evopipes
PART OF RADIUS GROUP

Pressure Piping Systems
EVO SCGR ULTRASTRESS and EVOAQUA

Catalogue and technical information

EVOPIPES provides a wide range of product assortment that is aimed at increasing client's work efficiency and reducing expenditure, as well as cost cutting during exploitation of pipelines. Pipelines are only about 4% of total costs on building of a pipeline systems, although pipelines are the main component of the all water supply systems. Quality of pipelines and their durability parameters, as well as operational costs are the main aspects to be considered by every proprietor of a pipeline system.

That is why **EVOPIPES** has elaborated a durable and reliable pipe system **EVO SCGR ULTRASTRESS**, which lowers costs for pipes installation, speeds up the process of installation and extends service life by up to 4 times (205 years at +20 °C) more than other polymer material pipes.

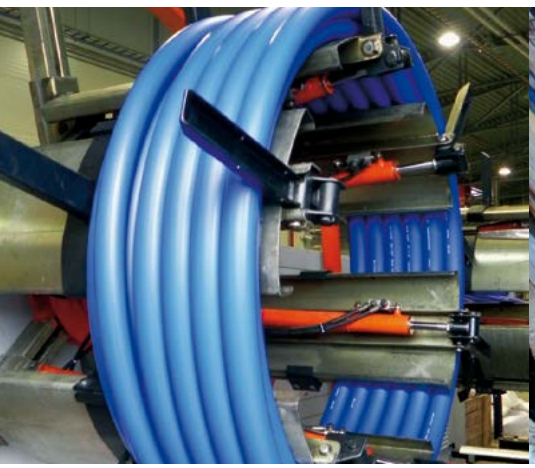
EVO SCGR ULTRASTRESS pipes slogan is well justified and reads as follows – **"Increase your efficiency!"**

Product Range:

EVOPIPES offers its clients innovative products for electrical installations, cable protection, creation of rainwater pipelines and sewage pipelines infrastructure, drainage systems, as well as creation of networks for water and gas provision.

Innovations:

EVOPIPES in cooperation with Institute of Polymer Materials and Department of Water Engineering and Technology at Riga Technical University, as well as together with its clients, continuously improves its products and elaborates new solutions, aimed at effectiveness and durability.



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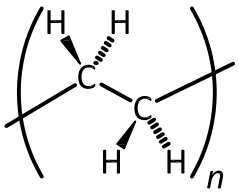
History of Polyethylene Material

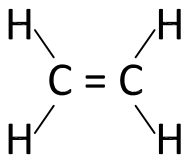


Polyethylene material was for the first time produced in the beginning of the 1930s, but production of pipes from polyethylene was begun in the middle of the 1940s. The first standard for polyethylene pipes was published in 1953 in England.

Structural formula of PE

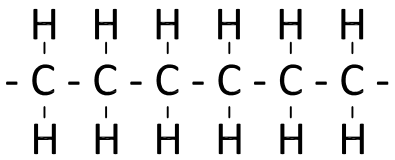
The raw materials for plastics production are oil and natural gas. The raw material for production of polyethylene is ethylene. Ethylene extract is extracted from ethane by means of the cracking method. Polymerization process allows to obtain polyethylene from the ethylene molecules.

Ethylene Molecule



After polymerization:

PolyethyleneMolecule



Polymers that consist only of carbon and hydrogen (hydrocarbons) are called polyolefins. Polyethylene (PE) also belongs to this group. This is a semi-crystalline thermoplastic. Therefore this material is not soluble in ordinary solvents, it hardly expands at all. As a result it is impossible to glue PE.

Advantages of the material:

- light;
- excellent elasticity;
- high friction resistance;
- high resistance to corrosion;
- high impact resistance even at low temperatures;
- high chemical resistance.

Polyethylene can be divided into several density types:

PELD	Polyethylen low density
PEMD	Polyethylen medium density
PEHD	**Polyethylen high density**

Design Parameters of Polyethylene Pressure Pipes

Pipes are divided into different classes according to minimum required strength of the material or **MRS**, see Table 1.

Table 1

PE class	MRS, [MPa]	Temperature, [1)][°C]	Operating life, [2)] [years]
PE40	4	+20	50
PE63	6.3	+20	50
PE80	8	+20	50
PE100	**10**	**+20**	**50**
PE100 - RC	**10**	**+20**	**>100**

MRS – minimum required strength;
PE - polyethylene;
[1)] – temperature of conveyance fluid (water);
[2)] – operating life of the system, provided by the pipe structure

1 MPa = 1 N/mm² = 10 bar

General Information on Pressure Pipe Made of Polyethylene Material

Minimum Required Strength (MRS) or minimum required long-term strength is a parameter allowing to determine polyethylene strength. This parameter is important for calculation of the allowed pipe's structural stress, that is vital for calculation of the required pipe's wall thickness. Allowed pipe's structural stress can be calculated by means of the following formula:

$$\sigma = \frac{MRS}{C}$$ **, where**

σ – allowed structural stress, [MPa];
MRS – minimum required strength, [MPa];
C* – minimum safety factor for water pressure pipes.
*value is determined by ISO 12126

Allowed pressure in the pipe refer to Table 2.

Table 2

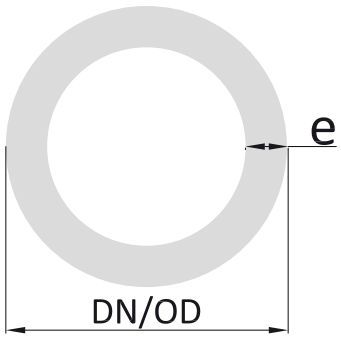
PE class	MRS, [MPa]	σ, [MPa]	
		Water-supply pipes (foll. ISO 12126)	Gas-supply pipes (foll. ISO 12126)
		C = 1.25	C = 2.0
PE80	8	6.4	4
PE100	**10**	**8**	5
PE100 - RC	**10**	**8**	5

σ – allowed structural stress, [MPa];
MRS – minimum required strength, [MPa];
C – minimum safety factor.

According to EN 12201 **SDR** (standard dimension ratio) is the ratio of pipe outside diameter to wall thickness.

$$SDR = \frac{DN/OD}{e}$$ **, where**

SDR – standard dimension ratio;
DN/OD –pipe nominal/outside diameter, [mm];
e –pipe wall thickness, [mm].



Relationship between **S**, **SDR, PN** and **σ**

$$S = \frac{SDR - 1}{2}, \quad PN = \frac{20 \cdot \sigma}{SDR - 1}$$ **, where**

S – polyethylene pipe pressure series;
PN – nominal pressure, [bar];
SDR – standard dimension ratio;
σ – allowed structural stress, [MPa].

$$S = \frac{10 \cdot \sigma}{PN} \Rightarrow PN = \frac{10 \cdot \sigma}{S} \Rightarrow \sigma = \frac{PN \cdot S}{10}$$ **, where**

PN – nominal pressure, [bar];
S – polyethylene pipe pressure series;
σ – allowed structural stress, [MPa].

General Information on Pressure Pipe Made of Polyethylene Material

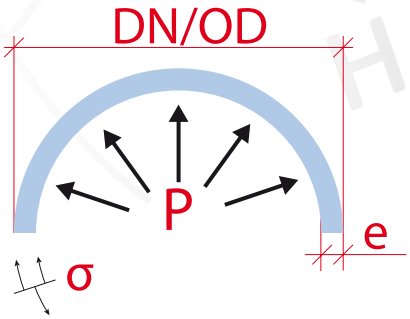
Strength Calculation for Polyethylene Pressure Pipes

Stress influencing the pipe walls as a result of the liquid pressure application, can be calculated by means of the following formula:

$$e = \frac{P \cdot DN/OD}{2 \cdot \sigma + P} \Rightarrow \sigma = \frac{P \cdot (DN/OD - e)}{2 \cdot e}$$, **where**

e – pipe wall thickness, [mm];
P* – pressure in the pipe, [MPa];
DN/OD – pipe nominal/outside diameter, [mm];
σ – allowed structural stress, [MPa].

*operating pressure of the water-supply network or estimated operating pressure of the system



Scheme: Liquid's pressure influence on the pipe walls.

Allowable stress depends on class of the polyethylene material and is a determinant of pipe wall thickness identification. Polyethylene pipes are manufactured according to standard pressure classes (usually from PN4 to PN25), where pressure class determines allowed (constant) operating pressure in the pipeline throughout its use (exploitation) at liquid operating temperature equal to + 20°C.
The higher pressure in a pipeline is also possible, but during a short period of time, for example, during hydraulic impact. If operating liquid temperature is higher than + 20 °C, permitted working pressure in the pipeline should be reduced. This reduction depends on class of the polyethylene material.

Relationship between **PN, MRS, S** and **SDR** at + 20°C, when C = 1.25 depending on class of the material (following EN 12201) is presented in Table 3.

Table 3

SDR	S	Class of the polyethylene material		
		PE80	PE100	PE100 - RC
41	20	PN3.2	PN4	PN4
33	16	PN4	PN5	PN5
26	12.5	PN5	PN6[a]	PN6[a]
21	**10**	PN6[a]	**PN8**	**PN8**
17.6	8.3	-	-	-
17	**8**	PN8	**PN10**	**PN10**
13.6	**6.3**	PN10	**PN12.5**	**PN12.5**
11	**5**	PN12.5	**PN16**	**PN16**
9	4	PN16	PN20	PN20
7.4	3.2	PN20	PN25	PN25
6	2.5	PN25	-	-

a – actually calculated value of PE100 and PE100-RC is 6.4 [bar] and PE80 – 6.3 [bar];
SDR – standard dimension ratio;
S – pipe series;
PN – pipe nominal pressure, [bar].

General Information on Pressure Pipe Made of Polyethylene Material

Relationship between **PN, MRS, S** and **SDR** at + 20°C with different C values is presented in Table 4.

Table 4

SDR	SDR 6	SDR 7.4	SDR 9	**SDR 11**	**SDR 13.6**	**SDR 17**	SDR 17.6	**SDR 21**	SDR 26	SDR 33	SDR 41
S	S 2.5	S 3.2	S 4	**S 5**	**S 6.3**	**S 8**	S 8.3	**S 10**	S 12.5	S 16	S 20
PE 80 C=1.25	PN 25	PN 20	PN 16	PN 12.5	PN 10	PN 8	-	PN 6^C	PN 5	PN 4	PN 3.2
PE 80 C=1.6	PN 20	PN 15.5	PN 12.5	PN 10	PN 7.5	PN 6	-	PN 5	PN 4	PN 3	PN 2.5
PE 80 C=2.0	PN 16	PN 12.5	PN 10	PN 8	PN 6	PN 5	-	PN 4	PN 3	PN 2.5	PN 2
PE 100 C=1.25	-	PN 25	PN 20	**PN 16**	**PN 12.5**	**PN 10**	-	**PN 8**	PN 6^C	PN 5	PN 4
PE 100 C=1.6	-	PN 19.5	PN 15.5	**PN 12.5**	**PN 9**	**PN 7**	-	**PN 6**	PN 5	PN 3.5	PN 3
PE 100 C=2.0	-	PN 15.5	PN 12.5	**PN 10**	**PN 7.5**	**PN 6**	-	**PN 5**	PN 4	PN 3	PN 2.5
PE 100 - RC C=1.25	-	PN 25	PN 20	**PN 16**	**PN 12.5**	**PN 10**	-	**PN 8**	PN 6^C	PN 5	PN 4
PE 100 - RC C=1.6	-	PN 19.5	PN 15.5	**PN 12.5**	**PN 9**	**PN 7**	-	**PN 6**	PN 5	PN 3.5	PN 3
PE 100 - RC C=2.0	-	PN 15.5	PN 12.5	**PN 10**	**PN 7.5**	**PN 6**	-	**PN 5**	PN 4	PN 3	PN 2.5

Note:
PN value for PE80, PE100 materials is calculated at liquid operating temperature equal to + 20°C with guaranteed continuous operating life of the system (durability) equal to 50 years and for material of the class PE100-RC with operating life > 100 years.

SDR – standard dimension ratio**, S** – pipe series**, PN** – pipe nominal pressure, [bar]**, C** – minimum safety factor**, c –** actually calculated value of PE100 and PE100-RC is 6.4 [bar] and PE80 – 6.3 [bar].

General Information on Pressure Pipe Made of Polyethylene Material

Polyethylene pressure pipes modification for external water supply networks following EN 12201, as well as DIN 8074/DIN 8075 and external pressure sewage networks following EN 13244 is presented in Table 5.

Beginning of Table 5

SDR	SDR 6		SDR 7.4		SDR 9		SDR 11		SDR 13.6		SDR 17		SDR 17.6	
S	S 2.5		S 3.2		S 4		S 5		S 6.3		S 8		S 8.3	
PE 80	PN 25		PN 20		PN 16		PN 12.5		PN 10		PN 8		-	
PE 100	-		PN 25		PN 20		PN 16		PN 12.5		PN 10		-	
PE 100 - RC	-		PN 25		PN 20		PN 16		PN 12.5		PN 10		-	
DN/OD	ID	e	ID	e	ID	e	ID	e	ID	e	ID	e	ID	e
16	10	3.0	11.4	2.3	12	2.0	-	-	-	-	-	-	-	-
20	13.2	3.4	14	3.0	15.4	2.3	**16**	**2.0**	-	-	-	-	-	-
25	16.6	4.2	20	2.5	19	3.0	**20.4**	**2.3**	**21**	**2.0**	-	-	-	-
32	21.2	5.4	23.2	4.4	24.8	3.6	**26**	**3.0**	**27.2**	**2.4**	**28.0**	**2.0**	28	2.0
40	26.6	6.7	29	5.5	31	4.5	**32.6**	**3.7**	**34**	**3.0**	**35.2**	**2.4**	35.4	2.3
50	33.4	8.3	36.2	6.9	38.8	5.6	**40.8**	**4.6**	**42.6**	**3.7**	**44.0**	**3.0**	44.2	2.9
63	42	10.5	45.8	8.6	48.8	7.1	**51.4**	**5.8**	**53.6**	**4.7**	**55.4**	**3.8**	55.8	3.6
75	50	12.5	54.4	10.3	58.2	8.4	**61.4**	**6.8**	**63.8**	**5.6**	**66.0**	**4.5**	66.4	4.3
90	60	15.0	65.4	12.3	69.8	10.1	**73.6**	**8.2**	**76.6**	**6.7**	**79.2**	**5.4**	79.8	5.1
110	73.4	18.3	79.8	15.1	85.4	12.3	**90**	**10.0**	**93.8**	**8.1**	**96.8**	**6.6**	97.4	6.3
125	83.4	20.8	90.8	17.1	97	14.0	**102.2**	**11.4**	**106.6**	**9.2**	**110.2**	**7.4**	110.8	7.1
140	93.4	23.3	101.6	19.2	108.6	15.7	**114.6**	**12.7**	**119.4**	**10.3**	**123.4**	**8.3**	124	8.0
160	106.8	26.6	116.2	21.9	124.2	17.9	**130.8**	**14.6**	**136.4**	**11.8**	**141.0**	**9.5**	141.8	9.1
180	120.2	29.9	130.8	24.6	139.8	20.1	**147.2**	**16.4**	**153.4**	**13.3**	**158.6**	**10.7**	159.6	10.2
200	133.6	33.2	145.2	27.4	155.2	22.4	**163.6**	**18.2**	**170.6**	**14.7**	**176.2**	**11.9**	177.2	11.4
225	150.2	37.4	163.4	30.8	174.6	25.2	**184**	**20.5**	**191.8**	**16.6**	**198.2**	**13.4**	199.4	12.8
250	167	41.5	181.6	34.2	194.2	27.9	**204.6**	**22.7**	**213.2**	**18.4**	**220.4**	**14.8**	221.6	14.2
280	187	46.5	203.4	38.3	217.4	31.3	**229.2**	**25.4**	**238.8**	**20.6**	**246.8**	**16.6**	248.2	15.9
315	210.4	52.3	228.8	43.1	244.6	35.2	**257.8**	**28.6**	**268.6**	**23.2**	**277.6**	**18.7**	279.2	17.9
355	237	59.0	258	48.5	275.6	39.7	**290.6**	**32.2**	**302.8**	**26.1**	**312.8**	**21.1**	314.8	20.1
400	-	-	290.6	54.7	310.6	44.7	**327.4**	**36.3**	**341.2**	**29.4**	**352.6**	**23.7**	354.6	22.7
450	-	-	327	61.5	349.4	50.3	**368.2**	**40.9**	**383.8**	**33.1**	**396.6**	**26.7**	399	25.5
500	-	-	-	-	388.4	55.8	**409.2**	**45.4**	**426.4**	**36.8**	**440.6**	**29.7**	443.4	28.3
560	-	-	-	-	-	-	**458.4**	**50.8**	**477.6**	**41.2**	**493.6**	**33.2**	496.6	31.7
630	-	-	-	-	-	-	**515.6**	**57.2**	**537.4**	**46.3**	**555.2**	**37.4**	558.6	35.7
710	-	-	-	-	-	-	-	-	605.6	52.2	625.8	42.1	629.6	40.2
800	-	-	-	-	-	-	-	-	682.4	58.8	705.2	47.4	709.4	45.3
900	-	-	-	-	-	-	-	-	-	-	793.4	53.3	798	51.0
1000	-	-	-	-	-	-	-	-	-	-	881.4	59.3	886.8	56.6
1200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1400	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1600	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SDR - standard dimension ratio, **S** – pipe series, **PE 80** – indication of the class of polyethylene, **DN/OD** – pipe nominal/outside diameter, [mm], **ID** – pipe inner diameter, [mm], **e** – pipe wall thickness, [mm], **PN** – pipe nominal pressure, [bar] , **C** – actually calculated value of PE100 and PE100-RC is 6.4 [bar] and PE80 – 6.3 [bar]. Minimum pressure (PN) value for pipes of the class PE80 and PE100 is determined with the minimum safety factor (C = 1.25) at liquid operating temperature equal to +20 °C with guaranteed continuous operating life of the system equal to 50 years and for material of the class PE100-RC with operating life > 100 years.

General Information on Pressure Pipe Made of Polyethylene Material

Polyethylene pressure pipes modification for external water supply networks following EN 12201, as well as DIN 8074/DIN 8075 and external pressure sewage networks following EN 13244 is presented in Table 5

End of Table 5

SDR	SDR 21		SDR 26		SDR 33		SDR 41	
S	S 10		S 12.5		S 16		S 20	
PE 80	PN 6[C]		PN 5		PN 4		PN 3.2	
PE 100	PN 8		PN 6[C]		PN 5		PN 4	
PE 100 - RC	PN 8		PN 6[C]		PN 5		PN 4	
DN/OD	ID	e	ID	e	ID	e	ID	e
16	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-
40	36	2.0	-	-	-	-	-	-
50	45.2	2.4	46	2.0	-	-	-	-
63	57	3.0	58	2.5	-	-	-	-
75	67.8	3.6	69.2	2.9	-	-	-	-
90	81.4	4.3	83	3.5	-	-	-	-
110	99.4	5.3	101.6	4.2	-	-	-	-
125	113	6.0	115.4	4.8	-	-	-	-
140	126.6	6.7	129.2	5.4	-	-	-	-
160	144.6	7.7	147.6	6.2	-	-	-	-
180	162.8	8.6	166.2	6.9	-	-	-	-
200	180.8	9.6	184.6	7.7	-	-	-	-
225	203.4	10.8	207.8	8.6	-	-	-	-
250	226.2	11.9	230.8	9.6	-	-	-	-
280	253.2	13.4	258.6	10.7	-	-	-	-
315	285	15.0	290.8	12.1	295.6	9.7	299.6	7.7
355	321.2	16.9	327.8	13.6	333.2	10.9	337.6	8.7
400	361.8	19.1	369.4	15.3	375.4	12.3	380.4	9.8
450	407	21.5	415.6	17.2	422.4	13.8	428	11.0
500	452.2	23.9	461.8	19.1	469.4	15.3	475.4	12.3
560	506.6	26.7	517.2	21.4	525.6	17.2	532.6	13.7
630	570	30.0	581.8	24.1	591.4	19.3	599.2	15.4
710	642.2	33.9	655.6	27.2	666.4	21.8	675.2	17.4
800	723.8	38.1	738.8	30.6	751	24.5	760.8	19.6
900	814.2	42.9	831.2	34.4	844.8	27.6	856	22.0
1000	904.6	47.7	923.6	38.2	938.8	30.6	951	24.5
1200	1085.6	57.2	1108.2	45.9	1126.6	36.7	1141.2	29.4
1400	-	-	1293	53.5	1314.2	42.9	1331.4	34.3
1600	-	-	1477.6	61.2	1502	49.0	1521.6	39.2

SDR - standard dimension ratio, **S** – pipe series, **PE 80** – indication of the class of polyethylene, **DN/OD** – pipe nominal/outside diameter, [mm], **ID** – pipe inner diameter, [mm], **e** – pipe wall thickness, [mm], **PN** – pipe nominal pressure, [bar] , **C** – actually calculated value of PE100 and PE100-RC is 6.4 [bar] and PE80 – 6.3 [bar]. Minimum pressure (PN) value for pipes of the class PE80 and PE100 is determined with the minimum safety factor (C = 1.25) at liquid operating temperature equal to +20 °C with guaranteed continuous operating life of the system equal to 50 years and for material of the class PE100-RC with operating life > 100 years.

General Information on Pressure Pipe Made of Polyethylene Material

Polyethylene pressure pipes strength depends on the ring stiffness **(SN)** and can be calculated by means of the formula presented in EN 13244.

$$SN = \frac{E \cdot I}{(DN/OD\text{-}e)^3} = \frac{E}{96 \cdot S^3}$$, where

$$I = \frac{e^3}{12}$$, where

SN – ring stiffness, [kN/m2];
E – elasticity modulus, [kPa];
I – pipe moment of inertia for 1 m pipe length, [$m^4/m = m^3$];
DN/OD – pipe nominal/outside diameter, [m];
e – pipe wall thickness, [m];
S – polyethylene pipe pressure series.

I –pipe moment of inertia for 1 m pipe length, [$m^4/m = m^3$];
e – pipe wall thickness, [m].

Initial ring stiffness for polyethylene pressure pipes following EN 13244 is presented in Table 6.

Table 6

SDR	S	E modulus, [MPa]		
		700	1200	1200
		Class of the polyethylene material		
		PE80	PE100	PE100 - RC
		Initial ring stiffness SN, [kN/m^2]		
41	20	0.9	1.6	1.6
33	16	1.8	3.1	3.1
26	12.5	3.7	6.4	6.4
21	**10**	7.3	**12.5**	**12.5**
17	**8**	14.2	**24.4**	**24.4**
13.6	**6.3**	29.2	**50.0**	**50.0**
11	**5**	58.3	**100.0**	**100.0**
9	4	113.9	195.3	195.3
7.4	3.2	222.5	381.5	381.5
6	2.5	466.7	800.0	800.0

SDR - standard dimension ratio;
S – polyethylene pipe pressure series.

1 kPa = 1 kN/m^2

Transport and Ground Influences on Pressure Pipes

When laying pipes in trench is done in accordance with the given instructions and guidelines, as well as during the installation process polyethylene pipes of the pressure class PN10 and higher are able to withstand ground and transport influences, and it is not necessary to reduce allowed operating pressure in the pipe. If the polyethylene pipes of the pressure class PN6 and lower are used, placing them deeply in ground or applying great transport load lead to the necessity of reduction of the allowed operating pressure.
In most cases operating pressure in the pipelines during their exploitation is 30% lower than the allowed operating pressure of the pipes that correspond to the pipe pressure class **(PN)** and is indicated on the pipe.

PN - pipe nominal pressure, [bar].

General Information on Pressure Pipe Made of Polyethylene Material

Polyethylene Pressure Pipes Stability against Temperature of Conveyance Fluid

Designing pressure systems consisting of polyethylene pipes one should consider, that minimum guaranteed operating life of pipes made of the material of classes PE80 and PE100 is 50 years, but minimum guaranteed operating life of pipes made of the material of class PE100-RC is > 100 years, upon condition, that during exploitation of the pipes operating pressure does not exceed nominal pressure **(PN)**, indicated on the pipes and conveyance fluid in the pipes is water, whose temperature during exploitation does not exceed + 20°C. Temperature and pressure of conveyance fluid in the system substantially influences operating life of the polyethylene pipes. Increase of the conveyance fluid temperature (for example, water) higher than + 20°C decreases operating life of pipes (term of service). In order not to reduce operating life of the system under 50 years consisting of pipes made of the material of classes PE80 and PE100, but for pipes made of the material of class PE100-RC under 100 years, designing a pressure system from polyethylene pipes engineers should consider pressure correction factor **(K)**, that reduces working pressure in relation to the nominal pressure of the pressure pipes **(PN)** and allows using pipes at high temperature of conveyance fluid, not reducing their term of service.

$$K = 1.260 - (0.013 \cdot T)$$, **where**

K – correction factor;
T – operating temperature of conveyance fluid, [°C].

$$P_{operating} = K \cdot PN$$, **where**

$P_{operating}$ – corrected (decreased operating pressure), [bar];
K – correction factor;
PN – pipe nominal pressure, [bar].

Example:
The used pipe is made of PEHD material, PE100, SDR17 – S8, PN10, DN/OD 110 mm with wall thickness e = 6.6 mm.
Conveyance fluid in the pipeline is water.
Water operating temperature is + 40°C.
Performing calculation of the correction factor, **K***:*

$$K = 1.260 - (0.013 \cdot 40) = 0.74$$

When the correction factor's value is calculated, performing calculation of the operating pressure ***$P_{operating}$*****:**

$$P_{operating} = 0.74 \cdot 10 = 7.4 \text{ [bar]}$$

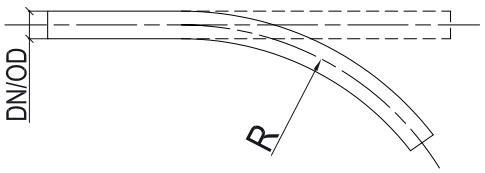
So, allowed operating pressure is the system cannot exceed ***7.4 [bar].***

1 kPa = 1000 Pa = 10 hPa = 10 mbar, 1 hPa = 100 Pa = 1 mbar

Allowed bending radius of the polyethylene pipe at air temperature equal to + 20°C depending on **SDR** and **S** is presented in Table 7.

Table 7

SDR	S	Allowed bending radius
41	20	50 x DN/OD
33	16	40 x DN/OD
26	12.5	30 x DN/OD
21	**10**	**30 x DN/OD**
17	**8**	**20 x DN/OD**
13.6	**6.3**	**20 x DN/OD**
11	**5**	**20 x DN/OD**
9	4	20 x DN/OD
7.4	3.2	20 x DN/OD
6	2.5	20 x DN/OD



SDR - standard dimension ratio;
S – polyethylene pipe pressure series.

General Information on Pressure Pipe Made of Polyethylene Material

Characteristics of Polyethylene Pressure Pipes

Advantages of the polyethylene material lead to its wide use in the water supply networks infrastructure.

Advantages of the material:

- Light weight of the pipes (light);
- Easy transportation;
- Easy to fuse (weld);
- High abrasion resistance, see Figure 1;
- Low pressure drop due to the smooth internal surface of the pipes;
- Resistance to UV radiation;
- Resistance to radioactive effluent;
- Non toxic;
- Elasticity. This property facilitates installation works;
- Pipes are not influenced by movement of ground. Breaking into pieces is not a characteristic of the pipes, unbreakable;
- High tolerance of impact, as well as resistance to damage in bends;
- An important advantage choosing diameter of the pipes is low roughness due to the smooth internal walls of the pipes;
- Pipes are suitable for underwater installation, not influenced by sea water and its movement;
- Pipes are not influenced by hazardous substances present in the soil, that cause corrosion;
- Resistant (inert) to influence of the chemical substances;
- Protection against sneak currents and electromagnetic field, there is no need for cathodic protection;
- Does not change water properties and taste.

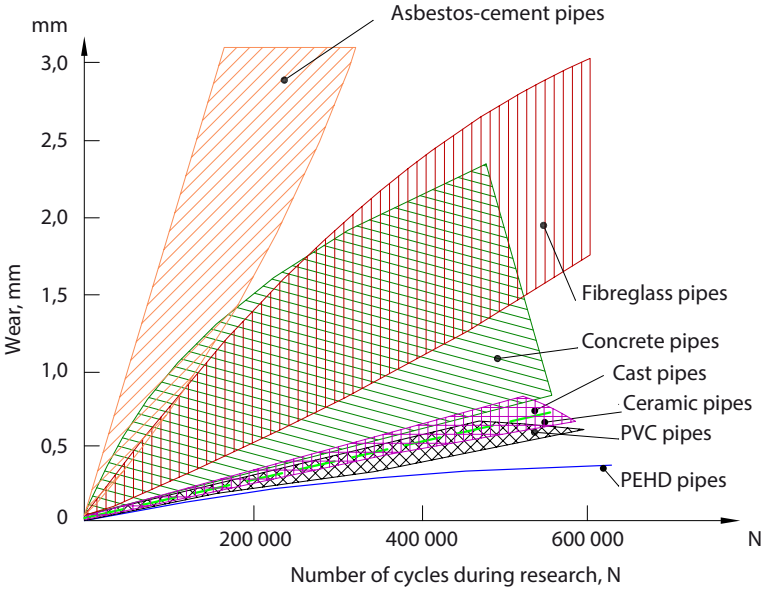


Figure 1

Chart of abrasion resistance

University of Darmstad (DIN 19534)

Comparison of special wear of the polyethylene material with other materials, used in production of pipes, is presented in Table 8.

Table 8

Material	Special wear, [mm]	Wear ratio to polyethylene
Polyethylene	0.17	–
PVC	0.75	4.4 times
Steel	1.72	10 times
Cast-iron	2.09	12 times
Clay	4.31	23 times
Concrete	15.90	94 times
Asbestos-cement	17.28	102 times

Quality Control

8-point Ultrasonic System (US)

During production of Evopipes EVO SCRG ULTRASTRESS and EVOAQUA pipes a highly technological quality control system ULTRASONIC is used. This system continuously monitors and automatically corrects quality parameters of the pipes during production:

- Wall thickness of both different layers and general thickness;
- Wall thickness classification by pipes parameters;
- Inside diameter;
- Outside diameter;
- Ovality;
- Eccentricity;
- Surface defects.

US documents all the substantial quality parameters and, thus, it can produce reviews on conformity of quality to the requirement of the generally accepted standards. The system is fully integrated into extrusion device.

Strong points:

- Complete correspondence to the standards is guaranteed.
- Immaculate production process.
- Documented goods quality conformance is accessible for the clients.

Use of the gravimetrical materials-handling system together with ultrasound system allows to apply the following innovative processes combination:

- US completely scans pipes along the perimeter along the whole length of the pipes, as a result every point along the perimeter is being monitored.
- US constantly determines actual weight (kg/m) of each metre of the pipe as a basis, using gravimetrical reading (kg/hour) and withdrawal rate of the pipe (m/min). According to the results obtained in the ultrasound readings the parameters of the production devices are automatically corrected. Thus the permanent high quality of the products is achieved.

Quality Control

Additional to the US system for continuous production process quality control, the enterprise uses the following quality control measurements, see Table 9.

Quality Control Parameters

Table 9

Properties	Periodicity	Number of samples
View of external layer, colour	Continuous monitoring process for all batches	-
Outside diameter OD, mm*	Once every 4 hours	1
Wall thickness, mm*	Once every 4 hours	1
Ovality, %*	Once every 4 hours	1
Weight, kg/m	Once every 4 hours	1
Pipes marking	Continuous monitoring process for all batches	-
Testing of the polyethylene pipes following EN 12201		
Hydrostatic force	Once in the framework of one batch	3
Tensile elongation	Once in the framework of one batch	3
Oxidation induction time	Once in the framework of one batch	3
Geometrical properties	Once in the framework of one batch	1
Melt index	Once in the framework of one batch	1

***** – OD ≤40 mm, following EN 12201, 4 measurements should be done for a sample, but if OD > 40 mm, following EN 12201, 6 measurements should be done for a sample.

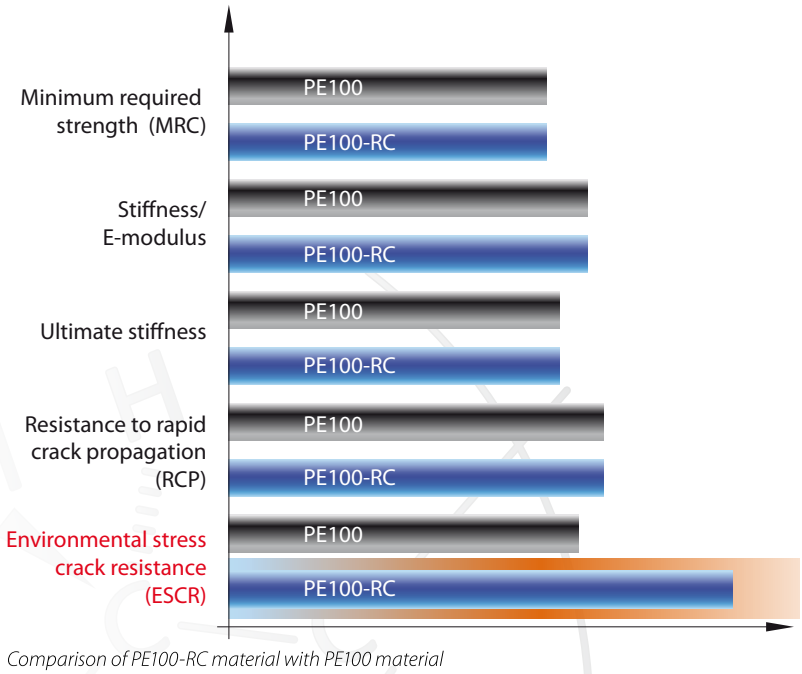
Section 2

Pressure Piping System
EVO SCGR ULTRASTRESS

SCGR is Evopipes' designation for water supply pressure pipes of the new generation. These pipes are made of the new PE100-RC material. SCGR pipes feature high environmental stress crack resistance during continuous exploitation.

Characteristics of EVO SCGR ULTRASTRESS

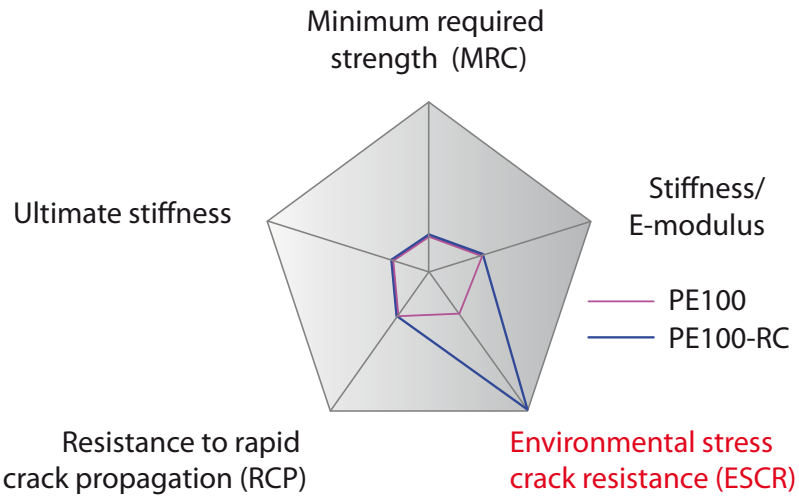
Growing demand for fast and cost-effective types of installation of pipes has led to the new manufacturing technologies (e.g., open-trench technique without filling with sand with reuse of the ground and trenchless technique, i. e. installation in place of old pipes with destruction of the old pipes or by means of insertion into an old pipe using horizontal drilling). This new technologies for installation into trenches dictate the known pre-conditions in regard to cracking properties of polyethylene pipes when put under stress. For this reason it is necessary to determine quality level of the polyethylene pipes, if their term of service is at least 100 years. EVO SCGR ULTRASTRESS pipe made of PE100-RC according to material quality and safety parameters exceeds any EN standards currently in force. These pipes feature higher resistance to crack propagation than pipes made of PE80 and PE100, that corresponds to the requirements of EN 12201 and DIN 8075. Usually preference is given to the trenchless technique if to compare with the open-trench technique, because it allows saving both time and money. Over the last few years the trenchless technique due to the higher mentioned advantages has obtained status of the most modern technology. Trenchless technique determines higher requirement in relation to pipes if to compare with the open-trench technique. Pipes that are environmental stress crack resistant during continuous exploitation are marked as pipes made of material PE100-RC. If the whole pipe is made of one mate-



Comparison of PE100-RC material with PE100 material

rial – PE100-RC, then it corresponds to the 1st type following **PAS 1075**. Alternative construction methods create complex physical loads on pipes or stress on pipes' material that cannot be exactly characterized by means of statistical calculations. In order to evaluate stress influence on a pipe, an experimental approach is used. In order to check required term of service, considering influence of the thermal aging process, it is necessary to evaluate thermal stability of the pipe. Activation energy of the thermal aging process is determined by means of the break time and Arrhenius law. Beginning of thermal aging with the lower probability limit of 100 years at +20°C is proven using extrapolation.

Pipes feature cuts and crack resistance during continuous exploitation. Point loads appear in the pipe during installation when using the open-trench technique, as well as the trenchless technique (e.g., due to friction of pipes with the stones located in the ground). In case of point loads the stress in pipes appears. It can lead to damage of the plastics and as a result to breaks in the internal surface of the pipes. Therefore **EVO SCGR ULTRASTRESS** pipe made of the PE100-RC material was introduced. It features point loads and crack resistance during continuous exploitation. EVO SCGR ULTRASTRESS pipe is environmental stress crack resistant, local deformations and increased stress resistant. Contrary to the analogues present at the market offered by other manufacturers, EVO SCGR ULTRASTRESS pipe is not a composite one. The pipe is completely manufactured from PE100-RC material and is a one-piece product. Pressure piping system EVO SCGR ULTRASTRESS features excellent mechanical properties, long term of service and installation convenience. The new pressure piping system makes installation an easy and quick process with minimum material investments, at the same time providing higher safety during installation and exploitation. Pipe testing performed in concordance with requirement of the applied standard, as well as time of testing used for pipes made of PE100 and PE100-RC material are summarized in Table 10.



Comparison of PE100-RC material with PE100 material

Table 10

	EN 12201, ISO 4427, ISO 4437	Pipe EVOAQUA PE100	Pipe EVO SCGR ULTRASTRESS PE100-RC
NPT – notched pipe test 9.2 bar, 80 °C for notch pipe testing following EN ISO 13479			
Water	> 165 h (> 500 h according to new ISO)	> 500 h	> 8760 h (1 year)
PLT – point load test 4 MPa, 80 °C) for pipe point load testing following Dr. Hessel method (elaborated by HESSEL Ingenieurtechnik GmbH)			
Water + 2% Arkopal N100			> 8760 h (1 year)
Water + 2 % NM5		> 500 h	> 8760 h (1 year)
FNCT – full notch creep test 4 MPa, 80°C) to determine local pipe stress concentration following ISO 16770 (elaborated by HESSEL Ingenieurtechnik GmbH)			
Water + 2 % Arkopal N100		> 1000 h	> 8760 h (1 year)
Water + 2 % NM5		> 100 h	> 8760 h (1 year)

Pressure Piping System
EVO SCGR ULTRASTRESS

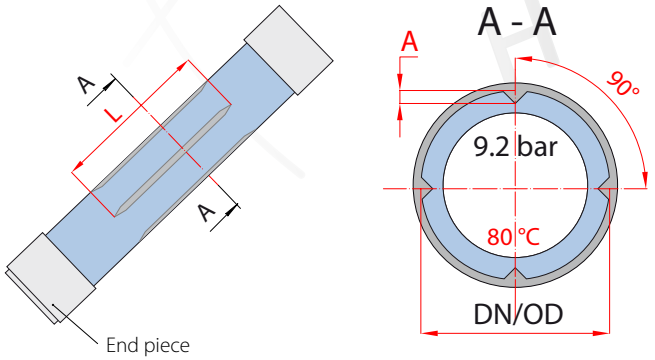
Explanation of Pipes EVO SCGR ULTRASTRESS Tests

NPT – notched pipe test for notch pipe testing following EN ISO 13479.

Test procedure:
There are 4 cuts each one making 90° made in the specimen of a pipe. The depth of each cut is > 20% of the pipe's wall thickness. Then the internal pressure equal to 9.2 bar is applied to the pipe at 80°C until the cracks appear. Test duration > 8760 h (1 year).

Test duration:
Applicable regulatory requirement to PE100 products
> 165 h (soon will be changed to > 500 h)

Test results:
PE100 > 500 h
PE100 - RC > 8760 h (1year)



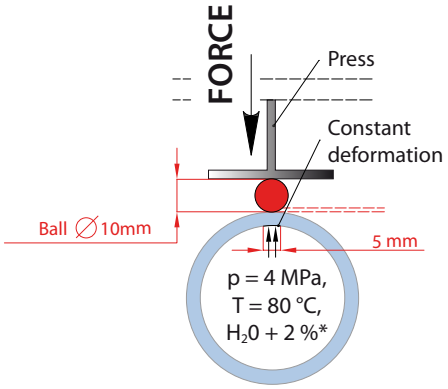
PLT – point load test for pipe point load testing following Dr. Hessel method (elaborated by HESSEL Ingenieurtechnik GmbH)

Test procedure:
During the test a steel ball Ø10 mm is applied to the specimen of a pipe. The specimen is immersed into 80°C liquid. Liquid consists of water with 2% of superficially active substance:
- Akrapolu N100 or
- NM5 (more aggressive)

Load is gradually increased until the material reaches its plastic limit. The specimen is maintained in this condition until it is damaged.

Test duration:
Applicable regulatory requirement to PE100 products
> 500 h (H_2O + 2 % NM5)

Test results:
PE100 > 500 h (H_2O + 2 % NM5)
PE100 - RC > 8760 h (1year)



*Superficially active substance

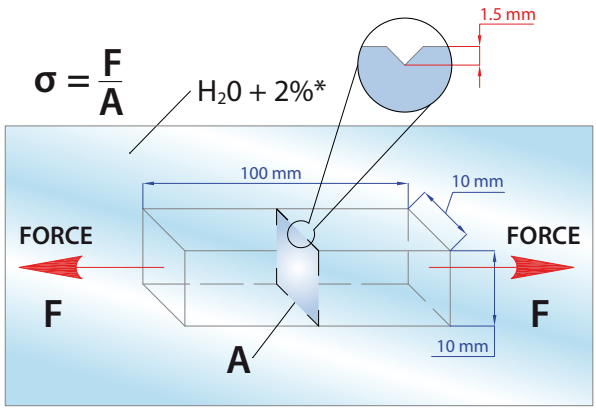
FNCT – full notch creep test to determine local pipe stress concentration following ISO 16770 (elaborated by HESSEL Ingenieurtechnik GmbH).

Test procedure:
A specimen with dimensions 10 x 10 x 100 mm. There are sharp cuts made in the specimen along its whole perimeter. The specimen is immersed into 80°C liquid. Liquid consists of water with 2% of superficially active substance:
- Akrapolu N100 or
- NM5 (more aggressive)

During the test the specimen was under constant stress load equal to 4 N/mm2 = 4 MPa until breaking of the specimen. In such a way local stress concentration are simulated.

Test duration:
Applicable regulatory requirement to PE100 products
> 500 h (H_2O + 2 % NM5)

Test results:
PE100 > 1000 h (H_2O + 2 % Akrapolu N100)
PE100 > 100 h (H_2O + 2 % NM5)
PE100 - RC > 8760 h (1year)



*Superficially active substance

Basing on Dr. Hessel testing methods and making correlation between PLT and FNCT testing methods, the crack resistance and durability are guaranteed when using trenchless technique or open-trench technique without filling with and backfilling.

Pressure Piping System EVO SCGR ULTRASTRESS

Pressure piping system **EVO SCGR ULTRASTRESS** includes PEHD water pressure pipes (of the type PE100-RC) in pressure classes from PN8 to PN16 [bar], as well as a comprehensive range of fittings. System features environmental stress crack resistance during continuous exploitation, as well as excellent mechanical properties and installation convenience.

Technical information

Standards

- Correspondence to EN 12201-2:2003 (Plastic piping systems for water supply. Polyethylene [PE] Part 2: Pipes);
- Mechanical properties tested according to ISO1167-1:2006 (hydrostatic pressure resistance), EN ISO 6259-1:2001, 6259-3:1997 (tensile elongation), EN ISO 13479:1997 and ISO 13480:1997 (resistance to slow crack growth) and EN ISO 13477:2008 (resistance to rapid crack propagation);
- Physical properties correspondence tested in accordance with EN ISO 1133:1999 (melt-flow rate), EN 728:1997 (thermal stability) and EN ISO 2505:2005 (longitudinal reversion), EN ISO 16871:2003 (erosion resistance), DVGW GW 323;
- Acceptance criteria of product's quality: PAS* 1075:2009-04, Type No. 1 (Pipes Made From Polyethylene For Alternative Installation Techniques – Dimensions, Technical Requirements And Testing).

*** - PAS** - Publicly Available Specification

Certification

Conclusion of the Conformity Assessment Centre of Construction Products of the Republic of Latvia (INSPECTA).

Operation Temperature

Pipe system is designed to be operated within temperature range from -25ºC up to +90ºC.

Nominal Measurements (DN)

Measurements in mm by outside diameter (OD), for materials PE100-RC from PN8 to PN16 pressure classes: DN/OD makes 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630 mm.

Lengths / Packaging

Diameters from DN/OD 20 up to 110 mm are available in rolls from 50 m up to 300 m.
Diameters from DN/OD 75 to 630 mm are available in bars of 6, 12, 13.4 m.

Colouring

Pipe colour is dark-blue, RAL 5005.

Marking

- Number of the standard (EN 12201);
- Requirements for material and type of pipe(PAS 1075 Type1)
- Producer identification (EVOPIPES);
- Product name (EVO SCGR ULTRASTRESS);
- Dimensions (diameter x wall thickness, e.g. 63 x 3.8);
- SDR series (e.g. SDR17);
- Material denomination (PE100-RC);
- Pressure class, in bars (e.g. PN10);
- Period of manufacture (date or code).

Joining methods of system's elements

By compression fittings;
By electrofusion fittings;
By buttfusion.

Pressure Piping System EVO SCGR ULTRASTRESS

Advantages of EVO SCGR ULTRASTRESS Pipe System

Using EVO SCGR ULTRASTRESS pipes made of PE100-RC material with high resistance to scratching, as well as resistance to environmental stress crack during continuous exploitation for construction of a pipeline system, they are protected from mechanical damage during installation works. Using an ordinary PE100 type pipe leads to higher costs when laying the pipe into a trench, as well as during movement and storage of the ground for filling up of this trench. During installation of a EVO SCGR ULTRASTRESS pipe into a trench it is allowed to use the same ground for filling that was taken out as an additional material around the pipe (see page 63, Table 17). This substantially lowers the amount of the total costs for the object, as well as substantially facilitates installation. In places, where it is impossible to apply open-trench technique, EVO SCGR ULTRASTRESS pressure pipe due to its mechanical properties, can be used for installation by means of the trenchless technique. For example, one of the problems that can appear during pipe's installation is that it can be scratched. An ordinary PE100 type pipe, in case of a scratch with the depth of > 10% of the pipe's wall thickness, loses its mechanical resistance, but EVO SCGR ULTRASTRESS pipe's resistance level is higher and it does not lose its mechanical resistance even in case of a scratch with the depth of 15%.

Pipe system of the type PE100-RC has the following features:

- easy stacking, transportation and installation – higher resistance to mechanical damage;
- easy pipe coupling, using a comprehensive range of fittings;
- decreased time and costs necessary for installation, using the same ground for filling that was taken out;
- can be used for horizontal directional drilling (trenchless technique);
- operating life > 100 years at + 20 °C (foll. HESSEL Ingenieurtechnik GmbH; ISO 4427; 4437).

Material

Pipes are made of the new generation high density polyethylene (PEHD) PE100 - RC.

Physical Properties of PE100-RC:

• Density	960 kg/m^3	foll. ISO 1872-2/ISO 1183;
• Elasticity Modulus (1 mm/min)	1200 MPa	foll. ISO 527-2;
• Melt-flow Rate	0,25 g/10min	foll. ISO 1133;
• Thermal conductivity	0,38 W/m °C	foll. DIN 52612 (at + 23 °C);
• Linear expansion	0,13 mm/m °C	foll. VDE 0304;
• Thermal capacity	1900 J/kg °C	calorimeter, (at + 23 °C).

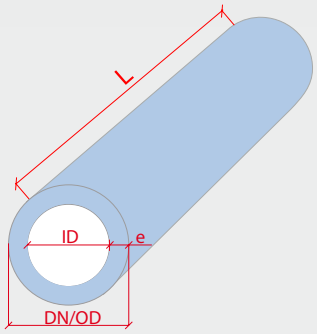
Advantages of PE100-RC:

- Environmental stress crack resistance during continuous exploitation;
- High local deformations resistance;
- Higher mechanical damage resistance;
- Increased stress resistance;
- Very low resistance to flow;
- Chemically and biologically inert material;
- Environmentally-friendly material: polyethylene is 100% recyclable

Chemical resistance

Following ISO/TR 10358 and ISO/TR 7620 the pipes and fittings possess chemical resistance between pH 2 (acid) and pH 12 (alkaline).

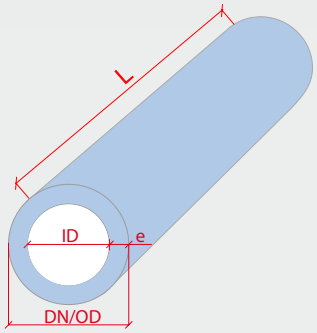
Pressure Piping System
EVO SCGR ULTRASTRESS



Pipe SDR 11 PE100-RC

pressure class PN 16 [bar]

DN/OD [mm]	e [mm]	ID [mm]	L [m]	Code
20	2.0	16.0	100/200	4111100204(100/200)BL
25	2.3	20.4	100/200	4111100254(100/200)BL
32	3.0	26.0	100/200	4111100324(100/200)BL
40	3.7	32.6	100/200	4111100404(100/200)BL
50	4.6	40.8	100/200	4111100504(100/200)BL
63	5.8	51.4	100	4111100634100BL
75	6.8	61.4	12/100	4111100754(012/100)BL
90	8.2	73.6	12/50/100	4111100904(012/050/100)BL
110	10.0	90.0	12/50/100	4111101104(012/050/100)BL
125	11.4	102.2	12	4111101254012BL
140	12.7	114.6	12	4111101404012BL
160	14.6	130.8	12	4111101604012BL
180	16.4	147.2	12	4111101804012BL
200	18.2	163.6	12	4111102004012BL
225	20.5	184.0	12	4111102254012BL
250	22.7	204.6	12	4111102504012BL
280	25.4	229.2	12	4111102804012BL
315	28.6	257.8	12	4111103154012BL
355	32.2	290.6	12	4111103554012BL
400	36.3	327.4	12	4111104004012BL
450	40.9	368.2	12	4111104504012BL
500	45.4	409.2	12	4111105004012BL
560	50.8	458.4	12	4111105604012BL
630	57.2	515.6	12	4111106304012BL

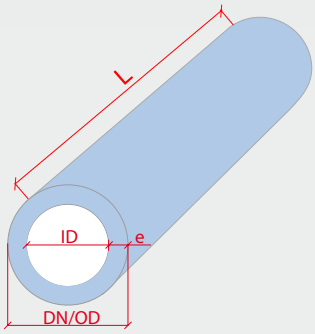


Pipe SDR 13.6 PE100-RC

pressure class PN 12.5 [bar]

DN/OD [mm]	e [mm]	ID [mm]	L [m]	Code
20	1.8	16.4	100/200	4111360204(100/200)BL
25	2.0	21.0	100/200	4111360254(100/200)BL
32	2.4	27.2	100/200	4111360324(100/200)BL
40	3.0	34.0	100/200	4111360404(100/200)BL
50	3.7	42.6	100/200	4111360504(100/200)BL
63	4.7	53.6	100	4111360634100BL
75	5.6	63.8	12/100	4111360754(012/100)BL
90	6.7	76.6	12/50/100	4111360904(012/050/100)BL
110	8.1	93.8	12/50/100	4111361104(012/050/100)BL
125	9.2	106.6	12	4111361254012BL
140	10.3	119.4	12	4111361404012BL
160	11.8	136.4	12	4111361604012BL
180	13.3	153.4	12	4111361804012BL
200	14.7	170.6	12	4111362004012BL
225	16.6	191.8	12	4111362254012BL
250	18.4	213.2	12	4111362504012BL
280	20.6	238.8	12	4111362804012BL
315	23.2	268.6	12	4111363154012BL
355	26.1	302.8	12	4111363554012BL
400	29.4	341.2	12	4111364004012BL
450	33.1	383.8	12	4111364504012BL
500	36.8	426.4	12	4111365004012BL
560	41.2	477.6	12	4111365604012BL
630	46.3	537.4	12	4111366304012BL

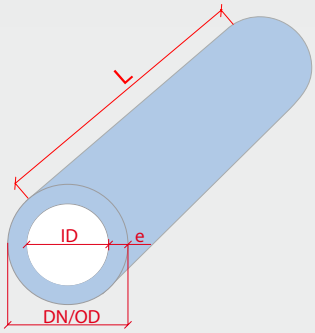
Pressure Piping System
EVO SCGR ULTRASTRESS



Pipe SDR 17 PE100-RC

pressure class PN 10 [bar]

DN/OD [mm]	e [mm]	ID [mm]	L [m]	Code
25	1.8	21.4	100/200	4111700254(100/200)BL
32	2.0	28.0	100/200	4111700324(100/200)BL
40	2.4	35.2	100/200	4111700404(100/200)BL
50	3.0	44.0	100/200	4111700504(100/200)BL
63	3.8	55.4	100	4111700634100BL
75	4.5	66.0	12/100	4111700754(012/100)BL
90	5.4	79.2	12/50/100	4111700904(012/050/100)BL
110	6.6	96.8	12/50/100	4111701104(012/050/100)BL
125	7.4	110.2	12	4111701254012BL
140	8.3	123.4	12	4111701404012BL
160	9.5	141.0	12	4111701604012BL
180	10.7	158.6	12	4111701804012BL
200	11.9	176.2	12	4111702004012BL
225	13.4	198.2	12	4111702254012BL
250	14.8	220.4	12	4111702504012BL
280	16.6	246.8	12	4111702804012BL
315	18.7	277.6	12	4111703154012BL
355	21.1	312.8	12	4111703554012BL
400	23.7	352.6	12	4111704004012BL
450	26.7	396.6	12	4111704504012BL
500	29.7	440.6	12	4111705004012BL
560	33.2	493.6	12	4111705604012BL
630	37.4	555.2	12	4111706304012BL



Pipe SDR 21 PE100-RC

pressure class PN 8 [bar]

DN/OD [mm]	e [mm]	ID [mm]	L [m]	Code
40	2.0	36.0	100/200	4112100404(100/200)BL
50	2.4	45.2	100/200	4112100504(100/200)BL
63	3.0	57.0	100	4112100634100BL
75	3.6	67.8	12/100	4112100754(012/100)BL
90	4.3	81.4	12/50/100	4112100904(012/050/100)BL
110	5.3	99.4	12/50/100	4112101104(012/050/100)BL
125	6.0	113.0	12	4112101254012BL
140	6.7	126.6	12	4112101404012BL
160	7.7	144.6	12	4112101604012BL
180	8.6	162.8	12	4112101804012BL
200	9.6	180.8	12	4112102004012BL
225	10.8	203.4	12	4112102254012BL
250	11.9	226.2	12	4112102504012BL
280	13.4	253.2	12	4112102804012BL
315	15.0	285.0	12	4112103154012BL
355	16.9	321.2	12	4112103554012BL
400	19.1	361.8	12	4112104004012BL
450	21.5	407.0	12	4112104504012BL
500	23.9	452.2	12	4112105004012BL
560	26.7	506.6	12	4112105604012BL
630	30.0	570.0	12	4112106304012BL

Section 3

Pressure Piping System EVOAQUA

Pressure piping system **EVOAQUA** includes PEHD water pressure pipes (of the type PE100) in pressure classes from PN8 to PN16, as well as a comprehensive range of fittings. System features excellent mechanical properties and installation convenience.

Technical Information

Standards
- Corresponds to EN 12201-2:2003;
- Mechanical properties tested following EN ISO 1167-1:2006;
- Conformity of physical properties tested following EN ISO 6259-1:2001, ISO 6259-3:1997, EN ISO 1133:1999 and EN 728.

Certification
Conclusion of the Conformity Assessment Centre of Construction Products of the Republic of Latvia (INSPECTA).

Operation temperature
Pipe system is designed to be operated within temperature range from -25ºC up to +90ºC.

Nominal measurements (DN)
Measurements in mm by outside diameter (OD), for materials PE100, from PN8 to PN16 pressure classes: DN/OD makes 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 140, 160, 180, 200, 225, 250, 280, 315, 355, 400, 450, 500, 560, 630 mm.

Lengths / Packaging
Diameters from DN/OD 20 up to 110 mm are available in rolls from 50 m up to 300 m;
Diameters from DN/OD 75 to 630 mm are available in bars of 6, 12, 13.4 m.

Colouring
Pipe colour is black, marking stripes are blue.

Marking
- Number of the standard (EN 12201);
- Producer identification (EVOPIPES);
- Product name (EVOAQUA);
- Dimensions (diameter x wall thickness, e.g. 63 x 3.8);
- SDR series (e.g. SDR17);
- Material denomination (PE100);
- Pressure class, in bars (e.g. PN10);
- Period of manufacture (date or code).

Joining Methods of System's Elements
- By compression fittings;
- By electrofusion fittings;
- By contact welding.

Advantages of EVOAQUA water pressure pipes
Pipe system of the type PE100 has the following features:
- excellent long-term durability properties (up to 50 years in service);
- high resistance to corrosion;
- very low resistance to flow;
- chemically and biologically inert material;
- comprehensive range of joints and adapter fittings;
- environmentally-friendly material PE is 100% recyclable.

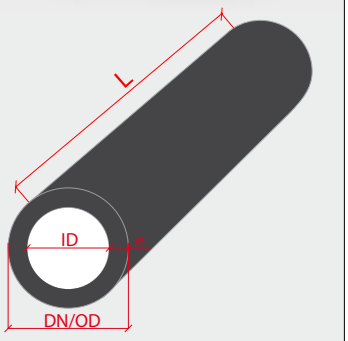
Material
Pipes are made of high density polyethylene (PEHD) type PE100.

Physical Properties of PE100:

• Density	950 kg/m^3	foll. ISO 1183;
• Elasticity Modulus	1200 MPa	foll. ISO 527;
• Melt-flow Rate	0,5 g/10min	foll. ISO 1133;
• Thermal conductivity	0,38 W/m ℃	foll. DIN 52612 (at + 23℃);
• Linear expansion	0,13 mm/m ℃	foll. VDE 0304;
• Thermal capacity	1900 J/kg ℃	calorimeter (at +23℃).

Chemical Resistance
Following ISO/TR 10358 and ISO/TR 7620 the pipes and fittings possess chemical resistance between pH 2 (acid) and pH 12 (alkaline).

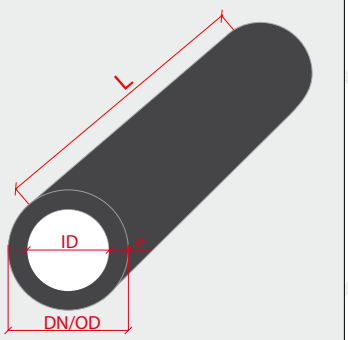
Pressure Piping System EVOAQUA



Pipe SDR 11 PE100

pressure class PN16 [bar]

DN / OD [mm]	e [mm]	ID [mm]	L [m]	Code
20	2,0	16,0	100/200	4111100203(100/200)
25	2,3	20,4	100/200	4111100253(100/200)
32	3,0	26,0	100/200	4111100323(100/200)
40	3,7	32,6	100/200	4111100403(100/200)
50	4,6	40,8	100/200	4111100503(100/200)
63	5,8	51,4	100	4111100633100
75	6,8	61,4	12/100	4111100753(012/100)
90	8,2	73,6	12/50/100	4111100903(012/050/100)
110	10,0	90,0	12/50/100	4111101103(012/050/100)
125	11,4	102,2	12	4111101253012
140	12,7	114,6	12	4111101403012
160	14,6	130,8	12	4111101603012
180	16,4	147,2	12	4111101803012
200	18,2	163,6	12	4111102003012
225	20,5	184,0	12	4111102253012
250	22,7	204,6	12	4111102503012
280	25,4	229,2	12	4111102803012
315	28,6	257,8	12	4111103153012
355	32,2	290,6	12	4111103553012
400	36,3	327,4	12	4111104003012
450	40,9	368,2	12	4111104503012
500	45,4	409,2	12	4111105003012
560	50,8	458,4	12	4111105603012
630	57,2	515,6	12	4111106303012

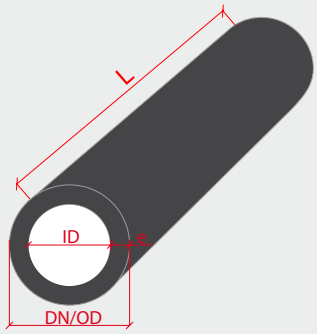


Pipe SDR 13.6 PE100

pressure class PN12.5 [bar]

DN / OD [mm]	e [mm]	ID [m]	L [m]	Code
20	1,8	16,4	100/200	4111360203(100/200)
25	2,0	21,0	100/200	4111360253(100/200)
32	2,4	27,2	100/200	4111360323(100/200)
40	3,0	34,0	100/200	4111360403(100/200)
50	3,7	42,6	100/200	4111360503(100/200)
63	4,7	53,6	100	4111360633100
75	5,6	63,8	12/100	4111360753(012/100)
90	6,7	76,6	12/50/100	4111360903(012/050/100)
110	8,1	93,8	12/50/100	4111361103(012/050/100)
125	9,2	106,6	12	4111361253012
140	10,3	119,4	12	4111361403012
160	11,8	136,4	12	4111361603012
180	13,3	153,4	12	4111361803012
200	14,7	170,6	12	4111362003012
225	16,6	191,8	12	4111362253012
250	18,4	213,2	12	4111362503012
280	20,6	238,8	12	4111362803012
315	23,2	268,6	12	4111363153012
355	26,1	302,8	12	4111363553012
400	29,4	341,2	12	4111364003012
450	33,1	383,8	12	4111364503012
500	36,8	426,4	12	4111365003012
560	41,2	477,6	12	4111365603012
630	46,3	537,4	12	4111366303012

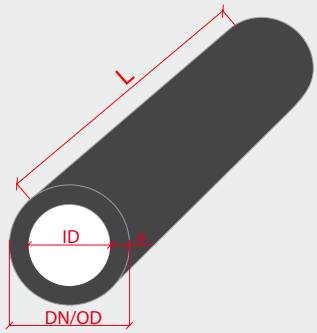
Pressure Piping System EVOAQUA



Pipe SDR 17 PE100

pressure class PN10 [bar]

DN / OD [mm]	e [mm]	ID [m]	L [m]	Code
25	1,8	21,4	100/200	4111700253(100/200)
32	2,0	28,0	100/200	4111700323(100/200)
40	2,4	35,2	100/200	4111700403(100/200)
50	3,0	44,0	100/200	4111700503(100/200)
63	3,8	55,4	100	4111700633100
75	4,5	66,0	12/100	4111700753(012/100)
90	5,4	79,2	12/50/100	4111700903(012/050/100)
110	6,6	96,8	12/50/100	4111701103(012/050/100)
125	7,4	110,2	12	4111701253012
140	8,3	123,4	12	4111701403012
160	9,5	141,0	12	4111701603012
180	10,7	158,6	12	4111701803012
200	11,9	176,2	12	4111702003012
225	13,4	198,2	12	4111702253012
250	14,8	220,4	12	4111702503012
280	16,6	246,8	12	4111702803012
315	18,7	277,6	12	4111703153012
355	21,1	312,8	12	4111703553012
400	23,7	352,6	12	4111704003012
450	26,7	396,6	12	4111704503012
500	29,7	440,6	12	4111705003012
560	33,2	493,6	12	4111705603012
630	37,4	555,2	12	4111706303012



Pipe SDR 21 PE100

pressure class PN8 [bar]

DN / OD [mm]	e [mm]	ID [m]	L [m]	Code
40	2,0	36,0	100/200	4112100403(100/200)
50	2,4	45,2	100/200	4112100503(100/200)
63	3,0	57,0	100	4112100633100
75	3,6	67,8	12/100	4112100753(012/100)
90	4,3	81,4	12/50/100	4112100903(012/050/100)
110	5,3	99,4	12/50/100	4112101103(012/050/100)
125	6,0	113,0	12	4112101253012
140	6,7	126,6	12	4112101403012
160	7,7	144,6	12	4112101603012
180	8,6	162,8	12	4112101803012
200	9,6	180,8	12	4112102003012
225	10,8	203,4	12	4112102253012
250	11,9	226,2	12	4112102503012
280	13,4	253,2	12	4112102803012
315	15,0	285,0	12	4112103153012
355	16,9	321,2	12	4112103553012
400	19,1	361,8	12	4112104003012
450	21,5	407,0	12	4112104503012
500	23,9	452,2	12	4112105003012
560	26,7	506,6	12	4112105603012
630	30,0	570,0	12	4112106303012

Section 4

Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Compression fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Compression fittings made from polypropylene guarantee excellent water-tightness in every pressure class. Fittings depending on their diameter are divided into two pressure classes: Rated pressure resistance for diameters DN/OD 16; 20; 25; 32; 40; 50; 63 mm is PN16 [bar], and for diameters DN/OD – 75; 90; 110 is PN10 [bar].

Coupler

DN / OD [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	blue/black	PN 16	50	4121010200
25	blue/black	PN 16	40	4121010250
32	blue/black	PN 16	25	4121010320
40	blue/black	PN 16	13	4121010400
50	blue/black	PN 16	15	4121010500
63	blue/black	PN 16	17	4121010630
75	blue/black	PN 10	14	4121010750
90	blue/black	PN 10	8	4121010900
110	blue/black	PN 10	4	4121011100

Reduction

DN / OD a [mm]	DN / OD b [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	16	blue/black	PN 16	45	412102020016
25	16	blue/black	PN 16	45	412102025016
	20				412102025020
32	20	blue/black	PN 16	30	412102032020
	25				412102032025
40	25	blue/black	PN 16	18	412102040025
	32				412102040032
50	32	blue/black	PN 16	22	412102050032
	40			20	412102050040
63	40	blue/black	PN 16	20	412102063040
	50				412102063050
75	63	blue/black	PN 10	14	412102075063
90	75	blue/black	PN 10	8	412102090075
110	90	blue/black	PN 10	5	412102110090

Elbow 90°

DN / OD [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	blue/black	PN 16	45	4121030200
25	blue/black	PN 16	35	4121030250
32	blue/black	PN 16	20	4121030320
40	blue/black	PN 16	12	4121030400
50	blue/black	PN 16	12	4121030500
63	blue/black	PN 16	14	4121030630
75	blue/black	PN 10	9	4121030750
90	blue/black	PN 10	6	4121030900
110	blue/black	PN 10	3	4121031100

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Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Compression fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

End Cap

DN / OD [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	blue/black	PN 16	125	4121040200
25	blue/black	PN 16	75	4121040250
32	blue/black	PN 16	50	4121040320
40	blue/black	PN 16	24	4121040400
50	blue/black	PN 16	30	4121040500
63	blue/black	PN 16	34	4121040630
75	blue/black	PN 10	23	4121040750
90	blue/black	PN 10	16	4121040900
110	blue/black	PN 10	8	4121041100

Transition to Inner Thread

DN / OD [mm]	Thread [inch]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	blue/black	PN 16	90	412105020050
	3/4"				412105020075
25	1/2"	blue/black	PN 16	60	412105025050
	3/4"				412105025075
	1"				412105025100
32	1/2"	blue/black	PN 16	35	412105032050
	3/4"				412105032075
	1"				412105032100
	1 1/4"				412105032125
40	1"	blue/black	PN 16	25	412105040100
	1 1/4"			22	412105040125
	1 1/2"				412105040150
50	1 1/2"	blue/black	PN 16	27	412105050150
63	2"	blue/black	PN 16	30	412105063200
75	2"	blue/black	PN 10	20	412105075200
	2 1/2"				412105075250
90	3"	blue/black	PN 10	12	412105090300
110	4"	blue/black	PN 10	6	412105110400

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Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Compression fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Transition to Outside Thread

DN / OD [mm]	Thread [inch]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	blue/black	PN 16	90	412106020050
	3/4"				412106020075
25	1/2"	blue/black	PN 16	60	412106025050
	3/4"				412106025075
	1"				412106025100
32	3/4"	blue/black	PN 16	45	412106032075
	1"				412106032100
	1 1/4"				412106032125
40	1"	blue/black	PN 16	23	412106040100
	1 1/4"				412106040125
	1 1/2"			22	412106040150
50	1 1/4"	blue/black	PN 16	30	412106050125
	1 1/2"				412106050150
	2"			27	412106050200
63	1 1/2"	blue/black	PN 16	34	412106063150
	2"				412106063200
75	2"	blue/black	PN 10	20	412106075200
	2 1/2"				412106075250
	3"				412106075300
90	3"	blue/black	PN 10	12	412106090300
110	4"	blue/black	PN 10	6	412106110400

Elbow with Transition to Inner Thread

DN / OD [mm]	Thread [inch]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	blue/black	PN 16	70	412107020050
	3/4"				412107020075
25	1/2"	blue/black	PN 16	40	412107025050
	3/4"				412107025075
	1"			30	412107025100
32	3/4"	blue/black	PN 16	30	412107032075
	1"				412107032100
40	1"	blue/black	PN 16	15	412107040100
	1 1/4"				412107040125
50	1 1/2"	blue/black	PN 16	18	412107050150
63	2"	blue/black	PN 16	20	412107063200
75	2 1/2"	blue/black	PN 10	14	412107075250
90	3"	blue/black	PN 10	8	412107090300
110	4"	blue/black	PN 10	4	412107110400

Elbow with Transition to Outside Thread

DN / OD [mm]	Thread [inch]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	blue/black	PN 16	70	412108020050
	3/4"				412108020075
25	1/2"	blue/black	PN 16	40	412108025050
	3/4"				412108025075
32	3/4"	blue/black	PN 16	30	412108032075
	1"				412108032100
40	1"	blue/black	PN 16	15	412108040100
	1 1/4"				412108040125
50	1 1/2"	blue/black	PN 16	18	412108050150
63	2"	blue/black	PN 16	20	412108063200

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Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Compression fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

T-Piece

DN / OD a [mm]	DN / OD b [mm]	DN / OD c [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	20	20	blue/black	PN 16	30	4121090200
25	25	25	blue/black	PN 16	20	4121090250
32	32	32	blue/black	PN 16	12	4121090320
40	40	40	blue/black	PN 16	6	4121090400
50	50	50	blue/black	PN 16	8	4121090500
63	63	63	blue/black	PN 16	10	4121090630
75	75	75	blue/black	PN 10	6	4121090750
90	90	90	blue/black	PN 10	4	4121090900
110	110	110	blue/black	PN 10	1	4121091100

T-Piece with Inner Thread

DN / OD a [mm]	Thread [inch]	DN / OD c [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	20	blue/black	PN 16	40	412110020050
	3/4"					412110020075
25	1/2"	25	blue/black	PN 16	25	412110025050
	3/4"					412110025075
	1"					412110025100
32	3/4"	32	blue/black	PN 16	15	412110032075
	1"					412110032100
40	1"	40	blue/black	PN 16	10	412110040100
	1 1/4"				9	412110040125
50	1 1/2"	50	blue/black	PN 16	10	412110050150
63	2"	63	blue/black	PN 16	11	412110063200
75	2 1/2"	75	blue/black	PN 10	10	412110075250
90	3"	90	blue/black	PN 10	4	412110090300
110	4"	110	blue/black	PN 10	2	412110110400

T-Piece with Outside Thread

DN / OD a [mm]	Thread [inch]	DN / OD c [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	20	blue/black	PN 16	40	412111020050
25	1/2"	25	blue/black	PN 16	30	412111025050
	3/4"					412111025075
32	1"	32	blue/black	PN 16	15	412111032100
40	1 1/4"	40	blue/black	PN 16	9	412111040125
50	1 1/2"	50	blue/black	PN 16	10	412111050150
63	2"	63	blue/black	PN 16	12	412111063200

Reducing T-Piece

DN / OD a [mm]	DN / OD b [mm]	DN / OD c [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
25	20	25	blue/black	PN 16	20	412112025020
32	25	32	blue/black	PN 16	12	412112032025
40	32	40	blue/black	PN 16	8	412112040032
50	32	50	blue/black	PN 16	8	412112050032
	40					412112050040
63	50	63	blue/black	PN 16	10	412112063050

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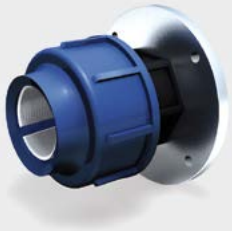
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Compression fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Fastening with Inner Thread

DN / OD [mm]	Thread [inch]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
20	1/2"	blue/black	PN 16	50	412113020050
25	3/4"	blue/black	PN 16	40	412113025075



Transition to Flange

DN / OD [mm]	Flange DN [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
50	50	blue/black	PN 16	10	4121140500
63	50	blue/black	PN 16	18	4121140630
75	65	blue/black	PN 10	10	4121140750
90	80	blue/black	PN 10	8	4121140900
110	100	blue/black	PN 10	6	4121141100

Universal Transition **Steel / PE**

Transition from various steel pipes to PE pipes

DN / OD [mm]	Colour	Pressure class, [bar]	Pack [pcs.]	Code
15-22 (1/2") / 20	black	PN 16	45	412115015022050020
15-22 (1/2") / 25	black	PN 16	40	412115015022050025
21-27 (3/4") / 20	black	PN 16	30	412115021027075020
21-27 (3/4") / 25	black	PN 16	30	412115021027075025
21-27 (3/4") / 32	black	PN 16	25	412115021027075032
27-35 (1") / 25	black	PN 16	18	412115027035100025
27-35 (1") / 32	black	PN 16	18	412115027035100032
27-35 (1") / 40	black	PN 16	15	412115027035100040

Wrench

DN / OD [mm]	Code
40 - 63	4121160406300
75 - 110	4121160751100

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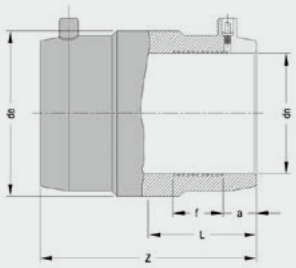
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

The electrofusion fittings are produced from polyethylene (PE), and their construction contains one or several integrated heating elements, which ensure transformation of electricity into the heat of fusion. The result of applying electrofusion fittings is a solid and safe joint of pipe and any other elements belonging to the pipeline system. Electrofusion joint features excellent pressure resistance and tightness.

Material / Colour
The fittings are manufactured from:
- Polyethylene PEHD PE100, black colour.

Standards
Fully corresponds to the requirements of specific norms:
- EN 12201-3:2003, part 3: Fittings;
- EN 1555-3:2003, part 3: Fittings.



Coupler

PE100, SDR 11-S5, SDR 17-S8

dn [mm]	de [mm]	L [mm]	f [mm]	a [mm]	Z [mm]	Pack [pcs.]	PN-S	Code
20	32	33	31	10	70	1	PN25-S5	4122010200
25	37	33	19	10	70	1	PN25-S5	4122010250
32	47	37	23	10	80	1	PN25-S5	4122010320
40	56	44	26	12	90	1	PN25-S5	4122010400
50	67	49	29	13	100	1	PN25-S5	4122010500
63	82	54	28	13	111	1	PN25-S5	4122010630
75	99	60	36	14	120	1	PN25-S5	4122010750
90	116	65	37	14	130	1	PN25-S5	4122010900
110	145	70	36	18	140	1	PN25-S5	4122011100
125	163	76	39	18	151	1	PN25-S5	4122011250
140	183	81	48	18	161	1	PN25-S5	4122011400
160	207	86	55	19	172	1	PN25-S5	4122011600
180	228	97	56	23	193	1	PN25-S5	4122011800
200	252	101	61	22	203	1	PN25-S5	4122012000
225	276	112	67	22	223	1	PN25-S5	4122012250
250	312	122	60	30	244	1	PN25-S5	4122012500
280	341	133	55	38	265	1	PN16-S5	4122012800
315	392	142	70	35	284	1	PN25-S5	4122013150
355	430	156	60	45	312	1	PN16-S5	4122013550
400	461	170	60	41	340	1	PN16-S8	4122014000

SDR – standard dimension ratio; **S** – series; **PN** – pressure class, [bar].

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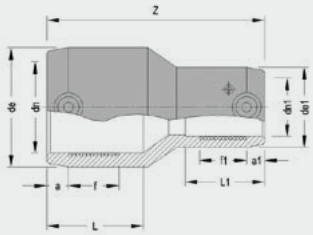
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

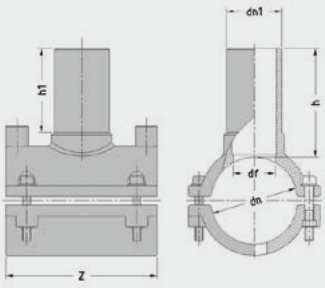


Reduction

PE100, SDR 11, PN16-S5

dn/dn1 [mm]		de/de1 [mm]		L [mm]	L1 [mm]	f [mm]	f1 [mm]	a [mm]	a1 [mm]	Z [mm]	Pack [pcs.]	Code
32	20	44	32	46	38	34	22	10	10	105	1	412202032020
32	25	45	36	44	45	31	21	10	10	103	1	412202032025
40	32	55	44	54	50	30	29	11	10	109	1	412202040032
50	32	66	44	53	49	30	29	12	10	121	1	412202050032
50	40	66	54	56	54	33	33	12	11	119	1	412202050040
63	32	81	46	62	45	32	24	15	12	156	1	412202063032
63	40	81	54	63	54	30	20	15	13	137	1	412202063040
63	50	81	66	62	55	26	24	16	16	131	1	412202063050
75	63	97	81	75	62	34	33	13	13	160	1	412202075063
90	50	117	66	79	56	45	25	18	16	185	1	412202090063
90	63	115	81	77	62	45	33	15	13	160	1	412202090075
90	75	115	97	81	60	39	30	18	18	159	1	412202110063
110	63	144	83	78	63	37	28	18	19	201	1	412202110090
110	90	141	115	87	77	41	39	19	18	181	1	412202125090
125	90	162	118	78	68	42	34	22	17	177	1	412202125110
125	110	162	144	79	73	33	36	22	20	164	1	412202160090
160	110	208	144	95	82	48	37	25	20	218	1	412202160110
160	125	208	162	98	88	47	30	26	21	208	1	412202160125

SDR – standard dimension ratio; **S** – series; **PN** – pressure class, [bar].



Branch Saddle beginning of table

PE100, SDR 11, PN16-S5

dn/dn1 [mm]		h1 [mm]	h [mm]	Z [mm]	df [mm]	Pack [pcs.]	Code
40	20	52	129	91	18	1	412203040020
	25	57	135	91	18	1	412203040025
50	20	52	134	101	18	1	412203050020
	25	57	140	101	18	1	412203050025
	32	110	145	101	18	1	412203050032
63	20	58	74	110	13	1	412203063020
	25	56	74	110	18	1	412203063025
	32	55	74	110	25	1	412203063032
	40	63	79	110	31	1	412203063040
	50	69	90	110	39	1	412203063050
75	25	56	143	110	30	1	412203075025
	32	63	146	110	30	1	412203075032
	40	50	141	110	30	1	412203075040
	50	57	136	110	30	1	412203075050
	63	100	145	125	30	1	412203075063
90	20	58	76	125	13	1	412203090020
	25	58	76	125	18	1	412203090025
	32	59	76	125	24	1	412203090032
	40	63	81	125	31	1	412203090040
	50	69	92	125	39	1	412203090050
	63	73	105	125	32	1	412203090063
110	25	57	78	160	18	1	412203110025
	32	59	79	160	24	1	412203110032
	40	61	84	160	31	1	412203110040
	50	68	95	160	39	1	412203110050
	63	77	105	160	49	1	412203110063

SDR – standard dimension ratio; **S** – series; **PN** – pressure class, [bar].

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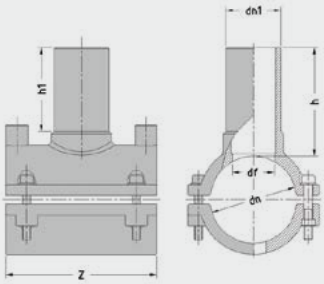
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Branch Saddle

end of table

PE100, SDR 11, PN16-S5



dn/dn1 [mm]		h1 [mm]	h [mm]	Z [mm]	df [mm]	Pack [pcs.]	Code
125	25	59	80	160	18	1	412203125025
	32	60	80	160	24	1	412203125032
	40	63	84	160	31	1	412203125040
	50	69	95	160	39	1	412203125050
	63	75	110	160	49	1	412203125063
	90	93	128	190	70	1	412203125090
140	25	56	150	125	34	1	412203140025
	32	63	153	125	34	1	412203140032
	40	50	148	125	34	1	412203140040
	50	57	143	125	34	1	412203140050
	63	100	145	160	34	1	412203140063
160	25	58	84	190	18	1	412203160025
	32	59	84	190	24	1	412203160032
	40	62	90	190	31	1	412203160040
	50	69	100	190	39	1	412203160050
	63	77	114	190	49	1	412203160063
	90	93	128	190	70	1	412203160090
	110	98	136	190	87	1	412203160110
180	25	56	150	160	34	1	412203180025
	32	63	153	160	34	1	412203180032
	40	50	148	160	34	1	412203180040
	50	57	143	160	34	1	412203180050
	63	100	140	160	34	1	412203180063
	90	93	128	190	70	1	412203180090
	110	98	136	190	87	1	412203180110
200	25	56	145	160	34	1	412203200025
	32	63	148	160	34	1	412203200032
	40	50	143	160	34	1	412203200040
	50	57	137	160	34	1	412203200050
	63	100	140	160	34	1	412203200063
	90	93	128	190	70	1	412203200090
	110	93	136	193	87	1	412203200110
225	25	56	145	160	34	1	412203225025
	32	63	148	160	34	1	412203225032
	40	50	143	160	34	1	412203225040
	50	57	138	160	34	1	412203225050
	63	100	142	190	34	1	412203225063
	90	93	128	190	70	1	412203225090
	110	98	136	190	87	1	412203225110
250	32	58	79	190	24	1	412203250032
	40	63	84	190	31	1	412203250040
	50	69	95	190	39	1	412203250050
	63	77	108	190	49	1	412203250063
	90	93	128	190	70	1	412203250090
	110	98	136	190	87	1	412203250110

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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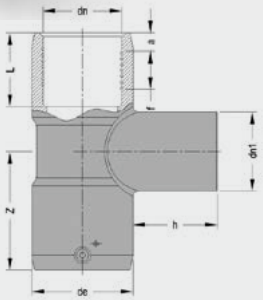
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

T-Piece

PE100, SDR 11, PN16-S5

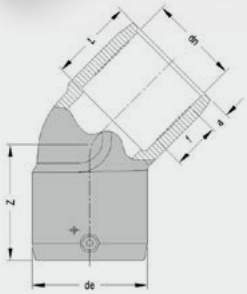


dn/dn1 [mm]		de [mm]	L [mm]	f [mm]	a [mm]	h [mm]	Z [mm]	Z1 [mm]	Pack [pcs.]	Code
25	25	39	33	15	11	61	53	111	1	412204025025
32	32	44	45	28	10	48	64	94	1	412204032032
40	40	54	47	29	11	57	73	112	1	412204040040
50	50	66	55	30	12	62	81	128	1	412204050050
63	63	81	61	45	13	72	94	153	1	412204063063
75	75	96	64	29	22	76	113	176	1	412204075075
90	90	116	70	37	24	85	125	202	1	412204090090
110	110	141	76	39	24	85	142	233	1	412204110110
125	125	161	78	45	19	100	156	269	1	412204125125
160	160	206	89	51	20	126	184	350	1	412204160160

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

Elbow 45°

PE100, SDR 11



dn [mm]	de [mm]	L [mm]	f [mm]	a [mm]	Z [mm]	PN-S	Pack [pcs.]	Code
32	46	40	20	10	57	PN25-S5	1	4122050320
40	56	47	24	11	70	PN25-S5	1	4122050400
50	68	53	30	12	75	PN25-S5	1	4122050500
63	82	52	29	13	86	PN25-S5	1	4122050630
75	97	64	29	22	98	PN16-S5	1	4122050750
90	116	70	37	24	108	PN16-S5	1	4122050900
110	140	76	39	24	114	PN16-S5	1	4122051100
125	162	79	42	19	119	PN16-S5	1	4122051250
160	206	89	45	20	134	PN16-S5	1	4122051600

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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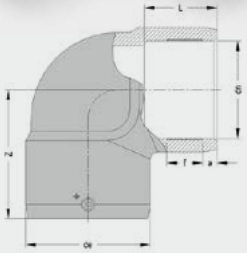
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

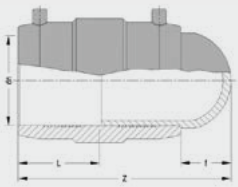


Elbow 90°

PE100, SDR 11

dn [mm]	de [mm]	L [mm]	f [mm]	a [mm]	Z [mm]	PN-S	Pack [pcs.]	Code
25	38	33	17	6	57	PN25-S5	1	4122060250
32	45	40	20	10	75	PN25-S5	1	4122060320
40	56	48	28	11	80	PN25-S5	1	4122060400
50	68	53	30	12	89	PN25-S5	1	4122060500
63	83	52	29	13	104	PN25-S5	1	4122060630
75	97	64	29	22	116	PN16-S5	1	4122060750
90	116	70	37	24	130	PN16-S5	1	4122060900
110	140	76	39	24	146	PN16-S5	1	4122061100
125	162	80	36	19	152	PN16-S5	1	4122061250
160	206	90	66	20	180	PN16-S5	1	4122061600
180	226	106	112	23	215	PN16-S5	1	4122061800
200	251	110	129	23	229	PN16-S5	1	4122062000

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

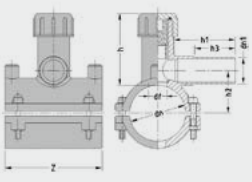


End Cap

PE100, SDR 11, PN25-S5

dn [mm]	f [mm]	L [mm]	Z [mm]	Pack [pcs.]	Code
20	26	33	100	1	4122070200
25	30	33	104	1	4122070250
32	22	37	98	1	4122070320
40	24	44	114	1	4122070400
50	24	49	127	1	4122070500
63	26	54	136	1	4122070630
75	44	44	164	1	4122070750
90	34	70	164	1	4122070900
110	47	68	187	1	4122071100
125	47	76	198	1	4122071250
140	45	85	207	1	4122071400
160	40	93	211	1	4122071600

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].



Branch Saddle Tee

beginning of table

PE100, SDR 11, PN16-S5

dn/dn1 [mm]		df [mm]	h1 [mm]	h2 [mm]	h [mm]	Z [mm]	h 3 [mm]	Pack [pcs.]	Code
40	20	18	54	60	98	91	54	1	412208040020
	25	18	54	60	98	91	54	1	412208040025
50	20	18	54	71	104	101	54	1	412208050020
	25	18	54	71	104	101	54	1	412208050025
	32	18	78	40	77	102	60	1	412208050032
63	20	25	90	55	101	110	70	1	412208063020
	25	25	90	55	101	110	70	1	412208063025
	32	25	105	55	101	110	70	1	412208063032
	40	25	120	55	101	110	70	1	412208063040
	50	33	80	96	201	110	80	1	412208063050
	63	33	75	96	201	110	75	1	412208063063
75	20	25	90	63	95	125	70	1	412208075020
	25	25	90	63	95	125	70	1	412208075025
	32	26	107	74	105	125	70	1	412208075032
	40	25	120	63	95	125	72	1	412208075040
	50	30	120	63	97	125	72	1	412208075050
	63	30	120	63	97	125	93	1	412208075063

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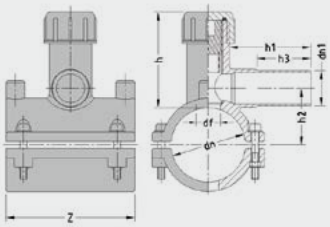
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Electrofusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes



Branch Saddle Tee

end of table

PE100, SDR 11, PN16-S5

dn/dn1 [mm]		df [mm]	h1 [mm]	h2 [mm]	h [mm]	Z [mm]	h 3 [mm]	Pack [pcs.]	Code
90	20	25	90	70	100	125	70	1	412208090020
	25	25	90	70	100	125	70	1	412208090025
	32	25	105	70	100	125	70	1	412208090032
	40	25	120	70	100	125	72	1	412208090040
	50	30	120	70	102	125	72	1	412208090050
	63	30	120	70	102	125	93	1	412208090063
110	20	25	92	78	104	160	72	1	412208110020
	25	25	92	88	101	160	72	1	412208110025
	32	26	107	84	105	160	70	1	412208110032
	40	25	120	80	101	160	72	1	412208110040
	50	30	120	80	103	160	72	1	412208110050
	63	30	120	80	103	160	83	1	412208110063
125	20	25	90	87	102	160	70	1	412208125020
	25	25	90	87	102	160	70	1	412208125025
	32	25	108	84	102	160	70	1	412208125032
	40	25	120	87	102	160	72	1	412208125040
	50	30	120	87	104	160	72	1	412208125050
	63	30	120	87	104	160	83	1	412208125063
140	20	25	90	96	94	160	70	1	412208140020
	25	25	90	96	94	160	70	1	412208140025
	32	25	105	96	94	160	70	1	412208140032
	40	25	120	96	94	160	72	1	412208140040
	50	30	120	96	96	160	72	1	412208140050
	63	30	120	96	96	160	73	1	412208140063
160	20	27	90	108	104	160	70	1	412208160020
	25	25	90	104	100	160	70	1	412208160025
	32	25	106	105	105	160	70	1	412208160032
	40	25	120	104	100	160	72	1	412208160040
	50	30	120	104	102	160	72	1	412208160050
	63	30	120	104	102	160	72	1	412208160063
180	20	25	90	110	101	160	70	1	412208180020
	25	25	90	110	101	160	70	1	412208180025
	32	25	105	110	101	160	70	1	412208180032
	40	25	120	110	101	160	72	1	412208180040
	50	30	120	110	103	160	72	1	412208180050
	63	30	120	110	103	160	72	1	412208180063
200	20	25	90	126	91	160	70	1	412208200020
	25	25	90	126	91	160	70	1	412208200025
	32	25	105	126	91	160	70	1	412208200032
	40	25	120	126	91	160	72	1	412208200040
	50	30	120	126	93	160	72	1	412208200050
	63	30	120	126	93	160	64	1	412208200063
225	20	25	90	140	103	160	70	1	412208225020
	25	25	90	140	103	160	70	1	412208225025
	32	25	105	140	103	160	70	1	412208225032
	40	25	120	140	103	160	72	1	412208225040
	50	30	120	140	105	160	72	1	412208225050
	63	30	120	140	105	160	64	1	412208225063
250	20	25	90	151	138	160	70	1	412208250020
	25	25	90	151	138	160	70	1	412208250025
	32	30	105	151	140	160	70	1	412208250032
	40	30	120	151	140	160	72	1	412208250040
	50	30	120	151	140	160	72	1	412208250050
	63	30	120	151	140	160	64	1	412208250063

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Buttfusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Elbow 5°-30°

PE100, SDR 17, PN10-S8

DN/OD [mm]	e [mm]	ID [mm]	Pack [pcs.]	Code
110	6,6	96,8	1	412303110(05/30)
125	7,4	110,2	1	412303125(05/30)
140	8,3	123,4	1	412303140(05/30)
160	9,5	141,0	1	412303160(05/30)
180	10,7	158,6	1	412303180(05/30)
200	11,9	176,2	1	412303200(05/30)
225	13,4	198,2	1	412303225(05/30)
250	14,8	220,4	1	412303250(05/30)
280	16,6	246,8	1	412303280(05/30)
315	18,7	277,6	1	412303315(05/30)
355	21,1	312,8	1	412303355(05/30)
400	23,7	352,6	1	412303400(05/30)
450	26,7	396,6	1	412303450(05/30)
500	29,7	440,6	1	412303500(05/30)
560	33,2	493,6	1	412303560(05/30)
630	37,4	555,2	1	412303630(05/30)

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

Elbow 31°-60°

PE100, SDR 17, PN10-S8

DN/OD [mm]	e [mm]	ID [mm]	Pack [pcs.]	Code
110	6,6	96,8	1	412303110(31/60)
125	7,4	110,2	1	412303125(31/60)
140	8,3	123,4	1	412303140(31/60)
160	9,5	141,0	1	412303160(31/60)
180	10,7	158,6	1	412303180(31/60)
200	11,9	176,2	1	412303200(31/60)
225	13,4	198,2	1	412303225(31/60)
250	14,8	220,4	1	412303250(31/60)
280	16,6	246,8	1	412303280(31/60)
315	18,7	277,6	1	412303315(31/60)
355	21,1	312,8	1	412303355(31/60)
400	23,7	352,6	1	412303400(31/60)
450	26,7	396,6	1	412303450(31/60)
500	29,7	440,6	1	412303500(31/60)
560	33,2	493,6	1	412303560(31/60)
630	37,4	555,2	1	412303630(31/60)

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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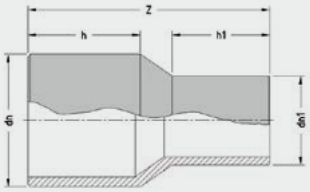
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Buttfusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

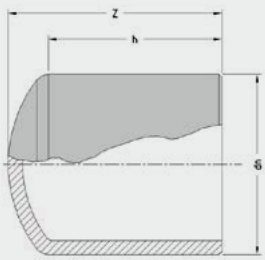


Reduction

PE100, SDR 17, PN10-S8

dn/dn1 [mm]		h [mm]	h1 [mm]	Z [mm]	Pack [pcs.]	Code
90	63	82	70	168	1	412305090063
	75	80	70	164	1	412305090063
110	63	85	69	188	1	412305110063
	75	86	73	173	1	412305110075
	90	86	81	181	1	412305110090
125	63	91	67	195	1	412305125063
	75	89	73	177	1	412305125075
	90	95	82	191	1	412305125090
	110	92	84	190	1	412305125110
140	90	94	82	208	1	412305140090
	110	94	83	193	1	412305140110
	125	93	89	196	1	412305140125
160	90	95	81	201	1	412305160090
	110	113	103	270	1	412305160110
	125	101	91	206	1	412305160125
	140	101	92	206	1	412305160140
180	125	107	88	220	1	412305180125
	140	105	96	223	1	412305180140
	160	107	101	224	1	412305180160
200	140	117	95	230	1	412305200140
	160	117	101	231	1	412305200160
	180	117	109	236	1	412305200180
225	90	120	89	279	1	412305225090
	125	133	100	298	1	412305225125
	160	132	120	292	1	412305225160
	180	132	125	285	1	412305225180
	200	132	130	277	1	412305225200
250	180	138	124	304	1	412305250180
	200	138	130	301	1	412305250200
	225	137	134	286	1	412305250225
315	225	172	138	389	1	412305315225
	250	174	150	381	1	412305315250

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].



End Cap

PE100, SDR 17, PN10-S8

dn [mm]	h [mm]	Z [mm]	Pack [pcs.]	Code
63	65	80	1	4123060630
75	74	89	1	4123060750
90	82	100	1	4123060900
110	91	118	1	4123061100
125	102	122	1	4123061250
140	104	125	1	4123061400
160	101	134	1	4123061600
180	114	150	1	4123061800
200	123	163	1	4123062000
225	125	180	1	4123062250
250	130	179	1	4123062500
315	176	298	1	4123063150

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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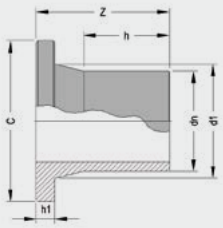
Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Buttfusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Stub End

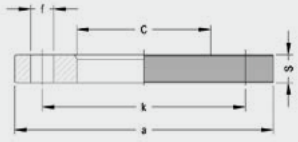
PE100



dn [mm]	h, [mm]		h1, [mm]		Z, [mm]		d1 [mm]	C [mm]	IPack [pcs.]	Code
	SDR 17 PN10-S8	SDR 11 PN16-S5	SDR 17 PN10-S8	SDR 11 PN16-S5	SDR 17 PN10-S8	SDR 11 PN16-S5				
63	66	64	14	14	98	99	75	102	1	412307063(0/1)
75	74	71	16	16	116	111	89	122	1	412307075(0/1)
90	80	82	17	17	117	117	105	138	1	412307090(0/1)
110	84	83	18	18	127	124	125	158	1	412307110(0/1)
125	94	105	18	25	131	158	132	158	1	412307125(0/1)
140	105	108	18	25	154	156	155	188	1	412307140(0/1)
160	110	106	18	30	156	159	175	212	1	412307160(0/1)
180	118	125	20	30	169	176	180	212	1	412307180(0/1)
200	116	112	24	32	181	182	232	268	1	412307200(0/1)
225	125	129	24	32	190	196	235	268	1	412307225(0/1)
250	134	133	25	35	205	205	285	320	1	412307250(0/1)
280	144	142	26	35	200	205	291	320	1	412307280(0/1)
315	202	209	25	35	267	275	335	370	1	412307315(0/1)
400	220	220	38	49	298	309	427	482	1	412307400(0/1)

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

Steel Flange with PP cover



dn, [mm] PE caurulei	D,[mm] Tērauda caurulei	c [mm]	s, [mm]		a, [mm]		k, [mm]		f, [mm]		caurumu skaits		Pack [pcs.]	Code
			PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16	PN10	PN16		
63	50	78	19	19	165	165	125	125	18	18	4	4	1	412312063(0/1)
75	65	92	20	20	185	185	145	145	18	18	4	4	1	412312075(0/1)
90	80	108	20	20	200	200	160	160	18	18	8	8	1	412312090(0/1)
110	100	128	22	22	220	220	180	180	18	18	8	8	1	412312110(0/1)
125	100	135	22	22	220	220	180	180	18	18	8	8	1	412312125(0/1)
140	125	158	22	22	250	250	210	210	18	18	8	8	1	412312140(0/1)
160	150	178	24	24	285	285	240	240	22	22	8	8	1	412312160(0/1)
180	150	188	24	24	285	285	240	240	22	22	8	8	1	412312180(0/1)
200	200	235	24	26	340	340	295	295	22	22	8	12	1	412312200(0/1)
225	200	238	24	26	340	340	295	295	22	22	8	12	1	412312225(0/1)
250	250	288	26	29	395	405	350	355	22	26	12	12	1	412312250(0/1)
280	250	294	26	29	395	405	350	355	22	26	12	12	1	412312280(0/1)
315	300	338	26	32	445	460	400	410	22	26	12	12	1	412312315(0/1)

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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Installation fittings for water supply systems EVO SCGR ULTRASTRESS and EVOAQUA

Buttfusion fittings for EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes

Elbow 61°-90°

PE100, SDR 17, PN10-S8

DN/OD [mm]	e [mm]	ID [mm]	Pack [pcs.]	Code
110	6,6	96,8	1	412303110(61/90)
125	7,4	110,2	1	412303125(61/90)
140	8,3	123,4	1	412303140(61/90)
160	9,5	141,0	1	412303160(61/90)
180	10,7	158,6	1	412303180(61/90)
200	11,9	176,2	1	412303200(61/90)
225	13,4	198,2	1	412303225(61/90)
250	14,8	220,4	1	412303250(61/90)
280	16,6	246,8	1	412303280(61/90)
315	18,7	277,6	1	412303315(61/90)
355	21,1	312,8	1	412303355(61/90)
400	23,7	352,6	1	412303400(61/90)
450	26,7	396,6	1	412303450(61/90)
500	29,7	440,6	1	412303500(61/90)
560	33,2	493,6	1	412303560(61/90)
630	37,4	555,2	1	412303630(61/90)

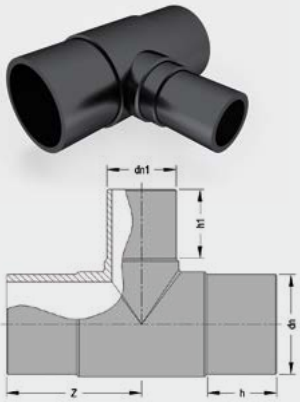
SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

T-Piece

PE100, SDR 17, PN10-S8

DN/DN1 (OD/OD1), [mm]		Pack [pcs.]	Code
DN(OD), [mm]	DN1(OD1), [mm]		
110	110	1	4123011100
125	125	1	4123011250
140	140	1	4123011400
160	160	1	4123011600
180	180	1	4123011800
200	200	1	4123012000
225	225	1	4123012250
250	250	1	4123012500
280	280	1	4123012800
315	315	1	4123013150
355	355	1	4123013550
400	400	1	4123014000
450	450	1	4123014500
500	500	1	4123015000
560	560	1	4123015600
630	630	1	4123016300

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].



Reducing T-Piece

PE100, SDR 11, PN16-S5

dn/dn1 (OD/OD1), [mm]		h [mm]	h1 [mm]	Z [mm]	Pack [pcs.]	Code
dn(OD), [mm]	dn1(OD1), [mm]					
90	63	90	74	147	1	412302090063
110	90	95	89	163	1	412302110090

SDR – standard dimension ratio; **S** – series; P**N** – pressure class, [bar].

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Section 5

EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes Transportation and Storage at the Construction Site

Transportation and Storage

Pipes are delivered to the construction site as pipe bundles or packed pipes, but fittings are factory-packaged.
Pipes and fittings should always be moved by specially designed vehicles and their loading and unloading should be supervised by a competent person. During transportation the pipes should rest on the largest possible surface area.
Pipes packs and bundles of the standard size can be moved by a mechanical lifting device. If pipes are moved by a lifting crane, ropes and other accessories that do not damage the pipes must be used. It is forbidden to use steel chains and ropes. In any case any chance of pallets, pipes and fittings falling should be avoided, as well as any impacts during handling. Lifting straps should be fixed at the middle of a pallet at the distance 3.5 m apart from each other.
During relocation of pallets they should be directed by hand. Using a load carrier for transportation of the pallets it is forbidden to use breakers and rods. Pallets with the help of a loading appliance should be perpendicularly placed on the forks of a loader, noticing that there is enough free space between forks. Pipes must not be thrown or dragged, nor should any fittings.

Read and apply!

- When transporting pipes, they must be protected against mechanical damage and loads.
- Depending on the diameter of the pipes they can be transported in pipe bundles or as individual pipes.
- Length of the unsupported part of a pipe transported in a means of transportation should not exceed 1 m.
- Pipes should be securely fixed before the transportation in order to guarantee minimum movement of the pipes and their fixtures.
- Transporting pipes at low temperature it should be considered that this leads to lower elasticity and resistance of these pipes.
- Pipe bundles and pallets shall be stored on a stable surface free from unexpected blows. Pipe bundles and pallets shall be placed on a sufficiently stable and flat surface in order to prevent pipe bundles and pallets or their bases collapse.
- Pipes and fittings should be stored in dry and clean conditions away from heat sources to guarantee that any pipe's surface temperature does not exceed + 40°C .

EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes Transportation and Storage at the Construction Site

Read and apply!

- If pipes are packed by means of the support frames or put on the ground, the height of the load cannot exceed 2 m. Both sides of the load should be supported.
- If individual pipes are stacked in the form of a pyramid, in order to prevent deformation of the lower pipes the height of the pyramid cannot exceed 1 m.
- All the holes should be closed by the plugs.
- Active chemical substances cannot be stored together with polyethylene products.
- Pipes stacked in rolls should be stored in the horizontal position. If rolls are stacked on top of one another, the total weight of the load cannot exceed 2000 kg. Pipes stacked in rolls cannot be hung.

Pipes stacked in rolls with DN/OD ≤ 63 mm can be transported only on supports or on flat (smooth) and clean platforms. Pipes should be fixed securely before the transportation. In case the pipes diameter is DN/OD > 63 mm, rolls should be transported separately.

EVO SCGR ULTRASTRESS and EVOAQUA pipes can be stored under direct sunlight (uncovered pipes) for not longer than one year from the date of manufacture. Direct sunlight (UV) worsens quality of the pipelines. UV radiation influence on the polyethylene pipes cannot exceed 3.5 GJ/m^2 (Average annual UV radiation from the sun in Latvia is 3.14 GJ/m^2). Storage life can be extended, if pipes are protected from the UV radiation. EVO SCGR ULTRASTRESS and EVOAQUA pipes during very hot summer season should be protected from excessive warming. In this case it is advisable to choose a shady place for storage or to cover pipes with bright, lightproof material..

The pipes packaged using wooden frames can be stacked height on top of one another. The pipes can be stacked as follows:

a) for DN/OD 75, 90, 110, 125, 140, 160, 180 and 200 mm pipes, maximum recommended stacking height on top of one another is four packs packaged using wooden frames;

b) for DN/OD 225, 250, 280, 315 mm pipes, maximum recommended stacking height on top of one another is five packs packaged using wooden frames;

c) for DN/OD 355, 400, 450 mm pipes, maximum recommended stacking height on top of one another is eight packs packaged using wooden frames;

d) for DN/OD 500, 560, 630 mm pipes, maximum recommended stacking height on top of one another is six packs packaged using wooden frames.

EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes Transportation and Storage at the Construction Site

Inspection of Materials

All the pipes and fittings should have Manufacturer's Certificates. The supplied pipes, pipeline elements and connection fittings should be inspected to make sure that the materials are properly labelled and conform to the customer's requirements. Manufacturer's instructions should be observed. All parts should be carefully inspected before both adjustment and installation to make sure that they have no damage. If the parts are damaged, they should be sent back making respective notes in the waybills.

EVO SCGR ULTRASTRESS and **EVOAQUA** pipes' marking should be as follows:

Marking of packing of the EVO SCGR ULTRASTRESS products

Marking of packing of the EVOAQUA products

Before the installation, the pipes and fittings should be inspected for conformity:

- to the marking;
- to the size – diameter, wall thickness;
- to physical form *(Without using a magnifying device, external pipe surface should look even, clean, without scratches or buckles and other surface defects, which can influence pipeline exploitation. Pipe ends should be clean, straight (perpendicular to the pipe's axis) cut and closed by the plugs. Pipes and fittings, whose surfaces have scratches deeper than 10% of the pipe's wall thickness, or pipes and fittings for which the limit for UV radiation from the sun is exceeded, should not be used. Scratches at the welding point of the product are not allowed.)*

Section 6

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Electrofusion jointing

The electrofusion welding system is the jointing process of pipes and/or fittings of the same connection diameter, and is carried out by fusion of the contact surfaces through an electrical resistance inserted in the electrofusion fitting. Today it is considered the most developed and safe method for realizing polyethylene jointings. Thanks to its versatility, can weld together pipes and/or fittings with different thickness and made from different polyethylene materials. The electrofusion welding process is defined by the standard **UNI 10521.**

Electrofusion sockets and fittings

The jointing quality directly depends on strictly compliance with the following instructions.

Preparation

The jointing process must be carried out in a dry and protect place. In case of adverse ambient conditions (humidity, rain, snow, blast, excessive solar irradiance), suitable measures must be taken to protect the working zone.

The ambient temperature must be always between -10°C and +40°C.

Critical element for the jointing reliability is the preparation of the pipe surface where the electrofusion fitting will be welded, through the removal of the oxidized layer and the accurate cleaning of the whole contact area with the fitting itself.

Check and prepare all the material necessary for the welding process using electrofusion unit:

1. electrofusion fitting
2. aligning clamp
3. manual or mechanical scraper
4. pipe cutter
5. detergent
6. cleaned cloth or strong soft paper
7. indelible marker pen or wax pencil

Visually check that the pipes are free of **cuts and abrasions** (the maximum depth admitted is equal to 10% of the wall thickness). Eventual anomalies must be taken out by cutting the interested pipe section.
The pipes ends to be welded must be cut **at right angle** preferably using proper **pipe cutters**.The coiled pipes must be unrolled at least 24 hours before its use. **Avoid the use of heat sources** to recover possible ovalizations or to reduce the pipe bending.

Electrofusion welding unit

Mechanical pipe scraper

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Scraping

Clean the pipes ends from dust, dum, grease and dirt. Mark the scraping area with an indelible marker pen or wax pencil, the pipe length interested to scraping must be larger than the insertion depth of the fitting **for at least 10 mm**. The electrofusion fitting MUST NOT be scraped.

Remove the oxidized surface of the pipe by scraping it. The operation must be done using a manual scraper supplied with the control unit, or using the special mechanical pipe scrapers. A uniform layer of material must be removed for **a depth of approximately 0,2 mm.**

Avoid the use of abrasive paper, rasp, emery wheels, saw blades or other equipment!

Cleaning

Just before the jointing with the electrofusion fitting, **clean all scraped surfaces** using a strong soft paper slightly drenched with a suitable detergent (i.e. isopropyl alcohol or methylene chloride) to remove any trace of dust and grease. Do not use products such as thrichloroethylene, denaturated alcohol, gasoline, acetone or paint diluent.

Clean in the same way the inner surface of the electrofusion fitting, which has to be removed from its protective wrapping only at the moment of use. **Do not touch with hands** the just cleaned surfaces; on the contrary, repeat cleaning.

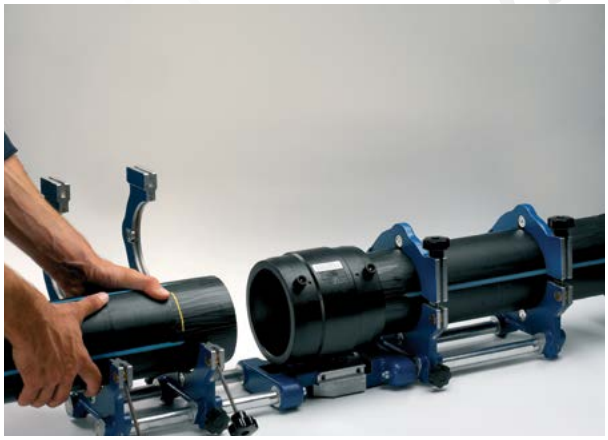
Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Positioning

It is compulsory the use of the **aligning clamp**, for all diameters to be welded, which:

- removes the jointing stresses during the fusion of material and the subsequent cooling time;
- allows to revise possible off-centering between the elements to be welded;
- allows to recover the out-of-round of parts, if ovalized.

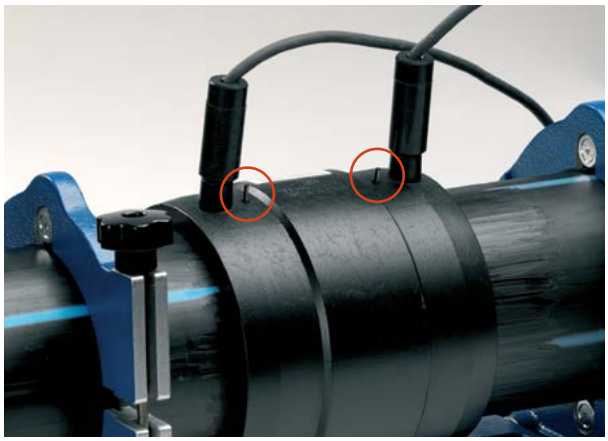
By using a colored pen or wax pencil sign on at least one third of the pipe circumference, in correspondence to the ends to be welded, the **insertion depth** in the electrofusion fitting. This operation must be carried out also in case of fittings with central stop. This mark, beyond helping the positioning of the fitting on the pipe, will permit the control at welding end that there are no movements of the jointing. Insert the electrofusion fitting on the end of the first pipe up to the location mark. Fasten the pipe into the aligning clamp. Insert the second pipe into the fitting up to its location mark and fasten it into the aligning clamp.



Welding

Connect the plugs of the control unit to the terminals of the fitting and proceed with the set-up of the welding parameters according to the instructions of the welding unit.
N.B.: If there is an accidental interruption of the welding cycle, the operation can only be repeated after the electrofusion joint has been totally cooled.

When the fusion cycle is completed, verify the fusion indicators coming out.
WARNING: the coming out of the fusion indicators cannot be the guarantee of good success of the welding. This is exclusively indication of the material fusion.



Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Cooling

Generally the cooling time of the jointing can vary, according to the diameter and fitting type, from 10 up to 30 minutes and anyway it is always **shown by the fitting manufacturer**. During this time, the joint cannot be either moved, or r**emoved from the aligning clamp**, or stressed. At fusion cycle end, it is advisable to write with a colored pen or wax pencil the time when the jointing will be completely cooled. It is absolutely forbidden the use of external cooling methods (water, compressed air, etc) to speed up the cooling. In any case, the pipeline can be put into pressure **not before 2 hours from the last fitting welding.** The welding parameters used for the jointing of each fitting must be recorded in a proper report.

Electrofusion sadles

During preparation, scraping, cleaning, positioning, welding and cooling the same principles that are mentioned above should be followed. After the preparation procedure, clamp the saddle on the pipe by tightening the four connection bolts: proceed alternatively, in a criss-cross way using a screwdriver or wrench according to the type of bolt. Proceed by tightening the bolts until the saddle is fully blocked on the pipe.

Boring

The saddle boring must be carried out only after a complete cooling of the welded joint, independently from the type of saddle, and anyway not before 20 minutes from the cooling shown on the fitting.

Unscrew the outlet cap of the saddle. Insert the manual hexagonal key into the built-in cutter. Avoid the use of pneumatic or electric screwers, which due to the excessive rotation speed can damage the cutter thread. Screw clockwise until the pipe perforation, this is evidenced by a great decrease in the screwing force. Screw anticlockwise and retract the cutter back to its original position. Remove the hexagonal key and strongly screw the cap checking the presence of the internal O-ring gasket. The saddle boring is carried out by using a normal hole-saw, whose external diameter is a little bit smaller than the internal branch diameter – see table 11. Pay attention avoiding damages on the branch internal walls. **WARNING: pipe boring is not allowed before the welding operation, this can seriously damage the jointing quality.**

Table 11

Branch saddle [mm]	External diameter hole-saw [mm]
20	12
25	17
32	25
40	32
50	38
63	48
90	68
110	82

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Buttfusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes

Buttfusion

The buttfusion jointing is defined as the jointing proceeding of two elements (pipes and/or fittings) where the surfaces to be welded are at first heated by contact with an heating element and subsequently, after the removal of the heating plate, are joined together with pressure in order to obtain the welding. The process is defined by the standard **UNI 10520.**

Compatibility

The buttfusion jointing is applicable to **PE 80, PE100 and PE 100 - RC** pipes and fittings **with the same nominal diameter** (preferably higher than 50 mm), **equal SDR** (therefore, same nominal thickness) and melt flow index (MFR) comprised in the range: 0,2 to 1,4 g / 10 min (190°C / 5 kg).

Ambient conditions

Welding must take place in a dry site and **ambient temperature field** comprised between: -10°C to +40°C.
When necessary, suitable protection measures must be taken to protect the welding operation from adverse ambient conditions such as portable tents, equipped boxes or others. It is absolutely forbidden the use of gas torch or flame burners in order to increase the temperature surfaces to be welded.

Welding stages:

Cleaning and facing

Before positioning of the elements to be welded, it is necessary to clean their internal and external surfaces in order to remove traces of dust, grease, earth residuals or mud and others. The operation is made by using a wet strong soft cloth drenched with proper detergent; avoid the use of water detergents.
The facing operation must be carried out by moving both parts close to the rotating facer, only after starting up the tool and working a gradual pressure, in order to avoid an excessive heating of the contact surfaces or causing the tool stop. If the facing operation is correctly done, the shavings are continuous on both ends to be welded. When facing is completed, the inside and outside shavings must be removed from the welding area using a clean cloth or brush. The faced ends cannot be touched any more with hands or get dirty; on the contrary, it is necessary to repeat the cleaning cycle.

Control

At the end of the operation, remove the facer tool, put into contact the surfaces to be welded in order to verify that:

- the maximum mismatch, measured on each point of the circumference, is not bigger than 10% of the thickness of the elements to be welded, with a maximum of 2 mm. On the contrary, it is necessary to repeat the aligning and facing cycle;
- the possible detachment between the contact ends is lower than the values stated in the table 12; on the contrary, the aligning and facing operations must be repeated.

Table 12

External nominal diameter, [mm]	Maximum detachment, [mm]
≤ 200	0.3
> 200 to 400	0.5
> 400 to 630	1.0

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

Heating plate temperature

The heating plate used to heat the parts must guarantee a constant temperature over the whole surface within 20 minutes. Independently from the material type (PE80, PE100 or PE100-RC) and from the dimensions of the pipes/fittings to be welded (diameter and thickness), the heating plate temperature must be:

210 °C ± 10 °C wall thickness ≤ 12 mm!
200 °C ± 10 °C wall thickness ≥ 12 mm!

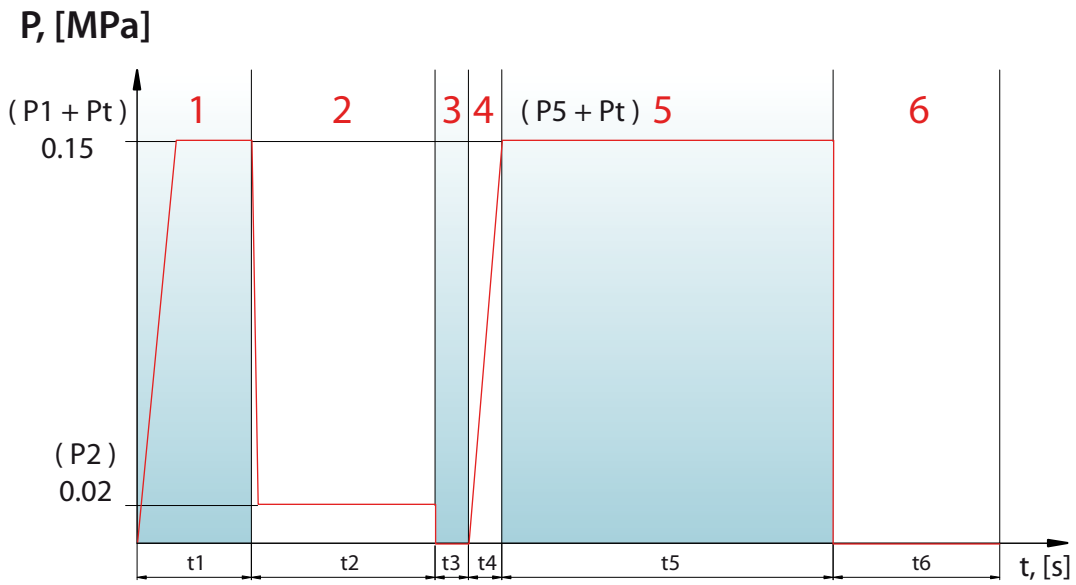
Welding pressure

The welding pressure required by the polyethylene is **0.15 N/mm²**. In general, the values are reported on proper tables supplied by the manufacturer according to the weldable diameters and thicknesses. The drag pressure **Pt** must be always added to these values.

Drag pressure

The **drag pressure Pt** is the minimum pressure value necessary in order to win the friction of the movable jaws of the welding machine (loaded with the pipe/ fitting), which depends on the weight of the gear and of the pipes/fittings to be welded, from the oil temperature in the hydraulic circuit and the jaws clamping force.

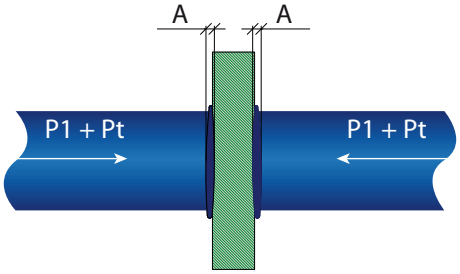
Welding cycles



1. Hauling and pre-heating

The two surfaces to be welded are put in contact with the heating plate with a pressure **P1** which is the sum of **P** (from table) and **Pt** (drag pressure). The pre-heating phase ends after a time **t1** as long as it forms on both welding ends a **ring of fused material** whose **width A** depends on the pipe thickness and is shown on the welding tables supplied with the machine. The following formula allows to estimate the **A** value:

$A = 0.5 + (0.1 \cdot e_n)$, [mm]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.

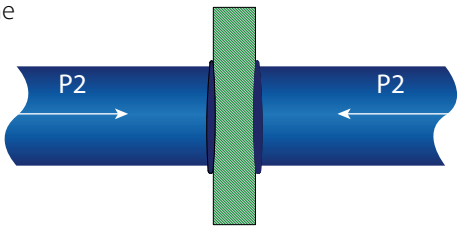


Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

2. Heating

In a relative short time it forms a melted plastic ring which shows that the material has started the fusion process. At this step, the pressure at contact of the ends with the heating plate must be released to **P2 ≤ 0,02 N/mm²**, avoiding the push-out of the **PE** material from the welding zone. Whenever **P2** is not specified in the table supplied with the machine, in the operative practice it is advisable to set the pressure gauge on a value next to zero but never higher than the **Pt**. If the operation is correct, the surface heating continues without increasing the overthickness of the ring.
In this phase, **the ends must be in contact with the heating plate** for a time equal to:

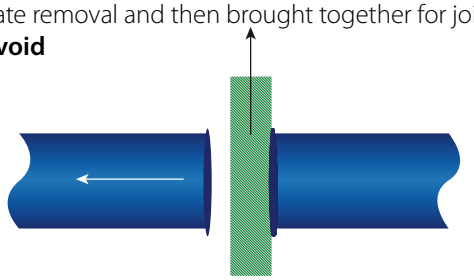
$t2 = 12 \cdot e_n$, [s]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.



3. Removal of the heating plate

At the expiring of the time **t2**, the ends are separated to allow the heating plate removal and then brought together for jointing. The removal of the heating plate has to **be as fast as possible in order to avoid the excessive cooling of the ends.**

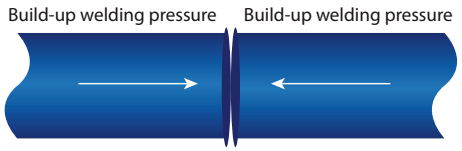
$t3 = 4 + (0.3 \cdot e_n)$, [s]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.



4. Build-up welding pressure

Put into contact the ends by increasing pressure in a progressive way and anyway to avoid a harsh and excessive coming-out of the melted material from both surfaces, up to the value of:
P5 + Pt (where P5 = P, is deducted from the tables supplied by the machine manufacturer). The reaching of this pressure must be within a time equal to:

$t4 = 4 + (0.4 \cdot e_n)$, [s]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.

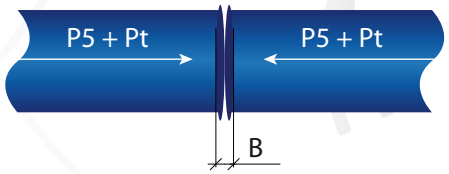


Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

5. Welding

Maintain the ends into contact with pressure **(P5 + Pt)** for a time equal to:

$t5 = 3 + e_n$, [min]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.



When value **P5** is achieved, a ring is formed whose width **B** must be within the range according to **UNI 10520 point 11.1.2** table 2, as shown in the following table 13:

Table 13

Thickness e_n, [mm]	Width B, [mm]	Thickness e_n, [mm]	Width B, [mm]
3	4 ÷ 6	22	13 ÷ 18
4	4 ÷ 7	24	14 ÷ 19
5	5 ÷ 8	27	15 ÷ 20
6	6 ÷ 9	30	16 ÷ 21
8	7 ÷ 10	34	17 ÷ 22
9	8 ÷ 11	40	18 ÷ 23
11	9 ÷ 12	45	20 ÷ 25
13	10 ÷ 14	50	22 ÷ 27
16	11 ÷ 15	55	24 ÷ 30
18	12 ÷ 16	60	26 ÷ 32
19	12 ÷ 18	65	28 ÷ 36

6. Cooling

At the expiring of the time **t5**, the pressure is released to zero and the welded joint can be removed from the clamps. **The joint must not be stressed until the complete cooling at touch,** because it is possible the formation of cracks and slackenings in the cut area. The cooling must be carried out naturally, avoid any quick cooling with water, compressed air and other methods. The cooling time must not be shorter than:

$t6 = 1.5 \cdot e_n$, [min]
where $\mathbf{e_n}$ is the nominal thickness of the pipe and/or fitting to be welded.

Buttfusion phases and welding parameters are shown in table 14.

Table 14

Phase		Contact pressure	Time, [s]	Notes
1	hauling and pre-heating	0.15 N/mm²	-	Time **t1** which allows to form a ring of fused material with width: A=0.5 + (0.1 x e_n), [mm]. (e_n is the nominal thickness of the pipe and/or fitting to be welded)
2	heating	≤ 0.02 N/mm²	12 x e_n	Release pressure and maintain the ends into contact with the heating plate.
3	removal of the heating plate	-	< 4 + (0.3 x e_n)	Remove the heating plate avoiding to damage both ends.
4	build-up of the welding pressure	0 ÷ 0.15 N/mm² + Pt	4 + (0.4 x e_n)	Put into contact the ends avoiding an excessive coming-out of melted material.
5	welding	0.15 N/mm² + Pt	(3 + e_n) x 60	Maintain the ends into contact.
6	cooling	-	1.5 x e_n x 60	The joint cannot be subjected to stresses.

Electrofusion jointing of EVO SCGR ULTRASTRESS and EVOAQUA pipes

EVO SCGR ULTRASTRESS and EVOAQUA pipes connection by means of compression fittings

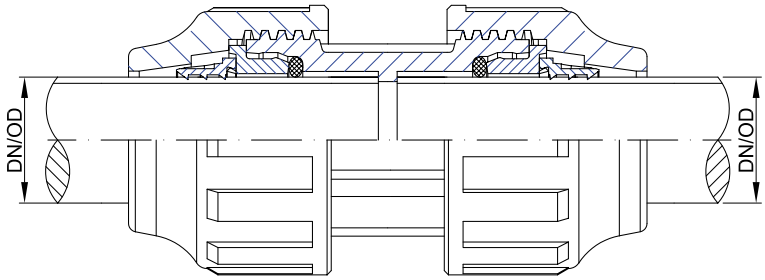
Constructing water-supply networks made of EVO SCGR ULTRASTRESS and EVOAQUA pipes can lead to a situation, when it is impossible to connect pipes using contact welding or electro welding fittings, or these methods are not economically viable. In this case the problem can be resolved by using mechanical connections, so-called compression fittings.

Compression fittings cannot be used for creation of networks for gas provisioning. A comprehensive range of compression fittings can resolve most of the problems, making connections in water-supply networks, supply systems at construction sites, metered irrigation systems, etc. The greatest advantage of the compression fittings is simple and rapid connection, as well as repeated use of compression fittings and their resistance to corrosion and ultraviolet radiation. The popularity of such fittings constantly increases as there is no necessity to use any special devices during installation.

Installation of fittings is a simple process. For fittings with diameter up to 32 mm is enough to screw out a nut, to place pipe's end till limit stop in the fitting and to screw up a nut finger tight. Installing compression fittings of a larger diameter it is necessary to take them to pieces and in such a way to install on a pipe, and then screw on tightly. Threaded fittings should be sealed hermetically (for example, at transition from a polyethylene pipe to a steel pipe using compressions fitting with inner thread). FUM tape made of fluoroplast is used for sealing of threads. Use of flax tow is forbidden.

Compression fittings consist of:

- Body (material – PP copolymer);
- Nut (material – PP copolymer);
- Sealing gasket (material – rubber);
- Press-on bush (material – PP copolymer);
- Compression ring (material – POM polyacetate).



When there is a necessity of transition from one material to another one, it is important to make this transition in such a way that will not lead to the change in straight-flow and hydraulic flow, as well as to the increase or decrease of the diameter, if such cases are not foreseen by the project. If there is a necessity of transition from one material to another one and preserve the previous diameter, correspondence of diameters is presented in Table 15.

EVO SCGR ULTRASTRESS and EVOAQUA pipes' diameters correspondence to the steel pipes' diameters with thread

Table 15

EVO SCGR ULTRASTRESS and EVOAQUA pipe	Steel pipe with thread
DN/OD (nominal/outside diameter), [mm]	**ID (inner diameter), [inch]**
20	½″
25	¾″
32	1″
40	1 ¼″
50	1 ½″
63	2″
75	2 ½″
90	3″
110	4″
125	5″
140	6″

The Table corresponds to:

- EN 12201, DIN 8075 (in relation to the pipes made of PEHD material)
- DIN 2440 (in relation to the steel pipes with thread)

Section 7

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

General Requirements to Water Supply Systems Construction

Construction of a pipeline generally is performed in a trench. If it is impossible and there is an adequate substantiation for it, the following types of construction can be used:

- on supports;
- in separate tunnels;
- in tunnels together with other supply pipelines.

At construction of pipelines in populated areas it is necessary to observe minimum distances (both vertical and horizontal) between different engineering utilities and buildings according to appropriate construction regulations. At construction of several parallel water mains, distance between their outer surfaces depends on the pipeline diameter, soil conditions, construction and repair possibilities. It is necessary to observe minimum distance in order to exclude possibility of carryover of soil in case of the pipeline failure. At crossing of railways, as well as highways of I and II category, pipelines should be placed in a pipe casing.

Vertical distances from upper surface of rails and road surface to pipe casing and tunnels is determined depending on soil conditions and traffic load; acceptable values are:

- larger than 1.0 m – construction with the open-trench technique;
- larger than 1.5 m – construction with the pipe ramming or tunnel method;
- larger than 2.5 m – using directional drilling method.

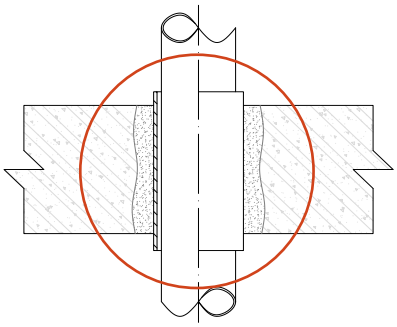
If pipe casing is put into chamber, the distance from the pipe casing's end or distance to external chamber of the well should be:

- at crossing of railways – 8 m from the outer railway track, 5 m from bottom of the embankment and 3 m from the construction ditch edge or road;
- at crossing of highways – 3 m from the edge or road, bottom of the embankment, construction ditch edge or roadside ditch.

One pipe casing can be used for several pipelines. Pipelines can be installed together with electricity cables and communication cables.

Crossing of Constructions

At crossing of any solid construction a protection casing hould be put at the crossing point. This casing protects a pipe from deformation or any other damage that can appear as a result of displacement of the solid construction (e.g. shrinkage of construction). At construction of inlet and outlet of the pipeline, as well as inlet and outlet of the chamber, it is necessarily to put a protection cover.



Pipeline Routing and Angle of Installation

Water-supply pipes are installed with an inclination of minimum 0.001 [m/m] in the direction of an outlet. In case of smooth relief this inclination can be decreased to 0.0005 [m/m]. Pipes should be installed straight and with such inclination, that is specified in the appropriate project. Any necessary changes and inclination corrections can be made by means of lifting or lowering of the trench base, providing support along the whole length of pipes.

Depth of Pipelines Installation

Depth of a water-supply pipeline installation (up to bottom of a pipe) is determined considering surface transport load and crossing with other overland lines of communication, as well as maximum ground frost level in certain area. This level should be minimum 0.5 m greater, than the one with acceptable temperature equal to 0°C. If it is impossible to install pipeline deeper than the ground frost level, they should be made coldproof.

As far as exploitation safety of EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes system depends on affectivity of all the system elements, the installation process should be carefully monitored. If additional material for the trench is correctly padded, reaching withstanding of maximum load, the system is mechanically stable.

Regulating Normative Documents

- EN 752-3;
- EN 805;
- EN 1508;
- EN 1295-1;
- EN 12889;
- EN 1610;
- ENV 1046.

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

General Requirements to Placement of EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes in a Trench

When laying pipes into a trench some measures have to be taken in order to decrease stress in pipes appearing as a result of temperature changes during exploitation. If ambient temperature is higher than + 10°C, pipes are installed with free bending ("snakelike" twists and turns), but if temperature is lower than + 10°C, pipes can be installed as a straight line.

Minimum necessary trench width depends on diameter of pipes and depth of installation. These requirements are regulated by valid regulatory documents and construction regulations, as well as state standards. EN 805, EN 1610, ENV1046 are applied for water-supply networks elaboration and construction, and EN 12889 and PAS 1075 for construction by means of a trenchless technique.

A trench should be protected against collapse. If necessary strengthening (supports) of a trench wall can be performed. It is recommended to lay pipes into a dry trench. Placing pipes into a trench it is necessary to avoid deformations. Pipes cannot be bent by means of a mechanical device or heating.

Trench excavation should be performed in such a way as to guarantee correct and safe laying of a pipeline. When laying two or more pipes in one trench or embankment the requirements for minimum horizontal workspace should be observed, as well as distance between pipelines. Unless otherwise specified, for pipes up to DN/OD 630 mm it should be 0.35 m (between outer diameters of the pipes), but for pipes larger than DN/OD 630 mm it should be 0.50 m (between outer diameters of the pipes). If necessary corresponding safety measure should be observed also for other supply pipelines, water-supply branches, as well as auxiliary facilities, constructions or surfaces used for water-supply, in order to protect them against influence of the harmful environment. If works are halted, it is recommended to close end of the pipes with end caps. These end caps should remain until the moment when pipes are connected to each other. Penetration of trench soil into pipes should be avoided. Soil that has penetrated into a pipe should be cleaned.

During winter it is not allowed to lay a pipe into a trench on the frozen ground. If the trench base is frozen, loose sand or fine-grained soil should be put on the trench base stay within the installation depth determined by the project.

During winter pipes can be reeled out only when air temperature is not lower than + 5°C. Pipes can be reeled out even at lower temperature if these pipes were in advance heated up to the temperature of + 5 °C. It is not allowed to stop work until the whole pipe roll is reeled out. In case if a pipeline section has cooled to its minimum threshold temperature, installation should be terminated, and the roll with the remaining pipe should be again warmed.

Measures for Ground Water Level Reduction in Trenches

At the time of pipes installation into a trench, the trench should be dry and free from water, for example, from rainwater, flows or ground water. Measures for ground water level reduction cannot influence fastening and pipelines. During ground water level reduction some protective measure should be taken in order to avoid loss of expensive materials. Similarly attention should be paid to the influence of ground water level reduction on ground water movement and stability of the surrounding territory. After finishing of ground water level reduction works all the temporary discharge pipes should be properly closed.

Trench Base

Inclination of the trench base and material of the trench base should comply with technical parameters of the project. Trench base material cannot be destroyed. In case it is destroyed, initial load-carrying capability should be regained in the appropriate way. If it is necessary to put the pipe on the trench base, it should be adjusted in relation to necessary inclination and form in order to guarantee support of the pipe. In case of necessity, under the pipe, in connection places at the bottom of the trench base, deeper pits should be created in the trench base in order to facilitate pipeline connection works in the trench. In case of frost the trench base should be protected in such a way that frozen layers were not left under or around pipes. In case the trench base is unstable or the load-carrying capability of the ground is low, all the necessary protection measures should be taken.

Trench Stability

Trench stability should be provided either by means of a support system – flattening sides of the trench or by means of any other acceptable method. Trench support systems are dismountable according to the project in order not to displace or damage pipelines.

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Length Change of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Polyethylene pipes feature high linear expansion that is influenced by temperature fluctuation, that lead to lengthening or shortening of the pipes. This factor should be considered at construction of the pipeline using EVO SCGR ULTRASTRESS and EVOAQUA pipes. This linear lengthening or shortening can be calculated using the following formula:

$\Delta L = \Delta t \cdot L \cdot \alpha$, **where**

ΔL – lengthening or shortening, [m];
Δt – temperature difference, [°C];
L – length of the installed pipe, [m];
α – linear expansion ratio, (foll. VDE 0304 is **1.3 x 10^{-4}** m/m °C).

$\Delta t = T1 - T2$, **where**

T1 – temperature of the ground at the moment of installation of a pipe in the trench, [°C];
T2 – temperature of the pipe surface at the moment of installation, [°C].

Example:
Installing a 600 m-long pipeline section in summer the pipe is put under the direct sunlight, pipe surface temperature can reach +35 °C. After installing this pipe into the trench the pipe surface temperature can decrease to + 10 °C. Basing on the above mentioned information let us make calculations:

$\Delta L = (10 - 35) \times 600 \times 1.3 \times 10^{-4} = -1.95$ m.

Calculations show, that in one night the pipeline section will shorten by 1.95 m. This value can be compensated by means of extension of this pipeline section by 1.95 m. Major inconveniences are usually created by shortening of pipeline sections, but not lengthening. In order to avoid changes in a pipeline section length, that are related to lengthening or shortening of pipes, the most effective method is to align temperature of the pipe surface and temperature of ground in the trench and only then perform connection works. Such temperature adjustment usually can be made within one day.

General Requirements to Installation of EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes in a Trench

Connection types of EVO SCGR ULTRASTRESS and EVOAQUA pipes are presented in Table 16.

Table 16

Connection type	DN/OD (pipe nominal/outside diameter), [mm]
Compression	from 16 to 90
Flange	from 63 to 1600
Electrofusion jointing	from 16 to 630
Buttfusion jointing	from 90 to 1600

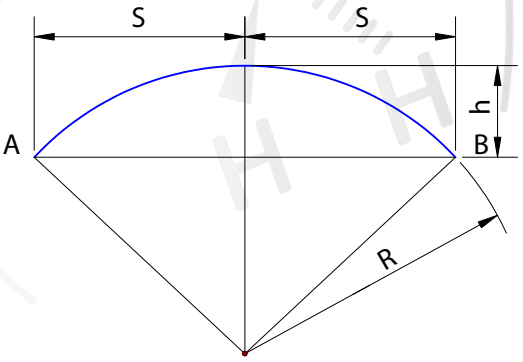
During construction of a pipeline sections, pipe's ends should be closed to prevent soil penetrating into the pipe.

Welding of the pipes should be done during dry weather conditions, when temperature is not lower than –10°C. In case of rain, snow, fog or if air temperature is lower than – 10°C, welding should be done in a closed place (e.g. under a tent) and, if necessary, with additional heating. The cover is necessary in order to avoid condensate formation on pipes and fittings. During welding of the pipes it is necessary to close ends of the pipes in order to avoid chimney effect (stack effect). If welding of a pipe is performed outside the trench, it can be installed into the trench not earlier than in 30 minutes after termination of the welding process and dismantling of the welding equipment. It is allowed to backfill the trench and compact ground not earlier than in two hours. The minimum distance from the welding place of the pipe to bending of the pipe (both vertical and horizontal) has to be ≥ 20 x DN/OD

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Change of pipeline route's direction

Change of EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes' direction can be made by means of the factory manufactured fittings with different turning angle. Turning angle up to 15° can be done without use of fittings, by means of pipes' material elasticity. The following condition should be taken into account: bending radius ≥ 20 x DN/OD. If radius is smaller, pipe's SDR and properties of the material should be taken into account. This information is presented in Table 7 (page 12.)



$$R = \frac{h^2 + s^2}{2 \cdot h} \Rightarrow h = R - \sqrt{(R^2 - s^2)}$$

Definitions Used in the Section

Bedding[4] : Part of a construction used for support of the pipes between the trench bottom and the sidefill or initial backfill. In case if a pipe is put on the bottom of a natural trench, bottom of the trench is the **bedding.**

Compaction layer thickness: Thickness of each new layer of fill material prior to its compaction.

Initial backfill[2] : Layer of the filling material just above the pipe surface.

Main backfill1[1] : Filling between the top of the embedment and the level of the ground, top of embankment or, when applicable, the bottom of the road or railway construction.

Minimum trench width: Minimum distance necessary for safety of the construction between the trench walls at the top of the lower bedding or depending on the situation between trench supports at any level.

Native soil: Soil from the excavation of the trench.

Nominal diameter: Numerical value of the size of a part, that is an integer number approximately identical to the manufacturing size in mm. It can be related to either inner diameter (DN/ID) or outside diameter (DN/OD) acc. to EN 12201, DIN 8075, EN 13244.

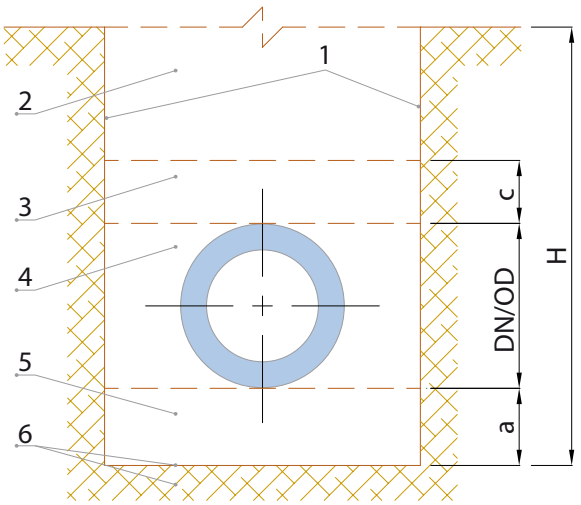
Prefabricated component: A product, that was manufactured separately from the installation process, usually at application of the product standard and/or quality control of the manufacturer.

Sidefill[3] : Material between bedding and initial backfill.

Trench depth[5] : Vertical distance from the trench bottom to the land surface.

1 – Trench walls
2 – Main backfill[1]
3 – Initial backfill[2]
4 – Sidefill[3]
5 – Bedding[4]
6 – Trench bottom
DN/OD – Pipe nominal/outside diameter, mm
H – Trench depth[5].

a – depth of bedding
c – depth of the initial backfill layer

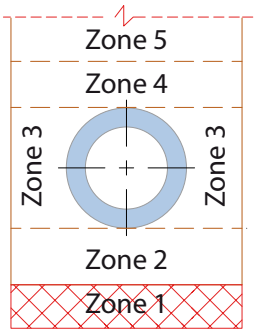


Note:
- *Minimum thickness of the bedding layer (a) at normal soil conditions is 100 mm and at rocky or heavy soil is 150 mm;*
- *Minimum thickness of the initial backfill layer (c) is 150 mm above pipe and 100 mm above fitting.*

Ground Materials Used for Filling up of Trenches

Recommended ground material types for trench filling (allowable values of foreign particle) are presented in Table 17.

Table 17

		Trench zone				
		Zone 1 (trench bottom) change of the material	Zone 2 (bedding) - pipe OD < 500 mm - pipe OD > 500 mm	Zone 3 (sidefill) - pipe OD < 500 mm - pipe OD > 500 mm	Zone 4 (initial backfill) - pipe OD < 500 mm - pipe OD > 500 mm	Zone 5 (main backfill) - present natural material
Type of material	One-size fractionated materials From 2 mm to 16 mm (for example, crushed stones 4 mm ÷ 8 mm)	**U** **A**	**U U** **A A**	**U U** **A A**	**U U** **A A**	Present natural material with maximum stone size equal to 0.64 m. Stone size and composition are determined for each individual case depending on the risk of freezing, etc.
	Granulated materials* Maximum size 32 mm Standard crushed stone 22 mm ÷ 32 mm ≤ 10%	**U** **A**	**U U** **A A**	**U U** **A A**	**U U** **A A**	
	Granulated materials* Maximum standard size is 50 mm	**U** **A**	**U U** **A**	**U U** **A A**	**U U** **A A**	
	Granulated materials* Maximum standard size is 64 mm	**U** **A**	**U U**	**U U** **A**	**U U** **A**	
	Present natural material Maximum stone size is 32 mm	**U**	**U U**	**U U**	**U U**	
	Present natural material Maximum stone size is 50 mm	**U**	**U U**	**U U**	**U U**	
	Present natural material Maximum stone size is 64 mm	**U**	**U**	**U**	**U**	

** Materials should be protected against freezing until the trench is filled up and the material is compacted. During compacting of the ground materials it is not allowed to use water.*

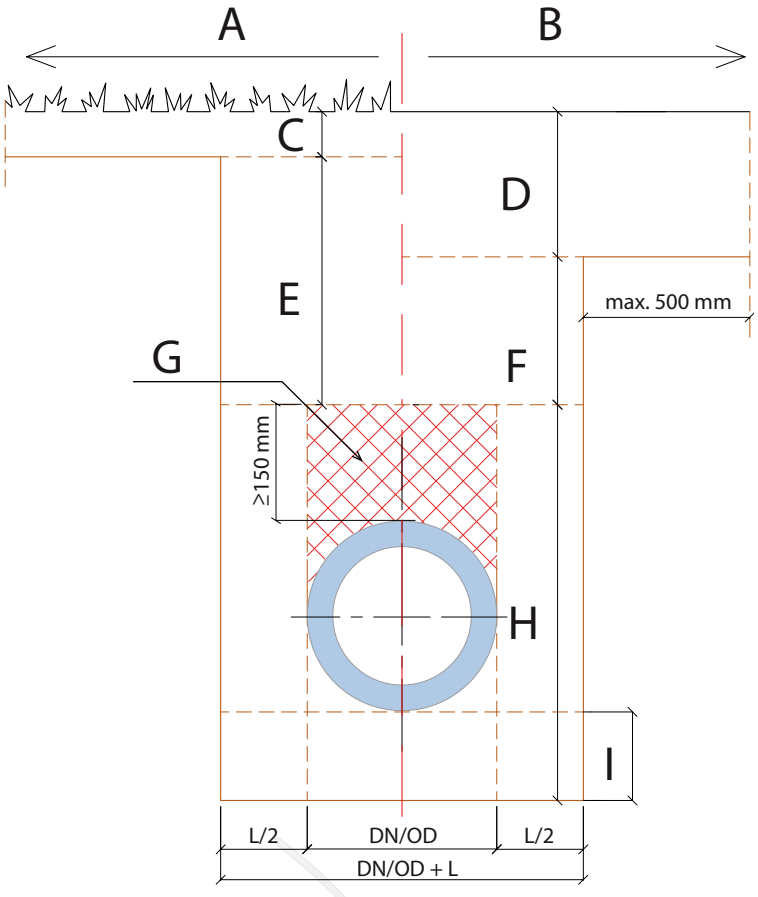
Denomination used in the table:
U – EVO SCGR ULTRASTRESS pipe (material of the class PE100-RC);
A – EVOAQUA pipe (material of the class PE100).

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Compacting of the Backfill Material in Trenches

If an engineer has determined the necessary compacting level, it is necessary to make sure, whether compacting is possible before installation of a pipeline. The trench should be filled up to such level, that filling material after compacting was at the planned height or at the land surface level. In the uninhabited areas trench compacting may be omitted only in cases if there is a dimple without any requirements applied to and landscape and shade gardening planned for.

In the traffic zone the final filling material has to be suitable for compacting and it has to be compacted for minimum 90% of the standard density according to Proctor Density method following EN 1610 and ENV1046. **If trenching is done in the green zone close to the road or under the road, filling and compacting should however be performed according to the requirements set for the traffic zone.** In other cases filling is compacted with the same density as surrounding ground. The trench has to be filled in a way, that later in the process of self-consolidation it will reach foreseen by the project height or the land surface level.



Denominations:

A – Green zone (without traffic load);
B – Under carriageway (with traffic load);
C – Black soil ≥ 150 mm;
D – Carriageway surface;
E – Filling with ground, tamp to Dr ≥ 85%;
F – Filling with ground, tamp to Dr ≥ 90%;
G – For EVO SCGR ULTRASTRESS and EVOAQUA pressure pipes without mechanical tamping ≥ 150 mm;
H – Embankment, tamped to Dr ≥ 90%;
I – Bedding if it is necessary makes ≥ 100 to 150 mm;
Dr – Standard density according to Proctor, [%].
DN/OD – pipe nominal/outside diameter, [mm].

Note:
Installation of a pipeline, as well as layer levelling and making of embankment should be done in a dry construction ditch (trench).

Degree of unloading of the elastic pipe due to transfer of load through filling to the ground wall sides depends not only on ground category, but also on its level of consolidation. Level of soil consolidation depends both on the compacting type, applied devices, and number of times ground compacting was done, as well as thickness of the tamped layer. Thickness of the tamped layer and number of times ground compacting is done are presented in Table 18.

Thickness of the tamped layer and number of times ground compacting is done

Table 18

Type of ground tamping	Number of operations in order to reach the desired compacting level (Standard density according to Proctor), [%]		Maximum thickness of the tamped layer, [m]				Minimum necessary thickness of the initial backfill above the pipe before tamping, [m]
	≥ 90 %	≥ 85 %	Crushed stones	Hogging, sand, pebbles, finely broken stones	Moraine sand, moraine hogging	Wet soil, bluestone, wet moraine soil	
Foot tamper	-	3	-	0.15	0.10	0.10	0.20
Hand tamper min. weight 15 kg	3	1	-	0.15	0.10	0.10	0.20
Mechanical tamper min. weight 80 kg	3	1	-	0.3	0.25	0.20	0.3
Vibro-tamper min. weight 70 kg	3	1	-	0.3	0.25	0.20	0.3
Vibro-tamper min. weight 50 kg	4	1	-	0.15	-	-	0.20
Vibro-tamper min. weight 100 kg	4	1	-	0.20	0.10	-	0.20
Vibro-tamper min. weight 200 kg	4	1	-	0.25	0.15	-	0.25
Vibro-tamper min. weight 400 kg	4	1	0.40	0.35	0.25	0.15	0.40
Vibro-tamper min. weight 600 kg	4	1	0.40	0.35	0.25	0.15	0.40
With roller weight from 500 to 2000 kg	6	-	0.40	0.30	0.20	-	0.50 ÷ 0.70

Granulated materials, such as finely broken stones of fraction 8 ÷ 12 mm or 8 ÷ 16 mm or pebbles 8 ÷ 22 mm are self-consolidating materials, and in case they are used as the filling material they are placed as layers, the thickness of each layer makes 0.15 ÷ 0.20 m, but compacting level ≥ 90% according to Proctor.

Trench Width for EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes

Maximum trench width:
- trench width cannot exceed maximum width determined by the project;
- if it is impossible, this issue should be discussed with design engineer.

Minimum trench width ration to nominal/outside diameter DN/OD is presented in Table 19.

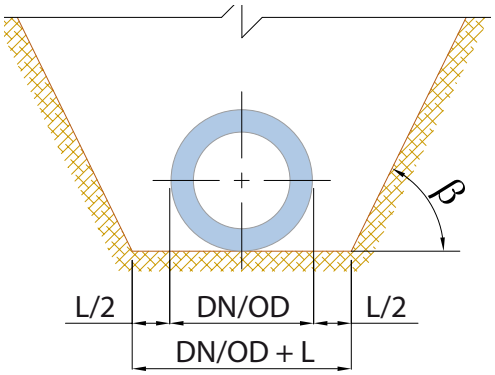


Table 19

DN/OD, [mm]	Minimum trench width (DN/OD + L), [m]		
	Trench with supports	Trench without supports	
		β > 60°	β ≤ 60°
≤225	DN/OD + 0.40	DN/OD + 0.40	
225≤315	DN/OD + 0.50	DN/OD + 0.50	DN/OD + 0.40
315≤630	DN/OD + 0.70	DN/OD + 0.70	DN/OD + 0.40

Values **DN/OD + L, L/2** are equal to minimum workspace between a pipeline and trench wall or support, where:
DN/OD - pipe nominal/outside diameter, m;
β - angle of the trench edge without support measured horizontally and presented in degrees.

Minimum trench width ratio to trench depth is presented in Table 20.

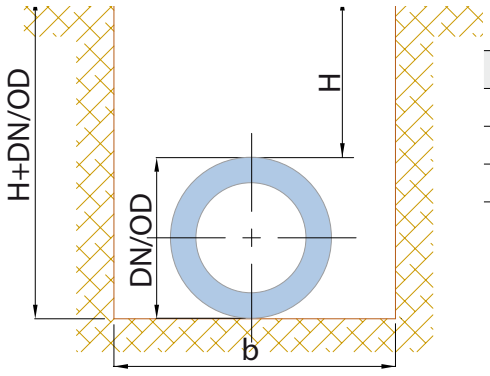


Table 20

Trench depth (H+DN/OD), [m]	Minimum trench width (b), [m]
≥ 1,00 ≤ 1,75	0,80
> 1,75 ≤ 4,00	0,90
> 4,00	1,00

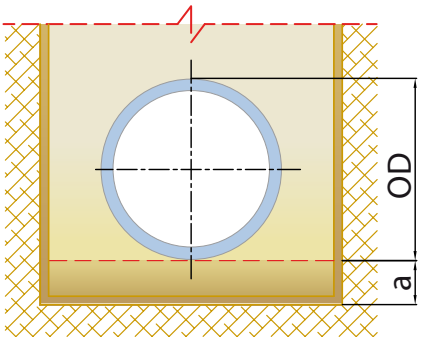
There can be some exceptions applied to minimum trench width

Minimum trench width, indicated in **Tables 19 and 20** can be changed in the following cases:
- if workers will never need to step into the trench, for example, automated installation technologies are used;
- if workers will never need to stand between the pipeline and the trench wall;
- in case of unavoidable restricting circumstances.

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Types of Bedding Structures

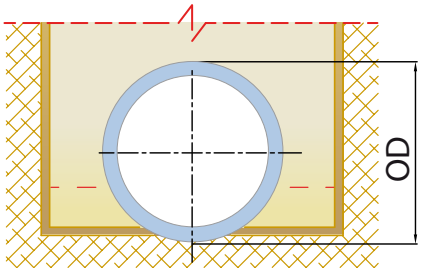
Type 1 Bedding Structure



Type 1 of the bedding structure can be used with any fastening ensuring support of the pipes along their entire length applying **a** layer thickness requirements. It applies to all sizes and shapes of the pipes. Unless otherwise specified, thickness of bottom bedding **a** measured under the pipe cannot be less than:

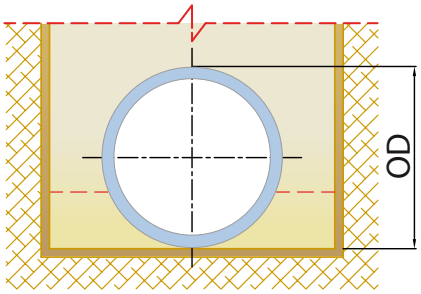
- 100 mm at normal soil conditions;
- 150 mm at rocky or heavy soil conditions.

Type 2 Bedding Structure



Type 2 of the bedding structure can be used with homogenous, relatively soft, grainy soil ensuring support of the pipes along their entire length. Pipes can be laid directly on the properly formed and levelled trench bedding.

Type 3 Bedding Structure



Type 3 of the bedding structure can be used with homogenous, relatively soft, grainy soil ensuring support of the pipes along their entire length. Pipes can be laid directly on the levelled trench bedding.

Special Bedding or Support Methods

If trench bedding has too low load bearing capacity to support the pipe base materials, it is necessary to apply special measures. Such situation may be due to unstable soil, for example, peat, shifting sands. Examples of possible measures may be replacement of soil with other materials, for example, sand, gravel and hydraulic binding materials, or resting the pipelines on pile supports, for example, using cross beams or swing mounts, longitudinal beams or reinforced concrete slabs connecting the piles. The same way during designing and construction attention should be paid to transfers from one kind of soil conditions to other, which would require different solutions. Special bedding or pipeline support methods can be used only if their suitability has been confirmed by structural design calculations.

Note:
Pipelines resting on piles underground can be subjected to extremely high loads.

Any amount of soft soil under the trench bedding should be removed and replaced with an appropriate bedding material. If a substantial amount of soft soil is discovered, it will be necessary to revise the structural design.

Fastenings and Supports for EVO SCGR ULTRASTRESS and EVOAQUA Pressure Pipes

General Information

Thickness of materials, beddings, supports and fastening should conform to the design requirements. Fastening materials and their connections with any support should be chosen considering:

- pipe size;
- pipe material and wall thickness;
- soil properties.

Width of the fastening should correspond to the trench width, unless specified otherwise. Width of pipeline bedding installed in the embankments should be 4 x DN/OD, unless specified otherwise.
Sometimes it is necessary to make pipes in the channels, so they have to be placed on supports. Number of supports depends on the temperature of conveyance fluid. Necessary distance between supports is presented in Table 21.

21. table is combined acc. to DVS 2210 – 1

Table 21

DN/OD, [mm]	Temperature of conveyance fluid, [°C]				
	+ 20	+ 30	+ 40	+ 50	+ 60
	Distance between supports, [mm]				
16	500	450	450	400	350
20	575	550	500	450	400
25	650	600	550	550	500
32	750	750	650	650	550
40	900	850	750	750	650
50	1050	1000	900	850	750
63	1200	1150	1050	1000	900
75	1350	1300	1200	1100	1000
90	1500	1450	1350	1250	1150
110	1650	1600	1500	1450	1300
125	1750	1700	1600	1550	1400
140	1900	1850	1750	1650	1500
160	2050	1950	1850	1750	1600
180	2150	2050	1950	1850	1750
200	2300	2200	2100	2000	1900
225	2450	2350	2250	2150	2050
250	2600	2500	2400	2300	2100
280	2750	2650	2550	2400	2200
315	2900	2800	2700	2550	2350
355	3100	3000	2900	2750	2550
400	3300	3150	3050	2900	2700

Denomination used in the table:
DN/OD – pipe nominal/outside diameter, [mm].

Ground Requirements when Constructing an EVOAQUA Pressure Pipes System

Granular Materials

Granular materials include:

- single size granular material;;
- graded granular material;
- sand;
- all-in aggregates;
- crushed aggregates.

Materials used for main backfill

The maximum size of the stones in the excavated material for backfill should be 50 mm thick or correspond to the initial backfill thickness, or half of the compaction layer thickness, depending on which one is smaller. The maximum size can be even more limited depending on soil conditions, ground water and pipe material. Special requirements can be applied in case of rocky area. Fastening materials cannot contain particles, which size exceed allowable values, see Table 22.

22. Table is composed according to EN 1610 requirements

Table 22

Outside diameter of sand/gravel particles, [mm]	DN/OD pipe nominal/outside diameter, [mm]
22	≤ 200
40 or (OD/10)	> 200 ≤ 630
60	> 630

Native Soil

The following requirements apply to native soil for reuse:

- correspondence to project requirements;
- compactability if specified;
- absence of materials that can be harmful for pipes (e.g. too large particles, depending on the pipes material, wall thickness and diameter – roots of trees, rubbish, organic matters, clay lumps > 75 mm, snow and ice).

Depending on the soil type the following trench constructions can be used, see Table 23.

Table 23

Soil type and characteristics	Necessary trench construction
Moraine (sand-clay mixture can contain big stones depending on sand composition)	Trench edges are stable, there is no necessity for the base levelling layer
Sward (humus, dirt, rubbish, limnetic chalk, peat)	Trench edges are relatively stable, organic soil falls to pieces in course of time and starts to settle, it is necessary to put geotextile, crushed stones can be used as filling to disperse load
Sand	It is necessary to put geotextile into trench, crushed stones can be used as trench filling
Rough moraine with stones	The base levelling layer is unnecessary
Solid sand clay and clayey soil	It is necessary to put geotextile into trench, gravel or crushed stones can be used as filling
Soft clayey soil	It is necessary to put geotextile into trench, use wooden/beam, steel plates or pile supports for the trench base, gravel or crushed stones can be used as filling
Very soft muddy soil	It is necessary to use wooden or steel plates or pile supports for the trench base

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Installation Methods for EVO SCGR ULTRASTRESS Pressure Pipes

EVO SCGR ULTRASTRESS pressure pipes can be installed by means of the open-trench technique or trenchless technique, see Table 24.

Table 24

Open-trench technique	Trenchless technique
Laying into a trench without creation of the sand protective layer	Horizontal directional drilling
Installation in ground by means of a plough	Installation in place of old pipes with destruction of the old pipes (pipe bursting)
Installation in ground by means of a milling tool	By means of insertion into an old pipe

Laying EVO SCGR ULTRASTRESS pressure pipes using open-trench technique

When laying EVO SCGR ULTRASTRESS pressure pipes by means of the open-trench technique it is allowed to use the same soil for filling that was taken out as an additional material around the pipe.

Brief description of the open-trench technique used for installation of EVO SCGR ULTRASTRESS pressure pipes

Horizontal directional drilling

It is applied at construction of the new or reconstructing of the old pipelines. At the time of reconstruction the old pipeline can fully function. There can be only short interruptions of work due to making of new connections. This method is applied in places where it is desirable to avoid ground work, for example: water obstacles, roads, railways, fields, buildings, etc.

Horizontal directional drilling usually includes three stages:

Stage 1	Stage 2	Stage 3
Pilot drilling	Reaming, if it is necessary	Pullback

Note:
If diameter difference between the inserted pipe and pilot drilling does not exceed sizes specified by the manufacturer, then reaming and pullback are performed simultaneously.

It is advisable to make a drill hole at the flattest angle possible. Carrying out drilling works it is necessary to use special drilling liquid. Before drilling works the geological soil survey should be performed, as a result of which the drilling liquid type is determined.

At drilling of a tunnel drilling liquid works as:

A means for transporting of soil particles	A means for creation of homogeneous mixture	A means for reinforcement of drill hole walls
Greasing	Pressure creator in the drill hole	Cooler of the drilling head

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Installation of a new pipe with destruction of the old pipe

This method is used in cases when the old pipeline is severely deformed or diameter of the old pipe does not correspond to the new requirements. A hydraulic destroying head is used as a lead that creates the way for a new pipe. A feature of this method is the fact, that the new pipe can be of the same diameter as the old one, or even larger.

Advantages of the chosen method:

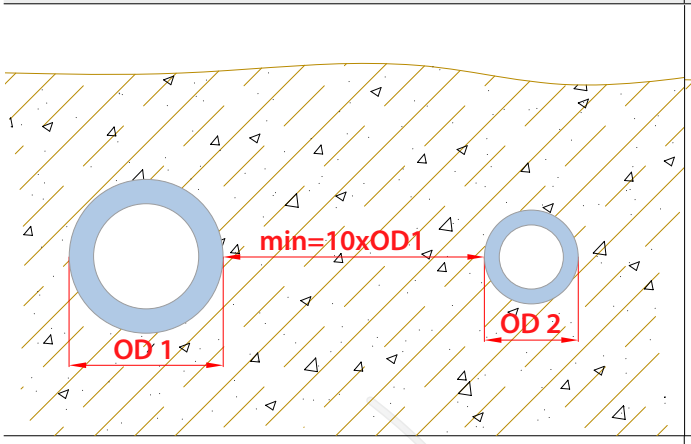
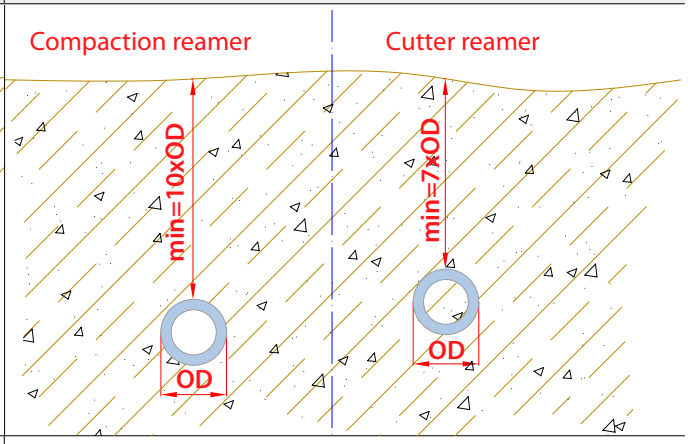
- It is possible to reconstruct pipes made of easily breakable material, such as: clay, concrete, cast-iron, polymer, thin steel.
- Straight-flow values of the new pipe are larger or equal to the straight-flow capability of the reconstructed pipe as the new pipe with larger diameter installation is possible.
- Compact equipment allows to work in complex environments.

Insertion of a new pipe into an old one

It is used for the reconstruction of old pipelines. By means of this method EVO SCGR ULTRASTRESS pressure pipe with a little bigger diameter is inserted into an old pipe. This construction does not allow water through, withstands high loads and is non-corrodible. Insufficient flow resistance increase is compensated by the smooth internal surface of the pipe and low material friction values, that balance flow rate in the pipe.

Insertion of a new pipe into an old one is a suitable method in many reconstruction cases. During implementation of works, only beginning of pipe section is to be dug, as well as pipe branching places. Free space between old and new pipes is filled with concrete foam in order to prevent possible damage in case of deconstruction of the old pipeline.

Carrying out drilling works it is necessary to remember and apply the following conditions:

Parallel drilling	Minimum drilling depth in order to prevent land surface deformation
	
Distance between two parallel drill holes is 10 times more the external diameter of the largest channel (10 x OD1).	Using compaction reamers, minimum depth is 10 x external diameter of the channel (10 x OD). Using cutter reamers, minimum depth is 7 x external diameter of the channel (7 x OD).

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Recommended EVO SCGR ULTRASTRESS pipe **SDR** values depending on the trenchless technique are presented in Table 25.

Table 25

Trenchless technique	Pipe standard dimension ratio SDR
Horizontal drilling	SDR11, SDR13.6, SDR17, SDR21
Installation in place of old pipes with destruction of the old pipes	SDR11
By means of insertion into an old pipe	SDR11, SDR13.6

It is necessary to consider that pull force applied in order to install pipe into a drill hole is a sum of two components: force that is necessary for pulling a pipe along the land surface or rolls and force that is necessary inside the drill hole. Maximum allowed pull force F, [kN] for EVO SCGR ULTRASTRESS pipe depending on **SDR** value is presented in Table 26.

table 26

Maximum allowed pull force for EVO SCGR ULTRASTRESS in the pipe-line ditch				
Nominal outside diameter DN/OD, [mm]	At air temperature + 20 [°C]			
	SDR 17.6	SDR 17	SDR 11	SDR 7.4
	Pull force F, [kN]	Pull force F, [kN]	Pull force F, [kN]	Pull force F, [kN]
20	-	-	1.1	1.5
25	-	1.3	1.6	2.4
32	1.7	1.8	2.7	3.8
40	2.7	2.8	4.2	6.0
50	4.3	4.4	6.6	9.3
63	6.7	7.1	10.4	14.7
75	9.6	10.0	14.6	20.9
90	13.6	14.4	21.1	30.0
110	20.5	21.4	31.4	45.0
125	26.3	27.3	40.7	58.0
140	33.2	34.3	50.8	72.9
160	43.1	44.9	66.7	95.0
180	54.4	56.9	84.3	120.1
200	67.5	70.3	103.9	148.6
225	85.3	89.1	131.7	187.9
250	105.2	109.4	162.1	231.9
280	131.9	137.4	203.2	290.8
315	167.1	174.1	257.3	368.2
355	211.5	221.3	326.5	467.0
400	269.1	280.2	414.8	593.4
450	340.1	355.1	525.7	750.6
500	420.8	438.8	648.4	926.3
560	526.1	549.5	812.6	
630	666.5	696.3	1029.3	

1 t = 10 kN = 10000 N

Note:

If insertion of a pipe by means of the trenchless technique lasts more than > 10 hours, then pull force (F) should be decreased by 10%, but if insertion lasts more than > 20 hours, then pull force (F) should be decreased by 25%.

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Securing of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Pipe axial force affects bolts, turns, branches and transitions. This force is to be balanced with pipes fastenings. Fastenings should balance the force created by internal pressure, test pressure, dynamic surface pressure, hydraulic impact, as well as local pressure created by surrounding surface. Fastening blocks function is transfer of the pressure force direction to the trench walls. Fastening blocks should be of such form that they will leave pipeline connection places free. In places where concrete lies directly near pipes or fastenings, pipes should be wrapped by means of some elastic material (for example, tape). Water-supply pipeline cannot be fastened by means of a chamber. If it is necessary to create fastening, then it is recommended to make it before the chamber. Fastening supports are made of concrete with hardness class not lower than K30. If industrial cast fittings are used with diameter smaller than 225 mm (for example, electrofusion fittings), fastening is not necessary.

Pipelines fastening by means of support blocks is recommended in the following cases:

- If diameter of a pipeline exceeds 225 mm;
- If electrofusion fittings are used that are made of pipe segments and their diameter exceeds 225 mm;
- At transition place (from pipes made of PEHD material to pipes made of PVC material);
- At transition place of the pipe diameter in case of contact welding;
- In place of installation of fasteners, if they were not installed in the chamber;
- In place of installation of water hydrants, if they were not installed in the chamber;
- At the closed (blanked off) ends of the water-supply pipeline.

Making calculations of the support blocks dimensions, the following parameters should be considered:

- internal pressure in the pipeline;
- pipeline diameter;
- composite force or axial force;
- physical and mechanical soil properties.

Calculations for the support blocks:

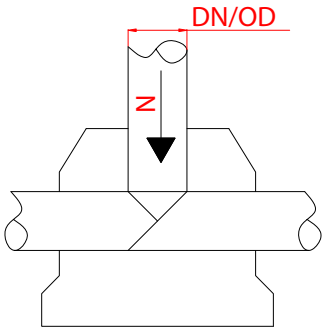
Axial force can be calculated by means of the following formula:

$$N = \frac{\pi \cdot DN/OD^2 \cdot p}{10^4 \cdot 4}$$ **, where**

N – axial force, [kN];
π – mathematical constant (π = 3.14), (without unit of measure);
DN/OD – pipe nominal/outside diameter, [mm];
p – maximum pressure in the pipeline in bars, usually it is test pressure (1 bar = 0.1 MPa).

$$N = p \cdot N1$$ **, where**

N – axial force, [kN],
p –maximum pressure in the pipeline in bars, usually it is test pressure (1 bar = 0.1 MPa);
N1 – axial force that corresponds to pressure of 1 bar, [kN].



Axial (N1) pressure [kN], that corresponds to internal pressure in the pipeline 1 [bar] is presented in Table 27.

Table 27

DN/OD pipe nominal/outside diameter), [mm]	Axial (N1) pressure [kN], that corresponds to internal pressure in the pipeline 1 [bar]
225	3.97
250	4.91
280	6.15
315	7.79
355	9.89
400	12.56
450	15.90
500	19.63
560	24.62
630	31.16

Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

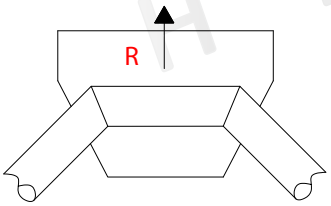
Resultant force, that influences pipeline bend can be calculated by means of the following formula:

$$R = 2 \cdot N1 \cdot p \cdot \sin\frac{\alpha}{2}$$, **where**

R – resultant force, [kN];
N1 – axial force that corresponds to pressure of 1 bar, [kN];
p – maximum pressure in the pipeline in bars, usually it is test pressure (1 bar = 0.1 MPa);
α – pipeline turning angle in degrees, [°].

$$k = 2 \cdot \sin\frac{\alpha}{2}$$, **where**

k – angle factor, (without unit of measure);
α – pipeline turning angle in degrees, [°].
*Note: **k** values are presented in Table 28.*



$$R = k \cdot p \cdot N1$$, **where**

R – resultant force, [kN];
k – angle factor, (without unit of measure);
p – maximum pressure in the pipeline in bars, usually it is test pressure (1 bar = 0.1 MPa);
N1 – axial force that corresponds to pressure of 1 bar, [kN].

Angle (k) factor are presented in Table 28.

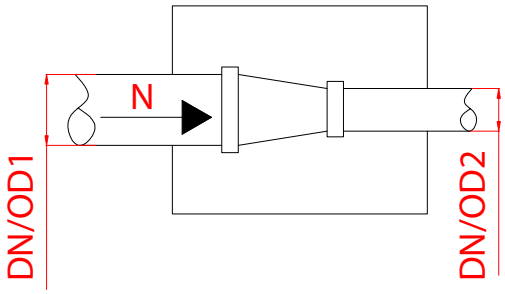
Table 28

Angle (α) in degrees, [°]																	
5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Factor, k (without unit of measure)																	
0.09	0.17	0.26	0.35	0.43	0.52	0.60	0.68	0.77	0.84	0.92	1.00	1.07	1.15	1.22	1.28	1.35	1.41

Axial force, that influences pipeline diameter at transition place can be calculated by means of the following formula:

$$N = \frac{\pi \cdot (DN/OD1^2 - DN/OD2^2) \cdot p}{4 \cdot 10^4}$$, **where**

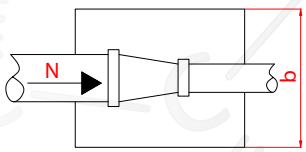
N – axial force, [kN];
π – mathematical constant (π = 3.14), (without unit of measure);
DN/OD1 – largest pipe nominal/outside diameter, [mm];
DN/OD2 – smallest pipe nominal/outside diameter, [mm];
p – maximum pressure in the pipeline in bars, usually it is test pressure (1 bar = 0.1 MPa).

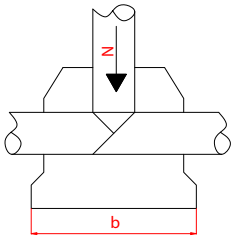


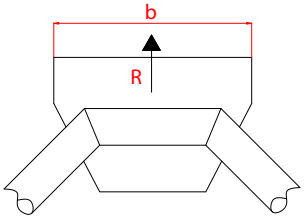
Width of the support block can be calculated by means of the following formula:

$$b = \frac{N}{h \cdot G} \Leftrightarrow b = \frac{R}{h \cdot G}$$, **where**

b – width of the fastening block, [m];
N – axial force, [kN];
R – resultant force, [kN];
h – height of the fastening block (usually ≥ 0.15 m), [m];
G – allowed ground influence (in most cases accepted equal to 200 kN/m^2), [kN/m^2].







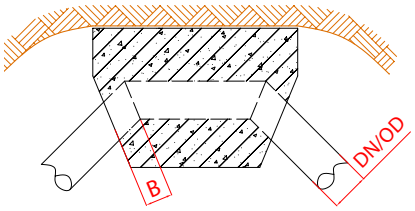
Construction of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Note:
Allowed ground influence is usually taken from the geological soil survey data that are received before beginning of the planning.

Buttfusion fittings fastening using support blocks

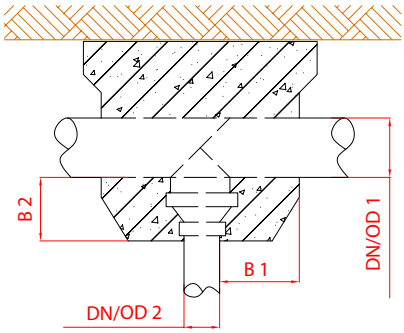
Construction of the water-supply pipeline using buttfusion fittings made of PEHD material and consisting of several segments, whose diameter is bigger than 225 mm should be fastened. Reinforced concrete support block should be of such a form that will provide distance from outer welding seam to outer surface of the support block **(B)** not smaller than indicated below:

For bends

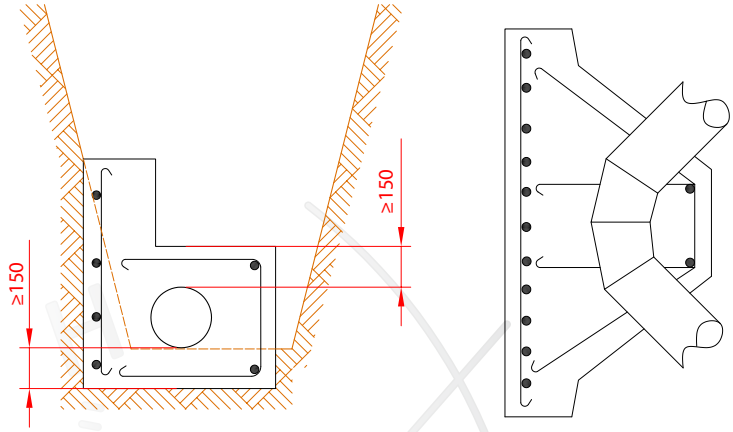


B ≥ DN/OD (but not less than 150 mm);
Thickness of support block from surface of the pipeline – not less than 150 mm.

For branches



B1 ≥ DN/OD1 (but not less than 200 mm);
B2 ≥ DN/OD2 (but not less than 200 mm);
Thickness of support block from surface of the pipeline – not less than 150 mm.



Minimum distance from the pipe surface to the outer edge of the support block is 150 mm. Armature in the support block is made according to requirements of the design engineer.

Section 8

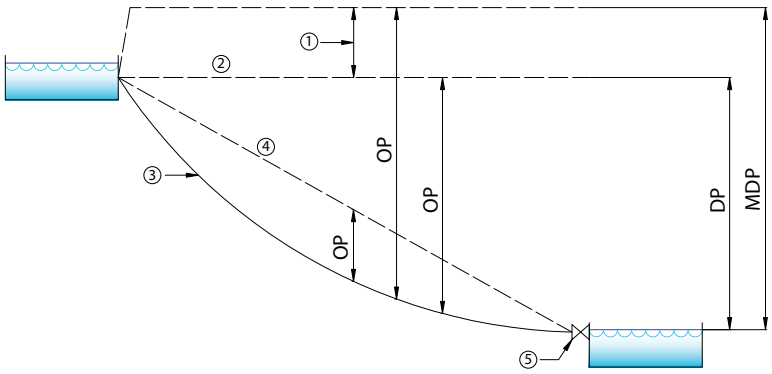
Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Pressure terms used in water supply

Pressure

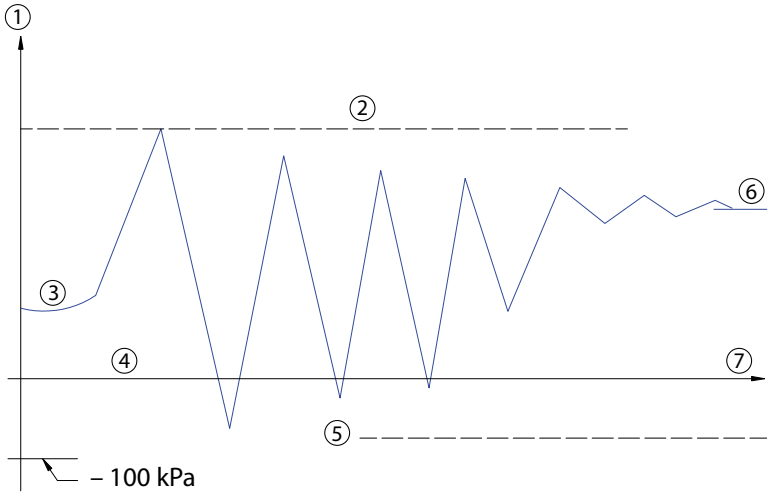
Surge is mainly related to flow velocity and not to internal pressure (see Figures 1 and 2).

Figure 1 – Example of pressurized gravity main



Denominations:
1 – Surge;
2 – No flow hydraulic gradient;
3 – Pipe profile;
4 – Hydraulic gradient;
5 – Valve.

Figure 2 – Hydraulic impact propagation, e.g. in the network



Denominations:
1 – Pressure;
2 – MDP (Maximum design pressure);
3 – Initial operating pressure (OP);
4 – Atmospheric (hydrostatic) pressure;
5 – Saturated vapour pressure;
6 – New operating pressure;
7 – Time.

Allowable maximum operating pressure (PMA)
Maximum pressure, that appears from time to time, including surge, that a component can withstand during normal operation.

Allowable operating pressure (PFA)
Maximum hydrostatic pressure, that a part can withstand during long-time operation.

Allowable site test pressure (PEA)
Maximum hydrostatic pressure, foreseen by the design engineer, considering development of the network in future, but taking into account surge.

Designed pressure (DP)
Maximum operating pressure of the system, foreseen by the design engineer, considering development of the network in future, but excluding surge.

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Maximum design pressure (MDP)
Maximum operating pressure of the system, foreseen by the design engineer, considering development of the network in future and surge, where:
- MDP is designated MDPa, when there is a fixed allowance for surge;
- MDP is designated MDPc, when the surge is calculated.

Operating pressure (OP)
Internal pressure that appears in the supply system at a certain time and place.

Pressure zones
Pressure oscillation amplitude areas in the water supply system.

Service pressure (SP)
Internal pressure that is delivered to the feed pipe at its connection place to consumer appliances at zero flow.

Surge
Rapid flow speed fluctuations that appear during short periods of time.

System test pressure (STP)
Hydrostatic pressure used for testing of the newly constructed pipelines in order to test their integrity and tightness.

International pressure denominations used in water supply are presented in Table 29.

Table 29

Abbreviation	Denomination	
DP	Designed pressure	**Related to system**
MDP	Maximum design pressure	
STP	System test pressure	
PFA	Allowable operating pressure	**Related to system elements**
PMA	Allowable maximal operating pressure	
PEA	Allowable site test pressure	
OP	Operating pressure	**Related to system**
SP	Service pressure	

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Protection Measures Before Pipeline Inspection

General Requirements

In order to ensure the integrity of pipelines, fittings and other parts, for example, integrity of support blocks, there should be water pressure testing performed for each pipeline after its installation.
The pipelines installed in trenches or unapproachable tunnels are inspected twice.
Initial inspection is performed before filling up the trench and armature installation. Unconsolidated places in the non-backfilled trench can be easily found and corrected. Final inspection of pipes is done after trench backfilling, but before hydrant, safety valves and air discharge valves installation. The inspection is repeated because during the trench backfilling the pipeline can be damaged. In case of uneven settlement of a pipeline there can appear breaks, cracks, unconsolidated places, etc. .

Equipment and Clothing

Before beginning of the works it should be checked if the necessary safety equipment is available, as well as if the personnel uses special clothing.

Construction Ditch

There should be constant monitoring from beginning of the excavation works till filling up the trench. During pressure testing in the pipeline trench none of the other works is allowed.

Filling and Inspection

Filling and inspection are performed with the use of water corresponding to the requirements applied to drinking water. Drinking water is water foreseen for human consumption and its quality is approved by appropriate state establishment.
Pipelines should be filled slowly. During filling of the pipeline ventilation device should be put outside.
Before beginning of the pressure testing it is necessary to check that testing equipment is calibrated, functions fine and is correctly fastened to the pipeline.
During pressure testing all the ventilation devices should be closed, but interline valves – opened.
In order to avoid excessive number of personnel, all the testing stages should be included into a planned list of actions and any fluctuations from this list should be controlled. All the personnel must be informed about load applied by the temporary installed devices and supporting devices as well as possible consequences in case the system will not withstand the load.
Pressure in pipes should be lowered gradually and, during emptying of the pipes, all the ventilation devices should be opened.

Pressure Testing

Preparation

Trench Filling and Anchoring

Prior to pressure testing pipes, where it is necessary, should be covered with backfill material that allows to avoid possible changes in soil conditions due to leakage. Filling above connections is optional. In order to withstand blows during pressure testing, permanent supports or anchors should be installed. It is necessary to provide sufficient anchoring of end caps or other temporary used devices, distributing load along the whole support base. Any temporary used supports or anchors used during testing should be left in the trench till decreasing of the pressure to zero.

Choice and Filling of the Section for Inspection

Pipeline is inspected as a whole, if it is necessary, or is divided into several inspection sections. If it is decided to inspect several sections, sections lengths for EVO SCGR ULTRASTRESS and EVOAQUA pipelines cannot exceed 0.5 km.

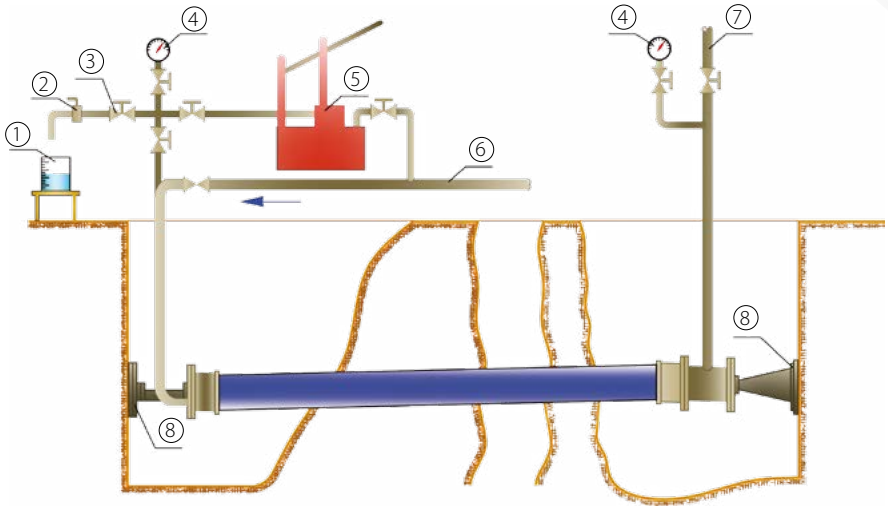
Inspection sections should be chosen in order to:

- achieve the planned test pressure in every lower inspected section;
- achieve at least maximum design pressure (MDP) in the highest point of every inspected section, if it is not otherwise stated by the design engineer;
- provide water and clear it up when it is necessary during testing.

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Any rubbish or foreign objects should be taken away prior to the pipeline inspection. The inspected section should be filled with water. If it is not otherwise stated by the design engineer, it is necessary to use drinking water for drinking water pipelines.
Filling should be performed slowly, if it is possible, from the lower pipeline section, and in such a way as to avoid water flowing back. Ends of the inspected pipeline section are closed with so called "blind" flanges and supports are installed in order to prevent pipes flowing off the couplings. Fasteners during inspection should be opened. Filling is performed in the lowest point of the pipeline section, but deaerator is installed in the highest point. A scheme of hydraulic testing is presented in Figure 3.

Figure 3 – Scheme of the pipeline hydraulic testing



Denominations:
1 – graduated vessel;
2 – faucet;
3 – adjusted valve;
4 – pressure gauge;
5 – hydraulic press;
6 – water inlet;
7 – air discharge valve;
8 – terminal supports.

System test pressure (STP) acc. to maximum design pressure (MDP) is calculated in the following way:

- During network inspection the hydraulic impact is considered:
  STP = MDPc + 100 kPa
  (MDPc – maximum (designed) operating pressure in the system with calculated hydraulic impact factor).

- During network inspection the hydraulic impact is not considered:
  STP = MDPa x 1,5
  or
  STP = MDPa + 500 kPa
  depending on which one is smaller.
  (MDPa – maximum (designed) operating pressure in the system with possible hydraulic impact factor).

Constant hydraulic impact allowance, considered in MDPa, cannot be less than 200 kPa.

Hydraulic impact calculations are performed according to the applicable methods using corresponding general equations considered foreseen by the project conditions and taking into account the most harsh exploitation conditions.
At normal conditions testing equipment is installed in the lowest point of the inspected section.
If it is impossible to install testing equipment in the lowest point of the inspected section, the pressure used for testing should be equal to system test pressure calculated for the lowest point of the inspected section subtracting heights difference from it.
In special cases, especially, if considerably small pipeline sections are constructed with nominal diameter ≤ 80 mm and section length does not exceed 100 m, if it is not otherwise stated by the design engineer, current operating pressure of the pipeline can be used as system test pressure.

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Inspection Procedure

General Requirements

Inspection procedure can be divided into three steps:
Step 1 – preparation for inspection;
Step 2 – pressure drop testing;
Step 3 – main pressure testing.

Step 1 – Preparation for Inspection

Preparation for inspection is meant for:
- performing of the major time-consuming activities, stabilization of the inspected pipeline section;
- reach sufficient filling with water if water absorbent materials are used;
- before main testing to reach pressure dependant volume increase in EVO SCGR ULTRASTRESS and EVOAQUA pipes.

Pipeline is divided into factual inspected sections, it is completely filled with water and ventilated. Pressure is increased at least up to operating pressure (OP), not exceeding test pressure (STP) in the system.
If there are any unacceptable changes or leakages in the pipeline, the pressure should be relieved and all the failures should be corrected.

Time for preparation for inspection depends on materials used in the pipeline and it is determined by the design engineer, considering standards applied to the corresponding product.

Pressure applied to EVO SCGR ULTRASTRESS and EVOAQUA pipes can increase their diameter. It can be seen already during the first working day. Therefore pressure drop, caused by the pipeline diameter increase can be incorrectly perceived, creating impression, that this pressure drop is due to leakage in the pipeline. EVO SCGR ULTRASTRESS and EVOAQUA pipelines require at least 24 hours in order to stabilize. Only after this time has passed it is possible to go on to the next inspection steps.

Step 2 – pressure drop testing

Testing of the pressure drop allows determining the air volume left in the pipeline.
If there is some air in the inspected section, it can lead to the erroneous result related to possible leakage or, in many cases, hide a small leak. If there is some air in the system, accuracy of the pressure testing and water loss testing decreases.
The design engineer has to indicate if pressure drop testing can be performed.

Step 3 – main pressure testing

General conditions

Main pressure testing cannot be started before preparation for inspection was performed and successfully completed and, if it is indicated, after pressure drop testing was performed and successfully completed.
It is necessary to consider possible changes due to high temperature.

Two main pressure testing methods are approved:
1. water loss method;
2. pressure drop method.

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Water Loss Method

According to the description of procedures presented below, it is allowed to use two equivalent water loss methods – measuring of volume of water flowing out or measuring of volume of water pumping in.

a) Measuring of Volume of Water Flowing Out

- Evenly increase pressure till system test pressure (STP) is reached, then keep it constant for at least one hour.
- Disconnect the pump. It is not allowed to fill in the system during inspection.
- At completion of the testing period measure reached pressure. Then restore STP and measure losses, pumping water out, till pressure drop determined at the end of the testing is reached again.

b) Measuring of Volume of Water Pumping In

- Evenly increase pressure till system test pressure (STP) is reached.
- Keep system test pressure (STP) constant for at least one hour or longer if it is indicated by the design engineer.
- During testing using any of the applicable testing tool measure water amount necessary to be pumped in for maintaining system test pressure (STP). Record measuring results.

The design engineer has to indicate which method is to be used.

Measured water loss at the end of the first few hours of testing cannot exceed value, calculated by means of the following formula:

$$\Delta Vmax = 1.2 \cdot V \cdot \Delta p \cdot \left(\frac{1}{Ew} + \frac{ID}{e \cdot Er} \right), \text{ where}$$

ΔV_{max} – allowed water loss, [l];
V – volume of the inspected pipeline, [l];
Δp – allowed pressure drop, [kPa];
Ew – volume elasticity modulus for water, [kPa];
ID – pipe inner diameter, [m];
e – pipe wall thickness, [m].
Er – pipe wall elasticity modulus in the direction of perimeter, [kPa];
1.2 – allowance factor (e.g. air content) during main testing.

Volume elasticity modulus for water (Ew) is 2200000 kPa, but this value can increase due to high water temperature. EVO SCGR ULTRASTRESS and EVOAQUA pipes wall elasticity modulus in the direction of perimeter (Er) is 1200000 kPa.

In order to simplify calculations, pressure influence factor is calculated:

$$K = \left(\frac{1}{Ew} + \frac{ID}{e \cdot Er} \right), \text{ where}$$

K – pressure influence factor, [kPa];
Ew – volume elasticity modulus for water, [kPa];
ID – pipe inner diameter, [m];
e – pipe wall thickness, [m].
Er – pipe wall elasticity modulus in the direction of perimeter, [kPa];

Pressure influence factor **(K)** depending on the pipe **SDR** is presented in Table 30.

Table 30

For EVO ULTRASTRESS and EVOAQUA pipes	SDR11	SDR13.6	SDR17	SDR21
K, [kPa]	0.000008	0.000010	0.000013	0.000016

*Denomination used in the table: **SDR** – standard dimension ratio.*

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Then allowed water loss **(ΔVmax)** can be calculated by means of the following formula:

$$\Delta Vmax = 1.2 \cdot V \cdot \Delta p \cdot K$$ **, where**

ΔV_{max} – allowed water loss, [l];
V – volume of the inspected pipeline, [l];
K – pressure influence factor, [kPa];
Δp – measured pressure drop, [kPa];
1.2 – allowance factor (e.g. air content) prior to main testing.

In order to interpret the results it is important to use an accurate **Er** value, taking into account temperature and testing duration. **Δp** and **ΔV** should be especially accurately and carefully measured for pipes with smaller diameter and in case of shorter testing duration. If **ΔV** value exceeds **ΔV_{max}**, halt testing, relief pressure and again ventilate the pipeline.

Water volume in the pipe depending on the pipe section length can be calculated by means of the following formula:

$$V = \frac{\pi \cdot ID^2}{4} \cdot L \cdot 10^{-6}$$ **, where**

V – pipe volume capacity for 1 m, [l/m];
π – mathematical constant (π = 3.14), (without unit of measure);
ID – pipe inner diameter, [mm];
L – pipe section length, [mm].

Water volume **(V)** in the pipe for one metre long pipe section depending in the pipe **SDR** is presented in Table 31.

Table 31

DN/OD, [mm]	SDR11	SDR13.6	SDR17	SDR21
	V, [l/m]	V, [l/m]	V, [l/m]	V, [l/m]
20	0.20	0.21	-	-
25	0.33	0.35	0.36	-
32	0.53	0.58	0.62	-
40	0.83	0.91	0.97	1.02
50	1.31	1.43	1.52	1.60
63	2.07	2.26	2.41	2.55
75	2.96	3.20	3.42	3.61
90	4.25	4.61	4.93	5.20
110	6.36	6.91	7.36	7.76
125	8.20	8.92	9.54	10.03
140	10.31	11.20	11.96	12.59
160	13.44	14.61	15.61	16.42
180	17.02	18.48	19.76	20.82
200	21.02	22.86	24.38	25.67
225	26.59	28.89	30.85	32.49
250	32.88	35.70	38.15	40.19
280	41.26	44.79	47.84	50.35
315	52.20	56.66	60.52	63.79
355	66.33	72.01	76.85	81.03
400	84.19	91.43	97.65	102.81
450	106.48	115.69	123.54	130.10
500	131.51	142.80	152.47	160.60
560	165.04	179.15	191.36	201.57
630	208.79	226.82	242.10	255.18

*Denomination used in the table: **DN/OD** – pipe nominal/outside diameter, [mm], **V** – water volume in the pipe for one metre long pipe section, [l/m], **SDR** – standard dimension ratio.*

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Pressure Drop Method

Evenly increase pressure till system test pressure (STP) is reached.

Pressure drop testing period is at least one hour or longer if it is indicated by the design engineer. During main testing pressure drop **Δp** should demonstrate regressive tendency and after first hours of testing it cannot exceed 20 kPa.

Hydraulic tests of pressure pipe systems EVO SCGR ULTRASTRESS and EVOAQUA should be performed according to requirements of EN 805:2000 standard, that are set in the article A.27 of the standard and are applied to elastic, viscous materials, such, as polyethylene and polypropylene. This method takes into account the material's expanding characteristics. Due to this reason a special procedure for its testing is described. The whole procedure includes preparation phase, including resting period, pressure drop testing being part of the inspection and main testing phase.

Hydraulic testing procedure for EVO SCGR ULTRASTRESS and EVOAQUA pipelines

1. Preparation Phase

Preparation phase is meant for:
- performing of the major time-consuming activities, stabilization of the inspected pipeline section;
- before main testing to reach pressure dependant volume increase in elastic pipes.

Operating pressure (OP) of the water supply system is used at the preparation phase. It cannot exceed test pressure (STP) of the water supply system.

Preparation phase for pipes made of polyethylene material lasts for 24 hours.
Pipeline is filled with water and deaerated. Then, pressure in the pipeline is increased up to value that is not lower than operating pressure (OP) of the water supply system, and not higher than test pressure (STP) of the water supply system. After these values are reached, pipeline is left for at least 24 hours. After 24 hours pressure testing is resumed.

2. Base Pressure Testing According to Pressure Drop Method

Inspection Procedure

The whole testing procedure includes:
2.1. Preparation phase, including resting period;
2.2. Pressure drop testing being part of the inspection and main testing phase.

Main task of the preparation phase is to provide preconditions for volume changes depending on pressure, time and temperature.

2.1. Preparation Phase, Including Resting Period
In order to avoid erroneous results at the base testing phase, it is necessary to perform the following actions during the preparation phase:

2.1.1. After pipeline rinsing and ventilation pressure can be decreased up to atmospheric pressure. Let the pipeline rest for 60 minutes in order to prevent any stresses created by pressure. It is necessary to avoid air penetration into the inspected pipeline section;

2.1.2. After resting period it is necessary to continuously and quickly increase pressure (faster than in 10 minutes) till test pressure (STP) is reached. After reaching test pressure (STP), it is foreseen, that pressure in the pipeline will drop due to elastic viscous properties of the pipes (pipe expansion). During the next 30 minutes it is necessary to maintain test pressure (STP) in the pipeline, injecting additional water into it from time to time. During this stage it is necessary to inspect pipe for possible leakage;

Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

2.1.3. After actions (during 30 minutes) stated in the point 2.1.2., it is necessary to stop filling of the pipeline and leave it with test pressure (STP) for 60 minutes in order the pipeline can stabilize. Due to viscous properties of the pipes they can stretch and their diameter can enlarge. At the end of this period (60 minutes) remaining pressure in the pipeline (P) is measured. Duration of the preparation phase is 90 minutes. Preparation phase is completed if finally measured actual pressure (P) does not exceed < 20% of the test pressure (STP) ***"P < 20% STP".***

If the preparation phase is successfully completed, the main pressure drop testing is performed.

2.2. Main testing phase (In order to begin main testing, the preparation phase is successfully completed).
Extension and stress of the elastic viscous material induced by test pressure (STP) are stopped by the pressure drop testing. At the end of the preparation phase, pressure is quickly decreased by 30% of the test pressure (STP). Rapid pressure decrease leads to compression of the pipeline.

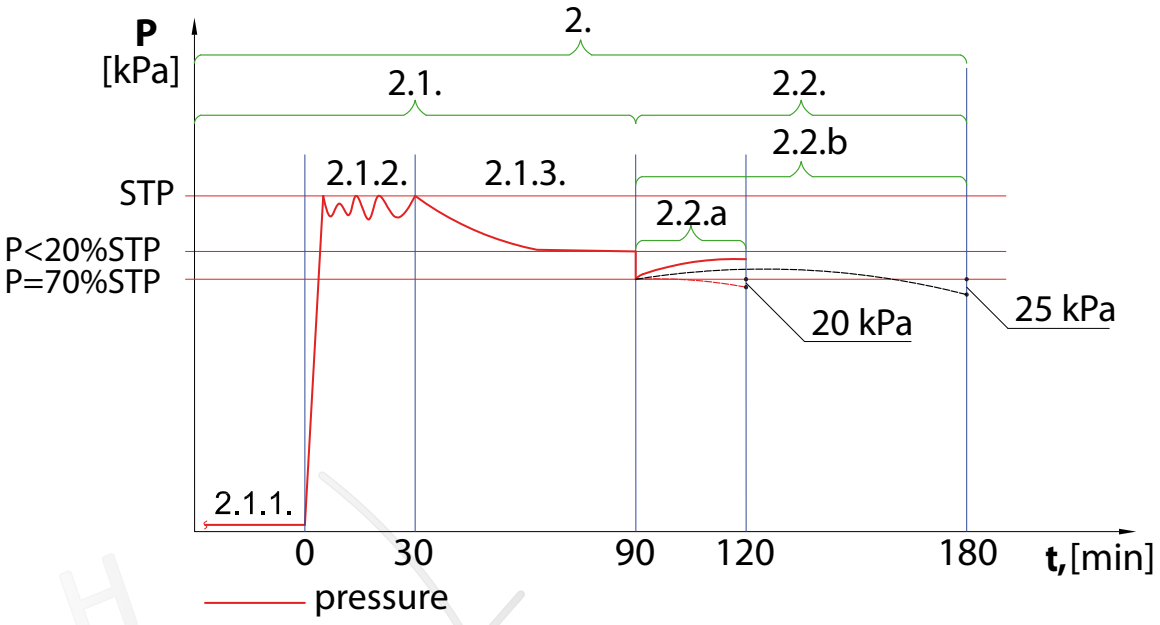
2.2.a After that 30 minutes are intended for supervision and recording of pressure values (P). Testing is successful, if pressure does not drop by more than 20 kPa, or pressure is constant, or increases.

2.2.b If there are any doubts, the main testing phase is extended to 90 minutes. In this case pressure drop cannot exceed 25 kPa.

The procedure described in the point 2 can be represented in diagram form (see Figure 4).

Diagram of hydraulic testing for EVO SCGR ULTRASTRESS and EVOAQUA pipes

Figure 4



Hydraulic Tests of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Diagram Interpretation:

This diagram reflects base pressure testing described in point 2.
According to point 2.1.1., the pipeline is left for resting during 60 minutes.
After 60 minutes resting period (point 2.1.1.) and adding extra 90 minutes the pressure testing is performed (point 2.1.) that is divided into two steps:

1. From minute 0 to minute 30 as described in point 2.1.2. The test pressure (STP) is reached and maintained for 30 minutes.
2. From minute 30 to minute 90 as described in point 2.1.3. The pipeline is left for one hour with test pressure (STP) and the actual final pressure (P) is determined at the 90th minute. It should correspond to the following condition: P > 20% STP. If this condition is hold true it is allowed to continue testing and proceed to the main pressure testing.

From minute 90 to minute 120 the main pressure testing is performed (point 2.2.). If there are any doubts, the testing period is extended to 180 minutes.

3. At the 90th minute pressure (P) is quickly decreased to the value corresponding to 70% of the test pressure (STP) of the water supply system. From minute 90 to minute 120 the main pressure testing is performed (point 2.2.a). If there are any doubts, the testing period is extended to 180 minutes (point 2.2.b).

If during testing pressure increases, it can be explained by the fact, that due to decreasing pressure in the pipeline the pipe compresses that leads to increase of pressure in the pipeline. In the longer term, if the pipeline works with stable operating pressure (OP), there should not be any size changes of the pipe noted.

If the preparation phase has been successfully completed, the testing can be continued. If pressure drops by more than 30% of STP, stop preparation phase and decrease pressure, discharging water from the inspected section. Check and adjust testing conditions (e.g. temperature influence, signs of leakage). Restore testing only after at least 60 minutes of resting period.

Evaluation of Test Results

If the specified pressure drop is exceeded or if there are failures found, the system should be inspected and, where it is necessary – corrected. Testing is repeated until the desired pressure drop is achieved.

Final System Inspection

When the whole pipeline during pressure testing is divided into two sections or more, all the sections are tested, and the results are satisfactory, if it is indicated by the design engineer, the whole system at least during 2 hours should maintain operating pressure. Any additional parts, that are added to the adjusted lines after pressure testing should be inspected for presence of leakages, as well as creation of changes in water supply pipelines and at all the levels.

Recording of Test Results

It is necessary to record all the data about tests. These records should be stored in a safe place. The Act is made about the final pipeline inspection.

Disinfection of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

General Conditions

After complete or partial construction of the water supply system, or replacement of a section of the water supply system, the disinfection of the pipelines and servicing equipment should be performed, including by means of disinfectants.
Water, used for this operations should be of drinking water quality. It is necessary to provide such conditions, that it will be possible to conveniently deliver water necessary for rinsing and disinfection, as well as safely discharge this water after using.

Preparation for Disinfection

General Requirements

If it is necessary, the pipeline system is divided into sections. The disinfected pipeline section is separated from the already used parts of the water supply system. In special cases, especially in case of small pipeline sections, or in case the pipes diameter is ≤ 80 mm and their length does not exceed 100 m, if it is not otherwise stated by the design engineer, it is allowed not to divide the pipeline into sections. In this case a great care should be taken in order to prevent water from the disinfected section penetrating into used sections.

Disinfection Equipment

All the equipment used for disinfection should be acceptable for water treatment.

Disinfectant Choice

The used disinfectant should correspond to the applicable EU Directive or EFTA regulations being in force, as well as local state laws and regulations.

It is recommended to use following disinfectants:

- chlorine gas (Cl_2);
- sodium hypochloride (NaClO);
- calcium hypochloride ($Ca(ClO)_2$);
- potassium permanganate ($KMnO_4$);
- hydrogen peroxide (H_2O_2);
- chlorine dioxide (ClO_2).

Storage, handling and use of these disinfectants can be dangerous. Manufacturer's instructions should be observed.
Disinfectants should be chosen observing such factors as their expiration date and ease of use (possibility of harm for operators and environment). Except for these factors, choice should be made considering necessary contact time and water quality considerations, e.g. pH value and, in case of calcium hypochloride, water hardness.
Every chemical used for disinfection of the water supply system should correspond to the requirements of the state standards, set for chemicals designated for water treatment.
Recommendations for disinfectant choice, maximum concentration, use limitations and neutralizers are presented in Table 32.

Table 32

Disinfectant (solution)	Recommended maximum concentration, [mg/l]	Neutralizers
chlorine gas Cl_2	50 (Cl)	Sulphur dioxide (SO_2) Sodium thiosulfate ($Na_2S_2O_3$)
sodium hypochloride NaClO	50 (Cl)	Sulphur dioxide (SO_2) Sodium thiosulfate ($Na_2S_2O_3$)
calcium hypochloride $Ca(ClO)_2$	50 (Cl)	Sulphur dioxide (SO_2) Sodium thiosulfate ($Na_2S_2O_3$)
potassium permanganate $KMnO_4$	50 ($KMnO_4$)	Sulphur dioxide (SO_2) Sodium thiosulfate ($Na_2S_2O_3$) Ferric sulphate ($FeSO_4$)
hydrogen peroxide H_2O_2	150 (H_2O_2)	Sodium thiosulfate ($Na_2S_2O_3$) Sodium sulphite (Na_2SO_3) Calcium sulphite ($CaSO_3$)
chlorine dioxide ClO_2	50 (Cl)	Sodium thiosulfate ($Na_2S_2O_3$)

Disinfection of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA according to requirements of EN 805

Disinfection Procedure

General Requirements

It is allowed to use following disinfection methods:

- rinsing, using drinking water without any added disinfectant or without air injection;
- static procedure, using drinking water with some added disinfectant;
- dynamic procedure, using drinking water with some disinfectant.

The design engineer has to indicate minimum contact time, considering diameter, material, length and conditions of installation of the disinfected section.
It should be provided that drinking water with added disinfectant does not penetrate into the used water supply system.

Rinsing Procedure

Rising is performed by means of the drinking water. The design engineer has to indicate water flow rate, minimum time of rinsing and necessity of air injection.

Static Procedure

Disinfection is performed by means of filling the whole pipeline section with disinfectant. The design engineer has to indicate disinfectant concentration and minimum contact time.
If it is indicated by the design engineer, disinfection performed by means of the static procedure is competed with main pressure testing. In this case the disinfected section should be physically separated from the used water supply system. Using this procedure, the design engineer should deliberately evaluate any possible harm to the environment in case of disinfectant leakage.

Dynamic Procedure

Disinfection is performed by means of discharging disinfectant along all the pipeline sections. The design engineer has to indicate amount and concentration of the disinfectant, as well as disinfectant flow rate.

Microbiological Purity and Reports

After contact period of the disinfection, the section should be rinsed as long as it is necessary to guarantee that concentration of the remaining disinfectant in the pipeline does not exceed concentration set in the EU Directives and EFTA requirements being in force. Disinfectant should be disposed of in an environmentally friendly way. If it is necessary, a neutralizer should be used (see Table 32).
When the system is filled with drinking water, a specimen should be taken in the places and intervals indicated by the design engineer according to the hygiene regulations being in force. These specimen should be analysed in order to determine correspondence to the microbiological indices. If it is not otherwise stated, sampling and analysis are not necessary during repair works of short sections of the pipeline of any diameter or in case the pipes diameter is ≤ 80 mm.
If results of the testing are satisfactory, in order to avoid repeated contamination it is necessary as soon as possible to connect sections to the water supply system.
If results of the testing are not satisfactory, prior to renewal of the pipeline's work, it is necessary to perform disinfection from the beginning till microbiological purity is reached.
All the testing procedures and results should be documented. These records should be stored in a safe place.

Additional Requirements

The following additional requirements should be observed:

- records of the successfully completed pressure testing;
- records and approvals of microbiological purity;
- records about systems constructed from the ground up and their location, indicating data about all the important parameters;
- inspection of functions of all the valves, including hydrants;
- data plates installation if it is foreseen by the holder of the water supply network, indicating all the necessary parameters (e.g. diameter, sizes, distances);
- if it is foreseen by the holder of the water supply network, manual with data about work of the system, e.g.:
    1. instructions about system operation, maintenance and parts functions inspections;
    2. measurements for avoidance of freezing;
    3. measurements for avoidance of corrosion and contamination;
    4. measurements of the pipes, where insufficient flow can be determined for avoidance of water stagnation.

Exploitation of Pressure Pipe Systems EVO SCGR ULTRASTRESS and EVOAQUA

Inspections and Monitoring

In order to decrease number of problems of water supply and harmful influence on the environment and people's health, water supply systems are subject to inspection and monitoring in order to determine damage or leakage in pipes or other system components. The monitoring includes flow and pressure measurements, service level and other necessary for operation information. Depending on the local conditions, it is allowed to use manual or automated methods.

Inspection of the water supply system includes:

- determination of damages and leakages;
- adherence to functional and hygienic requirements in order to guarantee correct work of valves and other devices, including hydrants.

Frequency and type of monitoring and inspections is mostly determined by the local conditions, but in any case the following factors are taken into account:

- functions and value of the pipelines and other parts;
- total amount of water loss;
- water quality, pressure, flow;
- transport load, soil quality, influence of external forces;
- material of pipes, fittings and other parts.

Service and Maintenance

There should be everyday, preventive and service programmes used for such parts as pumps, valves and electrical equipment. Planned future service, replacement and repair should correspond to the European, state and local requirements.

Update of Documents

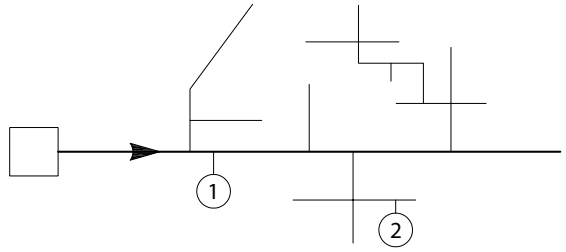
It is necessary to constantly update data on all the newly constructed objects and their location, e.g. valves and hydrants. If it is necessary, the new supplying pipes should also be stated in the documents.

Section 9

Hydraulic Calculations of the Systems EVO SCGR ULTRASTRESS and EVOAQUA

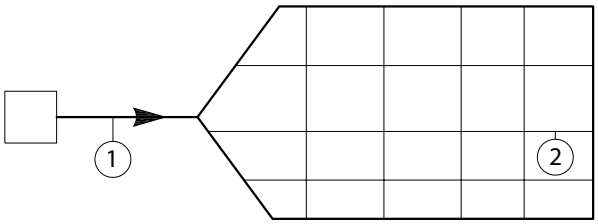
A water supply network – connected with each other pipelines and corresponding armature used to supply consumers with water delivering it from acquisition place or quality improvement systems. Network consists of water inlets, main pipes and distributing pipes.
Water inlets are used to transport water from acquisition to consumption places. In the highest points of the water inlets air discharge valves are installed in order to take in and discharge air, but in the lowest points – valves for water discharge from the sections, as well as decrease of hydraulic impact, etc. Main pipes are used for delivery of water to the large consumers and distributing pipelines. Main pipes determine direction of the main water flows. Distributing pipes deliver water to the consumers. Depending on the formation there are three types of water supply networks distinguished – individual branch mains network, ring mains network and combined.

Types of the water-supply networks



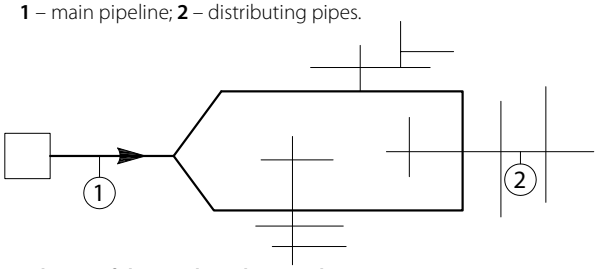
Scheme of the individual branch mains network
1 – main pipeline; **2** – distributing pipes.

Individual branch mains network consists of the main pipe, to which distributing pipelines with dead ends are connected. Such network cannot provide continuous water supply, as closing of any system section in case of any repair works or failure will lead to absence of water in every succeeding sections.



Scheme of the ring mains network
1 – main pipeline; **2** – distributing pipes.

Ring mains network includes closed pipes, that are created by means of connection of main pipes and distributing pipes with each other. If any of the sections is closed, the water will flow in the other line of the network. The loop-shaped network partially paralyses hydraulic impact. Water in the pipelines flows independent of the consumption place, so, if to compare with the individual branch network the possibility of freezing is decreased. Besides ring mains networks can be easily enlarged.



Scheme of the combined network
1 – main pipeline; **2** – distributing pipes.

Combined network (ring mains with individual branch mains) is formed in order to deliver water to the remote districts of the populated areas and several separately located consumers. Later the dead ends can be connected together, creating loops.

Calculations for the Water-Supply Pipeline

Calculations for household and industrial water-supply networks are made for higher water consumption. Water supply networks foreseen also for fire-fighting are inspected for total consumption for fire-fighting and household needs or production and, in case of necessity, change prior determined diameters of the pipelines. Usually calculations are performed for main pipes, but distributing pipelines diameter is accepted without any calculations.

Determination of the Pipe Diameter

Diameter for the pipeline sections is determined on the basis of the calculated water consumption.

$$ID = \sqrt{\frac{4 \cdot Q_{calc}}{\pi \cdot v}}$$, where

ID – pipe inner diameter, [m];
$\mathbf{Q_{calc}}$ – calculated consumption, [m³/s];
π - mathematical constant (π = 3.14), (without unit of measure);
v – flow rate, [m/s].

Hydraulic Calculations of the Systems EVO SCGR ULTRASTRESS and EVOAQUA

According to EN 805 recommended minimum pipe diameters for water supply for small residential estate is:

DN, [mm]	Habitancy
50[a]	30
80	100
100	250

a - at condition, that pipeline length does not exceed 100 m;
DN – pipe nominal diameter, mm.

Note:
If water consumption is foreseen for production needs and number of inhabitants is more than 250, it is obligatory to perform hydraulic calculations to determine pipeline network diameter.

Flow volume or flow passage in a round pipe can be calculated by means of the following formula:

$$Q = \frac{\pi \cdot ID^2 \cdot v}{4}$$ **, where**

Q – flow passage, [m³/s];
π - mathematical constant (π = 3.14);
ID – pipe inner diameter, [m];
v – flow rate, [m/s].

$$v = \frac{4 \cdot Q}{\pi \cdot ID^2}$$ **, where**

By decreasing flow rate it is necessary to increase pipes diameter, that leads to increase of costs, deductions for repair works and amortization of investments. By increasing flow rate it is possible to decrease pipes diameter, that leads to decrease of deductions for amortization, but increase of pressure loss in the pipe, pump lifting height, energy consumption and operational costs.

Economical pipe diameter – is a diameter at which the sum of deductions and operational costs is the lowest. Performing hydraulic calculations in the water supply networks according to EN 805, the recommended rates are:
- from 0.5 m/s to 2.0 m/s;
- In special cases 3.5 m/s is possible.

Performing hydraulic calculations for main pipelines flow rate can be from 0.8 m/s to 1.4 m/s.

Determination of pressure drop in the pipeline sections according to the EN 805 requirements

Pressure drop due to friction can be determined using Darcy-Weisbach formula (if we know friction resistance coefficient, that is determined depending on Reynolds number and permissible error).

Pressure drop **(Hr)** in the pipeline section for friction overcoming is calculated by means of Darcy-Weisbach formula:

$$Hr = \lambda \cdot \frac{L}{ID} \cdot \frac{v^2}{2 \cdot g}$$ **, where**

Hr – frictional pressure drop, [m/m];
λ – friction resistance coefficient, (without unit of measure);
L – length of the section, [m];
ID – pipe inner diameter, [m];
v – flow velocity, [m/s];
g – gravity acceleration (free-fall), (g = 9.81 [m/s²]).

or by means of the following formula:

$$\Delta P = \lambda \cdot \frac{L}{ID} \cdot \frac{\rho}{2} \cdot v^2$$ **, where**

ΔP – frictional pressure drop, [Pa/m];
λ – friction resistance coefficient, (without unit of measure);
L – length of the section, [m];
ID –pipe inner diameter, [m];
v – flow velocity, [m/s];
ρ – unit mass of water, [kg/m3].

100 kPa=1 bar =1 atm =10 m water column

Hydraulic Calculations of the Systems EVO SCGR ULTRASTRESS and EVOAQUA

Friction resistance coefficient depends on the pipe material, wall rigidity, diameter and flow rate. Friction coefficient can be calculated by means of Colebrook-White formula:

$$\frac{1}{\sqrt{\lambda}} = -2 \cdot \log_{10} \cdot \left(\frac{2.51}{Re \cdot \sqrt{\lambda}} + \frac{k}{3.71 \cdot ID} \right)$$ **, where**

λ – friction resistance coefficient, (without unit of measure);
Re – Reynolds number, (without unit of measure);
k – pipe rigidity coefficient, [m];
ID – pipe inner diameter, [m].

Note:
In other areas this formula can be applied observing the following condition (0.55 x 106 ≤ Re ≤ 107)

Reynolds number can be calculated by means of the following formula:

$$Re = \frac{v \cdot ID}{\gamma}$$ **, where**

Re – Reynolds number, (without unit of measure);
v – flow rate, [m/s];
γ – coefficient of kinematic viscosity of matter, [m²/s].

Recommended roughness (k) coefficients for EVO SCGR ULTRASTRESS and EVOAQUA pipes are
- ***k=0.01 mm (for pipes with ID ≤ 200 mm);***
- ***k=0.05 mm (for pipes with ID > 200 mm).***

For pipes made of other material roughness coefficient **(k)** values are presented in Table 33.

Table 33

Material	Roughness coefficient, k [mm]
New smooth asbestos-cement pipe	0.02
New steel pipe	0.05
New reinforced concrete pipe	0.05
New galvanized steel pipe	0.10
New clay pipe	0.20
New cast-iron pipe with concrete coating	0.50
New smooth concrete pipe	0.50

Pressure drop in the water supply network for overcoming of local resistance is rather small and it is not taken into account. If the pipeline sections are short and include a lot of fittings, frictional pressure drop in the pipeline section increases for 5 ÷ 10% (in special cases up to 30%).

In case if it is necessary for the project to calculate pressure drop for several network elements (nodes), this can be done by means of the following formula:

$$\Delta h = \varsigma \cdot \frac{v^2}{2 \cdot g}$$ **, where**

Δh – local pressure drop, [m];
ς – local resistance coefficient, (without unit of measure);
v – flow rate, [m/s];
g – gravitational acceleration (free-fall), (g = 9.81 [m/s²]).

Hydraulic Calculations of the Systems EVO SCGR ULTRASTRESS and EVOAQUA

Hydraulic Impact

Any change of the flow rate in the network can lead to pressure change in the pipeline. In case of rapid flow rate changes in the pipeline so called "hydraulic impact" appears. Oscillation amplitude and distribution intensity depend on the liquid's ability to compress and pipe walls elasticity. Hydraulic impact appears in the pressure pipes in case of rapid closing or opening of fasteners, as well as at the moment of pump's switching on and off.
It is rather difficult to calculate hydraulic impact force. Methodology of calculation is available in the specialized literature. In order to calculate this phenomenon, nowadays usually different specific computer software is used.
In relation to EVO SCGR ULTRASTRESS and EVOAQUA pipes capability to withstand hydraulic impact, the following information should be highlighted:

1. Hydraulic impact propagation rate in EVO SCGR ULTRASTRESS and EVOAQUA pipes if to compare with cast-iron or steel pipes is rather low. Hydraulic impact propagation rate in EVO SCGR ULTRASTRESS and EVOAQUA pipes is from 250 to 450 m/s, but in cast-iron and steel pipes from 1000 m/s. The hydraulic impact value is directly-proportional to the impact wave propagation rate, that also explains the fact why hydraulic impact in EVO SCGR ULTRASTRESS and EVOAQUA pipes is lower than in similar pipes made of cast-iron and steel.
2. Short-term strength of EVO SCGR ULTRASTRESS and EVOAQUA pipes often is almost four times greater than it is indicated for this class of pipes. Thus, EVO SCGR ULTRASTRESS and EVOAQUA pipes can withstand much larger short-time loads than it is indicated in the classification without risk of severe damage. It is generally supposed, that there is no need for hydraulic impact calculations for plastic pipes, if maximum pressure in the pipeline at the time of hydraulic impact does not exceed 1.5xPN of the pipe pressure class and hydraulic impacts number during the whole pipeline service life does not exceed 10^7 times.

Vacuum

During hydraulic impact due to pressure changes in the pipeline the negative pressure can appear. If negative pressure is rather large (about 10 m water column), homogeneous liquid flow in the pipeline is halted and vacuum is created. Calculation for the pressure pipes should be performed in such a way that negative pressure does not reach value at which vacuum appears.

Necessary Pressure in the Water-Supply Networks

During hours of maximum water consumption minimum water pressure in the water-supply network of the populated areas (at entrance to the building at land surface level) for a one-story building should be 0.1 MPa. For multi-storey buildings water pressure is increased by 0.04 MPa for every floor. During hours of minimum water consumption water pressure has to be 0.03 MPa for every floor, except for the first floor. Pressure in the network at stand pipes should be 0.1 MPa. Pressure in the water supply networks for delivery of drinking water for consumers should not exceed 0.6 MPa.

Unit of Measure used in Pressure Measuring

In practice there are different unit of measure used in pressure measuring. In most cases it is enough to know the following relation:

1 bar = 1 kg/cm² } = 100 kPa = 0.1 MPa = 10 m H_2O column = 100 kN/m² = 0.1 N/mm²
For exact calculations the following units are used: 1 bar = 1.0197 kg/cm²

Bar kg/cm²	m H_2O column	kPa kN/m²	MPa N/mm²
0	0	0	0
1	10	100	0.1
2	20	200	0.2
3	30	300	0.3
4	40	400	0.4
5	50	500	0.5
6	60	600	0.6
7	70	700	0.7
8	80	800	0.8
9	90	900	0.9
10	100	1000	1.0

Hydraulic Calculations of the Systems EVO SCGR ULTRASTRESS and EVOAQUA

Relation of pressure and head pressure units of measure is presented in Table 34.

Table 34

	Pa (N/m²)	bar	Atm	mm Hg	mm H_2O	m H_2O	kg/cm²
Pa (N/m^2)	1	10^{-5}	9.87×10^{-6}	0.0075	0.1	10^{-4}	1.02×10^{-5}
bar	10^5	1	0.987	750	1.0197×10^4	10.197	1.0197
Atm	1.01×10^5	1.013	1	759.9	10332	10.332	1.03
mm Hg	133.3	1.33×10^{-3}	1.32×10^{-3}	1	13.3	0.013	1.36×10^{-3}
mm H_2O	10	0.000097	9.87×10^{-5}	0.075	1	0.001	1.02×10^{-4}
m H_2O	10^4	0.097	9.87×10^{-2}	75	1000	1	0.102
kg/cm²	9.8×10^4	0.98	0.97	735	10000	10	1

Name of the unit of measure	Denomination
Pascal	Pa
Bar	bar
Physical atmosphere	Atm
Technical atmosphere	at
Water column metre	m H_2O
Millimetre of mercury column	mm Hg
Water column millimetre	mm H_2O

Decimal multipliers of the measuring units

Name	Denomination	Multipliers
giga	G	10^9
mega	M	10^6
kilo	k	10^3
hecto	h	10^2
deci	d	10^{-1}
centi	c	10^{-2}
mili	m	10^{-3}
micro	m	10^{-6}
nano	n	10^{-9}

Appendix

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 11 and Pressure Class PN 16 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. to *Darcy-Weisbach and Colebrook-White equations*) for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 11** and pressure class **PN 16 bar**. Calculations are performed with permissible error **k=0.01 mm** (for pipes with **ID ≤ 200 mm**) and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m^2/s)																		
DN/ODxe	20x2.0 mm			25x2.3 mm			32x3.0 mm			40x3.7 mm			50x4.6 mm			63x5.8 mm		
ID	16.0 mm			20.4 mm			26.0 mm			32.6 mm			40.8 mm			51.4 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,02	1,9	18,3	0,03	1,3	13,2	0,05	1,0	9,6	0,08	0,7	7,1	0,13	0,5	5,3	0,21	0,4	3,9
0,15	0,03	3,7	36,1	0,05	2,7	26,1	0,08	1,9	19,0	0,13	1,4	14,2	0,20	1,1	10,6	0,31	0,8	7,9
0,20	0,04	6,0	58,6	0,07	4,3	42,6	0,11	3,2	31,0	0,17	2,4	23,2	0,26	1,8	17,4	0,41	1,3	12,9
0,25	0,05	8,7	85,6	0,08	6,4	62,3	0,13	4,6	45,5	0,21	3,5	34,0	0,33	2,6	25,5	0,52	1,9	19,0
0,30	0,06	11,9	116,8	0,10	8,7	85,2	0,16	6,4	62,3	0,25	4,8	46,7	0,39	3,6	35,1	0,62	2,7	26,2
0,35	0,07	15,5	152,2	0,11	11,3	111,2	0,19	8,3	81,4	0,29	6,2	61,0	0,46	4,7	45,9	0,73	3,5	34,3
0,40	0,08	19,5	191,5	0,13	14,3	140,0	0,21	10,5	102,7	0,33	7,8	77,0	0,52	5,9	58,0	0,83	4,4	43,3
0,45	0,09	23,9	234,7	0,15	17,5	171,8	0,24	12,9	126,0	0,38	9,6	94,6	0,59	7,3	71,3	0,93	5,4	53,3
0,50	0,10	28,7	281,7	0,16	21,0	206,3	0,27	15,4	151,5	0,42	11,6	113,8	0,65	8,7	85,8	1,04	6,5	64,2
0,55	0,11	33,9	332,4	0,18	24,8	243,6	0,29	18,3	179,0	0,46	13,7	134,5	0,72	10,3	101,4	1,14	7,7	76,0
0,60	0,12	39,4	386,8	0,20	28,9	283,7	0,32	21,3	208,5	0,50	16,0	156,8	0,78	12,1	118,3	1,24	9,0	88,7
0,65	0,13	45,4	444,8	0,21	33,3	326,3	0,35	24,5	240,0	0,54	18,4	180,5	0,85	13,9	136,3	1,35	10,4	102,2
0,70	0,141	51,6	506,3	0,23	37,9	371,7	0,37	27,9	273,5	0,58	21,0	205,8	0,92	15,8	155,4	1,45	11,9	116,6
0,72	0,145	54,2	531,9	0,24	39,8	390,5	0,38	29,3	287,4	0,60	22,1	216,3	0,94	16,7	163,4	1,49	12,5	122,6
0,74	0,149	56,9	558,0	0,24	41,8	409,8	0,39	30,8	301,6	0,62	23,1	227,0	0,97	17,5	171,5	1,54	13,1	128,7
0,76	0,153	59,6	584,7	0,25	43,8	429,5	0,40	32,2	316,2	0,63	24,3	238,0	0,99	18,3	179,8	1,58	13,8	135,0
0,78	0,157	62,4	612,0	0,25	45,8	449,6	0,41	33,8	331,0	0,65	25,4	249,2	1,02	19,2	188,3	1,62	14,4	141,4
0,80	0,161	65,2	639,8	0,26	47,9	470,1	0,42	35,3	346,2	0,67	26,6	260,7	1,05	20,1	197,0	1,66	15,1	147,9
0,82	0,165	68,1	668,2	0,268	50,1	491,0	0,44	36,9	361,6	0,68	27,8	272,3	1,07	21,0	205,8	1,70	15,8	154,5
0,84	0,169	71,1	697,1	0,275	52,2	512,3	0,45	38,5	377,4	0,70	29,0	284,2	1,10	21,9	214,9	1,74	16,5	161,3
0,86	0,173	74,1	726,5	0,28	54,5	534,0	0,46	40,1	393,4	0,72	30,2	296,4	1,12	22,8	224,1	1,78	17,2	168,3
0,88	0,177	77,1	756,5	0,288	56,7	556,1	0,47	41,8	409,8	0,73	31,5	308,7	1,15	23,8	233,4	1,83	17,9	175,3
0,90	0,181	80,3	787,1	0,294	59,0	578,7	0,48	43,5	426,4	0,75	32,8	321,3	1,18	24,8	243,0	1,87	18,6	182,5
0,92	0,185	83,4	818,1	0,30	61,3	601,6	0,49	45,2	443,4	0,77	34,1	334,1	1,20	25,8	252,7	1,91	19,4	189,8
0,94	0,189	86,6	849,7	0,307	63,7	624,9	0,50	47,0	460,6	0,78	35,4	347,1	1,23	26,8	262,6	1,95	20,1	197,3
0,96	0,193	89,9	881,9	0,314	66,1	648,7	0,51	48,8	478,2	0,80	36,7	360,4	1,26	27,8	272,6	1,99	20,9	204,8
0,98	0,197	93,3	914,6	0,32	68,6	672,8	0,52	50,6	496,0	0,82	38,1	373,9	1,28	28,8	282,8	2,03	21,7	212,5
1,00	0,201	96,6	947,8	0,33	71,1	697,3	0,53	52,4	514,2	0,83	39,5	387,6	1,31	29,9	293,2	2,07	22,5	220,4
1,20	0,24	133,5	1308,9	0,39	98,3	963,9	0,64	72,5	711,5	1,00	54,7	536,8	1,57	41,4	406,5	2,49	31,2	305,7
1,40	0,28	175,6	1721,8	0,46	129,4	1269,0	0,74	95,6	937,4	1,17	72,2	707,7	1,83	54,7	536,2	2,90	41,1	403,5
1,60	0,32	222,8	2185,5	0,52	164,3	1611,8	0,85	121,5	1191,3	1,34	91,8	899,9	2,09	69,6	682,2	3,32	52,4	513,7
1,80	0,36	275,2	2699,1	0,59	203,1	1991,7	0,96	150,2	1472,8	1,50	113,5	1113,1	2,35	86,1	844,2	3,73	64,8	635,9
2,00	0,40	332,6	3261,9	0,65	245,5	2408,1	1,06	181,7	1781,5	1,67	137,3	1346,9	2,61	104,2	1022,0	4,15	78,5	770,1
2,20	0,44	395,0	3873,5	0,72	291,7	2860,7	1,17	215,9	2117,2	1,84	163,3	1601,3	2,88	123,9	1215,3	4,56	93,4	916,1
2,40	0,48	462,2	4533,3	0,78	341,5	3349,2	1,27	252,8	2479,5	2,00	191,3	1875,8	3,14	145,2	1424,2	4,98	109,5	1073,9
2,60	0,52	534,4	5240,9	0,85	394,9	3873,1	1,38	292,5	2868,3	2,17	221,3	2170,5	3,40	168,1	1648,3	5,39	126,8	1243,2
2,80	0,56	611,4	5996,1	0,92	451,9	4432,4	1,49	334,8	3283,3	2,34	253,4	2485,2	3,66	192,5	1887,7	5,81	145,2	1424,0
3,00	0,60	693,2	6798,4	0,98	512,5	5026,7	1,59	379,8	3724,4	2,50	287,5	2819,7	3,92	218,4	2142,2	6,22	164,8	1616,3
3,50	0,70	918,6	9009,2	1,14	679,6	6664,7	1,86	503,8	4940,5	2,92	381,5	3741,9	4,58	290,0	2844,0	7,26	218,9	2146,8
4,00	0,80	1173,6	11510,0	1,31	868,6	8518,2	2,12	644,1	6316,9	3,34	488,0	4786,1	5,23	371,0	3638,9	8,30	280,2	2747,7
4,50	0,90	1457,9	14298,5	1,47	1079,3	10585,3	2,39	800,6	7852,2	3,76	606,8	5951,1	5,88	461,5	4525,8	9,34	348,6	3418,4
5,00	1,01	1771,4	17372,6	1,63	1311,7	12864,6	2,65	973,3	9545,5	4,17	737,8	7236,0	6,54	561,2	5504,3	10,37	424,0	4158,4
5,50	1,11	2113,8	20730,8	1,80	1565,6	15354,8	2,92	1161,9	11395,6	4,59	881,0	8640,3	7,19	670,3	6573,7	11,41	506,5	4967,3
6,00	1,21	2485,0	24371,7	1,96	1841,0	18055,0	3,19	1366,5	13402,1	5,01	1036,3	10163,3	7,84	788,6	7733,7	12,45	596,0	5844,7

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 11 and Pressure Class PN 16 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. to *Darcy-Weisbach and Colebrook-White equations*) for **EVO SCGR ULTRASTRESS** (PE100-RC**)** and **EVOAQUA** (PE100) pressure pipes with **SDR 11** and pressure class **PN 16 bar.** Calculations are performed with permissible error **k=0.01 mm** (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	75x6.8 mm			90x8.2 mm			110x10.0 mm			125x11.4 mm			140x12.7 mm			160x14.6 mm		
ID	61.4 mm			73.6 mm			90.0 mm			102.2 mm			114.6 mm			130.8 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,30	0,3	3,1	0,43	0,3	2,5	0,64	0,2	1,9	0,82	0,2	1,6	1,03	0,1	1,4	1,34	0,1	1,2
0,15	0,44	0,6	6,3	0,64	0,5	5,0	0,95	0,4	3,8	1,23	0,3	3,3	1,55	0,3	2,8	2,02	0,2	2,4
0,20	0,59	1,1	10,3	0,85	0,8	8,2	1,27	0,6	6,4	1,64	0,6	5,4	2,06	0,5	4,7	2,69	0,4	4,0
0,25	0,74	1,6	15,2	1,06	1,2	12,1	1,59	1,0	9,4	2,05	0,8	8,0	2,58	0,7	7,0	3,36	0,6	5,9
0,30	0,89	2,1	20,9	1,28	1,7	16,7	1,91	1,3	13,0	2,46	1,1	11,1	3,09	1,0	9,6	4,03	0,8	8,1
0,35	1,04	2,8	27,4	1,49	2,2	21,9	2,23	1,7	17,0	2,87	1,5	14,5	3,61	1,3	12,6	4,70	1,1	10,7
0,40	1,18	3,5	34,7	1,70	2,8	27,7	2,54	2,2	21,6	3,28	1,9	18,4	4,13	1,6	16,0	5,37	1,4	13,6
0,45	1,33	4,4	42,7	1,91	3,5	34,1	2,86	2,7	26,6	3,69	2,3	22,7	4,64	2,0	19,7	6,05	1,7	16,8
0,50	1,48	5,2	51,5	2,13	4,2	41,1	3,18	3,3	32,0	4,10	2,8	27,4	5,16	2,4	23,8	6,72	2,1	20,2
0,55	1,63	6,2	60,9	2,34	5,0	48,7	3,50	3,9	38,0	4,51	3,3	32,5	5,67	2,9	28,2	7,39	2,4	24,0
0,60	1,78	7,2	71,1	2,55	5,8	56,8	3,82	4,5	44,3	4,92	3,9	37,9	6,19	3,4	32,9	8,06	2,9	28,0
0,65	1,92	8,4	82,0	2,77	6,7	65,5	4,14	5,2	51,1	5,33	4,5	43,7	6,70	3,9	38,0	8,73	3,3	32,3
0,70	2,07	9,5	93,5	2,98	7,6	74,8	4,45	6,0	58,4	5,74	5,1	50,0	7,22	4,4	43,4	9,41	3,8	37,0
0,72	2,13	10,0	98,4	3,06	8,0	78,6	4,58	6,3	61,4	5,91	5,4	52,5	7,43	4,7	45,7	9,67	4,0	38,9
0,74	2,19	10,5	103,3	3,15	8,4	82,6	4,71	6,6	64,5	6,07	5,6	55,2	7,63	4,9	48,0	9,94	4,2	40,8
0,76	2,25	11,0	108,3	3,23	8,8	86,6	4,83	6,9	67,7	6,23	5,9	57,9	7,84	5,1	50,3	10,21	4,4	42,8
0,78	2,31	11,6	113,5	3,32	9,3	90,7	4,96	7,2	70,9	6,40	6,2	60,7	8,05	5,4	52,7	10,48	4,6	44,9
0,80	2,37	12,1	118,7	3,40	9,7	94,9	5,09	7,6	74,2	6,56	6,5	63,5	8,25	5,6	55,2	10,75	4,8	47,0
0,82	2,43	12,6	124,1	3,49	10,1	99,2	5,22	7,9	77,5	6,73	6,8	66,4	8,46	5,9	57,7	11,02	5,0	49,1
0,84	2,49	13,2	129,5	3,57	10,6	103,6	5,34	8,3	81,0	6,89	7,1	69,3	8,66	6,1	60,3	11,29	5,2	51,3
0,86	2,55	13,8	135,1	3,66	11,0	108,1	5,47	8,6	84,5	7,05	7,4	72,3	8,87	6,4	62,9	11,56	5,5	53,5
0,88	2,61	14,4	140,8	3,74	11,5	112,6	5,60	9,0	88,0	7,22	7,7	75,4	9,08	6,7	65,5	11,82	5,7	55,8
0,90	2,66	14,9	146,5	3,83	12,0	117,3	5,73	9,3	91,6	7,38	8,0	78,5	9,28	7,0	68,2	12,09	5,9	58,1
0,92	2,72	15,5	152,4	3,91	12,4	122,0	5,85	9,7	95,3	7,55	8,3	81,6	9,49	7,2	71,0	12,36	6,2	60,5
0,94	2,78	16,2	158,4	4,00	12,9	126,8	5,98	10,1	99,1	7,71	8,7	84,9	9,70	7,5	73,8	12,63	6,4	62,9
0,96	2,84	16,8	164,5	4,08	13,4	131,7	6,11	10,5	102,9	7,88	9,0	88,1	9,90	7,8	76,7	12,90	6,7	65,3
0,98	2,90	17,4	170,7	4,17	13,9	136,6	6,23	10,9	106,8	8,04	9,3	91,5	10,11	8,1	79,6	13,17	6,9	67,8
1,00	2,96	18,0	177,0	4,25	14,4	141,7	6,36	11,3	110,8	8,20	9,7	94,9	10,31	8,4	82,5	13,44	7,2	70,3
1,20	3,55	25,1	245,7	5,11	20,1	196,8	7,63	15,7	154,0	9,84	13,4	131,9	12,38	11,7	114,8	16,12	10,0	97,8
1,40	4,15	33,1	324,5	5,96	26,5	260,1	8,91	20,8	203,6	11,48	17,8	174,4	14,44	15,5	151,8	18,81	13,2	129,4
1,60	4,74	42,1	413,3	6,81	33,8	331,3	10,18	26,5	259,4	13,13	22,7	222,4	16,50	19,7	193,6	21,50	16,8	165,1
1,80	5,33	52,2	511,8	7,66	41,8	410,4	11,45	32,8	321,5	14,77	28,1	275,6	18,57	24,5	240,0	24,19	20,9	204,7
2,00	5,92	63,2	619,9	8,51	50,7	497,3	12,72	39,7	389,7	16,41	34,1	334,2	20,63	29,7	291,0	26,87	25,3	248,2
2,20	6,51	75,2	737,7	9,36	60,3	591,9	14,00	47,3	463,9	18,05	40,6	397,9	22,69	35,3	346,6	29,56	30,1	295,6
2,40	7,11	88,2	864,8	10,21	70,8	694,0	15,27	55,5	544,1	19,69	47,6	466,7	24,76	41,5	406,6	32,25	35,4	346,9
2,60	7,70	102,1	1001,4	11,06	82,0	803,8	16,54	64,3	630,3	21,33	55,1	540,7	26,82	48,0	471,1	34,94	41,0	401,9
2,80	8,29	117,0	1147,2	11,91	93,9	921,0	17,81	73,7	722,3	22,97	63,2	619,7	28,88	55,1	540,0	37,62	47,0	460,8
3,00	8,88	132,8	1302,4	12,76	106,6	1045,7	19,09	83,6	820,2	24,61	71,8	703,8	30,94	62,5	613,4	40,31	53,4	523,4
3,50	10,36	176,4	1730,3	14,89	141,7	1389,8	22,27	111,2	1090,5	28,71	95,4	935,9	36,10	83,2	815,8	47,03	71,0	696,3
4,00	11,84	225,9	2215,2	17,02	181,5	1779,6	25,45	142,4	1396,8	32,81	122,3	1199,0	41,26	106,6	1045,2	53,75	91,0	892,3
4,50	13,32	281,1	2756,5	19,15	225,8	2214,9	28,63	177,3	1738,8	36,92	152,2	1492,8	46,42	132,7	1301,5	60,47	113,3	1111,2
5,00	14,80	342,0	3353,7	21,27	274,8	2695,3	31,81	215,8	2116,3	41,02	185,3	1817,1	51,57	161,6	1584,4	67,19	137,9	1352,9
5,50	16,29	408,5	4006,7	23,40	328,4	3220,5	34,99	257,9	2529,1	45,12	221,4	2171,7	56,73	193,1	1893,8	73,90	164,9	1617,2
6,00	17,77	480,8	4715,0	25,53	386,5	3790,3	38,17	303,5	2977,0	49,22	260,7	2556,5	61,89	227,3	2229,5	80,62	194,2	1904,1

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 11 and Pressure Class PN 16 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. to *Darcy-Weisbach and Colebrook-White equations*) for **EVO SCGR ULTRASTRESS** (PE100-RC**)** and **EVOAQUA** (PE100) pressure pipes with **SDR 11** and pressure class **PN 16 bar.** Calculations are performed with permissible error **k=0.01 mm** (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	180x16.4 mm			200x18.2 mm			225x20.5 mm			250x22.7 mm			280x25.4 mm			315x28.6 mm		
ID	147.2 mm			163.6 mm			184.0 mm			204.6 mm			229.2 mm			257.8 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	1,70	0,1	1,0	2,10	0,1	0,9	2,66	0,1	0,8	3,29	0,07	0,7	4,13	0,06	0,6	5,22	0,05	0,5
0,15	2,55	0,2	2,1	3,15	0,2	1,8	3,99	0,2	1,6	4,93	0,14	1,4	6,19	0,12	1,2	7,83	0,11	1,1
0,20	3,40	0,4	3,4	4,20	0,3	3,0	5,32	0,3	2,6	6,58	0,2	2,3	8,25	0,2	2,0	10,44	0,2	1,8
0,25	4,25	0,5	5,1	5,26	0,5	4,5	6,65	0,4	3,9	8,22	0,4	3,5	10,31	0,3	3,0	13,05	0,3	2,6
0,30	5,11	0,7	7,0	6,31	0,6	6,2	7,98	0,5	5,3	9,86	0,5	4,8	12,38	0,4	4,2	15,66	0,4	3,6
0,35	5,96	0,9	9,3	7,36	0,8	8,1	9,31	0,7	7,0	11,51	0,7	6,4	14,44	0,6	5,6	18,27	0,5	4,8
0,40	6,81	1,2	11,7	8,41	1,1	10,3	10,64	0,9	8,9	13,15	0,8	8,1	16,50	0,7	7,1	20,88	0,6	6,1
0,45	7,66	1,5	14,5	9,46	1,3	12,7	11,97	1,1	11,0	14,79	1,0	10,1	18,57	0,9	8,8	23,49	0,8	7,6
0,50	8,51	1,8	17,5	10,51	1,6	15,4	13,30	1,4	13,3	16,44	1,2	12,2	20,63	1,1	10,6	26,10	0,9	9,2
0,55	9,36	2,1	20,8	11,56	1,9	18,2	14,62	1,6	15,8	18,08	1,5	14,6	22,69	1,3	12,7	28,71	1,1	11,0
0,60	10,21	2,5	24,3	12,61	2,2	21,3	15,95	1,9	18,5	19,73	1,7	17,1	24,76	1,5	14,9	31,32	1,3	12,9
0,65	11,06	2,9	28,0	13,66	2,5	24,6	17,28	2,2	21,4	21,37	2,0	19,8	26,82	1,8	17,2	33,93	1,5	14,9
0,70	11,913	3,3	32,0	14,71	2,9	28,1	18,61	2,5	24,4	23,01	2,3	22,7	28,88	2,0	19,7	36,54	1,7	17,1
0,72	12,253	3,4	33,7	15,14	3,0	29,6	19,15	2,6	25,7	23,67	2,4	23,9	29,71	2,1	20,8	37,58	1,8	18,0
0,74	12,593	3,6	35,4	15,56	3,2	31,1	19,68	2,8	27,0	24,33	2,6	25,1	30,53	2,2	21,9	38,63	1,9	19,0
0,76	12,934	3,8	37,1	15,98	3,3	32,6	20,21	2,9	28,3	24,99	2,7	26,4	31,36	2,3	23,0	39,67	2,0	19,9
0,78	13,274	4,0	38,9	16,40	3,5	34,2	20,74	3,0	29,7	25,64	2,8	27,7	32,18	2,5	24,1	40,71	2,1	20,9
0,80	13,614	4,2	40,7	16,82	3,7	35,8	21,27	3,2	31,1	26,30	3,0	29,0	33,01	2,6	25,3	41,76	2,2	21,9
0,82	13,955	4,3	42,6	17,237	3,8	37,4	21,80	3,3	32,5	26,96	3,1	30,4	33,83	2,7	26,4	42,80	2,3	22,9
0,84	14,295	4,5	44,4	17,658	4,0	39,1	22,34	3,5	33,9	27,62	3,2	31,7	34,66	2,8	27,7	43,85	2,4	24,0
0,86	14,635	4,7	46,4	18,08	4,2	40,8	22,87	3,6	35,4	28,27	3,4	33,2	35,48	2,9	28,9	44,89	2,6	25,0
0,88	14,976	4,9	48,3	18,499	4,3	42,5	23,40	3,8	36,9	28,93	3,5	34,6	36,31	3,1	30,1	45,93	2,7	26,1
0,90	15,316	5,1	50,3	18,919	4,5	44,3	23,93	3,9	38,4	29,59	3,7	36,1	37,13	3,2	31,4	46,98	2,8	27,2
0,92	15,656	5,3	52,4	19,34	4,7	46,1	24,46	4,1	40,0	30,25	3,8	37,6	37,96	3,3	32,7	48,02	2,9	28,4
0,94	15,997	5,6	54,5	19,760	4,9	47,9	25,00	4,2	41,6	30,91	4,0	39,1	38,78	3,5	34,1	49,07	3,0	29,5
0,96	16,337	5,8	56,6	20,180	5,1	49,8	25,53	4,4	43,2	31,56	4,1	40,7	39,61	3,6	35,4	50,11	3,1	30,7
0,98	16,678	6,0	58,7	20,60	5,3	51,7	26,06	4,6	44,8	32,22	4,3	42,3	40,43	3,8	36,8	51,15	3,3	31,9
1,00	17,018	6,2	60,9	21,02	5,5	53,6	26,59	4,7	46,5	32,88	4,5	43,9	41,26	3,9	38,2	52,20	3,4	33,1
1,20	20,42	8,6	84,8	25,23	7,6	74,6	31,91	6,6	64,8	39,45	6,3	61,6	49,51	5,5	53,7	62,64	4,7	46,6
1,40	23,83	11,4	112,2	29,43	10,1	98,8	37,23	8,7	85,8	46,03	8,4	82,3	57,76	7,3	71,7	73,08	6,3	62,2
1,60	27,23	14,6	143,2	33,63	12,9	126,1	42,54	11,2	109,5	52,60	10,8	105,8	66,01	9,4	92,2	83,52	8,2	80,0
1,80	30,63	18,1	177,6	37,84	15,9	156,4	47,86	13,9	135,8	59,18	13,5	132,2	74,27	11,7	115,2	93,96	10,2	99,9
2,00	34,04	22,0	215,4	42,04	19,3	189,7	53,18	16,8	164,8	65,76	16,5	161,4	82,52	14,3	140,6	104,40	12,4	122,0
2,20	37,44	26,2	256,5	46,25	23,0	226,0	58,50	20,0	196,4	72,33	19,7	193,4	90,77	17,2	168,6	114,84	14,9	146,2
2,40	40,84	30,7	301,0	50,45	27,0	265,3	63,82	23,5	230,5	78,91	23,3	228,2	99,02	20,3	198,9	125,28	17,6	172,6
2,60	44,25	35,6	348,9	54,65	31,3	307,5	69,14	27,2	267,2	85,48	27,1	265,9	107,27	23,6	231,8	135,72	20,5	201,1
2,80	47,65	40,8	400,0	58,86	35,9	352,5	74,45	31,2	306,4	92,06	31,2	306,4	115,53	27,2	267,1	146,16	23,6	231,8
3,00	51,05	46,3	454,4	63,06	40,8	400,5	79,77	35,5	348,1	98,63	35,7	349,7	123,78	31,1	304,9	156,59	27,0	264,5
3,50	59,56	61,6	604,6	73,57	54,3	533,0	93,07	47,2	463,4	115,07	48,0	470,3	144,41	41,8	410,0	182,69	36,3	355,8
4,00	68,07	79,0	774,9	84,08	69,7	683,2	106,36	60,6	594,0	131,51	62,0	608,4	165,04	54,1	530,4	208,79	46,9	460,3
4,50	76,58	98,4	965,2	94,60	86,8	851,0	119,66	75,5	740,0	147,95	77,9	764,0	185,67	67,9	666,1	234,89	58,9	578,1
5,00	85,09	119,8	1175,2	105,11	105,7	1036,3	132,95	91,9	901,3	164,39	95,6	937,2	206,30	83,3	817,1	260,99	72,3	709,2
5,50	93,60	143,3	1404,9	115,62	126,3	1239,0	146,25	109,9	1077,6	180,83	115,0	1127,9	226,92	100,3	983,4	287,09	87,0	853,5
6,00	102,11	168,7	1654,2	126,13	148,8	1459,0	159,54	129,4	1269,0	197,27	136,2	1336,1	247,55	118,8	1164,9	313,19	103,1	1011,0

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 11 and Pressure Class PN 16 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe a*cc. to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 11** and pressure class **PN 16 bar.** Calculations are performed with permissible error **k=0.01 mm** (for pipes with **ID ≤ 200 mm**) and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6} m^2/s)																		
DN/ODxe	355x32.2 mm			400x36.3 mm			450x40.9 mm			500x45.4 mm			560x50.8 mm			630x57.2 mm		
ID	290.6 mm			327.4 mm			368.2 mm			409.2 mm			458.4 mm			515.6 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	6,63	0,04	0,4	8,42	0,04	0,4	10,65	0,03	0,3	13,15	0,03	0,3	16,50	0,03	0,3	20,88	0,02	0,2
0,15	9,95	0,09	0,9	12,63	0,08	0,8	15,97	0,07	0,7	19,73	0,06	0,6	24,76	0,05	0,5	31,32	0,05	0,4
0,20	13,27	0,15	1,5	16,84	0,1	1,3	21,30	0,1	1,1	26,30	0,1	1,0	33,01	0,09	0,9	41,76	0,08	0,8
0,25	16,58	0,2	2,3	21,05	0,2	2,0	26,62	0,17	1,7	32,88	0,15	1,5	41,26	0,1	1,3	52,20	0,1	1,1
0,30	19,90	0,3	3,1	25,26	0,3	2,7	31,94	0,2	2,4	39,45	0,2	2,1	49,51	0,18	1,8	62,64	0,16	1,6
0,35	23,21	0,4	4,2	29,47	0,4	3,6	37,27	0,3	3,1	46,03	0,3	2,7	57,76	0,2	2,4	73,08	0,2	2,1
0,40	26,53	0,5	5,3	33,67	0,5	4,6	42,59	0,4	4,0	52,60	0,4	3,5	66,01	0,3	3,0	83,52	0,27	2,6
0,45	29,85	0,7	6,6	37,88	0,6	5,7	47,91	0,5	4,9	59,18	0,4	4,3	74,27	0,4	3,8	93,96	0,3	3,3
0,50	33,16	0,8	8,0	42,09	0,7	6,9	53,24	0,6	6,0	65,76	0,5	5,3	82,52	0,5	4,6	104,40	0,4	4,0
0,55	36,48	1,0	9,5	46,30	0,8	8,2	58,56	0,7	7,1	72,33	0,6	6,3	90,77	0,6	5,5	114,84	0,5	4,7
0,60	39,80	1,1	11,1	50,51	1,0	9,6	63,89	0,9	8,4	78,91	0,8	7,4	99,02	0,7	6,4	125,28	0,6	5,6
0,65	43,11	1,3	12,9	54,72	1,1	11,2	69,21	1,0	9,7	85,48	0,9	8,5	107,27	0,8	7,4	135,72	0,7	6,5
0,70	46,43	1,5	14,8	58,93	1,3	12,8	74,53	1,1	11,1	92,06	1,0	9,8	115,53	0,87	8,5	146,16	0,8	7,4
0,72	47,75	1,6	15,6	60,61	1,38	13,5	76,66	1,2	11,7	94,69	1,1	10,3	118,83	0,9	9,0	150,33	0,796	7,8
0,74	49,08	1,7	16,4	62,30	1,4	14,2	78,79	1,26	12,3	97,32	1,11	10,8	122,13	0,96	9,5	154,51	0,8	8,2
0,76	50,41	1,76	17,2	63,98	1,5	14,9	80,92	1,3	12,9	99,95	1,2	11,4	125,43	1,0	9,9	158,68	0,88	8,6
0,78	51,73	1,8	18,1	65,67	1,6	15,6	83,05	1,4	13,6	102,58	1,22	12,0	128,73	1,1	10,4	162,86	0,9	9,1
0,80	53,06	1,9	18,9	67,35	1,7	16,4	85,18	1,45	14,2	105,21	1,3	12,5	132,03	1,11	10,9	167,03	1,0	9,5
0,82	54,39	2,0	19,8	69,03	1,75	17,2	87,31	1,5	14,9	107,84	1,34	13,1	135,33	1,2	11,4	171,21	1,01	9,9
0,84	55,71	2,1	20,7	70,72	1,8	17,9	89,44	1,6	15,6	110,47	1,4	13,7	138,63	1,22	12,0	175,39	1,1	10,4
0,86	57,04	2,2	21,7	72,40	1,9	18,7	91,57	1,66	16,3	113,10	1,46	14,3	141,93	1,3	12,5	179,56	1,11	10,9
0,88	58,37	2,3	22,6	74,08	2,0	19,6	93,70	1,7	17,0	115,73	1,5	15,0	145,23	1,33	13,0	183,74	1,2	11,3
0,90	59,69	2,4	23,6	75,77	2,1	20,4	95,83	1,8	17,7	118,36	1,6	15,6	148,53	1,4	13,6	187,91	1,20	11,8
0,92	61,02	2,5	24,5	77,45	2,2	21,3	97,96	1,9	18,4	120,99	1,66	16,2	151,83	1,45	14,2	192,09	1,3	12,3
0,94	62,35	2,6	25,6	79,14	2,3	22,1	100,09	2,0	19,2	123,62	1,7	16,9	155,13	1,5	14,8	196,27	1,31	12,8
0,96	63,67	2,7	26,6	80,82	2,3	23,0	102,22	2,0	20,0	126,25	1,8	17,6	158,43	1,56	15,3	200,44	1,4	13,3
0,98	65,00	2,8	27,6	82,50	2,4	23,9	104,35	2,1	20,8	128,88	1,86	18,3	161,74	1,6	15,9	204,62	1,41	13,8
1,00	66,33	2,9	28,7	84,19	2,5	24,8	106,48	2,2	21,5	131,51	1,9	19,0	165,04	1,7	16,6	208,79	1,5	14,4
1,20	79,59	4,1	40,3	101,02	3,6	34,9	127,77	3,1	30,3	157,81	2,7	26,7	198,04	2,4	23,3	250,55	2,1	20,2
1,40	92,86	5,5	53,8	117,86	4,8	46,6	149,07	4,1	40,5	184,11	3,6	35,7	231,05	3,2	31,1	292,31	2,8	27,0
1,60	106,12	7,1	69,2	134,70	6,1	60,0	170,36	5,3	52,1	210,42	4,7	45,9	264,06	4,1	40,0	334,07	3,5	34,8
1,80	119,39	8,8	86,5	151,54	7,6	74,9	191,66	6,6	65,1	236,72	5,8	57,3	297,07	5,1	50,0	375,83	4,4	43,5
2,00	132,65	10,8	105,6	168,37	9,3	91,5	212,95	8,1	79,5	263,02	7,1	70,0	330,07	6,2	61,1	417,59	5,4	53,1
2,20	145,92	12,9	126,6	185,21	11,2	109,7	234,25	9,7	95,3	289,32	8,6	83,9	363,08	7,5	73,3	459,34	6,5	63,7
2,40	159,18	15,2	149,4	202,05	13,2	129,5	255,55	11,5	112,4	315,63	10,1	99,1	396,09	8,8	86,5	501,10	7,7	75,2
2,60	172,45	17,8	174,1	218,89	15,4	150,9	276,84	13,4	131,0	341,93	11,8	115,5	429,09	10,3	100,8	542,86	8,9	87,6
2,80	185,71	20,5	200,6	235,72	17,7	173,9	298,14	15,4	151,0	368,23	13,6	133,1	462,10	11,8	116,2	584,62	10,3	101,0
3,00	198,98	23,4	229,0	252,56	20,2	198,4	319,43	17,6	172,4	394,53	15,5	151,9	495,11	13,5	132,6	626,38	11,8	115,3
3,50	232,14	31,4	308,0	294,66	27,2	266,9	372,67	23,6	231,9	460,29	20,8	204,3	577,63	18,2	178,4	730,78	15,8	155,1
4,00	265,30	40,6	398,5	336,75	35,2	345,4	425,91	30,6	300,0	526,04	27,0	264,4	660,14	23,5	230,9	835,17	20,5	200,7
4,50	298,47	51,0	500,5	378,84	44,2	433,8	479,15	38,4	376,8	591,80	33,9	332,1	742,66	29,6	290,0	939,57	25,7	252,1
5,00	331,63	62,6	614,0	420,94	54,3	532,1	532,39	47,1	462,3	657,55	41,5	407,5	825,18	36,3	355,8	1043,96	31,5	309,3
5,50	364,79	75,3	739,0	463,03	65,3	640,4	585,63	56,7	556,4	723,31	50,0	490,4	907,70	43,7	428,3	1148,36	38,0	372,3
6,00	397,95	89,3	875,4	505,12	77,4	758,7	638,86	67,2	659,1	789,06	59,2	581,0	990,22	51,7	507,4	1252,76	45,0	441,0

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 13.6 and Pressure Class PN 12.5 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 13.6** and pressure class **PN 12.5 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	20x1.8 mm			25x2.0 mm			32x2.4 mm			40x3.0 mm			50x3.7 mm			63x4.7 mm		
ID	16.4 mm			21.0 mm			27.2 mm			34.0 mm			42.6 mm			53.6 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,02	1,8	17,7	0,03	1,3	12,7	0,06	0,9	9,0	0,09	0,7	6,7	0,14	0,5	5,0	0,23	0,4	3,7
0,15	0,03	3,6	34,9	0,05	2,6	25,2	0,09	1,8	17,9	0,14	1,4	13,4	0,21	1,0	10,0	0,34	0,8	7,4
0,20	0,04	5,8	56,7	0,07	4,2	41,0	0,12	3,0	29,3	0,18	2,2	21,9	0,29	1,7	16,4	0,45	1,2	12,2
0,25	0,05	8,4	82,9	0,09	6,1	60,0	0,15	4,4	42,9	0,23	3,3	32,2	0,36	2,5	24,2	0,56	1,8	18,1
0,30	0,06	11,5	113,1	0,10	8,4	82,1	0,17	6,0	58,8	0,27	4,5	44,2	0,43	3,4	33,2	0,68	2,5	24,8
0,35	0,07	15,0	147,4	0,12	10,9	107,1	0,20	7,8	76,8	0,32	5,9	57,8	0,50	4,4	43,4	0,79	3,3	32,5
0,40	0,08	18,9	185,5	0,14	13,8	134,9	0,23	9,9	96,9	0,36	7,4	73,0	0,57	5,6	54,9	0,90	4,2	41,1
0,45	0,10	23,2	227,4	0,16	16,9	165,5	0,26	12,1	119,0	0,41	9,1	89,7	0,64	6,9	67,5	1,02	5,2	50,6
0,50	0,11	27,8	272,9	0,17	20,3	198,8	0,29	14,6	143,1	0,45	11,0	107,9	0,71	8,3	81,2	1,13	6,2	60,9
0,55	0,12	32,8	322,1	0,19	23,9	234,8	0,32	17,2	169,1	0,50	13,0	127,6	0,78	9,8	96,1	1,24	7,4	72,1
0,60	0,13	38,2	374,8	0,21	27,9	273,4	0,35	20,1	197,0	0,54	15,2	148,7	0,86	11,4	112,1	1,35	8,6	84,2
0,65	0,14	43,9	430,9	0,23	32,1	314,5	0,38	23,1	226,7	0,59	17,5	171,2	0,93	13,2	129,1	1,47	9,9	97,0
0,70	0,148	50,0	490,6	0,24	36,5	358,2	0,41	26,3	258,4	0,64	19,9	195,2	1,00	15,0	147,3	1,58	11,3	110,7
0,72	0,152	52,6	515,4	0,25	38,4	376,4	0,42	27,7	271,5	0,65	20,9	205,2	1,03	15,8	154,8	1,62	11,9	116,4
0,74	0,156	55,1	540,7	0,26	40,3	395,0	0,43	29,1	285,0	0,67	22,0	215,4	1,05	16,6	162,5	1,67	12,5	122,2
0,76	0,161	57,8	566,6	0,26	42,2	414,0	0,44	30,5	298,7	0,69	23,0	225,8	1,08	17,4	170,4	1,71	13,1	128,1
0,78	0,165	60,5	593,1	0,27	44,2	433,4	0,45	31,9	312,8	0,71	24,1	236,4	1,11	18,2	178,5	1,76	13,7	134,2
0,80	0,169	63,2	620,0	0,28	46,2	453,2	0,46	33,4	327,1	0,73	25,2	247,3	1,14	19,0	186,7	1,81	14,3	140,4
0,82	0,173	66,0	647,5	0,284	48,3	473,3	0,48	34,8	341,7	0,74	26,3	258,4	1,17	19,9	195,1	1,85	15,0	146,7
0,84	0,177	68,9	675,5	0,291	50,4	493,9	0,49	36,4	356,6	0,76	27,5	269,7	1,20	20,8	203,6	1,90	15,6	153,2
0,86	0,182	71,8	704,1	0,30	52,5	514,8	0,50	37,9	371,8	0,78	28,7	281,2	1,23	21,7	212,4	1,94	16,3	159,8
0,88	0,186	74,8	733,2	0,305	54,7	536,2	0,51	39,5	387,2	0,80	29,9	292,9	1,25	22,6	221,2	1,99	17,0	166,5
0,90	0,190	77,8	762,8	0,312	56,9	557,9	0,52	41,1	403,0	0,82	31,1	304,9	1,28	23,5	230,3	2,03	17,7	173,3
0,92	0,194	80,8	792,9	0,32	59,1	580,0	0,53	42,7	419,0	0,84	32,3	317,0	1,31	24,4	239,5	2,08	18,4	180,2
0,94	0,199	84,0	823,5	0,326	61,4	602,5	0,55	44,4	435,3	0,85	33,6	329,4	1,34	25,4	248,9	2,12	19,1	187,3
0,96	0,203	87,2	854,7	0,333	63,8	625,4	0,56	46,1	451,9	0,87	34,9	342,0	1,37	26,3	258,4	2,17	19,8	194,5
0,98	0,207	90,4	886,4	0,34	66,1	648,6	0,57	47,8	468,8	0,89	36,2	354,8	1,40	27,3	268,1	2,21	20,6	201,8
1,00	0,211	93,7	918,6	0,35	68,5	672,3	0,58	49,5	485,9	0,91	37,5	367,8	1,43	28,3	278,0	2,26	21,3	209,3
1,20	0,25	129,4	1268,7	0,42	94,8	929,5	0,70	68,6	672,5	1,09	51,9	509,5	1,71	39,3	385,3	2,71	29,6	290,3
1,40	0,30	170,2	1669,1	0,48	124,8	1223,8	0,81	90,4	886,2	1,27	68,5	671,8	2,00	51,8	508,4	3,16	39,1	383,3
1,60	0,34	216,0	2118,7	0,55	158,5	1554,5	0,93	114,8	1126,3	1,45	87,1	854,3	2,28	66,0	646,9	3,61	49,8	488,0
1,80	0,38	266,8	2616,8	0,62	195,9	1920,9	1,05	142,0	1392,6	1,63	107,8	1056,8	2,57	81,6	800,6	4,06	61,6	604,1
2,00	0,42	322,5	3162,6	0,69	236,8	2322,7	1,16	171,8	1684,7	1,82	130,4	1278,9	2,85	98,8	969,2	4,51	74,6	731,7
2,20	0,46	382,9	3755,7	0,76	281,4	2759,4	1,28	204,2	2002,3	2,00	155,0	1520,5	3,14	117,5	1152,7	4,96	88,8	870,5
2,40	0,51	448,2	4395,6	0,83	329,4	3230,7	1,39	239,1	2345,1	2,18	181,6	1781,3	3,42	137,7	1350,8	5,42	104,0	1020,4
2,60	0,55	518,2	5081,9	0,90	381,0	3736,3	1,51	276,6	2712,9	2,36	210,2	2061,2	3,71	159,4	1563,5	5,87	120,5	1181,3
2,80	0,59	592,8	5814,3	0,97	436,0	4275,9	1,63	316,7	3105,6	2,54	240,6	2360,1	3,99	182,6	1790,6	6,32	138,0	1353,2
3,00	0,63	672,2	6592,5	1,04	494,5	4849,4	1,74	359,2	3523,0	2,72	273,0	2677,9	4,28	207,2	2032,1	6,77	156,6	1536,0
3,50	0,74	890,8	8736,7	1,21	655,6	6430,0	2,03	476,5	4673,6	3,18	362,4	3554,1	4,99	275,1	2698,1	7,90	208,0	2040,3
4,00	0,84	1138,2	11162,4	1,39	838,0	8218,6	2,32	609,4	5976,1	3,63	463,5	4546,1	5,70	352,0	3452,4	9,03	266,3	2611,5
4,50	0,95	1414,0	13867,1	1,56	1041,4	10213,4	2,61	757,5	7429,1	4,09	576,4	5652,9	6,41	437,8	4294,1	10,15	331,3	3249,1
5,00	1,06	1718,0	16849,0	1,73	1265,7	12412,9	2,91	920,9	9031,5	4,54	700,9	6873,8	7,13	532,5	5222,7	11,28	403,0	3952,6
5,50	1,16	2050,1	20106,4	1,90	1510,7	14816,1	3,20	1099,4	10782,5	4,99	836,9	8208,1	7,84	636,0	6237,7	12,41	481,4	4721,6
6,00	1,27	2410,2	23638,1	2,08	1776,4	17421,9	2,08	1776,4	17421,9	5,45	984,5	9655,2	8,55	748,3	7338,6	13,54	566,5	5555,8

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 13.6 and Pressure Class PN 12.5 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 13.6** and pressure class **PN 12.5 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6}m^2/s)																		
DN/ODxe	75x5.6 mm			90x6.7 mm			110x8.1 mm			125x9.2 mm			140x10.3 mm			160x11.8 mm		
ID	63.8 mm			76.6 mm			93.8 mm			106.6 mm			119.4 mm			136.4 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,32	0,3	3,0	0,46	0,2	2,3	0,69	0,2	1,8	0,89	0,2	1,5	1,12	0,1	1,3	1,46	0,1	1,1
0,15	0,48	0,6	6,0	0,69	0,5	4,7	1,04	0,4	3,7	1,34	0,3	3,1	1,68	0,3	2,7	2,19	0,2	2,3
0,20	0,64	1,0	9,8	0,92	0,8	7,8	1,38	0,6	6,0	1,78	0,5	5,1	2,24	0,5	4,5	2,92	0,4	3,8
0,25	0,80	1,5	14,5	1,15	1,2	11,5	1,73	0,9	8,9	2,23	0,8	7,6	2,80	0,7	6,6	3,65	0,6	5,6
0,30	0,96	2,0	19,9	1,38	1,6	15,9	2,07	1,3	12,3	2,68	1,1	10,5	3,36	0,9	9,1	4,38	0,8	7,7
0,35	1,12	2,7	26,1	1,61	2,1	20,8	2,42	1,6	16,2	3,12	1,4	13,8	3,92	1,2	12,0	5,11	1,0	10,2
0,40	1,28	3,4	33,1	1,84	2,7	26,3	2,76	2,1	20,5	3,57	1,8	17,5	4,48	1,5	15,2	5,84	1,3	12,9
0,45	1,44	4,2	40,7	2,07	3,3	32,4	3,11	2,6	25,2	4,02	2,2	21,5	5,04	1,9	18,7	6,58	1,6	15,9
0,50	1,60	5,0	49,1	2,30	4,0	39,1	3,46	3,1	30,4	4,46	2,7	26,0	5,60	2,3	22,6	7,31	2,0	19,2
0,55	1,76	5,9	58,1	2,53	4,7	46,3	3,80	3,7	36,1	4,91	3,1	30,8	6,16	2,7	26,8	8,04	2,3	22,8
0,60	1,92	6,9	67,8	2,77	5,5	54,1	4,15	4,3	42,1	5,35	3,7	36,0	6,72	3,2	31,3	8,77	2,7	26,6
0,65	2,08	8,0	78,2	3,00	6,4	62,4	4,49	5,0	48,6	5,80	4,2	41,5	7,28	3,7	36,2	9,50	3,1	30,7
0,70	2,24	9,1	89,2	3,23	7,3	71,2	4,84	5,7	55,5	6,25	4,8	47,4	7,84	4,2	41,3	10,23	3,6	35,1
0,72	2,30	9,6	93,8	3,32	7,6	74,9	4,98	6,0	58,4	6,43	5,1	49,9	8,06	4,4	43,4	10,52	3,8	36,9
0,74	2,37	10,0	98,5	3,41	8,0	78,6	5,11	6,3	61,3	6,60	5,3	52,4	8,29	4,7	45,6	10,81	4,0	38,8
0,76	2,43	10,5	103,3	3,50	8,4	82,5	5,25	6,6	64,3	6,78	5,6	55,0	8,51	4,9	47,9	11,11	4,2	40,7
0,78	2,49	11,0	108,2	3,59	8,8	86,4	5,39	6,9	67,4	6,96	5,9	57,6	8,73	5,1	50,2	11,40	4,4	42,7
0,80	2,56	11,5	113,2	3,69	9,2	90,4	5,53	7,2	70,5	7,14	6,1	60,3	8,96	5,4	52,5	11,69	4,6	44,7
0,82	2,62	12,1	118,3	3,78	9,6	94,5	5,67	7,5	73,7	7,32	6,4	63,0	9,18	5,6	54,9	11,98	4,8	46,7
0,84	2,69	12,6	123,5	3,87	10,1	98,7	5,80	7,8	77,0	7,50	6,7	65,8	9,41	5,8	57,3	12,27	5,0	48,8
0,86	2,75	13,1	128,9	3,96	10,5	102,9	5,94	8,2	80,3	7,68	7,0	68,7	9,63	6,1	59,8	12,57	5,2	50,9
0,88	2,81	13,7	134,3	4,06	10,9	107,2	6,08	8,5	83,7	7,85	7,3	71,6	9,85	6,4	62,3	12,86	5,4	53,0
0,90	2,88	14,3	139,8	4,15	11,4	111,7	6,22	8,9	87,1	8,03	7,6	74,5	10,08	6,6	64,9	13,15	5,6	55,2
0,92	2,94	14,8	145,4	4,24	11,8	116,2	6,36	9,2	90,6	8,21	7,9	77,5	10,30	6,9	67,5	13,44	5,9	57,5
0,94	3,01	15,4	151,1	4,33	12,3	120,7	6,50	9,6	94,2	8,39	8,2	80,6	10,53	7,2	70,2	13,74	6,1	59,7
0,96	3,07	16,0	156,9	4,42	12,8	125,4	6,63	10,0	97,9	8,57	8,5	83,7	10,75	7,4	72,9	14,03	6,3	62,1
0,98	3,13	16,6	162,9	4,52	13,3	130,1	6,77	10,4	101,6	8,75	8,9	86,9	10,97	7,7	75,7	14,32	6,6	64,4
1,00	3,20	17,2	168,9	4,61	13,8	134,9	6,91	10,7	105,3	8,92	9,2	90,1	11,20	8,0	78,5	14,61	6,8	66,8
1,20	3,84	23,9	234,4	5,53	19,1	187,4	8,29	14,9	146,4	10,71	12,8	125,3	13,44	11,1	109,2	17,53	9,5	93,0
1,40	4,48	31,6	309,6	6,45	25,3	247,7	9,67	19,7	193,6	12,49	16,9	165,8	15,68	14,7	144,5	20,46	12,5	123,0
1,60	5,12	40,2	394,3	7,37	32,2	315,6	11,06	25,2	246,7	14,28	21,5	211,3	17,92	18,8	184,3	23,38	16,0	156,9
1,80	5,75	49,8	488,4	8,30	39,9	391,0	12,44	31,2	305,8	16,06	26,7	262,0	20,15	23,3	228,4	26,30	19,8	194,6
2,00	6,39	60,3	591,7	9,22	48,3	473,7	13,82	37,8	370,7	17,85	32,4	317,6	22,39	28,2	277,0	29,22	24,1	236,0
2,20	7,03	71,8	704,0	10,14	57,5	563,9	15,20	45,0	441,3	19,63	38,6	378,1	24,63	33,6	329,9	32,15	28,7	281,1
2,40	7,67	84,2	825,4	11,06	67,4	661,2	16,58	52,8	517,6	21,42	45,2	443,6	26,87	39,5	387,0	35,07	33,6	329,9
2,60	8,31	97,5	955,8	11,98	78,1	765,8	17,97	61,1	599,6	23,20	52,4	513,9	29,11	45,7	448,4	37,99	39,0	382,2
2,80	8,95	111,7	1095,1	12,90	89,5	877,6	19,35	70,1	687,2	24,99	60,1	589,1	31,35	52,4	514,1	40,91	44,7	438,2
3,00	9,59	126,8	1243,2	13,83	101,6	996,4	20,73	79,6	780,4	26,77	68,2	669,1	33,59	59,5	583,9	43,84	50,8	497,8
3,50	11,19	168,4	1651,8	16,13	135,0	1324,3	24,19	105,8	1037,6	31,24	90,7	889,7	39,19	79,2	776,6	51,14	67,5	662,2
4,00	12,79	215,6	2114,8	18,43	172,9	1695,9	27,64	135,5	1329,1	35,70	116,2	1139,9	44,79	101,5	995,1	58,45	86,5	848,7
4,50	14,39	268,3	2631,7	20,74	215,2	2110,8	31,10	168,7	1654,6	40,16	144,7	1419,3	50,39	126,4	1239,2	65,76	107,8	1057,0
5,00	15,98	326,5	3202,0	23,04	261,9	2568,7	34,55	205,3	2013,9	44,62	176,2	1727,7	55,98	153,8	1508,6	73,06	131,2	1286,9
5,50	17,58	390,1	3825,5	25,35	313,0	3069,4	38,01	245,4	2406,7	49,09	210,5	2064,9	61,58	183,9	1803,2	80,37	156,9	1538,4
6,00	19,18	459,0	4502,0	27,65	368,4	3612,6	41,46	288,9	2833,0	53,55	247,9	2430,9	67,18	216,5	2122,9	87,67	184,7	1811,3

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 13.6 and Pressure Class PN 12.5 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 13.6** and pressure class **PN 12.5 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	180x13.3 mm			200x14.7 mm			225x16.6 mm			250x18.4 mm			280x20.6 mm			315x23.2 mm		
ID	153.4 mm			170.6 mm			191.8 mm			213.2 mm			238.8 mm			268.6 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	1,85	0,1	1,0	2,29	0,1	0,8	2,89	0,1	0,7	3,57	0,07	0,6	4,48	0,06	0,6	5,67	0,05	0,5
0,15	2,77	0,2	2,0	3,43	0,2	1,7	4,33	0,2	1,5	5,35	0,14	1,3	6,72	0,12	1,2	8,50	0,10	1,0
0,20	3,70	0,3	3,3	4,57	0,3	2,9	5,78	0,3	2,5	7,14	0,2	2,2	8,96	0,2	1,9	11,33	0,2	1,7
0,25	4,62	0,5	4,8	5,71	0,4	4,2	7,22	0,4	3,7	8,92	0,3	3,3	11,20	0,3	2,9	14,17	0,3	2,5
0,30	5,54	0,7	6,7	6,86	0,6	5,9	8,67	0,5	5,1	10,71	0,5	4,6	13,44	0,4	4,0	17,00	0,4	3,5
0,35	6,47	0,9	8,8	8,00	0,8	7,7	10,11	0,7	6,7	12,49	0,6	6,1	15,68	0,5	5,3	19,83	0,5	4,6
0,40	7,39	1,1	11,2	9,14	1,0	9,8	11,56	0,9	8,5	14,28	0,8	7,7	17,92	0,7	6,7	22,67	0,6	5,8
0,45	8,32	1,4	13,8	10,29	1,2	12,1	13,00	1,1	10,5	16,06	1,0	9,6	20,15	0,9	8,4	25,50	0,7	7,2
0,50	9,24	1,7	16,6	11,43	1,5	14,6	14,45	1,3	12,7	17,85	1,2	11,6	22,39	1,0	10,1	28,33	0,9	8,8
0,55	10,16	2,0	19,7	12,57	1,8	17,3	15,89	1,5	15,0	19,63	1,4	13,8	24,63	1,2	12,1	31,16	1,1	10,4
0,60	11,09	2,4	23,1	13,72	2,1	20,3	17,34	1,8	17,6	21,42	1,7	16,2	26,87	1,4	14,1	34,00	1,2	12,3
0,65	12,01	2,7	26,6	14,86	2,4	23,4	18,78	2,1	20,3	23,20	1,9	18,8	29,11	1,7	16,4	36,83	1,4	14,2
0,70	12,937	3,1	30,4	16,00	2,7	26,7	20,22	2,4	23,2	24,99	2,2	21,6	31,35	1,9	18,8	39,66	1,7	16,3
0,72	13,307	3,3	32,0	16,46	2,9	28,1	20,80	2,5	24,4	25,70	2,3	22,7	32,25	2,0	19,8	40,80	1,7	17,1
0,74	13,676	3,4	33,6	16,92	3,0	29,6	21,38	2,6	25,7	26,42	2,4	23,9	33,14	2,1	20,8	41,93	1,8	18,0
0,76	14,046	3,6	35,3	17,37	3,2	31,0	21,96	2,7	26,9	27,13	2,6	25,1	34,04	2,2	21,9	43,06	1,9	18,9
0,78	14,416	3,8	37,0	17,83	3,3	32,5	22,54	2,9	28,2	27,85	2,7	26,3	34,93	2,3	22,9	44,20	2,0	19,9
0,80	14,785	3,9	38,7	18,29	3,5	34,0	23,11	3,0	29,5	28,56	2,8	27,6	35,83	2,5	24,0	45,33	2,1	20,8
0,82	15,155	4,1	40,5	18,744	3,6	35,6	23,69	3,1	30,9	29,27	2,9	28,9	36,73	2,6	25,2	46,46	2,2	21,8
0,84	15,525	4,3	42,3	19,201	3,8	37,2	24,27	3,3	32,3	29,99	3,1	30,2	37,62	2,7	26,3	47,60	2,3	22,8
0,86	15,894	4,5	44,1	19,66	4,0	38,8	24,85	3,4	33,7	30,70	3,2	31,5	38,52	2,8	27,5	48,73	2,4	23,8
0,88	16,264	4,7	46,0	20,115	4,1	40,4	25,43	3,6	35,1	31,42	3,4	32,9	39,41	2,9	28,7	49,86	2,5	24,9
0,90	16,633	4,9	47,9	20,573	4,3	42,1	26,00	3,7	36,6	32,13	3,5	34,3	40,31	3,0	29,9	51,00	2,6	25,9
0,92	17,003	5,1	49,8	21,03	4,5	43,8	26,58	3,9	38,0	32,84	3,6	35,7	41,20	3,2	31,1	52,13	2,8	27,0
0,94	17,373	5,3	51,8	21,487	4,6	45,6	27,16	4,0	39,6	33,56	3,8	37,2	42,10	3,3	32,4	53,26	2,9	28,1
0,96	17,742	5,5	53,8	21,944	4,8	47,3	27,74	4,2	41,1	34,27	3,9	38,7	43,00	3,4	33,7	54,40	3,0	29,2
0,98	18,112	5,7	55,9	22,40	5,0	49,1	28,31	4,3	42,7	34,99	4,1	40,2	43,89	3,6	35,0	55,53	3,1	30,4
1,00	18,482	5,9	58,0	22,86	5,2	51,0	28,89	4,5	44,2	35,70	4,3	41,7	44,79	3,7	36,4	56,66	3,2	31,5
1,20	22,18	8,2	80,7	27,43	7,2	71,0	34,67	6,3	61,6	42,84	6,0	58,6	53,75	5,2	51,1	68,00	4,5	44,3
1,40	25,87	10,9	106,8	32,00	9,6	94,0	40,45	8,3	81,6	49,98	8,0	78,3	62,70	7,0	68,2	79,33	6,0	59,2
1,60	29,57	13,9	136,2	36,57	12,2	119,9	46,23	10,6	104,2	57,12	10,3	100,7	71,66	8,9	87,7	90,66	7,8	76,1
1,80	33,27	17,2	169,0	41,15	15,2	148,7	52,01	13,2	129,3	64,26	12,8	125,7	80,62	11,2	109,6	101,99	9,7	95,1
2,00	36,96	20,9	205,0	45,72	18,4	180,4	57,79	16,0	156,8	71,40	15,7	153,5	89,58	13,6	133,8	113,33	11,8	116,1
2,20	40,66	24,9	244,2	50,29	21,9	215,0	63,56	19,1	186,9	78,54	18,8	184,0	98,53	16,4	160,4	124,66	14,2	139,2
2,40	44,36	29,2	286,5	54,86	25,7	252,3	69,34	22,4	219,4	85,68	22,1	217,1	107,49	19,3	189,3	135,99	16,8	164,3
2,60	48,05	33,9	332,1	59,43	29,8	292,4	75,12	25,9	254,3	92,82	25,8	253,0	116,45	22,5	220,6	147,32	19,5	191,4
2,80	51,75	38,8	380,7	64,00	34,2	335,3	80,90	29,7	291,6	99,96	29,7	291,5	125,41	25,9	254,2	158,66	22,5	220,6
3,00	55,44	44,1	432,5	68,58	38,8	381,0	86,68	33,8	331,3	107,10	33,9	332,7	134,36	29,6	290,1	169,99	25,7	251,8
3,50	64,69	58,7	575,5	80,00	51,7	507,0	101,12	45,0	441,0	124,95	45,6	447,4	156,76	39,8	390,2	198,32	34,5	338,6
4,00	73,93	75,2	737,7	91,43	66,3	650,0	115,57	57,7	565,4	142,80	59,0	578,8	179,15	51,5	504,8	226,65	44,7	438,1
4,50	83,17	93,7	918,8	102,86	82,6	809,7	130,02	71,8	704,4	160,65	74,1	726,9	201,54	64,6	634,0	254,98	56,1	550,2
5,00	92,41	114,1	1118,8	114,29	100,5	986,0	144,46	87,5	857,9	178,50	90,9	891,7	223,94	79,3	777,7	283,32	68,8	675,0
5,50	101,65	136,4	1337,6	125,72	120,2	1178,8	158,91	104,6	1025,8	196,35	109,4	1073,1	246,33	95,4	935,9	311,65	82,8	812,3
6,00	110,89	160,6	1575,0	137,15	141,5	1388,2	173,36	123,2	1208,1	214,20	129,6	1271,2	268,73	113,0	1108,7	339,98	98,1	962,3

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 13.6 and Pressure Class PN 12.5 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 13.6** and pressure class **PN 12.5 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6}m^2/s)																		
DN/ODxe	355x26.1 mm			400x29.4 mm			450x33.1 mm			500x36.8 mm			560x41.2 mm			630x46.3 mm		
ID	302.8 mm			341.2 mm			383.8 mm			426.4 mm			477.6 mm			537.4 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	7,20	0,04	0,4	9,14	0,04	0,4	11,57	0,03	0,3	14,28	0,03	0,3	17,92	0,02	0,2	22,68	0,02	0,2
0,15	10,80	0,09	0,9	13,72	0,08	0,7	17,35	0,07	0,6	21,42	0,06	0,6	26,87	0,05	0,5	34,02	0,04	0,4
0,20	14,40	0,15	1,4	18,29	0,1	1,2	23,14	0,1	1,1	28,56	0,1	0,9	35,83	0,08	0,8	45,36	0,07	0,7
0,25	18,00	0,2	2,2	22,86	0,2	1,9	28,92	0,16	1,6	35,70	0,14	1,4	44,79	0,1	1,2	56,71	0,1	1,1
0,30	21,60	0,3	3,0	27,43	0,3	2,6	34,71	0,2	2,2	42,84	0,2	2,0	53,75	0,18	1,7	68,05	0,15	1,5
0,35	25,20	0,4	4,0	32,00	0,3	3,4	40,49	0,3	3,0	49,98	0,3	2,6	62,70	0,2	2,3	79,39	0,2	2,0
0,40	28,80	0,5	5,0	36,57	0,4	4,4	46,28	0,4	3,8	57,12	0,3	3,3	71,66	0,3	2,9	90,73	0,26	2,5
0,45	32,41	0,6	6,3	41,15	0,6	5,4	52,06	0,5	4,7	64,26	0,4	4,1	80,62	0,4	3,6	102,07	0,3	3,1
0,50	36,01	0,8	7,6	45,72	0,7	6,6	57,85	0,6	5,7	71,40	0,5	5,0	89,58	0,4	4,4	113,41	0,4	3,8
0,55	39,61	0,9	9,0	50,29	0,8	7,8	63,63	0,7	6,8	78,54	0,6	6,0	98,53	0,5	5,2	124,75	0,5	4,5
0,60	43,21	1,1	10,6	54,86	0,9	9,2	69,41	0,8	8,0	85,68	0,7	7,0	107,49	0,6	6,1	136,09	0,5	5,3
0,65	46,81	1,3	12,3	59,43	1,1	10,6	75,20	0,9	9,2	92,82	0,8	8,1	116,45	0,7	7,1	147,43	0,6	6,1
0,70	50,41	1,4	14,1	64,00	1,2	12,2	80,98	1,1	10,6	99,96	0,9	9,3	125,41	0,83	8,1	158,78	0,7	7,0
0,72	51,85	1,5	14,8	65,83	1,31	12,8	83,30	1,1	11,1	102,82	1,0	9,8	128,99	0,9	8,6	163,31	0,757	7,4
0,74	53,29	1,6	15,6	67,66	1,4	13,5	85,61	1,19	11,7	105,67	1,05	10,3	132,57	0,92	9,0	167,85	0,8	7,8
0,76	54,73	1,67	16,4	69,49	1,4	14,2	87,93	1,3	12,3	108,53	1,1	10,8	136,15	1,0	9,5	172,38	0,84	8,2
0,78	56,17	1,8	17,2	71,32	1,5	14,9	90,24	1,3	12,9	111,38	1,16	11,4	139,74	1,0	9,9	176,92	0,9	8,6
0,80	57,61	1,8	18,0	73,15	1,6	15,6	92,55	1,38	13,5	114,24	1,2	11,9	143,32	1,06	10,4	181,46	0,9	9,0
0,82	59,05	1,9	18,9	74,98	1,66	16,3	94,87	1,4	14,2	117,09	1,27	12,5	146,90	1,1	10,9	185,99	0,96	9,5
0,84	60,49	2,0	19,7	76,80	1,7	17,1	97,18	1,5	14,8	119,95	1,3	13,1	150,49	1,16	11,4	190,53	1,0	9,9
0,86	61,93	2,1	20,6	78,63	1,8	17,8	99,49	1,58	15,5	122,81	1,39	13,6	154,07	1,2	11,9	195,07	1,05	10,3
0,88	63,37	2,2	21,5	80,46	1,9	18,6	101,81	1,6	16,2	125,66	1,5	14,2	157,65	1,27	12,4	199,60	1,1	10,8
0,90	64,81	2,3	22,4	82,29	2,0	19,4	104,12	1,7	16,8	128,52	1,5	14,8	161,24	1,3	13,0	204,14	1,15	11,2
0,92	66,25	2,4	23,4	84,12	2,1	20,2	106,44	1,8	17,5	131,37	1,58	15,5	164,82	1,38	13,5	208,68	1,2	11,7
0,94	67,69	2,5	24,3	85,95	2,1	21,0	108,75	1,9	18,3	134,23	1,6	16,1	168,40	1,4	14,0	213,21	1,24	12,2
0,96	69,13	2,6	25,3	87,78	2,2	21,9	111,06	1,9	19,0	137,09	1,7	16,7	171,98	1,49	14,6	217,75	1,3	12,7
0,98	70,57	2,7	26,3	89,61	2,3	22,7	113,38	2,0	19,7	139,94	1,77	17,4	175,57	1,5	15,2	222,29	1,34	13,2
1,00	72,01	2,8	27,3	91,43	2,4	23,6	115,69	2,1	20,5	142,80	1,8	18,1	179,15	1,6	15,8	226,82	1,4	13,7
1,20	86,41	3,9	38,4	109,72	3,4	33,2	138,83	2,9	28,8	171,36	2,6	25,4	214,98	2,3	22,2	272,19	2,0	19,3
1,40	100,82	5,2	51,2	128,01	4,5	44,4	161,97	3,9	38,5	199,92	3,5	33,9	250,81	3,0	29,6	317,55	2,6	25,7
1,60	115,22	6,7	65,9	146,29	5,8	57,1	185,11	5,1	49,5	228,48	4,5	43,7	286,64	3,9	38,1	362,92	3,4	33,1
1,80	129,62	8,4	82,3	164,58	7,3	71,3	208,24	6,3	61,9	257,04	5,6	54,6	322,47	4,9	47,6	408,28	4,2	41,4
2,00	144,02	10,2	100,5	182,87	8,9	87,1	231,38	7,7	75,6	285,60	6,8	66,6	358,30	5,9	58,2	453,64	5,2	50,6
2,20	158,43	12,3	120,5	201,15	10,6	104,4	254,52	9,2	90,6	314,16	8,1	79,9	394,13	7,1	69,8	499,01	6,2	60,6
2,40	172,83	14,5	142,2	219,44	12,6	123,2	277,66	10,9	107,0	342,72	9,6	94,3	429,96	8,4	82,4	544,37	7,3	71,6
2,60	187,23	16,9	165,7	237,73	14,6	143,6	300,80	12,7	124,7	371,28	11,2	109,9	465,79	9,8	96,0	589,74	8,5	83,4
2,80	201,63	19,5	191,0	256,02	16,9	165,5	323,93	14,7	143,7	399,84	12,9	126,7	501,62	11,3	110,6	635,10	9,8	96,1
3,00	216,03	22,2	218,0	274,30	19,3	188,9	347,07	16,7	164,0	428,40	14,7	144,6	537,45	12,9	126,3	680,47	11,2	109,7
3,50	252,04	29,9	293,2	320,02	25,9	254,0	404,92	22,5	220,6	499,80	19,8	194,5	627,03	17,3	169,9	793,88	15,1	147,6
4,00	288,05	38,7	379,3	365,74	33,5	328,7	462,76	29,1	285,5	571,19	25,7	251,7	716,60	22,4	219,9	907,29	19,5	191,0
4,50	324,05	48,6	476,4	411,45	42,1	412,8	520,61	36,6	358,6	642,59	32,2	316,2	806,18	28,2	276,2	1020,70	24,5	240,0
5,00	360,06	59,6	584,4	457,17	51,6	506,4	578,46	44,9	439,9	713,99	39,6	387,9	895,75	34,5	338,8	1134,11	30,0	294,4
5,50	396,06	71,7	703,4	502,89	62,2	609,5	636,30	54,0	529,5	785,39	47,6	466,9	985,33	41,6	407,8	1247,52	36,1	354,4
6,00	432,07	85,0	833,2	548,60	73,6	722,1	694,15	64,0	627,2	856,79	56,4	553,1	1074,90	49,3	483,1	1360,93	42,8	419,8

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 17 and Pressure Class PN 10 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 17** and pressure class **PN 10 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	25x1.8 mm			32x2.0 mm			40x2.4 mm			50x3.0 mm			63x3.8 mm			75x4.5 mm		
ID	21.4 mm			28.0 mm			35.2 mm			44.0 mm			55.4 mm			66.0 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,04	1,3	12,4	0,06	0,9	8,7	0,10	0,7	6,4	0,15	0,5	4,8	0,24	0,4	3,6	0,34	0,3	2,8
0,15	0,05	2,5	24,5	0,09	1,8	17,3	0,15	1,3	12,8	0,23	1,0	9,6	0,36	0,7	7,1	0,51	0,6	5,7
0,20	0,07	4,1	40,0	0,12	2,9	28,2	0,19	2,1	21,0	0,30	1,6	15,8	0,48	1,2	11,7	0,68	1,0	9,4
0,25	0,09	6,0	58,6	0,15	4,2	41,4	0,24	3,1	30,8	0,38	2,4	23,2	0,60	1,8	17,3	0,86	1,4	13,9
0,30	0,11	8,2	80,1	0,18	5,8	56,7	0,29	4,3	42,3	0,46	3,2	31,9	0,72	2,4	23,8	1,03	1,9	19,1
0,35	0,13	10,7	104,5	0,22	7,5	74,0	0,34	5,6	55,3	0,53	4,3	41,7	0,84	3,2	31,2	1,20	2,6	25,0
0,40	0,14	13,4	131,7	0,25	9,5	93,4	0,39	7,1	69,8	0,61	5,4	52,7	0,96	4,0	39,5	1,37	3,2	31,7
0,45	0,16	16,5	161,6	0,28	11,7	114,7	0,44	8,8	85,8	0,68	6,6	64,8	1,08	5,0	48,6	1,54	4,0	39,0
0,50	0,18	19,8	194,1	0,31	14,1	137,9	0,49	10,5	103,3	0,76	8,0	78,0	1,21	6,0	58,5	1,71	4,8	47,0
0,55	0,20	23,4	229,2	0,34	16,6	163,0	0,54	12,5	122,1	0,84	9,4	92,3	1,33	7,1	69,2	1,88	5,7	55,7
0,60	0,22	27,2	266,9	0,37	19,4	189,9	0,58	14,5	142,3	0,91	11,0	107,6	1,45	8,2	80,8	2,05	6,6	65,0
0,65	0,23	31,3	307,1	0,40	22,3	218,6	0,63	16,7	164,0	0,99	12,6	124,0	1,57	9,5	93,1	2,22	7,6	75,0
0,70	0,252	35,7	349,8	0,43	25,4	249,1	0,68	19,1	186,9	1,06	14,4	141,5	1,69	10,8	106,2	2,39	8,7	85,5
0,72	0,259	37,5	367,5	0,44	26,7	261,8	0,70	20,0	196,5	1,09	15,2	148,7	1,74	11,4	111,7	2,46	9,2	90,0
0,74	0,266	39,3	385,7	0,46	28,0	274,8	0,72	21,0	206,2	1,13	15,9	156,1	1,78	12,0	117,3	2,53	9,6	94,5
0,76	0,273	41,2	404,2	0,47	29,4	288,0	0,74	22,0	216,2	1,16	16,7	163,7	1,83	12,5	123,0	2,60	10,1	99,1
0,78	0,281	43,1	423,2	0,48	30,8	301,6	0,76	23,1	226,4	1,19	17,5	171,4	1,88	13,1	128,8	2,67	10,6	103,8
0,80	0,288	45,1	442,5	0,49	32,2	315,4	0,78	24,1	236,8	1,22	18,3	179,3	1,93	13,7	134,8	2,74	11,1	108,6
0,82	0,295	47,1	462,2	0,505	33,6	329,5	0,80	25,2	247,4	1,25	19,1	187,4	1,98	14,4	140,9	2,81	11,6	113,5
0,84	0,302	49,2	482,3	0,517	35,1	343,9	0,82	26,3	258,3	1,28	19,9	195,6	2,02	15,0	147,1	2,87	12,1	118,5
0,86	0,309	51,3	502,7	0,53	36,6	358,5	0,84	27,5	269,3	1,31	20,8	204,0	2,07	15,6	153,4	2,94	12,6	123,6
0,88	0,317	53,4	523,6	0,542	38,1	373,4	0,86	28,6	280,5	1,34	21,7	212,5	2,12	16,3	159,8	3,01	13,1	128,8
0,90	0,324	55,5	544,8	0,554	39,6	388,6	0,88	29,8	292,0	1,37	22,6	221,2	2,17	17,0	166,4	3,08	13,7	134,1
0,92	0,331	57,8	566,4	0,57	41,2	404,1	0,90	31,0	303,6	1,40	23,5	230,1	2,22	17,6	173,0	3,15	14,2	139,5
0,94	0,338	60,0	588,3	0,579	42,8	419,8	0,91	32,2	315,5	1,43	24,4	239,1	2,27	18,3	179,8	3,22	14,8	144,9
0,96	0,345	62,3	610,7	0,591	44,4	435,8	0,93	33,4	327,5	1,46	25,3	248,3	2,31	19,0	186,7	3,28	15,3	150,5
0,98	0,352	64,6	633,4	0,60	46,1	452,1	0,95	34,6	339,8	1,49	26,3	257,6	2,36	19,8	193,8	3,35	15,9	156,2
1,00	0,360	66,9	656,5	0,62	47,8	468,6	0,97	35,9	352,3	1,52	27,2	267,1	2,41	20,5	200,9	3,42	16,5	162,0
1,20	0,43	92,6	907,8	0,74	66,1	648,6	1,17	49,8	488,0	1,82	37,8	370,2	2,89	28,4	278,8	4,11	22,9	224,9
1,40	0,50	121,9	1195,2	0,86	87,2	854,8	1,36	65,6	643,5	2,13	49,8	488,6	3,37	37,5	368,1	4,79	30,3	297,1
1,60	0,58	154,8	1518,3	0,99	110,8	1086,5	1,56	83,5	818,5	2,43	63,4	621,7	3,86	47,8	468,6	5,47	38,6	378,4
1,80	0,65	191,3	1876,3	1,11	137,0	1343,5	1,75	103,2	1012,5	2,74	78,5	769,4	4,34	59,2	580,2	6,16	47,8	468,6
2,00	0,72	231,3	2268,8	1,23	165,7	1625,3	1,95	124,9	1225,4	3,04	95,0	931,6	4,82	71,7	702,8	6,84	57,9	567,7
2,20	0,79	274,8	2695,4	1,35	197,0	1931,8	2,14	148,6	1456,9	3,35	113,0	1107,9	5,30	85,3	836,1	7,53	68,9	675,6
2,40	0,86	321,8	3155,9	1,48	230,7	2262,6	2,34	174,0	1707,0	3,65	132,4	1298,4	5,79	99,9	980,1	8,21	80,8	792,1
2,60	0,94	372,2	3649,8	1,60	266,9	2617,6	2,53	201,4	1975,3	3,95	153,2	1502,9	6,27	115,7	1134,7	8,90	93,5	917,3
2,80	1,01	425,9	4177,1	1,72	305,5	2996,6	2,72	230,6	2261,8	4,26	175,5	1721,3	6,75	132,5	1299,9	9,58	107,2	1051,0
3,00	1,08	483,0	4737,4	1,85	346,6	3399,4	2,92	261,7	2566,4	4,56	199,2	1953,5	7,23	150,5	1475,5	10,26	121,7	1193,2
3,50	1,26	640,5	6281,7	2,16	459,9	4510,0	3,41	347,3	3406,3	5,32	264,5	2593,9	8,44	199,9	1960,1	11,97	161,7	1585,4
4,00	1,44	818,7	8029,3	2,46	588,0	5767,1	3,89	444,3	4357,3	6,08	338,4	3319,1	9,64	255,8	2509,0	13,68	207,0	2029,9
4,50	1,62	1017,4	9978,4	2,77	731,0	7169,5	4,38	552,5	5418,5	6,84	421,0	4128,5	10,85	318,3	3121,7	15,40	257,6	2526,1
5,00	1,80	1236,6	12127,6	3,08	888,7	8716,2	4,87	671,8	6588,9	7,60	512,0	5021,5	12,05	387,2	3797,7	17,11	313,4	3073,7
5,50	1,98	1476,0	14475,8	3,39	1061,1	10406,4	5,35	802,3	7868,1	8,36	611,5	5997,5	13,26	462,6	4536,7	18,82	374,4	3672,3
6,00	2,16	1735,6	17022,0	3,69	1248,0	12239,3	5,84	943,7	9255,5	9,12	719,5	7056,2	14,46	544,3	5338,3	20,53	440,7	4321,7

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 17 and Pressure Class PN 10 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 17** and pressure class **PN 10 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6} m^2/s$)																		
DN/ODxe	90x5.4 mm			110x6.6 mm			125x7.4 mm			140x8.3 mm			160x9.5 mm			180x10.7 mm		
ID	79.2 mm			96.8 mm			110.2 mm			123.4 mm			141.0 mm			158.6 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm^3/s l/s	mm/m m/km	Pa/m	dm^3/s l/s	mm/m m/km	Pa/m	dm^3/s l/s	mm/m m/km	Pa/m	dm^3/s l/s	mm/m m/km	Pa/m	dm^3/s l/s	mm/m m/km	Pa/m	dm^3/s l/s	mm/m m/km	Pa/m
0,10	0,49	0,2	2,2	0,74	0,2	1,7	0,95	0,2	1,5	1,20	0,1	1,3	1,56	0,1	1,1	1,98	0,1	0,9
0,15	0,74	0,5	4,5	1,10	0,4	3,5	1,43	0,3	3,0	1,79	0,3	2,6	2,34	0,2	2,2	2,96	0,2	1,9
0,20	0,99	0,8	7,5	1,47	0,6	5,8	1,91	0,5	4,9	2,39	0,4	4,3	3,12	0,4	3,6	3,95	0,3	3,1
0,25	1,23	1,1	11,0	1,84	0,9	8,6	2,38	0,7	7,3	2,99	0,6	6,3	3,90	0,5	5,4	4,94	0,5	4,6
0,30	1,48	1,6	15,2	2,21	1,2	11,8	2,86	1,0	10,1	3,59	0,9	8,8	4,68	0,8	7,4	5,93	0,7	6,4
0,35	1,72	2,0	19,9	2,58	1,6	15,5	3,34	1,3	13,2	4,19	1,2	11,5	5,47	1,0	9,8	6,91	0,9	8,4
0,40	1,97	2,6	25,3	2,94	2,0	19,7	3,82	1,7	16,8	4,78	1,5	14,6	6,25	1,3	12,4	7,90	1,1	10,7
0,45	2,22	3,2	31,1	3,31	2,5	24,3	4,29	2,1	20,7	5,38	1,8	18,0	7,03	1,6	15,3	8,89	1,3	13,2
0,50	2,46	3,8	37,5	3,68	3,0	29,3	4,77	2,5	25,0	5,98	2,2	21,7	7,81	1,9	18,4	9,88	1,6	16,0
0,55	2,71	4,5	44,4	4,05	3,5	34,7	5,25	3,0	29,6	6,58	2,6	25,8	8,59	2,2	21,9	10,87	1,9	18,9
0,60	2,96	5,3	51,9	4,42	4,1	40,5	5,72	3,5	34,6	7,18	3,1	30,1	9,37	2,6	25,6	11,85	2,3	22,2
0,65	3,20	6,1	59,8	4,78	4,8	46,8	6,20	4,1	39,9	7,77	3,5	34,7	10,15	3,0	29,5	12,84	2,6	25,6
0,70	3,45	7,0	68,3	5,15	5,4	53,4	6,68	4,6	45,6	8,37	4,0	39,7	10,93	3,4	33,7	13,83	3,0	29,2
0,72	3,55	7,3	71,8	5,30	5,7	56,2	6,87	4,9	47,9	8,61	4,3	41,7	11,24	3,6	35,5	14,22	3,1	30,7
0,74	3,65	7,7	75,5	5,45	6,0	59,0	7,06	5,1	50,3	8,85	4,5	43,8	11,55	3,8	37,3	14,62	3,3	32,3
0,76	3,74	8,1	79,1	5,59	6,3	61,9	7,25	5,4	52,8	9,09	4,7	46,0	11,87	4,0	39,1	15,01	3,5	33,9
0,78	3,84	8,5	82,9	5,74	6,6	64,8	7,44	5,6	55,3	9,33	4,9	48,2	12,18	4,2	41,0	15,41	3,6	35,5
0,80	3,94	8,8	86,8	5,89	6,9	67,8	7,63	5,9	57,9	9,57	5,1	50,4	12,49	4,4	42,9	15,80	3,8	37,2
0,82	4,04	9,2	90,7	6,03	7,2	70,9	7,82	6,2	60,5	9,81	5,4	52,7	12,80	4,6	44,8	16,20	4,0	38,9
0,84	4,14	9,7	94,7	6,18	7,6	74,1	8,01	6,4	63,2	10,05	5,6	55,1	13,12	4,8	46,8	16,59	4,1	40,6
0,86	4,24	10,1	98,8	6,33	7,9	77,3	8,20	6,7	66,0	10,29	5,9	57,5	13,43	5,0	48,9	16,99	4,3	42,4
0,88	4,34	10,5	102,9	6,48	8,2	80,5	8,39	7,0	68,7	10,52	6,1	59,9	13,74	5,2	50,9	17,39	4,5	44,2
0,90	4,43	10,9	107,2	6,62	8,5	83,8	8,58	7,3	71,6	10,76	6,4	62,4	14,05	5,4	53,0	17,78	4,7	46,0
0,92	4,53	11,4	111,5	6,77	8,9	87,2	8,77	7,6	74,5	11,00	6,6	64,9	14,37	5,6	55,2	18,18	4,9	47,9
0,94	4,63	11,8	115,9	6,92	9,2	90,7	8,97	7,9	77,4	11,24	6,9	67,5	14,68	5,9	57,4	18,57	5,1	49,8
0,96	4,73	12,3	120,4	7,06	9,6	94,2	9,16	8,2	80,4	11,48	7,1	70,1	14,99	6,1	59,6	18,97	5,3	51,7
0,98	4,83	12,7	124,9	7,21	10,0	97,7	9,35	8,5	83,5	11,72	7,4	72,7	15,30	6,3	61,9	19,36	5,5	53,7
1,00	4,93	13,2	129,5	7,36	10,3	101,4	9,54	8,8	86,6	11,96	7,7	75,4	15,61	6,5	64,2	19,76	5,7	55,7
1,20	5,91	18,3	179,9	8,83	14,4	140,9	11,45	12,3	120,4	14,35	10,7	104,9	18,74	9,1	89,3	23,71	7,9	77,5
1,40	6,90	24,2	237,8	10,30	19,0	186,3	13,35	16,2	159,2	16,74	14,2	138,8	21,86	12,1	118,2	27,66	10,5	102,6
1,60	7,88	30,9	303,0	11,77	24,2	237,5	15,26	20,7	203,0	19,14	18,1	177,1	24,98	15,4	150,8	31,61	13,3	130,9
1,80	8,87	38,3	375,4	13,25	30,0	294,4	17,17	25,7	251,7	21,53	22,4	219,5	28,11	19,1	187,0	35,56	16,6	162,3
2,00	9,85	46,4	454,9	14,72	36,4	356,8	19,08	31,1	305,1	23,92	27,1	266,2	31,23	23,1	226,8	39,51	20,1	196,9
2,20	10,84	55,2	541,5	16,19	43,3	424,8	20,98	37,0	363,3	26,31	32,3	317,1	34,35	27,5	270,1	43,46	23,9	234,6
2,40	11,82	64,8	635,0	17,66	50,8	498,3	22,89	43,5	426,2	28,70	37,9	372,0	37,47	32,3	317,0	47,41	28,1	275,3
2,60	12,81	75,0	735,5	19,13	58,9	577,2	24,80	50,4	493,8	31,10	44,0	431,0	40,60	37,5	367,3	51,37	32,5	319,1
2,80	13,79	85,9	842,8	20,61	67,5	661,6	26,71	57,7	566,0	33,49	50,4	494,1	43,72	42,9	421,1	55,32	37,3	365,9
3,00	14,78	97,6	957,0	22,08	76,6	751,3	28,61	65,6	642,9	35,88	57,2	561,3	46,84	48,8	478,4	59,27	42,4	415,6
3,50	17,24	129,7	1272,1	25,76	101,9	999,0	33,38	87,2	855,0	41,86	76,1	746,6	54,65	64,9	636,5	69,15	56,4	553,1
4,00	19,71	166,1	1629,1	29,44	130,5	1279,7	38,15	111,7	1095,4	47,84	97,5	956,6	62,46	83,2	815,7	79,02	72,3	709,0
4,50	22,17	206,8	2027,7	33,12	162,5	1593,2	42,92	139,1	1363,9	53,82	121,5	1191,3	70,27	103,6	1016,0	88,90	90,0	883,1
5,00	24,63	251,6	2467,6	36,80	197,7	1939,3	47,69	169,3	1660,4	59,80	147,9	1450,3	78,07	126,1	1237,0	98,78	109,6	1075,3
5,50	27,10	300,7	2948,6	40,48	236,3	2317,6	52,46	202,3	1984,5	65,78	176,8	1733,6	85,88	150,8	1478,8	108,66	131,1	1285,6
6,00	29,56	353,9	3470,5	44,16	278,2	2728,2	57,23	238,2	2336,2	71,76	208,1	2041,0	93,69	177,5	1741,2	118,54	154,4	1513,8

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 17 and Pressure Class PN 10 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 17** and pressure class **PN 10 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308x10^{-6}$ m²/s)																		
DN/ODxe	200x11.9 mm			225x13.4 mm			250x14.8 mm			280x16.6 mm			315x18.7 mm			355x21.1 mm		
ID	176.2 mm			198.2 mm			220.4 mm			246.8 mm			277.6 mm			312.8 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	2,44	0,1	0,8	3,09	0,1	0,7	3,82	0,1	0,6	4,78	0,06	0,5	6,05	0,05	0,5	7,68	0,04	0,4
0,15	3,66	0,2	1,7	4,63	0,1	1,4	5,72	0,1	1,3	7,18	0,11	1,1	9,08	0,10	1,0	11,53	0,08	0,8
0,20	4,88	0,3	2,7	6,17	0,2	2,4	7,63	0,2	2,1	9,57	0,2	1,9	12,10	0,2	1,6	15,37	0,1	1,4
0,25	6,10	0,4	4,1	7,71	0,4	3,5	9,54	0,3	3,2	11,96	0,3	2,8	15,13	0,2	2,4	19,21	0,2	2,1
0,30	7,32	0,6	5,6	9,26	0,5	4,9	11,45	0,5	4,4	14,35	0,4	3,8	18,16	0,3	3,3	23,05	0,3	2,9
0,35	8,53	0,8	7,4	10,80	0,7	6,4	13,35	0,6	5,8	16,74	0,5	5,1	21,18	0,4	4,4	26,90	0,4	3,8
0,40	9,75	1,0	9,4	12,34	0,8	8,2	15,26	0,8	7,4	19,14	0,7	6,5	24,21	0,6	5,6	30,74	0,5	4,8
0,45	10,97	1,2	11,6	13,88	1,0	10,1	17,17	0,9	9,2	21,53	0,8	8,0	27,24	0,7	7,0	34,58	0,6	6,0
0,50	12,19	1,4	14,0	15,43	1,2	12,2	19,08	1,1	11,2	23,92	1,0	9,7	30,26	0,9	8,4	38,42	0,7	7,3
0,55	13,41	1,7	16,7	16,97	1,5	14,4	20,98	1,4	13,3	26,31	1,2	11,6	33,29	1,0	10,0	42,27	0,9	8,7
0,60	14,63	2,0	19,5	18,51	1,7	16,9	22,89	1,6	15,6	28,70	1,4	13,6	36,31	1,2	11,8	46,11	1,0	10,2
0,65	15,85	2,3	22,5	20,05	2,0	19,5	24,80	1,8	18,1	31,10	1,6	15,7	39,34	1,4	13,6	49,95	1,2	11,8
0,70	17,069	2,6	25,7	21,60	2,3	22,3	26,71	2,1	20,7	33,49	1,8	18,0	42,37	1,6	15,6	53,79	1,4	13,5
0,72	17,556	2,8	27,1	22,21	2,4	23,5	27,47	2,2	21,8	34,44	1,9	19,0	43,58	1,7	16,5	55,33	1,5	14,3
0,74	18,044	2,9	28,4	22,83	2,5	24,7	28,23	2,3	22,9	35,40	2,0	20,0	44,79	1,8	17,3	56,87	1,5	15,0
0,76	18,532	3,0	29,8	23,45	2,6	25,9	29,00	2,5	24,1	36,36	2,1	21,0	46,00	1,9	18,2	58,40	1,6	15,8
0,78	19,019	3,2	31,3	24,07	2,8	27,1	29,76	2,6	25,3	37,31	2,2	22,0	47,21	1,9	19,1	59,94	1,7	16,5
0,80	19,507	3,3	32,7	24,68	2,9	28,4	30,52	2,7	26,5	38,27	2,4	23,1	48,42	2,0	20,0	61,48	1,8	17,3
0,82	19,995	3,5	34,2	25,299	3,0	29,7	31,28	2,8	27,7	39,23	2,5	24,2	49,63	2,1	21,0	63,01	1,8	18,1
0,84	20,482	3,6	35,7	25,917	3,2	31,0	32,05	3,0	29,0	40,18	2,6	25,3	50,84	2,2	21,9	64,55	1,9	19,0
0,86	20,970	3,8	37,3	26,53	3,3	32,4	32,81	3,1	30,3	41,14	2,7	26,4	52,05	2,3	22,9	66,09	2,0	19,8
0,88	21,458	4,0	38,9	27,151	3,4	33,7	33,57	3,2	31,6	42,10	2,8	27,6	53,26	2,4	23,9	67,62	2,1	20,7
0,90	21,945	4,1	40,5	27,768	3,6	35,1	34,34	3,4	33,0	43,05	2,9	28,7	54,47	2,5	24,9	69,16	2,2	21,6
0,92	22,433	4,3	42,1	28,38	3,7	36,6	35,10	3,5	34,3	44,01	3,1	29,9	55,68	2,6	25,9	70,70	2,3	22,5
0,94	22,921	4,5	43,8	29,002	3,9	38,0	35,86	3,6	35,7	44,97	3,2	31,1	56,89	2,8	27,0	72,24	2,4	23,4
0,96	23,408	4,6	45,5	29,619	4,0	39,5	36,63	3,8	37,2	45,93	3,3	32,4	58,10	2,9	28,1	73,77	2,5	24,3
0,98	23,896	4,8	47,3	30,24	4,2	41,0	37,39	3,9	38,6	46,88	3,4	33,7	59,31	3,0	29,2	75,31	2,6	25,3
1,00	24,384	5,0	49,0	30,85	4,3	42,5	38,15	4,1	40,1	47,84	3,6	34,9	60,52	3,1	30,3	76,85	2,7	26,2
1,20	29,26	7,0	68,3	37,02	6,0	59,2	45,78	5,7	56,3	57,41	5,0	49,1	72,63	4,3	42,6	92,22	3,8	36,9
1,40	34,14	9,2	90,4	43,19	8,0	78,5	53,41	7,7	75,2	66,97	6,7	65,6	84,73	5,8	56,9	107,58	5,0	49,3
1,60	39,01	11,8	115,3	49,36	10,2	100,2	61,04	9,9	96,7	76,54	8,6	84,3	96,84	7,5	73,1	122,95	6,5	63,3
1,80	43,89	14,6	143,1	55,54	12,7	124,3	68,67	12,3	120,8	86,11	10,7	105,3	108,94	9,3	91,4	138,32	8,1	79,1
2,00	48,77	17,7	173,6	61,71	15,4	150,8	76,30	15,0	147,5	95,68	13,1	128,6	121,05	11,4	111,6	153,69	9,9	96,7
2,20	53,64	21,1	206,8	67,88	18,3	179,7	83,93	18,0	176,7	105,25	15,7	154,1	133,15	13,6	133,8	169,06	11,8	115,9
2,40	58,52	24,8	242,8	74,05	21,5	210,9	91,56	21,3	208,6	114,81	18,6	181,9	145,26	16,1	157,9	184,43	13,9	136,8
2,60	63,40	28,7	281,4	80,22	24,9	244,5	99,19	24,8	243,0	124,38	21,6	212,0	157,36	18,8	184,0	199,80	16,2	159,4
2,80	68,27	32,9	322,7	86,39	28,6	280,4	106,82	28,6	280,0	133,95	24,9	244,3	169,47	21,6	212,0	215,17	18,7	183,6
3,00	73,15	37,4	366,6	92,56	32,5	318,6	114,45	32,6	319,6	143,52	28,4	278,8	181,57	24,7	242,0	230,54	21,4	209,6
3,50	85,34	49,7	487,9	107,99	43,2	424,1	133,53	43,8	429,8	167,44	38,2	375,0	211,83	33,2	325,5	268,96	28,7	281,9
4,00	97,54	63,8	625,5	123,41	55,4	543,8	152,61	56,7	556,1	191,36	49,5	485,1	242,10	42,9	421,1	307,39	37,2	364,8
4,50	109,73	79,4	779,1	138,84	69,1	677,5	171,68	71,2	698,4	215,27	62,1	609,3	272,36	53,9	528,8	345,81	46,7	458,2
5,00	121,92	96,7	948,9	154,26	84,1	825,2	190,76	87,3	856,7	239,19	76,2	747,4	302,62	66,1	648,7	384,23	57,3	562,1
5,50	134,11	115,7	1134,5	169,69	100,6	986,7	209,83	105,1	1031,0	263,11	91,7	899,5	332,88	79,6	780,8	422,66	69,0	676,5
6,00	146,30	136,2	1335,9	185,12	118,5	1162,0	228,91	124,5	1221,3	287,03	108,6	1065,5	363,14	94,3	924,9	461,08	81,7	801,4

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 17 and Pressure Class PN 10 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe acc. *to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 17** and pressure class **PN 10 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)															
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6}m^2/s)															
DN/ODxe	400x23.7 mm			450x26.7 mm			500x29.7 mm			560x33.2 mm			630x37.4 mm		
ID	352.6 mm			396.6 mm			440.6 mm			493.6 mm			555.2 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	9,76	0,04	0,3	12,35	0,03	0,3	15,25	0,03	0,3	19,14	0,02	0,2	24,21	0,02	0,2
0,15	14,65	0,07	0,7	18,53	0,06	0,6	22,87	0,06	0,5	28,70	0,05	0,5	36,31	0,04	0,4
0,20	19,53	0,12	1,2	24,71	0,1	1,0	30,49	0,1	0,9	38,27	0,1	0,8	48,42	0,07	0,7
0,25	24,41	0,2	1,8	30,88	0,2	1,5	38,12	0,14	1,4	47,84	0,12	1,2	60,52	0,1	1,0
0,30	29,29	0,3	2,5	37,06	0,2	2,2	45,74	0,2	1,9	57,41	0,2	1,6	72,63	0,15	1,4
0,35	34,18	0,3	3,3	43,24	0,3	2,8	53,36	0,3	2,5	66,97	0,2	2,2	84,73	0,2	1,9
0,40	39,06	0,4	4,2	49,41	0,4	3,6	60,99	0,3	3,2	76,54	0,3	2,8	96,84	0,2	2,4
0,45	43,94	0,5	5,2	55,59	0,5	4,5	68,61	0,4	4,0	86,11	0,4	3,5	108,94	0,3	3,0
0,50	48,82	0,6	6,3	61,77	0,6	5,5	76,23	0,5	4,8	95,68	0,4	4,2	121,05	0,4	3,6
0,55	53,71	0,8	7,5	67,95	0,7	6,5	83,86	0,6	5,7	105,25	0,5	5,0	133,15	0,4	4,3
0,60	58,59	0,9	8,8	74,12	0,8	7,6	91,48	0,7	6,7	114,81	0,6	5,9	145,26	0,5	5,1
0,65	63,47	1,0	10,2	80,30	0,9	8,9	99,10	0,8	7,8	124,38	0,7	6,8	157,36	0,6	5,9
0,70	68,35	1,2	11,7	86,48	1,0	10,2	106,73	0,9	8,9	133,95	0,8	7,8	169,47	0,69	6,8
0,72	70,31	1,3	12,3	88,95	1,09	10,7	109,78	1,0	9,4	137,78	0,8	8,2	174,31	0,7	7,1
0,74	72,26	1,3	13,0	91,42	1,1	11,3	112,83	1,01	9,9	141,60	0,88	8,7	179,15	0,77	7,5
0,76	74,21	1,39	13,6	93,89	1,2	11,8	115,88	1,1	10,4	145,43	0,9	9,1	183,99	0,8	7,9
0,78	76,16	1,5	14,3	96,36	1,3	12,4	118,93	1,1	10,9	149,26	0,97	9,5	188,84	0,8	8,3
0,80	78,12	1,5	15,0	98,83	1,3	13,0	121,97	1,17	11,5	153,08	1,0	10,0	193,68	0,89	8,7
0,82	80,07	1,6	15,7	101,30	1,39	13,6	125,02	1,2	12,0	156,91	1,07	10,5	198,52	0,9	9,1
0,84	82,02	1,7	16,4	103,77	1,5	14,2	128,07	1,3	12,5	160,74	1,1	10,9	203,36	0,97	9,5
0,86	83,98	1,7	17,1	106,24	1,5	14,9	131,12	1,34	13,1	164,57	1,17	11,4	208,20	1,0	9,9
0,88	85,93	1,8	17,9	108,71	1,6	15,5	134,17	1,4	13,7	168,39	1,2	11,9	213,05	1,06	10,4
0,90	87,88	1,9	18,7	111,18	1,7	16,2	137,22	1,5	14,3	172,22	1,3	12,4	217,89	1,1	10,8
0,92	89,83	2,0	19,4	113,65	1,7	16,9	140,27	1,5	14,9	176,05	1,32	13,0	222,73	1,15	11,3
0,94	91,79	2,1	20,2	116,12	1,8	17,6	143,32	1,6	15,5	179,87	1,4	13,5	227,57	1,2	11,7
0,96	93,74	2,1	21,0	118,60	1,9	18,3	146,37	1,6	16,1	183,70	1,4	14,0	232,41	1,24	12,2
0,98	95,69	2,2	21,9	121,07	1,9	19,0	149,42	1,7	16,7	187,53	1,49	14,6	237,25	1,3	12,7
1,00	97,65	2,3	22,7	123,54	2,0	19,7	152,47	1,8	17,4	191,36	1,5	15,2	242,10	1,3	13,2
1,20	117,18	3,3	31,9	148,24	2,8	27,7	182,96	2,5	24,4	229,63	2,2	21,3	290,52	1,9	18,5
1,40	136,70	4,3	42,6	172,95	3,8	37,0	213,46	3,3	32,6	267,90	2,9	28,5	338,94	2,5	24,8
1,60	156,23	5,6	54,8	197,66	4,9	47,6	243,95	4,3	42,0	306,17	3,7	36,7	387,35	3,2	31,8
1,80	175,76	7,0	68,5	222,37	6,1	59,5	274,44	5,4	52,5	344,44	4,7	45,8	435,77	4,1	39,8
2,00	195,29	8,5	83,7	247,07	7,4	72,7	304,94	6,5	64,1	382,71	5,7	56,0	484,19	5,0	48,6
2,20	214,82	10,2	100,3	271,78	8,9	87,1	335,43	7,8	76,8	420,98	6,8	67,1	532,61	5,9	58,3
2,40	234,35	12,1	118,4	296,49	10,5	102,9	365,92	9,2	90,7	459,25	8,1	79,2	581,03	7,0	68,8
2,60	253,88	14,1	138,0	321,19	12,2	119,9	396,42	10,8	105,7	497,52	9,4	92,3	629,45	8,2	80,2
2,80	273,41	16,2	159,1	345,90	14,1	138,2	426,91	12,4	121,8	535,79	10,8	106,4	677,87	9,4	92,5
3,00	292,94	18,5	181,6	370,61	16,1	157,7	457,40	14,2	139,1	574,07	12,4	121,4	726,29	10,8	105,6
3,50	341,76	24,9	244,2	432,38	21,6	212,1	533,64	19,1	187,1	669,74	16,7	163,4	847,34	14,5	142,0
4,00	390,58	32,2	316,0	494,15	28,0	274,5	609,87	24,7	242,1	765,42	21,6	211,4	968,39	18,7	183,8
4,50	439,41	40,5	396,9	555,91	35,2	344,8	686,11	31,0	304,1	861,10	27,1	265,5	1089,43	23,5	230,8
5,00	488,23	49,6	486,9	617,68	43,1	423,0	762,34	38,0	373,0	956,78	33,2	325,8	1210,48	28,9	283,2
5,50	537,05	59,8	586,0	679,45	51,9	509,1	838,57	45,8	449,0	1052,45	40,0	392,1	1331,53	34,8	340,9
6,00	585,88	70,8	694,2	741,22	61,5	603,1	914,81	54,2	531,9	1148,13	47,4	464,5	1452,58	41,2	403,9

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 21 and Pressure Class PN 8 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe *acc. to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 21** and pressure class **PN 8 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)																		
Coefficient of kinematic viscosity of liquid ($\gamma = 1.308 \times 10^{-6}$ m²/s)																		
DN/ODxe	40x2.0 mm			50x2.4 mm			63x3.0 mm			75x3.6 mm			90x4.3 mm			110x5.3 mm		
ID	36.0 mm			45.2 mm			57.0 mm			67.8 mm			81.4 mm			99.4 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	0,10	0,6	6,2	0,16	0,5	4,6	0,26	0,3	3,4	0,36	0,3	2,7	0,52	0,2	2,2	0,78	0,2	1,7
0,15	0,15	1,3	12,4	0,24	0,9	9,3	0,38	0,7	6,9	0,54	0,6	5,5	0,78	0,4	4,4	1,16	0,3	3,4
0,20	0,20	2,1	20,4	0,32	1,6	15,2	0,51	1,2	11,3	0,72	0,9	9,1	1,04	0,7	7,2	1,55	0,6	5,6
0,25	0,25	3,1	30,0	0,40	2,3	22,4	0,64	1,7	16,7	0,90	1,4	13,4	1,30	1,1	10,7	1,94	0,8	8,3
0,30	0,31	4,2	41,1	0,48	3,1	30,8	0,77	2,3	23,0	1,08	1,9	18,5	1,56	1,5	14,7	2,33	1,2	11,5
0,35	0,36	5,5	53,8	0,56	4,1	40,3	0,89	3,1	30,1	1,26	2,5	24,2	1,82	2,0	19,3	2,72	1,5	15,0
0,40	0,41	6,9	67,9	0,64	5,2	50,9	1,02	3,9	38,1	1,44	3,1	30,6	2,08	2,5	24,4	3,10	1,9	19,1
0,45	0,46	8,5	83,4	0,72	6,4	62,6	1,15	4,8	46,9	1,62	3,8	37,7	2,34	3,1	30,1	3,49	2,4	23,5
0,50	0,51	10,2	100,4	0,80	7,7	75,4	1,28	5,8	56,4	1,81	4,6	45,5	2,60	3,7	36,3	3,88	2,9	28,3
0,55	0,56	12,1	118,7	0,88	9,1	89,2	1,40	6,8	66,8	1,99	5,5	53,9	2,86	4,4	43,0	4,27	3,4	33,6
0,60	0,61	14,1	138,4	0,96	10,6	104,1	1,53	8,0	78,0	2,17	6,4	62,9	3,12	5,1	50,2	4,66	4,0	39,2
0,65	0,66	16,3	159,4	1,04	12,2	119,9	1,66	9,2	89,9	2,35	7,4	72,5	3,38	5,9	57,9	5,04	4,6	45,3
0,70	0,713	18,5	181,7	1,12	13,9	136,8	1,79	10,5	102,6	2,53	8,4	82,7	3,64	6,7	66,1	5,43	5,3	51,7
0,72	0,733	19,5	191,0	1,16	14,7	143,8	1,84	11,0	107,8	2,60	8,9	87,0	3,75	7,1	69,5	5,59	5,5	54,4
0,74	0,753	20,4	200,5	1,19	15,4	151,0	1,89	11,5	113,2	2,67	9,3	91,4	3,85	7,4	73,0	5,74	5,8	57,1
0,76	0,774	21,4	210,2	1,22	16,1	158,3	1,94	12,1	118,7	2,74	9,8	95,8	3,96	7,8	76,5	5,90	6,1	59,9
0,78	0,794	22,4	220,1	1,25	16,9	165,8	1,99	12,7	124,4	2,82	10,2	100,4	4,06	8,2	80,2	6,05	6,4	62,8
0,80	0,814	23,5	230,3	1,28	17,7	173,4	2,04	13,3	130,1	2,89	10,7	105,0	4,16	8,6	83,9	6,21	6,7	65,7
0,82	0,835	24,5	240,6	1,316	18,5	181,2	2,09	13,9	136,0	2,96	11,2	109,8	4,27	8,9	87,7	6,36	7,0	68,7
0,84	0,855	25,6	251,1	1,348	19,3	189,2	2,14	14,5	142,0	3,03	11,7	114,6	4,37	9,3	91,6	6,52	7,3	71,7
0,86	0,875	26,7	261,8	1,38	20,1	197,3	2,19	15,1	148,1	3,10	12,2	119,6	4,48	9,7	95,5	6,67	7,6	74,8
0,88	0,896	27,8	272,8	1,412	21,0	205,6	2,25	15,7	154,3	3,18	12,7	124,6	4,58	10,1	99,5	6,83	7,9	78,0
0,90	0,916	28,9	283,9	1,444	21,8	214,0	2,30	16,4	160,6	3,25	13,2	129,7	4,68	10,6	103,6	6,98	8,3	81,2
0,92	0,936	30,1	295,2	1,48	22,7	222,5	2,35	17,0	167,1	3,32	13,8	134,9	4,79	11,0	107,8	7,14	8,6	84,5
0,94	0,957	31,3	306,8	1,508	23,6	231,3	2,40	17,7	173,6	3,39	14,3	140,2	4,89	11,4	112,1	7,29	9,0	87,8
0,96	0,977	32,5	318,5	1,540	24,5	240,1	2,45	18,4	180,3	3,47	14,8	145,6	5,00	11,9	116,4	7,45	9,3	91,2
0,98	0,998	33,7	330,4	1,57	25,4	249,1	2,50	19,1	187,1	3,54	15,4	151,1	5,10	12,3	120,8	7,60	9,6	94,6
1,00	1,018	34,9	342,6	1,60	26,3	258,3	2,55	19,8	194,0	3,61	16,0	156,7	5,20	12,8	125,3	7,76	10,0	98,1
1,20	1,22	48,4	474,6	1,93	36,5	358,2	3,06	27,4	269,2	4,33	22,2	217,6	6,24	17,7	174,0	9,31	13,9	136,4
1,40	1,43	63,8	625,9	2,25	48,2	472,6	3,57	36,2	355,5	5,05	29,3	287,5	7,29	23,5	230,0	10,86	18,4	180,4
1,60	1,63	81,2	796,1	2,57	61,3	601,5	4,08	46,1	452,6	5,78	37,3	366,1	8,33	29,9	293,1	12,42	23,5	230,0
1,80	1,83	100,4	984,8	2,89	75,9	744,4	4,59	57,1	560,4	6,50	46,2	453,5	9,37	37,0	363,1	13,97	29,1	285,1
2,00	2,04	121,5	1192,0	3,21	91,9	901,3	5,10	69,2	678,8	7,22	56,0	549,5	10,41	44,9	440,1	15,52	35,2	345,6
2,20	2,24	144,5	1417,2	3,53	109,3	1072,0	5,61	82,3	807,6	7,94	66,7	653,9	11,45	53,4	523,8	17,07	42,0	411,4
2,40	2,44	169,3	1660,5	3,85	128,1	1256,4	6,12	96,5	946,7	8,66	78,2	766,7	12,49	62,6	614,3	18,62	49,2	482,6
2,60	2,65	195,9	1921,5	4,17	148,3	1454,3	6,63	111,8	1096,1	9,39	90,5	887,8	13,53	72,6	711,5	20,18	57,0	559,1
2,80	2,85	224,4	2200,3	4,49	169,8	1665,6	7,14	128,0	1255,7	10,11	103,7	1017,3	14,57	83,1	815,4	21,73	65,3	640,8
3,00	3,05	254,6	2496,7	4,81	192,8	1890,4	7,66	145,3	1425,4	10,83	117,8	1154,9	15,61	94,4	925,9	23,28	74,2	727,8
3,50	3,56	337,9	3313,9	5,62	256,0	2510,2	8,93	193,1	1893,5	12,64	156,5	1534,7	18,21	125,5	1230,7	27,16	98,7	967,7
4,00	4,07	432,3	4239,3	6,42	327,5	3212,2	10,21	247,2	2423,9	14,44	200,4	1965,0	20,82	160,7	1576,2	31,04	126,4	1239,7
4,50	4,58	537,5	5271,8	7,22	407,4	3995,7	11,48	307,5	3015,9	16,25	249,3	2445,4	23,42	200,0	1961,9	34,92	157,4	1543,4
5,00	5,09	653,7	6410,8	8,02	495,5	4860,0	12,76	374,1	3669,1	18,05	303,4	2975,5	26,02	243,5	2387,7	38,80	191,6	1878,6
5,50	5,60	780,6	7655,5	8,83	591,9	5804,8	14,03	446,9	4383,2	19,86	362,5	3555,1	28,62	290,9	2853,1	42,68	228,9	2245,2
6,00	6,11	918,2	9005,6	9,63	696,4	6829,6	15,31	525,9	5157,8	21,66	426,6	4183,9	31,22	342,4	3358,2	46,56	269,5	2643,0

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm³/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 21 and Pressure Class PN 8 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe a*cc. to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 21** and pressure class **PN 8 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)															
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6}m^2/s)															
DN/ODxe	125x6.0 mm			140x6.7 mm			160x7.7 mm			180x8.6 mm			200x9.6 mm		
ID	113.0 mm			126.6 mm			144.6 mm			162.8 mm			180.8 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	1,00	0,1	1,4	1,26	0,1	1,2	1,64	0,1	1,0	2,08	0,1	0,9	2,57	0,1	0,8
0,15	1,50	0,3	2,9	1,89	0,3	2,5	2,46	0,2	2,1	3,12	0,2	1,8	3,85	0,2	1,6
0,20	2,01	0,5	4,8	2,52	0,4	4,1	3,28	0,4	3,5	4,16	0,3	3,0	5,13	0,3	2,7
0,25	2,51	0,7	7,1	3,15	0,6	6,1	4,11	0,5	5,2	5,20	0,5	4,5	6,42	0,4	4,0
0,30	3,01	1,0	9,8	3,78	0,9	8,5	4,93	0,7	7,2	6,24	0,6	6,2	7,70	0,6	5,5
0,35	3,51	1,3	12,8	4,41	1,1	11,2	5,75	1,0	9,5	7,29	0,8	8,2	8,99	0,7	7,2
0,40	4,01	1,7	16,3	5,04	1,4	14,1	6,57	1,2	12,0	8,33	1,1	10,4	10,27	0,9	9,1
0,45	4,51	2,0	20,1	5,66	1,8	17,4	7,39	1,5	14,8	9,37	1,3	12,8	11,55	1,1	11,3
0,50	5,01	2,5	24,2	6,29	2,1	21,0	8,21	1,8	17,9	10,41	1,6	15,5	12,84	1,4	13,6
0,55	5,52	2,9	28,7	6,92	2,5	25,0	9,03	2,2	21,2	11,45	1,9	18,4	14,12	1,6	16,2
0,60	6,02	3,4	33,5	7,55	3,0	29,2	9,85	2,5	24,8	12,49	2,2	21,5	15,40	1,9	18,9
0,65	6,52	3,9	38,7	8,18	3,4	33,7	10,67	2,9	28,6	13,53	2,5	24,8	16,69	2,2	21,8
0,70	7,02	4,5	44,2	8,81	3,9	38,5	11,50	3,3	32,7	14,57	2,9	28,3	17,97	2,5	24,9
0,72	7,22	4,7	46,5	9,06	4,1	40,5	11,82	3,5	34,4	14,99	3,0	29,8	18,48	2,7	26,2
0,74	7,42	5,0	48,8	9,32	4,3	42,5	12,15	3,7	36,1	15,40	3,2	31,3	19,00	2,8	27,6
0,76	7,62	5,2	51,2	9,57	4,5	44,6	12,48	3,9	37,9	15,82	3,3	32,8	19,51	2,9	28,9
0,78	7,82	5,5	53,7	9,82	4,8	46,7	12,81	4,1	39,7	16,24	3,5	34,4	20,03	3,1	30,3
0,80	8,02	5,7	56,2	10,07	5,0	48,9	13,14	4,2	41,6	16,65	3,7	36,0	20,54	3,2	31,7
0,82	8,22	6,0	58,7	10,32	5,2	51,1	13,47	4,4	43,5	17,07	3,8	37,7	21,05	3,4	33,2
0,84	8,42	6,3	61,3	10,57	5,4	53,4	13,79	4,6	45,4	17,49	4,0	39,3	21,57	3,5	34,6
0,86	8,62	6,5	64,0	10,83	5,7	55,7	14,12	4,8	47,4	17,90	4,2	41,0	22,08	3,7	36,2
0,88	8,83	6,8	66,7	11,08	5,9	58,1	14,45	5,0	49,4	18,32	4,4	42,8	22,59	3,8	37,7
0,90	9,03	7,1	69,4	11,33	6,2	60,5	14,78	5,2	51,4	18,73	4,5	44,6	23,11	4,0	39,3
0,92	9,23	7,4	72,2	11,58	6,4	62,9	15,11	5,5	53,5	19,15	4,7	46,4	23,62	4,2	40,9
0,94	9,43	7,7	75,1	11,83	6,7	65,4	15,44	5,7	55,7	19,57	4,9	48,2	24,13	4,3	42,5
0,96	9,63	8,0	78,0	12,08	6,9	67,9	15,77	5,9	57,8	19,98	5,1	50,1	24,65	4,5	44,1
0,98	9,83	8,3	81,0	12,34	7,2	70,5	16,09	6,1	60,0	20,40	5,3	52,0	25,16	4,7	45,8
1,00	10,03	8,6	84,0	12,59	7,5	73,1	16,42	6,3	62,2	20,82	5,5	53,9	25,67	4,8	47,5
1,20	12,03	11,9	116,8	15,11	10,4	101,7	19,71	8,8	86,6	24,98	7,7	75,1	30,81	6,7	66,2
1,40	14,04	15,7	154,5	17,62	13,7	134,6	22,99	11,7	114,7	29,14	10,1	99,4	35,94	8,9	87,6
1,60	16,05	20,1	196,9	20,14	17,5	171,7	26,28	14,9	146,3	33,31	12,9	126,8	41,08	11,4	111,8
1,80	18,05	24,9	244,1	22,66	21,7	212,9	29,56	18,5	181,4	37,47	16,0	157,3	46,21	14,1	138,7
2,00	20,06	30,2	296,0	25,18	26,3	258,1	32,84	22,4	220,0	41,63	19,5	190,8	51,35	17,2	168,3
2,20	22,06	35,9	352,5	27,69	31,3	307,4	36,13	26,7	262,1	45,80	23,2	227,4	56,48	20,4	200,5
2,40	24,07	42,2	413,5	30,21	36,8	360,7	39,41	31,4	307,5	49,96	27,2	266,8	61,62	24,0	235,4
2,60	26,07	48,9	479,1	32,73	42,6	418,0	42,70	36,3	356,4	54,12	31,5	309,3	66,75	27,8	272,8
2,80	28,08	56,0	549,2	35,25	48,9	479,2	45,98	41,7	408,6	58,28	36,2	354,6	71,89	31,9	312,9
3,00	30,09	63,6	623,8	37,76	55,5	544,3	49,27	47,3	464,2	62,45	41,1	402,9	77,02	36,2	355,5
3,50	35,10	84,6	829,6	44,06	73,8	724,0	57,48	63,0	617,6	72,86	54,7	536,1	89,86	48,2	473,1
4,00	40,11	108,4	1063,0	50,35	94,6	927,8	65,69	80,7	791,6	83,26	70,1	687,2	102,69	61,8	606,6
4,50	45,13	135,0	1323,6	56,65	117,8	1155,4	73,90	100,5	985,9	93,67	87,3	856,0	115,53	77,0	755,6
5,00	50,14	164,3	1611,3	62,94	143,4	1406,7	82,11	122,4	1200,4	104,08	106,3	1042,4	128,37	93,8	920,2
5,50	55,16	196,4	1925,9	69,23	171,4	1681,4	90,32	146,3	1435,0	114,49	127,1	1246,3	141,20	112,2	1100,3
6,00	60,17	231,2	2267,2	75,53	201,9	1979,6	98,53	172,3	1689,7	124,90	149,6	1467,5	154,04	132,1	1295,7

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 21 and Pressure Class PN 8 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe a*cc. to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 21** and pressure class **PN 8 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)															
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6} m^2/s)															
DN/ODxe	225x10.8 mm			250x11.9 mm			280x13.4 mm			315x15.0 mm			355x16.9 mm		
ID	203.4 mm			226.2 mm			253.2 mm			285.0 mm			321.2 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	3,25	0,1	0,7	4,02	0,1	0,6	5,04	0,1	0,5	6,38	0,05	0,5	8,10	0,04	0,4
0,15	4,87	0,1	1,4	6,03	0,1	1,2	7,55	0,1	1,1	9,57	0,09	0,9	12,15	0,08	0,8
0,20	6,50	0,2	2,4	8,04	0,2	2,1	10,07	0,2	1,8	12,76	0,2	1,6	16,21	0,1	1,3
0,25	8,12	0,4	3,5	10,05	0,3	3,1	12,59	0,3	2,7	15,95	0,2	2,3	20,26	0,2	2,0
0,30	9,75	0,5	4,9	12,06	0,4	4,3	15,11	0,4	3,7	19,14	0,3	3,2	24,31	0,3	2,8
0,35	11,37	0,7	6,4	14,07	0,6	5,7	17,62	0,5	4,9	22,33	0,4	4,3	28,36	0,4	3,7
0,40	13,00	0,8	8,2	16,07	0,7	7,2	20,14	0,6	6,3	25,52	0,6	5,4	32,41	0,5	4,7
0,45	14,62	1,0	10,2	18,08	0,9	8,9	22,66	0,8	7,8	28,71	0,7	6,7	36,46	0,6	5,8
0,50	16,25	1,3	12,3	20,09	1,1	10,8	25,18	1,0	9,4	31,90	0,8	8,2	40,51	0,7	7,1
0,55	17,87	1,5	14,7	22,10	1,3	12,9	27,69	1,1	11,2	35,09	1,0	9,7	44,57	0,9	8,4
0,60	19,50	1,8	17,2	24,11	1,5	15,1	30,21	1,3	13,2	38,28	1,2	11,4	48,62	1,0	9,9
0,65	21,12	2,0	19,9	26,12	1,8	17,5	32,73	1,6	15,3	41,47	1,3	13,2	52,67	1,2	11,4
0,70	22,745	2,3	22,8	28,13	2,0	20,1	35,25	1,8	17,5	44,66	1,5	15,1	56,72	1,3	13,1
0,72	23,395	2,5	24,1	28,93	2,2	21,1	36,25	1,9	18,4	45,93	1,6	16,0	58,34	1,4	13,8
0,74	24,045	2,6	25,3	29,74	2,3	22,2	37,26	2,0	19,4	47,21	1,7	16,8	59,96	1,5	14,5
0,76	24,695	2,7	26,6	30,54	2,4	23,3	38,27	2,1	20,4	48,48	1,8	17,6	61,58	1,6	15,3
0,78	25,345	2,8	27,9	31,35	2,5	24,5	39,27	2,2	21,4	49,76	1,9	18,5	63,20	1,6	16,0
0,80	25,995	3,0	29,2	32,15	2,6	25,7	40,28	2,3	22,4	51,04	2,0	19,4	64,82	1,7	16,8
0,82	26,644	3,1	30,6	32,953	2,7	26,9	41,29	2,4	23,4	52,31	2,1	20,3	66,44	1,8	17,6
0,84	27,294	3,3	32,0	33,756	2,9	28,1	42,30	2,5	24,5	53,59	2,2	21,2	68,06	1,9	18,4
0,86	27,944	3,4	33,4	34,56	3,0	29,3	43,30	2,6	25,6	54,86	2,3	22,2	69,69	2,0	19,2
0,88	28,594	3,6	34,9	35,364	3,1	30,6	44,31	2,7	26,7	56,14	2,4	23,1	71,31	2,0	20,0
0,90	29,244	3,7	36,3	36,167	3,3	31,9	45,32	2,8	27,8	57,41	2,5	24,1	72,93	2,1	20,9
0,92	29,894	3,9	37,8	36,97	3,4	33,3	46,32	3,0	29,0	58,69	2,6	25,1	74,55	2,2	21,8
0,94	30,544	4,0	39,4	37,775	3,5	34,6	47,33	3,1	30,2	59,97	2,7	26,2	76,17	2,3	22,6
0,96	31,193	4,2	41,0	38,579	3,7	36,0	48,34	3,2	31,4	61,24	2,8	27,2	77,79	2,4	23,5
0,98	31,843	4,3	42,6	39,38	3,8	37,4	49,35	3,3	32,6	62,52	2,9	28,3	79,41	2,5	24,5
1,00	32,493	4,5	44,2	40,19	4,0	38,8	50,35	3,5	33,9	63,79	3,0	29,4	81,03	2,6	25,4
1,20	38,99	6,3	62,1	48,22	5,6	54,6	60,42	4,9	47,6	76,55	4,2	41,3	97,23	3,6	35,7
1,40	45,49	8,5	82,9	56,26	7,4	72,9	70,49	6,5	63,6	89,31	5,6	55,1	113,44	4,9	47,7
1,60	51,99	10,9	106,6	64,30	9,6	93,7	80,56	8,3	81,7	102,07	7,2	70,9	129,65	6,3	61,4
1,80	58,49	13,6	133,1	72,33	11,9	117,0	90,63	10,4	102,1	114,83	9,0	88,5	145,85	7,8	76,7
2,00	64,99	16,6	162,5	80,37	14,6	142,9	100,70	12,7	124,7	127,59	11,0	108,1	162,06	9,5	93,6
2,20	71,48	19,9	194,8	88,41	17,5	171,3	110,77	15,2	149,5	140,35	13,2	129,6	178,26	11,4	112,2
2,40	77,98	23,4	229,9	96,45	20,6	202,1	120,84	18,0	176,4	153,11	15,6	153,0	194,47	13,5	132,5
2,60	84,48	27,3	267,8	104,48	24,0	235,5	130,92	21,0	205,5	165,86	18,2	178,2	210,68	15,7	154,4
2,80	90,98	31,5	308,6	112,52	27,7	271,4	140,99	24,2	236,9	178,62	20,9	205,4	226,88	18,1	177,9
3,00	97,48	35,9	352,2	120,56	31,6	309,7	151,06	27,6	270,3	191,38	23,9	234,4	243,09	20,7	203,1
3,50	113,73	48,3	473,6	140,65	42,5	416,6	176,23	37,1	363,6	223,28	32,2	315,3	283,60	27,8	273,1
4,00	129,97	62,5	612,7	160,74	54,9	538,9	201,41	48,0	470,4	255,18	41,6	408,0	324,12	36,0	353,4
4,50	146,22	78,5	769,5	180,84	69,0	676,8	226,58	60,2	590,8	287,07	52,2	512,4	364,63	45,3	443,8
5,00	162,47	96,2	943,9	200,93	84,7	830,2	251,76	73,9	724,7	318,97	64,1	628,5	405,15	55,5	544,5
5,50	178,71	115,8	1135,9	221,02	101,9	999,1	276,94	88,9	872,2	350,87	77,1	756,5	445,66	66,8	655,3
6,00	194,96	137,2	1345,6	241,12	120,7	1183,6	302,11	105,3	1033,2	382,76	91,4	896,1	486,17	79,2	776,3

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Frictional Pressure Drop for EVO SCGR ULTRASTRESS (PE100-RC) and EVOAQUA (PE100) Pressure Pipe with SDR 21 and Pressure Class PN 8 bar

Table of hydraulic parameters for determination of frictional pressure drop (composed basing on the inner diameter of the pipe a*cc. to Darcy-Weisbach and Colebrook*-White equations**)** for **EVO SCGR ULTRASTRESS** (PE100-RC) and **EVOAQUA** (PE100) pressure pipes with **SDR 21** and pressure class **PN 8 bar**. Calculations are performed with permissible error **k=0.01** mm (for pipes with **ID ≤ 200 mm)** and **k=0.05 mm** (for pipes with **ID > 200 mm**).

Water temperature (t=10°C)															
Coefficient of kinematic viscosity of liquid (γ = 1.308x10^{-6}m^2/s)															
DN/ODxe	400x19.1 mm			450x21.5 mm			500x23.9 mm			560x26.7 mm			630x30.0 mm		
ID	361.8 mm			407.0 mm			452.2 mm			506.6 mm			570.0 mm		
v	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP	Q	Hr	ΔP
m/s	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m	dm³/s l/s	mm/m m/km	Pa/m
0,10	10,28	0,03	0,3	13,01	0,03	0,3	16,06	0,03	0,3	20,16	0,02	0,2	25,52	0,02	0,2
0,15	15,42	0,07	0,7	19,52	0,06	0,6	24,09	0,05	0,5	30,24	0,05	0,5	38,28	0,04	0,4
0,20	20,56	0,12	1,2	26,02	0,1	1,0	32,12	0,1	0,9	40,31	0,1	0,8	51,04	0,07	0,7
0,25	25,70	0,2	1,7	32,53	0,2	1,5	40,15	0,13	1,3	50,39	0,12	1,1	63,79	0,1	1,0
0,30	30,84	0,2	2,4	39,03	0,2	2,1	48,18	0,2	1,8	60,47	0,2	1,6	76,55	0,14	1,4
0,35	35,98	0,3	3,2	45,54	0,3	2,8	56,21	0,2	2,4	70,55	0,2	2,1	89,31	0,2	1,8
0,40	41,12	0,4	4,1	52,04	0,4	3,5	64,24	0,3	3,1	80,63	0,3	2,7	102,07	0,2	2,3
0,45	46,26	0,5	5,0	58,55	0,4	4,4	72,27	0,4	3,8	90,71	0,3	3,4	114,83	0,3	2,9
0,50	51,40	0,6	6,1	65,05	0,5	5,3	80,30	0,5	4,7	100,78	0,4	4,1	127,59	0,4	3,5
0,55	56,54	0,7	7,3	71,56	0,6	6,3	88,33	0,6	5,6	110,86	0,5	4,8	140,35	0,4	4,2
0,60	61,68	0,9	8,5	78,06	0,8	7,4	96,36	0,7	6,5	120,94	0,6	5,7	153,11	0,5	4,9
0,65	66,83	1,0	9,9	84,57	0,9	8,6	104,39	0,8	7,6	131,02	0,7	6,6	165,86	0,6	5,7
0,70	71,97	1,2	11,3	91,07	1,0	9,8	112,42	0,9	8,7	141,10	0,8	7,6	178,62	0,67	6,6
0,72	74,02	1,2	12,0	93,67	1,06	10,4	115,63	0,9	9,1	145,13	0,8	8,0	183,73	0,7	6,9
0,74	76,08	1,3	12,6	96,27	1,1	10,9	118,85	0,98	9,6	149,16	0,86	8,4	188,83	0,74	7,3
0,76	78,13	1,35	13,2	98,88	1,2	11,5	122,06	1,0	10,1	153,19	0,9	8,8	193,93	0,8	7,6
0,78	80,19	1,4	13,9	101,48	1,2	12,0	125,27	1,1	10,6	157,22	0,94	9,2	199,04	0,8	8,0
0,80	82,25	1,5	14,5	104,08	1,3	12,6	128,48	1,13	11,1	161,25	1,0	9,7	204,14	0,86	8,4
0,82	84,30	1,6	15,2	106,68	1,35	13,2	131,69	1,2	11,6	165,29	1,03	10,1	209,24	0,9	8,8
0,84	86,36	1,6	15,9	109,28	1,4	13,8	134,91	1,2	12,2	169,32	1,1	10,6	214,35	0,94	9,2
0,86	88,41	1,7	16,6	111,89	1,5	14,4	138,12	1,30	12,7	173,35	1,13	11,1	219,45	1,0	9,6
0,88	90,47	1,8	17,3	114,49	1,5	15,1	141,33	1,4	13,3	177,38	1,2	11,6	224,55	1,02	10,0
0,90	92,53	1,8	18,1	117,09	1,6	15,7	144,54	1,4	13,8	181,41	1,2	12,1	229,66	1,1	10,5
0,92	94,58	1,9	18,8	119,69	1,7	16,4	147,75	1,5	14,4	185,44	1,28	12,6	234,76	1,11	10,9
0,94	96,64	2,0	19,6	122,29	1,7	17,0	150,97	1,5	15,0	189,47	1,3	13,1	239,87	1,2	11,4
0,96	98,70	2,1	20,4	124,90	1,8	17,7	154,18	1,6	15,6	193,50	1,4	13,6	244,97	1,21	11,8
0,98	100,75	2,2	21,2	127,50	1,9	18,4	157,39	1,7	16,2	197,54	1,44	14,1	250,07	1,3	12,3
1,00	102,81	2,2	22,0	130,10	1,9	19,1	160,60	1,7	16,8	201,57	1,5	14,7	255,18	1,3	12,8
1,20	123,37	3,2	30,9	156,12	2,7	26,9	192,72	2,4	23,7	241,88	2,1	20,7	306,21	1,8	17,9
1,40	143,93	4,2	41,3	182,14	3,7	35,9	224,84	3,2	31,6	282,19	2,8	27,6	357,25	2,4	24,0
1,60	164,49	5,4	53,2	208,16	4,7	46,2	256,96	4,1	40,7	322,51	3,6	35,5	408,28	3,1	30,9
1,80	185,05	6,8	66,4	234,18	5,9	57,7	289,08	5,2	50,9	362,82	4,5	44,4	459,32	3,9	38,6
2,00	205,62	8,3	81,2	260,20	7,2	70,5	321,20	6,3	62,1	403,13	5,5	54,2	510,35	4,8	47,1
2,20	226,18	9,9	97,3	286,22	8,6	84,5	353,32	7,6	74,5	443,45	6,6	65,0	561,39	5,8	56,5
2,40	246,74	11,7	114,8	312,24	10,2	99,7	385,44	9,0	87,9	483,76	7,8	76,8	612,42	6,8	66,7
2,60	267,30	13,6	133,8	338,26	11,9	116,2	417,57	10,4	102,5	524,08	9,1	89,5	663,46	7,9	77,7
2,80	287,86	15,7	154,2	364,28	13,7	133,9	449,69	12,0	118,1	564,39	10,5	103,1	714,49	9,1	89,6
3,00	308,42	17,9	176,0	390,30	15,6	152,9	481,81	13,7	134,8	604,70	12,0	117,7	765,53	10,4	102,3
3,50	359,83	24,1	236,8	455,35	21,0	205,7	562,11	18,5	181,4	705,49	16,1	158,4	893,12	14,0	137,6
4,00	411,23	31,2	306,4	520,40	27,1	266,1	642,41	23,9	234,7	806,27	20,9	204,9	1020,70	18,2	178,1
4,50	462,64	39,2	384,8	585,45	34,1	334,3	722,71	30,1	294,8	907,05	26,2	257,4	1148,29	22,8	223,7
5,00	514,04	48,1	472,1	650,50	41,8	410,1	803,01	36,9	361,6	1007,84	32,2	315,8	1275,88	28,0	274,5
5,50	565,44	57,9	568,2	715,55	50,3	493,6	883,31	44,4	435,3	1108,62	38,8	380,2	1403,47	33,7	330,4
6,00	616,85	68,6	673,1	780,60	59,6	584,7	963,61	52,6	515,7	1209,40	45,9	450,4	1531,06	39,9	391,4

Denomination used in the table: DN/OD x e - pipe nominal/outside diameter x wall thickness, [mm]; **ID** - pipe inner diameter, [mm]; **v** - flow velocity, [m/s]; **Q** - water flow rate, [dm^3/s=l/s]; **Hr** - frictional pressure drop, [mm/m=m/km]; **ΔP** - frictional pressure drop, [Pa/m].

Standards of Products

Nr.	Standard number	Standard title
1	**EN 12201-2:2003**	Plastics piping systems for water supply - Polyethylene (PE) - Part 2: Pipes
2	**EN 12201-3:2003**	Plastics piping systems for water supply - Polyethylene (PE) - Part 3: Fittings
3	**EN 12201-4:2002**	Plastics piping systems for water supply - Polyethylene (PE) - Part 4: Valves
4	**EN 12201-7:2002**	Plastics piping systems for water supply - Polyethylene (PE) - Part 7: Guidance for the assessment of conformity
5	**EN 13244-2:2003**	Plastics piping systems for buried and above-ground pressure systems for water of general purposes, drainage and sewerage - Polyethylene (PE) - Part 2: Pipes
6	**EN 13244-3:2003**	Plastics piping systems for buried and above-ground pressure systems for water of general purposes, drainage and sewerage - Polyethylene (PE) - Part 3: Fittings
7	**EN 13244-4:2003**	Plastics piping systems for buried and above-ground pressure systems for water of general purposes, drainage and sewerage - Polyethylene (PE) - Part 4: Valves
8	**EN 1555-2:2003**	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 2: Pipes
9	**EN 1555-3:2003**	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 3: Fittings
10	**EN 1555-4:2003**	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 4: Valves
11	**CEN/TS 1555-7:2003**	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 7: Guidance for the assessment of conformity
12	**BS ISO 4427-1**	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - General
13	**BS ISO 4427-2**	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Pipes
14	**BS ISO 4427-3**	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Fittings
15	**EN 727:2000**	Plastics piping and ducting systems - Thermoplastics pipes and fittings - Determination of Vicat softening temperature (VST)
16	**EN 728:2000**	Plastics piping and ducting systems - Polyolefin pipes and fittings - Determination of oxidation induction time
17	**EN ISO 306:2004**	Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)
18	**EN ISO 527-1:2000**	Plastics - Determination of tensile properties - Part 1: General principles
19	**EN ISO 527-2:2000**	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
20	**EN ISO 580:2005**	Plastics piping and ducting systems - Injection-moulded thermoplastics fittings - Methods for visually assessing the effects of heating
21	**EN ISO 1133:2005**	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

Standards of Products

Nr.	Standard number	Standard title
22	EN ISO 1167-1:2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 1: General method
23	EN ISO 1167-2:2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 2: Preparation of pipe test pieces
24	EN ISO 1167-3:2008	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 3: Preparation of components
25	EN ISO 1167-4:2008	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 4: Preparation of assemblies
26	EN ISO 1183-1:2004	Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pyknometer method and titration method
27	EN ISO 1183-2:2004	Plastics - Methods for determining the density of non-cellular plastics - Part 2: Density gradient column method
28	EN ISO 1183-3:2000	Plastics - Methods for determining the density of non-cellular plastics - Part 3: Gas pyknometer method
29	EN ISO 13477:2008	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to rapid crack propagation (RCP) - Small-scale steady-state test (S4 test)
30	EN ISO 13478:2007	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to rapid crack propagation (RCP) - Full-scale test
31	EN ISO 13479:2000	Polyolefin pipes for the conveyance of fluids - Determination of resistance to crack propagation - Test method for slow crack growth on notched pipes (notch test)
32	EN ISO 1872-2:2007	Plastics - Polyethylene (PE) moulding and extrusion materials - Part 2: Preparation of test specimens and determination of properties
33	EN ISO 3126:2005	Plastics piping systems - Plastics components - Determination of dimensions
34	EN ISO 6259-1:2002	Thermoplastics pipes - Determination of tensile properties - Part 1: General test method
35	EN 12889:2001	Trenchless construction and testing of drains and sewers
36	EN 1610:2000	Construction and testing of drains and sewers
37	EN 805:2001	Water supply - Requirements for systems and components outside buildings
38	EN 1508:1998	Water supply - Requirements for systems and components for the storage of water
39	PAS 1075:2009-04	Pipes made from Polyethylene for alternative installation techniques-Dimensions, Technical Requirements and Testing
40	EN ISO 9001:2009 A/L	Quality management systems - Requirements (ISO 9001:2008)
41	ISO/TR 10358	Plastics pipes and fittings - Combined chemical-resistance classification table
42	ISO/TR 7620	Rubber materials - Chemical resistance

Chemical resistance of different plastic materials according to ISO/TR 10358

Chemical substances		PVC	Polyethylene	Polypropylene	Polycarbonate	Polyamide
	°C	PVC-U	PE	PP	PC	PA
Acetaldehyde, in water (40%)	40	d	®	®	-	d
Acetic acid (10%)	40	®	®	®	®	d
Acetic acid (10%-85%)	60	®	®	®	-	-
Acetic acid (85%-95%)	40	®	®	®	-	-
Acetic acid (>95%)	20	®	®	®	-	-
Acetone (small amount)	20	-	®	®	-	®
Ammonia, water liquid (20%)	40	®	®	®	-	®
Ammonia, dry gas	60	®	®	®	-	®
Ammonium chloride (20%)	20	®	d	d	d	-
Ammonium fluoride (2%)	20	®	d	d	d	-
Ammonium nitrate (20%)	20	®	d	d	d	-
Aniline (saturated liquid)	60	d	-	-	-	d
Orthoarsenic acid (<20%)	60	®	®	®	®	d
Beer	60	®	®	®	d	®
Benzene	20	-	d	d	-	®
Bleach (13%)	40	®	®	®	d	d
Borax, saturated liquid	60	®	®	®	d	d
Bromine acid, liquid (10%)	20	®	®	®	-	-
Butane, gas		®	-	-	®	®
Carbonic acid, dry	40	®	®	®	®	®
Carbonic acid, dry or moist	40	®	®	®	d	®
Carbon tetrachloride	20	-	-	-	-	®
Carbon disulphide	20	d	d	d	-	d
Sodium hydroxide (<40%)	40	®	®	®	-	®
Sodium hydroxide (40%-60%)	60	®	®	®	-	®
Cement. dry	20	®	®	®	®	®
Cement, mixture	20	®	®	®	-	®
Chlorine, dry or moist gas	20	d	d	d	-	-
Chlorine, water liquid	20	d	-	-	-	-
Chlorinated carbohydrate		-	-	-	-	®
Chlorosulphuric acid (100%)	20	d	d	d	-	-
Chromic acid, water liquid (<50%)	50	®	®	®	-	-
Chromic acid (20%)		d	d	d	®	-
Chromosulphuric acid (20%)		d	d	d	-	-
Citric acid, saturated liquid	60	®	®	®	®	®
Cresol, liquid (<90%)	45	d	d	d	-	-
Copper sulphate, saturated liquid	60	®	®	®	®	d
Copper chloride, saturated liquid	60	®	®	®	®	d
Diesel fuel	20	®	®	®	d	®
Photo developers	40	®	®	®	d	®
Dextrin (18%)	20	®	®	®	d	®
Esther		-	-	-	-	®
Ethyl alcohol (<40%)	40	®	®	®	d	®
Ethyl ether	20	-	d	d	d	®
Butyric acid	20	®	d	d	d	®
	40	®	®	®	d	®
Chlorinated fluorocarbohydrate		®	d	d	®	®
Formaldehyde, liquid	30	®	®	®	d	®
Formic acid (<30%)	40	®	®	®	d	-
Formic acid, concentrate	20	®	®	®	-	-

Chemical substances		PVC	Polyethylene	Polypropylene	Polycarbonate	Polyamide
	°C	PVC-U	PE	PP	PC	PA
Glycerine, liquid	60	®	®	®	d	®
Hydrochloric acid, liquid	40	®	®	®	d	-
Hydrochloric acid, concentrate	60	®	®	®	-	-
Hydrofluoric acid (40%)	20	®	®	®	-	-
Hydrofluoric acid (60%)	20	®	®	®	-	-
Hydrofluoric acid (100%)	20	®	®	®	-	-
Hydrogen (100%)	60	®	®	®	®	®
Hydrogen peroxide (20%)	20	®	®	®	d	d
Hydrogen sulphide, dry or moist	60	®	®	®	d	d
Hydrogen sulphide, liquid	40	®	®	®	d	d
Ketone		-	-	-	-	®
Lactic acid (10%-90%)	40	®	®	®	®	®
Methyl alcohol, liquid	40	®	®	®	-	®
Mineral oil	20	®	®	®	d	®
Sodium chlorate, liquid	20	®	®	®	d	®
Sodium hydroxide (<10%)	20	®	®	®	d	®
Nitric acid (<30%)	40	®	®	®	-	-
Nitric acid (<30%-45%))	45	®	®	®	-	-
Nitric acid (<50%-60%))	20	®	d	d	-	-
Nitrogen gases, dry or moist	60	d	d	d	-	d
Oils and fats	60	®	®	®	-	®
Oxalic acid, liquid (10%)	40	®	®	®	®	d
Oxalic acid, liquid (concentrate)	60	®	®	®	-	-
Oxygen	60	®	®	®	d	®
Ozone	20	®	d	d	-	d
Perchloric acid (10%)	20	®	®	®	d	®
Perchloric acid (70%)	60	-	d	d	-	d
Permanganate (<6%)	20	®	®	®	d	-
Gasoline	60	®	d	d	-	®
Petroleum	20	®	®	®	d	®
Phenol (<90%)	45	d	d	d	-	-
Orthophosphoric acid, liquid (<30%)	40	®	®	®	-	-
Orthophosphoric acid, liquid (>30%)	60	®	®	®	-	-
Potassium nitrate	60	®	®	®	-	®
Potassium chloride	60	®	®	®	-	®
Propane, liquid		®	-	-	®	®
Saline liquid	40	®	®	®	®	®
Seawater	40	®	®	®	d	®
Sulphur dioxide (all states)	40	®	®	®	d	d
Sulphuric acid, liquid (<40%)	40	®	®	®	d	-
Sulphuric acid, liquid (40%-80%)	60	®	®	®	-	-
Sulphuric acid, liquid (80%-90%)	40	®	®	®	-	-
Sulphuric acid, liquid (90%-96%)	20	®	®	®	-	-
Sodium chloride liquid (weak)	40	®	®	®	®	®
Tartaric acid (10%)	60	®	®	®	®	®
Urine	40	®	®	®	®	®
Water	60	®	®	®	®	®
Xylene (100%)	20	-	d	d	-	®
Zinc chloride, liquid (all types)	60	d	®	®	d	-
Zinc chloride, liquid (weak)	60	®	®	®	d	-

Legend:

® The plastic product is resistant against the chemical substance in the standard burying conditions
d The plastic product is partially resistant against the chemical substance in the standard burying conditions
– The plastic product does not withstand the chemical substance

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