Faso-plast®
GR. FASSOIS S.A.

INDUSTRY OF PLASTIC PIPES AND FITTINGS
PVC - POLYETHYLENE (PE) - POLYPROPYLENE (PP)

POLYETHYLENE (PE)

PIPES FOR IRRIGATION, WATER AND NATURAL GAS TRANSPORTATION

TECHNICAL CATALOGUE PE

ΕΛΟΤ

FASO-PLAST GR. CHR. FASOIS S.A.

EAOT EN ISO 9001:2000

IQNet

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

FASO-PLAST GR. CHR.FASOIS S.A.

EAOT EN ISO 9001:2000

ΕΛΟΤ

FASO-PLAST ΓΡΗΓ. ΧΡ. ΦΑΣΟΗΣ Α.Β.Ε.Ε.

EAOT EN ISO 9001:2000

ZERTIFIKAT SKZ

Certificate

Faso-Plast Greg Fasois S.A.
Industry of Plastics
Thesis 2 Pefka
19300 Aspropyrgos Attikis
Greece

A 375

Heating pipes
Pipes made of crosslinked polyethylene PE-Xb

ZERTIFIKAT SKZ

Certificate

Faso-Plast Greg Fasois S.A.
Industry of Plastics
Thesis 2 Pefka
19300 Aspropyrgos Attikis
Greece

A 387

Heating pipes
Pipes made of polypropylene PP-R

WRAS

Water Regulations Advisory Scheme

"ITEMS WHICH HAVE PASSED FULL TESTS OF EFFECT ON WATER QUALITY - BS 6920"

POLYETHYLENE COMPONENTS

FASO PLAST GR FASOIS SA

WRAS

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POLYPROPYLENE COMPONENTS

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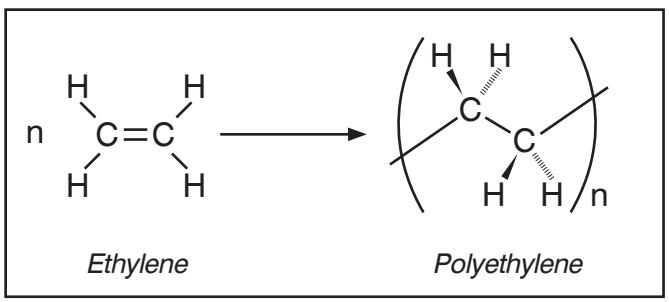
CONTENTS

Polyethylene, PE, is a thermoplastic polymer consisting of large chains of ethylene monomers and it is considered to be the most commercial polymer. It is estimated that more than 60 million tons of polyethylene are produced every year. It consists of carbon and hydrogen and the polymerization reaction process is schematically:



POLYETHYLENE TYPES

Polyethylene is classified into different categories which are mainly based on the density and the molecular internal structure:

- **Low Density Polyethylene (LDPE)**. The density ranges between 0,910–0,940 g/cm^3. The high branch degree and the long chains result in exceptional fluidity properties.
- **Medium Density Polyethylene (MDPE)**. The density ranges between 0,926–0,940 g/cm^3. It presents good impact strength and crack resistance.
- **High Density Polyethylene (HDPE)**. The density ranges in values greater than or equal to 0,95 g/cm^3. It has low branch degree and hence stronger intermolecular forces and tensile strength. The highest value of stress is required for break or permanent distortion.

Polyethylene types are categorised according to the minimum required strength (MRS) which refers to the maximum circumferential stress a pipe can bear when it operates at its nominal pressure (PN) for 50 years at 20° C.

PE	TYPE	DESCRIPTION	MINIMUM REQUIRED STRENGTH, MRS (MPa)	DESIGN STRESS, σ_s (MPa)
PE32	LDPE	low density	3,2	2,5
PE63	MDPE	medium density	6,3	5,0
PE80	HDPE	2nd generation high density	8,0	6,3
PE100	HDPE	3rd generation high density	10,0	8,0

σ_s: *Design stress* $\quad \sigma_s = MRS / C$

C: *Overall service (design) coefficient. For water applications under pressure: C = 1,25 and for gaseous fuels applications: C = 2,0.*

POLYETHYLENE TECHNICAL CHARACTERISTICS

	Standard	Units	PE80	PE100
Physical Properties				
Density	ASTM D 792	g/cm^3	0,95-0,965	0,95-0,965
Melt flow rate, MFR (5 kg load)	ISO 1133	g/10min	0,35-0,70	0,20-0,650
Mechanical Properties				
Modulus of elasticity (50 mm/min, 23°C)	ISO 527	MPa	1200	1300
Tensile strength (50 mm/min, 23°C)	DIN 53455	MPa	28	38
Stress at yield (50 mm/min, 23°C)	DIN 53455	MPa	20	25
Elongation at break (50 mm/min, 23°C)	DIN 53455	%	>600	>600
Environmental Stress Cracking Resistance (ESCR)	Bell Telephone Test F 50	h	>1000	>1000
Thermal Properties				
Vicat softening temperature (1 kg)	DIN 53460	°C	121	127
Thermal conductivity	DIN 52612	W/m °C	0,45	0,43
Specific heat	Calorimetric	kJ/kg K	3,4	1,9
Coefficient of linear thermal expansion	ASTM D 696	m/m °C	$1,3 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
Temperature at break	ASTM D 746	°C	< -100	< -100
Electrical Properties				
Dielectric constant	DIN 53483	-	2,6	2,6
Dielectric strength	DIN 53481	kV/cm	$2,2 \cdot 10^2$	$2,2 \cdot 10^2$
Specific resistance	DIN 53482	Ω cm	$\geq 10^{17}$	$\geq 10^{17}$
Surface resistance	DIN 53482	Ω	$\geq 10^{14}$	$\geq 10^{14}$

BENEFITS OF PE PIPES

- **Environmental friendly**

Polyethylene is a thermoplastic product. It is recyclable and does not pollute environment.

- **Appropriate for potable water**

2nd and 3rd generation pipes are not toxic due to the absence of additives and plasticizers and their suitability for potable water is certified.

- **Smooth surfaces**

Due to the smooth pipe surfaces, undesirable material accretion is avoided.

- **Lengthy pipes transport**

Due to their flexibility, pipes at large lengths can be transported without using special equipment and thus reducing transportation costs.

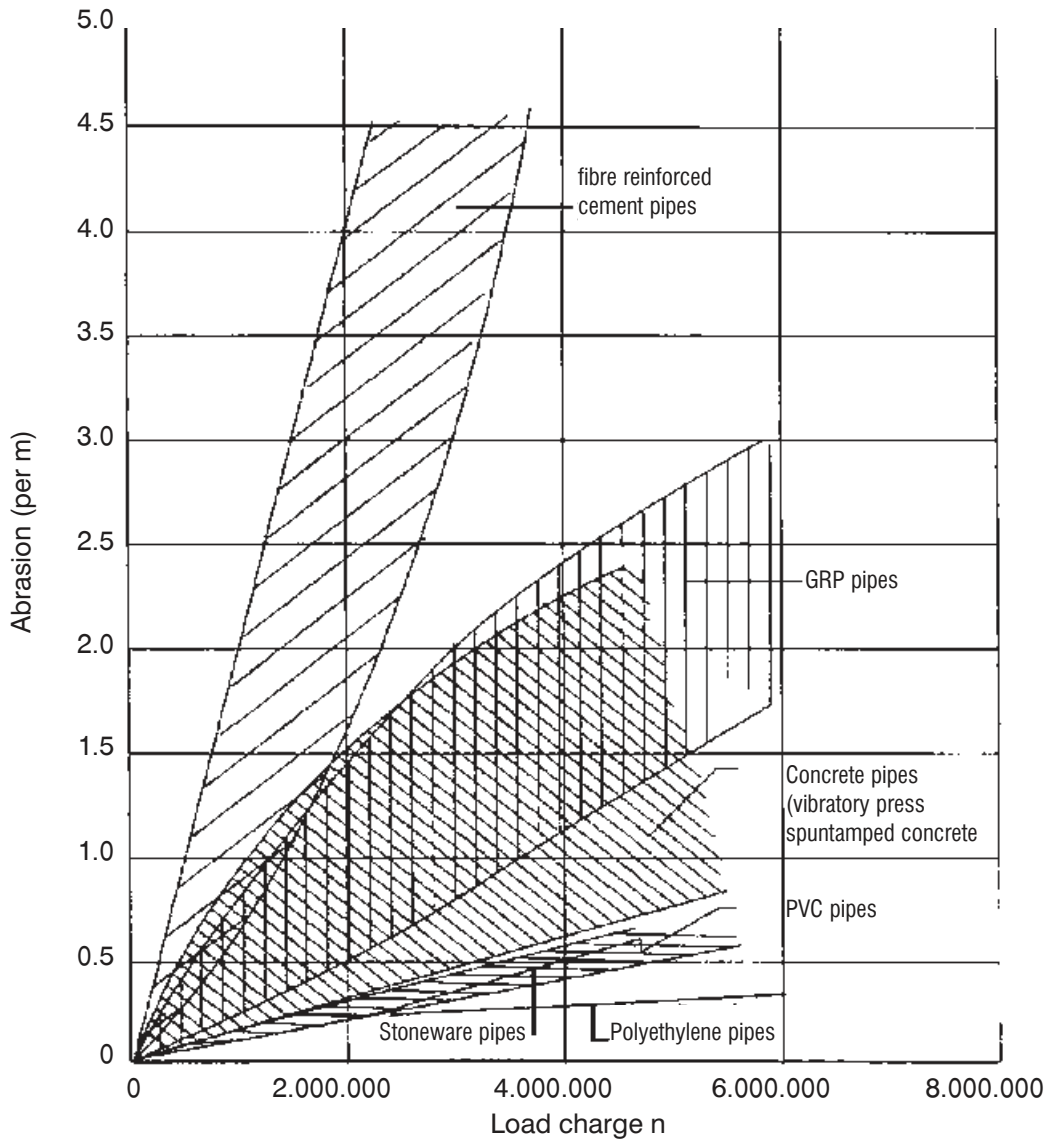
- **Vibration absorbance**

Polyethylene pipes absorb the mechanical stress, have anti-impact properties and elasticity. These properties make them particularly appropriate at seismic regions.

- **Low friction coefficient**

Polyethylene pipes have the lowest friction coefficient compared to all other polymers, thus reduced accretions at the pipe walls. Next diagram shows the results of abrasion tests for various pipe materials.

Abrasion figures, measured by Darmstadt method, for pipes made of various materials



- **High resistance to chemical corrosion**

Polyethylene is resistant to a variety of chemical substances; hence it can be used for the conveyance of not only water but also other materials, liquids and/or gases, preventing any leakages.

CHEMICAL RESISTANCE OF PE

The next table shows the chemical resistance of PE to various chemical substances at different temperatures and concentrations, according to the standard ISO/TR 10358.

CHEMICAL SUBSTANCES	CONC*	LDPE TEMPERATURES		HDPE	
		20°C	60°C	20°C	60°C
Waste gases or air/gas mixture					
Containing Carbon dioxide		10	10	10	10
Containing Sulphur dioxide	l.c.	10	10	10	10
Containing Sulphuric acid		10	10	10	10
Containing Carbon monoxide		10	10	10	10
Containing Nitrogen oxide	tr	10	10	10	10
Containing Hydrogen fluoride	tr	10	10	10	10
Containing Hydrogen chloride		10	10	10	10
Essential oils		-	-	5	5
Ethanol (Ethyl alcohol)	96%	5	0	10	10
Acetone	100%	5	0	0	5
Acetone	tr	10	10	10	10
Brine saturated		10	10	10	10
Ammonia gaseous		10	10	10	10
Ammonia liquid	100%	10	-	10	10
Starch		10	10	10	10
Sodium carbonate		10	10	10	10
Detergents (soap solutions)		10	10	10	10
Benzine		5	0	10	5
Benzene		0	0	5	5
Borax (disodium tetraborate)		10	10	10	10
Potassium borate	1% aq	10	10	10	10
Boric acid		10	10	10	10
Butanol (butyl alcohol)		10	10	10	10
Potassium bromide		10	10	10	10
Lactic acid		10	10	10	10
Glycerol		10	10	10	10
Glucose		-	-	-	-
Dextrin (starch gum)	18% aq	10	-	10	10
Diethyl ether (ethyl ether)		0	0	5	5
Carbon disulphide		0	-	5	-
Sodium sulphurous	l.c.	10	10	10	10
Carbon dioxide		10	10	10	10
Sulphur dioxide		10	10	10	10
Dichloroethane		5	5	5	5
Dichloroethene		0	0	0	0
Potassium dichromate	40% aq	10	10	10	10
Oils and fats, animal and vegetable		-	10	10	5
Heating oils		-	10	5	10
Sulphuric salts of metals		10	10	10	10
Sulphuric acid	40% aq	10	10	10	10
Sulphuric acid	98%	5	0	5	0
Sulphuric acid, fuming (oleum)		0	0	0	0
Sulphurous acid		10	10	10	10
Potassium hydroxide		10	10	10	10
Sodium hydroxide		10	10	10	10
Acetone		5	0	10	5
Citric acid		10	10	10	10
Fatty acids		10	0	10	5
Methanol		10	5	10	10
Molasses		-	-	10	10
Beer		10	10	10	10
Formic acid		10	10	10	10
Naphtha		10	5	10	5
Naphthalene		10	5	10	5
Nitrate salts of metals		10	10	10	10

CHEMICAL SUBSTANCES	CONC*	LDPE TEMPERATURES		HDPE	
		20°C	60°C	20°C	60°C
Nitric acid	25% aq	10	10	10	10
Nitric acid	50% aq	5	0	5	0
Nitrobenzene		5	0	10	5
Nitrogen monoxide gaseous		10	-	10	10
Ozone		5	0	5	0
Acetic acid	10% aq	10	10	10	10
Acetic acid	100% aq	5	0	10	5
Acetic acid ethyl ether		5	0	5	0
Acetic acid anhydride		5	-	10	5
Vinegar		-	-	10	10
Lubricant oils		5	0	10	5
Urea	33% aq	10	10	10	10
Parafin emulsions		10	10	10	10
Petrolium ether		5	0	10	5
Unrefined oil		5	0	10	5
Diesel fuel		5	0	10	5
Propanol		10	10	10	10
Propylen glycole		10	10	10	10
Sodium silicate		10	10	10	10
Stearate acid		10	0	10	5
Alums		10	10	10	10
Tannic acid	10% aq	10	10	10	10
White spirit		5	0	5	0
Carbon tetrachloride		0	0	0	0
Tertrachloroethane		0	0	0	0
Toluene		0	0	0	0
Iron (III) chloride		10	10	10	10
Trichloroethylene		0	0	0	0
Tartaric acid		10	10	10	10
Mercury		10	10	10	10
Hydrogen bromide	50% aq	10	10	10	10
Hydrogen gaseous		10	10	10	10
Hydrogen sulphide		10	10	10	10
Hydrochloric acid	36% aq	10	5	10	10
Hydrogen gaseous		10	10	10	10
Potassium permanganate	sat, aq	10	5	10	5
Hydrogen peroxide	30% aq	10	10	10	10
Hydrogen peroxide	90% aq	10	0	10	0
Perchloride	20% aq	10	-	10	10
Calcium hypochlorite		10	10	10	10
Sodium hypochlorite		5	5	10	10
Phenol		5	0	10	5
Formaldehyde	40% aq	10	10	10	10
Phosphoric acid	25% aq	10	10	10	10
Phosphoric acid	50% aq	10	10	10	10
Phosphoric acid	85% aq	10	5	10	5
Photo fixing baths		10	10	10	-
Chlorine gaseous, dry		5	0	0	0
Chloroacetic acid		0	0	10	10
Chloride salts of metals		10	10	10	10
Chloromethane		0	0	5	5
Sodium chlorius	50% aq	5	0	10	10
Chloroform		0	0	0	0
Chromic acid	50% aq	0	0	10	0
Fruit pulp		10	10	10	10

10 = *resistant*
5 = *conditionally resistant*
0 = *not resistant*

- = *no data are available*
***%** = *% w/w*
aq = *aqueous solution*

l.c. = *low concentration*
tr = *traces*

QUALITY MANAGEMENT SYSTEM

FASOPLAST S.A. applies the Quality Management System ELOT EN ISO 9001:2000 in all of its production activities, marketing and development of new products. The company is certified by the certification body ELOT, which is a member of the International Certification Network IQNet.

CERTIFICATES BY INTERNATIONAL INSTITUTES OF QUALITY

In addition to the Quality Management System ELOT EN ISO 9001:2000, Fasoplast S.A is certified by the following international prestigious institutes:

- SKZ TeConA GmbH ➔ Mechanical properties of products
- WRAS ➔ Contact with potable water

FASOPLAST TESTING LABORATORY

The company's testing laboratory is located at a secluded place of the plant. It is equipped with a wide range of laboratory instruments, tools and apparatus that are calibrated on an annual basis. They are used by the expert company's scientific and technical personnel qualified to carry out, according to European and International Standards, all the required tests for the quality control of the raw materials and products, in order to determine their physicochemical and mechanical properties. In particular, the laboratory is equipped with the following apparatus:

- Pipe hydraulic strength test apparatus
- Impact strength test apparatus (falling weight)
- Pendulum impact strength test apparatus
- Tensile strength equipment
- Melt flow index equipment
- Squeeze-off technique equipment
- Oven for heat reversion tests
- Vicat softening temperature equipment
- Apparatus for determining the PE-Xb degree of cross-linking
- Apparatus for bulk density estimation
- Laboratory granulator
- Specimen preparation system
- Equipment for specimen conditioning at low temperatures (approximately 0° C)
- Instruments for dimensional characteristics measurements (calipters, circometers, round micrometers etc.)

TECHNICAL CHARACTERISTICS

STANDARD: EN 12201.02/2002 (σ_s 80, MRS 10, PE 100)
NOMINAL PRESSURE (PN, bar): 6 – 10 – 12,5 – 16 – 20 – 25 – 32
AVAILABILITY: ∅16 –∅32 at 250m coils
∅40 –∅ 125 at 100m coils
∅140 –∅ 630 up to 12m pipe length
COLOR: Blue or black

APPLICATIONS

- Potable water conveyance
- Water transportation in public water mains networks (municipalities, communities etc.)

	PN - 6		PN - 10		PN - 12,5		PN - 16		PN - 20		PN - 25		PN - 32*	
DN	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m
16									2,0	0,088	2,3	0,100	3,0	0,122
20							2,0	0,114	2,3	0,130	3,0	0,160	3,4	0,177
25					2,0	0,146	2,3	0,167	3,0	0,207	3,5	0,237	4,2	0,274
32			2,0	0,191	2,4	0,227	3,0	0,274	3,6	0,322	4,4	0,381	5,4	0,448
40	1,8	0.227	2,4	0,289	3,0	0,355	3,7	0,423	4,5	0,502	5,5	0,593	6,7	0,693
50	2,0	0,310	3,0	0,445	3,7	0,540	4,6	0,656	5,6	0,778	6,9	0,925	8,3	1,08
63	2,5	0,491	3,8	0,709	4,7	0,861	5,8	1,04	7,1	1,24	8,6	1,46	10,5	1,71
75	2,9	0,672	4,5	1,00	5,6	1,22	6,8	1,45	8,4	1,75	10,3	2,07	12,5	2,42
90	3,5	0,975	5,4	1,44	6,7	1,75	8,2	2,10	10,1	2,52	12,3	2,97	15,0	3,49
110	4,2	1,43	6,6	2,14	8,1	2,59	10,0	3,11	12,3	3,74	15,1	4,45	18,3	5,20
125	4,8	1,84	7,4	2,73	9,2	3,34	11,4	4,04	14,0	4,84	17,1	5,73	20,8	6,70
140	5,4	2,32	8,3	3,43	10,3	4,18	12,7	5,04	15,7	6,07	19,2	7,20	23,3	8,41
160	6,2	3,04	9,5	4,47	11,8	5,45	14,6	6,61	17,9	7,90	21,9	9,37	26,6	11,0
180	6,9	3,79	10,7	5,66	13,3	6,92	16,4	8,36	20,1	9,99	24,6	11,8	29,9	13,9
200	7,7	4,69	11,9	6,98	14,7	8,49	18,2	10,3	22,4	12,4	27,4	14,7	33,2	17,1
225	8,6	5,89	13,4	8,86	16,6	10,8	20,5	13,0	25,2	15,6	30,8	18,5	37,4	21,7
250	9,6	7,30	14,8	10,9	18,4	13,3	22,7	16,0	27,9	19,2	34,2	22,9	41,5	26,7
280	10,7	9,10	16,6	13,6	20,6	16,6	25,4	20,1	31,3	24,2	38,3	28,7	46,5	33,5
315	12,1	11,6	18,7	17,3	23,2	21,1	28,6	25,5	35,2	30,6	43,1	36,3	52,3	42,5
355	13,6	14,6	21,1	22,0	26,1	26,7	32,2	32,3	39,7	38,8	48,5	46,0		
400	15,3	18,6	23,7	27,8	29,4	33,9	36,3	41,0	44,7	49,3	54,7	58,5		
450	17,2	23,5	26,7	35,2	33,1	43,0	40,9	52,0	50,3	62,4	61,5	74,0		
500	19,1	28,9	29,7	43,5	36,8	53,0	45,4	64,1	55,8	76,8				
560	21,4	36,2	33,2	54,5	41,2	66,5	50,8	80,3						
630	24,1	45,9	37,4	69,0	46,3	84,0	57,2	101,8						

**Although the nominal pressure PN32 is not specified in the standard EN 12201, the values for the wall thickness have been estimated so that the relevant quality specifications are met as well as the pressure requirements of HDPE installations for PN32 are satisfied.*

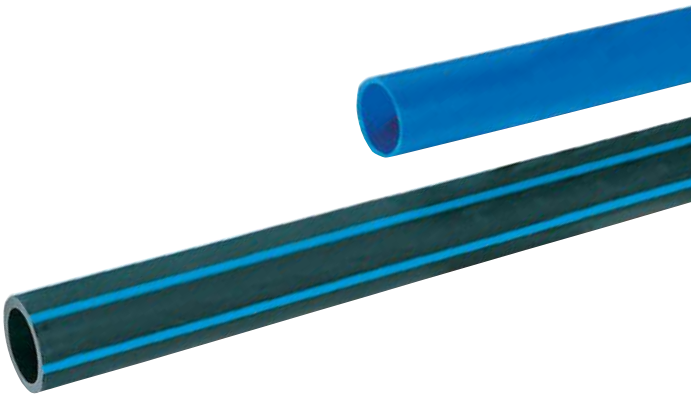
TECHNICAL CHARACTERISTICS

STANDARD: DIN 8074-8075/1999 (σ_s 63, MRS 8, PE 80)
NOMINAL PRESSURE (PN, bar): 6 – 10 – 16
AVAILABILITY: ∅10 – ∅32 at 250m coils
∅ 40 – ∅125 at 100m coils
∅ 140 – ∅ 630 up to 12m pipe length
COLOR: Blue or black

APPLICATIONS

- Potable water conveyance
- Water transportation in public water mains networks (municipalities, communities etc.)

NOMINAL PRESSURE	PN – 6 SDR 17,6		PN – 10 SDR 11		PN – 16 SDR 7,4	
EXTERNAL DIAMETER	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m
10					1,8	0,048
12					1,8	0,060
16			1,8	0,083	2,2	0,099
20	1,8	0,107	1,9	0,112	2,8	0,154
25	1,8	0,137	2,3	0,170	3,5	0,240
32	1,9	0.186	2,9	0,277	4,4	0,386
40	2,3	0,284	3,7	0,428	5,5	0,600
50	2,9	0,438	4,6	0,662	6,9	0,936
63	3,6	0,684	5,8	1,05	8,6	1,47
75	4,3	0,971	6,8	1,48	10,3	2,09
90	5,1	1,38	8,2	2,11	12,3	3,00
110	6,3	2,07	10,0	3,13	15,1	4,49
125	7,1	2,65	11,4	4,06	17,1	5,77
140	8,0	3,32	12,7	5,09	19,2	7,25
160	9,1	4,33	14,6	6,63	21,9	9,44
180	10,2	5,45	16,4	8,38	24,6	11,9
200	11,4	6,75	18,2	10,3	27,4	14,8
225	12,8	8,51	20,5	13,1	30,8	18,6
250	14,2	10,5	22,7	16,1	34,2	23,0
280	15,9	13,1	25,4	20,2	38,3	28,9
315	17,9	16,6	28,6	25,6	43,1	36,5
355	20,1	21,1	32,2	32,4	48,5	46,3
400	22,7	26,7	36,3	41,2	54,7	58,8
450	25,5	33,8	40,9	52,1	61,5	74,4
500	28,3	41,7	45,4	64,3		
560	31,7	52,2	50,8	80,7		
630	35,7	66,1	57,2	102,0		



TECHNICAL CHARACTERISTICS

STANDARD: EN 12201.02/2002 (σ_s 63, MRS 8, PE 80)
NOMINAL PRESSURE (PN, bar): 6 – 10 – 12,5 – 16
AVAILABILITY: ∅ 16 –∅ 32 at 250m coils
∅ 40 –∅ 125 at 100m coils
∅140 – ∅ 630 up to 12m pipe length
COLOR: Blue or black

APPLICATIONS

- Potable water conveyance
- Water transportation in public water mains networks (municipalities, communities etc.)

NOMINAL PRESSURE	PN – 6 SDR 21		PN – 10 SDR 13,6		PN – 12,5 SDR 11		PN – 16 SDR 9	
EXTERNAL DIAMETER	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m
16							2,0	0,088
20					2,0	0,114	2,3	0,130
25			2,0	0,146	2,3	0,167	3,0	0,207
32			2,4	0,227	3,0	0,274	3,6	0,322
40	2,0	0,242	3,0	0,355	3,7	0,423	4,5	0,502
50	2,4	0,366	3,7	0,540	4,6	0,656	5,6	0,778
63	3,0	0,568	4,7	0,861	5,8	1,04	7,1	1,24
75	3,6	0,813	5,6	1,22	6,8	1,45	8,4	1,75
90	4,3	1,17	6,7	1,75	8,2	2,10	10,1	2,52
110	5,3	1,75	8,1	2,59	10,0	3,11	12,3	3,74
125	6,0	2,24	9,2	3,34	11,4	4,04	14,0	4,84
140	6,7	2,80	10,3	4,18	12,7	5,04	15,7	6,07
160	7,7	3,67	11,8	5,45	14,6	6,61	17,9	7,90
180	8,6	4,62	13,3	6,92	16,4	8,36	20,1	9,99
200	9,6	5,70	14,7	8,49	18,2	10,3	22,4	12,4
225	10,8	7,20	16,6	10,8	20,5	13,0	25,2	15,6
250	11,9	8,80	18,4	13,3	22,7	16,0	27,9	19,2
280	13,4	11,20	20,6	16,6	25,4	20,1	31,3	24,2
315	15,0	14,00	23,2	21,1	28,6	25,5	35,2	30,6
355	16,9	17,80	26,1	26,7	32,2	32,3	39,7	38,8
400	19,1	22,70	29,4	33,9	36,3	41,0	44,7	49,3
450	21,5	28,70	33,1	43,0	40,9	52,0	50,3	62,4
500	23,9	35,50	36,8	53,0	45,4	64,1	55,8	76,8
560	26,7	44,40	41,2	66,5	50,8	80,3		
630	30,0	56,10	46,3	84,0	57,2	101,8		

TECHNICAL CHARACTERISTICS

STANDARD: EN 12201.02/2002 (σ_s 63, MRS 8, PE 80)
NOMINAL PRESSURE (PN, bar): 12,5 – 16 – 20 – 25
AVAILABILITY: ∅15 – ∅32 at 100m coils
COLOR: Blue or black

APPLICATIONS

- Conveyance of cold potable water inside buildings.

EXTERNAL DIAMETER (mm)	WALL THICKNESS (mm)
15	2,5
16	2,0
18	2,0
18	2,5
20	2,0
22	3,0
25	3,0
28	3,0
32	3,0

** Some values are not specified in the standard EN 12201, but they have been estimated so that the pipes satisfy its requirements.*

PE PIPES (LDPE) DRIP

TECHNICAL CHARACTERISTICS

STANDARD: DIN 8074-8075/1999 (σ_s 25, MRS 3,2, PE 32)
AVAILABILITY: ∅12 – ∅32 at 250m coils. Any other coil length is available upon request.
COLOR: Black

APPLICATIONS

- Irrigation systems with micro-blasts or drippers.

EXTERNAL DIAMETER (mm)	WALL THICKNESS (mm)	MASS (kg/m)	COIL MASS (kg)
12	1,3	0,045	11,25
16	1,5	0,070	17,50
20	1,7	0,100	25,00
25	1,9	0,138	34,50
32	2,3	0,210	52,50

PE PIPES FOR CABLE PROTECTION (FIBRE OPTICS)

These pipes are smooth at their outer surface, while their inner surface is ribbed, so that the installation of cables/fiber optics inside them is carried out much more easily. There is also the capability of producing three-channel conduits.

TECHNICAL CHARACTERISTICS

SPECIFICATIONS: Hellenic Telecommunication Organization No. 04.1.4/C/2nd
AVAILABILITY: ∅32 – ∅50. The three-channel conduit is available at ∅50/50/50.
COLOR: Black

APPLICATIONS

- Protection of cables and fibre optics

	PN4	PN6	PN8	PN10
EXTERNAL DIAMETER (mm)	WALL THICKNESS (mm)	WALL THICKNESS (mm)	WALL THICKNESS (mm)	WALL THICKNESS (mm)
32	1.8	1.9	2.4	3.0
40	1.8	2.3	3.0	3.7
50	2.0	2.9	3.7	4.6
50/50/50	-	3.0	-	-

Three - channel conduit

TECHNICAL CHARACTERISTICS

STANDARD: DIN 8074-8075/1999 (σ_s 63, MRS 8, PE 80)
NOMINAL PRESSURE (PN, bar): 4 – 6 – 10 – 16
AVAILABILITY: ∅10 – ∅32 at 250m coils
∅40 – ∅125 at 100m coils
∅140 – ∅630 up to 12m pipe length
COLOR: Black

APPLICATIONS

- Conveyance of fluids
- Cable protection (underground, under water, surface)
- Constructions (underground, drainage)

NOMINAL PRESSURE	PN – 4 SDR 26		PN – 6 SDR 17,6		PN – 10 SDR 11		PN – 16 SDR 7,4	
EXTERNAL DIAMETER	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m
10							1,8	0,048
12							1,8	0,060
16					1,8	0,083	2,2	0,099
20			1,8	0,107	1,9	0,112	2,8	0,154
25			1,8	0,137	2,3	0,170	3,5	0,240
32	1,8	0,178	1,9	0.186	2,9	0,277	4,4	0,386
40	1,8	0,227	2,3	0,284	3,7	0,428	5,5	0,600
50	2,0	0,314	2,9	0,438	4,6	0,662	6,9	0,936
63	2,5	0,494	3,6	0,684	5,8	1,05	8,6	1,47
75	2,9	0,675	4,3	0,971	6,8	1,48	10,3	2,09
90	3,5	0,978	5,1	1,38	8,2	2,11	12,3	3,00
110	4,2	1,43	6,3	2,07	10,0	3,13	15,1	4,49
125	4,8	1,84	7,1	2,65	11,4	4,06	17,1	5,77
140	5,4	2,32	8,0	3,32	12,7	5,09	19,2	7,25
160	6,2	3,04	9,1	4,33	14,6	6,63	21,9	9,44
180	6,9	3,79	10,2	5,45	16,4	8,38	24,6	11,9
200	7,7	4,69	11,4	6,75	18,2	10,3	27,4	14,8
225	8,6	5,89	12,8	8,51	20,5	13,1	30,8	18,6
250	9,6	7,30	14,2	10,5	22,7	16,1	34,2	23,0
280	10,7	9,10	15,9	13,1	25,4	20,2	38,3	28,9
315	12,1	11,6	17,9	16,6	28,6	25,6	43,1	36,5
355	13,6	14,6	20,1	21,1	32,2	32,4	48,5	46,3
400	15,3	18,6	22,7	26,7	36,3	41,2	54,7	58,8
450	17,2	23,5	25,5	33,8	40,9	52,1	61,5	74,4
500	19,1	28,9	28,3	41,7	45,4	64,3		
560	21,4	36,2	31,7	52,2	50,8	80,7		
630	24,1	45,9	35,7	66,1	57,2	102,0		

TECHNICAL CHARACTERISTICS

STANDARD: EN 12201.02/2002 (σ_s 63, MRS 8, PE 80)
NOMINAL PRESSURE (PN, bar): 4 – 5 – 6 – 10 – 12,5 – 16
AVAILABILITY: ∅16 – ∅ 32 at 250m coils
∅40 – ∅125 at 100m coils
∅ 140 – ∅ 630 up to 12m pipe length
COLOR: Black

APPLICATIONS

- Conveyance of fluids
- Cable protection (underground, under water, surface)
- Constructions (underground, drainage)

NOMINAL PRESSURE	PN – 4 SDR 33		PN – 5 SDR 26		PN – 6 SDR 21		PN – 10 SDR 13,6		PN –12,5 SDR 11		PN – 16 SDR 9	
EXTERNAL DIAMETER	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m	mm	kg/m
16											2,0	0,088
20									2,0	0,114	2,3	0,130
25							2,0	0,146	2,3	0,167	3,0	0,207
32							2,4	0,227	3,0	0,274	3,6	0,322
40					2,0	0,242	3,0	0,355	3,7	0,423	4,5	0,502
50			2,0	0,305	2,4	0,366	3,7	0,540	4,6	0,656	5,6	0,778
63			2,5	0,483	3,0	0,568	4,7	0,861	5,8	1,04	7,1	1,24
75	2,3	0,538	2,9	0,662	3,6	0,813	5,6	1,22	6,8	1,45	8,4	1,75
90	2,8	0,775	3,5	0,960	4,3	1,17	6,7	1,75	8,2	2,10	10,1	2,52
110	3,4	1,15	4,2	1,41	5,3	1,75	8,1	2,59	10,0	3,11	12,3	3,74
125	3,9	1,49	4,8	1,82	6,0	2,24	9,2	3,34	11,4	4,04	14,0	4,84
140	4,3	1,85	5,4	2,29	6,7	2,80	10,3	4,18	12,7	5,04	15,7	6,07
160	4,9	2,39	6,2	3,01	7,7	3,67	11,8	5,45	14,6	6,61	17,9	7,90
180	5,5	3,02	6,9	3,74	8,6	4,62	13,3	6,92	16,4	8,36	20,1	9,99
200	6,2	3,79	7,7	4,64	9,6	5,70	14,7	8,49	18,2	10,3	22,4	12,4
225	6,9	4,72	8,6	5,83	10,8	7,20	16,6	10,8	20,5	13,0	25,2	15,6
250	7,7	5,85	9,6	7,23	11,9	8,80	18,4	13,3	22,7	16,0	27,9	19,2
280	8,6	7,32	10,7	9,01	13,4	11,20	20,6	16,6	25,4	20,1	31,3	24,2
315	9,7	9,27	12,1	11,5	15,0	14,00	23,2	21,1	28,6	25,5	35,2	30,6
355	10,9	11,7	13,6	14,5	16,9	17,80	26,1	26,7	32,2	32,3	39,7	38,8
400	12,3	14,9	15,3	18,4	19,1	22,70	29,4	33,9	36,3	41,0	44,7	49,3
450	13,8	18,8	17,2	23,3	21,5	28,70	33,1	43,0	40,9	52,0	50,3	62,4
500	15,3	23,2	19,1	28,7	23,9	35,50	36,8	53,0	45,4	64,1	55,8	76,8
560	17,2	29,2	21,4	36,0	26,7	44,40	41,2	66,5	50,8	80,3		
630	19,3	36,8	24,1	45,6	30,0	56,10	46,3	84,0	57,2	101,8		

**Some values are not specified in the standard EN 12201, but they have been estimated so that the pipes satisfy its requirements.*

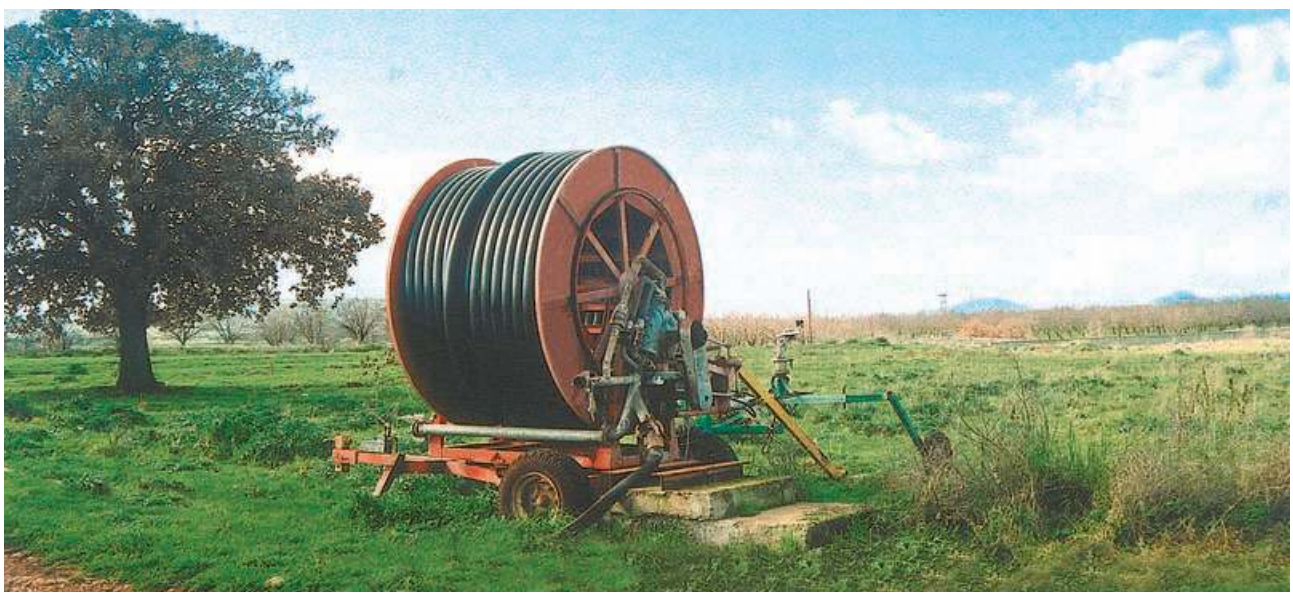
TECHNICAL CHARACTERISTICS

STANDARD: DIN 8074-8075/1999 (σ_s 50, MRS 6,3, PE 63)
NOMINAL PRESSURE (PN, bar): 8 – 9 – 10
AVAILABILITY: ∅50 – ∅125 at 250m coils. Any other coil length is available upon request.
COLOR: Black

APPLICATIONS

- Automatic irrigation systems with micro-blasts or drippers.

	PN - 8		PN - 9**		PN - 10	
EXTERNAL DIAMETER	WALL THICKNESS	MASS	WALL THICKNESS	MASS	WALL THICKNESS	MASS
mm	mm	kg/m	mm	kg/m	mm	kg/m
50	3,7	0,546	4,2	0,614	4,6	0,662
63	4,7	0,869	5,2	0,954	5,8	1,05
70	5,2	1,07	5,8	1,17	6,4	1,28
75	5,6	1,23	6,2	1,35	6,9	1,48
80	6,0	1,40	6,7	1,55	7,3	1,67
82	6,1	1,47	6,8	1,61	7,5	1,76
90	6,7	1,76	7,5	1,95	8,2	2,11
100	7,5	2,19	8,3	2,39	9,1	2,60
110	8,2	2,63	9,1	2,89	10,0	3,13
125	9,3	3,38	10,4	3,74	11,4	4,06



** Some values are not specified in the standard DIN 8074/8075, but they have been estimated so that the pipes satisfy its requirements.*
*** Although the nominal pressure PN9 is not specified in the standard DIN 8074/8075, the values for the wall thickness have been estimated so that the relevant quality specifications are met as well as the pressure requirements of MDPE installations for PN9 are satisfied.*

FASOPLAST S.A. has the ability to produce upon request, drilled pipes which are used for water evacuation at diameters ∅90 -∅400 in any desired wall thickness.

VARIATION OF FLOW RATE AND VELOCITY ACCORDING TO THE PIPE FILLING

The pipe flow rate for full flow, in cases where water flows in pipes by gravity, is estimated using the Manning – Strickler equation:

$$Q = J^{1/2} \cdot RH^{2/3} \cdot E \cdot k_{str}$$

$$Q = V \cdot E$$

where:
Q: volumetric flow rate (m^3/sec)
V: water velocity (m/sec)
J: pipe slope
k_{str}: Strickler constant (it has a value of 110 for PE)

E: pipe cross sectional area in contact with water: $E = \frac{\pi(D-2S)^2}{4}$
RH: hydraulic radius (m)

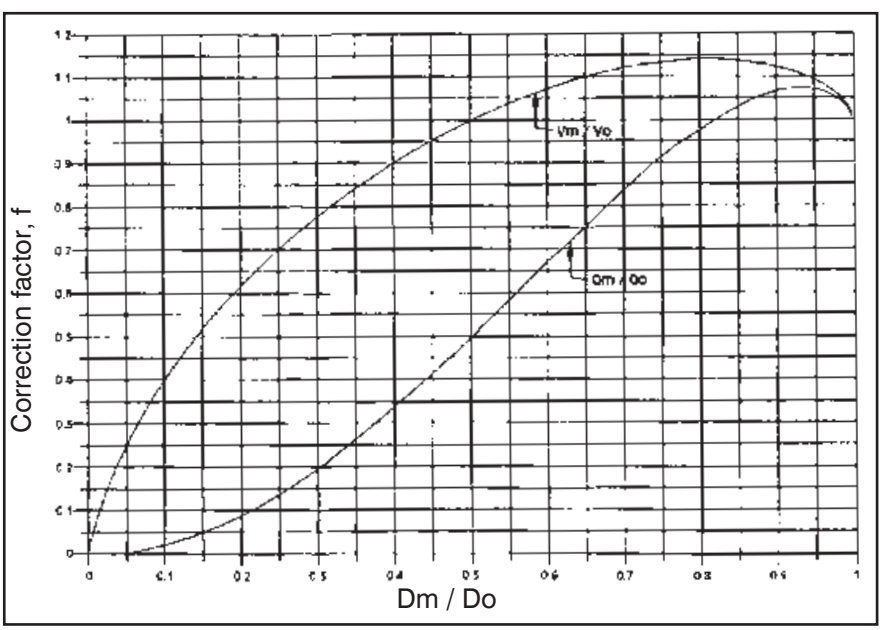
The hydraulic radius RH is the ratio of the cross-sectional area to the length of the perimeter in contact with water.

For full flow, the hydraulic radius is: $RH = \frac{\pi R^2}{2\pi R} = \frac{R}{2} = \frac{D-2S}{4}$

where:
R: internal pipe radius (m)
D: external pipe diameter (m)
S: pipe wall thickness (m)

In case the pipe is not fully filled with fluid, a correction factor, f, is used, according to the next diagram, where:

Dm/**Do:** ratio of pipe filling height to its internal diameter
Qm/**Qo:** flow rates ratio
Vm/**Vo:** velocities ratio



TECHNICAL CHARACTERISTICS

STANDARD: EN 1555-02/2002 (σ_s 63, MRS 8, PE 80)
AVAILABILITY: ∅16 – ∅125 at 100m - 200m coils
∅ 140 – ∅ 630 up to 12m pipe length
COLOR: Yellow or black

APPLICATIONS

- Conveyance of gaseous fuels (natural gas etc)

	SDR 17,6 S 8,3	SDR 11 S 5
EXTERNAL DIAMETER	WALL THICKNESS	WALL THICKNESS
(mm)	(mm)	(mm)
16	2,3	3,0
20	2,3	3,0
25	2,3	3,0
32	2,3	3,0
40	2,3	3,7
50	2,9	4,6
63	3,6	5,8
75	4,3	6,8
90	5,2	8,2
110	6,3	10,0
125	7,1	11,4
140	8,0	12,7
160	9,1	14,6
180	10,3	16,4
200	11,4	18,2
225	12,8	20,5
250	14,2	22,7
280	15,9	25,4
315	17,9	28,6
355	20,2	32,3
400	22,8	36,4
450	25,6	40,9
500	28,4	45,5
560	31,9	50,9
630	35,8	57,3

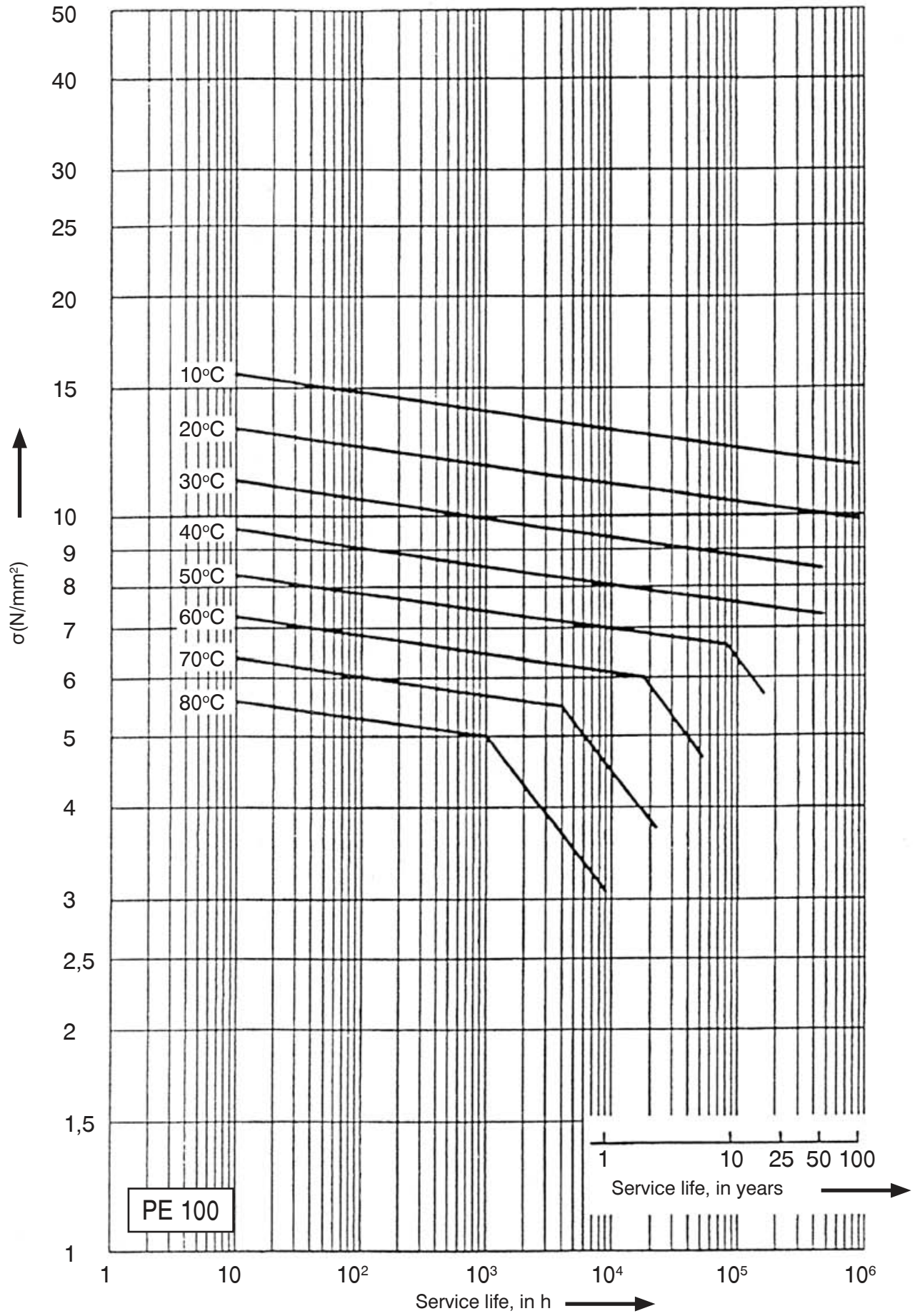
RELATION BETWEEN NOMINAL PRESSURE (PN) AND SDR

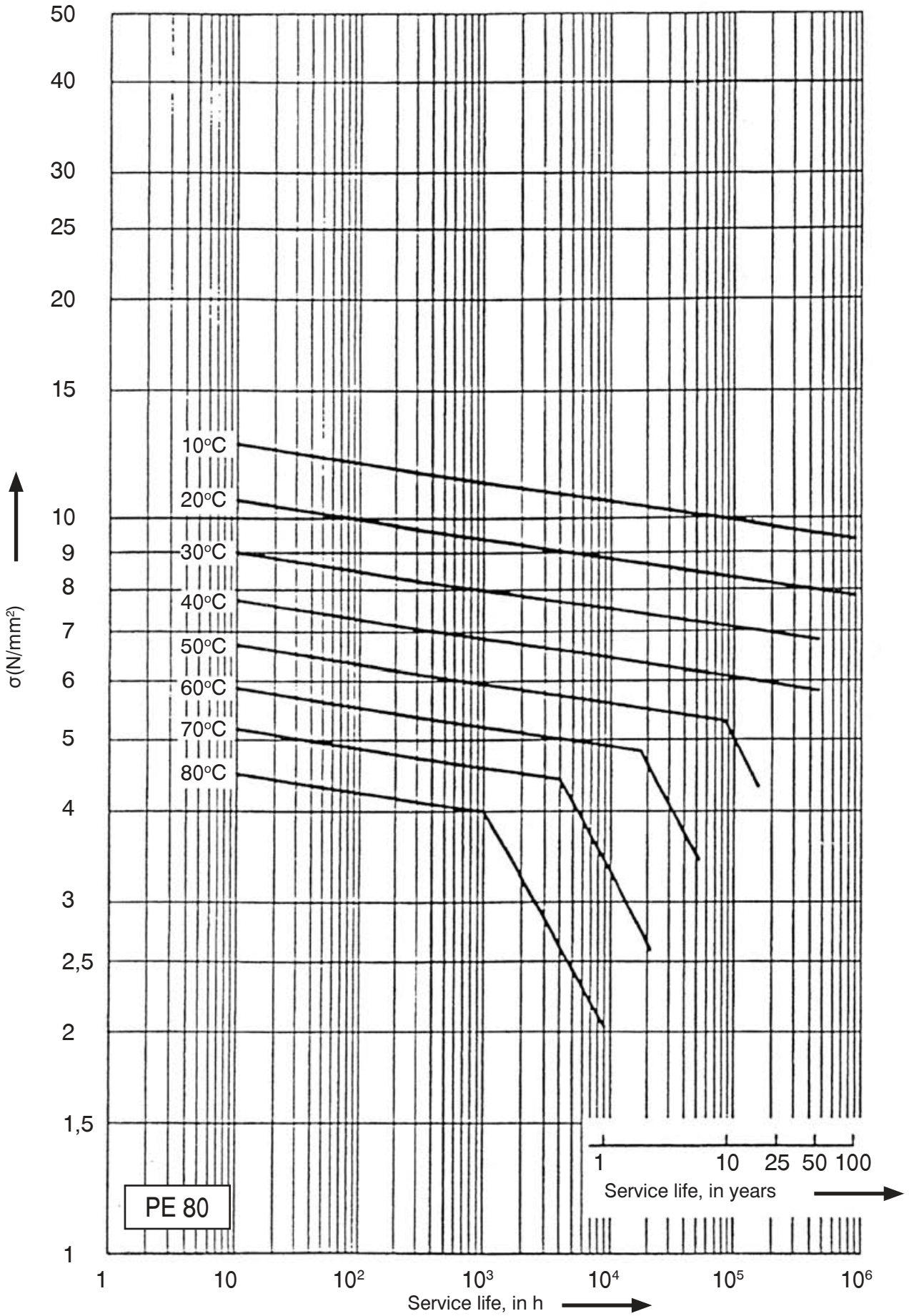
SDR	Nominal Pressure (PN)		
	PE 63	PE 80	PE 100
41	2,5	3,2	4
33	3,2	4	5
26	4	5	6
21	5	6	8
17,6	6	-	-
17	-	8	10
13,6	8	10	12,5
11	10	12,5	16
9	-	16	20
7,4	-	20	25
6	-	25	32
The values for nominal pressure have been estimated for overall service (design) coefficient C = 1,25			

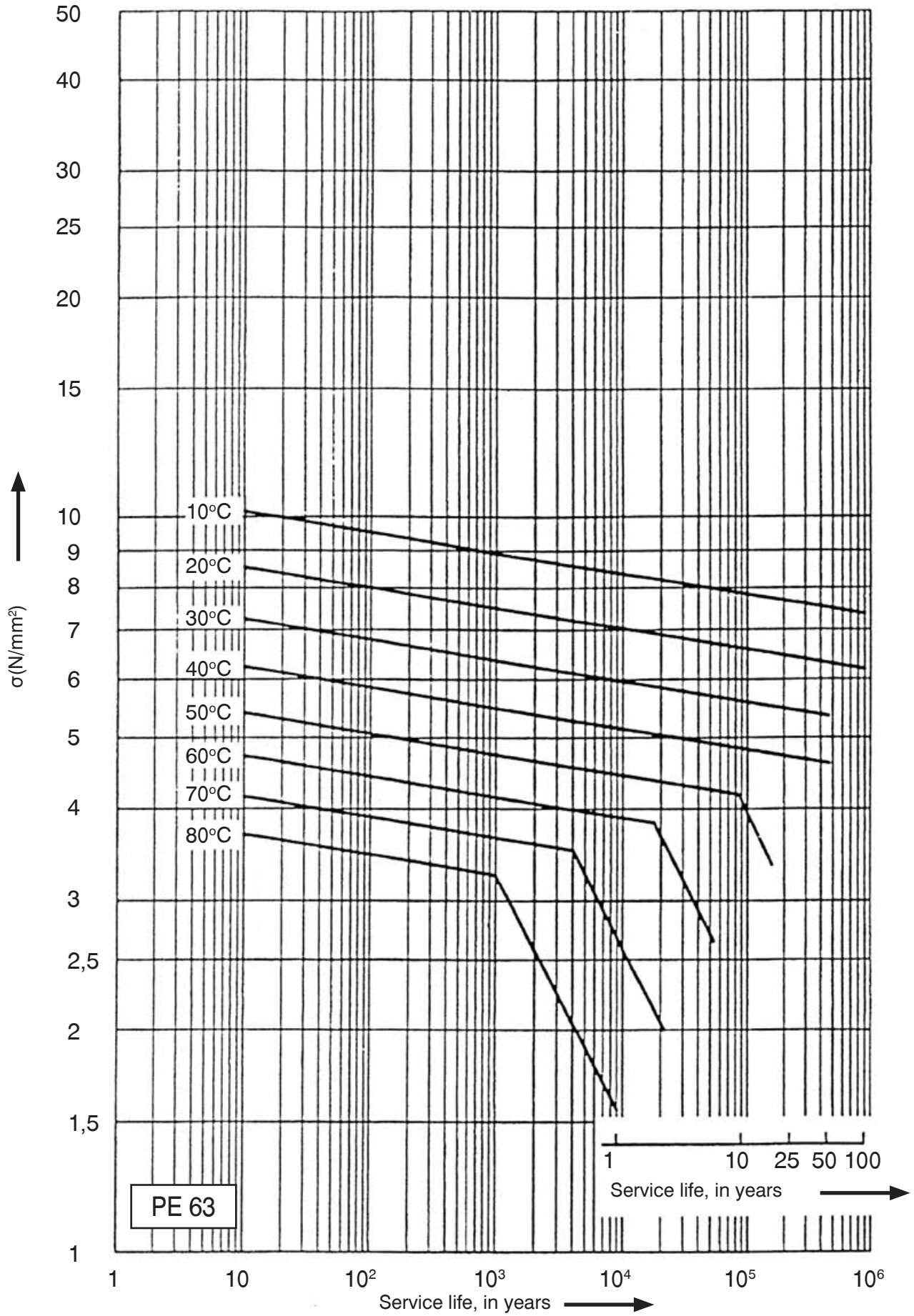
LONG-TERM BEHAVIOR IN HYDROSTATIC PRESSURE

Polyethylene pipes exhibit high hydrostatic pressure strength at temperatures up to 80° C.

From the next diagrams, the values of circumferential stress are selected, according to standards DIN 8075 and EN 12201, and the PE pipes hydrostatic strength is tested.


σ(N/mm²)
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2,5
2
1,5
1
10°C
20°C
30°C
40°C
50°C
60°C
70°C
80°C
PE 100
1
10
10²
10³
10⁴
10⁵
10⁶
Service life, in h
1
10
25
50
100
Service life, in years


50
40
30
25
20
15
10
9
8
7
6
5
4
3
2,5
2
1,5
1
σ(N/mm²)
10°C
20°C
30°C
40°C
50°C
60°C
70°C
80°C
PE 80
1
10
10²
10³
10⁴
10⁵
10⁶
Service life, in h
1
10
25
50
100
Service life, in years


σ(N/mm²)
50
40
30
25
20
15
10
9
8
7
6
5
4
3
2,5
2
1,5
1
10°C
20°C
30°C
40°C
50°C
60°C
70°C
80°C
PE 63
1
10
10²
10³
10⁴
10⁵
10⁶
Service life, in years
1
10
25
50
100
Service life, in years

ALLOWABLE OPERATING PRESSURE FOR PIPES
PE 100 (C=1,25)

Faso-plast®

PE 100

Temperature (°C)	Years of service	S 25	S 20	S16	S12,5	S 10,5	S 10	S 8,3	S 8	S 6,3	S 5	S 4	S 3,2	S 2,5	S 2
		Pipe Series													
		Standard Dimension Ratio (SDR)													
		51	41	33	26	22	21	17.6	17	13.6	11	9	7.4	6	5
		ALLOWABLE OPERATING PRESSURE (bar)													
10	5	4.0	5.0	6.3	7.9	9.4	10.1	12.1	12.6	15.7	20.2	25.2	31.5	40.4	50.5
	10	3.9	4.9	6.2	7.8	9.3	9.9	11.9	12.4	15.5	19.8	24.8	31.0	39.7	49.6
	25	3.8	4.8	6.0	7.6	9.0	9.6	11.6	12.1	15.1	19.3	24.2	30.2	38.7	48.4
	50	3.8	4.7	5.9	7.5	8.9	9.5	11.4	11.9	14.8	19.0	23.8	29.7	38.0	47.6
	100	3.7	4.6	5.8	7.3	8.7	9.3	11.2	11.6	14.6	18.7	23.3	29.2	37.4	46.7
20	5	3.3	4.2	5.3	6.6	7.9	8.4	10.2	10.6	13.2	16.9	21.2	26.5	33.9	42.4
	10	3.3	4.1	5.2	6.5	7.8	8.3	10.0	10.4	13.0	16.6	20.8	26.0	33.3	41.6
	25	3.2	4.0	5.0	6.4	7.6	8.1	9.8	10.1	12.7	16.2	20.3	25.4	32.5	40.7
	50	3.2	4.0	5.0	6.3	7.5	8.0	9.6	10.0	12.5	16.0	20.0	25.0	32.0	40.0
	100	3.1	3.9	4.9	6.1	7.3	7.8	9.4	9.8	12.2	15.7	19.6	24.5	31.4	39.2
30	5	2.8	3.6	4.5	5.6	6.7	7.2	8.6	9.0	11.2	14.4	18.0	22.5	28.8	36.0
	10	2.8	3.5	4.4	5.5	6.6	7.0	8.5	8.8	11.0	14.1	17.7	22.1	28.3	35.4
	25	2.7	3.4	4.3	5.4	6.4	6.9	8.3	8.6	10.8	13.8	17.2	21.6	27.6	34.5
	50	2.7	3.3	4.2	5.3	6.3	6.7	8.1	8.4	10.6	13.5	16.9	21.2	27.1	33.9
40	5	2.4	3.0	3.8	4.8	5.8	6.1	7.4	7.7	9.6	12.3	15.4	19.3	24.7	30.9
	10	2.4	3.0	3.8	4.7	5.7	6.0	7.3	7.6	9.5	12.1	15.2	19.0	24.3	30.4
	25	2.3	2.9	3.7	4.6	5.5	5.9	7.1	7.4	9.2	11.8	14.8	18.5	23.7	29.7
	50	2.3	2.9	3.6	4.5	5.4	5.8	7.0	7.2	9.1	11.6	14.5	18.2	23.3	29.1
50	5	2.1	2.6	3.3	4.2	5.0	5.3	6.4	6.7	8.3	10.7	13.4	16.7	21.4	26.8
	10	2.0	2.6	3.2	4.0	4.8	5.2	6.2	6.5	8.1	10.4	13.0	16.2	20.3	26.0
	15	1.9	2.3	2.9	3.7	4.4	4.7	5.7	5.9	7.4	9.5	11.8	14.8	19.0	23.7
60	5	1.5	1.9	2.4	3.0	3.6	3.8	4.6	4.8	6.0	7.7	9.7	12.1	15.5	19.4
70	2	1.2	1.5	1.9	2.4	2.9	3.1	3.7	3.9	4.9	6.2	7.8	9.8	12.5	15.7

The values of pressure have been estimated for overall service (design) coefficient C = 1,25 and refer to 3rd generation PE pipes (HDPE) for potable water (HYDROTHENE)

PE 80

Temperature (°C)	Years of service	Pipe Series													
		S 25	S 20	S16	S12,5	S 10,5	S 10	S 8,3	S 8	S 6,3	S 5	S 4	S 3,2	S 2,5	S 2
		Standard Dimension Ratio (SDR)													
		51	41	33	26	22	21	17.6	17	13.6	11	9	7.4	6	5
		ALLOWABLE OPERATING PRESSURE (bar)													
10	5	3.1	4.0	5.0	6.3	7.5	7,9	9,4	10.1	12,6	15,8	20,2	25,3	31,6	40.5
	10	3.1	3.9	4.9	6.2	7.4	7,8	9,3	9.9	12,4	15,5	19,8	24,8	31,0	39.7
	25	3.0	3.8	4.8	6.0	7.2	7,6	9,0	9.7	12,1	15,1	19,4	24,2	30,3	38.8
	50	2.9	3.8	4.7	5.9	7.1	7,5	8,9	9.5	11,9	14,8	19,0	23,8	29,7	38.0
	100	2.9	3.7	4.6	5.8	7.0	7,3	8,7	9.3	11,6	14,6	18,7	23,3	29,2	37.4
20	5	2.6	3.4	4.2	5.3	6.3	6,6	7,9	8.5	10,6	13,2	17,0	21,2	26,5	34.0
	10	2.6	3.3	4.1	5.2	6.2	6,5	7,8	8.3	10,4	13,0	16,7	20,8	26,0	33.4
	25	2.5	3.2	4.0	5.0	6.1	6,4	7,6	8.1	10,1	12,7	16,2	20,3	25,4	32.5
	50	2.5	3.2	4.0	5.0	6.0	6,3	7,5	8.0	10,0	12,5	16,0	20,0	25,0	32.0
	100	2.4	3.1	3.9	4.9	5.8	6,1	7,3	7.8	9,8	12,2	15,7	19,6	24,5	31.4
30	5	2.2	2.8	3.6	4.5	5.4	5,6	6,7	7.2	9,0	11,2	14,4	18,0	22,5	28.9
	10	2.2	2.8	3.5	4.4	5.3	5,5	6,6	7.0	8,8	11,0	14,1	17,7	22,1	28.3
	25	2.1	2.7	3.4	4.3	5.1	5,4	6,4	6.9	8,6	10,8	13,8	17,3	21,6	27.6
	50	2.1	2.7	3.3	4.2	5.0	5,3	6,3	6.7	8,4	10,6	13,5	16,9	21,2	27.1
40	5	1.9	2.4	3.1	3.8	4.6	4,8	5,8	6.2	7,7	9,6	12,4	15,5	19,3	24.8
	10	1.9	2.4	3.0	3.8	4.5	4,7	5,7	6.0	7,6	9,5	12,1	15,2	19,0	24.3
	25	1.8	2.3	2.9	3.7	4.4	4,6	5,5	5.9	7,4	9,2	11,8	14,8	18,5	23.7
	50	1.8	2.3	2.9	3.6	4.3	4,5	5,4	5.8	7,2	9,1	11,6	14,5	18,2	23.3
50	5	1.6	2.1	2.6	3.3	4.0	4,2	5,0	5.3	6,7	8,4	10,7	13,4	16,8	21.5
	10	1.6	2.0	2.5	3.2	3.8	4,0	4,8	5.1	6,4	8,1	10,3	12,9	16,2	20.7
	15	1.4	1.8	2.2	2.8	3.4	3,6	4,3	4.5	5,7	7,1	9,1	11,4	14,3	18.3
60	5	1.1	1.4	1.8	2.2	2.7	2,8	3,3	3.6	4,5	5,6	7,2	9,0	11,3	14.4
70	2	0.8	1.1	1.3	1.7	2.0	2,2	2,6	2.7	3,4	4,3	5,5	6,9	8,7	11.1

The values of pressure have been estimated for overall service (design) coefficient C = 1,25 and refer to 2nd generation PE pipes (HDPE) for potable water (HYDROTHENE)

PE 80															
Temperature (°C)	Years of service	Pipe Series													
		S 25	S 20	S16	S12,5	S 10,5	S 10	S 8,3	S 8	S 6,3	S 5	S 4	S 3,2	S 2,5	S 2
		Standard Dimension Ratio (SDR)													
		51	41	33	26	22	21	17.6	17	13.6	11	9	7.4	6	5
		ALLOWABLE OPERATING PRESSURE (bar)													
10	5	2.0	2.5	3,1	4,0	4.8	5,0	6,0	6.3	7,7	10,1	12,6	15,5	20.2	25.3
	10	1.9	2.4	3,1	3,9	4.7	4,9	5,9	6.2	7,6	9,9	12,4	15,2	19.8	24.8
	25	1.9	2.4	3,0	3,8	4.6	4,8	5,8	6.0	7,4	9,7	12,1	14,9	19.4	24.2
	50	1.9	2.3	2,9	3,8	4.5	4,7	5,7	5.9	7,3	9,5	11,9	14,6	19.0	23.8
	100	1.8	2.3	2,9	3,7	4.4	4,6	5,6	5.8	7,1	9,3	11,6	14,3	18.7	23.3
20	5	1.7	2.1	2,6	3,4	4.0	4,2	5,1	5.3	6,5	8,5	10,6	13,0	17.0	21.2
	10	1.6	2.0	2,6	3,3	3.9	4,1	5,0	5.2	6,4	8,3	10,4	12,8	16.7	20.8
	25	1.6	2.0	2,5	3,2	3.8	4,0	4,9	5.0	6,4	8,1	10,1	12,5	16.2	20.3
	50	1.6	2.0	2,5	3,2	3.8	4,0	4,8	5.0	6,3	8,0	10,0	12,3	16.0	20.0
	100	1.5	1.9	2,4	3,1	3.7	3,9	4,7	4.9	6,0	7,8	9,8	12,0	15.7	19.6
30	5	1.4	1.8	2,2	2,8	3.4	3,6	4,3	4.5	5,5	7,2	9,0	11,1	14.4	18.0
	10	1.4	1.7	2,2	2,8	3.3	3,5	4,2	4.4	5,4	7,0	8,8	10,9	14.1	17.7
	25	1.3	1.7	2,1	2,7	3.2	3,4	4,1	4.3	5,4	6,9	8,6	10,6	13.8	17.3
	50	1.3	1.6	2,1	2,7	3.2	3,3	4,0	4.2	5,3	6,7	8,4	10,4	13.5	16.9
40	5	1.2	1.5	1,9	2,4	2.9	3,1	3,7	3.8	4,7	6,2	7,7	9,5	12.4	15.5
	10	1.2	1.5	1,9	2,4	2.9	3,0	3,6	3.8	4,6	6,0	7,6	9,3	12.1	15.2
	25	1.1	1.4	1,8	2,3	2.8	2,9	3,5	3.7	4,5	5,9	7,4	9,1	11.8	14.8
	50	1.1	1.4	1,8	2,3	2.7	2,9	3,5	3.6	4,4	5,8	7,2	8,9	11.6	14.5
50	5	1.0	1.3	1,6	2,1	2.5	2,6	3,2	3.3	4,1	5,3	6,7	8,2	10.7	13.4
	10	1.0	1.2	1,6	2,0	2.4	2,5	3,1	3.2	3,9	5,1	6,4	7,9	10.3	12.9
	15	0.9	1.1	1,4	1,8	2.1	2,2	2,7	2.8	3,5	4,5	5,7	7,0	9.1	11.4
60	5	0.7	0.9	1,1	1,4	1.7	1,8	2,1	2.2	2,7	3,1	3,9	4,9	6.3	7.9
70	2	0.5	0.6	0,8	1,1	1.3	1,3	1,6	1.7	2,1	2,7	3,4	4,3	5.5	6.9

The values of pressure have been estimated for overall service (design) coefficient C = 2,00 and refer to 2nd generation PE pipes (HDPE) for multiple applications and pipes for conveyance of gaseous fuels.

In case a PE pipe system operates under constant temperature greater than 20°C and up to 40°C, a derating factor, f_T, has to be taken into consideration, according to the next table:

TEMPERATURE (°C)	DERATING FACTOR, f_T
20	1,00
30	0,87
40	0,74

The above values apply for PE 100 and PE 80

In case the pipeline does not transport water, but another fluid, an additional factor, f_A, for reducing (or increasing) pressure should be incorporated. The allowable operating pressure in continuous use shall, then, be calculated by:

$$[PFA] = f_T \times f_A \times [PN]$$

where:
[PFA]: allowable operating pressure, bar
f_T : derating factor for service temperatures between 20° C – 40° C
f_A: derating (or uprating) factor related to the application (for water conveyance: $f_A = 1$)
[PN]: nominal pressure, bar

EXAMPLE
A “HYDROTHENE” pipe with DN 40mm and wall thickness 2,4mm operates under constant temperature at 40° C and it is used for water conveyance.

From the pipe dimensions, we conclude that the pipe series is S 8 and the nominal pressure is 10bar. Thus, the allowable operating pressure of the pipe, under these conditions, is:

[PFA] = 0,74 x 10 = 7,4 bar

FLUID VELOCITY

The next table provides with representative velocity values for pipes conveying fluids under steady flow conditions, i.e. flow that does not change over time. With respect to “real” conditions, i.e. non-steady flow conditions, fluid velocity values have to be reduced by approximately 50% compared to the values presented on the table, so that the system is not stressed due to the pressure increase.

APPLICATION		VELOCITY (m/s)
Conveyance pipes	petroleum oil	1 – 2
	natural gas	10 – 20
	saturated steam	15 – 25
	overheated steam	30 – 60
	low pressure gas	5 – 10
	high pressure gas	10 – 30
Distribution networks	potable water	1 – 2
	liquefied gas	≤ 1
Pump inlet	low viscosity fluids	0,3 – 1,0
	viscous fluids	0,05 – 0,15
Pump outlet	low viscosity fluids	1,20 – 3,0
	viscous fluids	0,20 – 0,60
Industrial pipe systems	low viscosity fluids	1,4 – 2,4
	viscous fluids	0,05 – 0,60

PIPE ROUGHNESS

The extent of disorders each solid body’s surface displays, irrespective of its size, is called roughness, e. This quantity constitutes a crucial factor for flow in pipes and it increases when accretions on the walls and pipe corrosion increase. Next table presents roughness values for pipes made of different materials, revealing that plastic materials exhibit the lowest value. This characteristic gives them an important benefit compared to other materials.

PIPE MATERIAL	ROUGHNESS (e, mm)
commercial steel	0,046
cast iron	0,26
galvanized iron	0,15
tar iron	0,12
copper & other light metals	0,013 – 0,015
concrete	0,3 – 3,0
ceramic	~ 0,07
plastic	0,0016

For flow in horizontal pipe of circular cross section, pressure loss is estimated by the following equation:

$$\Delta P = \frac{f \cdot \rho \cdot u^2 \cdot l}{2 \cdot d_{in}}$$

where:
ΔP: pressure loss (Pa, 1Pa = 10^{-5} atm)
f: friction coefficient
d_{in}: internal pipe diameter (m)
ρ: fluid density (kg/m³)
u: mean fluid velocity (m/s)
l: pipe length (m)

The friction coefficient, f, is a dimensionless quantity that can be estimated by using Moody's diagram, based on the relative roughness (e/d_{in}) and Reynolds number (Re). Reynolds number determines the flow type inside the pipe (laminar or turbulent flow) and can be estimated by the formula:

$$\mathrm{Re} = \frac{\rho \cdot u \cdot d_{in}}{\mu}$$

where:
Re: Reynolds number
μ: fluid dynamic viscosity (Pa • s), where for water at low pressure and temperature at 20°C, it is: μ = 10^{-3} Pa • s, whereas at other temperatures it is estimated by using the empirical formula:

$$\frac{\mu}{\mu_o} = \exp\left(\frac{a}{b+T} - \frac{a}{b+T_o}\right)$$

where:
T_o: reference temperature (Kelvin, usually T_o = 273 K)
μ_o: value of dynamic viscosity at reference temperature (Pa • s, for water: μ_o = 17,91 • 10^{-4} Pa • s)
a and b: parameters characteristic for the fluid (Kelvin, for water: a = 511,6 K and b = -149,4 K)

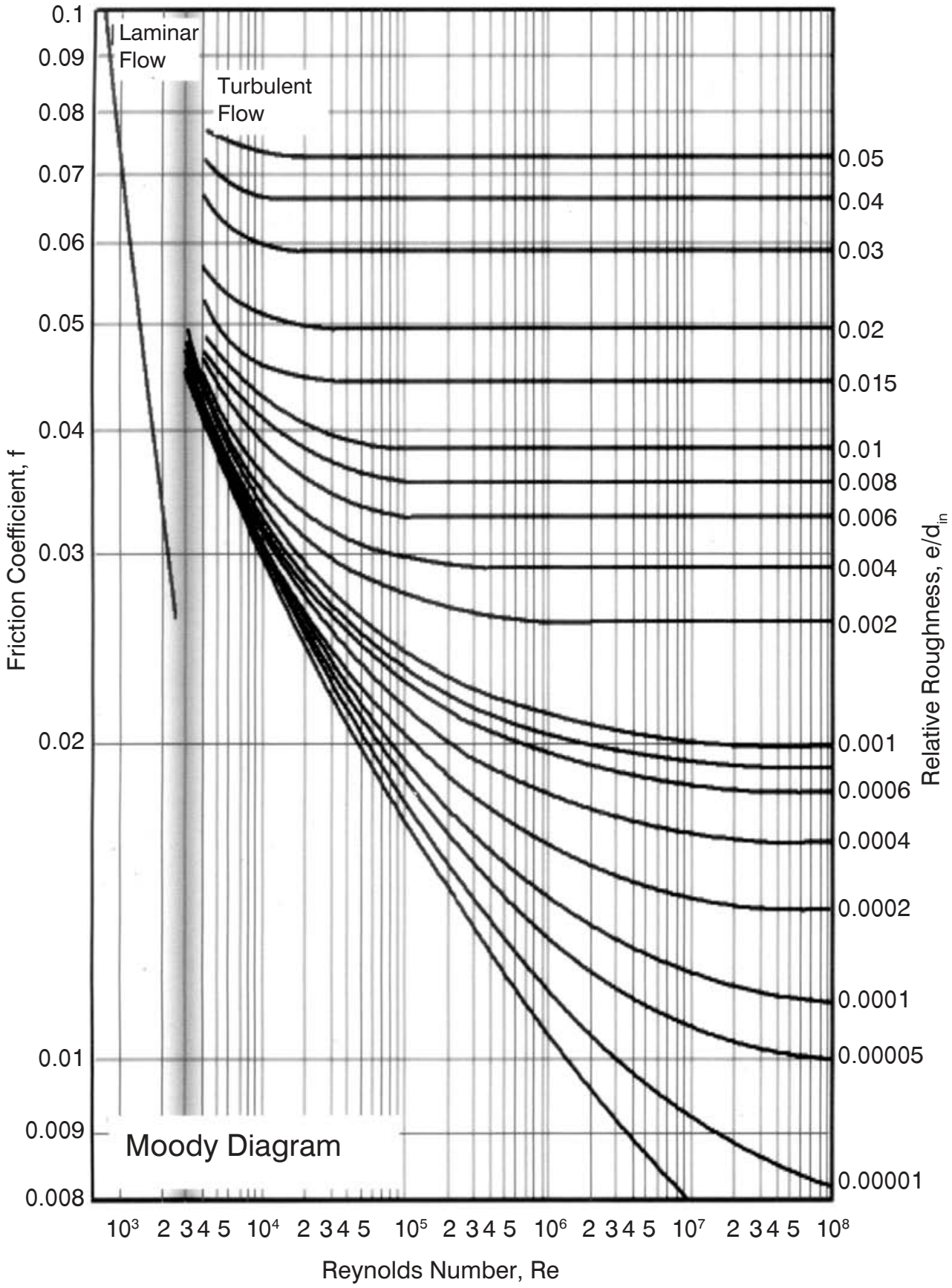
For more accurate calculations, the next formula can be used:

$$\frac{1}{\sqrt{f}} = -2.03 \log\left(\frac{2.51}{\mathrm{Re}\sqrt{f}} + \frac{k}{3.7D}\right)$$

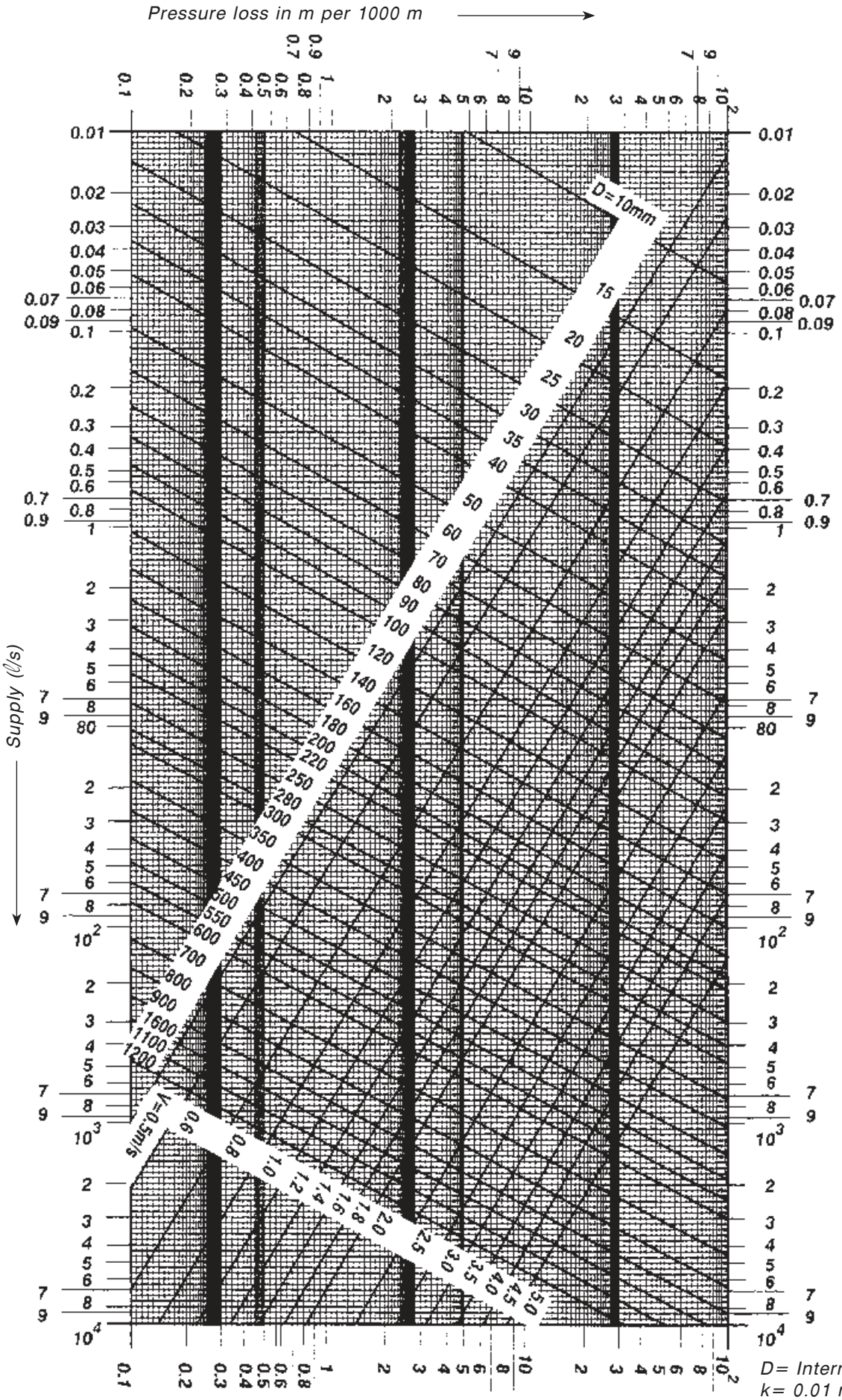
where:
k: absolute roughness of the inner pipe walls (mm). For pipes with diameter up to 200 mm: k = 0,01 mm, and for pipes of diameter more than 200 mm: k = 0,05 mm.

The fluid volumetric flow rate, Q (m³/s), is given by the equation:

$$Q = \frac{\pi d_{in}^{\,2}}{4} \cdot u$$


Laminar Flow
Turbulent Flow
Moody Diagram
Friction Coefficient, f
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.009
0.008
Relative Roughness, e/d_in
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0006
0.0004
0.0002
0.0001
0.00005
0.00001
10^3 2 3 4 5 10^4 2 3 4 5 10^5 2 3 4 5 10^6 2 3 4 5 10^7 2 3 4 5 10^8
Reynolds Number, Re

PRESSURE LOSS IN PE PIPES



D= Internal Diameter
k= 0.01 mm, D≤200 mm
k= 0.05 mm, D>200 mm

A factor that should be taken into consideration when designing the application of a PE pipe system is the estimation of its expansions/contractions. For external installations, the pipe linear expansions at hot water systems have to be estimated and all the required measures should be taken (proper support, anti-expansion ways of connection). At points of direction change, the necessary margins for bearing the expansions should be taken into account and applied.

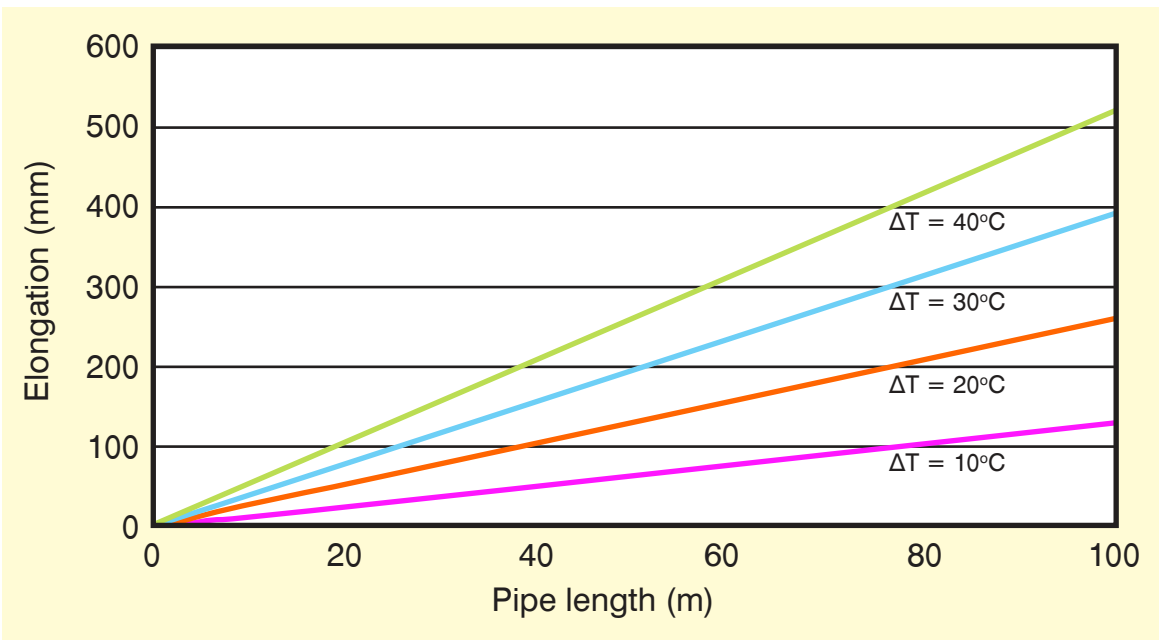
The expected elongation of a pipeline due to thermal expansion is estimated by using the mathematical formula:

$$\Delta\ell = L \cdot \lambda \cdot \Delta T$$

where:
$\Delta\ell$: pipeline expansion/contraction (mm)
L: initial pipeline length (m)
λ: mean coefficient of linear thermal expansion
ΔT: difference between the lowest and highest expected value of operating temperature (°C)

The coefficient of linear thermal expansion for PE is: λ = 0,13 mm/m°C for temperatures in the range of 0° C – 80° C (e.g. for ΔT=20° C and pipeline system length of 40 m, the expansion will be 104 mm).

The next diagram shows the elongation of a PE pipeline due to thermal expansion versus the pipe length at various temperature differences.



TRANSPORTATION

Polyethylene pipes should be transported according to some guidelines, so that their properties are reserved and any possible degradation and/or pipe damage is avoided.
It is prohibited to drag them, to be in contact with sharp items, to be placed in trucks with rough surfaces and to be rejected during their loading.
The unloading of the pipes by overthrowing them from the sidecar of the truck is forbidden, but the unloading with hoisting equipment (crane or forklift) is suggested.

STORAGE

Polyethylene pipes storage should be carried out in such a way that their properties and characteristics are not affected. Pipes and fittings should not be stored under the sun, in particular the blue or yellow ones. A large burden on the pipes and the fittings should not be placed, since they could be distorted.
The ground where they are placed should be as flat as possible, while the heavier pipes should be placed under the lighter ones, although pipes of different diameters should be stored separately.
The pipes should be placed with care in order to avoid possible deformations, and the total height of the stack should not exceed 1m. Finally, the coils should be stored at horizontal ground level in case of long-term storage.

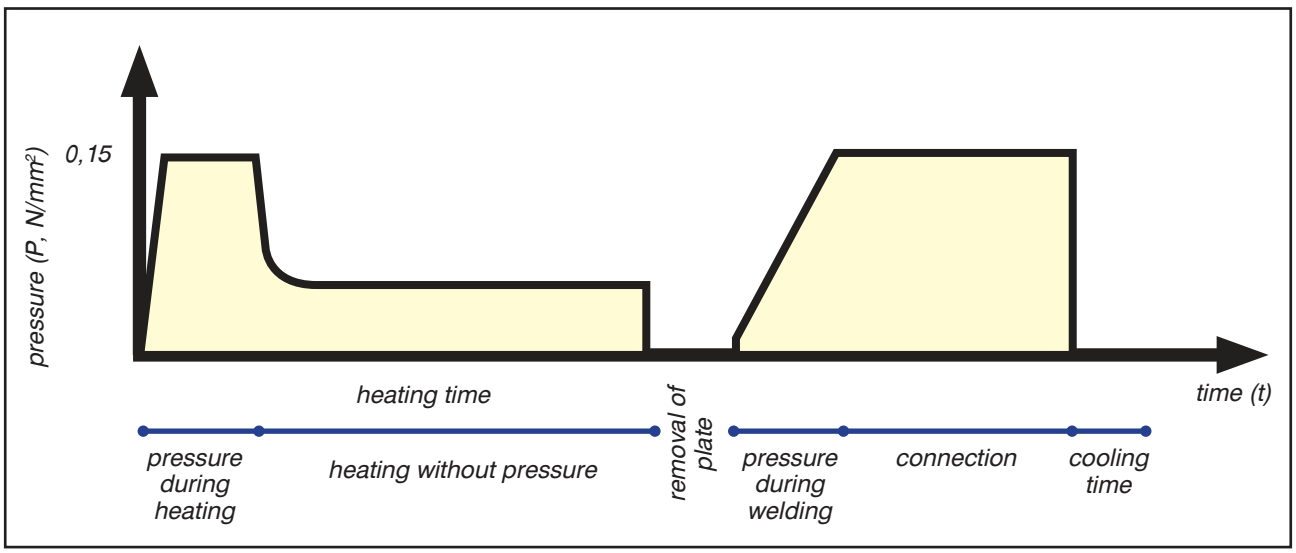
CONNECTION

Polyethylene pipes connection can be made either mechanically using proper devices or by welding.
Polyethylene is welded self-productively. The ends of the pipes that are to be connected are heated at 210^{o}C and they melt over time as pressure increases. As a result, new bonds among the polyethylene molecules are created and, by this way, the welding of two different pipe pieces, the load distribution along the entire pipe system length and the preservation of smooth inner surface are attained. The welding has been demonstrated as the fastest and more secure plastic pipes connection method. The process is carried out by either butt fusion welding or electro fusion welding.

A. BUTT FUSION WELDING USING THERMAL PLATE

The ends of the pipes and fittings are adjusted by a special device and they are cleaned, as well as the thermal plate, using a proper material, such as acetone, which easily evaporates and does not affect polyethylene, so that dust, oils, moisture and any impurity that could affect the welding quality are removed. Particular care should be taken concerning the partitions placement, since improper alignment results in false welding.
The environment the process takes place in should be taken into account, as well, since moisture, extreme cold or hot conditions, wind currents etc should be avoided. Prior the process initiation, the thermal plate has to be uniformly heated.
During the first step of the process, heat under pressure is applied for a specific time interval until a quantity of melted material is formed. Pressure and time depend on the pipe dimensions and the material connection pressure.

Polyethylene welding requires connection pressure of 0,15 N/mm². Heat keeps on under constant pressure of lower value.
During the second and more important step, the thermal plate is removed and the ends are re-connected. At the next step, the welding is performed, while pressure returns to its initial value. Finally, the pipe is let to cool at ambient conditions.
The whole process is shown at the following figure:



B. ELECTRO FUSION WELDING USING ELECTRO SOCKET

For this method, cleaning should be thorough and uniform using special equipment and detergents, as well. The pieces to be welded are connected with the electro socket through which direct electric current is supplied, so that they melt and the welding is performed.

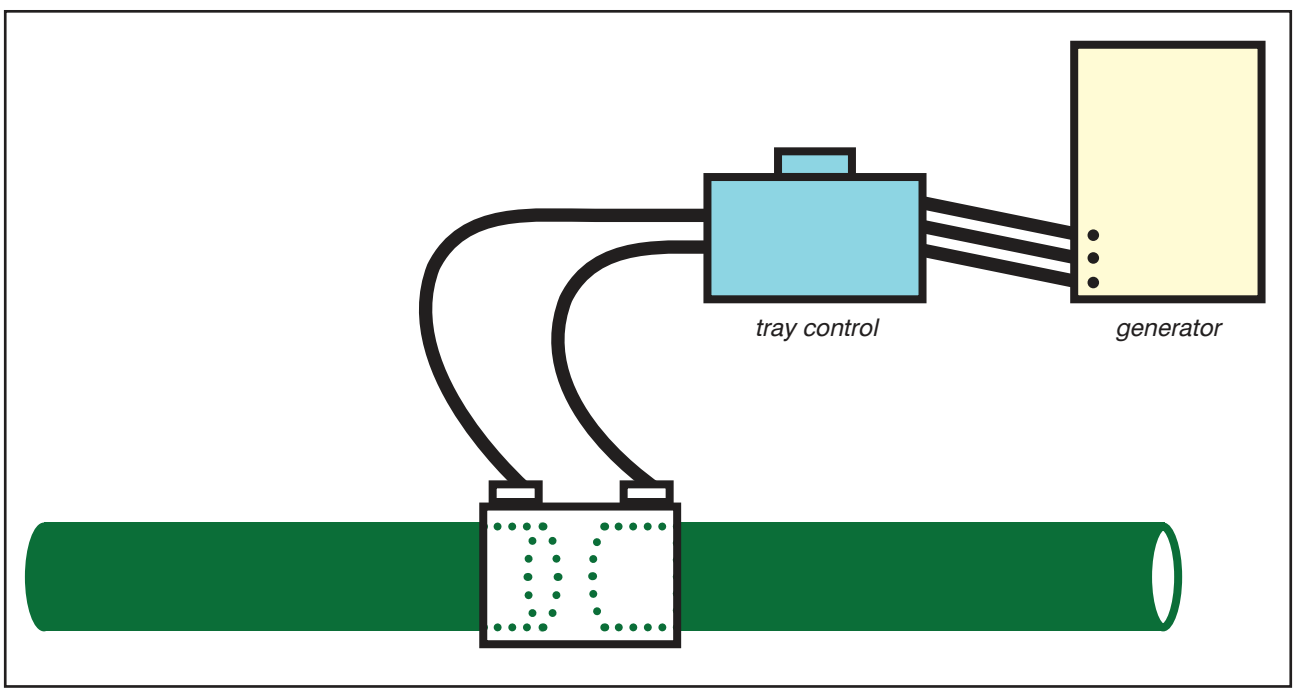
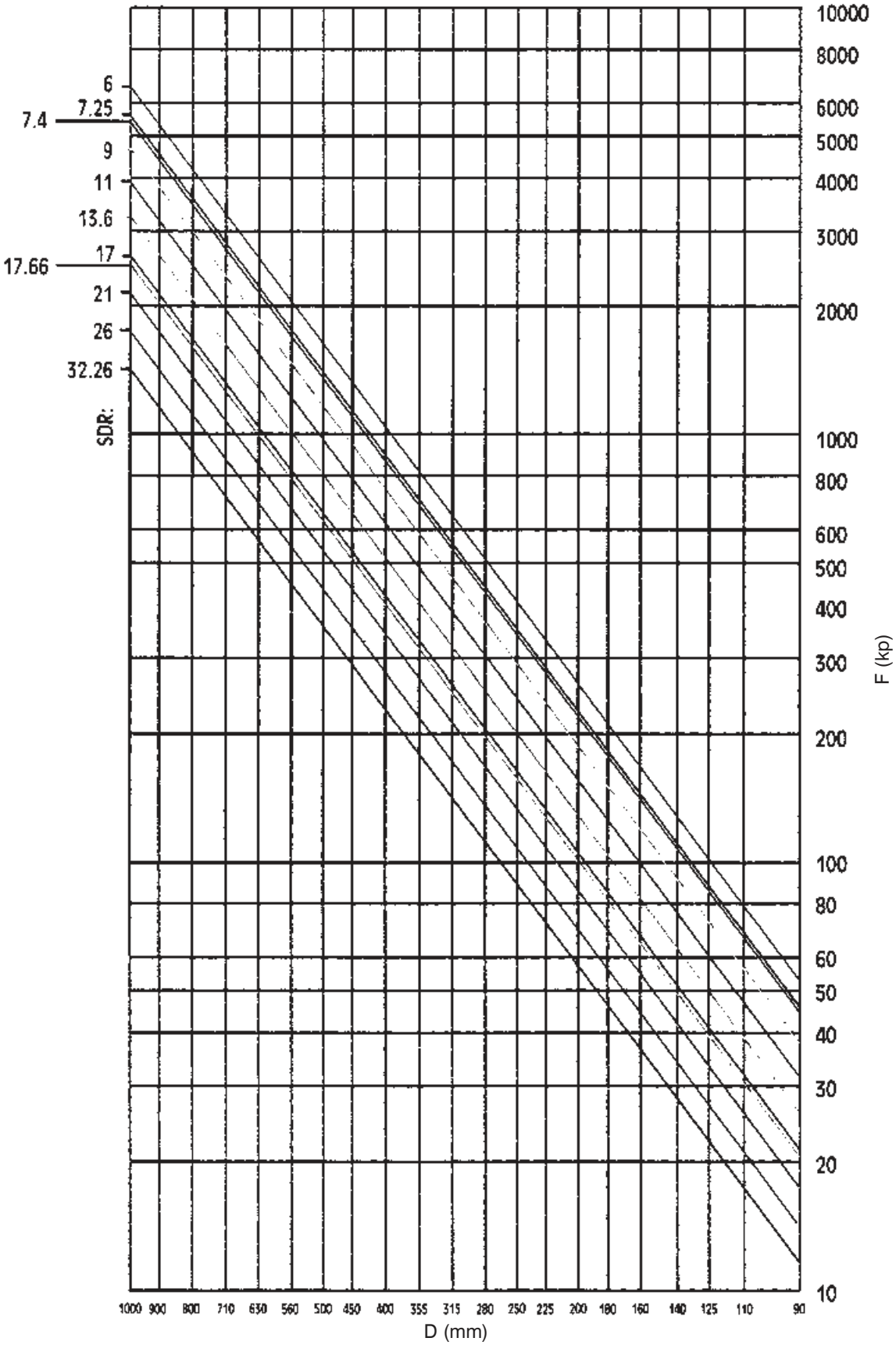


DIAGRAM OF FRONTAL PIPE'S COMPRESSION STRENGTH



Reading of the monometer (in bars): F/f*
* f: is given by the manufacturer of the machine (1bar=f Kp)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