel bends according to the European Standard EN 10253-2 min. class P235GH, extended at the ends using steel sockets of the same quality of the pipes, for bigger diameters than DN300.



PREINSULATED BRANCHES

Tee branch
Two different types of tee branches can be supplied, according to the dimension, design type and requirements of the Customer.

- Derived from steel pipe of the same quality of the one used for pre-insulated pipes, with branch directly welded on the main pipe;
- Derived from forged according to the European Standard EN 10253-2, adding steel sockets of the same type used for the pipes.

On request or if necessary after the stress analyses, it is anyway possible to manufacture branches using different materials and thickness.
Note: In case of doubts, do not hesitate to contact our offices for further details.

Insulation

- Rigid polyurethane foam according to the European Standard EN 253;
- CCOT > 160°C for 30 years;
- Applied blowing agent: cyclopentane;
- Thermal conductivity ≤ 0,027 W/m°C [a 50 °C]
- Compressive strength ≥ 0,3 MPa Surveillance system wires;
- Preparation for the surveillance system with 2 copper cables (one bare copper, the other tinned copper) of 1,5 mm2, inserted in the insulation at 11,05 position, about 15 mm from the main pipe.
- The system is in accordance with the European Standard EN 14419

Outer casing

- It consists of a high density polyethylene pipe according to EN253;
- Elongation at break: → 350%;
- MFI variation ←= 0,5 g/10 m.;
- Corona treatment on the internal surface.

Assembled Tee

- Pre-insulated tees in accordance with EN448 with 45° branch perpendicular to the main pipe;
- Ends without insulation for 150÷200 mm.;
- Max. operating temperature = 155 °C.

WARNINGS: tee dimensions can be slightly modified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, contact our TECHNICAL DEPARTEMENT for data confirmation.

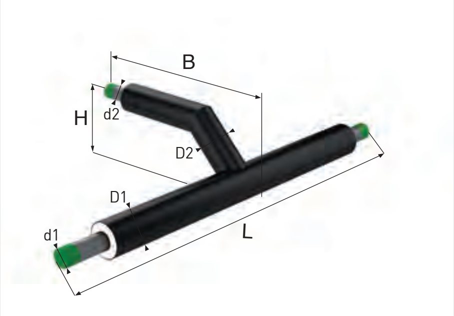
TEE 45°, PARALLEL AND STRAIGHT BRANCHES

SERIES 1-2-3

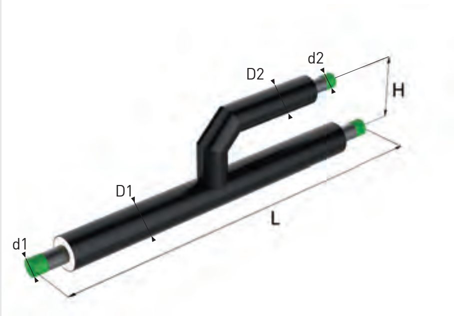
A) A] Steel Tee branch of the same quality of the pipes, welded with direct or reinforced connection for smaller derivations than the main one of more than 2 diameters. For the 45° bends used for the branch, please refer to the information provided for the pre-insulated elbows.

B) Forged steel Tee branches in accordance with the European Standard EN 10253-2, min. class P235GH, extended at the ends using steel sockets of the same quality of the pipes, for derivations of the same diameter of the main pipe or a diameter smaller.
For the 45° bends used for the branches, please refer to the information provided for the pre-insulated elbows.

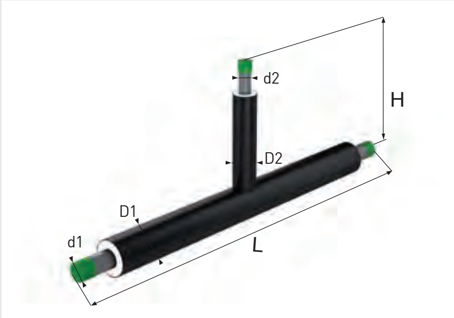
TEE BRANCH 45°



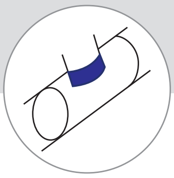
TEE PARALLEL

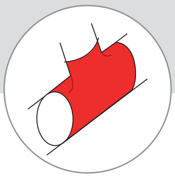


TEE STRAIGHT



TEE BRANCH 45°



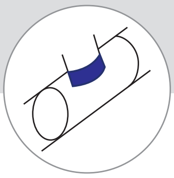


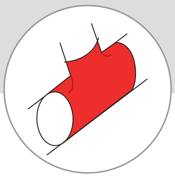
SERIE 1

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	90	90	110	110	125	140	160	200
MAIN PIPE										
d1	D1									
20	90	H	170							
		B	590							
25	90	H	170	170						
		B	590	590						
32	110	H	180	180	190					
		B	600	600	655					
40	110	H	185	185	190	190				
		B	605	605	655	655				
50	125	H	190	190	210	200	210			
		B	610	610	675	665	700			
65	140	H	200	200	215	220	210	220		
		B	620	620	680	685	700	725		
80	160	H	200	200	220	220	230	230	240	
		B	620	620	685	685	720	735	765	
100	200	H	230	230	230	230	240	260	260	280
		B	650	650	695	695	730	765	785	890
125	225	H	240	240	250	240	250	270	310	290
		B	660	660	715	705	740	775	835	900
150	250	H	250	250	260	270	260	280	320	330
		B	670	670	725	735	750	785	845	940
200	315	H	290	290	300	300	310	300	350	350
		B	710	710	765	765	800	805	875	960
250	400	H	350	350	350	350	360	370	380	400
		B	770	770	815	815	850	875	905	1010
300	450	H	370	370	380	380	390	400	400	430
		B	790	790	845	845	880	905	925	1040
350	500	H	400	400	400	400	400	410	420	440
		B	822	822	865	865	890	915	945	1050
400	560	H			430	430	430	440	450	480
		B			895	895	920	945	975	1090
450	630	H			470	470	470	480	490	520
		B			935	935	960	985	1015	1130
500	710	H								
		B								
600	800	H								
		B								

*All dimensions are in mm

TEE BRANCH 45°

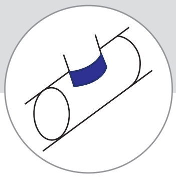
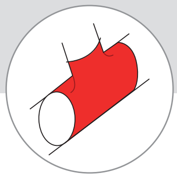




125	150	200	250	300	350	400	450	500	600	L
225	250	315	400	450	500	560	630	710	800	
										900
										1000
310										1100
765										
320	340									
775	795									
360	370	410								1200
815	825	895								
420	430	470	520							1400
875	885	955	1070							
440	460	490	540	570						1500
895	915	975	1090	1145						
450	470	500	550	580	590					
905	925	985	1100	1155	1175					
490	500	540	590	610	640	670				1600
945	955	1025	1140	1185	1225	1315				
530	540	580	630	650	680	720	750			1800
985	995	1065	1180	1225	1265	1365	1420			
		630	680	700	730	770	810	850		1900
		1115	1230	1275	1315	1415	1480	1545		
			730	750	780	820	860	900	950	2000
			1280	1325	1365	1465	1530	1595	1685	

*All dimensions are in mm

TEE BRANCH 45°

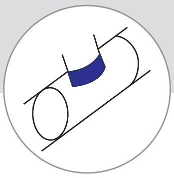



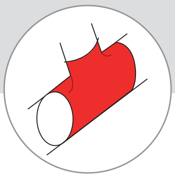
SERIE 2

MAIN PIPE d1	MAIN PIPE D1	BRANCH PIPE d2	20	25	32	40	50	65	80	100
		D2	110	110	125	125	140	160	180	225
20	110	H	170							
		B	590							
25	110	H	170	170						
		B	590	590						
32	125	H	180	180	190					
		B	600	600	655					
40	125	H	185	185	190	190				
		B	605	605	655	655				
50	140	H	190	190	210	200	210			
		B	610	610	675	665	700			
65	160	H	200	200	215	220	210	220		
		B	620	620	680	685	700	725		
80	180	H	200	200	220	220	230	230	240	
		B	620	620	685	685	720	735	765	
100	225	H	230	230	230	230	240	260	260	280
		B	650	650	695	695	730	765	785	890
125	250	H	240	240	250	240	250	270	310	290
		B	660	660	715	705	740	775	835	900
150	280	H	250	250	260	270	260	280	320	330
		B	670	670	725	735	750	785	845	940
200	355	H	290	290	300	300	310	300	350	350
		B	710	710	765	765	800	805	875	960
250	450	H	350	350	350	350	360	370	380	400
		B	770	770	815	815	850	875	905	1010
300	500	H	370	370	380	380	390	400	400	430
		B	790	790	845	845	880	905	925	1040
350	560	H	400	400	400	400	400	410	420	440
		B	822	822	865	865	890	915	945	1050
400	630	H			430	430	430	440	450	480
		B			895	895	920	945	975	1090
450	710	H			470	470	470	480	490	520
		B			935	935	960	985	1015	1130
500	800	H								
		B								
600	900	H								
		B								

*All dimensions are in mm

TEE BRANCH 45°

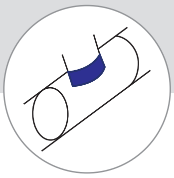


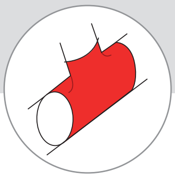


125 250	150 280	200 355	250 450	300 500	350 560	400 630	450 710	500 800	600 900	L
										900
										1000
310										1100
765										
320	340									
775	795									
360	370	410								1200
815	825	895								
420	430	470	520							1400
875	885	955	1070							
440	460	490	540	570						1500
895	915	975	1090	1145						
450	470	500	550	580	590					
905	925	985	1100	1155	1175					
490	500	540	590	610	640	670				1600
945	955	1025	1140	1185	1225	1315				
530	540	580	630	650	680	720	750			1800
985	995	1065	1180	1225	1265	1365	1420			
		630	680	700	730	770	810	850		1900
		1115	1230	1275	1315	1415	1480	1545		
			730	750	780	820	860	900	950	2000
			1280	1325	1365	1465	1530	1595	1685	

*All dimensions are in mm

TEE BRANCH 45°



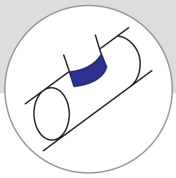
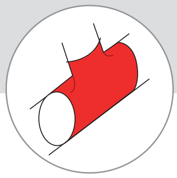


SERIE 3

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	125	125	140	140	160	180	200	250
MAIN PIPE										
d1	D1									
20	125	H	185							
		B	560							
25	125	H	185	185						
		B	560	560						
32	140	H	195	195	200					
		B	570	570	580					
40	140	H	195	195	200	200				
		B	570	570	580	580				
50	160	H	205	205	210	210	220			
		B	580	580	590	590	605			
65	180	H	215	215	220	220	230	240		
		B	590	590	600	600	615	710		
80	200	H	255	255	255	265	275	285	310	
		B	635	635	635	650	745	770	815	
100	250	H	230	230	230	230	240	260	260	280
		B	650	650	695	695	730	765	785	890
125	280	H	265	265	270	270	280	290	300	325
		B	640	640	650	650	665	760	785	830
150	315	H	285	285	290	290	300	310	320	345
		B	660	660	670	670	685	780	805	850
200	400	H	325	325	330	330	340	350	360	385
		B	700	700	710	710	725	820	845	890
250	500	H	375	375	380	380	390	400	410	435
		B	750	750	760	760	775	870	895	940
300	560	H			410	410	420	430	440	465
		B			790	790	805	900	925	970
350	630	H			445	445	455	465	475	500
		B			825	825	840	935	960	1005
400	710	H				425	435	445	515	540
		B				805	820	915	1000	1045
450	800	H				530	540	550	560	585
		B				910	925	1020	1050	1090
500	900	H								
		B								
600	1000	H								
		B								

*All dimensions are in mm

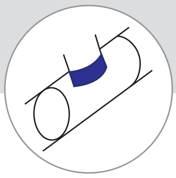
TEE BRANCH 45°

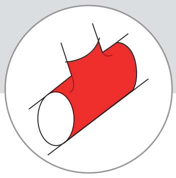



125	150	200	250	300	350	400	450	500	600	L
280	315	400	500	560	630	710	800	900	1000	
										900
										1000
340										1100
800										
360	375									
820	830									
400	420	469								1200
860	875	945								
450	470	510	560							1400
910	925	995	1115							
480	500	540	590	620						1500
940	955	1025	1145	1195						
515	535	575	625	655	690					
975	990	1060	1180	1230	1280					
555	757	615	665	695	730	770				1600
1015	1030	1100	1220	1270	1320	1415				
600	620	660	710	740	775	815	860			1800
1060	1075	1145	1265	1315	1365	1460	1530			
		740	790	810	840	880	920	960		1900
		1240	1350	1395	1440	1525	1590	1655		
			840	860	890	930	970	1010	1060	2000
			1400	1445	1490	1575	1640	1705	1795	

*All dimensions are in mm

TEE 90° PARALLEL



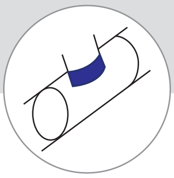


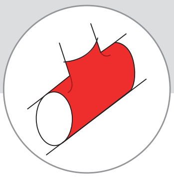
SERIE 1

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	90	90	110	110	125	140	160	200
MAIN PIPE										
d1	D1									
20	90	H								
25	90	H		270						
32	110	H		280	285					
40	110	H		280	285	285				
50	125	H		285	295	295	310			
65	140	H		265	270	270	315	335		
80	160	H		290	290	290	330	350	380	
100	200	H		305	310	310	345	365	395	350
125	225	H		320	325	325	355	375	410	370
150	250	H		340	335	335	370	390	425	390
200	315	H		365	375	375	395	415	450	425
250	400	H		420	425	425	435	445	475	470
300	450	H		445	450	450	560	470	500	500
350	500	H		475	480	480	490	500	520	530
400	560	H								
450	630	H								
500	710	H								
600	800	H								

*All dimensions are in mm

TEE 90° PARALLEL

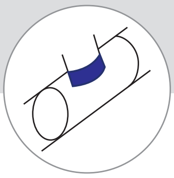


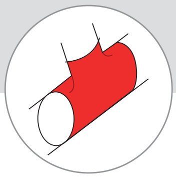


125	150	200	250	300	350	400	450	500	600	L
225	250	315	400	450	500	560	630	710	800	
										900
										1000
385										1100
395	410									
430	445	485								1200
500	520	560	595							1400
515	525	580	620	710						1500
545	560	600	640	730	810					
	600	630	680	710	840	915				1600
	635	670	720	745	860	960	1030			1800
		720	770	790	890	970	1060	1150		1900
			820	840	940	1020	1110	1200	1350	2000

*All dimensions are in mm

TEE 90° PARALLEL



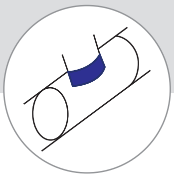


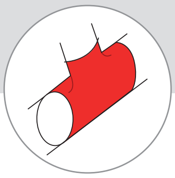
SERIE 2

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	110	110	125	125	140	160	180	225
MAIN PIPE										
d1	D1									
20	110	H								
25	110	H		270						
32	125	H		280	285					
40	125	H		280	285	285				
50	140	H		285	295	295	310			
65	160	H		265	270	270	315	335		
80	180	H		290	290	290	330	350	380	
100	225	H		305	310	310	345	365	395	350
125	250	H		320	325	325	355	375	410	370
150	280	H		340	335	335	370	390	425	390
200	355	H		365	375	375	395	415	450	425
250	450	H		420	425	425	435	445	475	470
300	500	H		445	450	450	560	470	500	500
350	560	H		475	480	480	490	500	520	530
400	630	H								
450	710	H								
500	800	H								
600	900	H								

*All dimensions are in mm

TEE 90° PARALLEL

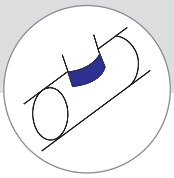


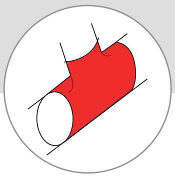


125 / 250	150 / 280	200 / 355	250 / 450	300 / 500	350 / 560	400 / 630	450 / 710	500 / 800	600 / 900	L
										900
										1000
										1100
385										
395	410									
430	445	485								1200
500	520	560	595							1400
515	525	580	620	710						1500
545	560	600	640	730	810					
	600	630	680	710	840	915				1600
	635	670	720	745	860	960	1030			1800
		720	770	790	890	970	1060	1150		1900
			820	840	940	1020	1110	1200	1350	2000

*All dimensions are in mm

TEE 90° PARALLEL



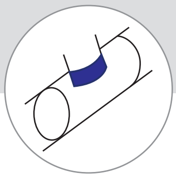
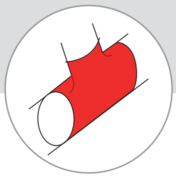


SERIE 3

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	125	125	140	140	160	180	200	250
MAIN PIPE										
d1	D1									
20	125	H								
25	125	H		310						
32	140	H		320	325					
40	140	H		320	325	325				
50	160	H		325	335	335	350			
65	180	H		305	310	310	355	375		
80	200	H		340	330	330	370	390	420	
100	250	H		345	350	350	385	405	435	390
125	280	H		360	365	365	395	415	450	410
150	315	H		380	375	375	410	440	465	430
200	400	H		405	415	415	435	455	490	465
250	500	H		460	465	465	475	485	515	510
300	560	H		485	490	490	600	510	540	540
350	630	H		515	520	520	530	540	560	570
400	710	H								
450	800	H								
500	900	H								
600	1000	H								

*All dimensions are in mm

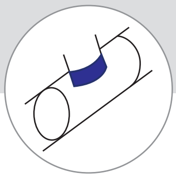
TEE 90° PARALLEL

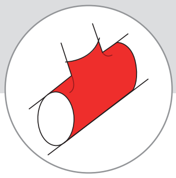



125	150	200	250	300	350	400	450	500	600	L
280	315	400	500	560	630	710	800	900	1000	
										900
										1000
425										1100
435	450									
470	485	525								1200
540	560	600	635							1400
555	565	620	660	750						1500
585	600	640	680	770	850					
	660	700	750	780	840	915				1600
	710	750	800	830	860	960	1050			1800
		800	850	880	890	970	1060	1150		1900
			900	930	940	1020	1110	1200	1350	2000

*All dimensions are in mm

TEE STRAIGHT



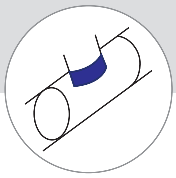


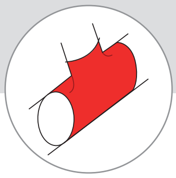
SERIE 1

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	90	90	110	110	125	140	160	200
MAIN PIPE										
d1	D1									
20	90	H	500							
25	90	H	500	500						
32	110	H	500	500	500					
40	110	H	500	500	500	500				
50	125	H	500	500	500	500	500			
65	140	H	500	500	500	500	500	500		
80	160	H	500	500	500	500	500	500	500	
100	200	H	600	600	600	600	600	600	600	600
125	225	H	600	600	600	600	600	600	600	600
150	250	H	600	600	600	600	600	600	600	600
200	315	H	600	600	600	600	600	600	600	600
250	400	H	700	700	700	700	700	700	700	700
300	450	H	800	800	800	800	800	800	800	800
350	500	H	800	800	800	800	800	800	800	800
400	560	H	800	800	800	800	800	800	800	800
450	630	H	900	900	900	900	900	900	900	900
500	710	H	1000	1000	1000	1000	1000	1000	1000	1000
600	800	H	1000	1000	1000	1000	1000	1000	1000	1000

*All dimensions are in mm

TEE STRAIGHT

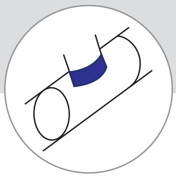


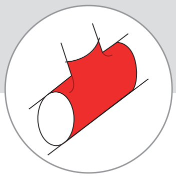


125	150	200	250	300	350	400	450	500	600	L
225	250	315	400	450	500	560	630	710	800	
										900
										1000
600										1100
600	600									
600	600	600								1200
700	700	700	700							1400
800	800	800	800	800						1500
800	800	800	800	800	800					
800	800	800	800	800	800	800				1600
900	900	900	900	900	900	900	900			1800
1000	1000	1000	1000	1000	1000	1000	1000	1000		1900
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	2000

*All dimensions are in mm

TEE STRAIGHT





SERIE 2

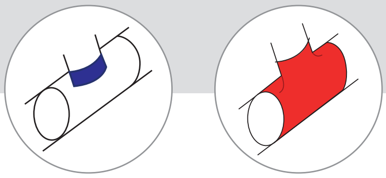
BRANCH PIPE

MAIN PIPE

d1	D1	d2	20	25	32	40	50	65	80	100
		D2	110	110	125	125	140	160	180	225
20	110	H	500							
25	110	H	500	500						
32	125	H	500	500	500					
40	125	H	500	500	500	500				
50	140	H	500	500	500	500	500			
65	160	H	500	500	500	500	500	500		
80	180	H	600	600	600	600	600	600	600	
100	225	H	600	600	600	600	600	600	600	600
125	250	H	600	600	600	600	600	600	600	600
150	280	H	600	600	600	600	600	600	600	600
200	355	H	700	700	700	700	700	700	700	700
250	450	H	800	800	800	800	800	800	800	800
300	500	H	800	800	800	800	800	800	800	800
350	560	H	800	800	800	800	800	800	800	800
400	560	H	900	900	900	900	900	900	900	900
450	630	H	1000	1000	1000	1000	1000	1000	1000	1000
500	710	H	1000	1000	1000	1000	1000	1000	1000	1000
600	800	H	1100	1100	1100	1100	1100	1100	1100	1100

*All dimensions are in mm

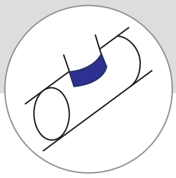
TEE STRAIGHT

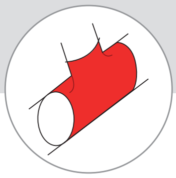


125	150	200	250	300	350	400	450	500	600	L
250	280	355	450	500	560	630	710	800	900	
										900
										1000
										1100
600										
600	600									
700	700	700								1200
800	800	800	800							1400
800	800	800	800	800						1500
800	800	800	800	800	800					
900	900	900	900	900	900	900				1600
1000	1000	1000	1000	1000	1000	1000	1000			1800
1000	1000	1000	1000	1000	1000	1000	1000	1000		1900
1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	2000

*All dimensions are in mm

TEE STRAIGHT



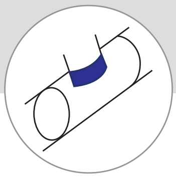


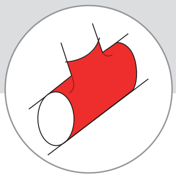
SERIE 3

BRANCH PIPE		d2	20	25	32	40	50	65	80	100
		D2	125	125	140	140	160	180	200	250
MAIN PIPE										
d1	D1									
20	125	H	500							
25	125	H	500	500						
32	140	H	500	500	500					
40	140	H	500	500	500	500				
50	160	H	500	500	500	500	500			
65	180	H	500	500	500	500	500	500		
80	200	H	600	600	600	600	600	600	600	
100	250	H	600	600	600	600	600	600	600	600
125	280	H	600	600	600	600	600	600	600	600
150	315	H	600	600	600	600	600	600	600	600
200	400	H	700	700	700	700	700	700	700	700
250	500	H	800	800	800	800	800	800	800	800
300	560	H	800	800	800	800	800	800	800	800
350	630	H	800	800	800	800	800	800	800	800
400	560	H	900	900	900	900	900	900	900	900
450	630	H	1000	1000	1000	1000	1000	1000	1000	1000
500	710	H	1000	1000	1000	1000	1000	1000	1000	1000
600	800	H	1100	1100	1100	1100	1100	1100	1100	1100

*All dimensions are in mm

TEE STRAIGHT





125	150	200	250	300	350	400	450	500	600	L
280	315	400	500	560	630	710	800	900	1000	
										900
										1000
										1100
600										
600	600									
700	700	700								1200
800	800	800	800							1400
800	800	800	800	800						1500
800	800	800	800	800	800					
900	900	900	900	900	900	900				1600
1000	1000	1000	1000	1000	1000	1000	1000			1800
1000	1000	1000	1000	1000	1000	1000	1000	1000		1900
1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	2000

*All dimensions are in mm

VALVES

Pre-insulated valves can be installed at any point of the buried network and they are applicable to all installation methods.
In this catalogue all the valves are reduced bore valves, with floating ball (other type valves can be supplied).

- **Stem**: coated stainless steel;
- **Steel body**: min. P235GH;
- **Seals**:
  1. for the stem, PTFE reinforced carbon and FPM
  2. for the ball, PTFE reinforced carbon
- **Max. axial loading** = 300 N/mm^2.
- **Operating pressure** = PN25
- **Available from DN 25 to DN300** [for different dimensions, please contact our Sales Department];
- Insulation, surveillance system wires and outer casing as for the previous products.

Assembled Valve

- **Pre-insulated** reduced bore valves in accordance with EN448, with handling stem; Reduction gear with 90° gearbox for DN>150
- **Ends without insulation** for 150÷200 mm;
- **Max. operating temperature** = 155 °C;
- They can have also n. 1 or 2 air vents/drains and equipped with lever valves and closing water stop to be installed on site; as an alternative, vents and drains can be replaced by proper stainless steel valves, already sealed with water stop.

WARNINGS: valve dimensions can be slightly modified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, contact our TECHNICAL DEPARTEMENT for data confirmation.

1.

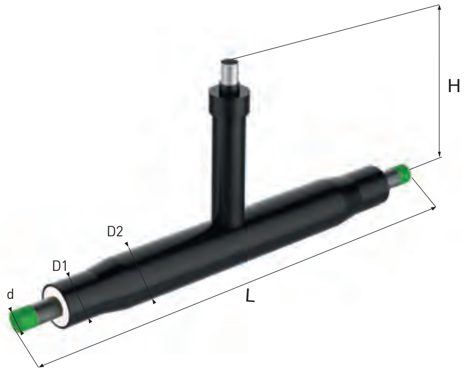
2.

3.

[1] Valves
[2] Valves with 1 vent
[3] Valves with 2 vents

VALVES

		SERIES 1		SERIES 2		SERIES 3				
Steel pipe		HDPE casing	HDPE casing	HDPE casing	HDPE casing	HDPE casing	HDPE casing	Ø bore	H	L
DN	d [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	DN	[mm]	[mm]
25	33,7	90	90	110	110	125	125	20	620	1500
32	42,4	110	110	125	125	140	140	25	630	1500
40	48,3	110	110	125	125	140	140	32	650	1500
50	60,3	125	125	140	140	160	160	40	650	1500
65	76,1	140	160	160	160	180	180	50	650	1500
80	88.9	160	200	180	180	200	200	65	650	1500
100	114,3	200	250	200	200	250	250	80	650	1500
125	139,7	225	250	250	250	280	280	100	650	1500
150	168,3	250	280	280	280	315	315	125	700	1500
200	219,1	315	355	355	355	400	400	150	700	1500
250	273,0	400	500	450	450	500	500	200	700	1500
300	323,9	450	560	500	500	560	560	250	700	1800

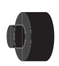


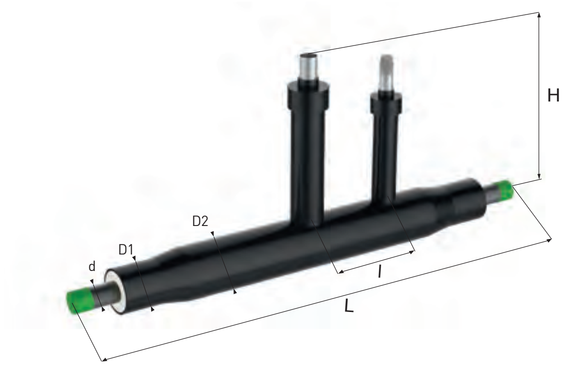
For other kind of valves or more information, please contact our sales department.

VALVES WITH N. 1 VENT

Steel pipe		SERIES 1 HDPE casing	SERIES 1 HDPE casing	SERIES 2 HDPE casing	SERIES 2 HDPE casing	SERIES 3 HDPE casing	SERIES 3 HDPE casing	Ø bore	Ø vent	I	H	L
DN	d [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	DN	DN	[mm]	[mm]	[mm]
40	48,3	110	110	125	125	140	140	32	25	320	650	1500
50	60,3	125	125	140	140	160	160	40	25	320	650	1500
65	76,1	140	160	160	160	180	180	50	25	320	650	1500
80	88,9	160	200	180	180	200	200	65	25	320	650	1500
100	114,3	200	250	200	200	250	250	80	25	320	650	1500
125	139,7	225	250	250	250	280	280	100	25	320	650	1500
150	168,3	250	280	280	280	315	315	125	25	320	700	1500
200	219,1	315	355	355	355	400	400	150	25	320	700	1500
250	273,0	400	500	450	450	500	500	200	25	320	700	1500
300	323,9	450	560	500	500	560	560	250	25	420	700	1800


Vent valve


Water Stop



1.

[1] Valves with 1 vent (or drain)

For other kind of valves or more information, please contact our sales department

VALVES WHIT N. 2 VENTS

		SERIES 1		SERIES 2		SERIES 3						
Steel pipe		HDPE casing	HDPE casing	HDPE casing	HDPE casing	HDPE casing	HDPE casing	Ø bore	Ø vent	I	H	L
DN	d [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	D1 [mm]	D2 [mm]	DN	DN	[mm]	[mm]	[mm]
40	48,3	110	110	125	125	140	140	32	25	320	650	1500
50	60,3	125	125	140	140	160	160	40	25	320	650	1500
65	76,1	140	160	160	160	180	180	50	25	320	650	1500
80	88,9	160	200	180	180	200	200	65	25	320	650	1500
100	114,3	200	250	200	200	250	250	80	25	320	650	1500
125	139,7	225	250	250	250	280	280	100	25	320	650	1500
150	168,3	250	280	280	280	315	315	125	25	320	700	1500
200	219,1	315	355	355	355	400	400	150	25	320	700	1500
250	273,0	400	500	450	450	500	500	200	25	320	700	1500
300	323,9	450	560	500	500	560	560	250	25	420	700	1800


Vent valve


Water Stop

1.

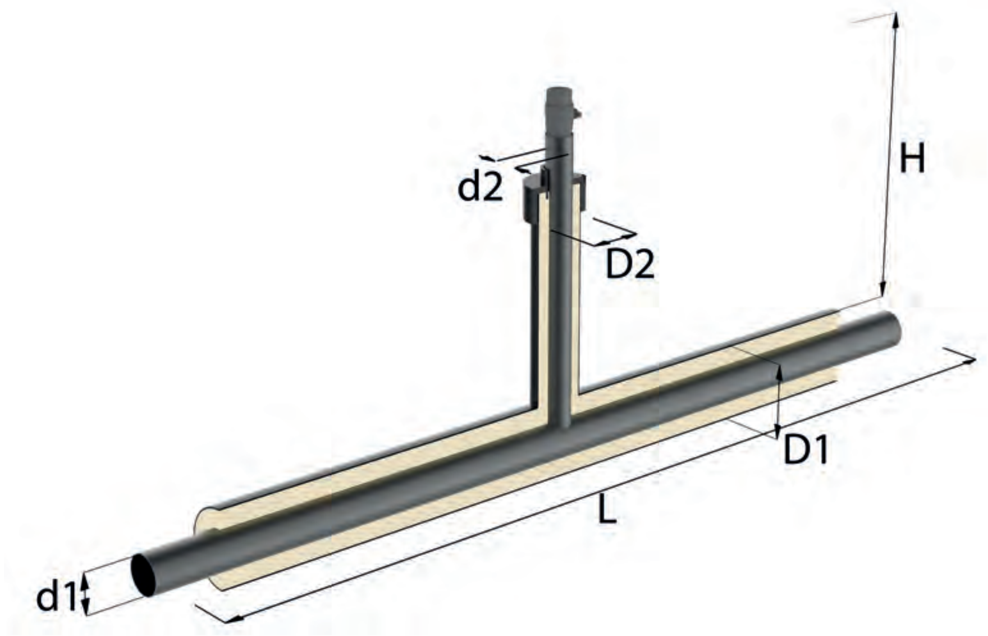
[1] Valves with 2 vents (or drains)

For other kind of valves or more information, please contact our sales department

STRAIGHT TEE FOR VENT/DRAIN

Where requested the presence of vents and/or drains, it is possible to install specific straight tee branches equipped with stainless steel vent valve, properly sealed with water stop. The other used materials are the same of the standard tee branches.
This type of accessory comply with the European Standard EN 448.

- **Max. axial loading** = 300 N/mm^2.
- **Operating pressure** = PN25



STRAIGHT TEE FOR VENT/DRAIN

SERIES 1

VENT PIPE		d2	25	32	40	50	L
		D2	90	110	110	125	
MAIN PIPE							
d1	D1						
32	110	H	500				900
40	110	H	500				
50	125	H	500	500	500		
65	140	H	500	500	500	550	
80	160	H	550	550	550	600	1000
100	200	H	550	550	550	600	1100
125	225	H	550	550	550	600	
150	250	H	550	550	550	600	
200	315	H	600	600	600	650	1200
250	400	H	600	600	600	650	1400
300	450	H	650	650	650	700	1500
350	500	H	650	650	650	700	
400	560	H	700	700	700	750	1600
450	630	H	700	700	700	750	1800
500	710	H	750	750	750	800	1900
600	800	H	750	750	750	800	2000

*H = unit of measure mm

STRAIGHT TEE FOR VENT/DRAIN

SERIES 2

MAIN PIPE d1	MAIN PIPE D1	VENT PIPE d2 / D2	25 / 110	32 / 125	40 / 125	50 / 140	L
32	125	H	500				900
40	125	H	500	500	500		
50	140	H	500	500	500	550	
65	160	H	500	500	500	550	
80	180	H	550	550	550	600	1000
100	225	H	550	550	550	600	1100
125	250	H	550	550	550	600	
150	280	H	550	550	550	600	
200	355	H	600	600	600	650	1200
250	450	H	600	600	600	650	1400
300	500	H	650	650	650	700	1500
350	560	H	650	650	650	700	
400	560	H	700	700	700	750	1600
450	630	H	700	700	700	750	1800
500	710	H	750	750	750	800	1900
600	800	H	750	750	750	800	2000

*H = unit of measure mm

STRAIGHT TEE FOR VENT/DRAIN

SERIES 3

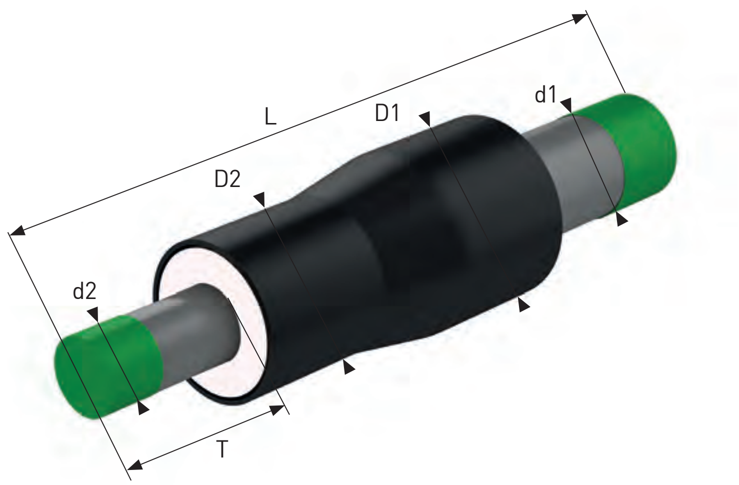
MAIN PIPE d1	MAIN PIPE D1	VENT PIPE d2	25	32	40	50	L
		D2	125	140	140	160	
25	125	H	500	500	500		
32	140	H	500	500	500		
40	140	H	500	500	500		900
50	160	H	500	500	500	550	
65	180	H	500	500	500	550	
80	200	H	550	550	550	600	1000
100	250	H	550	550	550	600	
125	280	H	550	550	550	600	1100
150	315	H	550	550	550	600	
200	400	H	600	600	600	650	1200
250	500	H	600	600	600	650	1400
300	560	H	650	650	650	700	1500
350	630	H	650	650	650	700	
400	560	H	700	700	700	750	1600
450	630	H	700	700	700	750	1800
500	710	H	750	750	750	800	1900
600	800	H	750	750	750	800	2000

*H = unit of measure mm

PREINSULATED REDUCTIONS

ECOLINE proposes to its customers the supply of preinsulated reductions manufactured following the same criteria of the other preinsulated accessories [pipes, bends, tee, etc.] included the surveillance system. Reductions are generally supplied with a difference of maximum 2 diameters. The difference of a diameter guarantees an axial strength maximum value of 300 N/mm², while the limit for a two diameters difference is 150 N/mm². It is anyway possible, on request, to realize larger differences, provided that the design requirements are satisfied.

WARNINGS: reduction dimensions can be slightly modified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, contact our TECHNICAL DEPARTEMENT for data confirmation.



PREINSULATED REDUCTIONS

SERIES 1

Steel		HDPE	x	Steel		HDPE	L [mm]
DN_1	D_1 [mm]	D_1 [mm]	x	DN_2	D_2 [mm]	D_2 [mm]	
25	33,7	90	x	20	26,9	90	1000
32	42,4	110	x	25	33,7	90	1000
32	42,4	110	x	20	26,9	90	1000
40	48,3	110	x	32	42,4	110	1000
40	48,3	110	x	25	33,7	90	1000
50	60,3	125	x	40	48,3	110	1000
50	60,3	125	x	32	42,4	110	1000
65	76,1	140	x	50	60,3	125	1000
65	76,1	140	x	40	48,3	110	1000
80	88,9	160	x	65	76,1	140	1000
80	88,9	160	x	50	60,3	125	1000
100	114,3	200	x	80	88,9	160	1000
100	114,3	200	x	65	76,1	140	1000
125	139,7	225	x	100	114,3	200	1000
125	139,7	225	x	80	88,9	160	1000
150	168,3	250	x	125	139,7	225	1000
150	168,3	250	x	100	114,3	200	1000
200	219,1	315	x	150	168,3	250	1000
200	219,1	315	x	125	139,7	225	1000
250	273,0	400	x	200	219,1	315	1200
250	273,0	400	x	150	168,3	250	1200
300	323,9	450	x	250	273,0	400	1200
300	323,9	450	x	200	219,1	315	1200
350	355,6	500	x	300	323,9	450	1400
350	355,6	500	x	250	273,0	400	1400
400	406,4	560	x	350	355,6	500	1400
400	406,4	560	x	300	323,9	450	1400
450	457,0	630	x	400	406,4	560	1400
450	457,0	630	x	350	355,6	500	1400
500	508,0	710	x	450	457,0	630	1600
500	508,0	710	x	400	406,4	560	1600
600	609,6	800	x	500	508,0	710	1600
600	609,6	800	x	450	457,0	630	1600

PREINSULATED REDUCTIONS

SERIES 2

Steel		HDPE	x	Steel		HDPE	L [mm]
DN_1	D_1 [mm]	D_1 [mm]	x	DN_2	D_2 [mm]	D_2 [mm]	
25	33,7	110	x	20	26,9	110	1000
32	42,4	125	x	25	33,7	110	1000
32	42,4	125	x	20	26,9	110	1000
40	48,3	125	x	32	42,4	125	1000
40	48,3	125	x	25	33,7	110	1000
50	60,3	140	x	40	48,3	125	1000
50	60,3	140	x	32	42,4	125	1000
65	76,1	160	x	50	60,3	140	1000
65	76,1	160	x	40	48,3	125	1000
80	88,9	180	x	65	76,1	160	1000
80	88,9	180	x	50	60,3	140	1000
100	114,3	225	x	80	88,9	180	1000
100	114,3	225	x	65	76,1	160	1000
125	139,7	250	x	100	114,3	225	1000
125	139,7	250	x	80	88,9	180	1000
150	168,3	280	x	125	139,7	250	1000
150	168,3	280	x	100	114,3	225	1000
200	219,1	355	x	150	168,3	280	1000
200	219,1	355	x	125	139,7	250	1000
250	273,0	450	x	200	219,1	355	1200
250	273,0	450	x	150	168,3	280	1200
300	323,9	500	x	250	273,0	450	1200
300	323,9	500	x	200	219,1	355	1200
350	355,6	560	x	300	323,9	500	1400
350	355,6	560	x	250	273,0	450	1400
400	406,4	630	x	350	355,6	560	1400
400	406,4	630	x	300	323,9	500	1400
450	457,0	710	x	400	406,4	630	1400
450	457,0	710	x	350	355,6	560	1400
500	508,0	800	x	450	457,0	710	1600
500	508,0	800	x	400	406,4	630	1600
600	609,6	900	x	500	508,0	800	1600
600	609,6	900	x	450	457,0	710	1600

PREINSULATED REDUCTIONS

SERIES 3

Steel		HDPE	x	Steel		HDPE	L [mm]
DN_1	D_1 [mm]	D_1 [mm]	x	DN_2	D_2 [mm]	D_2 [mm]	
25	33,7	125	x	20	26,9	125	1000
32	42,4	140	x	25	33,7	125	1000
32	42,4	140	x	20	26,9	125	1000
40	48,3	140	x	32	42,4	140	1000
40	48,3	140	x	25	33,7	125	1000
50	60,3	160	x	40	48,3	140	1000
50	60,3	160	x	32	42,4	140	1000
65	76,1	180	x	50	60,3	160	1000
65	76,1	180	x	40	48,3	140	1000
80	88,9	200	x	65	76,1	180	1000
80	88,9	200	x	50	60,3	160	1000
100	114,3	250	x	80	88,9	200	1000
100	114,3	250	x	65	76,1	180	1000
125	139,7	280	x	100	114,3	250	1000
125	139,7	280	x	80	88,9	200	1000
150	168,3	315	x	125	139,7	280	1000
150	168,3	315	x	100	114,3	250	1000
200	219,1	400	x	150	168,3	315	1000
200	219,1	400	x	125	139,7	280	1000
250	273,0	500	x	200	219,1	400	1200
250	273,0	500	x	150	168,3	315	1200
300	323,9	560	x	250	273,0	500	1200
300	323,9	560	x	200	219,1	400	1200
350	355,6	630	x	300	323,9	560	1400
350	355,6	630	x	250	273,0	500	1400
400	406,4	710	x	350	355,6	630	1400
400	406,4	710	x	300	323,9	560	1400
450	457,0	800	x	400	406,4	710	1400
450	457,0	800	x	350	355,6	630	1400
500	508,0	900	x	450	457,0	800	1600
500	508,0	900	x	400	406,4	710	1600
600	609,6	1000	x	500	508,0	900	1600
600	609,6	1000	x	450	457,0	800	1600

FITTINGS JOINT ON-SITE INSULATION

ECOLINE can also supply, on Customer's request, the necessary materials for fittings realization on site. The supply composition for each kit joint realization is, in general terms, reported below. For further details, **ECOLINE** Technical Department is at its Customers disposal to evaluate the best ways to carry out the works.
In special cases, such as for the limited size of the deviation to realize, it could be necessary to realize a bend on site. The realization kit, available for elbows with diameters included between DN 25 and DN 200, provides the supply of:

Elbow
- Steel bend, with the same features of the pre-insulated elbows;
- Spacers;
- HDPE heat shrink flex-sealed joint;
- Foam pack for insulation restoration;
- Plugs to weld;

If a derivation would be realized on site [for example on an already laid network, in service or not], it is possible to use the following products supplied by **ECOLINE**:

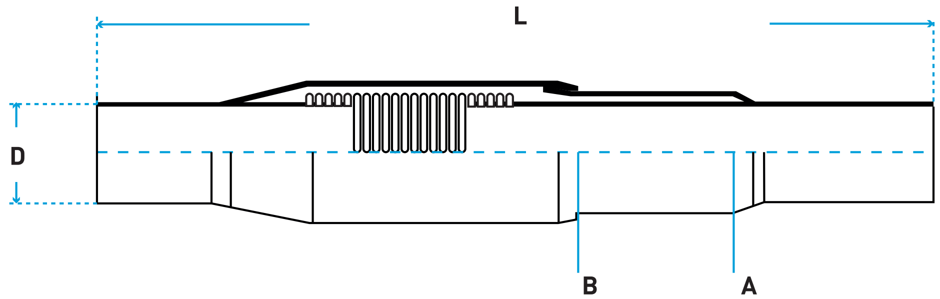
Kit T-Joint
- Kit consisting in steel plate reinforcement (if request to design calculation) and steel bend, with the same feature of the main pipe;
- Spacers;
- T-Joint HDPE and heat shrink -sealed joint for the derivation bend;
- Foam pack for insulation restoration

When, usually for space reasons, it is not possible to install a preinsulated reduction, it is possible to realize a diameter reduction on site [up to DN 150], using the following **ECOLINE** supplying products:

Kit joint reductions
- Steel reduction, according to the European Standard EN 10253-2;
- Spacers;
- Heat shrink dual-seal or crosslinked reduced joint;
- Foam pack for insulation restoration.

ONE TIME COMPENSATORS

One time compensators
The one time compensator is an axial compensator working only once and it is used as a simplified installation technique. At an intermediate temperature between the laying and the operating one, the compensator absorbs part of the total operating expansion. After that, the compensator is permanently blocked and only the rest of the expansion will be transformed in stress on the service pipe. The one time compensator is designed for functioning at max. operating pressure of 16 bar [pressure test at 24 bar]. For higher pressures, it is possible to produce on request.
The compensator ends to be welded are in steel P235GH, while the "bellows" or the expansion absorbing spring is in stainless steel AISI 321. L is the compensator length, when supplied. The value [A-B] is the maximum expansion length. Upon request, it is possible to supply a precharged at the desired value compensator.



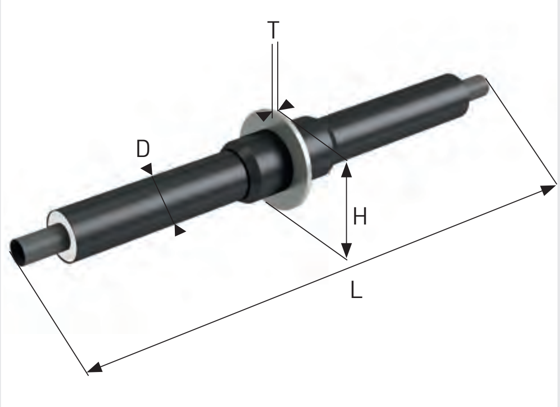
ONE TIME COMPENSATOR		
D	L	Stroke (A-B)
(DN)	[mm]	[mm]
40	450	50
50	450	50
65	500	70
80	500	70
100	550	80
125	550	80
150	630	100
200	700	120

ONE TIME COMPENSATOR		
D	L	Stroke (A-B)
(DN)	[mm]	[mm]
250	700	120
300	730	140
350	730	140
400	730	140
450	800	150
500	800	150
600	800	150

ANCHORS

Fixed point or anchors
Preinsulated anchors are used to fix the pipeline and to avoid undesirable expansion, absorbing the relative mechanical stresses.

Application data
Max. operating pressure: **25 bar**
Max. tolerable stress on the anchor plate:
150 N/mm²
If required, anchors are supplied with wires for the connection to the surveillance system, of the same type of the preinsulated pipes.



SERIES 1

ANCHORS				
DN	D [mm]	L [mm]	Ø Flange [mm]	T [mm]
20	90	2000	215	15
25	90	2000	215	15
32	110	2000	215	15
40	110	2000	215	15
50	125	2000	215	15
65	140	2000	245	15
80	160	2000	260	15
100	200	2000	300	15
125	225	2000	350	25
150	250	2000	380	25
200	315	2000	415	25
250	400	2400	500	30
300	450	2400	550	35
350	500	2400	600	35
400	560	2400	660	35
450	630	2400	730	45
500	710	2400	810	45
600	800	2400	900	50

ANCHORS

Main features

Service pipe:
- Welded steel pipe according to the European Standard 10217-1, 2, 3 or 5
- Steel class = P235GH, P355NH
- Steel plate [S 235 JR]

Preinsulation: according to EN 448

Finished piece:
- Plate protection with specific sleeve heat-shrinkable casing;
- Cut back insulation for 150÷200 mm.

WARNINGS: anchor dimensions can be slightly modified by the production standard improvement. Tolerances are in accordance with the reference standards.

If necessary, please contact our TECHNICAL DEPARTEMENT for data confirmation.

SERIES 2

ANCHORS				
DN	D [mm]	L [mm]	Ø Flange [mm]	T [mm]
20	110	2000	215	15
25	110	2000	215	15
32	125	2000	215	15
40	125	2000	215	15
50	140	2000	245	15
65	160	2000	260	15
80	180	2000	280	15
100	225	2000	350	25
125	250	2000	350	25
150	280	2000	380	25
200	355	2000	500	30
250	450	2400	550	35
300	500	2400	600	35
350	560	2400	660	35
400	630	2400	730	45
450	710	2400	810	45
500	800	2400	900	50

ANCHORS

SERIES 3

ANCHORS				
DN	D [mm]	L [mm]	Ø Flange [mm]	T [mm]
20	125	2000	215	15
25	125	2000	215	15
32	140	2000	245	15
40	140	2000	245	15
50	160	2000	260	15
65	180	2000	280	15
80	200	2000	300	15
100	250	2000	350	25
125	280	2000	380	25
150	315	2000	415	25
200	400	2000	500	30
250	500	2400	600	35
300	560	2400	660	35
350	630	2400	730	45
400	710	2400	810	45
450	800	2400	900	50
500	900	2400	1000	50

JOINTS

KIT JOINTS

ECOLINE can deliver four different joint systems, all according to the European Standard EN489 (certified with 100/1000 cycle tests):

1) Double sealing joint

- Available for Øe HDPE = 90÷900 mm;
- Pre-installation of a heat-shrinkable overcasing with heat-shrinkable sleeves;
- Sealing checking and following foaming "on-site".

2) Crosslinked joint without mould

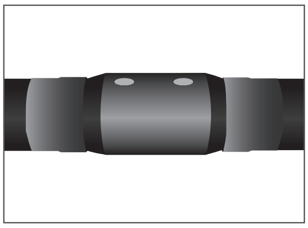
- Available for Øe HDPE = 90÷710 mm.;
- Pre-installation of a cross-linked heat-shrinkable overcasing;
- Sealing checking and following foaming "on-site".

3) Crosslinked with mould

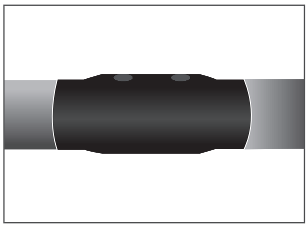
- Available for Øe HDPE = 90÷250 mm., with one-way mould;
- Available for Øe HDPE = 280÷710 mm., with deposit mould;
- Preparation of a cross-linked heat-shrinkable overcasing and foaming "on-site" in mould. Foaming check and final sealing heat shrinking the muff.

4) Electric welded joint

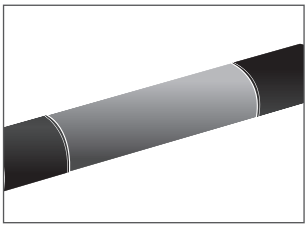
- Available for Øe HDPE = 90÷900 mm.;
- Pre-installation of a electric weld overcasing;
- Sealing checking and following foaming "onsite".



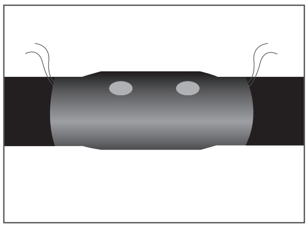
1.



2.



3.



4.

JOINTS

FEATURES AND ADVANTAGES OF THE AVAILABLE JOINTS

There is a large number of factors which influence the choice of the type of system to adopt:

a) Soil conditions
b) Experience/Tradition of the Customer/Designer
c) Cost/benefit analysis
d) Repeatability of the seal
e) Contractor experience

ECOLINE can suggest to the right choice, having enough experience to underline you, in details, the advantages of a system or another one.

Specific features/advantages

1) Dual seal

a) cost-effectiveness;
b) consolidated system.

2) Crosslinked without mould

a) seal guarantee in severe conditions [groundwater presence. etc.];
b) simple installation.

3) Crosslinked with mould

a) possibility to verify the foaming before the sealing;
b) no bulges on the joint area;
c) no holes, then no welding plugs.

4) Electric welded

a) seal guarantee when water is always present;
b) seal guaranteed by electric welding and not by heat-shrinking.

JOINTS

INSTALLATION REQUIREMENTS

The requirements for installers and tools dependent on the chosen joint system type:

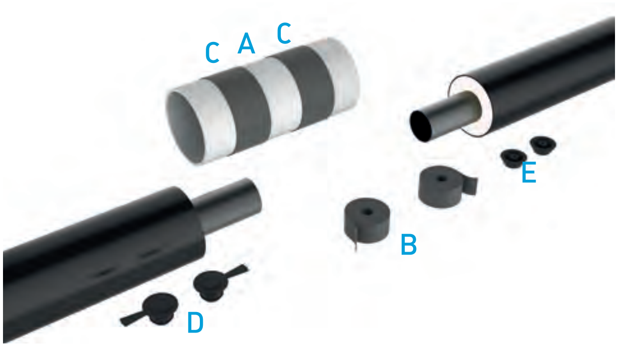
	REQUIREMENTS FOR THE INSTALLER	TOOLS
Double seal joint:	Can be installed correctly, after simple and short instruction, but good shrinkage requires experience	Simple hand tools (crimp pliers, stripper, chisel, hammer, etc.) + gas burner + plug welder
Shrink joints:	Can be installed correctly, after simple and short instruction, but good shrinkagerequires experience	Simple hand tools (crimp pliers, stripper, chisel, hammer, etc.) + gas burner + plug welder
Weld joints:	Must only be installed by certified installers	Weld machine

Note for all the types: Store materials and substances contained in the kit in dry and well ventilated places, in the original boxes, out of direct sunshine, rain, snow, dust or other adverse environmental conditions.

In particular, for the polyurethane components, storage temperatures must be kept between 10°C and 25°C.

It is recommended to contact ECOLINE offices in order to plan appropriate training courses for the installers.

Technical specifications for each available type
DUAL SEAL: 1 kit contains:



A) n. 1 heat-shrinkable mechanically expanded polyethylene overcasing;
B) Sealing mastic (could be included);
C) n. 2 heat-shrinkable rings (sleeves);
D) n. 2 venting plugs;
E) n. 2 welding plugs*;

- Polyurethane pre-dosed components for "on-site" insulation;
- Electric set [wires, spacers, connectors, etc.] for the connection to the surveillance system, if required.

* Alternatively, it is possible to supply n. 2 heat close patches [FOPS]

JOINTS

Equipment to provide on site:

- Plug welder;
- Gas tank;
- Propane gas torch with diameter Ø 30÷50 mm.;
- Pressure regulator;
- Power drill;
- Hole cutter Ø 24 mm;
- Sandpaper, grain 60÷80 in rolls of a width of 50 mm;
- Different hand tools (hammer, screwdriver, chisel, etc.);
- Alcohol and rags.

HDPE De [mm]	STD kit overcasing length [mm]	One time compensator kit overcasing length [mm]
90	500	1500
110	500	1500
125	500	1500
140	500	1500
160	500	1500
180	500	1500
200	500	1500
225	500	1500
250	500	1500
280	500	1500
315	500	1500
355	500	1500
400	600	1500
450	600	1500
500	600	1500
560	600	1500
630	600	1500
710	600	1500
800	600	1500
900	600	1500
1000	600	1500

WARNINGS: dimensions can be slightly mod- ified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, please contact our TECHNICAL DEPARTEMENT for data confirmation.

JOINTS

CROSSLINKED WITHOUT MOULD
kit contains

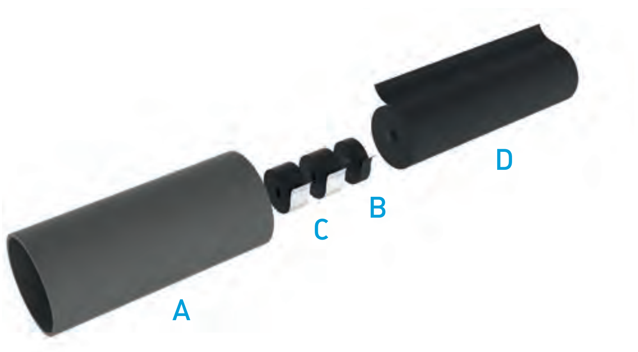
A) n. 1 heat-shrinkable crosslinked polyethylene overcasing Cleaning set [towels with solvent
B) n. 2 venting plugs;
C) n. 2 welding plugs;
- Polyurethane pre-dosed components for "on-site" insulation;
- Electric set [wires, spacers, connectors, etc.]
- for the connection to the surveillance system, if required.

Equipment to provide on site:
- Plug welder;
- Gas tank;
- Propane gas torch with diameter Ø 30÷50 mm.;
- Pressure regulator;
- Power drill;
- Conical cutter Ø 27 mm;
- Sandpaper, grain 60÷80 in rolls of a width of 50 mm;
- Different hand tools (hammer, screwdriver, chisel, etc.);
- Equipment for pressure test.

HDPE De [mm]	90	110	125	140	160	180	200	225	250	280	315	355	400	450	500	560	630	710
STD kit overcasing length [mm]	600	600	600	600	600	600	600	600	600	600	600	600	700	700	700	700	700	700

JOINTS

CROSSLINKED WITH MOULD
kit contains



A) n. 1 heat-shrinkable crosslinked polyethylene overcasing;
B) Tension tape;
C) n. 2 adhesive strips;
D) n. 1 heat shrink film;
- Polyurethane pre-dosed components for "on site" insulation;
- Electric set [wires, spacers, connectors, etc.] for the connection to the surveillance system, if required;
- "Disposable" or "deposit" mould, depending on the size.

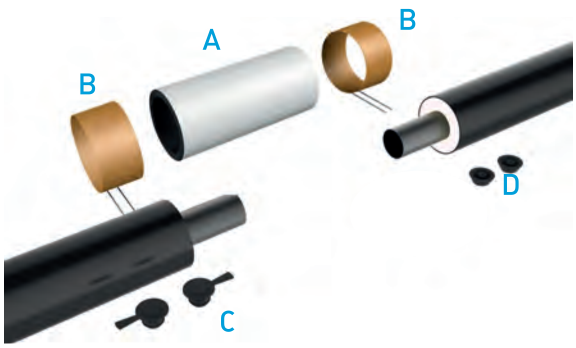
Equipment to provide on site:
- Thermometer
- Gas tank
- Propane gas torch with diameter Ø 30÷50 mm.
- Pressure regulator
- Roll
- Cleaning solvent
- Sandpaper, grain 60÷80 in rolls of a widht of 50 mm
- Different hand tools (hammer, screwdriver, chisel, etc.)
- Triangular scraper

JOINTS

HDPE De [mm]	STD kit overcasing length [mm]	Mould
90	750	disposable
110	750	disposable
125	750	disposable
140	750	disposable
160	750	disposable
180	750	disposable
200	750	disposable
225	750	disposable
250	750	disposable
280	750	deposit
315	750	deposit
355	750	deposit
400	750	deposit
450	750	deposit
500	750	deposit
560	750	deposit
630	750	deposit
710	750	deposit

JOINTS

ELECTRIC WELDED: kit contains



- A) n. 1 polyethylene shrinkable overcasing;
- B) n. 2 electric resistances;
- C) n. 2 venting plugs;
- D) n. 2 welding plugs;
- Polyurethane pre-dosed components for "on-site" insulation;
- Electric kit [wires, spacers, connectors, etc.] for the connection to the surveillance system, if required.

Equipment to provide on site:

- Plug welder
- Welding machine and appropriate equipment for the muff electric welding
- Gas tank
- Propane gas torch with diameter Ø 30÷50 mm.
- Pressure regulator
- Power drill
- Hole cutter Ø 24 mm
- Sandpaper, grain 60÷80 in rolls of a width of 50 mm
- Different hand tools (hammer, screwdriver, chisel, etc.)
- Alcohol and rags

HDPE De [mm]	90	110	125	140	160	180	200	225	250	280
STD kit overcasing length [mm]	600	600	600	600	600	600	600	600	600	600

HDPE De [mm]	315	355	400	450	500	560	630	710	800	900	1000
STD kit overcasing length [mm]	700	700	700	700	700	700	700	700	700	700	700

WARNINGS: dimensions can be slightly mod- ified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, please contact our TECHNICAL DEPARTEMENT for data confirmation.

END JOINT

At the end of a line or a connection, special terminations can be installed depending on the intervention limit features.

1) End fitting

- Available for HDPE external diameter Ø = 90÷900 mm.;
- IIt is used to protect preinsulated pipes ends which should remain buried for possible future extensions;
- Installation of a end heat-shrinkable overcasing;
- Sealing check and further foaming in place.

2) End sealing (water stop)

- Available for HDPE external diameter Ø = 90÷900 mm.;
- It is used in order to prevent moisture from penetrating into polyurethane insulation and it is generally applied at the end of the preinsulated line, in the substations and/or thermal power plant.
- The end-cap is heat-shrunk on the service pipe [cut-back] as well as the HDPE outer casing.
- It is placed into the pipelines before welding.
- If welding has already been performed, or for bigger or different from standard diameters, specific different products are available, on request.

3) Wall entry sleeve

- Available for HDPE external diameter Ø = 90÷900 mm, it is made of extremely resistant rubber and it is used to seal the external pipes surface, inside the wall thickness of the entry walls. It allows small pipe expansions with no damaging of the contact surfaces.

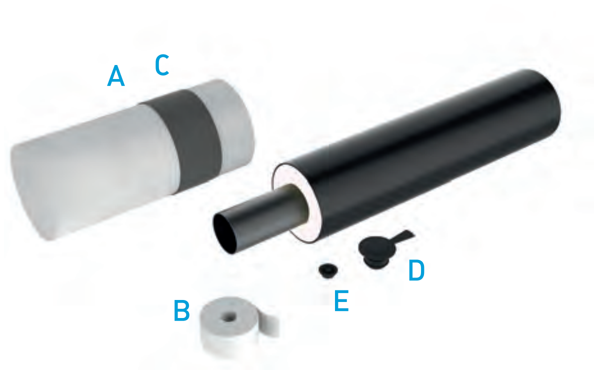
1.

2.

3.

END JOINT

General description with available elements and their use END FITTING
The kit contains



A) n. 1 heat-shrinkable polyethylene mechanically enlarged cap;
B) Sealing mastic;
C) n. 1 heat-shrinkable ring;
D) n. 1 venting plugs;
E) n. 1 welding plugs*;
- Steel cap;
- Polyurethane pre-dosed components for "on site" insulation;
- Electric set [wires, spacers, connectors, etc.] for the connection to the surveillance system, if required.

Equipment to provide on site:
- Plug welder;
- Gas tank;
- Propane gas torch outlet diameter Ø 30÷50 mm.;
- Pressure regulator;
- Power drill;
- Hole cutter Ø 24 mm;
- Sandpaper, grain 60÷80 in rolls of a width of 50 mm;
- Different hand tools (hammer, screwdriver, chisel, etc.);
- Alcohol and rags.

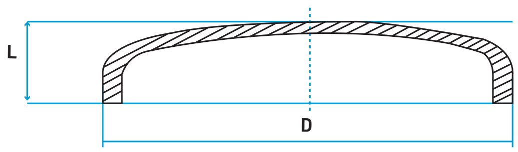
END JOINT

HDPE De mm	90	110	125	140	160	180	200	225	250	280
STD kit overcasing length mm	500	500	500	500	500	500	500	500	500	500

HDPE De mm	315	355	400	450	500	560	630	710	800	900	1000
STD kit overcasing length mm	600	600	600	700	700	700	700	700	700	700	700

STEEL CAP DIMENSIONS

D (DN)	L [mm]	D (DN)	L [mm]	D (DN)	L [mm]
20	25	80	51	300	152
25	25	100	64	350	165
32	38	125	76	400	178
40	38	150	89	450	203
50	38	200	102	500	229
65	38	250	127	600	267



FOAM PACK

FOAM PACK (BOTTLES)
ECOLINE foam pack includes the suppling of two plastic bottles containing chemical components to mix up in order to get polyurethane foam.
The containers, if stored in accordance with the supplied rules, have three month validity from the manufacturing date.

Foam packs materials comply with the European Standard EN253.
Component products [A = polyol + **cyclopentane**, B=isocyanate] are pre-dosed according to each pipe diameter, inside special plastic containers supplied in polystyrene box in order to have protection against changes in ambient temperature.

WARNING!
The bottles containing the components for polyurethane foam must be stored at temperatures between 15 °C and 35 °C, and have three month validity from the manufacturing date indicated on the package.

Once the components have been mixed, a small part of the mixture must be poured in the second bottle, so that the reacted product is present in both the bottles. This operation prevents from having bottles containing toxic products, which are difficult to eliminate.

FOAM PACK

SERIES 1

Polyurethane pre-dosed foam pack			
Service pipe DN	HDPE D_e [mm]	Polyol [kg]	Isocyanate [kg]
20	90	0,10	0,14
25	90	0,10	0,14
32	110	0,14	0,19
40	110	0,14	0,19
50	125	0,17	0,23
65	140	0,19	0,26
80	160	0,24	0,33
100	200	0,37	0,5
125	225	0,42	0,57
150	250	0,47	0,64
200	315	0,68	0,92
250	400	1,42	1,92
300	450	1,73	2,34
350	500	2,19	2,96
400	560	2,6	3,52
450	630	2,57	3,47
500	710	4,17	5,63
600	800	4,56	6,16

WARNINGS: quantity can be slightly mod- ified by the production standard improvement. Tolerances are in accordance with the reference standards.If necessary, please contact our TECHNICAL DEPARTEMENT for data confirmation.

FOAM PACK

SERIES 2

Polyurethane pre-dosed foam pack			
Service pipe DN	HDPE D_e [mm]	Polyol [kg]	Isocyanate [kg]
20	110	0,12	0,17
25	110	0,12	0,17
32	125	0,17	0,23
40	125	0,17	0,23
50	140	0,20	0,28
65	160	0,23	0,31
80	180	0,29	0,40
100	225	0,44	0,60
125	250	0,50	0,69
150	280	0,56	0,77
200	355	0,82	1,10
250	450	1,70	2,30
300	500	2,08	2,80
350	560	2,63	3,55
400	630	3,12	4,22
450	710	3,08	4,16
500	800	5,00	6,75
600	900	5,47	7,40

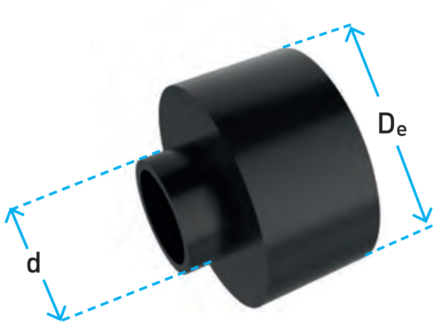
FOAM PACK

SERIES 3

Polyurethane pre-dosed foam pack			
Service pipe DN	HDPE D_e [mm]	Polyol [kg]	Isocyanate [kg]
20	125	0,14	0,20
25	125	0,14	0,20
32	140	0,20	0,27
40	140	0,20	0,33
50	160	0,24	0,33
65	180	0,27	0,37
80	225	0,34	0,48
100	250	0,53	0,72
125	280	0,60	0,82
150	315	0,68	0,92
200	400	0,98	1,32
250	500	2,04	2,76
300	560	2,49	3,37
350	630	3,15	4,26
400	710	3,74	5,06
450	800	3,70	5.00
500	900	6,00	8,10
600	1000	6,56	8,90

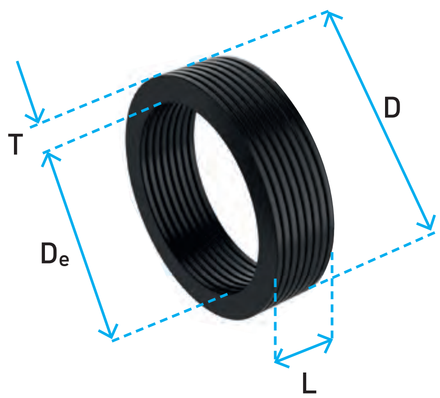
ACCESSORIES

End sealing (water stop)



SERVICE PIPE DN	d [mm]	HDPE D_e [mm]
20-25	26,9 -33,7	90
25-32	33,7 - 42,4	110-125
32	42,4	140
40	48,3	110-140
50-65	60,3-76,1	125-140
50-80	60,3-88,9	160-180
80-100	88,9 - 114,3	200
100-125	114,3 - 139,7	225
125 - 150	139,7 - 168,3	250
150	168,3	280
200	219,1	315
200 - 250	219,1 - 273	355 - 400
300	323,9	450

WALL ENTRY SLEEVE
Sleeves have a thickness of T= about 18,5 mm. and a length L= about 50 mm.



PEAD D_e [mm]	Wall Entry Sleeve D [mm]
90	127
110	147
125	162
140	177
160	197
180	217
200	237
225	262
250	287
280	317
315	352
355	392
400	437
450	487
500	537
560	597
630	667
710	747
800	837
900	937
1000	1037

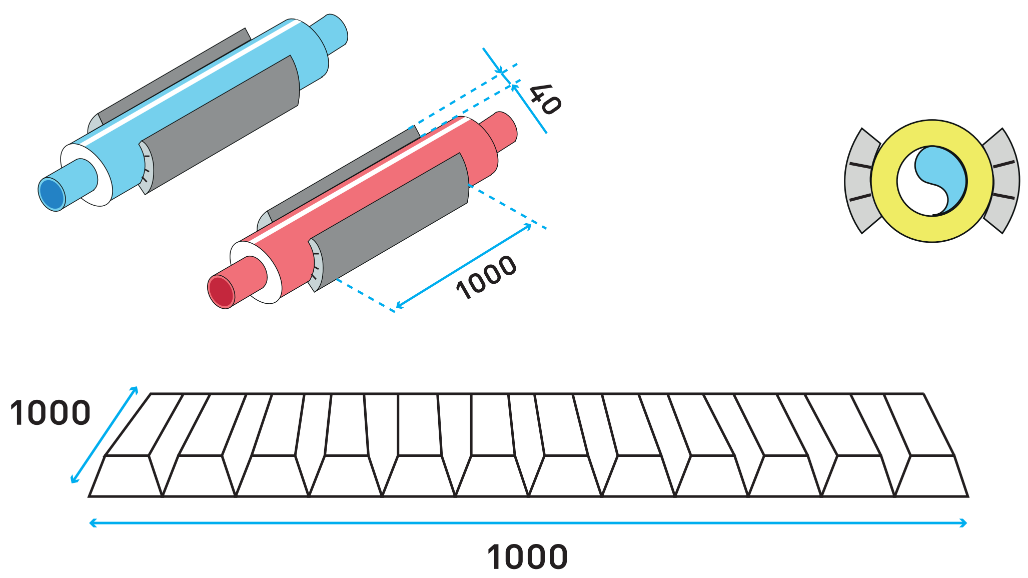
WARNINGS: dimensions can be slightly mod- ified by the production standard improvement. Tolerances are in accordance with the reference standards. If necessary, please contact our TECHNICAL DEPARTEMENT for data confirmation.

ACCESSORIES

ACCESSORIES

Foam pads
They allow the thermal expansion of preinsulated pipes installed in the ground. Pipe length to cover and the numbers of layers should be stated in accordance with the network thermal expansion movement.
Installation technique should be restricted to a max. continuous surface temperature of the outer casing of 50° C. Foam pads are made of polyethylene foam with closed cells, non-decomposable, with a density of about 30 kg/mc.
They are supplied in plate of 40 mm. thickness and in two different dimensions:
1] 1000 x 1000 mm;
2] 2000 x 1000 mm.
The pipeline outer diameter determines the layers of the foam pads and therefore the necessary quantity [see picture in the following page].

FOAM PADS ARRANGEMENT AND COVER AREA
N.B.: foam pads quantity is stated in the laying plan



ACCESSORIES

Warning tape
When the preinsulated pipe is being buried, at a distance of about 50 cm. from the natural surface, or anyway according to the design specific requirements, it is appropriate to place a district heating pipelines warning tape. On **ECOLINE** plastic tape is written "WARNING DISTRICT HEATING PIPELINE", it is red/purple and it is delivered in rolls of 200 m length and 100 m width.

SURVEILLANCE SYSTEM

Concept and importance of the system
The detect concept for preinsulated pipes making constant surveillance of the pipe network consists of 2 copper alarm wires. As a consequence, damages on HDPE outer casing or losses from service pipe or joints will be detected in due time, before corrosion damages on the service pipe or severe moisture damages to the insulation appear. There are two phases in the service life of a buried preinsulated pipe network where the advantages of a surveillance system are obvious:

1) Installation phase
The system can be used as an active part of the quality ensuring procedure on which the plant suppling is based for the plant start-up [first funcioning phase].

2) Operating period
A surveillance system working well to detect damages to the insulation, such as excavation damages or moisture penetration from outside/inside.
Anyway, a rapid analysis involves lower damages and lower costs to repair damages.

System description
In order to monitor them, in the preinsulated pipes and fittings are contents two copper wires with a 1,5 mm^2 cross sectional area (one tinned, the other not), inside polyurethane insulation. This system is commonly defined 'Nordic System'. Other monitoring and leak detecting systems are anyway available, using different wires. Contact our offices for further explanations.

Element for the realization of the extractions
According to the circuit length and of the surveillance system, it can be necessary to realize one or more 'cable extractions'. These extractions represent points of the network where the wires are extracted outside the pipeline in order to realize the sectioning of the circuits or a simple check point. **ECOLINE** provides the necessary material for this type of application, as described below.

Cable
For connecting the wires to the terminal box, it is generally used a 3/5 conductor wires of the same cross sectional area of the wires alarm system and it is suitable for burying [double coating], as well as temperature resistant. It is supplied in the requested lengths.

SURVEILLANCE SYSTEM

Extraction accessories
The above mentioned wire is connected to the wires alarm system through appropriate connectors [the same supplied in the 'electrical' kits provid- ed in the joint kits] and it comes out of the pipe- line through an appropriate extraction elbow 90° HDPE welded directly on the HDPE outer casing in the same way as for joint welding caps. For wire sealing, coming out of that extraction system, a heat-shrinkable tubular is supplied.
To sum up:
A) Electric connectors [CRIMP]
B) HDPE elbow 90°
C) heat-shrinkable tubular for final sealing

Surveillance systems
Wires coming out of the surveillance system extractions can be connected to proper instmuments according to the type of checks to be performed. For a passive surveillance, where checks are performed by an operator through on site tests, wires can be simply connected to a terminal box installed inside a fibreglass box. For active surveillance system, where the checks are carried out continuously by the installed surveillance system, wires are connected to proper alarm system control panels.
ECOLINE offers different solution which can guarantee continuous surveillance or surveillance by consulting the installed alarm system and, through its Technical Department, is available to evaluate the best surveillance system for every specific need.

ECOTHERM SYSTEM

Designing

INTRODUCTION

The design of a system of district heating, can be indicatively divided into the following macrofases:

- **design of the generation system of the heat;**
- **design of the distribution network of the heat;**
- **design of transfer systems heat to the user.**

The purpose of this section of the catalog of **ECOLINE** is to provide designers the indications necessary for correct design of the distribution network of a district heating system.
The executive design of a network of distribution of heat is divided in turn in the following macrophase:

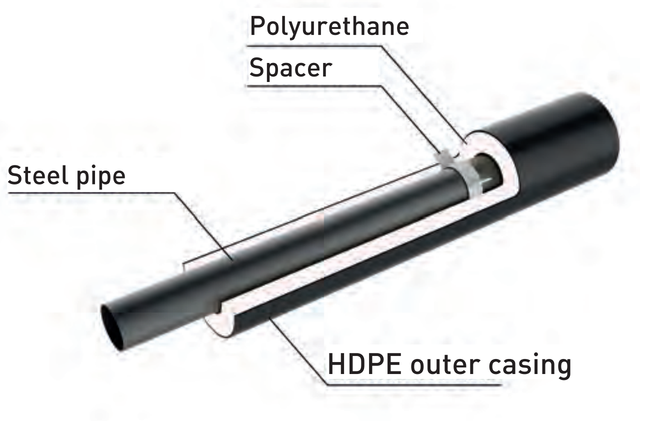
- **plano-altimetric definition of the pipeline layout;**
- **fluid dynamic design;**
- **mechanical design;**
- **electrical design;**
- **definition of the characteristics of the materials used in the construction of the pipeline network (Tender Specifications);**
- **computation of the works.**

In the sequel to the manual (in particular) they will be provide the design information (fluid dynamics and mechanics) of a network of district heating distribution, doing reference to simplified schemes and using some basic assumptions.
The design of more intricate systems e complex needs specific insights performed by the designer of the works.
ECOLINE Technical Office remains at available to offer their expertise in order to support the designers / customers in the evaluation of specific details of the system under development.

MECHANICAL DESIGN

1. Introduction
Modern district heating systems use bonded pre-insulated pipelines, composed by:

1. **service pipe;**
2. **polyurethane foam insulation;**
3. **high density polyethylene outer casing.**



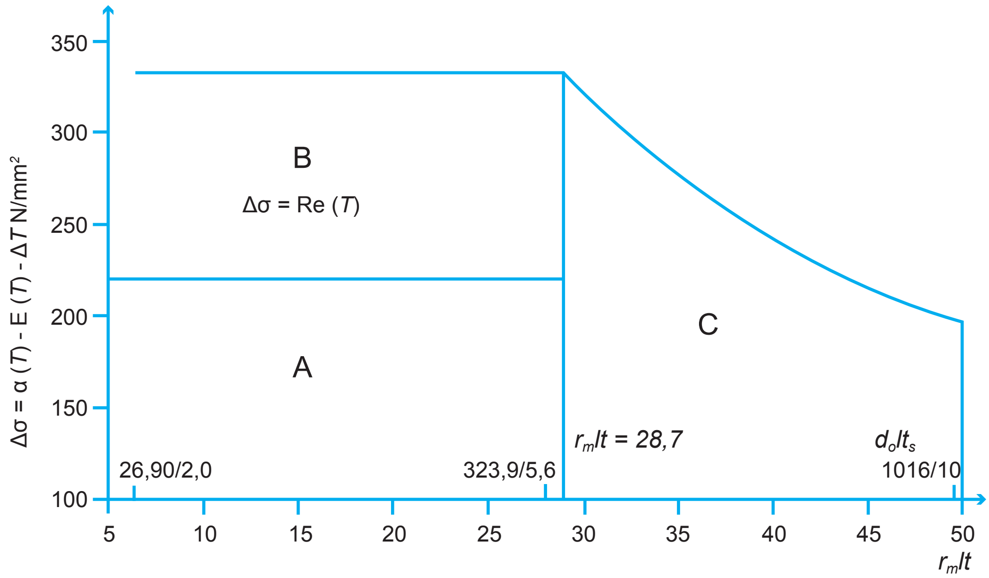
In this catalogue will be considered pipelines with a steel service pipe.
Expansions occur to buried pipelines, because of the difference between the laying temperature and the operating one; these expansions are partially prevented by the friction between the soil and the polyethylene outer casing. In the preinsulated systems, friction stresses are transferred from the outer casing to the service pipe through the polyurethane foam, causing axial stresses on the pipeline. Designing a district heating network, it is therefore necessary to take into consideration those stresses and to perform the so called main pipe mechanical dimensioning consisting essentially in:

- **calculating the compression/traction axial stresses in the pipelines and check the compatibility with the admitted tensional level;**
- **calculating expansions at the straight segments ends or anyway at the expansion points and define the absorption modes for those expansions in order to avoid damages to the polyurethane foam;**
- **performing the network components [elbows, TEE, etc.] fatigue test.**

At European level, the standard defining criteria to be followed for a district heating network mechanical dimensioning is EN 13941.
That standard classifies the district heating networks in three groups, according to the tensional level which may occur in the main pipe.
In particular, the following division is stated:
Class A: small and medium diameters with limited axial stresses
Class B: small and medium diameters with elevate axial stresses
Class C: big diameters or pipelines subjected to elevate inner pressures.

MECHANICAL DESIGN

In the following picture, extracted from the European standard, the three project classes are graphically represented:



1.

According to the project class, the European standard defines some elements to respect in network designing and realization such as:

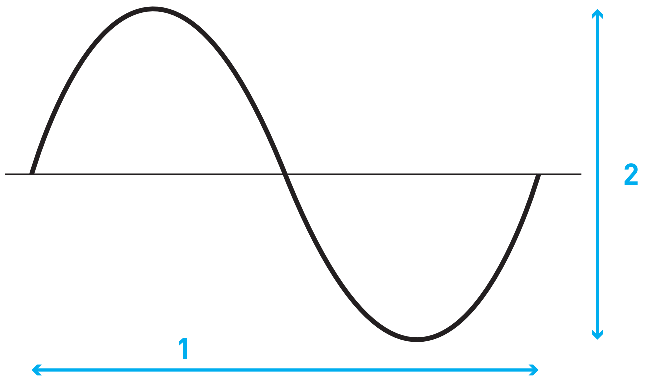
- **methods of weld examination;**
- **safety coefficient to adopt for the fatigue analyses;**
- **depth of calculation to perform during mechanical dimensioning.**

In details, as concerning the level of calculation to perform during mechanical dimensioning, the European Standard defines that for class A and B networks, the mechanical project can be performed as a "tabular" dimensioning, that is using the recommendations found in the producers' manuals with reference to the specific parameters of the projecting network.

[1] extracted from EN 13941

MECHANICAL DESIGN

For class C networks, the European Standard involves that the mechanical project is done performing all the verifications at the pipelines limit status, for which it can be useful to use a finite element analysis.
As regards to the fatigue verification of the network components, the European standard classifies pipelines according to the service features to be guaranteed to those classes and associates the minimum number of complete thermal cycles the pipeline must be able to withstand.
According to the European standard, a complete thermal cycle comprises a complete heating and cooling cycle undergone by the pipelines, as better described in the following picture, extracted from EN 13941.



1.

Key
1 one action Cycle
2 Temperature or stress range

In this catalogue, calculations have been performed so that to respect the following minimum values, as indicate in the above mentioned European Standard:

PIPELINE SYSTEM	NUMBER OF FULL ACTION CYCLES
Major pipelines	100
Main pipelines	250
Service connections	1000

[1] extracted from EN 13941

MECHANICAL DESIGN

In the following pages of **ECOLINE** catalogue will be provided necessary recommendations for a district heating system project identified in class A or class B, complying with the European standard.

According to the recommendations in this design manual and taking into account the specific conditions of the designing system, it is ensured the respect of the static constraints imposed by the European Standard. This catalogue represents also a guide line for the general design for class C system, whose calculation details must be better explored according to the specific standard recommendations.

ECOLINE, with its Technical Department, is available for Clients to better explore the static calculations performed directly by the Client, as well as to offer the necessary advise to perform calculations complying with the specific needs and features of the network to be projected.

Moreover, **ECOLINE** is available for Clients in order to perform Class C networks' verifications, using sisKMR software, which is the referring international standard for the mechanical calculation of the district heating system, always updated to the last available version.

2. Friction Forces

Expansions occur to buried pipelines, because of the difference between the laying temperature and the operating one; these expansions are partially prevented by the friction between the soil and the polyethylene outer casing. In the preinsulated bonded systems, pipelines behave as one body and friction stresses are transferred from the outer casing to the service pipe through the polyurethane foam, determining stresses on the pipeline.

In particular, those are compression stresses during pipeline heating and traction stresses during pipeline cooling.

Friction force increases augmenting the length of the laid system straight section and essentially depends on:

- **backfilling material features;**
- **backfilling depth;**
- **superficial loads;**
- **preinsulated pipeline outer diameter;**
- **water presence.**

In details, friction force is represented by the following formula:

$$F = \mu \left(\frac{1+K_0}{2} \sigma_v \varpi D + G - \gamma_S \varpi \left(\frac{D}{2} \right)^2 \right); \quad \left[\frac{N}{m} \right] \qquad \text{[Eq. 2.1]}$$

MECHANICAL DESIGN

where:

μ: coefficient of friction between sand and polyethylene [later on stated at 0,4]

K_0: coefficient of soil resting expansion (follow on stated at 0,5)

σ_V: soil tension at the pipeline barycentre [N/m]

D: PE outer casing outer diameter [m]

G: weight of waterfilled pipe [N/m]

γ_S: soil specific weight [N/m3]

Soil stress value σ_V is represented by different expressions according to the eventually existing groundwater level [Hw]. Being H pipeline burying depth, meant as distance between the natural surface and the pipeline upper extrados,

- se $H_w < Z$ $\sigma_v = \gamma_S H_W + \gamma_{SW} (Z-H_W)$
- se $H_w \geq Z$ $\sigma_v = \gamma_S Z$

where Z=H+D/2.

In the following pages of the catalogue, will be considered situations in which the groundwater is at a lower level in comparison to pipelines laying level, that is $H_w \geq Z$.

MECHANICAL DESIGN

3. Maximum stress in the pipeline, natural fixed point and locked section

Stresses undergone by a preinsulated pipeline through which flows a hot fluid in pression are due to two types of reasons: a mechanical one and a thermic one .

The first one is mainly determined by the fluid pressure in the pipeline, while the second one is caused by expansions deriving from the difference between laying and operating temperature which, as already described above, are partially prevented by the soil friction.

Longitudinal stress, parallel to the pipeline axis is determined by both the causes (mechanical and thermal).

Longitudinal stress σ_p deriving from internal pressure is always tensile stress and it is obtained through the formula:

$$\sigma_p = \frac{(d_i P)}{4t}$$

being:

d_i: service pipeline inner diameter;
P: operating pressure;
t: service pipeline thickness.

In an above-ground pipeline or in an under-grund blocked pipeline at the ends, the stress coming from the thermal contribute is constant and it is proportionally direct to the thermal difference ΔT and it is compression stress when heating the pipeline, tensile stress when cooling the pipeline.

In a preinsulated line with ends free to expand, the stress is different in each pipeline section and increases at increasing distance from a free end, until the blocked area is reached, as follows.

In particular, during heating the stress, caused by the friction, always compression stress, results as follows:

$$\sigma = \frac{Fl}{A_s}$$

being:

F: friction stress;
l: distance from the free end;
A_s: cross-sectional area of the service pipe.

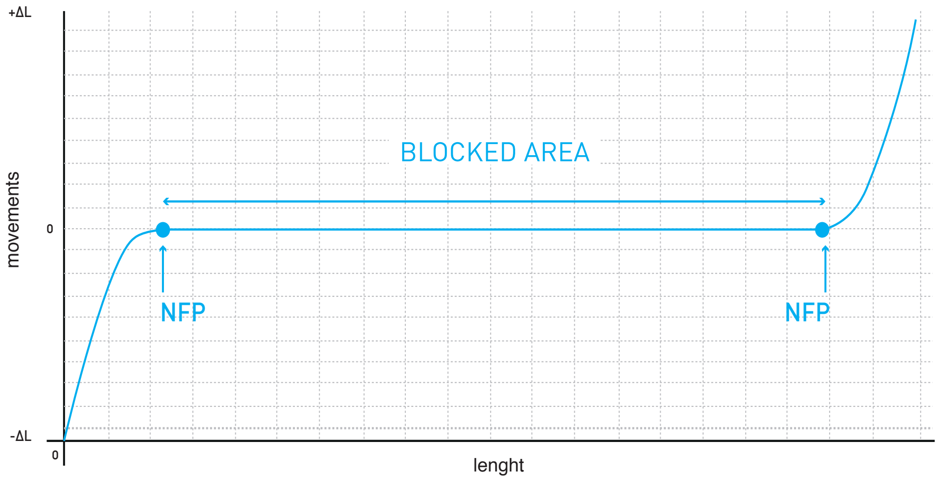
Effects on longitudinal tension determined by inner pressure during heating of the pipeline reduce the compression stress and therefore, for safety reasons, they will not be mentioned in the following pages.

In the operating phase it will be anyway essential to avoid sudden cooling and at the same time to keep high network pressure, since this situation provides overlapping tensile stresses on the pipeline, which could generate problems especially on pipeline sections laid through prestressing technique”.

If there is a straight lenght of preinsulated, buried and heated pipeline, expansions are maximum at

MECHANICAL DESIGN

the free end where there is no friction stress and reduce at increasing lengh until they completely disappear in the section where the thermal stress and the friction stress are the same, determining the maximum compression **stress value in the pipeline**.
From this point forward, **called natural fixed point** (NFP), the pipeline completely blocked and the axial stress value reaches the maximum value remaining then constant. The length included between the free end the natural **fixed point is called friction length**.



MECHANICAL DESIGN

In this situation the axial stress, which as already explained reaches the maximum value in the natural fixed point and remains constant during all the blocked section, assumes a value equal to the thermal stress, that is:

$$\sigma_{max}=E\sigma\Delta_T\left[\frac{N}{mm^2}\right]; \text{[Eq. 3.1]}$$

being:
E: steel modulus of elasticity;
α: steel coefficient of thermal expansion.
The steel modulus of elasticity and the coefficient of thermal expansion change according to the following table:

TEMPERATURE	E [N/mm²]	α [1/C°]
20	212.857	$1{,}16x10^{-5}$
50	211.143	$1{,}18x10^{-5}$
70	210.000	$1{,}19x10^{-5}$
90	208.857	$1{,}21x10^{-5}$
100	208.286	$1{,}22x10^{-5}$
110	207.714	$1{,}23x10^{-5}$
120	207.143	$1{,}23x10^{-5}$
130	206.571	$1{,}24x10^{-5}$
140	206.000	$1{,}25x10^{-5}$

In the following pages of the catalogue will be always used the values below for the elasticity modulus and for the coefficient of thermal expansion:

$E = 210\ kN/mm^2$
$\alpha = 1{,}2*10^{-5}$

MECHANICAL DESIGN

As described above, in the blocked section the thermal stress and the friction stress are equal therefore, using the above mentioned formulas:

$$E\alpha\Delta_T = \frac{FL_F}{A_S} = \sigma_{max} \text{ [Eq. 3.2]}$$

being:

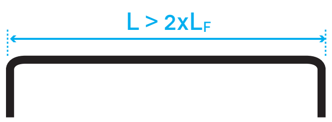
L_F: distance from the expansion bend to the maximum axial stress occurs, **also called friction length;**

A_S: cross-sectional area of the service pipe.

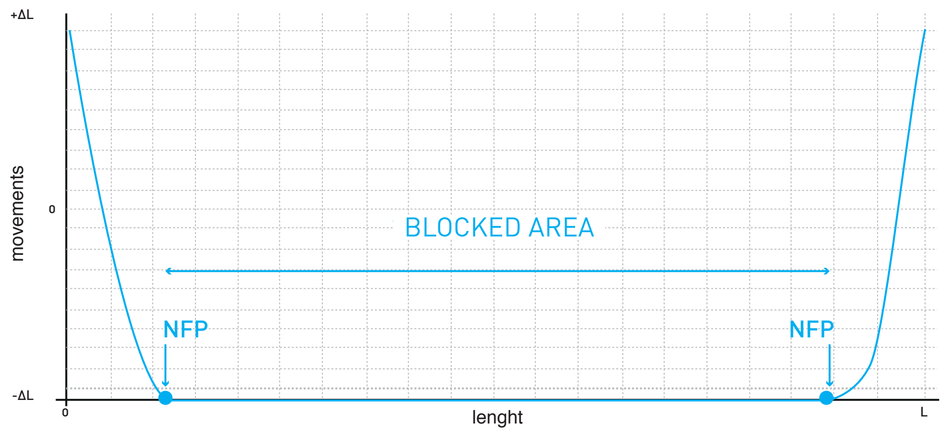
It is possible therefore to determine the so called friction length LF through the formula:

$$L_F = \frac{\sigma_{max} A_S}{F} \text{ [Eq. 3.3]}$$

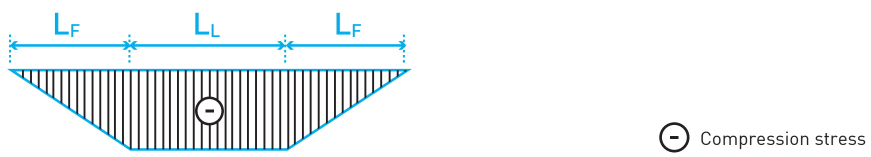
1.



2.



3.



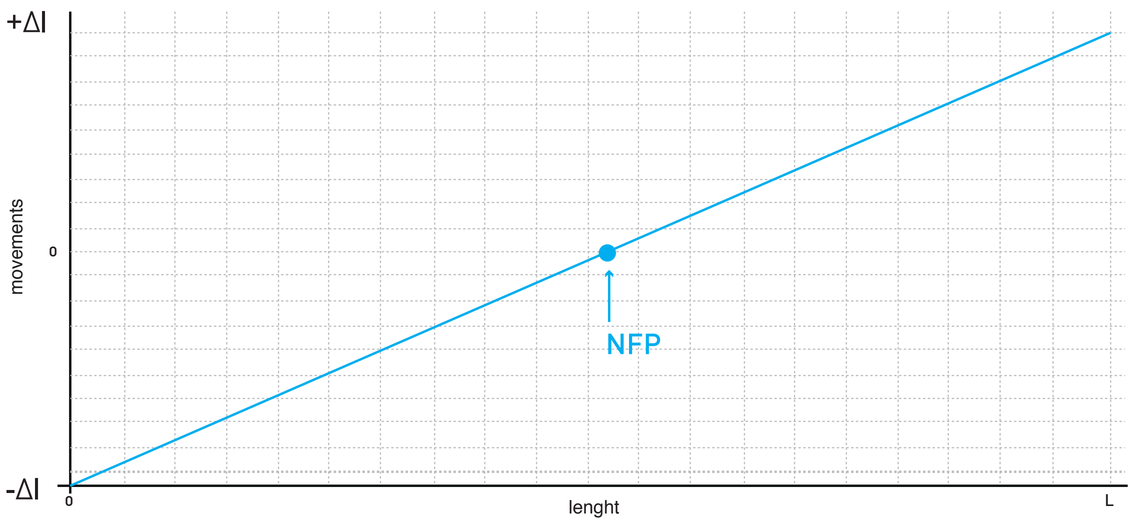
[1] network geometrical scheme
[2] expansion diagram
[3] tension diagram

MECHANICAL DESIGN

If the result is:
$L \leq 2L_F$
expansions, maximum and opposite at the free ends, disappear in the centre of the segment in the natural fixed point (NFP).

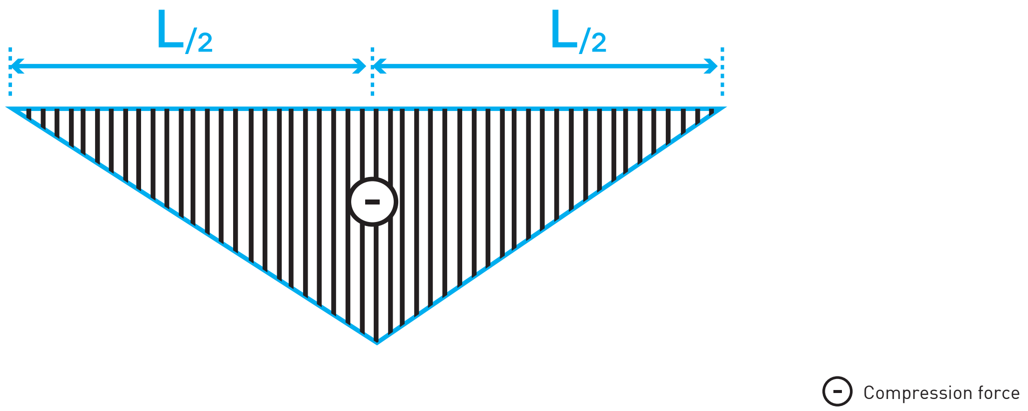
In this case in the pipeline no sections are completely blocked, but there is only one point where there are no expansions. In this point compression stress reaches the maximum value.

1.


2.


[1] network geometrical scheme
[2] expansion diagram

MECHANICAL DESIGN



3.

In a situation like this, that is when:
$L \leq 2L_F$

In such a situation the maximum stress in the steel pipeline assumes a value equal to:

$$\sigma_{max} = \frac{F\frac{L}{2}}{A_s} \quad \left[\frac{N}{mm^2}\right]; \quad [\text{ Eq. 3.4}]$$

[3] stresses diagram

MECHANICAL DESIGN

Numerical examples

1. Line with blocked segment

- Pipeline DN 200 - DE 315;
- Extrados backfilling equal to 1 m;
- Operating temperature: 80°C;
- Laying temperature: 10°C;
- Length included between free ends: 200 m.

First of all friction stress is determined with the formula [2.1]:

$$F = \mu \left(\frac{1+K_0}{2} \sigma_v \varpi D + G - \gamma_S \varpi \left(\frac{D}{2} \right)^2 \right) ; \left[\frac{N}{m} \right]$$

stating:

γs: 18.000 N/m³;

G: 644,25 N/m;

Replacing, the result is:

F = 5.882,10 N/m.

Friction length L_F is therefore calculated through the formula [3.3] LF so, being:

$\sigma_{max}=E\alpha\Delta_T=210.000*1.2*10^{-5}*(80-10)=176,40\ N/mm^2$

As = 0,00303 m²

as a consequence

$$L_F = \frac{\sigma_{max} A_s}{F} = \frac{176,40*3.033,84}{5.882,10} = 90,98 m$$

Considering that $L_F<L/2$, in the examined segment a blocked part will be formed. In particular, called "l" the distance from a free end, the result is

- 0 m < l < 90,98 m
  Segment with an increasing stress from 0 a σ_{max} leaving the free end;
- 90,98 m < l < 109,02 m
  Blocked segment with a constant stress equal to σ_{max};
- 109,02 m < l < 200,00 m
  Segment with a decreasing stress from σ_{max} a 0 approaching the free end.

2. Segment with natural fixed point formation

- Pipeline DN 200 - DE 315;
- Extrados backfilling equal to 1 m;
- Operating temperature:120°C;
- Laying temperature: 10°C;
- Length included between free ends: 180 m.

As in the previous example, the friction stress is equal to:

F = 5.882,10 N/m

The maximum thermal stress is equal to:

$\sigma_{max}=E\alpha\Delta_T=210.000*1.2*10^{-5}*(120-10)=277,20\ N/mm^2$

and therefore the friction length L_F is:

$$L_F = \frac{\sigma_{max} A_s}{F} = \frac{277,20*3.033,84}{5.882,10} = 142,97 m$$

MECHANICAL DESIGN

Considering that L_F > L/2, in the examined segment a blocked part will be formed at L/2. In particular, called l the distance from a free end, the result is:

- 0 m < l < 90 m
  Segment with an increasing stress from 0 a $\sigma_{t,max}$ leaving the free end
- 90 m < l < 180 m
  Segment with a decreasing stress from $\sigma_{t,max}$ a 0 approaching the free end

The maximum longitudinal stress is reached in this case through the relation [3.4] and it is equal to:

$$\sigma_{t,max} = \frac{F\frac{L}{2}}{A_s} = \frac{5.882,10*90}{3.033,84} = 174,49 \text{ m}\left(\frac{N}{mm^2}\right)$$

4. Determination of the maximum allowable stress

In the previous paragraph has been specified the maximum axial stress occurring in a pipeline, which is equal to:

$\sigma_{max} = E\alpha\Delta_T [N/mm^2]$.

That stress must be in accordance with the pipeline stability, both at local level (pipeline stability), and at global level (pipeline stability as regard to the surrounding conditions).

The local stability is meant as a protection against the risk that in the pipeline occur buckling or folding processes. This risk is present in case of high axial stress values together with large diameters and it depends on the steel pipeline thickness.

The risk can be completely eliminated working in a way that keeps the maximum axial stress value below the curve limit for what the European Standard EN 13941 defines boundary status C1, as in the picture below.

In the following pages of this catalogue will be indicated in detail the limit values which guarantee the respect of the pipeline local stability condition.

As regard to the global stability of a pipeline straight section, it must be taken into consideration different conditions determining the maximum axial stress value. This value depends on the existing conditions in the designing moment, as well as on the possible future conditions, such as:

- end expansions;
- position, number and geometrical features of the branches;
- diameter reductions along the line;
- valves position and other handling fittings position;
- presence of obstacles along the line;
- bent pipelines stability laid with reduced backfilling;
- parallel or transversal excavations in comparison with the pipeline direction;
- distance from existing or future sub-service connections.

MECHANICAL DESIGN

For designing, the European Standard EN 13941 allows to use as maximum axial stress value, a value which respects the limit in the diagram above mentioned.
Each network owner/operator can also state his own axial stress value, which must be obviously lower than the one above mentioned.
In the following pages of the catalogue will be described the laying procedures to build up a district heating network using the axial stress value mentioned in the diagram in EN 13941, stating indeed the single conditions to respect for the fatigue analysis.
Furthermore, here will be described the laying procedures which indeed allow installing a pipeline limiting the axial stress at a default maximum value equal to 190 N/mm^2.

This value is largely used in district heating network design and it allows to reach a safety factor equal to 1,1, with reference to a steel pipeline type P235 GH, where the yielding stress is measured according to the expression of the European Standards EN 253 and EN 13941, that is:

R_e=227-0,28(T-50) [N/mm^2] con T = 114°C

It is important therefore to underline that, if are used pipelines with different mechanical features, the maximum allowable stress value must be carefully evaluated, also according to the safety coefficient which is taken into consideration.
Refer for example to yielding stress values defined for a pipeline P235 GH in the European Standard EN 10217 as follows:

Steel grade		Minimum proof streght $P_{p0,2}$ MPa at temperature of°C						
Steel name	Steel number	100	150	200	250	300	350	400
P195GH	1.0348	175	165	150	130	113	102	94
P235GH	1.0345	198	187	170	150	132	120	112
P265GH	1.0425	226	213	192	171	154	141	134
16Mo3	1.5415	243	237	224	205	173	159	156

At the above mentioned temperature T = 114 °C, by a linear interpolation of the the table values, it is obtained a yielding stress of about 195 N/mm^2 and, as a consequence, adopting a safety factor equal to 1,1 it is obtained a maximum allowable stress of 177 N/mm^2. Therefore, in this case, using as maximum allowable stress the usual value 190 N/mm^2 would mean to adopt a safety coefficient equal to 1,026.

1. cold installation (without stress reduction);
2. pre-heating;
3. pre-tensioning;
4. natural compensation.

MECHANICAL DESIGN

5. Laying methods
As already indicated, the main methods used for the installation of district heating pipes are:
1. cold installation (without effort reduction);
2. natural compensation;
3. preheating;
4. pretension.
In the following sections these possible methods of laying will be analyzed in detail, indicating advantages and disadvantages of each with particular reference to operational simplicity and economic aspects.

5.1 Cold installation
The technique of cold installation consists in laying straight pipe sections of indefinite length and directly heating at operating temperature after the backfilling.

Two different conditions can occur by adopting this laying technique, in accordance with the maximum operating temperature. In facts, as already widely described above, the maximum axial stress value which can be registered in a pipeline is equal to:

$$\sigma_{max}=E\alpha\Delta_T \text{ [N/mm}^2\text{]}.$$

Laying in conditions of "**low axial stress**" is said when the maximum axial stress is lower than the maximum allowable axial stress, defined as the maximum yielding stress reduced of a proper safety coefficient, fixed at 1,1.
Adopting for the yielding stress the EN 253 and EN 13941 value referred to P235 GH,

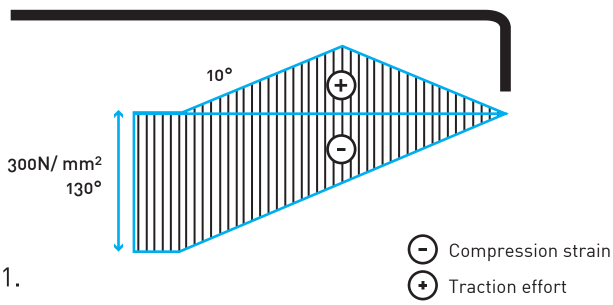
$$R_e=227-0,28(T-50) \text{ [N/mm}^2\text{]}$$

is obtained ΔT value which determines this condition and in particular, for a laying temperature of 10° C, the result is: $\Delta T \leq 78°C$.

MECHANICAL DESIGN

Laying in conditions of "**high axial stress**" is said when the maximum axial stress is higher than the yielding stress (even being inferior than the ultimate breaking strength, condition which is obtained by guaranteeing not to overcome the limit values shown in the diagram in the European Standard EN 13941).
Below is shown approximately the diagram of the axial stress in case of laying without stresses reduction, with installation in conditions of high axial stress. In particular for a pipeline installed at 10 °C and whose maximum operating temperature is equal to 130 °C, it results a maximum axial stress slightly higher than 300 N/mm².

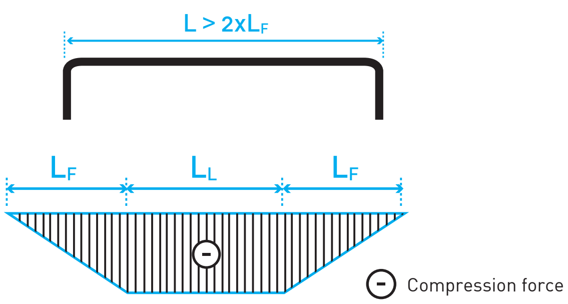
Cold installation technique, in case of laying in high axial stress conditions, can involve the overcoming of steel yielding stress, whose plastic behaviour is exploited.
In the section where it occurs, the steel, undergone by a constant stress, yields as a consequence of the prevented expansions. Plasticization involves a deformation which reduces the stressing state in the steel, inducing a "self pre-tensioning".
If the length of a straight pipe section is higher than L_F (ref. eq. 3.2), as already mentioned above, the axial stress value will increase on a linear basis starting from zero (at the free end) until the maximum value is reached at the distance L_F from the free end. The axial stress diagram results symmetrical to the straight segment midpoint: at the two ends results a stress triangular diagram, in the central part (locked section) the stress value is constant and equal to the maximum value.



1.

[1] stresses diagram

MECHANICAL DESIGN



1.

In the points at a lower distance than L_F from the free end, the stress results equal to:

$$\sigma_x = \frac{L_x F}{A_s} \left(\frac{N}{mm^2} \right);$$

In order to verify the local stability, must be checked only that:

$$E\alpha\Delta_T \leq \sigma_{lim}$$

being σ_{lim} the axial stress value obtained from the EN 13941 diagram and whose data are shown in the following table:

DN	σ_{lim} [N/mm²]
≤ 300	334
350	308
400	303
450	270
500	244
600	230
800	214
1000	214
1200	203

For pipelines with a diameter DN ≤ 300 realized using steel with similar features to the steel P235GH, the local stability is verified when:

$$E\alpha\Delta_T \leq 334 \text{ [N/mm}^2\text{]};$$

that is when:

$$\Delta_T \leq 130°C;$$

Therefore, laying preinsulated pipelines whose service pipe has features similar to the steel P235GH, the cold installation technique could be used for pipelines DN≤300 which undergo a delta temperature lower than 130 °C.

For larger diameters, the allowable maximum delta temperature decreases because of the minor value of ultimate breaking strength and can be calculated, known the maximum stress value, starting from the previous formula. Moreover, ΔT values are shown in the following table:

DN	ΔT[°C]
≤ 300	130
350	120
400	118
450	105
500	95
600	90
800	84
1000	84
1200	76

[1] stresses diagram

MECHANICAL DESIGN

The above mentioned concepts are valid with reference to the pipeline local stability; the compatibility with the system global stability must obviously always be verified and must be performed the fatigue analysis of the installed elements along the network (bends, Tees, etc.).

5.2 Natural compensation

Natural compensation laying technique consists in laying network straight sections where the distance between the free ends in lower than the double laying maximum length.

The laying maximum length can be calculated in accordance with the pre-set allowable maximum stress value, considering the satisfaction of the following formula:

$$\sigma_{amm} A_s \geq FL$$

as a consequence:

$$L_{max} = \frac{\sigma_{amm} A_S}{F}$$

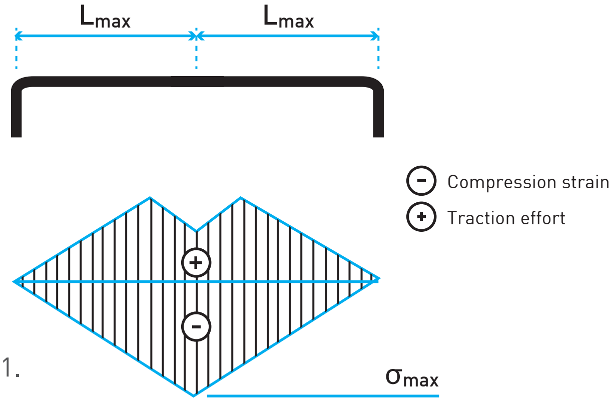
being F the friction force calculated through the relation already reported in the preceding paragraphs, or

$$F = \mu \left(\frac{1+K_0}{2} \sigma_v \varpi D + G - \gamma_s \varpi \left(\frac{D}{2}\right)^2 \right); \left(\frac{N}{m^2} \right)$$

The length L is the **maximum length** and it is correspondent to the maximum distance included between the free end and the natural fixed point , in order not to determine higher axial stresses than the pre-set limit value; the maximum straight length included between two pipeline free ends so that this stress limit is respected is therefore equal to the double of the maximum length.

$$L_{tot,max} = 2L_{max}$$

In a system operating at a minimum temperature of 10 °C and a maximum temperature of 130 °C, the stresses diagram results as follows:



1.

[1] stresses diagram

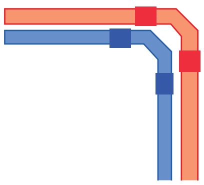
MECHANICAL DESIGN

At the free ends, in order to allow pipeline to expand, are realized geometrical compensations which can be:

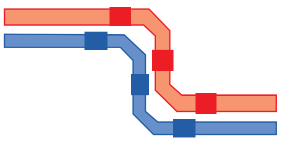
- L type;
- Z type;
- Omega type (U-Bends).

whose minimum length is calculated so that the resulting stress value respect the fatigue verifications on the network component.

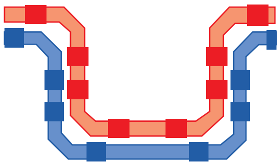
L compensation



Z compensation



Omega compensation (U-Bends)



In the following tables are showed the valves of friction force and L_{max} as a function of the pipe diameter and the insulation series.

All the tables have been constructed referring to the following parameters:

σ_{amm}: 190 N/mm²;
ϕ: 32,5°;
γ: 18.000 [N/m³]
μ: 0,4

As already mentioned above, the maximum permissible mechanical stress value of 190 N / mm² is widely used in the mechanical design of district heating networks.

This value allow to reach values of mechanical stress lower than the yield stress with a safety factor of 1.1, with reference to a steel pipe type P235 GH in which the yield stress is calculated according to the expression indicated in the standard EN 253 and EN 13941, namely:

$$R_e=227-0,28(T-50) \quad [N/mm^2]$$

In detail, the value of $\sigma_{amm} \leq 190$ N/mm² is obtained for T ≤ 114°C.

To maintain the safety coefficient equal to 1.1 as required by the standard EN 13941, for operating temperatures higher than T = 114 °C the mechanical stress values indicated in the table below must be used

MECHANICAL DESIGN

T_{es}[C°]	σ_{max} [N/mm²]
115	189,82
116	189,56
117	189,31
118	189.05
119	188,80
120	188.55
121	188,29
122	188,04
123	187,78
124	187,53
125	187,27
126	187,02
127	186,76
128	186,51
129	186,25
130	186,00

In the following tables are showed the friction stress and Lmax values according to the pipeline diameter and to the insulation Series. All the tables have been built with reference to the following referring parameters:

$$L_{max,\sigma}=L_{max,tab}\ \sigma/190$$

Numerical example

- DN 200 - DE 315 pipes;
- backfill on the extrados of 1 m;
- operating temperature: 120 ° C;
- laying temperature: 10 ° C;
- length included between free ends: 180 m.

With the expression [2.1] the friction force is obteind:

$$F=\mu\left(\frac{1+K_0}{2}\,\sigma_v\varpi D+G-\gamma_s\varpi\left(\frac{D}{2}\right)^2\right);\left(\frac{N}{m^2}\right)$$

tacking:

γs: 18.000 N/m³

G: 644,25 N/m

replacing is obteined:

F = 5.882,10 N/m = 5,88 kN/m

In order to calculate the maximum length according to different values of the allowable stress can be used the following formula, referring to data showed in the following tables:

$$L_{max}=\frac{\sigma_{amm}A_s}{F}$$

wherein, from the table above for an operating temperature of 120°C, σ_{amm} = 188,55 N/mm².
Being A_s = 3030 mm², we obtain:

$$L_{max}=\frac{\sigma_{amm}A_s}{F}=\frac{188{,}55*3.030}{5.882{,}10}=97{,}13\text{ m}$$

Therefore, in the example shown, the maximum straight length between two free ends of a pipe for which the permissible stress limit set is complied with is twice the maximum length, ie

$$L_{tot,max}=2xL_{max}=2*97{,}13=194{,}26\text{ m}$$

MECHANICAL DESIGN

FRICTION FORCE AND LAYING MAXIMUM LENGTH OF PIPELINE-INSULATION SERIES 1									
DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]
20	90	1,26	23,67	1,56	19,04	1,87	15,93	2,32	12,79
25	90	1,26	34,24	1,56	27,56	1,87	23,06	2,33	18,52
32	110	1,55	39,91	1,92	32,16	2,29	26,93	2,85	21,64
40	110	1,55	45,74	1,92	36,87	2,30	30,88	2,86	24,83
50	125	1,77	56,02	2,20	45,21	2,62	37,90	3,26	30,50
65	140	2,00	63,29	2,48	51,15	2,95	42,92	3,66	34,58
80	160	2,30	71,03	2,85	57,49	3,39	48,28	4,20	38,93
100	200	2,91	81,64	3,59	66,22	4,27	55,70	5,29	44,98
125	225	3,32	88,13	4,08	71,65	4,85	60,36	5,99	48,82
150	250	3,73	105,16	4,58	85,68	5,43	72,28	6,70	58,56
200	315	4,81	119,76	5,88	98,00	6,95	82,93	8,55	67,39
250	400	6,27	127,63	7,62	104,91	8,98	89,06	11,02	72,60
300	450	7,21	147,66	8,73	121,84	10,26	103,71	12,55	84,76
400	560	9,28	162,08	11,18	134,54	13,08	115,00	15,93	94,43
500	710	12,24	154,11	14,65	128,77	17,06	110,59	20,67	91,26
600	800	14,31	178,57	17,02	150,10	19,74	129,46	23,81	107,32

MECHANICAL DESIGN

FRICTION FORCE AND LAYING MAXIMUM LENGTH OF PIPELINE-INSULATION SERIES 2

DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]
20	110	1,54	19,30	1,91	15,54	2,29	13,00	2,85	10,44
25	110	1,54	27,93	1,92	22,49	2,29	18,83	2,85	15,13
32	125	1,76	35,05	2,19	28,25	2,61	23,66	3,25	19,013
40	125	1,77	40,18	2,19	32,29	2,61	27,14	3,25	21,82
50	140	1,99	49,92	2,47	40,30	2,94	33,79	3,65	27,20
65	160	2,29	55,32	2,83	44,72	3,38	37,53	4,19	30,24
80	180	2,60	63,07	3,21	51,06	3,82	42,89	4,73	34,59
100	225	3,29	72,33	4,05	58,70	4,82	49,40	5,96	39,91
125	250	3,69	79,19	4,54	64,40	5,39	54,26	6,66	43,90
150	280	4,19	93,66	5,14	76,34	6,09	64,43	7,51	52,21
200	355	5,44	105,96	6,64	86,76	7,85	73,44	9,66	59,70
250	450	7,08	112,98	8,61	92,94	10,13	78,93	12,42	64,38
300	500	8,03	132,43	9,73	109,34	11,43	93,11	13,97	76,15
400	630	10,50	143,35	12,63	119,09	14,77	101,86	17,98	83,69
500	800	13,89	135,78	16,61	113,59	19,32	97,64	23,39	80,64
600	900	16,21	157,67	19,26	132,67	22,31	114,51	26,89	95,01

MECHANICAL DESIGN

FRICTION FORCE AND LAYING MAXIMUM LENGTH OF PIPELINE-INSULATION SERIES 3									
DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]	F [kN/m]	L_{max}[m]
20	125	1,75	16,94	2,18	13,64	2,60	11,42	3,24	9,18
25	125	1,76	24,52	2,18	19,76	2,61	16,54	3,24	13,30
32	140	1,98	31,22	2,45	25,17	2,93	21,09	3,64	16,96
40	140	1,98	35,79	2,46	28,87	2,93	24,19	3,64	19,46
50	160	2,28	43,57	2,82	35,19	3,37	29,51	4,18	23,77
65	180	2,58	49,06	3,19	39,68	3,80	33,31	4,72	26,84
80	200	2,89	56,64	3,57	45,87	4,25	38,54	5,27	31,09
100	250	3,67	64,89	4,51	52,70	5,36	44,36	6,63	35,85
125	280	4,15	70,47	5,10	57,34	6,05	48,34	7,48	39,12
150	315	4,73	82,95	5,80	67,66	6,87	57,13	8,47	46,32
200	400	6,16	93,60	7,52	76,70	8,87	64,97	10,91	52,84
250	500	7,91	101,13	9,61	83,27	11,30	70,77	13,85	57,77
300	560	9,05	117,57	10,95	97,17	12,85	82,80	15,70	67,77
400	710	11,92	126,20	14,33	104,99	16,74	89,88	20,35	73,92
500	900	15,79	119,50	18,84	100,13	21,89	86,17	26,48	71,26
600	1000	18,16	140,68	21,56	118,54	24,95	102,42	30,04	85,06

MECHANICAL DESIGN

5.3 Pre-heating

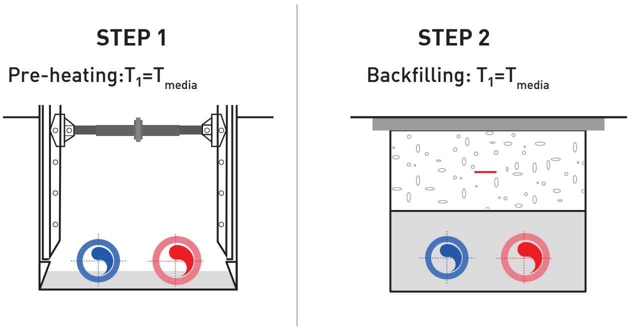
The pre-heating laying technique consists in preliminary pre-heating the network at the following temperature:

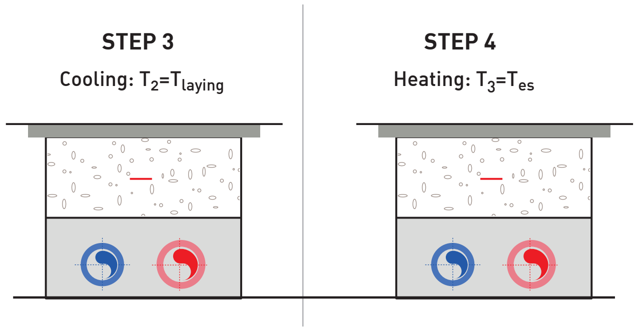
$$T_1 = \left(\frac{T_{es} + T_{laying}}{2} \right)$$

where:
Top.= operating temperature;
Tlaying= laying temperature.

After the backfilling the pipeline is cooled down again at a temperature equal to the laying temperature, in order to determine in the steel pipe a tensile stressing state which reduces at about half of the maximum theoretical value the compression stress induced by the following heating.

This laying technique involves the necessity to





maintain open simultaneously long straight excavation sections and this determines applicability strong limits to the routes in densely urbanised areas, where this involves serious problems to the ordinary roads.
There are anyway operative methodologies allowing, maintaining the district heating section heated, to perform partial backfilling decreasing the inconveniences and increasing the possibility to use this technology.
ECOLINE is available for the Clients to describe in details the possible operating and executive procedures, in order to define the best technology according to the specific surrounding conditions.
As above mentioned, trench backfilling is performing at an intermediate temperature between the operating one and the minimum operative one, therefore expansions at the ends are sensitively reduced and occur in both the directions, in expansion when heating and in contraction when cooling.

MECHANICAL DESIGN

In a system where the maximum operating temperature is 130° and the minimum operative temperature after the backfilling is 10°, the maximum axial stress is about 150 N/mm^2, if the heating temperature is 70°. The approximate diagram is shown in the following picture:
The axial stresses generating during pre-heating, occurring without backfilling, do not exist.
When cooling, after trench backfilling, occur axial stresses equal to:

$$\sigma_{pre} = E\alpha\,(T_{pre} - T_{min})$$

During final heating at the maximum operating temperature occur axial stresses whose value is expressed by the following formula:

$$\sigma_{max} = E\alpha\,(T_{max} - T_{pre})$$

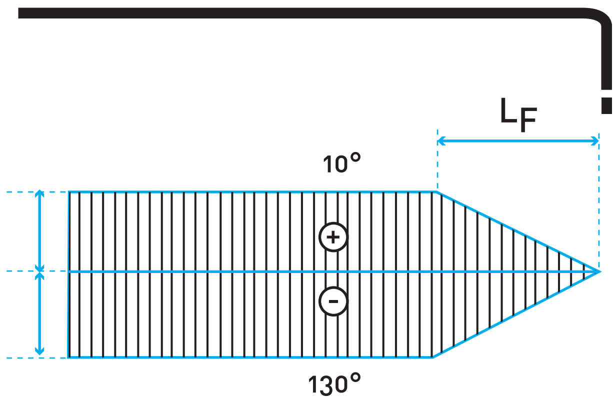
If the pre-heating temperature T_{pre} is fixed equal to the average between the maximum operating temperature and the minimum operative temperature, the result is:

$$|\sigma_{pre}| = |\sigma_{max}|$$

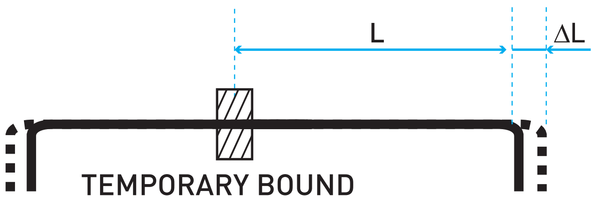
It will be important to verify that during no operative steps is overcome the maximum allowable stress defined during designing.
At the pipeline free end, when pre-heating, there will be a pipeline expansion equal to:

$$\Delta L = (T_{pre} - T_{min})\,\alpha L$$

Being L the distance between the free end and the section average point or anyway the point where was locally created a bound to the expansion [for example with a partial sand backfilling].



1.



2.

[1] stresses diagram
[2] network geometrical scheme

MECHANICAL DESIGN

5.4 Pre-tensioning

The pre-tensioning laying technique, as the pre-heating one, exploit the principle to induce in the pipeline a preliminary tensile status in order to limit the compression axial stresses during the operating period.
According to the procedure used to heat the pipeline, two different laying technique are defined.

5.4.1 Pre-tensioning with one time compensator

Along the network straight sections [whose length is not undergone to mechanical bounds if the allowable stress is 190 N/mm^2 and $\Delta T \leq 75°C$], in definite positions, are installed some elements called one time compensators which are free to slide under the effect of the thermal expansion and which are preloaded, pressing them, according to the movement design calculation they must perform when pre-heating.
Applying this laying procedure, the network is pre-heated in advance at a temperature equal to the half of the difference between the laying temperature and the operating one after the backfilling, leaving the trench open only where are the compensators.

As a consequence:

$$T_1 = \left(\frac{T_{es} + T_{posa}}{2} \right)$$

Because of the pipeline heating, the compensators move until the expansion compensation will be completed and, maintaining constant the temperature in the network, the compensator is welded.
The following cooling induce a tensile tensional status in the steel pipeline which reduces of about half the maximum compression stress theoretical value caused by the heating at operative conditions.

5.4.2 Electrical pre-tensioning

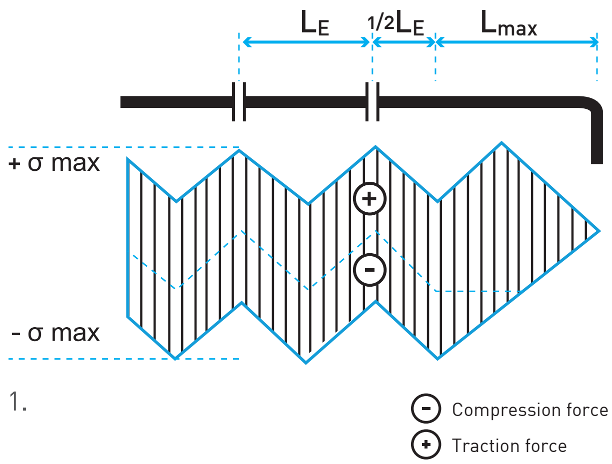
The laying technique through electrical pre-tensioning is similar to the pre-tensioning one using one time compensators, with the difference that instead of compensators are left
some empty spaces among the laid network sections, creating the so-called gaps.
During heating at the pre-tensioning temperature, performed exploiting the principle of the Joule effect, according to which a conductor in which passes electric power dissipates energy

MECHANICAL DESIGN

in the form of heat in a quantity which is proportional to the circuit power and to the spent time, the network expands until the pipelines opposite faces at the gaps enter in contact and welding is performed.
Once again the following cooling induces a tensile tensional status in the steel pipeline which reduces of about a half the maximum theoretical value of compression stress caused by the following heating.

5.4.3 Mechanical effects of pretensioning (electric or hot water)

Independently of the adopted pre-tensioning procedure (compensators or gaps), in a system where the maximum operating temperature is 130° and the minimum temperature after the backfilling is 10°, having set the maximum allowable axial stress at 190 N/mm², the stress diagram results approximately as follows:



1.

In the graphic the dotted line represents the stress at the pre-tensioning temperature.
Each compensator or gap must be placed having before and after a pipeline straight section with no direction changes [deviations] of a minimum length of 12 metres.
As already mentioned, designing a network in which the stresses reduction is realized through the pre-tensioning technique, the straight pipeline sections are divided through inserting compensators/gaps in pre-set positions, so that stresses in the pipelines are reduced.

[1] stresses diagram

MECHANICAL DESIGN

The number of gaps/compensators is stated according to some parameters, such as:

- maximum allowable stress set during designing;
- covering on the pipelines;
- maximum operating Temperature;
- pre-tensioning Temperature;
- minimum operative Temperature.

In order to reduce the number of compensators/gaps, it is possible to introduce the expedient of wrapping the pipelines inside a plastic (PE) foil limiting the friction value of about 30%, increasing therefore the length of free installation and as a consequence the distance among the compensators.

In the following pages of the catalogue, as a precautionary measure, will **not be considered** this installation expedient.
The pre-tensioning temperature is generally set equal to the average between the maximum operating temperature and the minimum operative temperature.

$$T_{pre} = \frac{T_{max} + T_{min}}{2}$$

Once set the allowable stress value, in order it is not overcome nor during pre-tensioning, nor during operation, the pre-tensioning temperature must be always chosen in the range stated by the following formula:

$$T_{max} - \frac{\sigma_{amm}}{\alpha(T_{es})\, E(T_{es})} \leq T_{pre} \leq T_{ins} + \frac{\sigma_{amm}}{\alpha(T_{es})\, E(T_{es})}$$

Being:

$\alpha(T_{es})$: thermal expansion coefficient at the operating temperature;

$E(T_{es})$: steel elasticity module at the operating temperature.

Defined as:

L_E: distance between two following compensators;

L_B: distance between the first compensator and the section free end;

the maximum values of these length derive from the following formulas

$$L_E = 2\,\frac{(\sigma_{amm} - \alpha E\,(\,T_{max} - T_{pre}))\, A_s}{F}$$

$$L_B = L_{max} + \frac{L_E}{2}$$

Being L_{max} the maximum distance included between the free end and the natural fixed point in order not to determine higher axial stresses than the pre-set limit value, whose determination procedures will be better described in the following paragraph.:

$$L_{max} = \frac{\sigma_{amm} A_s}{F}$$

MECHANICAL DESIGN

In the following tables are showed L_E and L_B values according to diameter of the pipeline and the insulation series, both in the case the pre-tensioning temperature is set equal to the average between the maximum operating temperature and the minimum operative temperature, and in the case the pre-tensioning temperature is set equal to the maximum possible value compatible with the allowable axial stress during designing, with reference to the above mentioned range of values.

$$T_{pre} = \frac{T_{max} + T_{min}}{2}$$

All the tables have been built using the following reference parameters:

σ_{amm}: 190 [N/mm^2]
φ: 32,5°
γ: 18.000 [N/m^3]
ч: 0,4
T_{es}: 130°
T_{ins}: 10°

As already indicated on several occasions, the maximum allowable mechanical stress value of 190 N / mm^2 allows to reach values of mechanical stress admissible lower than the yield stress with a safety factor greater than or equal to 1.1 at an operating temperature of less than or equal to 114 ° C (for a P235 GH steel pipe).

In order to maintain a safety factor of 1.1 having operating temperatures above T = 114 ° C, the permissible mechanical stress values given in the table in the paragraph concerning stress limitation using the natural compensation technique should be used.

MECHANICAL DESIGN

DISTANCE AMONG PIPELINES COMPENSATORS INSULATION SERIES 1 - $T_{pretensioning} = T_{avarage}$									
DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]
20	90	9,67	28,51	7,78	22,93	6,50	19,18	5,22	15,40
25	90	13,99	41,24	11,26	33,19	9,42	27,77	7,56	22,30
32	110	16,30	48,07	13,13	38,73	11,00	32,43	8,84	26,06
40	110	18,68	55,08	15,06	44,39	12,61	37,18	10,14	29,90
50	125	22,88	67,46	18,47	54,44	15,48	45,64	12,46	36,73
65	140	25,85	76,21	20,89	61,60	17,53	51,69	14,12	41,64
80	160	29,01	85,53	23,48	69,23	19,72	58,14	15,90	46,88
100	200	33,34	98,31	27,05	79,74	22,75	67,07	18,37	54,16
125	225	36,00	106,13	29,26	86,28	24,65	72,69	19,94	58,79
150	250	42,95	126,63	34,99	103,17	29,52	87,05	23,92	70,51
200	315	48,91	144,21	40,02	118, 01	33,87	99,86	27, 52	81,15
250	400	52,13	153,69	42,85	126,33	36,37	107,24	29,65	87,43
300	450	60,31	177,82	49,76	146,73	42,36	124,89	34,63	102,10
400	560	66,20	195,17	54,95	162,01	46,97	138,49	38,57	113,71
500	710	62,94	185,59	52,59	155,07	45,17	133,17	37,27	109,90
600	800	72,93	215,04	61,30	180,75	52,87	155,89	43,83	129,23

MECHANICAL DESIGN

DISTANCE AMONG PIPELINES COMPENSATORS INSULATION SERIES 2 - $T_{pretensioning} = T_{avarage}$

DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]
20	110	7,88	23,24	6,35	18,71	5,31	15,66	4,27	12,58
25	110	11,41	33,64	9,19	27,09	7,69	22,67	6,18	18,22
32	125	14,32	42,21	11,54	34,02	9,66	28,49	7,77	22,91
40	125	16,41	48,38	13,23	39,01	11,08	32,68	8,91	26,28
50	140	20,39	60,12	16,46	48,53	13,80	40,69	11,11	32,76
65	160	22,59	66,62	18,26	53,85	15,33	45,19	12,35	36,41
80	180	25,76	75,95	20,85	61,48	17,52	51,65	14,13	41,65
100	225	29,54	87,10	23,97	70,69	20,17	59,48	16,30	48,06
125	250	32,34	95,36	26,30	77,55	22,16	65,34	17,93	52,86
150	280	38,25	112,78	31,18	91,93	26,31	77,59	21,32	62,87
200	355	43,28	127,60	35,43	104,47	30,00	88,44	24,38	71,89
250	450	46,14	136,05	37,96	111,92	32,24	95,05	26,30	77,53
300	500	54,09	159,48	44,66	131,67	38,03	112,12	31,10	91,70
400	630	58,55	172,62	48,64	143,41	41,60	122,66	34,18	100,78
500	800	55,46	163,51	46,39	136,79	39,88	117,57	32,94	97,11
600	900	64,40	189,87	54,19	159,77	46,77	137,90	38,80	114,41

MECHANICAL DESIGN

DISTANCE AMONG PIPELINES COMPENSATORS INSULATION SERIES 3 - $T_{pretensioning} = T_{max. allowable}$

DN	D_E [mm]	H=0,8 m		H=1,0 m		H=1,2 m		H=1,5 m	
		L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]	L_E [m]	L_B[m]
20	125	6,92	20,40	5,57	16,43	4,66	13,75	3,75	11,05
25	125	10,02	29,53	8,07	23,79	6,76	19,92	5,43	16,01
32	140	12,75	37,59	10,28	30,32	8,61	25,40	6,93	20,43
40	140	14,62	43,10	11,79	34,76	9,88	29,13	7,95	23,44
50	160	17,79	52,46	14,37	42,38	12,05	35,54	9,71	28,62
65	180	20,04	59,08	16,21	47,78	13,60	40,11	10,96	32,33
80	200	23,13	68,20	18,73	55,24	15,74	46,41	12,70	37,44
100	250	26,50	78,14	21,52	63,46	18,12	53,42	14,64	43,18
125	280	28,78	84,85	23,42	69,05	19,74	58,21	15,98	47,11
150	315	33,88	99,89	27,63	81,48	23,33	68,80	18,92	55,77
200	400	38,23	112,72	31,33	92,36	26,53	78,23	21,58	63,63
250	500	41,30	121,79	34,01	100,28	28,90	85,22	23,59	69,56
300	560	48,02	141,58	39,69	117,01	33,82	99,71	27,68	81,61
400	710	51,54	151,97	42,88	126,43	36,71	108,23	30,19	89,02
500	900	48,81	143,91	40,90	120,58	35,19	103,77	29,10	85,81
600	1000	57,46	169,41	48,41	142,74	41,83	123,33	34,74	102,43

MECHANICAL DESIGN

As already mentioned above, compensators must be preloaded, that is they must be pressed before the installation along the line so that is left a free gap equal to the movement the compensator will undergo during pre-tensioning, as a consequence of the thermal expansion occurring on both side of the line.
The movement at a gap/compensator included among other compensators can be calculated through the following formula, where it is considered that the compensators have been installed at a constant distance among each other.

$$\Delta L_E = 2(\alpha(T_{pre} - T_{inst})\ ½\ L_E - \frac{F½L_E^2}{2EA_S})$$

In the case the compensators have been installed at various distances, the formula becomes:

$$\Delta L_E = \alpha\ (T_{pre} - T_{inst})\ ½\ L'_E - \frac{F½L'^2_E}{2EA_S} + \alpha\ (T_{pre} - T_{inst})\ ½\ L''_E - \frac{F½L''^2_E}{2EA_S}$$

Being L'_E and L''_E the distances among the compensator to calculate and respectively the previous compensator and the following one.
For the first compensators after the section free end the gap to be left during pretensioning is calculated through the formula:

$$\Delta L_B = \alpha\ (T_{pre} - T_{inst})\ ½\ L_B - \frac{F½L_B^2}{2EA_S} + ½\ \Delta L_E$$

MECHANICAL DESIGN

5.5 Comparison among the different laying techniques

In the following table are approximately described some of the main advantages and disadvantages of the laying techniques above mentioned.

ECOLINE, with its Technical Department and its consultants, is available for the Clients in order to evaluate the best technique to adopt according to the laying network features.

LAYING TECHNIQUE	ADVANTAGES	DISADVANTAGES
Cold installation	• Very simple installation technique; • Cheaper installation technique; • Long sections of the pipeline blocked.	• High axial tension; • High expansions at the ends; • Limitation of employment in case of large diameters and high operating temperature; • Buckling danger in case of parallel excavations.
Pre-heating	• Simple installation technique; • Cheap installation technique; • Long sections of the network locked; • $\sigma_{max} \leq \sigma_{amm}$	• Limited employment to situations where it is possible to maintain long excavation trenches simultaneously open; • Higher costs for performing the initial heating of the section.
Pre-tensioning	• The trench can be completely backfilled, except for the holes at the compensator gaps; • Long sections of the network locked; • $\sigma_{max} \leq \sigma_{amm}$	• Higher costs per compensators supply and for possible opening holes at the compensator gaps; • Higher costs for performing the initial heating of the section.
Natural compensation	• The trench can be completely backfilled; • Consolidated laying technique providing less problems about inserting branches after the first heating to the line; • $\sigma_{max} \leq \sigma_{amm}$	• Higher costs for special pieces supply and for trench excavation civil works; • Increase in load losses and following increase in the costs for the circulation of the vector fluid.

MECHANICAL DESIGN

6. Expansions at the ends

Independently from the choice of the laying technique, along the unblocked sections and especially at the straight sections ends occur expansion movements in the pipeline (during heating) or contraction movements (during cooling).

At a section end, the expansion can be calculated through the following formula:

$$\Delta L = \alpha(T_{es} - T_{inst}) L_F - \frac{FL_F^2}{2EA_s}$$

where L_F represents the friction length, as calculated in the paragraph 3. If the section total length L_{TOT} is lower than the double the friction length, it results that:

From the above expression we can deduce that the movement of the pipe is a function of two components:

- the thermal component, which causes an expansion in the pipe during the heating phase;
- the friction component, which during the heating phase retains the expansion of the pipe.

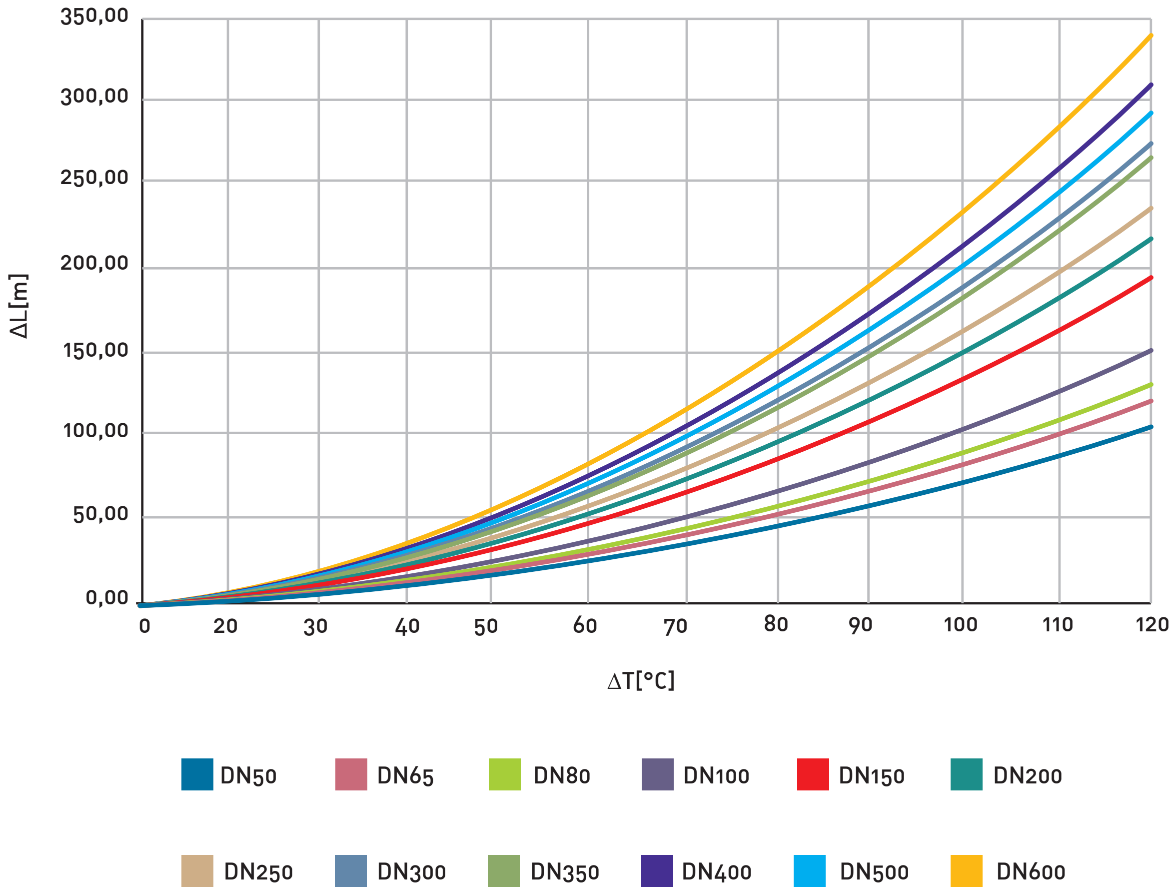
The following diagram shows the value of the expansion at the end of a straight section at the maximum operating temperature when the value of ΔT, changes, due to the effect of the only thermal contribution and due to the effect of both contributions (thermal and friction).

The diagrams are derived in the hypothesis that the length of the straight section is greater than or equal to twice the friction length and have been calculated using the values indicated below:

φ: 32,5°;
γ: 18.000 [N/m³];
μ: 0,4;
H: 1,0 m.

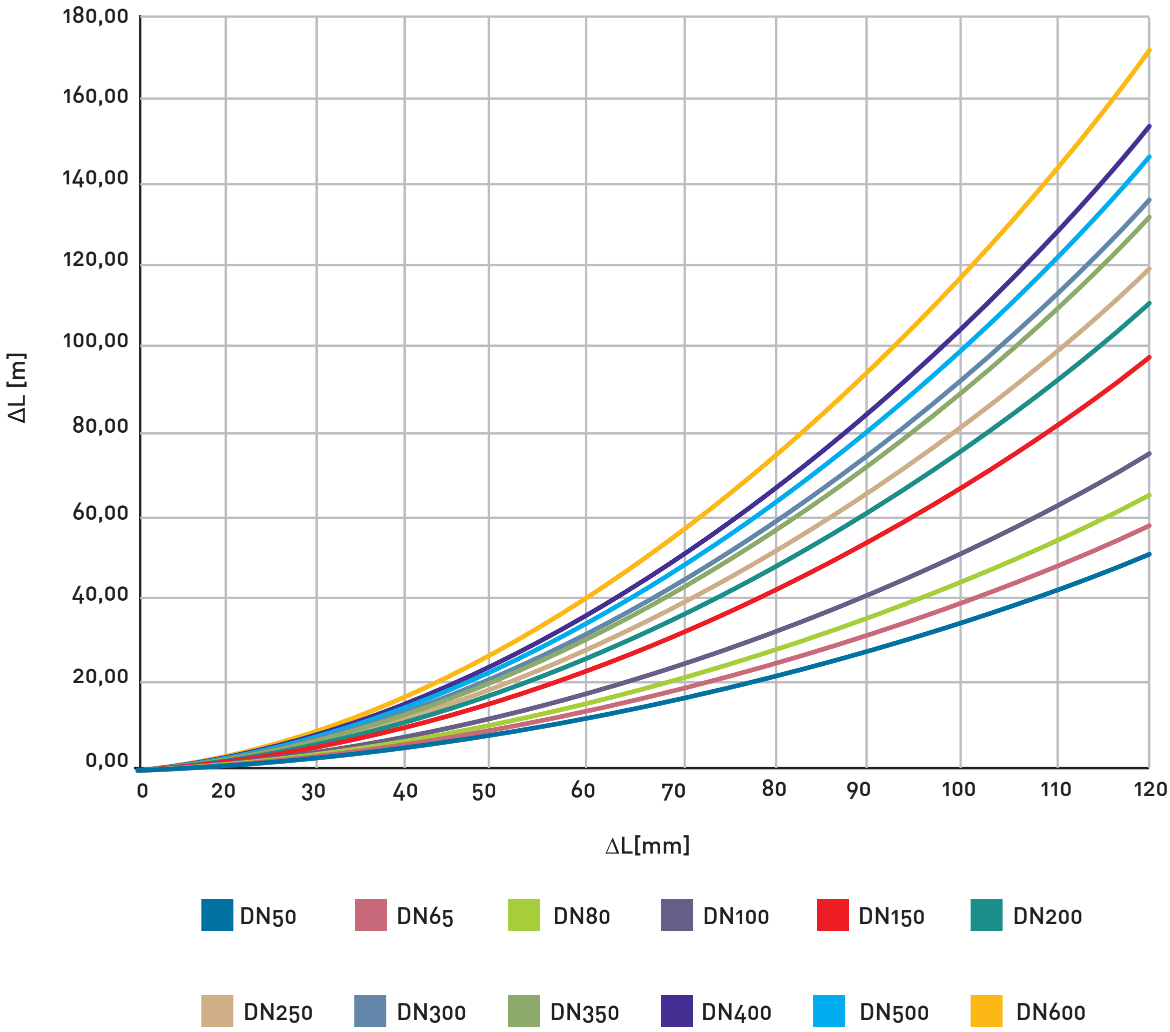
MECHANICAL DESIGN

Expansion at the ends (only thermal component) - H = 1.0 m



MECHANICAL DESIGN

Expansion at the ends -H=1,0 m



MECHANICAL DESIGN

If the total lenght L_{TOT} is less than twince of the friction lenght, it is obtained that:

$$\Delta L = \alpha(T_{es} - T_{inst}) \frac{L_{TOT}}{2} - F \frac{\left(\frac{L_{TOT}}{2}\right)^2}{2EA_s}$$

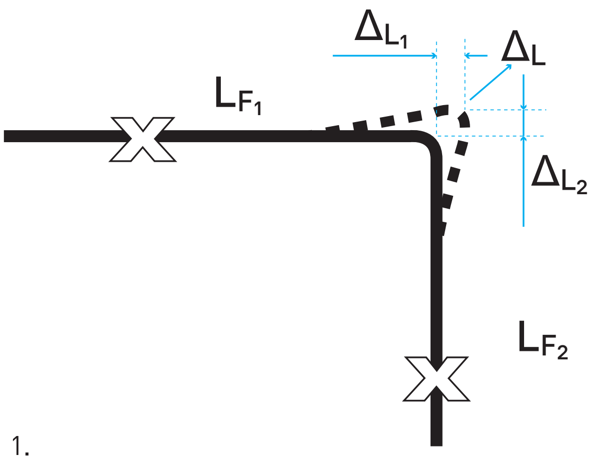
In correspondence of a elbow, the pipeline expands due to the movements that derive from both straight lines that converge in the elbow, so combining the effects is achieved a radial movement of the pipe, the result of which is equal to:

$$\Delta L = \sqrt{\Delta L_1^{\,2} + \Delta L_2^{\,2}}$$

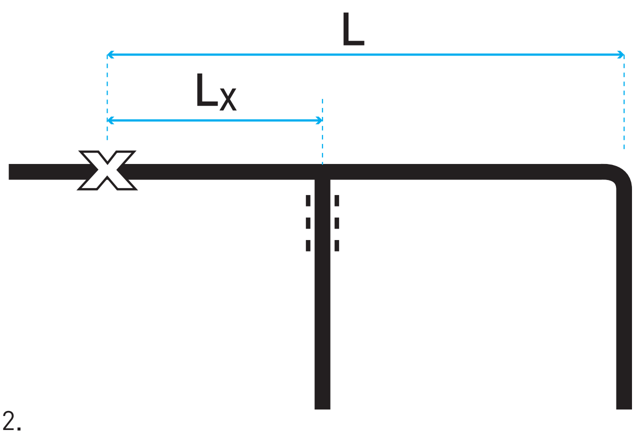
At an intermediate point of the line, for example at a branch Tee, positioned along the section of sliding and thus at a distance from one end free lower than the friction length LF, the dilatation can be calculated using the following formula:

$$\Delta L_x = \alpha(T_{es} - T_{inst}) L_x - \frac{F(2L-L_x)L_x}{2EA_s}$$

where L represents the distance between the free end and the natural fixed point, which will be at maximum equal to the friction length L_F.



1.



2.

1 / 2 network geometrical scheme

MECHANICAL DESIGN

Numerical examples
Two numerical examples of calculation of the dilatation at a straight end are shown below, in the case in which the length of the segment between two straight ends is greater than twice of friction lenght and in the case in which this length is less than friction length.
For simplicity, the data of the examples will be used numerical data in paragraph 3

1. Segment with trapped line formation
- DN 200 - DE 315 pipes;
- backfill of the extrados of 1 m;
- operating temperature: 80 ° C;
- laying temperature: 10 ° C;
- length between free ends: 200 m.

The friction length L_F cthe expression [3.3] results:

$$L_F = \frac{(\sigma_{max} A_s)}{F} = \frac{176{,}40*3.033{,}84}{5.882{,}10} = 90{,}98 \text{ m}$$

Considering therefore that it is that $L_F < L/2$, the dilatation at the end of the section will be calculated with the expression:

$$\Delta L = \alpha(T_{max} - T_{inst}) L_F - \frac{(FL_F^2)}{2EA_s} = \left(1{,}2*10^{-5}*(80-10)*90{,}98 - \frac{5.882{,}10*90{,}98^2}{2*210.000*3.033{,}8}\right)*1000 = 38{,}21 \text{mm}$$

2. Segment with natural fixed point formation
- DN 200 - DE 315 pipes;
- backfill of the extrados of 1 m;
- operating temperature: 120 ° C;
- laying temperature: 10 ° C;
- length between free ends: 180 m

The friction length LF calculated through the expression [3.3] is equal to:

$$L_F = \frac{\sigma_{max} A_s}{F} = \frac{277{,}20*3.033{,}84}{5882{,}10} = 142{,}97 \text{ m}$$

In this case $L_F > L/2$, therefore the dilatation at the end of the section will be calculated with the expression:

$$\Delta L = \alpha(T_{max} - T_{inst}) \frac{L}{2} - \frac{F\left(\frac{L}{2}\right)^2}{2EA_s} =$$

$$= \left(1{,}2*10^{-5}*(120-10)*\frac{180}{2} - \frac{5.882{,}10*\left(\frac{180}{2}\right)^2}{2*210.000*3.033{,}8}\right)*1000 =$$

result= 81,41 mm

MECHANICAL DESIGN

7. Fatigue dimensioning of the network elements

7.1 L, Z and Omega (U-bends) compensations

As already mentioned above, because of the temperature variations of the vector fluid and as a consequence of the service pipe, district heating pipeline move.
These are expansion movements during heating and contraction movements during cooling and provide compression and cutting stresses on the polyurethane insulation, together with fatigue stresses at the expansion points (bends, Tee, etc).
Direction changes in a district heating network must be carefully designed so that the stresses on the polyurethane insulation and the fatigue stresses of the compensation elements comply with the limits in EN 13941.
In the following pages of the catalogue will be supplied the necessary information so that the requirements based on EN 13941 are respected.
The movements at a straight section end cause compression and cutting stresses on the polyurethane insulation, which can be partially absorbed applying on the pipeline in the expansion area some foam pads. In general, it is possible to suppose that every layer of foam pads absorbs about 30 mm expansion; in the following pages, of the catalogue will be supplied details about the optimal foam pads arrangement on the bends.
It has been already mentioned above that expansion and contraction movements cause fatigue stresses on the elbows. The European Standard EN 13941 defines, according to the pipeline type and the design class, the minimum number of fatigue cycles which a component must undergo, as already written in paragraph 1 of this catalogue.
In the following pages of the catalogue will be supplied recommendations, which if correctly applied, allow to design district heating networks respecting EN 13941 requirements. Precautionary and for safety reasons, pipelines have been classified, according to the diameter, in design class B or design class C. Therefore pipelines which could be classified in class A result surely fatigue tested following the design recommendations of this catalogue.
In order to perform a right design of the network elements and to respect the requirements in EN 13941 must be defined the following details:

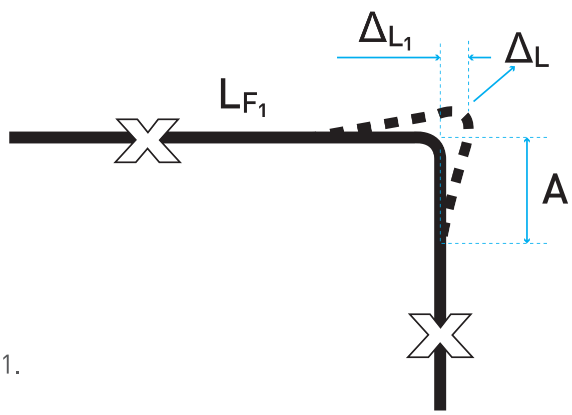
- minimum length of the compensation elements;
- minimum pipeline length at the compensation elements to cover using foam pads

MECHANICAL DESIGN

7.2 Elbows with angle between 80-90° - L compensation

In order to define the network minimum length to cover with foam pads at an L elbow with angle between 80° and 90° first of all must be calculated the expansion at the straight section end, using formulas in paragraph 6.
Once known the expansion, using the diagrams in the following pages of this catalogue, it will be possible to calculate, according to the steel pipeline diameter, the length A, meant as length starting from the bend to be protected with the foam pads in order to prevent damages at the polyurethane insulation.

Inserting in the diagram on the x-axis the ΔL value, calculated according to the series of the pipeline insulation and the height of the backfilling soil, it will be possible to obtain on the y-axis, using the specific bend for the designing pipeline diameter, the above described length A.



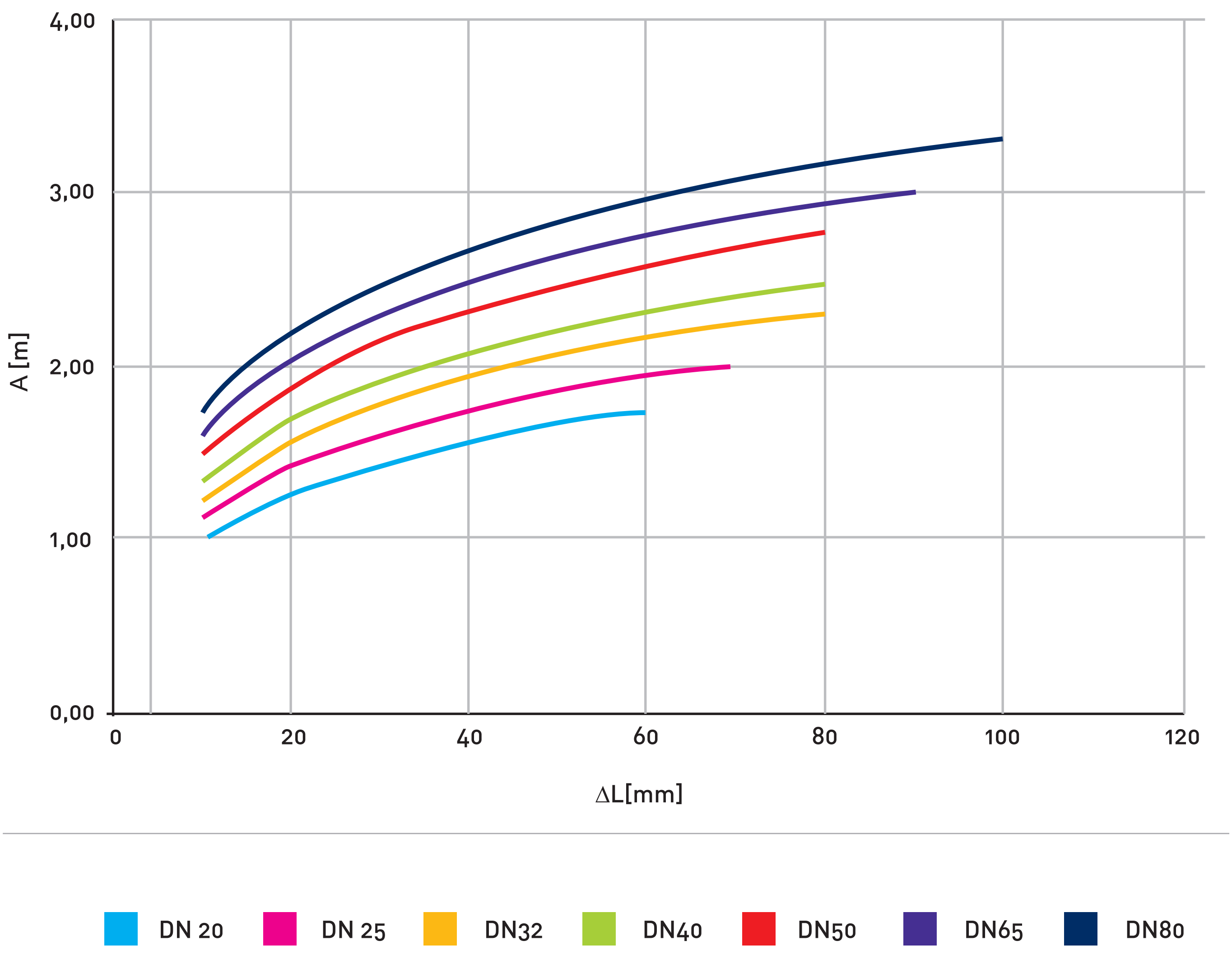
1.

---

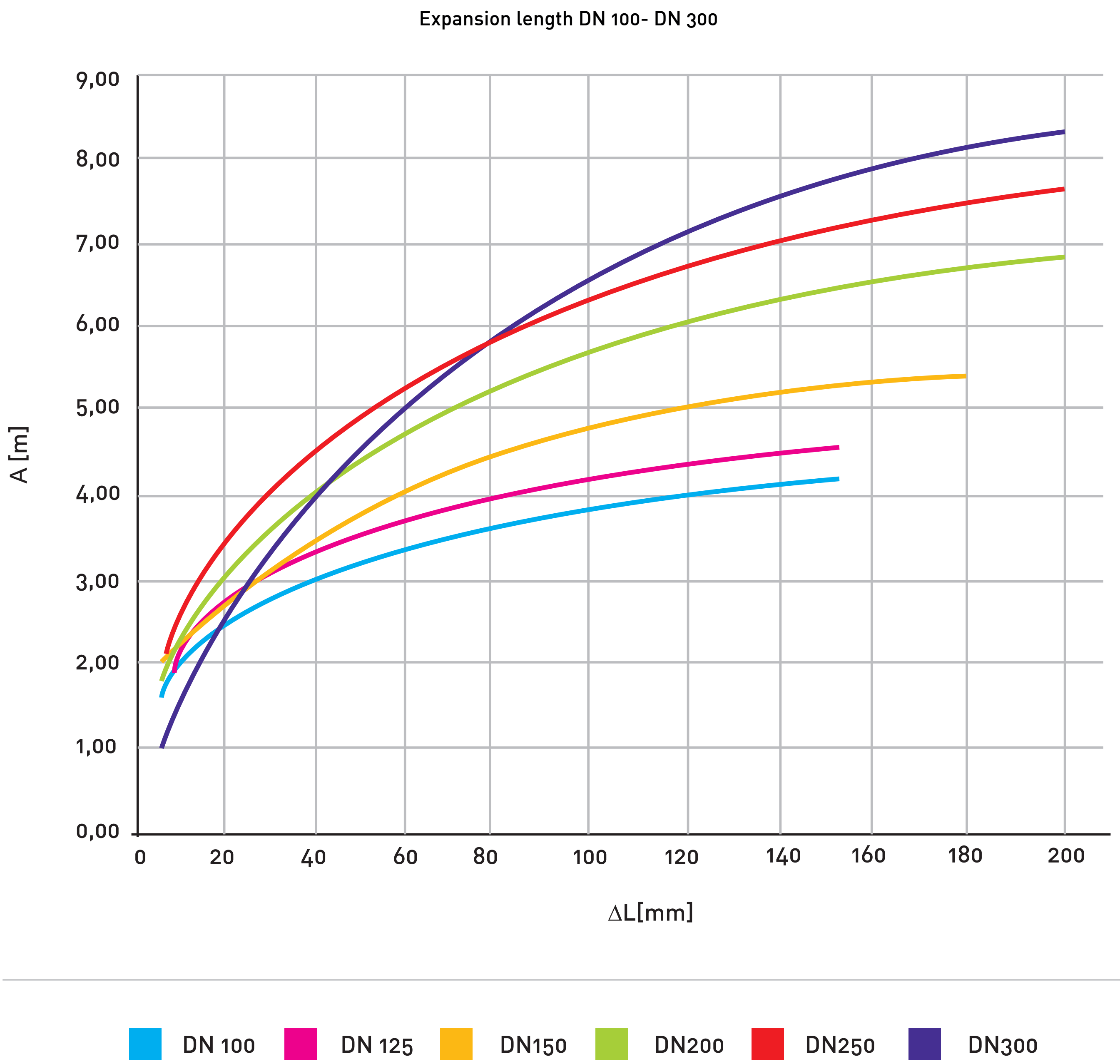
[1] network geometrical scheme

MECHANICAL DESIGN

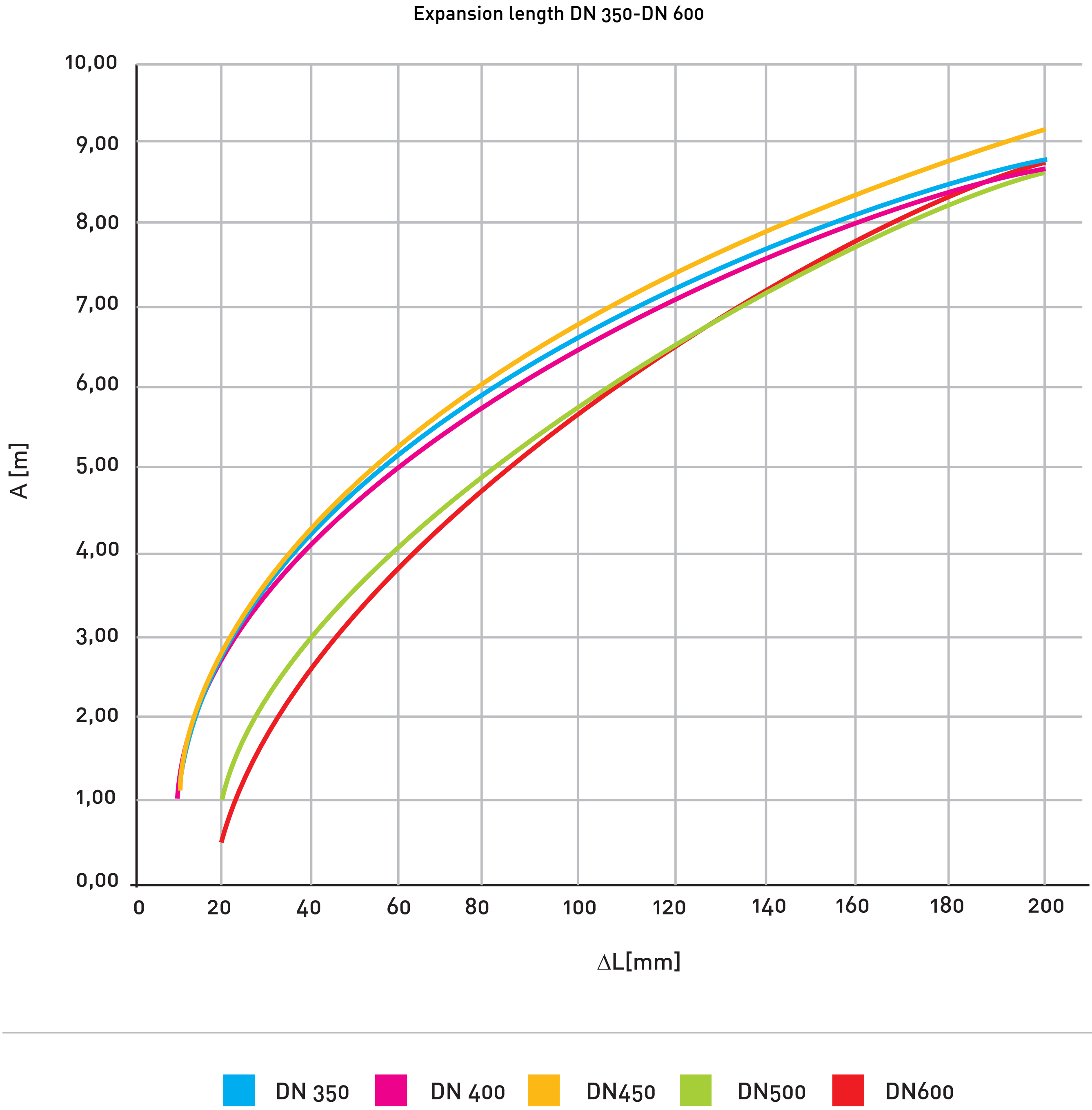
Expansion length DN 20- DN 80



MECHANICAL DESIGN



MECHANICAL DESIGN



MECHANICAL DESIGN

Once known the expansion minimum length, it is necessary to state the number of foam pads to arrange along this pipeline section and the way to arrange them.
In order to define the necessary maximum number of foam pads layers first of all must be calculated the resulting strain using the formula mentioned above, that is:

$$\Delta L_{TOT} = \sqrt{\Delta L_1^2 + \Delta L_2^2} \quad [mm]$$

The minimum foam pad thickness necessary to absorb the expansion results taking into consideration that the foam pads can be compressed by 75% (a foam pad with a thickness of 40 mm absorbs an expansion of 30 mm), therefore it results that:

$$s_{mat} = \frac{\Delta L_{TOT}}{0,75} \quad [mm]$$

ECOLINE foam pads are available with 40 mm thickness and can be overlapped in different layers in order to absorb strongest expansions.
Foam pads, necessary in order to avoid damages to the polyurethane insulation when pipeline is expanding, have however the disadvantage to cause a temperature increase on the surface of the PEAD outer casing. The European standard EN 13941 suggests to limit this temperature value at the maximum value of 50°, in order not to damage the outer casing (because of the softening phenomena induced by too high temperatures). It has been showed that, in order to limit the temperature value at the maximum value of 50° it is necessary that are not arranged on the pipeline more than foam pads layers. Considered what above mentioned, the maximum expansion which can be therefore absorbed through the foam pad is about 90 mm.
Once known the minimum thickness of the necessary foam pads to absorb the expansions, s mat , the number of layers is obtained rounding 1 2 up the result of the following formula:

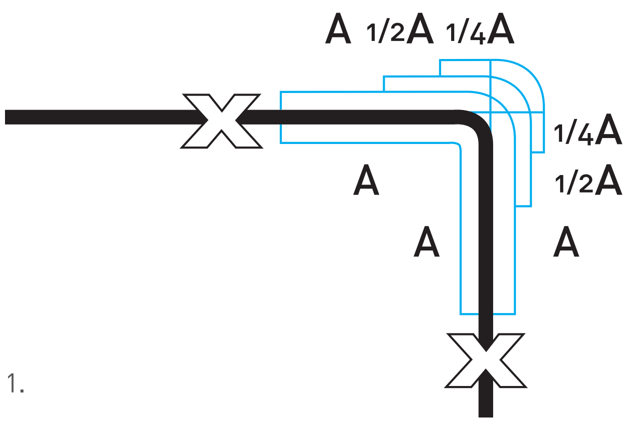
$$n_{mat} = \frac{s_{mat}}{40}$$

In order to arrange the foam pads along the expansion section A, the following practical rule must be taken into consideration:

- arrange 1 foam pad layer along all the length A;
- arrange the possible second foam pad layer for a length equal to A/2;
- arrange the possible and last third layer for a length equal to A/4.

MECHANICAL DESIGN

In practical terms, considered the foam pads commercial dimensions, it is common to round up to the entire value (in metres) the resulting length as described above.
The above calculated foam pads must be arranged so that they can absorb the expansion and therefore on the outer side of the pipeline.
On the inner side it is enough to arrange a foam pad layer for all the expansion length, considered that the pipeline contraction movement during cooling is shorter than the first expansion one because it is limited by the friction stress.
In the district heating network sections where axial stresses are reduced by pre-heating, the foam pads must be arranged in a symmetrical way, both on the inner side, and on the outer side.
What above mentioned is showed in the following picture:



1.

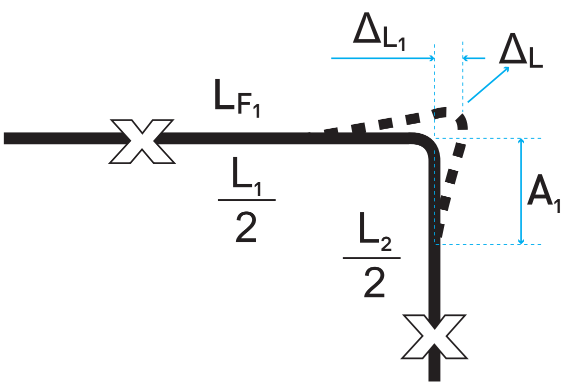
[1] foam pad arrangement scheme

MECHANICAL DESIGN

Numerical example
A numerical example is presented below with the calculation of the mode of installation of the pads at a 90 ° elbow. For simplicity, the values of the second are reused numerical example illustrated in paragraph 6:

- DN 200 - DE 315 pipes;
- backfill on the extrados of 1 m;
- operating temperature: 120 ° C;
- laying temperature: 10°C;
- section length 1 (between free ends): 120 m;
- section lenght 2 (between free ends): 54 m.

Recalling what we saw in the previous paragraphs, in this case it results L_F > L/2, therefore the dilatation at the end of the section will go calculated with the expression:



1.

$$\Delta L_1 = \alpha (T_{max} - T_{inst}) \frac{L_1}{2} - \frac{F\left(\frac{L_1}{2}\right)^2}{2EA_s} =$$

$$= \left(1{,}2*10^{-5}*(120-10)*\frac{120}{2} - \frac{5.882{,}10*\left(\frac{180}{2}\right)^2}{2*210.000*3.033{,}8}\right)*1.000 = 62{,}58 \text{ mm}$$

e

$$\Delta L_2 = \alpha (T_{max} - T_{inst}) \frac{L_2}{2} - \frac{F\left(\frac{L_2}{2}\right)^2}{2EA_s} =$$

$$= \left(1{,}2*10^{-5}*(120-10)*\frac{54}{2} - \frac{5.882{,}10*\left(\frac{54}{2}\right)^2}{2*210.000*3.033{,}8}\right)*1.000 = 32{,}27 \text{ mm}$$

Using the previous diagram for the diameter DN 200 we obtain the length of pipe to be covered with pads at the 90 ° elbow:

A_1 ~ 4,90 m
A_2 ~ 3,85 m

The maximum thickness of pads is defined as a function of the resulting displacement for which:

$$\Delta L_{tot} = \sqrt{\Delta L_1^2 + \Delta L_2^2} = \sqrt{62{,}58^2 + 32{,}27^2} = 70{,}41 \text{ mm}$$

In detail, the minimum thickness of pads necessary to absorb the dilatation is obtained from the expression:

---

[1] foam pad arrangement scheme

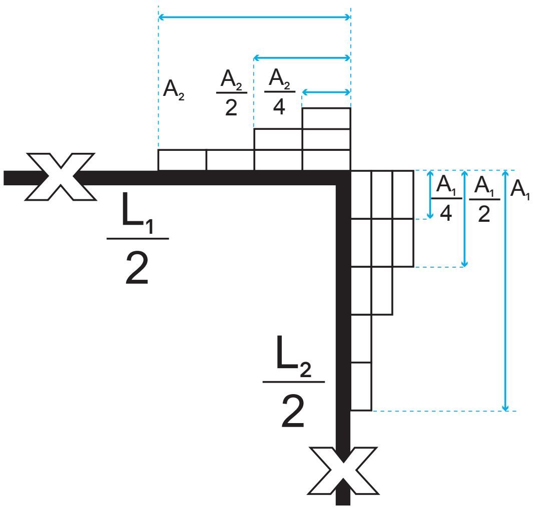
MECHANICAL DESIGN

$$s_{mat} = \frac{\Delta L_{tot}}{0{,}75} = \frac{70{,}41}{0{,}75} = 93{,}88$$

The pads supplied by Ecoline have a thickness of 40 mm (having already taken into account the previous expression of the absorption capacity of a single pad); the number of layers is obtained by rounding up the result of the following relation:

$$n_{mat} = \frac{s_{mat}}{40} = 3$$

Therefore, using the rule for the distribution of pads previously described, the pads at the elbow will be positioned as shown in the following figure:



1.

7.3 Z compensation

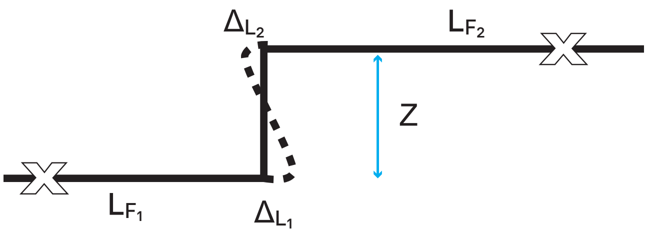
Z compensations, thanks to the greater flexibility they offer, allow to absorb stronger expansions than the L compensations. The necessary minimum Z-length can be calculated through the formula:

$$Z = 0{,}45\ (A_1 + A_2)$$

being:

A_1: lexpansion minimum length for the straight section with a length L_1;

A_2: expansion minimum length for the straight section with a length L_2.



2.

[1] network geometric scheme

[2] network geometric scheme

MECHANICAL DESIGN

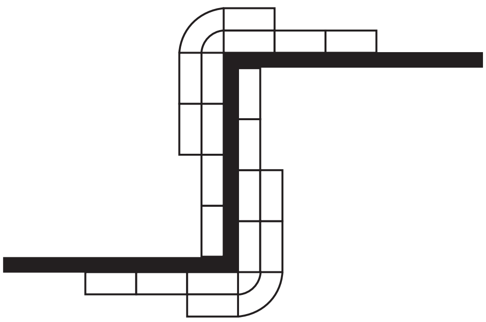
A1 e A2 values can be calculated, once known their respective expansion values ΔL1 e ΔL2, through the above diagrams.
In the same way, exploiting the formula of the previous paragraph, the necessary foam pads thickness will be calculated together with the number of layers to arrange along the Z arm.
Foam pads arrangement on the Z arm respect the practical rule already described in the previous paragraph, taking care of covering with the foam pads all the compensation arm .
On the straight sections ending on the compensation it will be enough to arrange a section of pads with a length of 1 m with a thickness equal to the maximum thickness placed on the compensation arm, followed by a foam pad layer having the same length, according to the diameter:

- DN ≤ 50 → 1 m;
- 50 < DN < 100 → 2 m;
- DN ≥ 125 → 3 m;

The pads above mentioned must be arranged on the outer side of the pipeline.
On the inner side will be placed only one pad layer with the same length of the ones placed on the outer side.

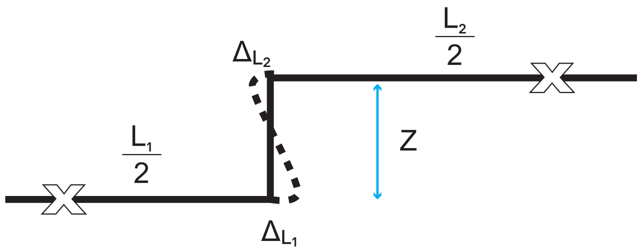
Numerical example
A numerical example is presented below with the calculation of how the pads are laid in correspondence with a Z compensation. The values of the numerical example used for the 90 ° elbows are used to simplify the comparison.

- DN 200 - DE 315 pipes;
- backfill on the extrados of 1 m;
- operating temperature: 120 ° C;
- laying temperature: 10 ° C;
- length of section 1 (included between free ends): 120 m;
- section length 2 (between free ends): 54 m.

1.


[1] foam pad arrangement scheme

MECHANICAL DESIGN



1.

The dilatations at the calculated ends are equal to:
ΔL_1=62,58 mm and ΔL_2=32,27 mm

As already seen, using the diagrams necessary to determine the extension of the expansion zone, we obtain
A_1 ~ 4,90 m
A_2 ~ 3,85 m

and then using the previously introduced report, the minimum length of the Z compensation will be equal to:
$Z=0{,}45(A_1+A_2)=0{,}45(4{,}90+3{,}85)=3{,}94$ m

The maximum thickness of the pads on each elbow is defined according to the specific displacement, so

$$s_{mat,1}=\frac{\Delta L_1}{0{,}75}=\frac{62{,}58}{0{,}75}=83{,}44$$

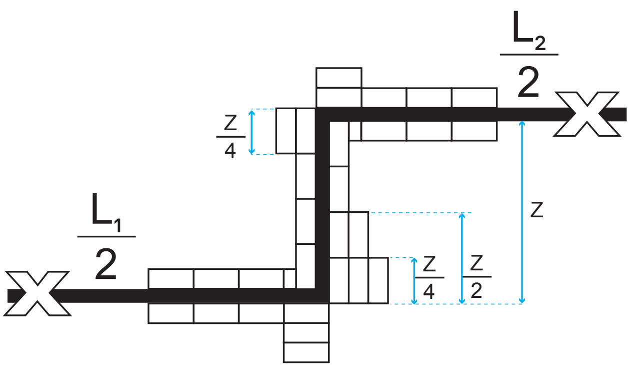
$$s_{mat,2}=\frac{\Delta L_2}{0{,}75}=\frac{32{,}57}{0{,}75}=43{,}43$$

The number of layers is then obtained by rounding up the result of the following relation:

$$n_{mat,1}=\frac{s_{mat,1}}{40}=3$$

$$n_{mat,2}=\frac{s_{mat,2}}{40}=2$$

Therefore, using the rule for the distribution of pads previously described, the pads at the elbow will be positioned as shown in the following figure:



2.

[1] network geometric scheme
[2] foam pad arrangement scheme

MECHANICAL DESIGN

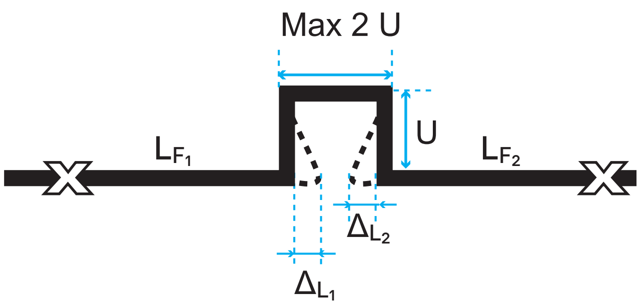
7.4 Omega compensation (U-Bends)

An Omega compensation results even more flexible than a Z compensation and it is able to absorb greater expansions, length being equal/in case of equal length.

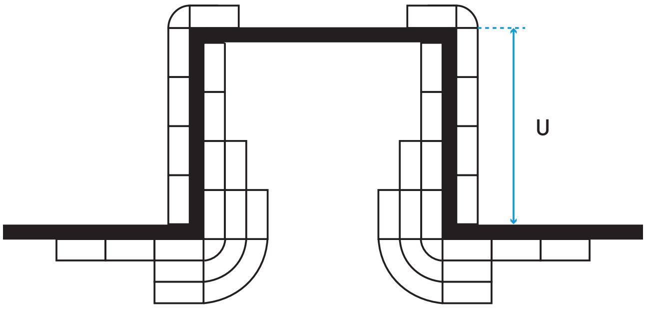
The minimum length of the Omega arm U can be calculated through the following formula:

$$U=0,8\ A_{max}$$

Being A_{max} the maximum expansion length among the ones of each of the two straight arms ending in the omega.
The length of the Omega inner arm is equal at least to double the length of the preinsulated bend arm (for obvious reasons of component installation) and at maximum to double U.
If the inner arm exceeds this length the compensation must be calculated as Z compensation and not as Omega compensation As concerning the minimum pad thickness, the number of layers and the arrangements ways, the above mentioned recommendations with reference to pad laying on a Z compensation arm are still valid.
On the inside lenght of the omega (loop) it is usually sufficient to place a layer of pads for an extension of two meters from the elbow.



1.



2.

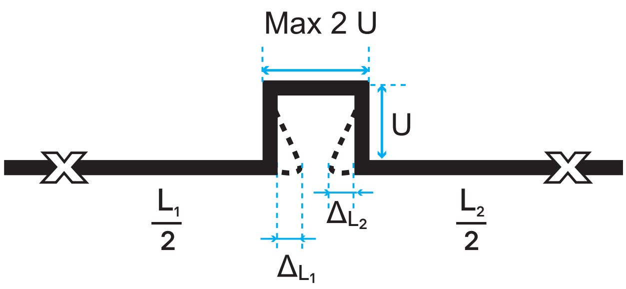
Numerical example
Also in this case there is a numerical example with the calculation of the mode of installation of the pads in correspondence with an Omega compensation, using the values of the previous numerical examples.

- DN 200 - DE 315 pipes;
- coating on the extrados of 1 m;
- toperating temperature: 120 ° C;
- laying temperature: 10°C;
- length of sectional (included between free ends): 120 m;
- Length of section 2 (included between free ends): 54 m.

[1]network geometric scheme
[2]foam pad arrangement scheme

MECHANICAL DESIGN

The dilatations at the calculated ends are equal to:



1.

ΔL_1=62,58 mm and ΔL_2=32,27 mm

As already seen, using the diagrams necessary to determine the extension of the expansion zone, we obtain
A_1 ~ 4,90 m
A_2 ~ 3,85 m

and then using the previously introduced relation, the minimum length of the Omega (loop) , U, can be calculated through the following relation:
$U=0,8\ A_{max}=0,8*4,90=3,92$

The maximum thickness of the pads on each elbow is defined according to the specific displacement, so

$$s_{mat,1}= \frac{\Delta L_1}{0,75} = \frac{62,58}{0,75} = 83,44$$

e

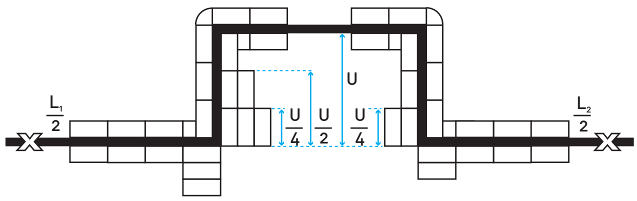
$$s_{mat,2}= \frac{\Delta L_2}{0,75} = \frac{32,57}{0,75} = 43,43$$

The number of layers is then obtained by rounding up the result of the following relation:

$$n_{mat,1}= \frac{s_{mat,1}}{40} = 3$$

$$n_{mat,2}= \frac{s_{mat,2}}{40} = 2$$

Therefore, using the rule for the distribution of pads previously described, the pads at the elbow will be positioned as shown in the following figure:



2.

[1]network geometric scheme
[2] foam pad arrangement scheme

MECHANICAL DESIGN

7.5 Elbows with an angle between 5°- 80°

In some situations, because of the peculiarity of the designing network route, it can be necessary to insert along the line elbows with an angle between 5° e 80°.

The displacement at a bend with angle inferior to 80° can be calculated through the following formula:

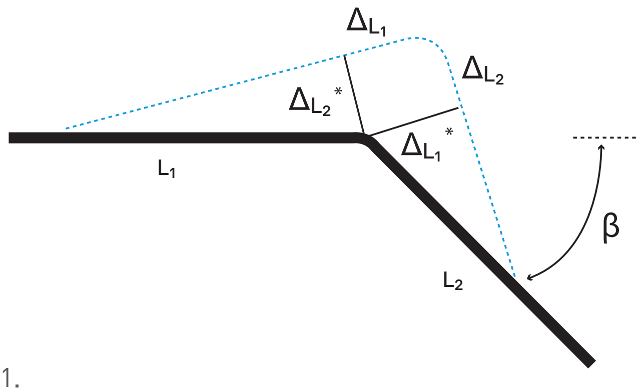
$$\Delta L^*_2 = \frac{\Delta L_1}{\tan(\beta)} + \frac{\Delta L_2}{\sin(\beta)}$$

e

$$\Delta L^*_2 = \frac{\Delta L_1}{\tan(\beta)} + \frac{\Delta L_2}{\sin(\beta)}$$

Being ΔL_1 e ΔL_2 the axial movement deriving from expansion of the straight sections with the length L_1 and L_2 and that they can be calculated through the already mentioned formula:

$$\Delta L_{1,2} = \alpha(T_{es} - T_{inst})\frac{L_{1,2}}{2} - \frac{F(L_{1,2}/2)^2}{2EA_s}$$



1.

In general for small value of the angle ß, the pipeline transversal movement assumes so high values that it is not possible to verify it any longer; furthermore, decreasing the angular deviation angle, increases the distance from the elbow where the pipeline lateral movement disappears. The use of preinsulated elbows with angles equal or inferior to 45° must be reduced, because it is difficult to compensate the expansions; indeed, even if there are small expansions in axial direction, occur pipeline great lateral movements which require absolutely the use of more than one layer of foam pads, with the risk of having on the outer casing surface a higher temperature than the limit value of 50°C.

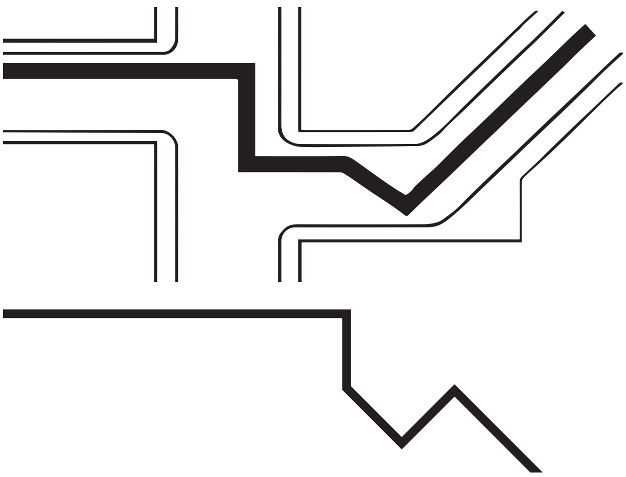
On the other hand, a reduction in the foam pads layer complete thickness involves too high values of compression and cutting stresses on the polyurethane foam, with the risk of damaging the insulation. This occurs also, even to a lesser extent, also in preinsulated elbows with 60° angle.

As a consequence, only elbows with higher or equal angle to 80° are suitable elements for the natural compensation. It is therefore reasonable to use elbows with low angle only for very short line adjustments.

[1] network geometric scheme

MECHANICAL DESIGN

For elbows with angular deviation angle lower than 80°C, **ECOLINE** is available for its own Clients for giving the necessary details in order to verify if the elbow complies with the limit set by the current regulations.
As an alternative, it is possible to compensate through the use of 90° elbows as described on the right.



1.

In the altimetric direction changes, must be done the same considerations, taking into account that for low excavation depths it must be checked, in case of angles towards the top, that the soil load is suitable to contain the pipeline push.

[1] network geometric scheme with angles < 90°

MECHANICAL DESIGN

7.6 Pipes laid using the elastic radius
If the radius of the trench and that of the bended pipes available are different, it is possible to make an "elastic" adaptation following the indications of the following table (radius / angle for tubes L = 12 m).

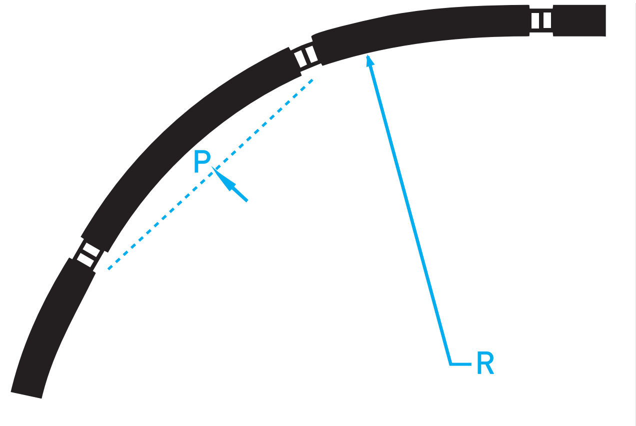
Steel pipe d [mm]	ANGLE/RADIUS ELASTIC	
	Angle [°]	Radius [m]
114.3	11	57
139.7	9	70
168.3	7	84
219.1	6	110
273.0	5	137
323.9	4	162
355.6	3,5	178
406.4	3	203
457.2	3	229
508.0	3	254
609.6	2	305

The pipes can be installed as elastic curves on road sections with large bending radii, in accordance with the values in the following table (stress = max. 210 N / mm^2)

$R_{min\ permissible}$ = 500 x outside diameter of the steel pipe.
Weld the pipes in a single straight stretch and then install them in a curved excavation.

MECHANICAL DESIGN

Steel pipe d [mm]	Minimum Radius allowed [m]	Angular Variation v° every 12 m [°]	Distance P of the resulting arc for approximately length 12 m [mm]
26,9	13	51	1320
33.7	17	41	1060
42.4	21	32	840
48.3	24	28	740
60.3	30	23	600
76.1	38	18	470
88.9	44	15	400
114.3	57	11	310
139.7	70	9	260
168.3	84	8	210
219.1	110	7	160
273.0	137	5	130
323.9	162	4	110
355.6	178	3,5	100
406.4	203	3	90
457.2	229	3	80
508.0	254	3	70
609.6	305	2	60

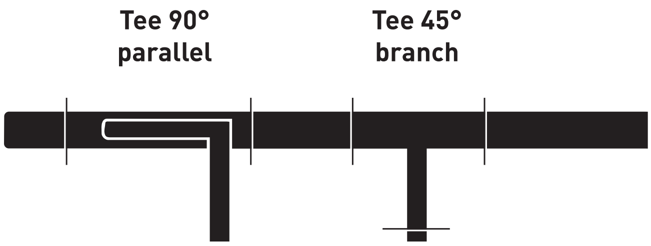


1.

[1] bended pipe

MECHANICAL DESIGN

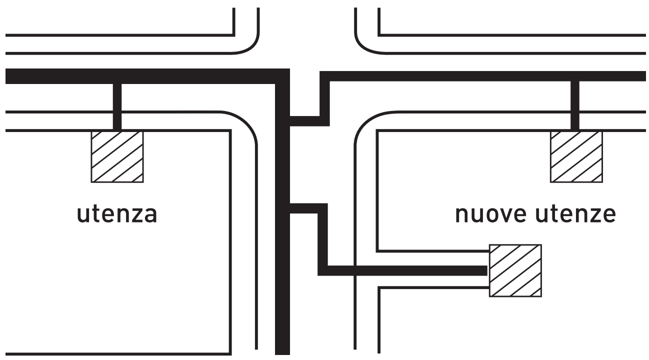
7.7 Network and service connection derivations
At the points where must be realized some derivations from the main network in order to create secondary networks or service connection, are generally installed prefabricated elements, called Tee, which allow this derivation. There are two types of prefabricated preinsulated tees:
• preinsulated perpendicular Tee branches;
• preinsulated parallel Tee branches.



1.

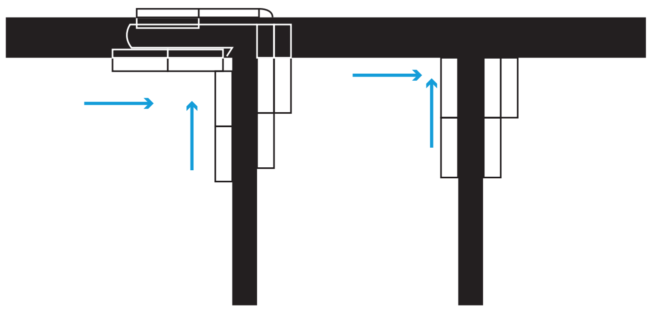
There is another type of prefabricated preinsulated Tees, the straight Tees, whose use is anyway quite limited.

During main line trench excavation must be taken into consideration that derivations must go over the main line. It is also possible to place derivations downwards; it must be taken into consideration that this could be require a cleaning discharge.



2.

Tees must be carefully designed from a mechanical point of view because they are the network elements which are mostly undergone by fatigue stresses.
As a matter of facts, they must resist to the stresses and to the expansion movements both of the main pipeline, and of the derivation pipeline; that is why both the stresses must be considered during designing.



3.

[1] tee derivation type
[2] network geometric scheme
[3] foam pad arrangement scheme

MECHANICAL DESIGN

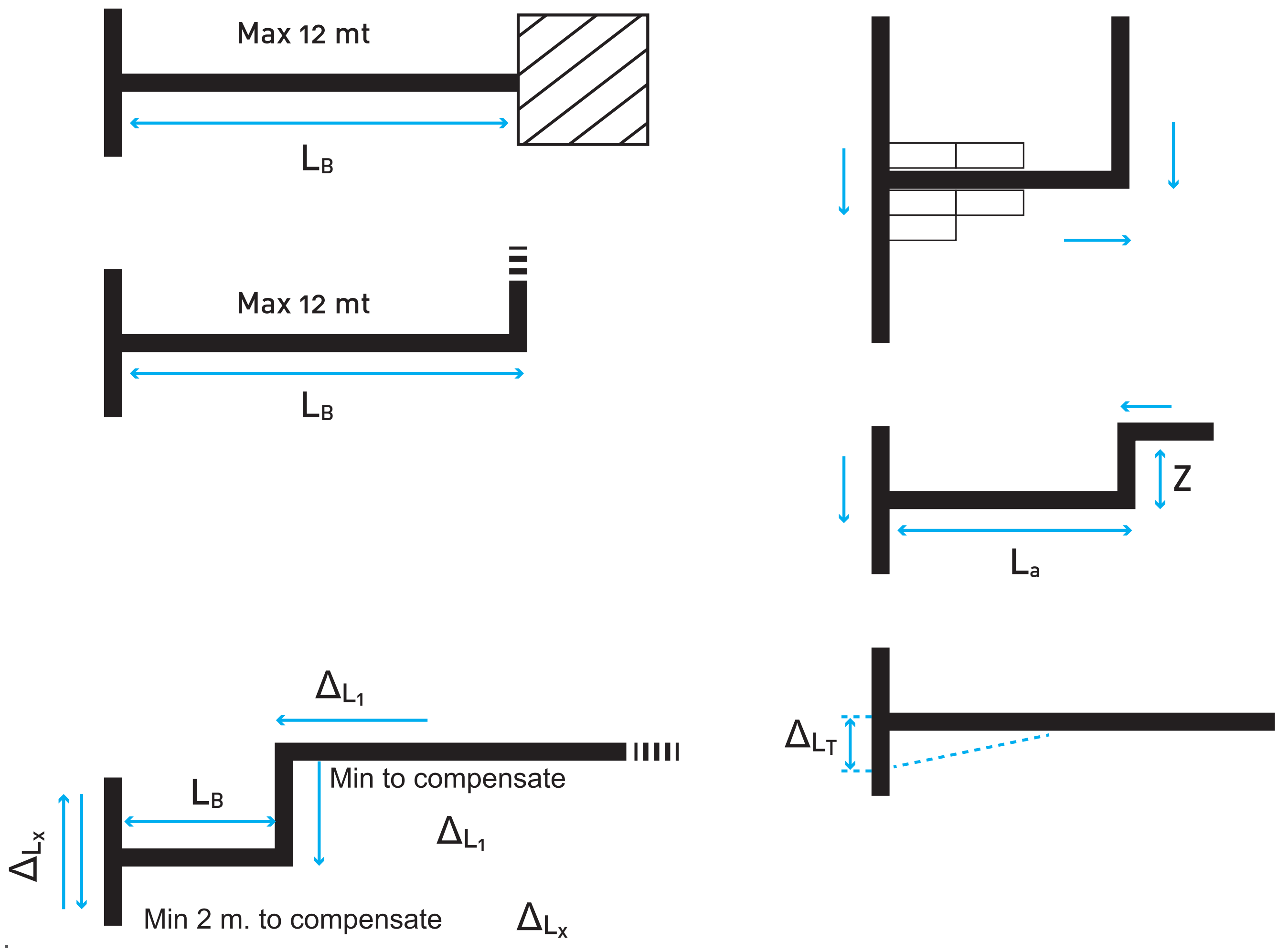
The mechanical design of this network elements consists in:

- choice of the suitable type of Tees to install;
- definition of Tee arm's length;
- definition of the number and position of the foam pads on Tee arms;
- definition of possible extra thicknesses both of the main pipeline and of the derived pipeline at the Tee in order to satisfy mechanical verifications.

Tee mechanical designing is of course one of the most delicate activity during mechanical dimensioning as these elements, because of the stresses they undergo, are among the most fragile of the entire system.
It is indeed really difficult to define clearly some table instructions which allow the fatigue verification of the Tee with suitable safety margins.
ECOLINE is therefore available, through its Technical Department, for the necessary checks on the Tee to be installed along the network, in order to find out the right type of Tees to place and their minimum dimensions according to the peculiarity of the designing line.
It is possible anyway to suggest some useful measures to apply when designing service connection derivations, according to the type of Tee adopted.

Perpendicular Tee branch
This type of Tee results laterally by the movements coming from the main pipeline.
Once known the main pipeline expansion ΔL_x at the derivation, the Tee arm length L_b must be calculated as the expansion length for L compensations.
Furthermore, the Tee arm length L_b must not exceed specific length values in order to avoid that expansions coming from the derived pipeline involve excessive stresses on the Tee.
In general terms it is assumed that the derivation Tee maximum length is equal to 12 m.
If the length of the derivation to realize exceeds this dimension, once reached the value of 12 m a compensation element will be insert (ex. a Z one, suitably dimensioned as already described in the specific paragraph of this catalogue).
Also for what concerns the foam pad arrangement ways at the TEE arm must be applied the laying recommendations supplied in the paragraph about the elbows with angle between 80° e 90°.

MECHANICAL DESIGN



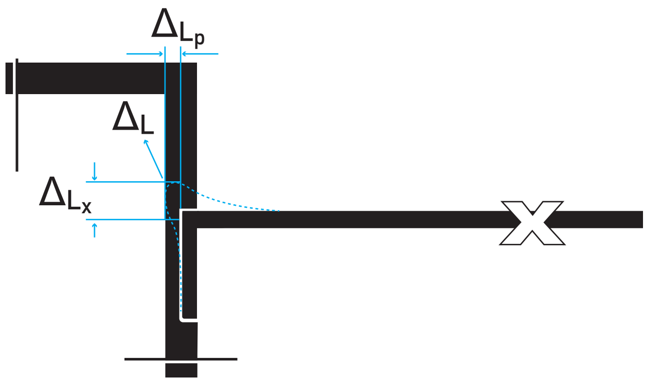
1.

[1] network geometric scheme

MECHANICAL DESIGN

Tee parallel

The parallel Tee branch and in particular the parallel arm of the Tee of length L_p, must to be dimensioned according to the movements of expansion of both the main line, and the branch. At the derivation 90° bend a radial movement, composition of the two above mentioned movements.



1.

The expansion movement value of the main line at the derivation can be calculated through the formula used to determine the movement at any point of the line:

$$\Delta L_x = \alpha(T_{es} - T_{inst})\, L_x - \frac{F(2L - L_x)\, L_x}{2EA_s}$$

The expansion movement value of the derivation can be instead calculated through the formula used to determine the movement at the section end:

$$\Delta L_p = \alpha(T_{es} - T_{inst})\, \frac{L_p}{2} - \frac{F\left(\frac{L_p}{2}\right)^2}{2EA_{s,\,stacco}}$$

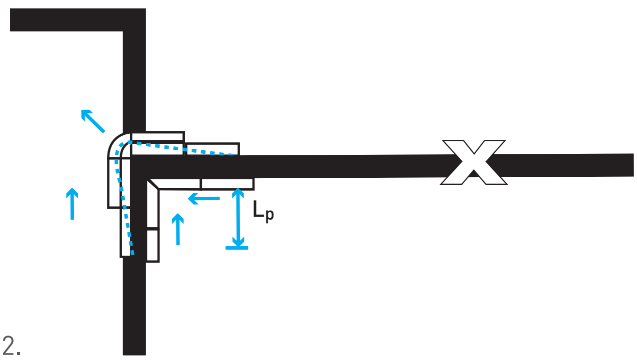
The resulting movement is therefore equal to:

$$\Delta L = \sqrt{\Delta L_x^2 + \Delta L_p^2}$$

The arm length Lp must be calculated as already done in order to determine the expansion minimum length of a 90° bend (L compensation), according to the expansion ΔLp.

Moreover, it is possible to verify that to reduce stresses on the derivation Tees, Lp length must not exceed specific values and in particular it must approximately be included in the range:

$1{,}5\ m \le L_P \le 4m$



2.

[1]network geometric scheme
[2]foam pad arrangement scheme

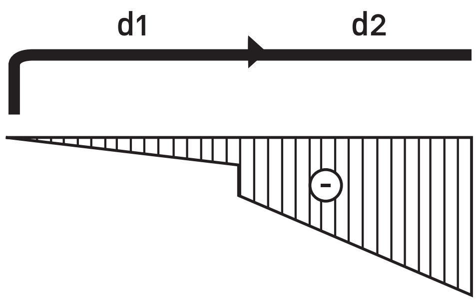
MECHANICAL DESIGN

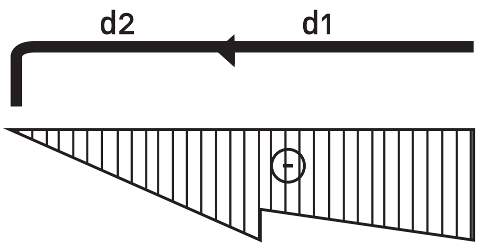
7.8 Reductions

When installing a reduction, occurs a modification of the axial stress depending on the variation of the steel traversal section. In particular, the stresses diagram presents a peculiarity with an increase of the axial stress on the side of the inferior diameter pipeline, expressed by the formula:

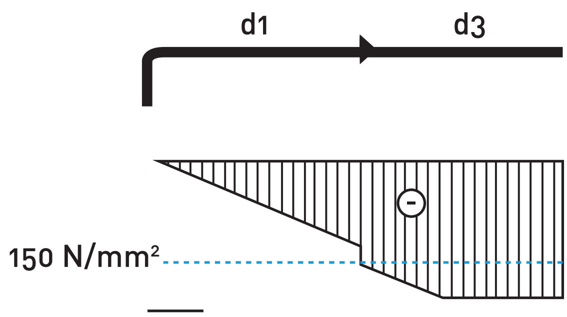
$$\sigma_2 = \sigma_1 \frac{A_{s,1}}{A_{s,2}}$$

The stresses diagram assumes the shape of the following picture:





From a designing and mechanical dimensioning point of view, it is important to verify that a reduction involving a difference of two diameters is placed in a point where the axial stress (on the side of the inferior diameter pipeline) results lower than 150 N/mm^2, as shortly indicated in the following picture.



When the reduction is placed in a completely blocked area, on both sides of the reduction, occurs sliding areas which make it not easy any longer to evaluate the axial stress along the pipeline. With the reduction in a blocked area it is acceptable the difference of a unique nominal diameter.

(-) Compression force
(+) Traction force

HYDRAULIC DESIGN

1. Introduction

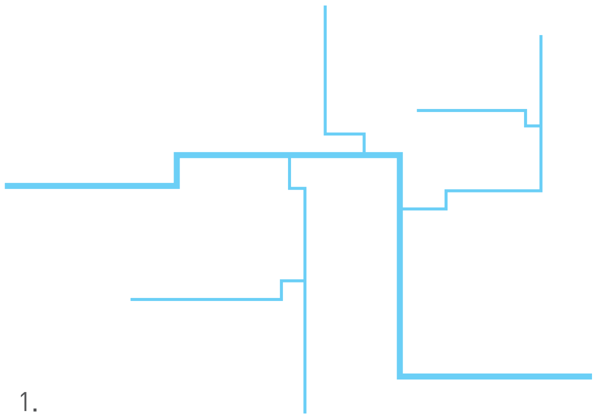
Fluid dynamic dimensioning of a district heating network involves two important aspects:

- hydraulic dimensioning of the district heating system sections;
- calculation of the heat losses in the different sections of the district heating system and calculation of total heat losses.

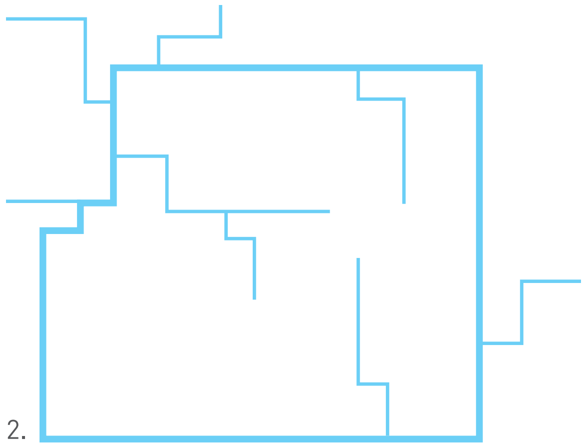
2. Hydraulic dimensioning

Hydraulic dimensioning of a district heating network consists in defining, for each section of the designing system, the section diameter and as a consequence of the main hydraulic parameters, such as speed, load losses, pressure in the nodes. The first aspect to define before developing a district heating system is the choice about the network configuration. The network structure can have one of the following shape:

- tree structure: the route is determined by the big service connections and by the partial service connections barycentre at thermal loads medium-low density;
- ring structure: it allows supplying of sensible service connections using different lines, increasing the reliability of the service;
- mesh structure: there are different routes to reach every single service connection; it is a very reliable system used in district heating networks serving big urban and densely populated areas.



1.

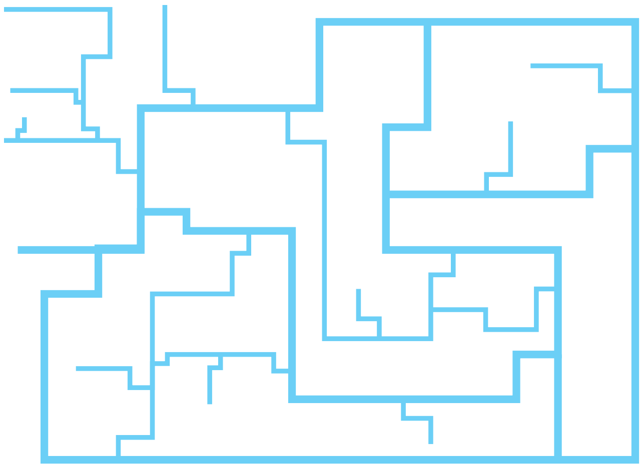


2.

[1]network with a tree or branched structure

[2]network with a ring structure

HYDRAULIC DESIGN



3.

In general it is possible to say that with the complexity of the structure improves the reliability of the service, but at the same time increases the realization cost and it is more difficult to manage. The choice of the type of structure to adopt depends essentially on the level of complexity of the district heating system which will be developed.
Plants serving big urban areas, with a lot of different service connections, require the realization of a very reliable system which will be provided with a developed managing structure and it will be therefore better to realize a ring or mashes system; on the contrary, district heating systems serving small communities must require lower building costs and easier managing, choosing tree systems.
Another important element to define in the preliminary phase of a district heating system developing concerns the choice of the vector fluid and of the network operating temperature.
In the district heating networks are generally used two types of fluid:

- hot water (T_{supply} 70÷95°C, T_{return} 50÷60°C);
- superheated water (T_{supply} 105÷140°C, T_{return} 60÷80°C).

Having lower temperature of the water in the return pipe, it is possible to maximise thermal recovery from co-generation units or similar plants. Furthermore, low water temperature allows to reduce pipelines thermal losses and determines less problems of mechanical stresses in the networks because of smaller thermal expansions.
At the same transmitted thermic power, the higher temperature difference available between supply and return pipes allows to reduce flows and, as a consequence, diameters as well as pipelines supplying and laying costs.
The most modern designing guidelines are leading to developing the so called 4^{th} generation district heating which, in its principles, aims to:

[3] network with a mesh structure

HYDRAULIC DESIGN

- use and integrate different heat sources present on the territory;
- reduce the district heating networks operating temperature, even improving the reduction of the users consumptions.

Without references to the choices about the system structure which will be developed and to the type of vector fluid employed, as already above mentioned, the hydraulic dimensioning of the distribution network consists in defining, for each section of laid pipeline, the main hydraulic reference parameters.

Every network can be divided in single elements (pipeline sections), bounded at the ends by two nodes; the system hydraulic dimensioning involves the necessity to find out the diameter and the speed of every network section and to calculate at each node the total load and the pressure.

In order to do that, first of all it is necessary to find out the thermic power which should pass in each pipeline section, defining the users to serve and the respective thermic powers to provide.

In the initial phase of studying and developing a district heating system it is very important to identify the potential service connections, which determine the size of the heat generation system and the diameter of the first pipelines which will be laid near the power plant.

Under-dimensioning will involve indeed a limit in the future developing and as a consequence of the power plant profitability.

On the contrary, over dimensioning will involve very high investments in the power plant and network construction which will not be compensated by the revenues for heat selling.

Once stated the thermic power of a single pipeline section it will be possible to calculate the circulating flow through the formula

$$Q = \frac{P}{C_s \Delta_T} V_s \left[\frac{l}{s}\right] \qquad [1]$$

where:

P: thermic power [kW];

c_s: water specific heat [kJ/kg*K];

ΔT: temperature difference between supply and return pipelines [K];

V_s: water specific volume [dm^3/kg].

Once known the flow and stated the speed of the circulating fluid in the pipeline, it is therefore possible to calculate the theoretical diameter of the pipeline segment, which has been dimensioning, through the formula:

$$D = \sqrt{\frac{4}{\varpi v} * \frac{Q}{1.000}} \qquad [2]$$

HYDRAULIC DESIGN

where:
Q: water flow calculated with the formula [1] [l/s];
v: fluid speed [m/s].

The real pipeline diameter is identified choosing the first higher commercial diameter than the one identified through the formula [2].
The parameter of water speed used to calculate the diameter is stated also according to the function of the dimensioning pipeline (transport network or distribution network).
In general terms it is possible to refer to the values in the following table:

network diameter [DN]	speed [m/s]
≤ 100	1
100 < DN < 300	1 ÷ 2
DN ≥ 300	2 ÷ 3

Furthermore, the choice of the fluid speed in a pipeline section determines load losses in that specific network section. Load losses per length unit can be calculated through the Darcy-Weisbach formula, so that:

$$J = \frac{\lambda v^2}{2gD} \left[\frac{m}{m}\right] \qquad [3]$$

where:
λ: dimensionless friction coefficient;
The coefficient λ depends on the so called Reynolds number, defined by the formula:

$$Re = \frac{vD}{\eta} \qquad [4]$$

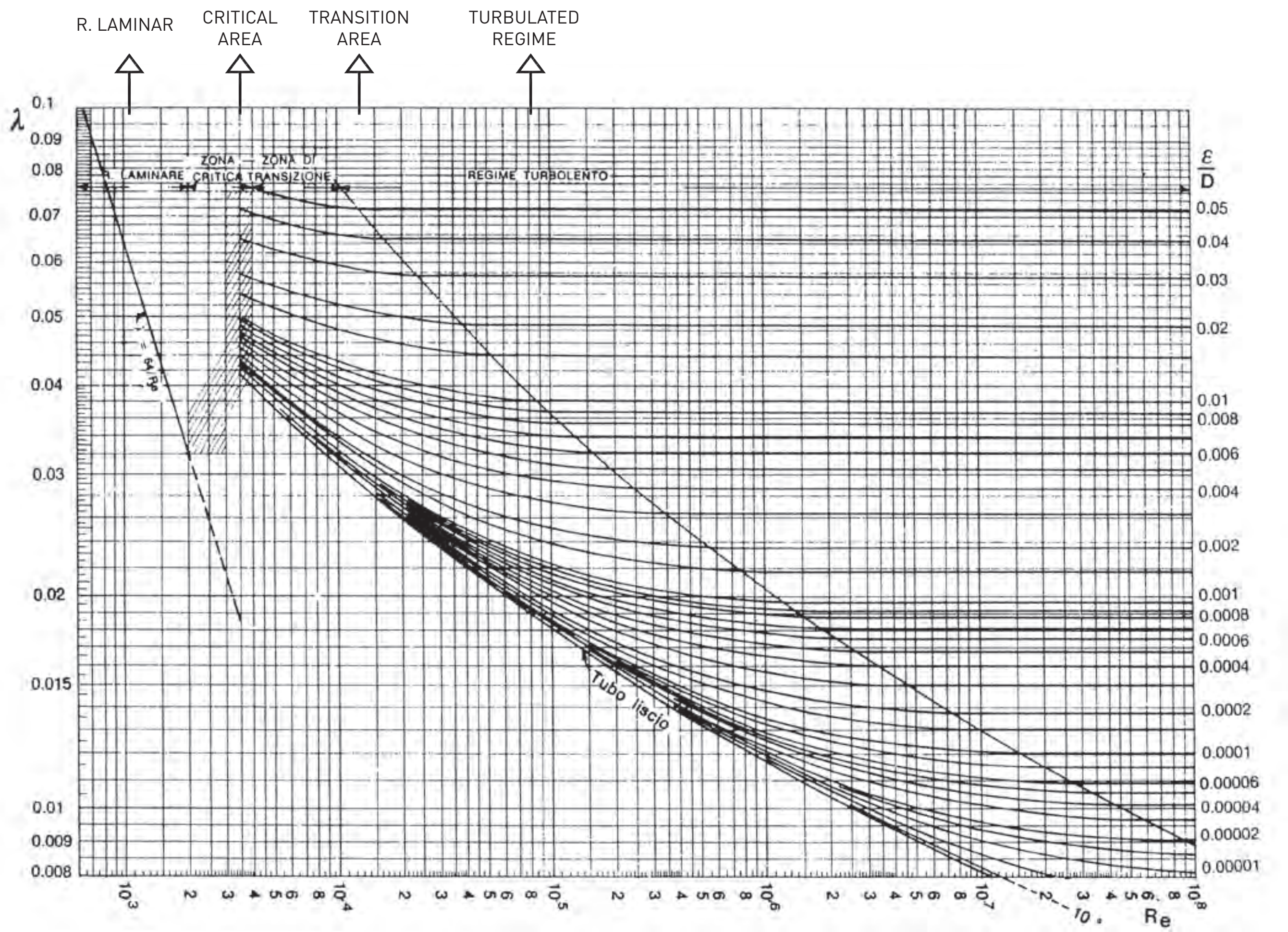
where:
η: fluid kinematic viscosity [m^2/s].

For turbulent regimes of flow, typical of the water and district heating networks operating (Re>3500), the coefficient λ can be calculated through the Colebrook-White formula:

$$\frac{1}{\sqrt{\lambda}} = -2\log\left(\frac{2{,}51}{Re\sqrt{\lambda}} + \frac{\varepsilon}{3{,}71D}\right) \qquad [5]$$

where:
ε: equivalent height of the pipeline roughness. network diameter [DN] speed [m/s] Formula [5] is generally represented also in the so called Moody chart, a logarithmic diagram in which is traced a curve beam characterized by constant relative roughness ε/D.

HYDRAULIC DESIGN



The equation [5] presents the inconvenient of not to allow to explicit the coefficient λ, so it is necessary to find out its solution through following repetition of calculation, both in the verification problems, and in designing problems. For that reason different practical formulas have been studied in order to determine the friction pressure loss, once known the flow and the speed. One of these, valid absolutely turbulent regimes of flow, is the Gauckler-Strickler equation, according to which:

HYDRAULIC DESIGN

$$J = \frac{6,35\ v^2}{K^2 D^{4/3}}$$

K: roughness coefficient [$m^{1/3}s^{-1}$].
In literature there are a lot of tables in which are reported K values depending on the pipeline features; it results for example:

- K = 110 ÷ 130 130 $m^{1/3}s^{-1}$ for new steel pipelines;
- K = 80 ÷ 100 $m^{1/3}s^{-1}$ for operating steel pipelines.

The correct hydraulic dimensioning of the district heating system pipelines involves the following values of linear load losses:

- distribution network: J ≤ 10 m/km
- transport network: J ≤ 15 m/km

There are below two example tables obtained applying the Colebrook-White formula, in which are shown the speed and flow value correspondent to two fixed load losses values, generally used as a reference in the calculations.
It is also indicated thermal power of each diameter for the calculated fluid speed value, according to two typical network operating temperatures.

HYDRAULIC DESIGN

TABLE 1

Calculation hypotheses
ε = 0,2 mm; J = 10 m/km; T_{RETURN} = 60°C

DN	$d_{int,acc}$ [mm]	v [m/s]	Q [l/s]	Q [m³/h]	Power [kW]	
					T=120°C	T=90°C
25	29,10	0,41	0,27	0,98	68	34
32	37,20	0,48	0,52	1,89	131	65
50	54,50	0,62	1,45	5,21	363	181
65	70,30	0,73	2,84	10,21	712	356
80	82,50	0,80	4,29	15,43	1.076	538
100	107,10	0,96	8,60	30,97	2.160	1.080
125	132,50	1,09	15,03	54,11	3.774	1.887
150	160,30	1,23	24,72	89,00	6.209	3.104
200	210,10	1,45	50,10	180,35	12.582	6.291
250	263,00	1,67	90,51	325,82	22.731	11.365
300	312,70	1,85	142,38	512,58	35.760	17.880
400	393,80	2,14	260,16	936,58	65.342	32.671
500	495,40	2,45	472,44	1.700,78	118.657	59.328
600	595,80	2,74	764,47	2.752,08	192.003	96.001
700	695,00	3,00	1138,86	4.099,89	286.036	143.018
800	795,40	3,27	1625,83	5.852,98	408.342	204.171

HYDRAULIC DESIGN

TABLE 2

Calculation hypotheses
Ɛ = 0,2 mm; J = 15 m/km; T_{RETURN} = 60°C

DN	$d_{int,acc}$ [mm]	v [m/s]	Q [l/s]	Q [m³/h]	Power [kW]	
					T=120°C	T=90°C
25	29,10	0,50	0,33	1,19	83	41
32	37,20	0,59	0,64	2,30	160	80
50	54,50	0,75	1,76	6,32	441	220
65	70,30	0,89	3,45	12,41	865	432
80	82,50	0,98	5,24	18,88	1.317	658
100	107,10	1,16	10,44	37,59	2.622	1.311
125	132,50	1,33	18,27	65,77	4.588	2.294
150	160,30	1,49	30,15	108,55	7.572	3.786
200	210,10	1,77	61,26	220,54	15.386	7.693
250	263,00	2,03	110,28	397,01	27.697	13.848
300	312,70	2,26	173,64	625,10	43.611	21.805
400	393,80	2,61	317,28	1.142,22	79.689	39.844
500	495,40	3,00	577,49	2.078,96	145.042	72.521
600	595,80	3,35	933,98	3.362,31	234.577	117.288
700	695,00	3,68	1.396,07	5.025,85	350.637	175.318
800	795,40	3,99	1.982,59	7.137,34	497.948	248.974

HEAT LOSSES

In order to perform the correct hydraulic dimensioning of the district heating network must be calculated the total load losses value along the most disadvantaged hydraulic route, obtained as the sum of the terms relating to:

- geodetic losses.
- distributed losses.
- concentrated losses in case of presence of specific network elements (such as valves, reductions etc.) which are proportional to the square speed.

This value allows to define the pressure value the circulating pumps, generally installed in the production power plants, must be able to supply.
It will be also necessary to verify, at the hydraulically most disadvantaged user, is guaranteed a load difference between the supply pipe and the return one equal at least to 1 ÷ 1,5 bar.
The procedure above shortly mentioned shows schematically the steps which must be performed during hydraulic dimensioning of the district heating network.
The complex systems such as the mesh ones or the ring ones usually requires the use of specific software for hydraulic dimensioning.
ECOLINE is available through its Technical Department and its Consultants in order to support the Client in doing the most suitable choices during network hydraulic dimensioning.

3. Heat losses in a district heating network
In a district heating network, the temperature of the fluid transporting heat decreases (exponentially) when increases the covered distance, according to a proportion which depends on the fluid features, on the speed, on the pipeline diameter, on the insulating properties of the pipeline and of the "bed" on which is laid, on the supply temperature of the fluid itself and on the environmental temperature.
This temperature reduction determines a reduction of the transported thermal power; the heat quantity dissipated during heat transportation from the power plant to the service connections is generally defined as "network loss". It is therefore expressed by the formula:

$$P_r = \Sigma_{i=1}^{n} E_{c,1} - \Sigma_{j=1}^{m} E_{u,j}$$

where:

P_r: network loss in absolute terms of energy/power;
$E_{c,i}$: energy supplied by the ith heat source;
$E_{u,j}$: energy absorbed (sell) by the jth service connection.

HEAT LOSSES

The difference between the produced heat in the power plant and the heat supplied (sold) to the service connections, divided for the produced heat, is the so called relative network loss. It is therefore expressed by the formula:

$$\Delta P_r = \frac{\left(\sum_{i=1}^{n} E_{c,1} - \sum_{j=1}^{m} E_{u,j}\right)}{\sum_{i=1}^{n} E_{c,1}}$$

In a district heating network heat losses can be essentially related to:

- service pipeline features;
- insulating layer features;
- features of the soil where the pipeline is laid;
- supply and return fluid temperature.

District heating network losses can be calculated through the simplified formula:

$$\Phi = U\,[(T_m + T_r) - 2T_t]$$

where:

Φ: single heat loss for pipelines couple [W/m];
U: thermal transmission coefficient, inversely proportional to the thermal resistances of the materials [W/(m°C)];
T_m: supply fluid temperature [°C];
T_r: return fluid temperature [°C];
T_t: ground temperature [°C].

The coefficient U can be calculated as the inverse of the sum of the thermal resistances of different materials, taking into consideration also, in the calculation, the ground resistance and the exchange resistance between the supply and return pipelines. In details:

$$U = \frac{1}{(R_{T,ts} + R_{T,i} + R_{T,tg} + R_{T,t} + R_{T,s})}$$

where:

$R_{T,ts}$: service pipeline thermal resistance [(m°C)/W];
$R_{T,i}$: insulation thermal resistance [(m°C)/W];
$R_{T,tg}$: outer casing thermal resistance [(m°C)/W];
$R_{T,t}$: ground thermal resistance [(m°C)/W];
$R_{T,s}$: exchange thermal resistance between the two pipelines [(m°C)/W].

The different resistance parameters can be calculated through the following formulas:

$$R_{T,ts} = \frac{1}{2\varpi\lambda_{ts}} \ln\left(\frac{d}{d_i}\right)$$

$$R_{T,i} = \frac{1}{2\varpi\lambda_{i}} \ln\left(\frac{D_i}{d}\right)$$

$$R_{T,ts} = \frac{1}{2\varpi\lambda_{ts}} \ln\left(\frac{D}{D_i}\right)$$

$$R_{T,t} = \frac{1}{2\varpi\lambda_{t}} \ln\left(\frac{4Z_c}{D}\right)$$

$$R_{T,s} = \frac{1}{4\varpi\lambda_{t}} \ln\left[1 + \left(\frac{2Z_c}{C}\right)^2\right]$$

HEAT LOSSES

where:

λ_{ts}: service pipeline thermal conductivity [W/(m°C)];
λ_i: insulation thermal conductivity [W/(m°C)];
λ_{tg}: outer casing thermal conductivity [W/(m°C)];
λ_t: soil thermal conductivity [W/(m°C)];
D: outer casing outer diameter [m];
D_i: outer casing inner diameter [m];
d: service pipeline outer diameter [m];
d_i: service pipeline inner diameter [m];
Z: effective laying depth referred to the pipeline axle [m];
Z_C: virtual laying depth [m];
C: distance between the pipelines axles [m].

Z_C value is obtained through the formula:

$$Z_C = Z + R_0 \lambda_t$$

being R_0 the superficial transition resistance stated at 0,0685 [m^2°C/W].

The single materials resistance values have been stated as follows:

λ_{ts}: 52,33 [W/(m°C)] – complying with UNI EN 10217-2 for steel type P235GH;
λ_i: 0,027 [W/(m°C)]; - complying with UNI 253
λ_{tg}: 0,45 [W/(m°C)];
λ_t: 1,60 [W/(m°C)].

In the following tables are showed the heat losses values per length unit according to the adopted insulation thickness (preinsulated pipeline series).
Calculations have been performed for two different values of the term (T_m+T_r), equal to180 W/m°K and 130 W/m°K, having stated the soil temperature equal to 8° C.

HEAT LOSSES

TABLE SERIE 1

HEAT LOSSES IN THE PIPELINES – INSULATION SERIE 1				
DN	D_E [mm]	U [W/(m°C)]	Φ [W/m] (T_m+T_S) = 130°C	Φ [W/m] (T_m+T_S) = 180°C
20	90	0,14	15,70	22,59
25	90	0,17	19,22	27,65
32	110	0,18	19,63	28,24
40	110	0,20	22,62	32,54
50	125	0,23	25,29	36,38
65	140	0,27	29,85	42,94
80	160	0,28	30,78	44,29
100	200	0,29	31,72	45,63
125	225	0,33	36,79	52,92
150	250	0,40	43,59	62,71
200	315	0,43	47,40	68,19
250	400	0,41	45,74	65,80
300	450	0,48	52,63	75,71
400	560	0,48	53,39	76,81
500	710	0,47	52,12	74,99
600	800	0,58	63,49	91,34
700	900	0,66	72,62	104,47
800	1000	0,75	82,23	118,29

HEAT LOSSES

TABLE SERIE 2

HEAT LOSSES IN THE PIPELINES – INSULATION SERIE 2				
DN	D_E [mm]	U [W/(m°C)]	Φ [W/m] (T_m+T_S) = 130°C	Φ [W/m] (T_m+T_S) = 180°C
20	110	0,12	13,38	19,25
25	110	0,14	15,85	22,80
32	125	0,15	17,23	24,79
40	125	0,17	19,50	28,05
50	140	0,19	21,75	31,29
65	160	0,21	24,40	35,11
80	180	0,22	25,56	36,78
100	225	0,23	26,52	38,15
125	250	0,27	30,54	43,94
150	280	0,30	34,61	49,79
200	355	0,32	36,35	52,30
250	450	0,31	35,41	50,94
300	500	0,35	40,38	58,09
400	630	0,35	40,00	57,55
500	800	0,34	39,06	56,19
600	900	0,40	45,03	64,78
700	900	0,45	50,91	73,24
800	1000	0,50	56,99	81,98

HEAT LOSSES

TABLE SERIE 3

HEAT LOSSES IN THE PIPELINES – INSULATION SERIE 3				
DN [mm]	D_E [mm]	U [W/(m°C)]	Φ [W/m] (T_m+T_S) = 130°C	Φ [W/m] (T_m+T_S) = 180°C
20	125	0,11	12,26	17,64
25	125	0,13	14,31	20,58
32	140	0,14	15,62	22,47
40	140	0,15	17,45	25,11
50	160	0,17	18,86	27,14
65	180	0,19	21,21	30,51
80	200	0,20	22,46	32,31
100	250	0,20	23,19	33,37
125	280	0,23	25,96	37,34
150	315	0,25	28,62	41,17
200	400	0,26	29,75	42,80
250	500	0,26	29,76	42,81
300	560	0,29	32,73	47,09
400	710	0,28	32,18	46,29
500	900	0,28	31,66	45,55
600	1000	0,32	36,28	52,19
700	900	0,36	40,85	58,77
800	1000	0,40	45,53	65,49

HEAT LOSSES

From the previous tables it is evident that the heat losses of the network increase with increasing diameters; diameters that are too high therefore decrease the energy efficiency of the network.

Therefore, district heating systems consisting of oversized pipes are characterized by low system performance.

Moreover, with the same diameter, heat losses increase proportionally as the flow rate decreases (or in the same way as the fluid velocity); in fact, it occurs that during the summer seasons network losses sometimes take on extremely high values. Heat losses can also occur in a district heating pipeline as a result of water leaks on the network itself.
ECOLINE remains available to customers to perform grid loss calculations according to the specific conditions of the system under examination and to make evaluations of economic convenience in the adoption of suitable insulation series pipes.

ECOTHERM SYSTEM

Laying and Installation

LAYING AND INSTALLATION

1. Introduction

The following catalogue section contains a description of the district heating building phases and the arrangements to be implemented to guarantee a high quality of the final work.

District heating systems are designed and conceived to guarantee a life of at least 30-50 years; achieving that life time is possible only if during the installation and the operating phases appropriate arrangements have been implemented to guarantee and maintain the laid product quality.

The Customer is responsible for planning the laying and the installation of the district heating system components which will be realized; he is also responsible for the oversight, checking, verifying and approval of the work detailed rules.

The Contractor, instead, is responsible for the correct installation of the network components. As well as in accordance with the European Standard EN 13941, it will be performed also:

- in accordance with the detailed engineering and with the specifications written by the customer;
- in accordance with the pipelines producer's user and installation manual;
- in order not to damage things or people inside the working area.

This section represents a summary of the contents which must be analysed in details and developed in the specifications, as part of the design documentation.

ECOLINE is at Customer's disposal to offer the necessary support to write the specifications about proper district heating network handling, laying and installation.

The right execution of the work can be obtained by:

- detailed design of work;
- systematic planning of the actions;
- constant testing activity in progress;

District Heating network realization, with reference to pipelines laying activities, can be divided approximately into the following steps:

- material unloading, handling and storage;
- excavation of the trench;
- preparation of the components and laying in the trench;
- surveillance system wires connection at the welding points;
- insulation restoration at the welding points;
- foam-pad installation and well laying at specific points of the network (ex. vents, drains, valves, etc.);
- backfilling of the trench and execution of the superficial handling;
- check list inspection.

ECOLINE Technical Department is available to offer its competence in order to support the designers/customers during the evaluation of specific details, proper for the developing system.

WARNINGS: operations and equipment described in this manual must in any case be subject to the regulations of every single nation regarding the safety and health of workers.

LAYING AND INSTALLATION

2. Preparations for laying

The necessary pipelines and materials to realize a district heating network can be transported to the site by the pipelines' producer or by the Customer, according to the specific contractual conditions. It is very important that preparations for laying, starting from receiving the materials on site, are done following appropriate procedures and taking all the precautions in order to avoid damages to the pipelines and/or to the special fittings.

2.1 Unloading and handling

Unloading operations from the truck are generally involving the Contractor.

Pipelines can be delivered in any place where can enter an articulated vehicle with appropriate dimensions for transporting pipes of 12 m length. Straight pipes are transported on appropriate wooden bars for the distribution of the loading in order to avoid damages to the outer casing.

All the pipelines and the special fittings are supplied with plastic caps at the ends, in order to prevent water, filth or other material from penetrating into them. Those caps must always be maintained on the network components till the beginning of the joint and welding steps. The contractor must guarantee the presence on site of appropriate vehicles for unloading (ex. crane lorries, backhoe for lifting loads, etc.) and competent staff to check unloading steps and to sign materials acceptance report.

Pipes are supplied in assembles for small loads or in piles on wooden bars.

During unloading, special attention must be paid to avoid damages at the polyethylene casing and the polyurethane insulation. As a consequence, when pipes are unloaded using a crane or other handling vehicles, pipes must be lifted at two distant spots so that insulation compression loading is distributed.

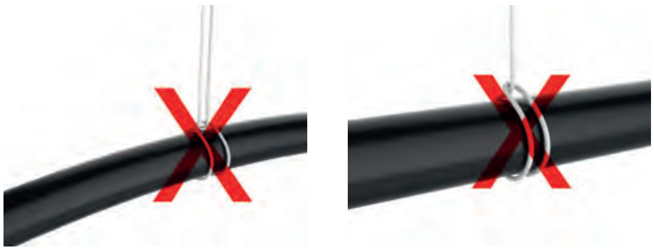
Pipes must be lifted using polyester straps or similar [with a width of min. 150 mm]; the Contractor should prepare on site appropriate straps for the weight to handle, according to what stated in the section 'Products' of this catalogue.

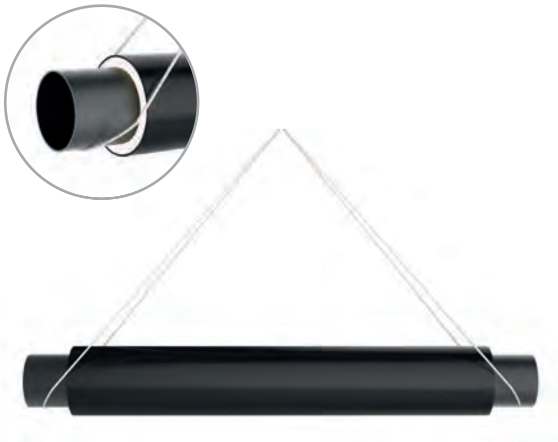
For pipes of considerable length and weight, a lifting beam should be provided for a more appropriate load distribution and handling. The maximum pressure on the outer casing should be 0,3 N/mm^2 $_{(at\ 20°C)}$ in order to avoid damages.

LAYING AND INSTALLATION

For unloading wire ropes and chains can be used only lifting at the steel pipe ends. Proper length chains must be accurately chosen in order to avoid damages at the outer casing.
Manual unloading must be very accurate; a sure and efficient way of unloading is using ramps from the vehicle floor to the ground.
Never let the pipes fall from the transport vehicle. Special fittings must be handled following the same precautions as for the pipes. Because of their lower weight and less space taken, the majority of the special fittings can be handled manually. In case of large diameters, it is suggested to sling special fittings on the steel ends.


1.


2.


3.


4.

[1] correct handling
[2] incorrect handling
[3] handling using wire ropes and chains
[4] Tee storage method

LAYING AND INSTALLATION

2.2 Storage

Materials have to be stored on site in an area which has been identified and properly closed in advance in order to prevent them from unintentional impacts by the construction machinery.

Before leaving the manufacturer's warehouse, steel pipe ends are coated with a protective varnish in order to prevent rain or moisture to damage the pipe during storage on site or transport.

For long term storage, contact directly **ECOLINE** Technical Department to evaluate the most appropriate methods according to the specific features of the available site.

Pipes stored on site have to be always kept in an orderly manner.

Stack the pipes so their labels are always at the same end and so that it is prominent for the following quantity and quality checks.

Materials have to be kept lifted from the ground. For that purpose they can be placed on:

- sand cushions;
- wooden bars.

Storage on sand cushions

The best way for the correct pipes storage consists in stacking the pipes on a solid level surface of stoneless sand.

This level surface of sand has to be lifted at least 20 cm from the natural surface, in order to prevent moisture from penetrating into the insulation.

In addition, in order to prevent soil or foreign deposits to lay on the insulation or on the steel pipe ends where the joints which will be insulated again, the sand level should be prepared so that pipes protrude for at least 1 m in length.

1.

In order to limit the necessary sand quantity for storage, pipes can also be placed on sand cushions.

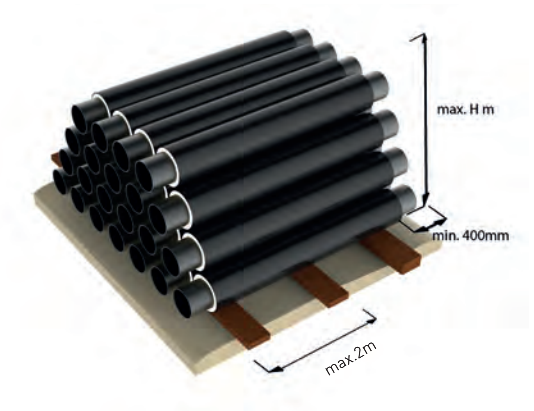
It will be necessary to realize two support bases at the two ends, at a maximum distance of 40 cm from the same ends. In addition, it will be necessary to realize intermediate support bases with a maximum axle spacing of 5 metres.

[1] curves storage method

LAYING AND INSTALLATION

Storage on wooden bars

If the pipes are stored on wooden bars, these must have a minimum length of 10 cm and must be placed at a distance of no more than 2 m from each other in order to offer a proper support.
As for the sand level surface, pipes have to be lifted at least 20 cm from the natural surface, in order to prevent moisture from penetrating into them. The maximum pressure on the outer casing must be 0,3 N/mm^2.



1.

The maximum dimensions of the pipelines stacks are showed in the following table, in accordance with the external diameter of the preinsulated component and the storage method:

Pipeline external diameter [De]	Storage on sand cushions [m]	Storage on wooden bars [m]
90 - 160	1,50	1,50
180 - 355	2,00	1,50
400 - 1100	3,00	2,00
1200 - 1400	3,00	maximum 2 rows

Special fittings storage

Special fittings have to be stored on wooden bars as fot the pipes.
Special attention has to be paid so that all the special fittings are kept with the ends facing downwards or anyway horizontally in order to avoid waterlogging at the end without insulation.

[1] pipes storage practical guidance

LAYING AND INSTALLATION

1. 

2. 

Foam packs have to be stored in dry areas, protected from direct sun-rays, vertically.
Kits contain dangerous chemical products [polyol and isocyanate], therefore they have to be preserved and handled in accordance with the specific requirements stated on the safety data sheets delivered together with the materials.
Products have also an expiry date label on the packaging: this provided that products have been preserved as indicated above. Otherwise, component reaction could be of inappropriate quality for the technical requirements.
In case of doubts about the products preservation, it can be useful to do some reaction tests inside plastic bags in order to verify the foam quality before casting in the joints.
Other accessories, such as:

- heat-shrinkable sleeves;
- rubber wall entry sleeves;
- polyethylene overcasing (shrink and all types);

have to be stored protected from direct sun-rays and from loads, because they may deform and consequently not be proper for a correct use.
In particular, necessary casings for joints have to be stored vertically in order to avoid permanent ovality.
Other elements such as raw and preinsulated valves, compensators, fittings have to bestored sheltering them from bad weather.
Any surveillance system accessories have to be preserved in building/container, perfectly dry and packaged.
Foam pads can be stored under a shed in order to avoid water from penetrating into them in case of rain, which, without impairing functionality, prevents foam pads from their correct placement during installation.

2.3 Arrangements for winter periods

If works are carried out in winter or with temperatures lower than 0°C, specific precautions have to be adopted both during pipes and components handling and storage, and during cutting and removal of polyethylene outer casing and polyurethane insulation parts.
In such temperature conditions, in fact, plastic material becomes more rigid and fragile and consequently more likely to break down.

[1] Tee storage method
[2] Elbows storage method

LAYING AND INSTALLATION

Handling

Special attention has to be paid in order to:

- not to expose the outer casing to impacts;
- not to expose the outer casing to high compression forces;
- limit flexion movements in the components.

3.

Storage of the components

As already stated above, materials such as foam packs, wall entry sleeves, elements for the surveillance system restoration have to be preserved in a closed area, protected from weather conditions. In particular foams have to be preserved at a temperature between 15 and 25 °C. That means that during winter season foam pack components have to be preserved in an heated area till the moment of their use.

Cutting and modifications of preinsulated components

Before cutting polyethylene outer casing, it has to be flame pre-heated at a temperature of about 20-30 °C.

Even if heat spreads slowly in plastic material, it is very important to avoid an outer casing overheating, especially in the areas which should be electro welded.

[3] incorrect pipes handling

LAYING AND INSTALLATION


4.

2.4 Preparing tests for laying preinsulated pipes
Before laying network components it is appropriate to test them, also to check material compliance with the Special Tender Specifications and EN 253. Therefore, receiving the materials it is important at least to:

- check consistency between materials and transport documents;
- check dimensions tolerances (steel/PE thickness, length, etc.);
- verify absence of damages at the polyethylene outer casing;
- verify absence of separation between steel and polyurethane and between polyurethane and polyethylene;
- verify eccentricity and out-of-roundness do not exceed the tolerance limits;
- verify presence of closure plugs;
- verify presence of the label and its correspondence with the component features;
- verify the component manufacturing date;
- verify the surveillance system (electric continuity and insulation resistance tests);
- verify the presence of certifications according to EN 253;

Before laying, it is appropriate to repeat at least the following tests:

- verify absence of damages at the polyethylene outer casing;
- verify absence of separation between steel and polyurethane and between polyurethane and polyethylene;
- verify the surveillance system (electric continuity and insulation resistance tests).

3. Excavations
3.1 Introduction
District heating network construction sites generally have a strong impact on the surrounding environment and especially on the ordinary roads as they request:

- site with a proper width, according to the trench dimension at the presence of two pipelines side-by-side;
- site area minimum length of 50 m to allow the presence of at least 36 m of open site in order to guarantee a proper production and promptly correct the path in case of any interferences.

[4] preinsulated pipelines cutting

LAYING AND INSTALLATION

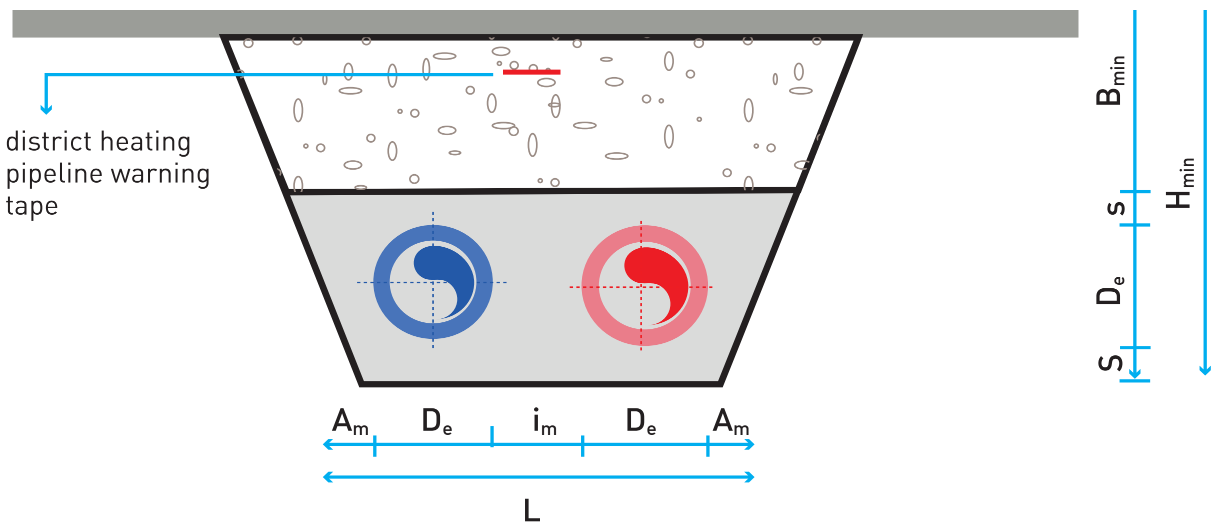
Site area transversal section width has to guarantee the passage of the working vehicles, as well as installation materials storage.

3.2 Trench

Trench dimensions depend on different factors, first of all possible interferences with other underground utilities. Apart from local problems, trench has to respect minimum dimensions due to permit enough space between the pipelines and the trench wall in order to:

- to perform network installation, especially welding and kit joints insulation;
- to compact backfilling materials, especially sand around the pipelines;
- to perform safe laying.

In the following table are reported the minimum dimensions of the trench to realize, according to the HD PE casing outer diameter. The minimum height of backfilling depends on the superstructure and on the risks connected to it, such as heavy road loads or risks of damages caused by working vehicles during the laying in agricultural/ industrial zones.



1.

[1] excavation trench

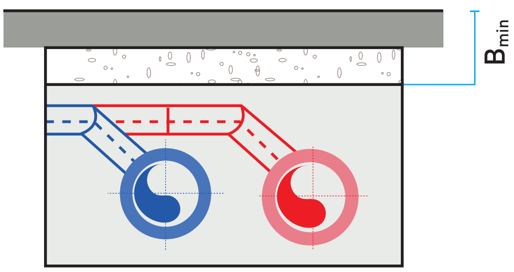
LAYING AND INSTALLATION

EXCAVATION MINIMUM DIMENSIONS FOR DISTRICT HEATING LAYING

D_e [mm]	i_m [mm]	A_m [mm]	L [mm]	s [mm]	B_{min} [mm]	H_{min} [mm]
90	150	200	750	100	400	700
110	150	200	800	100	400	750
125	150	200	800	100	400	750
140	150	200	850	100	400	750
160	200	200	950	100	400	800
180	200	200	1.000	100	400	800
200	200	200	1.000	100	400	800
225	250	250	1.200	100	400	850
250	250	250	1.250	100	400	850
280	300	300	1.500	100	400	900
315	300	300	1.550	100	400	950
355	300	300	1.650	100	400	1.000
400	300	300	1.700	100	400	1.000
450	300	300	1.800	100	400	1.050
500	350	350	2.050	100	400	1.100
520	350	350	2.100	100	400	1.150
560	350	350	2.200	100	400	1.200
630	350	350	2.350	100	400	1.250
710	350	350	2.500	100	400	1.350
780	350	350	2.650	100	400	1.400
800	400	400	2.800	100	400	1.400
900	400	400	3.000	100	400	1.500
1.000	400	400	3.200	100	400	1.600
1.100	400	400	3.400	100	400	1.700
1.200	400	400	3.600	100	400	1.800
1.300	400	400	3.800	100	400	1.900
1.400	400	400	4.000	100	400	2.000

LAYING AND INSTALLATION

In the table a value of 50 cm has been stated; also smaller backfilling values are admitted, provided that pipelines are protected, for example realizing a reinforced concrete slab to cover them or putting some steel plates of a proper thickness on the backfilling sand.
In order to forewarn the operators of any other works in the district heating network zone, it is important to foresee the laying on each pipeline (or in the middle between the two pipelines in case of outer casing diameters De < 315 mm) of the warning tape.
Top width of the trench depends on the slope of the trench which will be defined considering the friction angle of the soil on the base of the geological report, attached to the Executive Project.
In case of deep trench or if it is not possible to enlarge to much the top width of the trench, it will be necessary, also in order to ensure security to the workers in the trench, to implement wall reinforcement systems (for example modular metal shoring).
It is important that the trench depth along the pipeline takes into consideration the minimum backfilling also at Tee branches.



The same attention must be paid also in special points of the network, such as valves and vents, where the backfilling height must be stated according to special fitting stem, so that to allow the valve installation in the well, guaranteeing a minimum distance between the handling tools and the manhole frame.

4. Operation inside the trench
of pipelines and special fittings inside the trench.
Pipelines installation technique, according to the trench features and in general of the site construction area and the organization of the Contractor vehicles and personnel, are as below:

- installation of pipelines in the trench;
- installation of pipelines (par sections) above the trench;
- installation of pipelines (par sections) out of the trench and lowering then into the trench.

In general, to guarantee safety on site and speed of execution, it is better to organise to site so that the majority of welding and casing joint can be performed out of the trench.
Pipelines are layered in the trench in the position showed in the projects or Special Tender Specifications. Some practical indications can be:

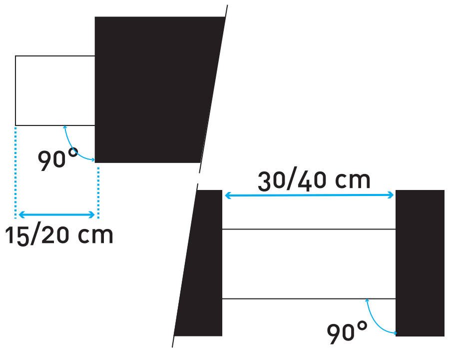
- laying pipelines in the trench with the supply piping on the right, having generally behind the power plant;
- laying pipelines in the trench always with the label facing toward the power plant;

LAYING AND INSTALLATION

- laying pipelines in the trench with the surveillance system wires facing up.

4.1 Pipelines cutting and steel pipe ends preparation

District heating pipelines length must be often adapted on site according to the route andthe possible interferences.
In addition, it could be necessary to cut the polyethylene outer casing and to remove thepolyurethane foam in a section of the line in order to prepare a new branch on site.
Cutting a preinsulated pipe, it is necessary to remove part of the PE outer casing and the polyurethane insulation for a length allowing then performing welding and casing joint in that zone. This length is:
• a cut at an end of the pipeline > 22 cm;
• a cut in the middle of the line > 44 cm.

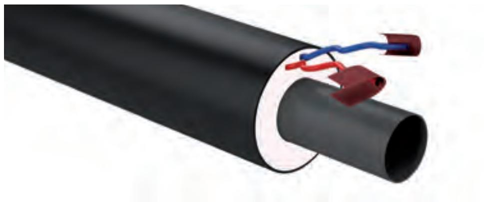


Polyethylene outer casing must be cut using a manual or electric saw with a cutting-in depth nose unit, performing first of all the two round cuttings and then cutting it longitudinally in order to remove it.
In this phase, special attention must be paid in order not to damage the polyethylene outer casing in the parts not to be cut, as any marks could determine a fracture propagation in the outer casing.

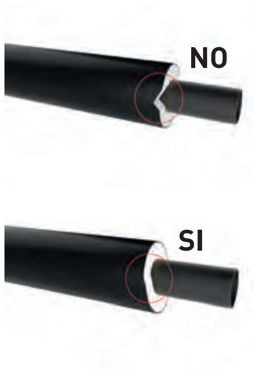
LAYING AND INSTALLATION

It is allowed the use of a grinder only if it is necessary to cut the steel pipe later in order to realize a pipe section.
Special attention must be paid in case of cutting a pipe provided with surveillance system wires, especially using the electric saw.
After cutting and removal of the polyethylene outer casing, polyurethane foam must be removed, using a proper chisel, paying attention not to cut any surveillance system wires.

Also in this phase, it is important to preserve the wires status, eliminating any possible trace of polyurethane foam.
It is necessary to free the surveillance system wires, cut them and, once removed the foam from the steel pipeline, eliminate any other foam residuals from the wires, cleaning them for example using sandpaper.
Then the pipeline can be cut and the steel pipe end can be prepared, welding the pipe again.



During preparation of the ends, special attention must be paid in order not to cut the polyethylene outer casing and, if it should occur, this parts should be absolutely eliminated.
When connecting the ends of the steel pipe, the polyurethane foam, the polyethylene outer casing and the surveillance system wires must be repaired in case of welding splashes and sparks.



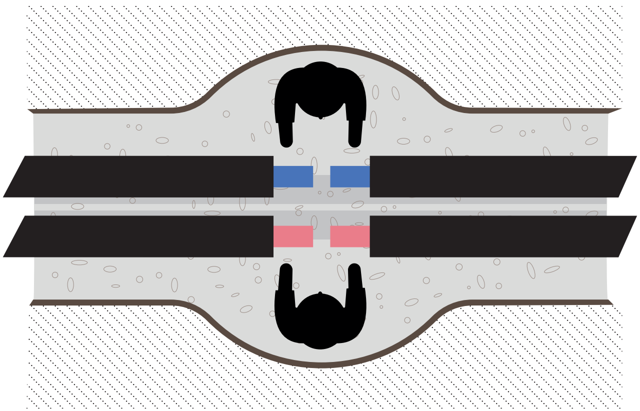
LAYING AND INSTALLATION

4.2 Installation in the trench

Pipelines are connected to each other inside the trench, putting them on the already prepared sand base or on sand cushions (or alternatively temporary wooden bars) placed at a distance which avoid pipelines load to damage the outer casing and the insulation.

In case of wooden bars' use to support pipelines, these must be removed before the backfilling of the trench.

Where welding and casing joint should be performed, it should be useful to enlarge the trench creating niches, which allow to perform safely the above mentioned operations.

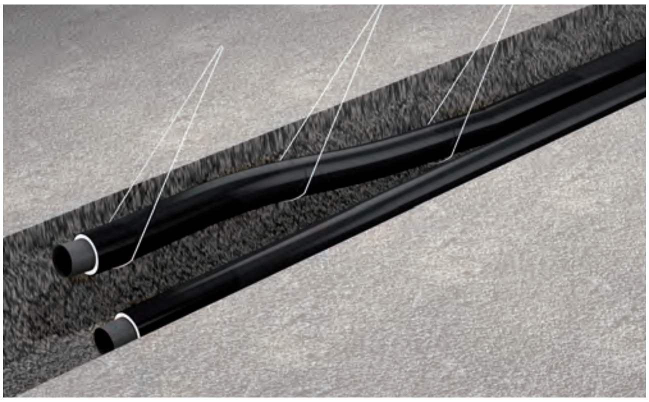


4.3 Installation above trench

Pipelines are connected above the trench, after putting them on wooden bars for supporting them. This method can be applied only when there are no existing underground utilities and services crossing the trench, which would interfere with following lowering into the trench.

Special measures have to be taken to allow operators to weld and joint safely. Wooden supports should be correctly placed in order to resist to the pipelines load, according to their resistance; they also must be long enough to support the load on the anchor point and not to cause trench wall landslides.

LAYING AND INSTALLATION



4.4 Installation outside the trench

A straight section of the network is prepared completing welding and casing joint outside the trench. Then the straight section is lifted by straps and lowered into the trench. In this way, the number of welding and casing joints inside the trench is significantly reduced.
This method can be limited by the presence of underground utilities and services crossing the trench, as they can interfere with the lowering operations into the trench. The number of straps to be employed depends on the length of the performed section and on the load to be lifted.
Please note that the pipe is very resistant and also very long sections can be lowered into the trench, paying attention to lifting them always using large straps. Pipe flexibility can be exploited to connect sections performed out of trench with already buried sections.

4.5 Pipes installation exploiting the elastic radius

Straight pipelines can be installed into curved trenches, presenting a wide bending radius, in order to follow the road direction or to solve any interferences with existing underground utilities and services.
This operation is performed exploiting the elastic radius of the pipes, which must be welded out of the trench, realizing a proper length straight section.
It is then lowered into the curved trench, maintaining the bending radius through the use of proper "supports" such as sandbags or wooden bars inserted into the trench.
Alternatively, if the local conditions allow it (usually for sections layered in vegetal soils), it is possible also to dig a larger trench then the one strictly necessary for a straight section laying and, once connected the pipelines together, to pull one

LAYING AND INSTALLATION

of the ends in order to obtain the desired bending radius, fixing pipelines properly as described above using sandbags or wooden bars.
Bending operation must be accurately made in order to avoid damages to the outer casing and to the polyurethane insulation.
The realizing bending radius exploiting the elastic radius is limited to the maximum stress in the pipeline after bending it. As a consequence:

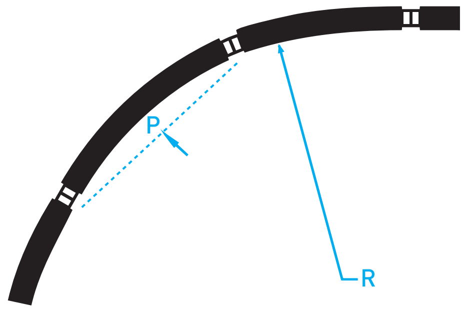
$$R_{min}=500_{ext}{}^{*}d_{EXT}$$

where: d_{ext} steel pipeline outer diameter.
In the following table are reported the obtained values, where:

α: bending angle for each pipe;

p: arc deviation obtained bending a straight pipe whose length is 12 m.

Network sections containing curved pipelines exploiting the elastic radius behave from a mechanical point of view as a straight section.



DN [mm]	d_{ext} [mm]	R_{min} [m]	α [°]	p [mm]
20	26,9	13	51	1320
25	33,7	17	41	1060
32	42,4	21	32	840
40	48,3	24	28	740
50	60,3	30	23	600
65	76,1	38	18	470
80	88,9	44	15	400
100	114,3	57	12	310
125	139,7	70	10	260
150	168,3	84	8	210
200	219,1	110	6	160
250	273,0	137	5	130
300	323,9	162	4	110
350	355,6	178	4	100
400	406,4	203	3	90
450	457,0	229	3	80
500	508,0	254	3	70
600	610,0	305	2	60

LAYING AND INSTALLATION

4.6 Backfilling of the excavation trench

It is very important that the backfilling phase of the network is also properly treated to avoid damage to the components.

The first portion of the excavation trench must be filled with sand up to a height of at least 10 cm above the upper extrados of the pipe. It must be used sifted and washed sand, free from debris, organic material, stones or any other foreign material and free from materials that can expand in the presence of water. The sand must have characteristics corresponding to the granulometric curve required by the EN 13941 standard, with percentages expressed in weight:

a) passing through the screen 2 mm: 100%;

b) passing through the sieve 1 mm: >95%;

c) passing through the screen 0.074 mm: <5% or, alternatively, passing through the screen 0.020 mm: <3%;

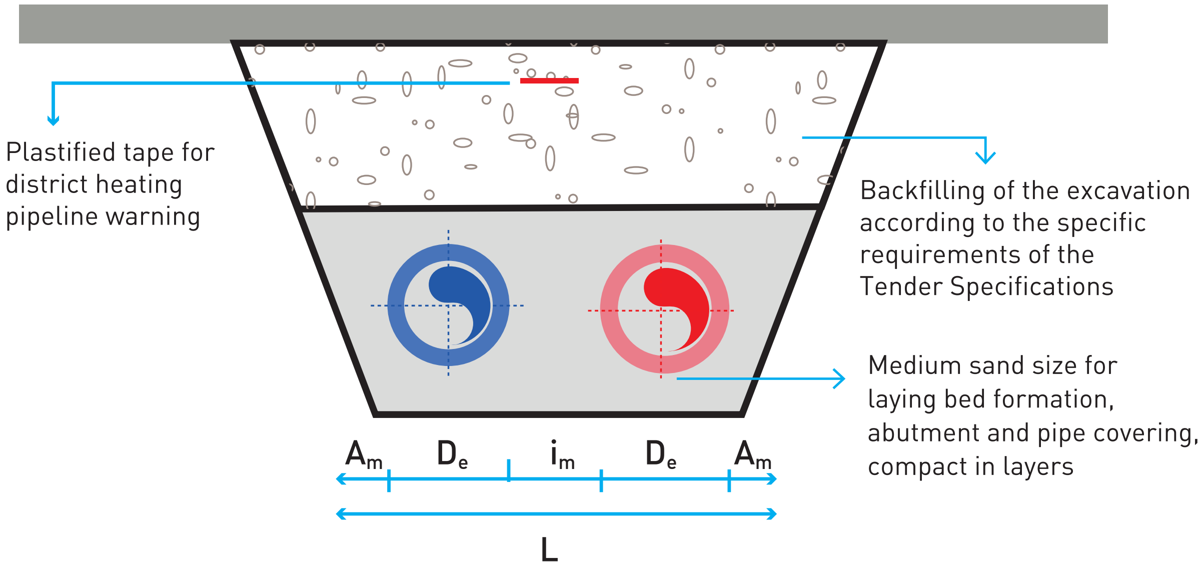
- degree of non-uniformity: $G=d_{60}/d_{10}$ >1,8 being:

d_{60}: corresponding average diameter, in the granulometric diagram, to the 60% of the weight;

d_{10}: corresponding average diameter, in the granulometric diagram, to 10% of the weight.

At the end of the sand filling layer, the monitor tape will be positioned to warn of the presence of the pipes in case of subsequent excavation work.

The filling of the surface layer will be carried out according to the specific requirements of the Special Tender Specifications and in compliance with current regulations.



1.

[1] strench excavation type section

LAYING AND INSTALLATION

5. Welding

Network components must be welded together by operators patented according to the Standard EN 287-1 [now UNI EN ISO 9606-1]. They are licensed on the base of specific valid points of reference:

- adopted WPS (welding procedure specification);
- allowed diameters;
- materials groups;
- welding positions.

Welding should be checked by certified operators according to the Standard EN 473 [now EN ISO 9712:2012].

Check tests and their frequency are stated in the Tender Specifications according to the project class and the specific features of network in construction.

All the fusion welding processes are allowed, but for pipelines with a thickness t>3 mm (DN≥100) electric arc welding in a protective atmosphere created by a flux of inert gas and arc welding with coated electrodes are better.

TIG (TUNGSTEN INERT GAS) process

It indicates an electric arc welding with fusion of the base material, without filler material, in a protective atmosphere created by a flux of inert gas (argon). The arc burns between the tungsten electrode and the pipeline steel. The weld seam is generally "thin", so it is necessary to well prepare the edges (be careful of thicknesses and distances).

Electric arc welding process with filler weld seam with basic electrode

It indicates an electric arc welding with fusion of the base material, with filler material, which consists of the electrode material.

The weld seam protection is provided by the special material covering the electrode (basic covering), able to remove the oxides in the form of waste inside the welding.

The arc burns between the electrode and the pipeline steel. The electric arc melts the welding edges and the electrode supplies the filler material.

The electrode covering causes drosses and oxides liquefaction so that they go out of the weld pool and float on the surface.

The welding process must be qualified, that is approved on the base of tests done on a welding sample.

Mechanical and qualifying tests are usually performed.

For the welding bead building, please refer to the European Standards.

General rules for coding and qualifying welding processes are described in ISO 15607. WPS (Welding Procedure Specification) is a document describing in details the chosen welding process, indicating the materials (base and filler material and consumables) and the working procedures.

LAYING AND INSTALLATION

Also repairs must be done according to WPS. Before welding, edges to be joined must be prepared in accordance with the recommendations in EN ISO 9692-1.
Pipes ends, before being preliminary welded, have to be aligned using tools, in order to correct any out-of-roundness.
Longitudinal welds have to be shifted 10 times the wall thickness, with a minimum value of 50 mm.
The start and end of each weld layer must be shifted of 30 mm.
The weld zone (50 mm on the right and the left of the weld seam) must be absolutely cleaned (free from dust deposits, dirt, grease and water) and must be protected from wind and rain.
With temperatures < 5°C and moist air, edges to be welded must be heated, in order to prevent condensation processes.
It is important to avoid to form the electric arc on the pipe surface; if an electric arc burns, the fusion point must be removed through grinding.
Also it is important to avoid air movement inside the pipe (always keep an and closed).
At the end of welding process, remove any splashes. Weld seam must be free from drosses.
During installation it could be necessary to perform small angle deviations during welding in order to correct pipelines route without using prefabricated elbow with small angle.
These deviations should be placed in limited axial stressed zones (expansion sections). If it should be necessary to perform those deviations, please refer to indications in the following table:

Max. ΔT	max. angle deviation*
90°C	2°
100°C	1°
110°C	0,5°

* installation tolerance excluded
(it should be limited to ± 0,25°).

6. Kit joint insulation
In the following, the catalog will be illustrated in detail the mode of realization of the recovery of the insulation in correspondence with the welded joints in relation to various types of available kits joint, analyzed in the section relating to the products in this catalog.

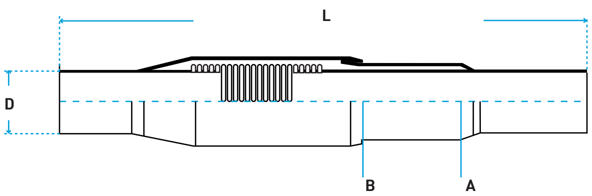
LAYING AND INSTALLATION

7. Network specific components installation

7.1 One time compensators

One time compensators, as already described in the "Design" section of this catalogue, are used in special situations when it is necessary and/or possible to realize network straight sections of more than the double length of free installation and then it is necessary to adopt special arrangements in order to minimize the axial stresses.

The one time compensator is an element which, as suggested by the name itself, acts only once during network pre-loading when, free to move under thermic action on the pipeline, absorbs the expansion exerted by a fixed length specific pipeline section.



Before welding one time compensator along the pipeline, it is necessary to perform some preparations.

The compensator is first of all pre-loaded and pressed so that to leave a free running of the same value obtained during stress analysis calculation. The compensator must be pressed using proper equipment eventually provided by the building company or directly in the workshop.

ECOLINE anyway is available to support the client in order to choose the right compensator pre-loading procedure.

It is important not to pre-load the compensator on site as this can break the compensator or cause a wrong functionality of the element.

LAYING AND INSTALLATION

Once preloaded, the compensator must be fixed in this position welding a temporary anchorage element which gives the necessary resistance to the compensator during installation and network pressure test.
Then the compensator must be welded along the line in the position stated during network stress analysis calculation. The compensator is welded as the other network components.
For a right functioning, it is important that the compensator is welded having 24 metres straight pipe, with no changes of directions, nor deviations.

Once completed the entire straight section laying and anyway the complete working line laying, it is possible to put the compensator into operation.
First of all, the compensator must be brought "to light" (if for traffic reasons the trench had been closed at the compensator position) and the pre-welded temporary anchorage element must be removed. Take care when removing it, so that any residues do not limit the compensator movements.
In order to put the compensator into operation, heat the complete straight line at the pretensioning temperature fixed during stress analysis calculation (which is generally a medium value between the installation temperature and the operating temperature).

LAYING AND INSTALLATION

As a consequence of the thermal expansions, the compensator ends will move towards each-other until compensation is completed. At this point, the compensator can definitely be welded.
When single action compensators are used, line heating is generally made letting hot water circulating in the network, after having realized a by-pass between the supply pipeline and the return one.

Finally the compensator will be insulated as the other elements of the network, taking care to use appropriate joints which are longer than the usual ones.

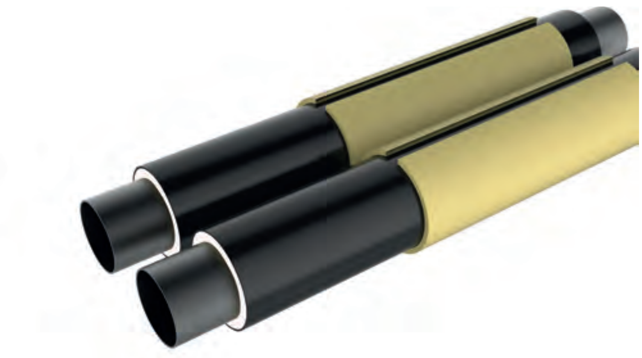
7.2 Foam pad laying
As known, at network free terminations or anyway when there are changes of direction, district heating pipelines move because of thermal effect.
In order to prevent the polyethylene outer casing and the polyurethane foam from any damages, it is possible to install special polyethylene foam pads which allow absorbing expansions.
The number of pads to install, that is the number of overlapping layers and of measured length starting from the point of direction change, is stated according to network stress analysis test.
According to the expansion at the end, pads are generally installed as followings:

- 0 mm < $\Delta L \leq$ 30 mm -> 1 layer
- 30 mm < $\Delta L \leq$ 60 mm -> 2 layers
- 60 mm < $\Delta L \leq$ 90 mm -> 3 layers

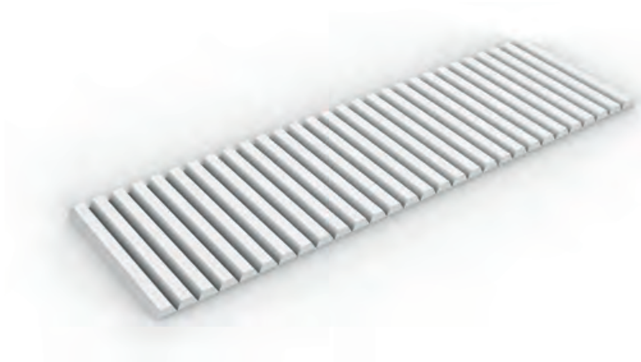
LAYING AND INSTALLATION

It is appropriate not to exceed in the number of installed pads, which do not have to be more than 3 layers in order to avoid too high temperature on the polyethylene outer casing, damaging it quickly.
For expansion values higher than 105 mm, special arrangements must be done during installation. **ECOLINE** and its Technical Department are available to evaluate the best solutions according to the obtained expansion values.

Pads are available in two dimensions. According to the outer diameter of the pipeline on which they will be installed, they will be teared off transversally in order to obtain the right dimension elements.



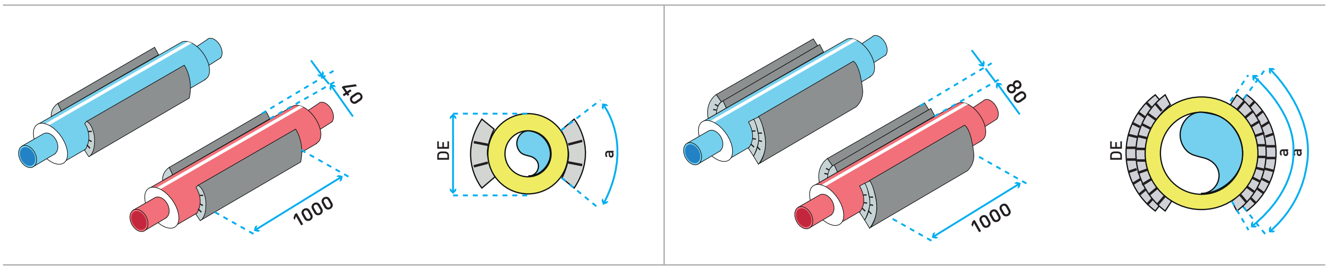
Pads are available in two dimensions. According to the outer diameter of the pipeline on which they will be installed, they will be teared off transversally in order to obtain the right dimension elements.



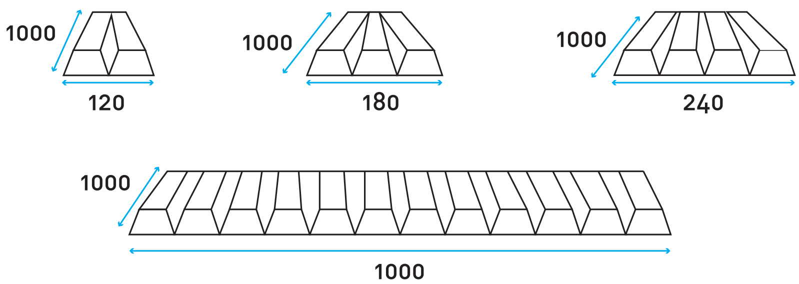
The following table shows the tear off length according to the outer diameter.

LAYING AND INSTALLATION

Pads arrangement and covering area
N.B.: the quantity of necessary pads is written in the laying scheme.

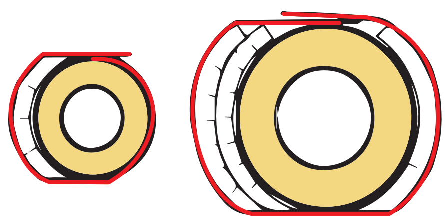


DE 90: a =120 mm	DE 140: a =120 mm	DE 225: a =240 mm	DE 400: a =420 mm	DE 560: a =660 mm	DE 800: a =900 mm
DE 110: a =120 mm	DE 160: a =180 mm	DE 250: a =240 mm	DE 450: a =480 mm	DE 630: a =720 mm	DE 900: a =1000 mm
DE 125: a =120 mm	DE 200: a =180 mm	DE 315: a =300 mm	DE 500: a =480 mm	DE 710: a =780 mm	DE 1000: a =1000 mm



Pads must be installed only on the lateral side of the pipeline, on the outer and inner sides according to the design documents.
Except for special situations which must be carefully described in the design documents, don't wrap completely the pipelines with the pads in order to avoid too high temperatures on the polyethylene outer casing.

Pads must be fixed to the pipelines through elements which do not damage the polyethylene outer casing (ex. adhesive tape/paper tape).



1.

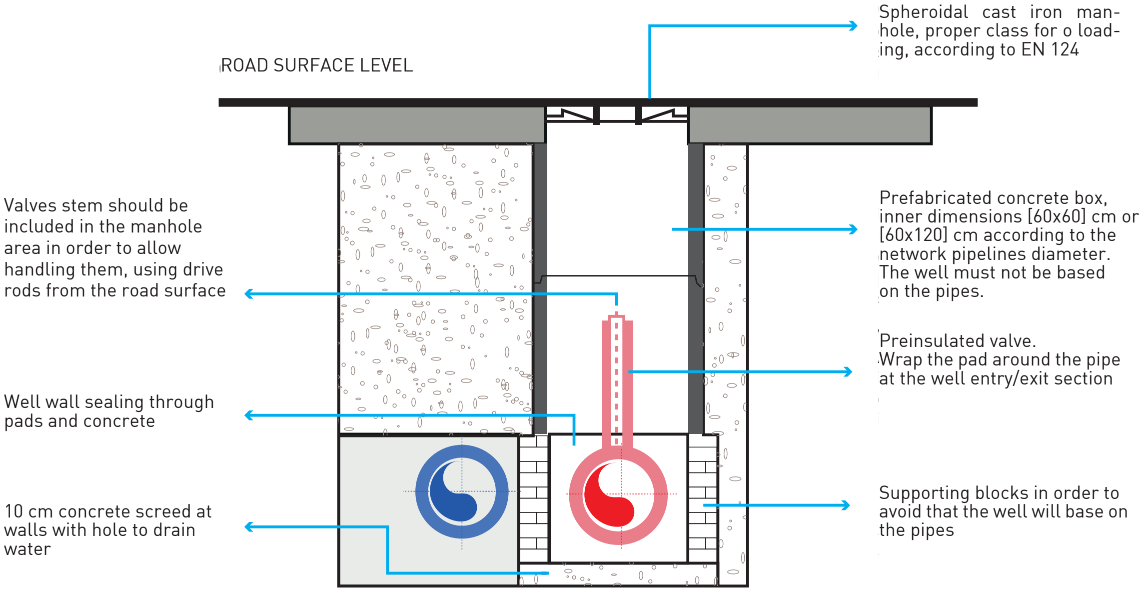
[1] pad fixing method

LAYING AND INSTALLATION

7.3 Shut-off valves and vent laying
Shut-off valves and preinsulated vents are installed along the network as any other components, according to the specific future requirements of district heating system management.
Consequently, during laying, they must be welded and jointed as the other components taking care of:

- keeping valves open during welding;
- installing preinsulated components near bends after laying a socket of pipe in order to allow the realization of the casing joint;
- for bigger than DN 100 diameters or anyway according to the specific requirements Specifications, installing staggered valves on supply and return pipes in order to allow the following building of inspection and handling wells.

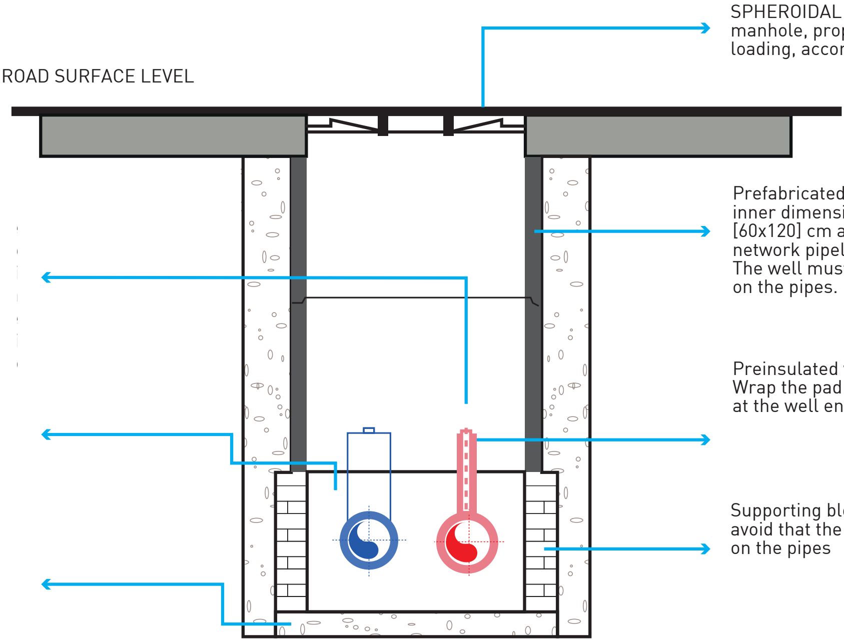
As already described, those components are placed inside proper wells (where possible also prefabricated) of various dimensions according to the outer diameter of the polyethylene outer casing.
In the following pictures are shown some details about the realization of those wells.



1.

[1] valves in separated wells

LAYING AND INSTALLATION



2.

It is appropriate to keep the component stem free from backfilling sand so that the thermal expansion does not cause stresses on the component itself.
In addition, in this way it is possible to avoid that any infiltrations from the manhole causes the contact between the component not pre-insulated stainless steel portions and the soil: it can damage them because of rusting.
As concerning maintenance aspects, before each thermal season it is suggested to inspect all the wells where valves are installed, handling them to verify their functioning.

8. SURVEILLANCE SYSTEM

8.1 Introduction

District heating pipelines supplied by **ECOLINE** are provided with a system which allows a constant network check, detecting any losses or water infiltration from the outside.
This system is realized, as standard, of a couple of copper wires inside the insulation polyurethane foam.
In order to satisfy specific Client requirements, **ECOLINE** can prepare pipelines and network components with the proper number of couples of wires according to the Customer's requests in his order.

[2] valve laying in the same well

LAYING AND INSTALLATION

To realize a complete surveillance system, it is necessary to have:

- pipelines and components equipped with alarm wires;
- necessary elements for wire connection;
- necessary elements to realize the wires extractions;
- detecting control unit in the event of the realization of a complete and 'active' surveillance system.

An 'active' surveillance system is provided with equipment which can continuously signal any malfunctions.
A surveillance system is 'passive' if the malfunctioning check is done only by specific tests on site.
The surveillance system allows to detect any malfunctions such as:

- polyethylene outer casing breaking with water infiltration from the outside;
- water loss from the service pipe with water leakage;
- water infiltration from the casing joints if not correctly installed.

Thanks to this system, it is possible to detect any malfunctioning, before moisture corrodes the service pipe or the polyurethane foam can be damaged.
In order to have a well-functioning surveillance system, it is important that it has been properly installed when building the network and the electrical as-built has been completed at the end of the system installation.
Failing the complete drawing of the realized connections on site, it is not possible, in case of a malfunctioning, to find out the real malfunctioning point, but an inspection with excavations will be necessary and repair costs will be consequently higher.
Wires inside the polyurethane foam can be two types:

- Nordic system: consisting in a bare copper wire and a tinned copper one with a cross section area of 1,5 mm^2;
- Brandes system: consisting in a Nickel Chrome wire (sensor wire) and a copper wire. The sensor wire is coated by a sheath with micro holes at regular intervals.

ECOLINE is available for the client in order to evaluate the type of surveillance system to adopt, according to the specific surveillance requirements. Ecoline produces pipelines, as standard, with "Nordic" surveillance system.
Instructions reported in the rest of the catalogue refer therefore to the adoption of that system.
For Brandes system installation and functioning details please refer to the specific information provided by that system manufacturer.

LAYING AND INSTALLATION

8.2 The surveillance system in the life-time of the District Heating network
The surveillance system is essential both during the network building and during operation.

District Heating network laying
When laying the district heating network, progressive testing and systematic registration of measured data allow to check that the system has been correctly installed.
At the end of laying it is essential to inspect the surveillance system in order to verify that the Contractor has correctly installed it.

District heating network operation
During district heating network operation, as already written above, a proper functioning surveillance system allows to find out quickly any malfunctioning, in order to prevent damages which could be particularly expensive and allows therefore to limit repair costs.

8.3 Surveillance system wires connections at the welded joints
At the ends of welded joints, the two wires must be connected. In order to connect them, the equipment listed below is necessary:

1. plastic spacers (provided by **ECOLINE**);
2. shears;
3. wire clamps for wires connections (provided by **ECOLINE**);
4. gas and tin sealer (for electrical connections tinning);
5. crimp (for ex. Type USAG mod. 749);
6. insulating tape;
7. insulation stripper;
8. Insulation/continuity tester or “Megger”.

Precautions to be observed on site
During pipes welding it is necessary to protect wires from heat and sparks.
It is necessary that connections are realized free from moisture, protecting the place, the pipes and all the material.

Preparations
At the beginning of the work, connect temporarily the wires of each pipe in order to close the circuit and do the check readings during working, ensuring that wires and connecting points are dry and don’t enter in contact with the steel pipe.
Starting from the nearest connection (after the temporary loop), connect as described below:

LAYING AND INSTALLATION

Connections between pipe and pipe

Place the pipelines with the wires upwards (11-05 o'clock) in order to:

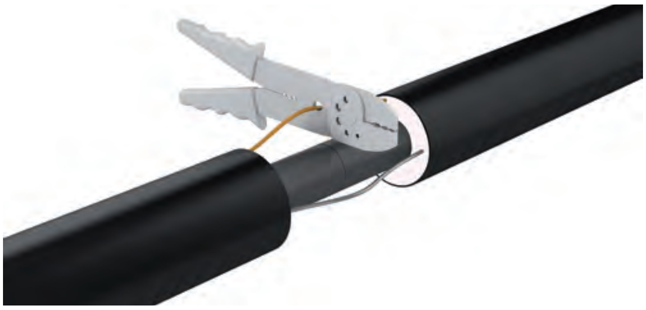
- make the system installation easy;
- make the access to the surveillance wires easy, in case of positioning a branch later on;
- make the access to the surveillance wires easy, in case of checks and repair works;

Place two spacers at the wires exit, staggering the position of the two pipes' ends, out of the welding area.

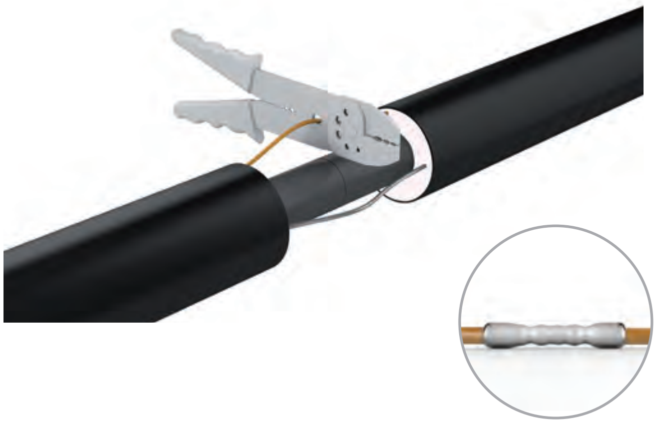
Extract the wires from pipes' ends and pull them so that they are straight and remove the polyurethane foam for about 2-3 cm in order to overcome any moisture presence.

Connect the wires using a "crimp" for butt wires connections.

For a proper interpretation of the connections and the complete circuit, are not allowed overlapping and/or mixing the connected wires (both bare copper with bare copper or bare copper with tinned copper).



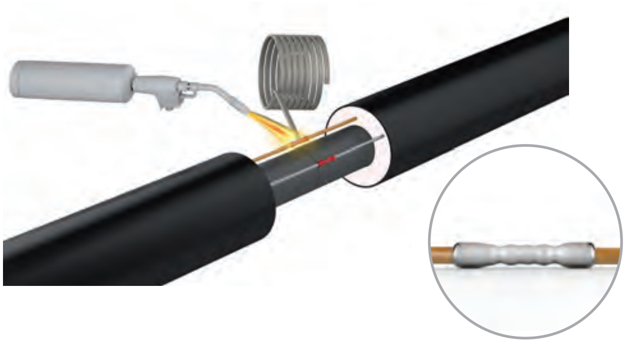
Shorten the wires to be connected to each other, so that it is easy to insert stripped wires in the clamp from both sides and the ends cannot overlap, but they can only near touch each-other. Insert wires inside the clamp for all the available length and, slightly pulling them, crimp them using the proper crimp.



LAYING AND INSTALLATION

Pull the connection manually to check leak: if the connection is not correct, repeat crimping using a new crimp.
For better connections, it is appropriate to tin the connectors ends: in addition to guaranteeing the stability of the connection, if the electrical continuity is adversely affected by not properly cleaned wires, this would be detected through the tin drops which hardly adhere to the wires themselves.

Circuit must be closed connecting wires in the same pipe to each other, avoiding them to enter in contact with the steel pipe.

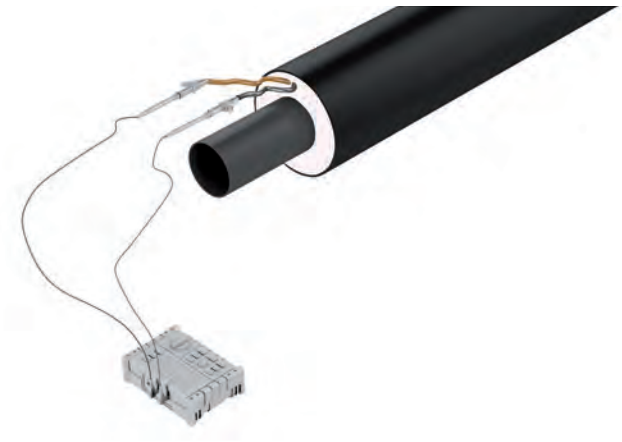


8.4 Surveillance system check
It is important to check electrical continuity and the circuit insulation level in order to verify the connections were successfully executed.
Checks must be performed after each connection, both before and after the joint restoration. Only in this way it is possible to guarantee the detection of, already during installation, wire breaks and moisture presence, before burying the pipes.
As already written above, at the beginning of the work it is necessary to connect temporarily the wires of each pipe in order to close the circuit to check it during the progress of work, ensuring that wires and connections are dry and do not enter in contact with the steel pipe.
In this way, two test circuits are realized, one on the flow pipe and one on the return pipe.

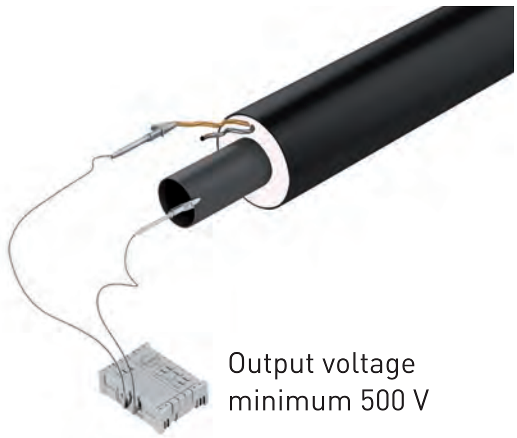
LAYING AND INSTALLATION

Checking the correct installation means to perform two different measuring:
1. electrical continuity test;
2. insulation resistance test.

Electrical continuity test
This test verify there are not electrical breaks along the installed circuit. The test is performed connecting each tester connector to an alarm wire, after having cleaned and dried it, and measuring then the Ohm resistance in the wires.
24 Ohm each 1000 metres of circuit is a correct installation value.



Electrical insulation resistance test
This test verify there is not moisture inside the polyurethane foam. The test is performed connecting to a tester connector one of two wires and touching with the other connector the steel pipe, measuring then the insulation resistance. >10 MΩhm/km is a correct installation value.

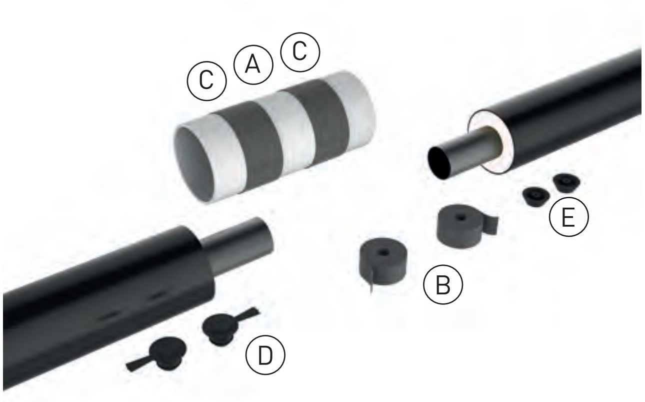


LAYING AND INSTALLATION

8.5 Surveillance system extractions
In order to make possible to perform measurements at the end of the network laying, the surveillance system wires must be made accessible. This is generally done at the box connections, inside the thermal power station room, so that the wires are in a protected position. In this case wires are extracted from the water stop at the pipe ends.
In special situations, for example to limit the circuit length, it can be necessary to perform surveillance system wires extractions along the main pipeline.
In order to realize a surveillance system extraction, the following equipment is necessary:

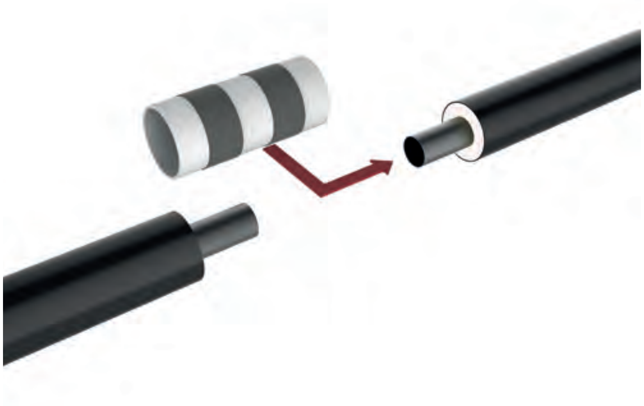
1. extraction plastic "pipette" (provided by **ECOLINE**);
2. elements for the ground wire;
3. sealing materials (provided by **ECOLINE**);
4. heat-shrinkable "pipette" (provided by **ECOLINE**);
5. connection cable.

DOUBLE SEAL JOINT



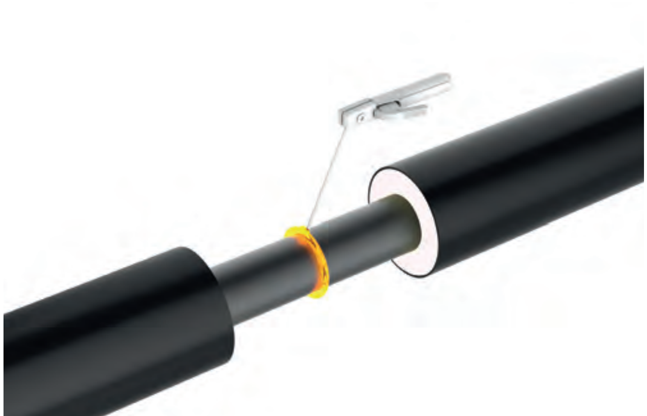
Kit contents:
A) nr. 1 Mechanically enlarged shrinkable polyethylene overcasing;
B) sealant mastic (it can be supplied already pre applied inside the Overcasing);
C) nr. 2 heat-shrinkable rings;;
D) nr. 2 vent plugs;;
E) nr. 2 weld plugs *;
- pre-dosed polyurethane components for "on-site" insulation;
- electric kit (spacers, connectors, etc.) for connection to the remote alarm system, if required.

* alternatively, it is possible to supply 2 closing tags (FOPS) heat-sealers.



1.

Before welding steel pipes, to insert the overcasing and heat-shrinkable sleeve on one of their ends



2.

Weld the steel pipes and possibly pressure test them. Then, joint the surveillance system wires, if any, as indicated in the specific paragraph

3.

Remove about 1÷2 cm insulation from pipe ends. Clean the HDPE outer casing for at least 150 mm on both ends using sand paper. Surfaces must be CLEAN AND DRY.

EQUIPMENT TO BE PROVIDED ON SITE

- plug welder;
- gas tank
- propane gas torch with diameter Ø 30÷50 mm
- pressure regulator
- power drill
- hole cutter Ø 24 mm
- sandpaper, grain 60÷80 in rolls of a width of 50 mm
- hand tools (hammer, screwdriver, chisel, etc.)
- alcohol and rags
- Pressure tess tool.

DOUBLE SEAL JOINT

4.

Heat gently the outer casing for at least 150 mm on both the pipes ends until the surface looks opaque.

5.

Place the mastic around the outer casing of both the pipes ends at about 20 mm from the edge. Press both the mastic ends against each other.

6.

Remove the protective film from the overcasing. Check that it is CLEAN AND DRY, inside and outside. To Centre overcasing in the casing joint area. After having placed the overcasing in the right position, remove the mastic protective film. Check again the overcasing is properly centred and heatshrink both its ends for about 100 mm.

7.

Use the sand paper to clean and roughen the surface where the heatshrinkable sleeves has been applied and use a rag and alcohol to remove any polyethylene or sand traces or waste.

DOUBLE SEAL JOINT

8.

Remove the packaging material and the protective film from the heatshrinkable sleeve.
Check the protective film is completely removed. Centre the sleeve on the overcasing end and heatshrink starting from the centre towards the ends with a rotating movement around the pipe. Repeat the same operations with the other heatshrinkable sleeve on the other overcasing end.

9.

Cut hole (or holes) on the overcasing for foaming. [n. 1 hole for ØHDPE ≤ 315 mm – n. 2 holes for ØHDPE > 315 mm]

10.

If the holes are 2, close one of them using a venting plug

11.

After properly mixing the two polyurethane components, pour the compound in the open hole; then close the injection hole using its venting plug and carefully clean the area around the plug/s.

DOUBLE SEAL JOINT

NOTA

Once completed the shrinking, sleeve must be left to cool as much as possible before the burying (from minimum 30 minutes to one hour). This ensure that the adhesive cools completely, guaranteeing the sealing. In order to prevent damages at the overcasing, use proper backfill material (free from cutting and big dimensions stones).

12.

At the end of the polyurethane foam expansion and once the reaction is finished, remove the venting plug/s. Adjust the temperature of the plug heating equipment at about 260 °C [± 10 °C]. Heatshrink the hole, pushing down the appropriate crucible.

HDPE Outer casing dimensions and heating time

066÷125	140÷200	225÷315	355÷500	560÷630
↓	↓	↓	↓	↓
10 sec.	20 sec.	30 sec.	40 sec.	50 sec.

13.

Place the welding plug inside the heating crucible, with the aid of the temporary handle tool.
Pressing and holding the welding plug on the crucible and, as a consequence, the crucible on the hole which must be closed, heat contemporary the edges which will be then in contact in order to be welded.

14.

Once the two parts will be properly heated, remove the heating equipment and insert immediately the plug into the hole. Pull until the top surface of the plug and the hole one are aligned. Do not overcome this limit. Then press and hold properly so that the welding surfaces keep in touch for at least one minute. N. 1 or 2 weld seams should appear around the plug edge. Until the welded plug temperature is high, do not remove the temporary handle. If the holes are two, repeat the same for the other plug.

15.

The joint is ready.

CROSSLINKED JOINT

Kit components:
A) n. 1 heat-shrinkable mechanically expanded polyethylene overcasing sealing mastic
B) n. 2 heat-shrinkable rings
C) n. 2 venting plugs
- n. 2 welding plugs*
- polyurethane pre-dosed components for "on-site" insulation
- electric set (wires, spacers, connectors, etc.) for the connection to the surveillance system, if required

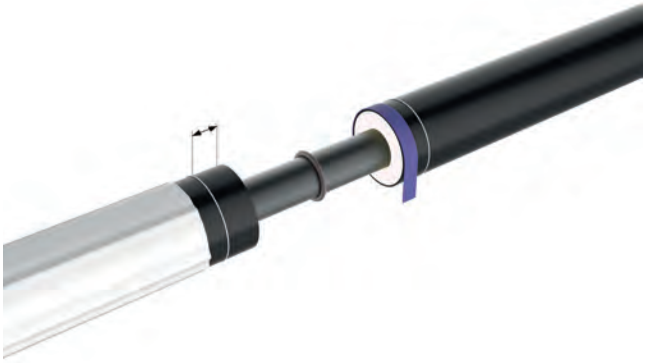
* Alternatively, it is possible to supply n. 2 heat bonding patches [FOPS]

1.

Before welding the steel pipes, to insert the sleeve on one of their ends

2.

Weld the steel pipes and pressure test them



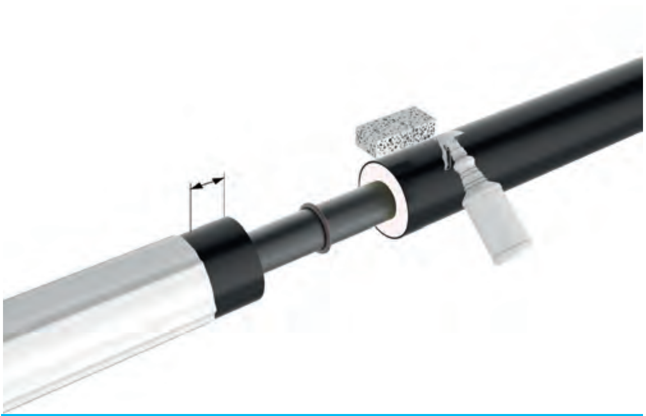
3.

Remove about 1÷2 cm insulation from pipe ends. Clean the HDPE outer casing for at least 150 mm on both ends using sand paper. Surfaces must be CLEAN AND DRY.

EQUIPMENT TO BE PROVIDED ON SITE

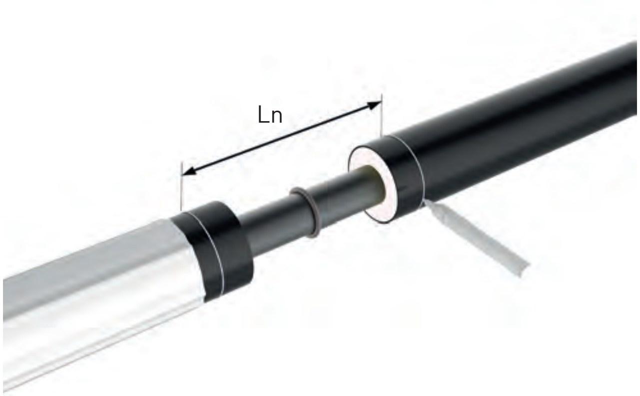
- plug welder
- gas tanck
- propane gas torch with outer diameter Ø 30÷50 mm.
- pressure regulator
- power drill
- hole cutter Ø 24 mm
- sandpaper, grain 60÷80 in rolls of a width of 50 mm
- hand tools (hammer, screwdriver, chisel, etc.)
- pressure test equipment

CROSSLINKED JOINT



4.

Remove the grease from HDPE surface using cleaning kit and joint the surveillance system wires, if any, as indicated in the specific paragraph.



5.

Using a felt pen, mark the position of the sleeve edge
Ln= sleeve nominal length

6.

Heat HDPE pipe surface using a soft flame at a temperature of about 60°C.

7.

Remove the protective film and insert the sleeve onto the joint area Remove the adhesive protective paper

CROSSLINKED JOINT

8.

Shrink the ends of the sleeve with the flame with a rotating motion along the circumference of the pipe.

9.

Finish the shrinkage when the ends are round and smooth

10.

After cooling, pressure test the joint applying a pressure of 0,2 bar

11.

Insert the first venting plug

CROSSLINKED JOINT

12.

After mixing up properly the two polyurethane components, pour the compound in the open hole

13.

Insert the second venting plug and wait 30 minutes until the foam hardens and the casing joint is cool.

14.

Remove the venting plugs.

15.

Remove PUR foam dresses and clean the area near the holes

CROSSLINKED JOINT

NOTA

Once completed the shrinking, sleeve must be left to stand as much as possible before the burying (from minimum 30 minutes to one hour). This ensure that the adhesive cools completely, guaranteeing the sealing. In order to prevent damages at the overcasing, use proper backfill material (free from cutting and big dimensions stones).

16.

Place the cap to be welded inside the reheating crucible, using the temporary handle. Holding down the cap to weld on the crucible and, consequently, the crucible on the hole to be closed, simultaneously heat up the flaps which will subsequently come in contact to carry out the welding.

17.

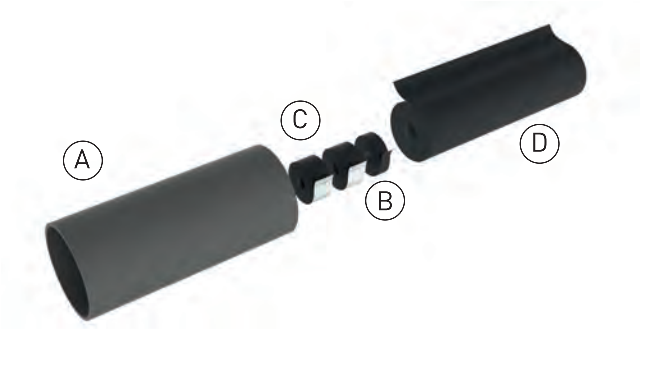
Check visually the joint

EQUIPMENT TO BE PROVIDED ON SITE

- thermometer
- gas tank
- propane gas torch with outlet diameter Ø 30÷50 mm
- pressure regulator
- roll
- cleaning solvent
- sandpaper, grain 60÷80 in rolls of a width of 50 mm
- hand tools (hammer, screwdriver, chisel, etc.)
- triangular scraper

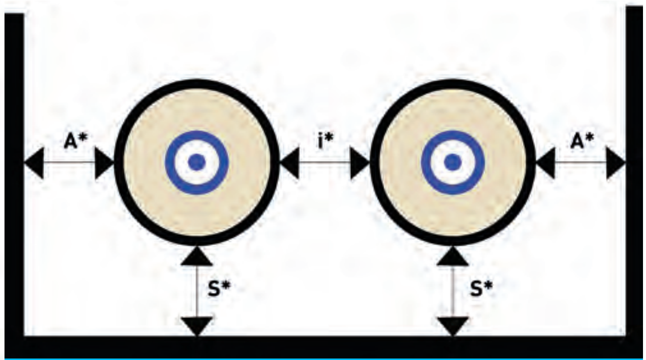
CROSSLINKED JOINT (WITH FOAMING INSPECTION)

Application for HDPE diameter until Ø250 [disposable mould]



Kit content:
A) nr.1 heat-shrinkable crosslinked polyethylene overcasing;
B) cleaning kit;
C) nr. 2 venting plugs;
D) n. 2 welding plugs;
- polyurethane pre-dosed components for "on-site" insulation;
- electric kit (wires, spacers, connectors, etc.) for the connection to the surveillance system, if required.

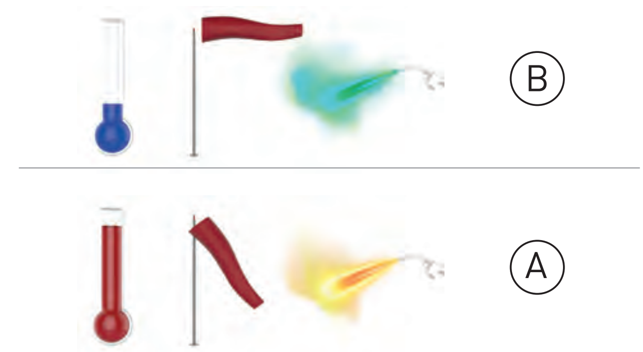
TRENCH DIMENSIONS



1.

* Ensure there is adequate work space area around the pipe in the backfilling trench.

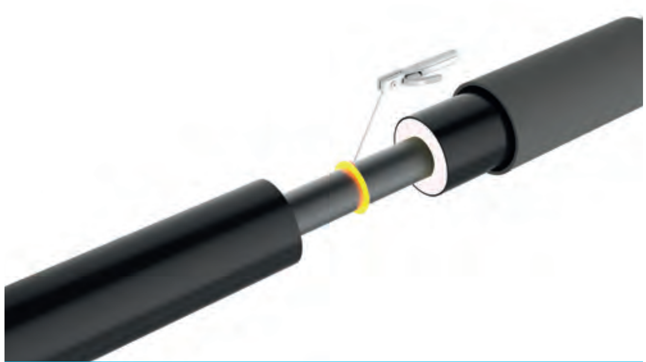
FLAME INTENSITY



2.

Adjust the flame according to outside conditions.
a) use high intensity (yellow) flame for low wind, higher temps.;
b) use moderate intensity (blue) flame for high wind, lower temps.
Always aim the torch perpendicular to the shrink area of the sleeve and move in a circumferential direction quickly around the pipe. **Do not overheat the pipe as it will burn with excessive heating**

PREPARATION

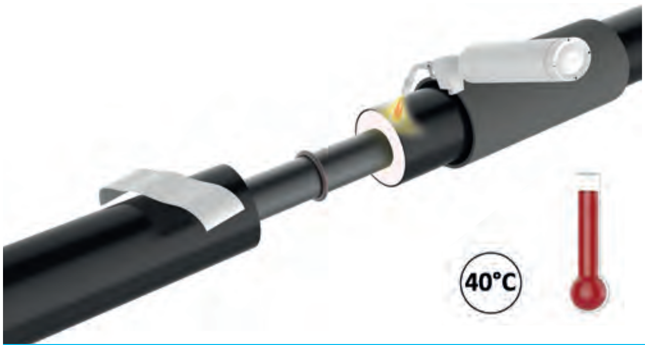


3.

Check the sleeve to ensure that it is not damaged. Before welding together the ends, to insert the overcasing as far away from the joint as possible.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

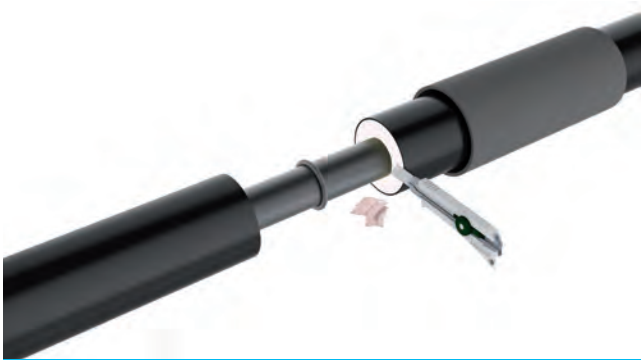
GENERAL CLEANING



4.

Use a propane torch with a very low flame to dry the pipe polyethylene. Use a dry and clean rag to wipe clean the pipe.

PIPE PREPARATION



5.

Remove any wet PUR foam from the end of the pre-insulated pipe.

6.

Using a triangular scraper, clean the edges of the pipe to remove any burrs and dirt from the sealing area.

POSITION MARKING

7.

Place the mould in the middle of the joint so that the feeding hole is on the upper part of the joint. Fix the mould using one of the straps provided.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

POSITION MARKING

8.

Verify that the mould is free from polyurethane residues from the previous feeding. Finish fixing the two hemishells using the straps provided. Place two straps near the feeding hole and two outside the supplementary venting holes.

FEEDING HOLE

9.

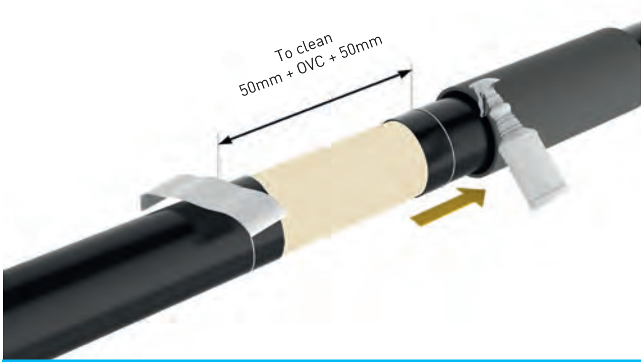
Feed the hole and insert the venting plug on the feeding hole.

FOAM CHECK

10.

Remove the mould after about 30 minutes and check the foam is uniform.

SURFACE PREPARATION

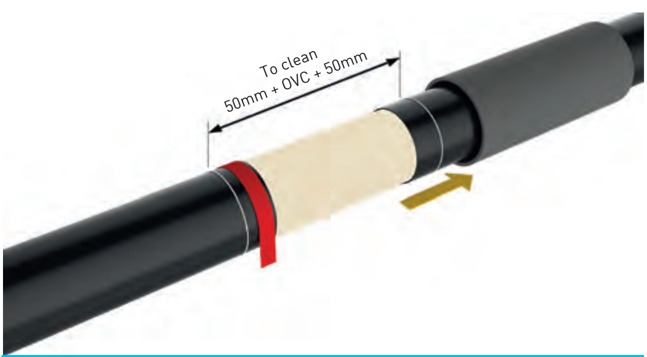


11.

Clean the pipe polyethylene surface and inside the sleeve in order to remove dirt. Remove the grease from the polyethylene surface and inside the overcasing using a clean and moistened of solvent rag.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

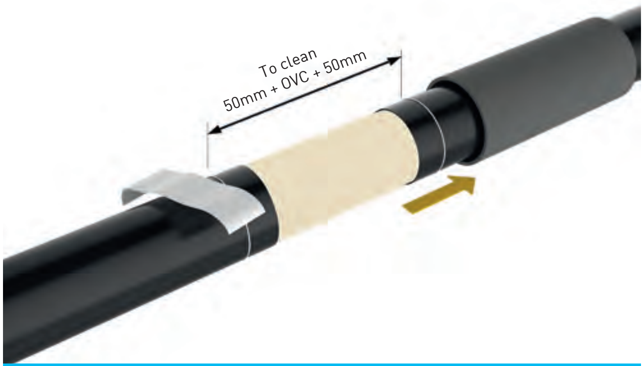
SURFACE ABRASION



12.

Abrade pipe surface on both ends near the cut-back and inside the sleeve, using sand paper [grade 40-50].

FINAL CLEANING



13.

Use a clean and dry rug for cleaning the polyethylene in the abraded area, removing any polyethylene parts or possible sand.

PRE-HEATING

14.

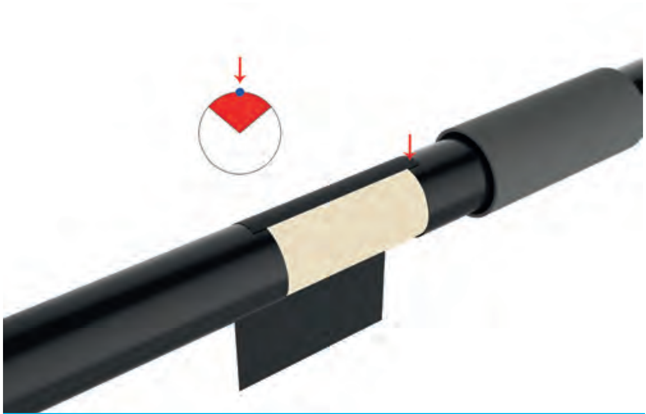
Using a propane torch with not intense flame, heat at 40 °C - 100 mm of the polyethylene on each side of the cut-back, paying attention not to heat the insulation or overheat the polyethylene itself.

FILM INSTALLATION (recommended in the presence of ground water)

15.

Remove partially the protective film and heat the film at about 150 mm from the edge.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)



16.

Place the beginning between 10 and 2 o'clock, centring the film over the joint, so that to cover polyurethane, overlap both the ends on the polyethylene. Remove the exceeding film.

17.

Wrap tightly the film to the pipe, being sure the overlap is enough. Check the film is completely in contact with the foam and the polyethylene. Film must perfectly adhere to the polyurethane; no cracks or holes should be present in the coating film.

18.

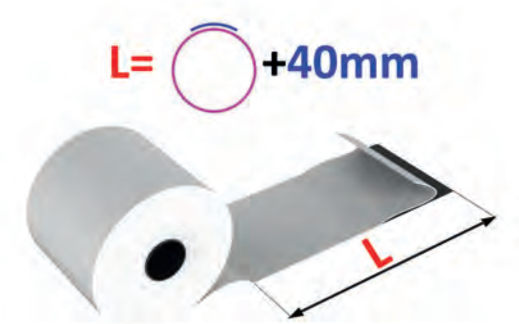
To facilitate the operations, centre the sleeve on the joint and mark two lines outside the overcasing along the PE pipe circumference. Be sure that the number of the Quality Check [QA] on the sleeve is placed on the top part of the joint (12 o'clock).

19.

Move the sleeve away from the joint

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

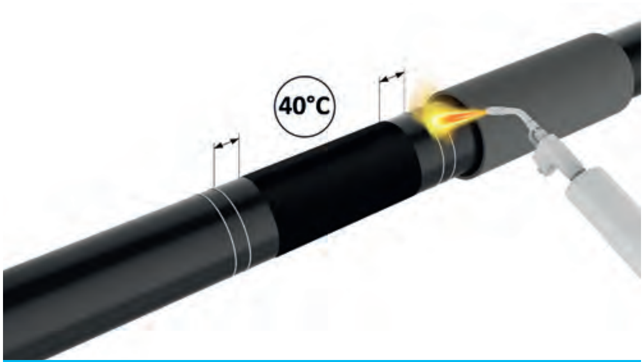
ADHESIVE LENGTH (ON A ROLL)



20.

If you do not use the pre-cut adhesive, cut two adhesive strips with a length equal to the circumference + 40mm

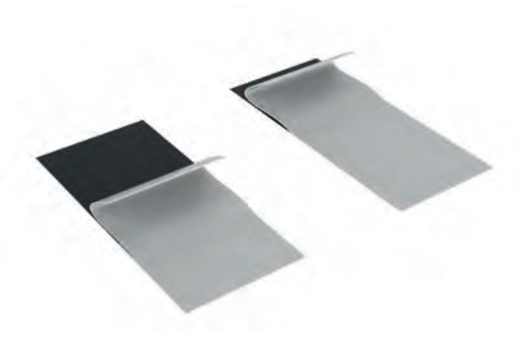
PRE-HEATING



21.

Pre-heat the polyethylene at about 40°-50°C. Ensure the right temperature measuring it with a thermometer. Do not exceed 60°, it could be difficult to remove the protection.

ADHESIVE PROTECTION



22.

Remove the thinnest protection (opposite the crosslinked part) from both the adhesive strips.

ADHESIVE APPLICATION

23.

Apply the adhesive in strips very tightly to the HDPE pipe with the crosslinked part towards the top. The adhesive strips must be applied inside the two casing space marks (about 10 mm). Partially remove the protection from the overlapping area.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

24.

Move part of the protection outward in order to be able to remove it easily after the casing placement.

CSC-X PLACEMENT

25.

Place carefully the sleeve on the joint, so that it is in the middle between the adhesive strips.

CSC-X INSTALLATION

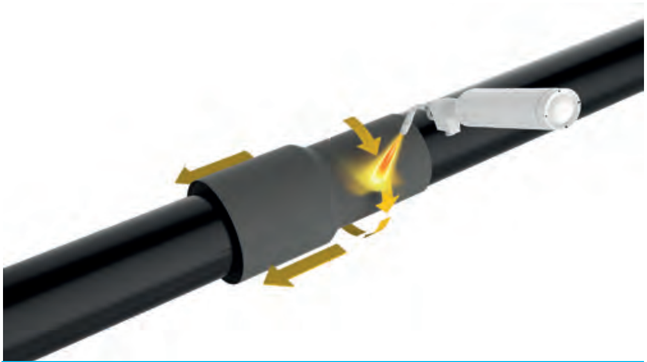
26.

Completely remove the protection from the adhesive strips.

27.

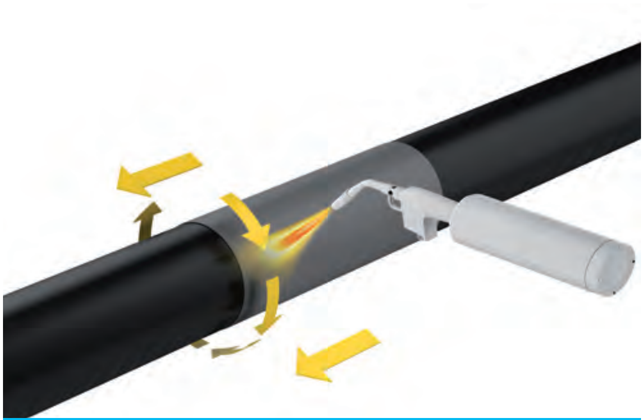
Heat-shrink a side of the overcasing uniformly and along all the circumference of the pipe. Keep the torch in movement in order to avoid overheating and any spots, to guarantee enough heat also in the lower part of the pipe.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)



28.

Make width circular movement on the sleeve.



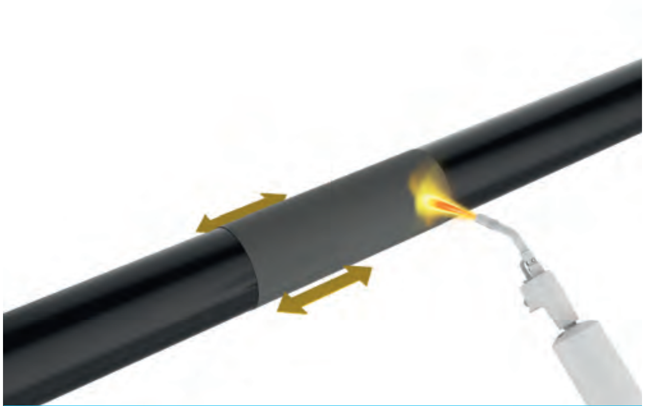
29.

Until the final part of the overcasing is reached.

QUALITY TEST (FINGER TEST)

30.

Using a protected finger, ensure that in the heat shrunk area (the ideal position is between 5 and 7 o'clock) the joint and the adhesive are soft. In case of bubbles or spots, the sleeve should be heated again.



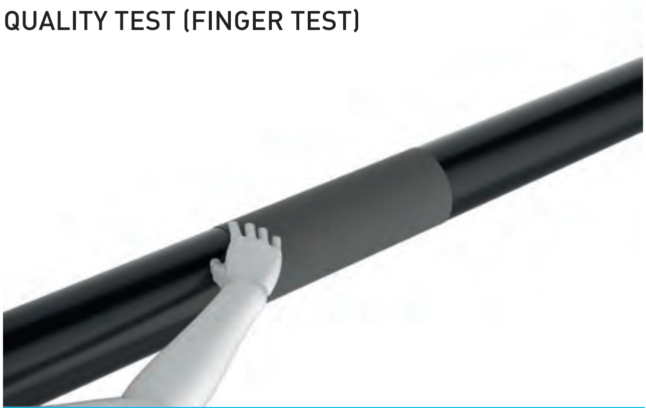
31.

The overcasing shrinking is complete when both the film and the sleeve perfectly adhere to the polyethylene. A leakage of the adhesive from the overcasing ends can normally occur.

CROSSLINKED JOINT (WITH FOAMING INSPECTION)

NOTA
Once completed the shrinking, sleeve must be left to stand as much as possible before the burying (from minimum 30 minutes to one hour). This ensure that the adhesive cools completely, guaranteeing the sealing. In order to prevent damages at the overcasing, use proper backfill material (free from cutting and big dimensions stones).

QUALITY TEST (FINGER TEST)



32.

As a final check, ensure that all the overcasing perfectly adhere to the pipe surfaces; the leakage of the adhesive from both sides and from all the circumference is the confirmation. If this is not the case, heat again.

33.

Installation is perfectly completed when the sleeve adhere perfectly to the pipe and to the polyurethane. Check visually:

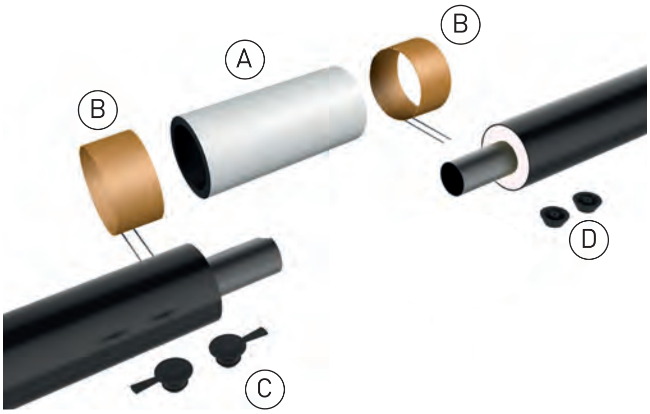
- that the overcasing is in complete contact with the preinsulated joint;
- the adhesive leakage from both sides; absence of bubbles, cracks or holes.

LASHING BELT APPLICATION

34.

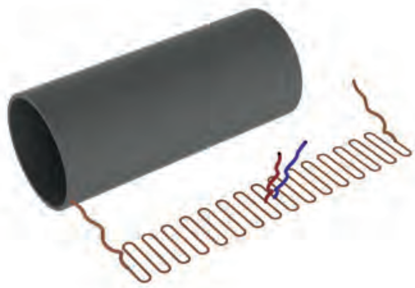
Starting from the diameter Ø 335 and for bigger ones, apply on both the sleeve ends the lashing belt immediately after the shrinking and when the casing is still soft. In case of cooling, heat again.

ELECTRICALLY WELDABLE JOINT



Kit contet:
A) nr. 1 heat-shrinkable polyethylene overcasing;
B) nr. 2 resistance sleeve;
C) nr. 2 venting plugs;
- polyurethane pre-dosed components
- for "on-site" insulation;
- electric set [wi res, spacers, connectors, etc.] for the connection to the surveillance system, if required G. "disposable" or "deposit" mould, depending on the size.

D) werding plugs;



1.

Electric welded sleeve, with heating elements and temperature sensors.

2.

Insert the overlasing on the main pipe, before welding the steel pipes.

3.

Centre the electric welding sleeve on the joint area.

ELECTRICALLY WELDABLE JOINT

EQUIPMENT TO BE PROVIDED ON SITE

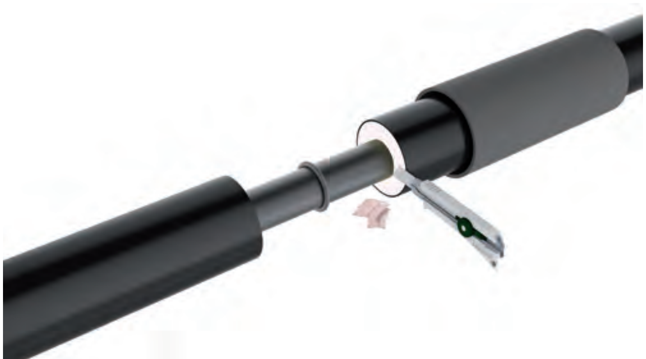
- plug welder;
- welding machine and appropriate "bands" for the sleeve electric welding;
- gas tank;
- propane gas torch with outlet diameter Ø 30÷50 mm;
- pressure regulator;
- power drill;
- hole cutter ø 24 mm;
- sandpaper, grain 60÷80 in rolls of a width of 50 mm;
- different hand tools (hammer, screwdriver, chisel, etc.);
- alcohol and rags;
- pressure test equipment;

4.

Using a white felt pen, mark the electric welding sleeve, centring it on the main pipe.

5.

Move the electric welding sleeve from the joint area.



6.

Remove about 1÷2 cm insulation from pipes ends and clean the outer casing, before cleaning it with the sand paper.

7.

Clean the pipes HDPE outer casing for at least 150 mm on both ends using the sand paper.

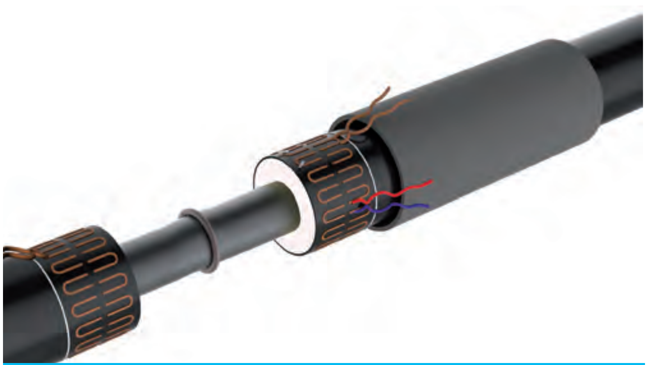
ELECTRICALLY WELDABLE JOINT

8.

Clean the HDPE outer casing on both the ends, after cleaning with sand paper. The surfaces must be CLEAN AND DRY

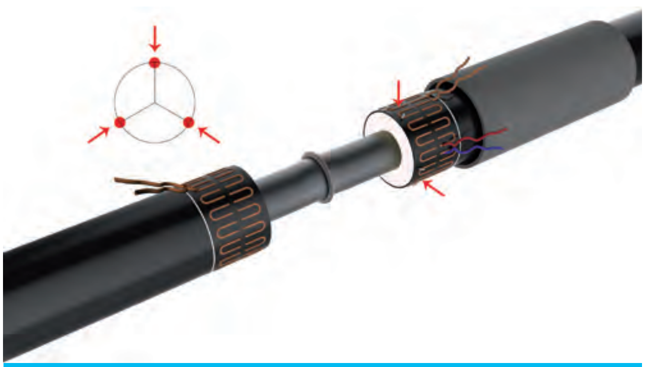
9.

Place the thermoelements on the HDPE casing pipe.



10.

Use some staples to fix the thermocouples on the main pipe.



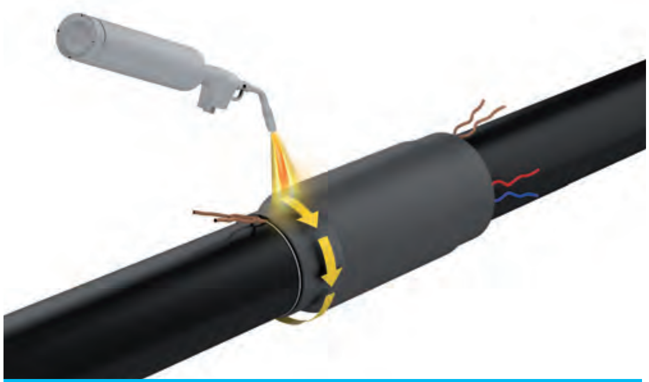
11.

Choose as fixing points the ones at 12, 4 and 8 o'clock.
IMPORTANT: do not expose the sensors to direct sunlight

ELECTRICALLY WELDABLE JOINT

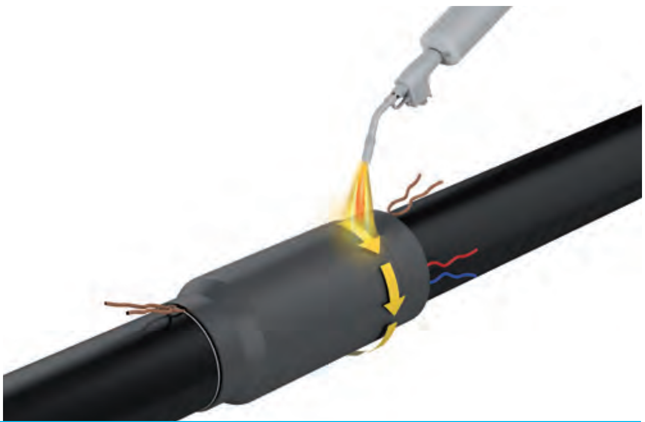
12.

Place the electro welding sleeve, centring on the joint area (respect the space marks done in advance).



13.

Heat, in order to heatshrink each sleeve end, around all the circumference.



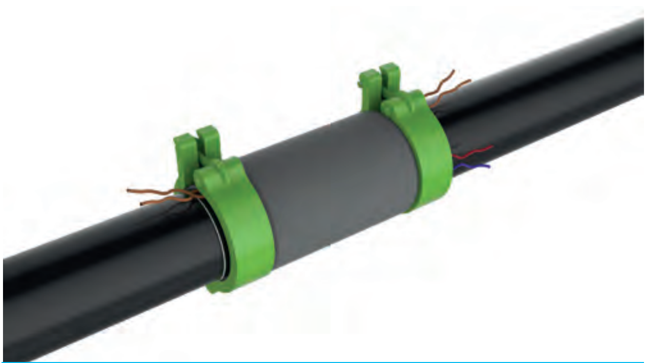
14.

Heat, in order to heatshrink each sleeve end, around all the circumference.

15.

Heat until the complete heatshrinking of both sleeve sides.

ELECTRICALLY WELDABLE JOINT

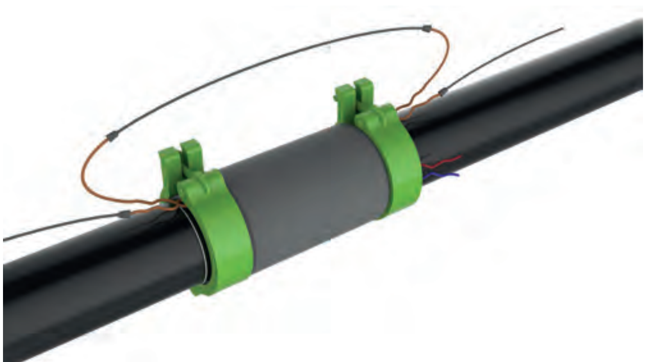


16.

Tighten the ends using the appropriate clamps.

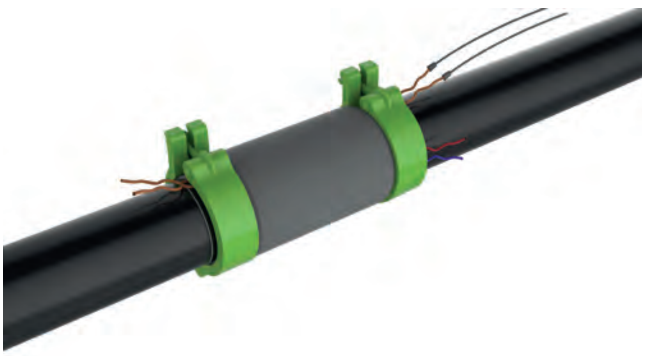
17.

Before using the welder, read carefully the operating instructions.



18.

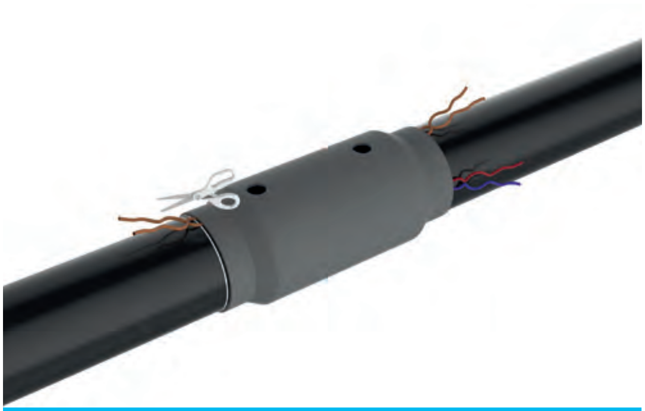
Until the outer diameter of Ø560 included, it is possible to weld both the ends at the same time. Connect the thermocouples and the temperature sensors to the welder.



19.

If the outer diameter is bigger Ø560, weld only one end at a time. Connect the thermocouples and the temperature sensors to the welder

ELECTRICALLY WELDABLE JOINT



20.

Cut holes on the cool sleeve for the foaming phase.

21.

Cut holes on the cool sleeve for the foaming phase.

22.

Test the casing at a pressure of at least 0,2 bar.

23.

After mixing the two polyurethane components, pour the compound in the open hole; than close the injection hole using the appropriate venting plug and clean carefully the area around the plug/s.

ELECTRICALLY WELDABLE JOINT

24.

Partial foaming from the vent plugs indicates the correct foaming of the joint.

25.

At the end of the expansion of the polyurethane foam and when the reaction is complete (after about an hour), remove the vent plug (s). Bring the caps heating equipment to the temperature of approx. 260 ° C (±10°C). Heat the hole by pressing the appropriate crucible downwards. PEHD casing dimensions and heating time.

Dimensioni guaina PEAD e Tempo di riscaldo

066÷125	140÷200	225÷315	355÷500	560÷630
10 sec.	20 sec.	30 sec.	40 sec.	50 sec.

26.

Place the cap to be welded inside the reheating crucible, using the temporary handle. Holding down the cap to weld on the crucible and, consequently, the crucible on the hole to be closed, simultaneously heat up the flaps which will subsequently come in contact to carry out the welding.

27.

When both areas are adequately heated, remove the heating equipment and immediately insert the plug into the hole. Press until the top surface of the cap is aligned with that of the hole. This limit should not be exceeded. At this point maintain a soft pressure sufficient to maintain the contact of the surfaces in fusion for at least 1 minute. 1 or 2 cords of material must appear around the edge of the cap. As long as the temperature of the welded cap is warm to the touch, the temporary handle must not be removed. In the case of the two holes, repeat the operation for the other cap.

ELECTRICALLY WELDABLE JOINT

NOTA
Once completed the shrinking, sleeve must be left to stand as much as possible before the burying (from minimum 30 minutes to one hour). This ensure that the adhesive cools completely, guaranteeing the sealing. In order to prevent damages at the overcasing, use proper backfill material (free from cutting and big dimensions stones).

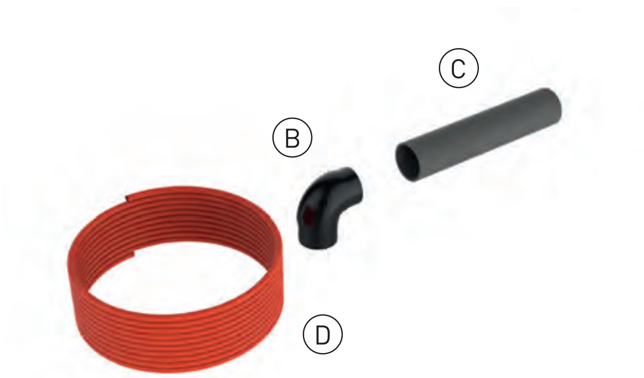
28.

The joint is ready

WIRES SECTIONING KIT

EQUIPMENT TO BE PROVIDED ON SITE

- plug welder
- gas tank
- propane gas torch with outlet diameter Ø 30÷50 mm
- pressure regulator
- power drill
- hole cutter Ø24 mm
- sandpaper, grain 60÷80 in rolls of a width of 50 mm
- different hand tools (hammer, screwdriver, chisel, etc.)
- alcohol and rags



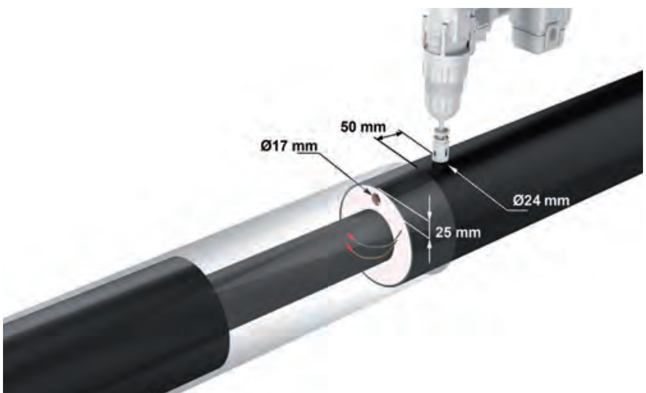
Kit content:

- electric kit (wires, spacers, connectors, etc.) for the connection to the surveillance system;

B) HDPE 90° elbow "pipetta";
C) theat-shrinkable tubular/pipe for final sealing if requested;
D) double coating 5-conductor wire.

1.

Extracting wires on the pipes outer casing, near the joint area (and not inside it), the system is valid for every kind of joint. Note: if the laying system provides the use of joint with polyurethane preformed shells, where are performed wires extracting, joints must be anyway performed with foaming "on-site".



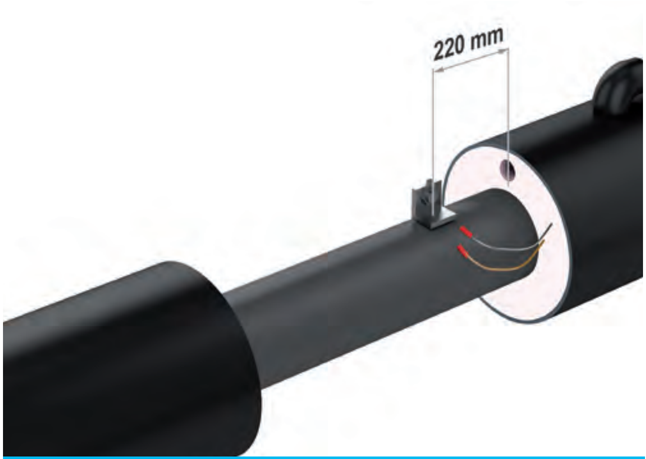
2.

At a distance of about 50 mm from the joint, cut a hole using a hole cutter Ø24 mm, remove insulation residues and bevel the hole edge.
At a distance of about 25 mm from the outer surface of the HDPE outer casing, cut a perpendicular hole to the one already cut, large about 17 mm.

3.

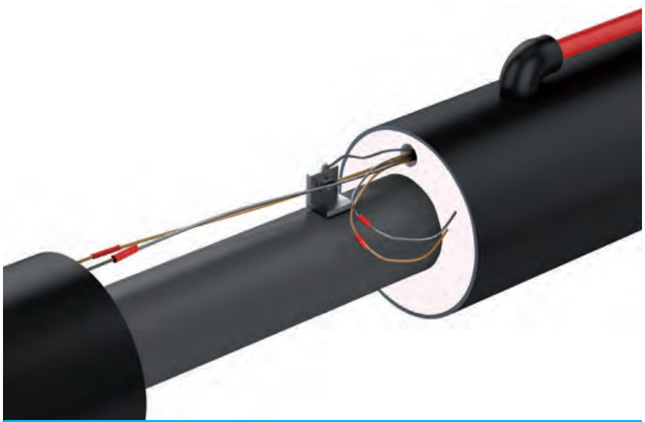
Bevel the edge using the appropriate tool. After properly heating the welder, heat simultaneously the hole edge and the 90° elbow welding end, then, once the molten material edgings will be visible, remove the welder and insert the elbow in the hole, pressing for about 30 seconds (until a welded seam is visible).

WIRES SECTIONING KIT



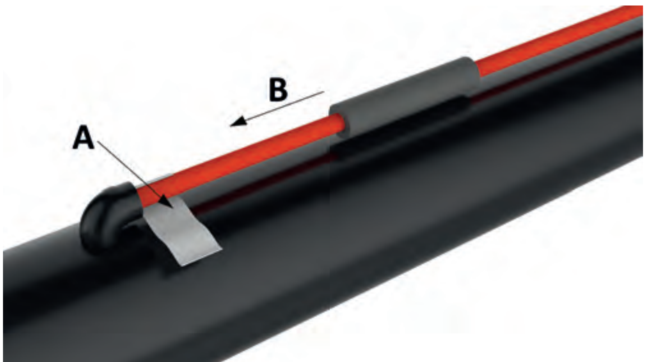
4.

Near the pipes welding, prepare a ground connection for the surveillance system. Before connecting the wires, ensure there are no oxidations and foreign material which could compromise the electrical connection.



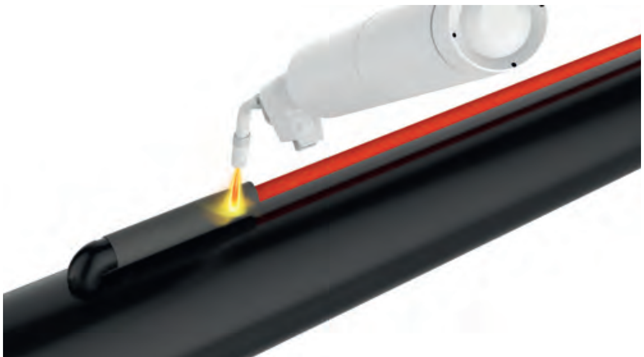
5.

Before embedding the 5-conductor wire into the 90° elbow, insert the heat-shrinkable pipe.
Connect the yellow-green wire to the ground connection. Connect the other 4 connectors to the wires in the pipes (as in the drawing), taking care to note or number the connections to be able to identify them, once extraction is completed.



6.

Wrap the filling mastic around the wire in order to fill as better as possible inside the elbow [A] and place the heat-shrinkable pipe centring it on the end to be sealed [B].



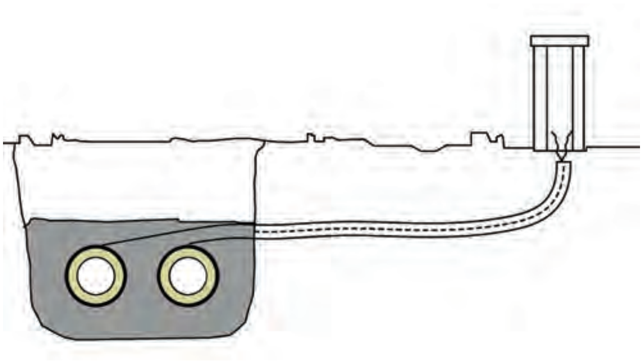
7.

Gently heat until the pipe is completely shrunk around the "pipette" and the 5-conductor wire. Check the right wires connection before the joint restoration.

WIRES SECTIONING KIT

8.

Registered temperatures in the different preinsulated pipeline systems involve possible movements of the pipe itself. Consequently, it is appropriate to leave a longer length [see picture] to the wire before connecting it to the shell.



9.

It is recommended to position the wire inside a pipe (for ex. PVC corrugated), in order to have a proper protection from any damages which can occur during trench excavation or similar operations.

finished printing in March 2019
www.ecoline.it

VIA TRIESTE, 66 - 25018 MONTICHIARI (BS) - ITALY
TEL. +39 030961562 - FAX +39 030961599
info@ecoline.it - **www.ecoline.it**