Installation instructions
EUCALENE DW – WW/DA

Issue 2015/06

Drinking water and waste water pressure pipes made of PE80 and PE100

Kabelwerk EUPEN AG pipe

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Contents

General

These installation guidelines have been created by Kabelwerk EUPEN AG. The purpose of these guidelines is to compile in good faith all technical specifications und instructions already existing in this field.
In spite of careful research, the editor cannot accept liability for the accuracy of the contents.

The handling and installation of EUCALENE PE pipes and of fittings made of polyethylene (PE80 and PE100) should be entrusted only to pipeline construction companies that hold a DVGW certificate in accordance with DVGW worksheet GW 301 "Procedure for issuing the DVGW certificate for pipeline construction companies". All persons employed to carry out the installation work for such building projects must be trained in accordance with DVGW leaflet GW 330 titled "PE welders; training and testing plan".
The implementation must be supervised by a welding coordinator as per DVGW leaflet GW 331 "PE welding coordinator; training and testing plan". When building the ducts, attention must also be paid to the network operator's (client) additional technical requirements. Furthermore, compliance is expected with the accident prevention regulations from the Labour Inspection Board and any other entities involved in the country in question.
For work carried out in traffic areas, the Road Traffic Regulations (StVO) is particularly important; the Guidelines for the Safety of Jobs on Roads (RSA) must be observed.
For construction work contracts granted in accordance with VOB (Regulations on Contract Awards for Public Works), the VOB/C's "General technical terms and conditions for construction work" must apply.

Scope

The provisions of these installation guidelines shall apply for the installation of pipes and fittings as per EN12201, DIN 8074 and DIN 8075.

Environmental aspects

Plastic pipes and piping components require for their production, transport and installation, less energy than those made of other materials. Pipe sections that result from the processing and installation can be removed. Thus, the pipes can be re-used for other applications or other products. The safe incineration of polyethylene also makes it possible to exploit the high energy content from heavily soiled pipes.

Polyethylene as a pipe material

Polyethylene PE80 and PE100 are thermoplastics and are characterised by:
- High levels of toughness and elongation
- Very good chemical resistance
- High resistance to stress crack formation
- Very good processability and workability, in particular ideal weldability

Physical properties

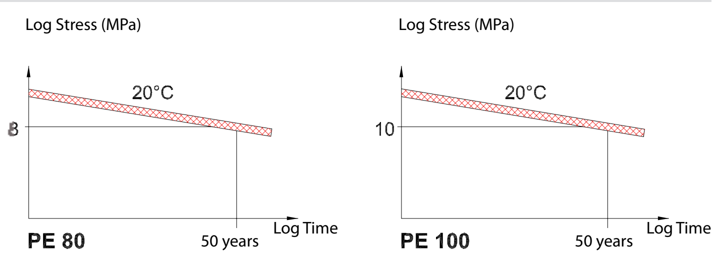
Typical properties for both PE80 and PE100 polyethylene materials. The values may vary depending on the material type of these specifications (approximate values)

Properties	*Unit*	*PE80*	*PE100*
Density at 23°C	g/cm^3	0,93…0,96	0,95…0,97
Melt index MFR190/5	g/10 min	0,3…0,8	0,2…0,55
Yield stress	MPa	18…22	22…25
E-modulus (tensile)	MPa	650…1000	1000…1400
Tensile creep modulus (1 h)	MPa	300…500	500…550
Tensile creep modulus (1000 h)	MPa	190…280	250…300
Minimum required strength (Internal pressure creep rupture Strength 20°C, 50 years)	MPa	Min.8	Min.10

Rupture strength

The most important characteristic of PE80 and PE100 pipes is the creep behaviour under internal pressure. It concerns the minimum life expectancy of a pipe or piping component that is under internal pressure. This creates stress in the pipe wall. The corresponding strength is calculated from the internal pressure and pipe dimensions, i.e. the average diameter and wall thickness. The rupture strength also depends on the temperature and medium inside the pipe.
Rupture strength after 50 years of operation at 20°C and using water as a process medium is essential for the calculations.
The calculation will take in the various areas of application with a so-called total operating coefficient (safety factor).

On the basis of some 50 years prior experience and scientific calculations, a service life of at least 100 years can be assured.



Typical creep curves for PE80 and PE100 at 20°C

Chemical resistance

Polyethylene PE80 and PE100 exhibits excellent resistance to chemicals and other media of various types and composition.
Electrochemical processes that lead metals to corrosion do not occur with polyethylene.
The suitability of polyethylene pipelines for various media is clear from the extensive resistance lists (ISO/TR 10358, DIN8075 Supplement 1).
For further information, please contact us.

Physiological and toxicological properties

The safety of the pipes and piping components, or their raw materials, used for drinking water, is confirmed by independent accredited institutions (e.g. Belgaqua, TZW, ….).
Polyethylene pipelines can be used as drinking water pipes in all types of soil.
For heavily contaminated soils, suitability must be ascertained on a case by case basis.

Abrasion resistance

The abrasion rates for polyethylene pipes when transporting sand or similar solids are far lower than when using conventional pipe material.
For example, the abrasion is about 6 times lower with polyethylene pipes than with steel pipes.
When compared with other plastics as well, polyethylene pipes have lower abrasion rates.

Behaviour during freezing

Polyethylene pipes are not usually damaged by the increase in volume when freezing water turns to ice. Metal fittings and in particular piping c omponents can be damaged in such cases.
Water pipes must always be installed so as to be protected from frost.

Pipe series/SDR class

Polyethylene pipes are divided into pipe series depending on their dimensions (outer diameter and wall thickness) as per ISO 4065. Pipes of similar pipe series have the same ratio of pipe’s outer diameter to wall thickness. They have the same strength, for the same material and same classification. This also applies to piping components.

Pipe series S is defined by the formula:

$$S = \frac{De\text{-}e}{2 \,.\, e}$$

S= Pipe series
De = Outer diameter
e = Wall thickness

The SDR class is defined by the formula:

$$SDR = \frac{De}{e}$$

SDR = Standard dimension ratio

The relationship between the S pipe series and SDR is:

$$S = \frac{SDR - 1}{2}$$

$$SDR = 2 \,.\, S + 1$$

Maximum operating pressure

The highest operating pressures used for water pipelines and water pipe networks are indicated in Table 1 depending on the material and SDR series.

Table 1: Maximum permissible operating pressure for pipes and fittings at a temperature of 20°C

Pipe series		PE80	PE100
SDR7,4	S3,2	PN20	PN25
SDR9	S4	PN16	PN20
SDR11	S5	PN12,5	PN16
SDR13,6	S6,3	PN10	PN12,5
SDR17	S8	PN8	PN10
SDR21	S10	PN6	PN8
SDR26	S12,5	PN5	PN6
SDR33	S16	PN4	PN5
SDR41	S20	PN3,2	PN4

The relation between the pipe dimensions, the permissible stress calculation, the safety factor and the permissible operating pressure show the following relationship:

$$PN = \frac{10 \,.\, \sigma s}{c \,.\, S}$$

PN = permissible operating pressure in bar.
σ = Stress calculation in MPa or N/mm^2
c = Safety factor 1.25 (as per EN12201 – water medium)
S = Pipe series number
e = Wall thickness in mm
de = Outer diameter in mm

$$PN = \frac{20 \,.\, e \,.\, \sigma s}{e \,.\, (De - e)}$$

Pressure surges

Pressure surges are mostly harmless for polyethylene pipes, as long as the medium stress does not exceed the stress at the maximum permissible operating pressure, i.e. for example for a PE100 pipe of the S5/SDR11 series with a maximum operating pressure of 16.0 bar at 20°C, the average pressure should not exceed 16.0 bar.
The pressure amplitude may in that case reach 16.0 bar at the most.
The size of the pressure amplitude for water at 20°C and for polyethylene pipes is calculated with the following equation (derived from the Joukowsky formula):

$$Ps = \frac{14{,}49}{\sqrt{1 + \frac{1{,}25 \,.\, dm}{e}}} \,.\, V \quad \text{(in bar)}$$

Ps = Pressure amplitude in bar
v = Flow velocity of the water in m/s.
dm = Medium pipe diameter (De - e) in mm
e = Wall thickness of the pipe in mm.

Exposure to inner negative pressure

For vacuum-operated pipelines and water pipes, for which switching off the pumps or closing the valves may result in negative pressures, it is necessary to check the resistance to internal negative pressure.
For a pipe wall temperature not exceeding 20°C, the polyethylene pipes made of PE80 and PE100 from the S5/SDR11 pipe series are vacuum-safe.
They hold outer excess pressure up to 1.6 bar for an operating life of 50 years.
Pipes from the S8/SDR17 series can be used for a lasting negative pressure up to -0.4 bar (safety factor 2.0).
In case of higher pipe wall temperatures and/or pipe deformations, the negative pressure decreases.

Forces between the pipe and the fastening caused by the internal pressure

For pipe systems that are locked fully by longitudinal force (e.g. with welded pipe connections), the internal pressure does not act as an external force.
As result, no special measures are necessary.
In pipe systems whose joints are not permanently locked by longitudinal force, the pressure acts on the inside of the pipe by pushing on the outside at the pipe holders and supports. The fastening must be able to withstand the highest resulting force (e.g. as a result of the test pressure).
In the case of buried of pipelines, the permissible floor loading should be noted per type of soil.
The longitudinal forces caused by the internal pressure are calculated as follows:

$$\mathbf{Fl} = \frac{Da^2 . \pi}{40} . p$$

Fl = Longitudinal force in N
da = Outer diameter of the pipe in mm.
p = Internal pressure in bar

The active force resulting at the elbows is therefore:

$$\mathbf{Fl} = 2 . Fl . \frac{\alpha}{2}$$

Fr = Resulting force in N.
Fl = Longitudinal force in N.
α = Angle of elbow

The resulting forces can assume considerable values. The resulting force of a 45° elbow, e.g. for a pipe with an outer diameter of 200 mm and at a 15 bar test pressure is 36.070 N.

Forces between the pipe and the fastening caused by the changes in temperature

For firmly clamped piping systems, the forces caused by differences in temperature must be absorbed by fixed points. In case of buried pipelines, these forces will be largely absorbed by the soil around them.
The counter-forces acting on pipes that are either firmly clamped or buried shall be absorbed without harm by them, provided the maximum permissible stress is not exceeded.

The longitudinal forces arising from averted thermal expansion or shrinkage on the fastening are calculated as follows:

$$\mathbf{Ft} = Ar . \alpha . \Delta T . Ec$$

Ft = Longitudinal force, thermally induced, in N.
Ar = Pipe wall annular width in mm²
ΔT = Difference in temperature in °K.
α = Thermal length variation coefficient (for PE = 0.2 mm/m/°K).
Ec = Mean creep modulus in MPa or N/mm². For PE between -20°C and °°C : Ec = 950 MPa, between 0°C and 20°C: EC = 640 MPa)

$$\mathbf{Ar} = \frac{(De^2 – Di^2) . \pi}{4}$$

Ar = Pipe wall annular width in mm²
De = Outer diameter in mm
Di = Inner diameter in mm

Location

EUCALENE PE pipes can be subsequently located using electronic pipe locating equipment. Accurate calibration is nevertheless recommended. If one needs to be able to locate pipes subsequently, then locating tapes should be used.
Leaks in plastic pipes can be located separately using a noise tracking device.
Modern detection systems that use the correlation method provide more accurate results.

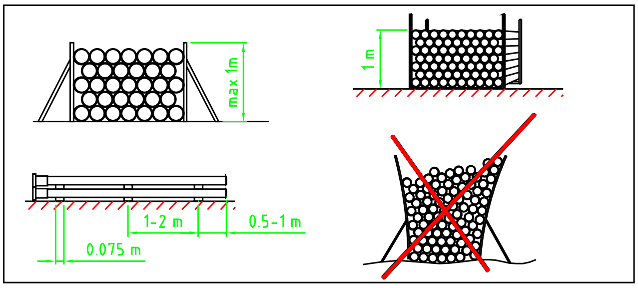
Transport and storage of piping components

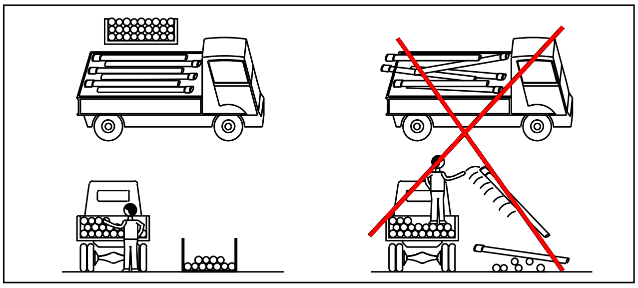
For temperatures ranging from -20 °C to 50 °C, EUCALENE PE pipes can be transported in their original packaging without any problem.
For pipe temperatures >35 °C, deformation of pipes must be prevented by staking them loosely.

This implies having a lower stack height or covering the pipes with white foil.
The piping components must be transported using suitable vehicles, and competently loaded and unloaded. Pipes should be supported along their entire length, if possible.

The storage and transport of EUCALENE PE pipes and mouldings on the site should be carried out in such way that no permanent deformation and/or damage occur.

The storage area should be levelled so as to ensure adequate support. Coils shall be stored lying down. Other types of storage require appropriate measures (risk of buckling).
The following measures have proven successful for the storage of standard size pipes:





Palletised bundles of pipes can be stacked atop each other, provided the wood parts rest on one another.

If the pipes are provided on pallets, then the stacking height of loose pipes should not exceed 1.0 m.
The pipe stack must be secured on the sides.

In the case of extended outdoor storage (several months), EUCALENE PE pipes and fittings must be protected from direct solar radiation, by covering them for example.

Thin-walled pipes in particular may exhibit bends if exposed to solar radiation on one side, because of the difference in temperature (banana effect).
Covering the pipes can help prevent this from happening or reverse the process.

Contact with damaging substances such as engine fuel, solvents, or the like, must be excluded.

Installation in open pipes trenches, permissible minimum bending radii

PE80 and PE100 materials are considered as elastic materials, i.e. depending on the installation temperature, they must be laid more or less flexibly, and can often spare mouldings and welding points. Besides the installation temperature, attention should also be paid to the pipe's wall thickness or pressure rating. The table below apply to PE80 and PE100 that are used for buried applications.

SDR classe 7,4 – 9 – 11 – 13,6 – 17			
Material	Installation temperature		
	0°C	10°C	20°C
PE80 PE100 PE100-RC	50 x da	35 x da	20 x da

SDR classe 26			
Material	Installation temperature		
	0°C	10°C	20°C
PE80 PE100 PE100-RC	75 x da	52,5 x da	30 x da

SDR classe 33			
Material	Installation temperature		
	0°C	10°C	20°C
PE80 PE100 PE100-RC	100 x da	70 x da	40 x da

SDR classe 41			
Material	Installation temperature		
	0°C	10°C	20°C
PE80 PE100 PE100-RC	125 x da	87,5 x da	50 x da

Pipes trenches design

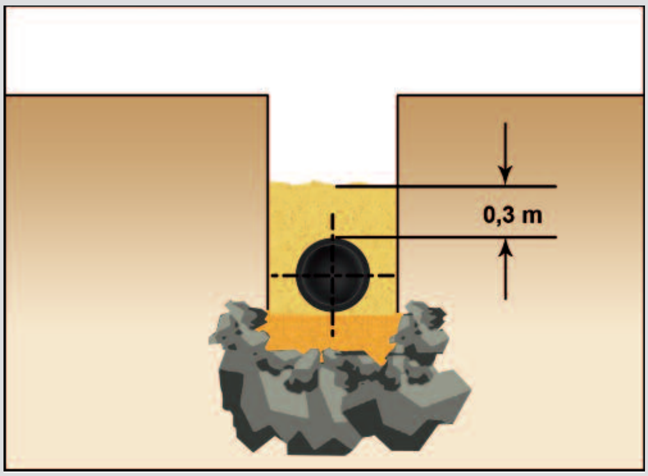
As regards the pipes trenches design, the specifications set out in DIN 4124 shall apply.

EUCALENE PE pipes and piping components can be installed in depths detailed in Table 1 and in compliance with the conditions set out in worksheet ATV-DVWK-A 127 under the following constraints: (Proctor density 90%) no ground water, G1 soil, trench width as per EN 1610.
When installing by bundle of pipes, one should select SDR series smaller or equal to 17. In compliance with these constraints, it is not necessary to have a separate static verification for both cases.
For special applications, Kabelwerk EUPEN AG can create appropriate verifiable pipe static as per ATV-A 127.

Table 1: installation depth

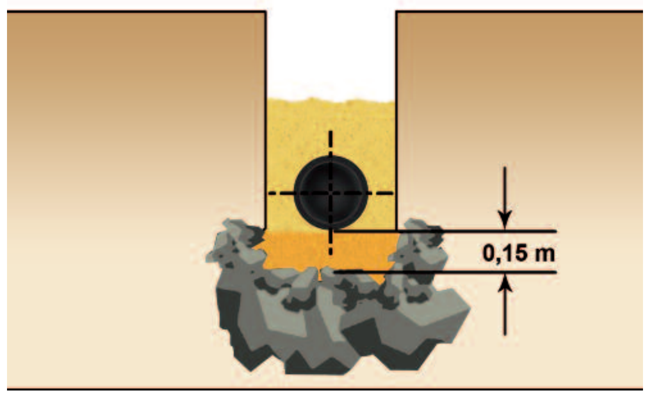
Circulation area up to SLW 60	
SDR17	SDR11
0,8 – 5 m	

Only stone-free, compactable material should be used for the bottom of the trench and the pipe bedding



The bottom of the pipes trenches must be compacted using light compaction equipment before the installation process.

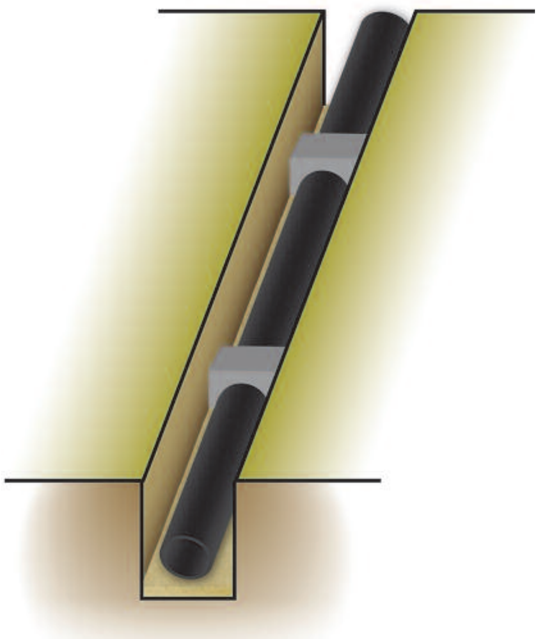
In rocky or stony ground, the bottom of the trench must be excavated on 0.15 m minimum and the excavated hole must be replaced with a stone-free layer (sand, fine gravel with an aggregate size of 20 mm in diameter).



For bottoms of trenches that are unsustainable or have high water content, and due to the danger of washing off the backfill material by changing the ground water levels, stabilisation must be ensured by taking appropriate measures.

The support and integration of the pipes and fittings must be carried out in accordance with EN 1610.

As regards steep slopes, adequate safeguards should be used to help prevent the pipe bedding from being washed away and the pipeline from being flushed. On slopes and steep sides, the pipeline must be secured against slippage, using bars and bolts for examples.



The pipe connection points should be kept clear as much as possible for the pressure testing.

__Installation of line parts and production of pipe connections__

Prior to installation, the piping components must be checked for damages and other similar impairments and cleaned in the joint area.
The joint area must be free of damage in order to achieve lasting tightness.

Grooves and scratches on the pipe should not be deeper than 10 % of the permissible minimum pipe wall thickness.
Damaged parts should be discarded.

The pipes and fittings should have approximately the same temperature during installation. They can be installed in temperatures ranging from -10 °C to 35 °C. The length variations caused by temperature and applying to polyethylene pipes should be observed.

If necessary, the pipes should be cut to length using a fine-toothed saw or a suitable pipe cutter. Pipes must be cut at a right angle.

Ridges and bumps on the cut surface must be removed using a suitable tool, e.g. coarse file, drawing knife or scraper. Incisions and notches should be avoided.

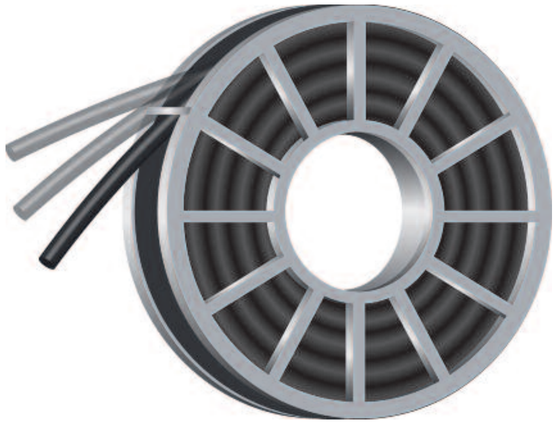
As necessary, the pipe ends should be worked on depending on the type of joint.

There are several ways to take the pipes off the ring. For pipes up to 63 mm in outer diameter, the bundle is usually unrolled in the vertical position and the start of the pipe must be fixed.

For larger sizes, an unwinding device must be used. The specifications of the equipment manufacturer should be observed.

The pipes are reeled off straight and should not be bent.

When unwinding the pipes from drums or coils, one should pay attention to the fact that pipe ends or single layers of coil can fly off when loosening the fastening. Once the pipe ends have been fixed, the bindings must be loosened in sequence from the outside to the inside



Since considerable forces can be released in the case of larger pipes in particular, it is essential **to proceed with caution (risk of accident!).**

Additionally, when unwinding, one should also note that the flexibility of the pipe is affected by the ambient temperature. For temperatures close to freezing, it is recommended to place the still coiled pipes in a heated hall or heated tent for several hours, for easier handling. Warming using an open flame is not allowed.

All pipes must be installed without tension.
In order to achieve a tension-free installation, one should pay attention to the pipe's length variation caused by temperature. When the pipe wall temperature rises or decreases by 1 Kelvin (1 K = 1 °C), a PE-HD pipe expands or shortens by 0.2 mm per meter length.

Before setting a fixing point (e.g. shaft connection), the pipe must therefore be adjusted to the soil's temperature.
The adjustment time should take at least 2 hours. With this in mind, it is recommended to cover by partial filling or protect the piping components from direct solar radiation.

Determination of the length variation

Length variation through differences in temperature

For determining the length variations caused by temperature for PE80 or PE100 pipelines, the following applies:

$\Delta La = \alpha \cdot L \cdot \Delta t$

ΔLa = Temperature-dependent length variation in mm.
α = Linear expansion coefficient 0.2 mm/m. /°K.
L = Length of the pipe section in question in m.
Δt = Temperature difference in °K.

Pipe connections

The following types of connection are generally used for EUCALENE PE pipes made of PE80 and PE100:

– Heating element -butt welding
– Heating element -spiral welding
– Clamp and bolt connections
– Flange connections

Production of welded joints

Welding work should be carried out by trained plastic welders only (see DVGW leaflet GW 330 or see Belgian standard NBN-T42-011).
The welding work must be supervised in accordance with DVGW leaflet GW 331.
The welding process must occur in accordance with DVS 2207-1 or NBN T42-010.
The welding equipment must meet the requirements set out in DVS 2208-1 "Welding of thermoplastic materials, machinery and equipment for the heating element welding of pipes, piping components and boards".
Furthermore, the guidelines provided by the fittings and welding equipment manufacturers should also be observed.

Brief description of the welding process

Heating element butt welding

The connecting surfaces of the parts to be welded are adjusted under pressure on the heating element (adjustment), then warmed at the welding temperature under reduced pressure (warming) and after removal of the heating element (shift), joined together (joining) under pressure. During the cooling off period, the joining pressure of the parts clamped in the welding jig must be maintained. Measures to accelerate the cooling off the welded parts are not allowed.

Heating element -spiral welding

The connecting surfaces (pipe's outer surface and sleeve's inner surface) are warmed to welding temperature and welded using the electric current from the resistance wire fitted in the sleeve.
The welding is carried out using specially and purposely designed welding equipment.
Holding devices must be used if they have been specified by the manufacturer.

Clamp and bolt connections

PE80 or PE100 pipes can be joined using plastic or metal clamp connections. Plastic clamp connections must meet the requirements set out in DIN 8076-3 and metal ones must meet those set out in DIN 8076-1. Manufacturer's assembly instructions should be observed.

Flange connections

For connecting PE pipes using flanges, stub flanges with loose or fixed flanges are available with outer diameter up to 32 mm. Two methods of execution are commonly used.

- Stub flange for heating element - butt welding
- Stub flange for heating element - spiral welding

The use of a torque wrench is recommended to tighten the flange connections on the cross.
The specifications of the sealing ring manufacturer should be observed when applying tightening torque. When using a steel-reinforced plastic flange, washers should be used, in order to evenly spread the effective axial force over the flange. It is important to ensure that the flange and bolt connections are installed free of stress.

Cast iron fittings and heavy mountings

Fittings with high dead weight should be supported, as required, so that the pipeline is not weighed down by its weight.

Corrosion preventive metallic accessories

In terms of corrosion protection, one should ensure that the damaging insulating material does not come into contact with PE pipes. When working on casting compounds for example, shrink sleeves must avoid the harmful influence of temperature of pipes and fittings. One must ensure that the casting compounds are compatible with the pipe material.

Subsequent work on installed ducts

For repair work on idle ducts, the damaged pipe section is separated by vertical cuts to the pipe axis. After chamfering both pipe ends, a double plug-in sleeve with a longer sleeve part is pushed to the end of the pipe until it stops and the gap between both double plug-in sleeves is measured.

The appropriate fitting length provided with the chamfered ends is inserted in one of the two double plug-in sleeves until it stops and the opposite double plug-in sleeve is pulled back to the fitting length until it stops.

When repairing engaged ducts, the appropriate repair kit must be used.

The subsequent installation of fittings can be done using clamp and bolt connections or welded joints.

If welded joints are chosen, one must ensure that the welding area is free from the influence of humidity.

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Backfilling and compacting

The compacting contributes directly to the stability of the buried pipe and is therefore carried out with care.

Both sides of the pipeline are free of stones; compressible soil (aggregate size ∅20 mm) must be piled up in layers up 0.3 m and compacted by hand or using a light mechanical device. The pipes should not shift sideways.

Pipes of smaller nominal size must be secured by integrating them by height.

For backfilling and compacting operations, standard EN 1610 must be observed. When compacting on the sides, one must pay particular attention to avoid any subsequent deformation of the pipes.

The pipe connections should be kept clear as much as possible for the leak test.

Leak test (Internal pressure test)

Underground drinking water pipes are usually subjected to a pressure test. The purpose of the pressure test is to determine the tightness of the entire piping system. This test will then be used to create a protocol to serve the execution of the project. The pressure test is implemented in accordance with standard EN805 and DVGW worksheet W400-2.

The following testing procedures apply for EUCALENE PE pipes:

- The contraction process
- The normal procedure
- The visual test procedure (e.g. for repairs)

See DVGW W400-2

Contraction process

Determination of the test section

The pressure test must always be performed at a pressure higher than the maximum system operating pressure, MDP. The system test pressure, STP, must be determined for all pipelines. This shall be measured at the deepest point. For height differences greater than 40m, the pipe must checked in several sections.

Abbreviations :

- DP = Operating pressure (network pressure)
- MDP = Maximum system operating pressure (incl. pressure surge)
- STP = System test pressure
- MDPa= Assumed maximum system operating pressure (incl. pressure surge)
- MDPc= Calculated maximum system operating pressure (incl. pressure surge)

Determination of the system test pressure, STP

At the highest point of the test section:
STP min = 1,1 x MDP
With a pressure surge:
STP = MDPc + 1 bar
Without a pressure surge:
MDPa min = DP + 2 bar
STP = MDPa x 1,5 oder
STP = MDPa + 5 bar
(whichever is the lower)

Pipelines made of PE100 SDR17 max. 12 bar
Pipelines made of PE100 SDR11 max. 21 bar

Preparation

The following points should be observed, among others:

- Protect the pipes from direct sunlight. Pipe wall temperature of 20°C maximum.
- Keep pipes from moving (e.g. add wrapping materials)
- Maintain easy access to the connection points on the pipe to be tested
- Shut-off valves must be waterproof and airtight.

Implementing the contraction test

1 Relaxation phase
After filling and venting the water pipe, the test section must be kept without pressure for 60 minutes. The pipe's temperature should not exceed 20°C for the entire duration of the test process.

2 Pressure build-up
Build-up the system test pressure STP within 10 minutes, using a motor pump if necessary for longer pipe sections.

3 Pressure holding phase
The STP system test pressure is maintained for 30 minutes by re-pumping constantly.

4 Resting phase
Then comes a one-hour long resting phase. During that period, the pipe becomes viscoelastic. Within 60 minutes, the STP should sink by 20% maximum.
Note: an excessive drop in pressure indicates a leak or an unacceptable pipe wall temperature. If this occurs, the test must be repeated.

5 Pressure drop/pressure decrease test
With the aim to stop the pipe from further viscoelastic elongation, the pressure is lowered within 2 minutes maximum. The volume change when the air is absent, which results theoretically from the measured pressure decrease is compared with the actually measured amount of water ΔVg. A pipe is sufficiently free of air when the measured drained amount of water is less than the calculated maximum allowed volume of water Vzul.

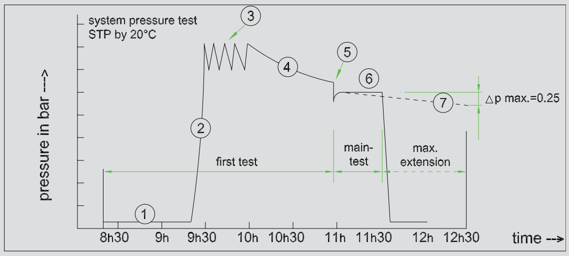
Material	*SDR classe*	*Pressure drop Pab*
PE80	SDR11	2,2 bar
PE80	SDR7,4	3,6 bar
PE100	SDR17	2,0 bar
PE100	SDR11	3,2 bar

For SDR17, see also DVGW W400-2 (Appendix A)

6 Main test
The pipe is deemed tight when the press line exhibits an increasing to constant trend during the 30-minute long contraction.

7 Prolonged main test
In case of doubt, the test can be extended from 1 hour to 1.5 hours. In that case, the pressure decrease should not be more than 0.25 bar from the highest value reached after the pressure drop.

The results of the test procedure should be continuously recorded and logged.



Permissible maximum water volume Vk in ml per meter of pipe length

Pipe's outer Ø	*PE80*		*PE100*	
	SDR11	SDR7,4	SDR17	SDR11
32	1,29	0,98		1,28
40	1,96	1,54		1,95
50	3,12	2,41		3,10
63	4,98	3,94		4,95
75	7,28	5,53	8,30	7,22
90	10,43	8,07	12,01	10,35
110	15,70	11,98	18,02	15,57
125	20,20	15,61	23,76	20,04
140	25,60	19,50	29,81	25,39
160	33,17	25,61	38,93	32,90
180	42,13	32,55	49,26	41,79
200	52,17	40,01	60,81	51,74
225	65,96	50,77	76,96	65,41
250	81,95	62,80	95,90	81,27
280	103,04	78,85	120,17	102,17
315	130,31	99,79	151,94	129,22
355	165,88	127,21	192,81	164,48
400	210,54	161,25	246,02	208,76

Calibration

After completion of the leak test, a calibration should be performed. The calibre to be used shall be agreed with the client on the basis of the intended allocation of EUCALENE PE pipes. Attention should be paid to the different oval shapes between the coiled goods and the ready-made goods.

Special measures

Depending on the intended allocation of underground EUCALENE PE pipes, one should observe the relevant safety distances for intersections and parallel installations set out in the relevant rules and regulations.

Reduction factors of the pressure class at higher operating temperatures

Operating temperature	Pressure reduction factor fT
20°C	1,00
30°C	0,87
40°C	0,74

PFA = fT x PN
PN = Assumed value for the nominal pressure
fT = Pressure reduction factor

Maximum permissible tensile strength for EUCALENE PE80 pipes

The maximum permissible tensile strengths at an installation temperature of 20°C are described in the following table:

Outer diameter	25		20		16		12,5	
	51		41		33		26	
	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force
mm	mm	kgf	mm	kgf	mm	kgf	mm	kgf
10								
12								
16								
20								
25								
32								
40							1,8	177
50					1,8	223	2,0	246
63			1,8	283	2,0	313	2,5	388
75	1,8	338	1,9	356	2,3	429	2,9	536
90	1,8	407	2,2	495	2,8	626	3,5	776
110	2,2	608	2,7	743	3,4	929	4,2	1139
125	2,5	785	3,1	969	3,9	1210	4,8	1479
140	2,8	985	3,5	1224	4,3	1495	5,4	1863
160	3,2	1286	4,0	1599	4,9	1948	6,2	2443
180	3,6	1627	4,4	1980	5,5	2459	6,9	3060
200	3,9	1960	4,9	2450	6,2	3079	7,7	3794
225	4,4	2487	5,5	3093	6,9	3856	8,6	4768
250	4,9	3077	6,2	3873	7,7	4780	9,6	5913
280	5,5	3868	6,9	4828	8,6	5980	10,7	7383
315	6,2	4906	7,7	6063	9,7	7587	12,1	9390
355	7,0	6241	8,7	7719	10,9	9610	13,6	11896
400	7,9	7936	9,8	9797	12,3	12218	15,3	15080
450	8,8	9947	11,0	12372	13,8	15422	17,2	19072
500	9,8	12308	12,3	15369	15,3	19000	19,2	23533
560	11,0	15472	13,7	19175	17,2	23919	21,4	29530

EUCALENE PE80 pipes maximum allowed tensile force for installation at a temperature of 20°C

	Series (S)																			
	10,5		10		8,3		8		6,3		5		4		3,2		2,5		2	
	Diameter/wall thickness ratio (SDR)																			
	22		21		17,6		17		13,6		11		9		7,4		6		5	
	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile	Wall	Tensile
	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force	thickness	force
	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf
																	1,8	38	2,0	41
															1,8	48	2,0	52	2,4	60
													1,8	66	2,2	78	2,7	92	3,3	108
									1,8	84	1,9	89	2,3	105	2,8	124	3,4	145	4,1	168
							1,8	107	1,9	113	2,3	134	2,8	160	3,5	193	4,2	224	5,1	261
					1,8	140	1,9	147	2,4	183	3,0	223	3,6	262	4,4	312	5,4	368	6,5	425
	1,9	186	1,9	186	2,3	223	2,4	232	3,0	285	3,7	345	4,5	410	5,5	487	6,7	572	8,1	662
	2,3	282	2,4	293	2,9	350	3,0	362	3,7	439	4,6	536	5,6	638	6,9	762	8,3	887	10,1	1033
	2,9	447	3,0	462	3,6	548	3,8	577	4,7	703	5,8	850	7,1	1017	8,6	1199	10,5	1413	12,7	1637
	3,5	642	3,6	659	4,3	779	4,5	813	5,6	996	6,8	1189	8,4	1434	10,3	1708	12,5	2002	15,1	2318
	4,1	903	4,3	945	5,1	1110	5,4	1171	6,7	1430	8,2	1719	10,1	2068	12,3	2449	15,0	2883	18,1	3335
	5,0	1346	5,3	1422	6,3	1674	6,6	1749	8,1	2115	10,0	2562	12,3	3079	15,1	3672	18,3	4300	22,1	4977
	5,7	1743	6,0	1830	7,1	2145	7,4	2230	9,2	2730	11,4	3318	14,0	3982	17,1	4728	20,8	5553	25,1	6425
	6,4	2191	6,7	2289	8,0	2706	8,3	2801	10,3	3423	12,7	4142	15,7	5000	19,2	5943	23,3	6967	28,1	8056
	7,3	2856	7,7	3005	9,1	3519	9,5	3663	11,8	4481	14,6	5439	17,9	6517	21,9	7749	26,6	9091	32,1	10519
	8,2	3610	8,6	3777	10,2	4438	10,7	4642	13,3	5681	16,4	6874	20,1	8235	24,6	9794	29,9	11499	36,1	13309
	9,1	4451	9,6	4683	11,4	5509	11,9	5735	14,7	6979	18,2	8477	22,4	10193	27,4	12117	33,2	14188	40,1	16428
	10,3	5666	10,8	5927	12,8	6959	13,4	7265	16,6	8863	20,5	10741	25,2	12900	30,8	15324	37,4	17976	45,1	20787
	11,4	6969	11,9	7260	14,2	8579	14,8	8919	18,4	10918	22,7	13219	27,9	15876	34,2	18909	41,6	22211	50,1	25658
	12,8	8763	13,4	9153	15,9	10759	16,6	11202	20,6	13691	25,4	16568	31,3	19944	38,3	23717	46,5	27818	56,2	32224
	14,4	11090	15,0	11529	17,9	13625	18,7	14196	23,2	17344	28,6	20986	35,2	25233	43,1	30024	52,3	35200	63,2	40771
	16,2	14062	16,9	14639	20,1	17246	21,1	18050	26,1	21993	32,2	26630	39,7	32069	48,5	38085	59,0	44742		
	18,2	17803	19,1	18639	22,7	21943	23,7	22849	29,4	27915	36,3	33824	44,7	40689	54,7	48390	66,5	56819		
	20,5	22558	21,5	23603	25,5	27733	26,7	28956	33,1	35354	40,9	42868	50,3	51508	61,5	61213				
	22,8	27875	23,9	29152	28,4	34314	29,7	35786	36,8	43671	45,4	52876	55,8	63502	68,3	75540				
	25,5	34919	26,7	36480	31,7	42906	33,2	44808	41,2	54761	50,8	66271	62,5	79661						

Maximum permissible tensile strength for EUCALENE PE100 pipes

The maximum permissible tensile strengths at an installation temperature of 20°C are described in the following table:

EUCALENE PE100 pipe

Outer diameter	25		20		16		12,5		10,5		10	
	51		41		33		26		22		21	
	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force
mm	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf
10												
12												
16												
20												
25												
32												
40							1,8	221	1,9	232	1,9	232
50					1,8	278	2,0	308	2,3	352	2,4	366
63			1,8	353	2,0	391	2,5	485	2,9	559	3,0	577
75	1,8	422	1,9	445	2,3	536	2,9	670	3,5	802	3,6	824
90	1,8	509	2,2	619	2,8	782	3,5	970	4,1	1128	4,3	1181
110	2,2	760	2,7	928	3,4	1161	4,2	1424	5,0	1682	5,3	1778
125	2,5	981	3,1	1211	3,9	1513	4,8	1848	5,7	2178	6,0	2287
140	2,8	1231	3,5	1530	4,3	1869	5,4	2328	6,4	2739	6,7	2861
160	3,2	1607	4,0	1999	4,9	2434	6,2	3054	7,3	3570	7,7	3756
180	3,6	2034	4,4	2475	5,5	3074	6,9	3825	8,2	4512	8,6	4721
200	3,9	2450	4,9	3062	6,2	3848	7,7	4742	9,1	5564	9,6	5854
225	4,4	3109	5,5	3867	6,9	4820	8,6	5960	10,3	7082	10,8	7409
250	4,9	3847	6,2	4841	7,7	5975	9,6	7391	11,4	8711	11,9	9074
280	5,5	4835	6,9	6035	8,6	7475	10,7	9228	12,8	10953	13,4	11441
315	6,2	6132	7,7	7578	9,7	9484	12,1	11738	14,4	13863	15,0	14411
355	7,0	7802	8,7	9649	10,9	12012	13,6	14870	16,2	17577	16,9	18299
400	7,9	9920	9,8	12246	12,3	15272	15,3	18850	18,2	22253	19,1	23299
450	8,8	12434	11,0	15465	13,8	19278	17,2	23840	20,5	28197	21,5	29504
500	9,8	15385	12,3	19211	15,3	23749	19,1	29416	22,8	34844	23,9	36440
560	11,0	19340	13,7	23969	17,2	29899	21,4	36912	25,5	43649	26,7	45600

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maximum allowed tensile force for installation at a temperature of 20°C

Series (S)															
8,3		8		6,3		5		4		3,2		2,5		2	
Diameter/wall thickness ratio (SDR)															
17,6		17		13,6		11		9		7,4		6		5	
Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force	Wall thickness	Tensile force
mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf	mm	kgf
												1,8	48	2,0	52
										1,8	59	2,0	65	2,4	74
								1,8	82	2,2	98	2,7	115	3,3	135
				1,8	105	1,9	111	2,3	131	2,8	155	3,4	181	4,1	209
		1,8	134	1,9	141	2,3	168	2,8	200	3,5	241	4,2	280	5,1	326
1,8	175	1,9	184	2,4	228	3,0	279	3,6	328	4,4	389	5,4	460	6,5	531
2,3	278	2,4	289	3,0	356	3,7	431	4,5	512	5,5	608	6,7	715	8,1	828
2,9	438	3,0	452	3,7	549	4,6	669	5,6	797	6,9	953	8,3	1109	10,1	1291
3,6	685	3,8	721	4,7	878	5,8	1063	7,1	1272	8,6	1499	10,5	1766	12,7	2046
4,3	974	4,5	1016	5,6	1245	6,8	1486	8,4	1792	10,3	2135	12,5	2502	15,1	2897
5,1	1387	5,4	1464	6,7	1788	8,2	2149	10,1	2585	12,3	3061	15,0	3603	18,1	4168
6,3	2093	6,6	2186	8,1	2644	10,0	3203	12,3	3849	15,1	4590	18,3	5375	22,1	6222
7,1	2681	7,4	2787	9,2	3412	11,4	4148	14,0	4977	17,1	5909	20,8	6941	25,1	8031
8,0	3382	8,3	3501	10,3	4279	12,7	5178	15,7	6250	19,2	7428	23,3	8708	28,1	10070
9,1	4398	9,5	4579	11,8	5601	14,6	6799	17,9	8146	21,9	9686	26,6	11364	32,1	13148
10,2	5547	10,7	5802	13,3	7101	16,4	8593	20,1	10293	24,6	12243	29,9	14373	36,1	16636
11,4	6886	11,9	7169	14,7	8724	18,2	10597	22,4	12741	27,4	15146	33,2	17735	40,1	20535
12,8	8699	13,4	9081	16,6	11079	20,5	13426	25,2	16125	30,8	19155	37,4	22470	45,1	25983
14,2	10723	14,8	11148	18,4	13648	22,7	16524	27,9	19845	34,2	23636	41,6	27764	50,1	32073
15,9	13448	16,6	14003	20,6	17113	25,4	20710	31,3	24929	38,3	29646	46,5	34772	56,2	40279
17,9	17031	18,7	17745	23,2	21680	28,6	26232	35,2	31541	43,1	37530	52,3	43999	63,2	50963
20,1	21558	21,1	22563	26,1	27491	32,2	33287	39,7	40087	48,5	47606	59,0	55928		
22,7	27428	23,7	28561	29,4	34893	36,3	42280	44,7	50861	54,7	60488	66,5	71023		
25,5	34666	26,7	36195	33,1	44192	40,9	53584	50,3	64385	61,5	76516				
28,4	42892	29,7	44732	36,8	54589	45,4	66095	55,8	79377	68,3	94425				
31,7	53632	33,2	56010	41,2	68451	50,8	82839	62,5	99576						

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Standards and guidelines

EN 805	Water supply - Requirements for water supply systems and their components outside buildings
EN 1610	Construction and testing of waste water drains and ducts
EN 12201 - 1	Plastic piping systems for the water supply and for drainage and sewerage pressure pipes - Polyethylene (PE); Part 1: General
EN 12201 - 2	Plastic piping systems for the water supply and for drainage and sewerage pressure pipes - Polyethylene (PE); Part2: pipes
EN 12201 - 5	Plastic piping systems for the water supply and for drainage and sewerage pressure pipes - Polyethylene (PE); Part 1: suitability of the system
DIN 1960	Part A: General provisions for the award of construction contracts
DIN 1961	PART B: General terms and conditions for the execution of works
DIN 4124	Excavations and trenches – slopes, planking and strutting breadths of working spaces
DIN 8074	Polyethylene (PE) pipes - PE 80, PE 100 – Dimensions
DIN 8075	Polyethylene (PE) pipes - PE 80, PE 100 – General quality requirements, testing
DIN 8075	Supplement 1 Polyethylene pipes with a higher density (HDPE); Chemical resistance of pipes and piping components
DIN 8076	Pressure pipelines made from thermoplastics materials, metal and plastic clamps connectors for pipes made from Polyethylene (PE) – general quality requirements and testing
DIN 18300	Part C: General technical specifications in construction contracts (ATV); Earthworks
DIN 18303	Part C: General technical specifications in construction contracts (ATV); timbering to trench work
DIN 18307	Part C: General technical specifications in construction contracts (ATV); Laying of pressure pipes in soil
NBN T42-010	Pipes and accessories made of Polyethylene – Guidelines for the construction and testing of welded joints
NBN T42-011	Piping systems made of Polyethylene – Guidelines for the training, testing and repeat testing of welders for heating elements -flash-butt welding process and spiral welding process
ISO 4065	Thermoplastics pipes – Universal wall thickness table
ISO/TR 10358	Plastic pipes and fittings; summarised classification panel for chemical resistance
Worksheet	Structural analysis of ATV-DVWK-A 127 Waste water ducts and pipes

DVS data sheets:

DVS 2205-1	Calculation of tanks and devices made of thermoplastics – characteristic values
DVS 2207-1	Welding of thermoplastic materials – heating element welding of pipes, piping components and boards made of PE-HD
DVS 2208-1	Welding of thermoplastic materials – machinery and equipment for the heating element butt welding of pipes, piping components and boards

DVGW –Technical rules (work and data sheets)

W400-1	Technical rules for water distribution systems (TRWV) Part 1: Planning
W400-2	Technical rules for water distribution systems (TRWV) Part 2: Construction and testing
W400-3	Technical rules for water distribution systems (TRWV) Part 1: Operation and maintenance
GW 301	Qualification criteria for pipeline construction companies
GW 330	Welding of pipes and piping components made of Polyethylene (PE80, PE100 and PE-Xa) for gas and water pipes; training and testing plan
GW 331	Welding coordinator for welding on pipelines made of PE-HD for the gas and water distribution; training and testing plan
GW 332	Squeezing of Polyethylene pipelines in the gas and water distribution

GW 335 – Part 2 Plastic piping systems in the gas and water distribution; requirements and testing;
Part A2: pipes made of PE80 and PE100

Specifications :

PAS 1031	Polyethylene (PE) for the production of pressure pipes and fittings – Requirements and tests

KRV worksheets

A135	Installation instructions PE80 and PE100 pressure pipes for drinking water supply outside of buildings

References

Plastic pipe manual; Piping systems for supply and disposal, as well as other areas of application; 4th edition, Vulkan publishers Essen;
ISBN 3-8027-2718-5.

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