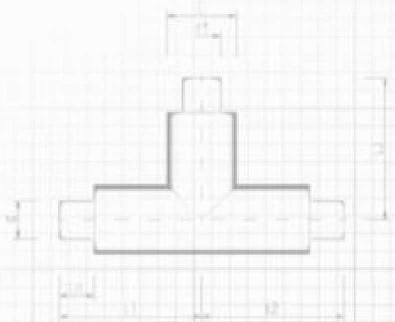
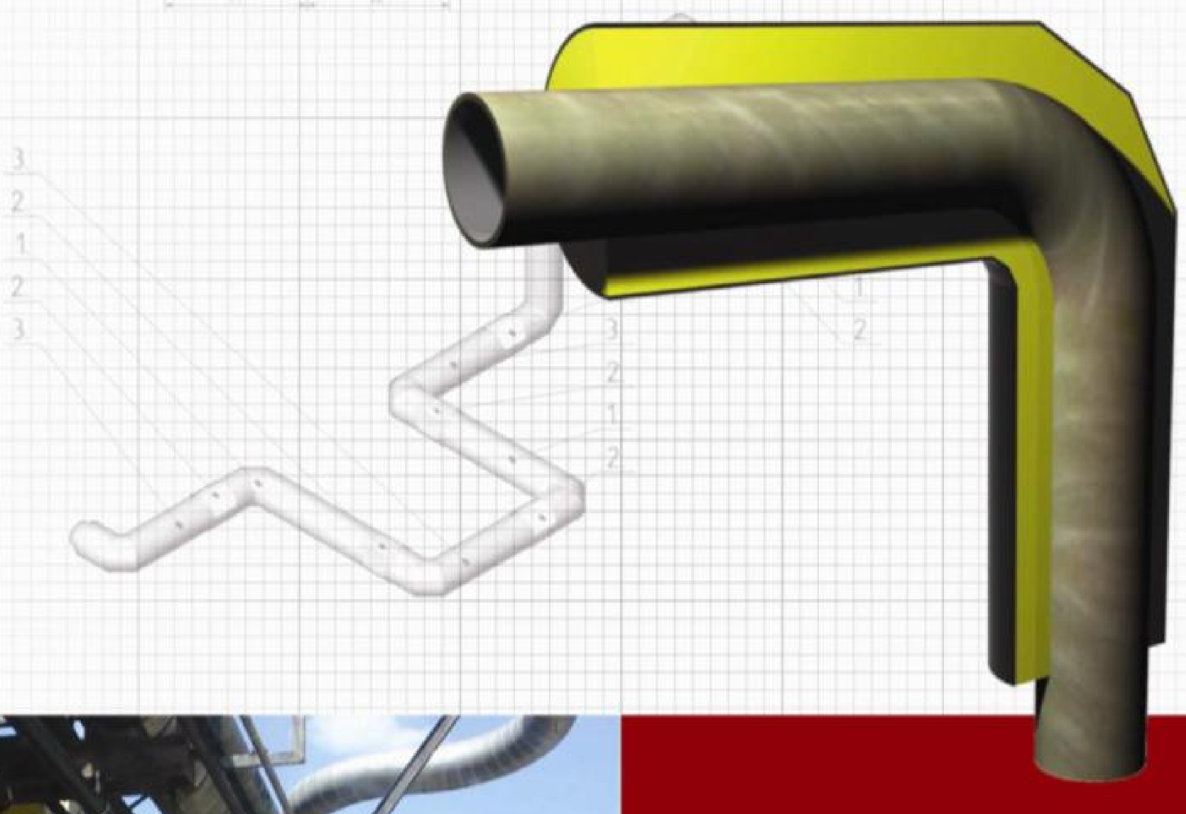
TERMOTECH
DUROPLASTY

TECHNICAL CATALOGUE





COMPOSITE PIPELINE SYSTEM

Grupa Konsultingowo-Inżynieryjna
kompleks®

1. APPLICATION

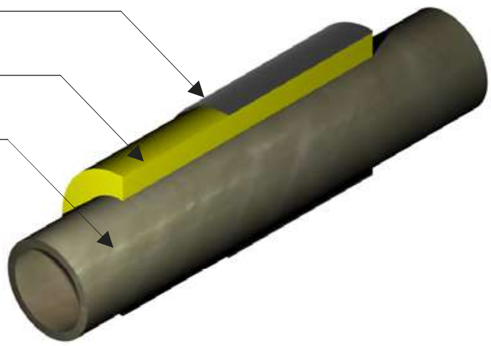
- chemical systems (for acids, bases, various chemical mixtures)
- process water systems
- cooling agent systems
- pipelines requiring the pumped agent to retain constant temperature
- outdoor potable water pipelines (e.g. pipeline river crossings)
- pipelines in mountainous areas
- geothermal water pipelines

2. SYSTEM COMPONENTS

- composite pipes
- composite fittings
- connector unit
- fasteners
- additionally pipes, fittings and valves without preinsulation

3. STRUCTURE

- Sleeve pipe
- Poliurethane foam
- Conduit pipe



Additional TERMOTECH system elements

- **Electric heating cable**
- **Tightness monitoring**

3.1. Conduit pipe - GRP

Glass-Reinforced Plastic (GRP). It is produced by oversaturation of glass materials with various types of resins (polyester, vinyl ester and epoxide resins).

The industrial systems are among the most demanding areas of application in terms of structural, material and functional requirements. Therefore, the materials required in these applications must be characterized by high corrosion and chemical resistance, physical strength and long service time. GRP meets these requirements. It is an ideal material for industrial applications wherever the operating conditions are demanding.

However, it is not only its properties, but also the variety of applications which makes its truly superior to other materials.

3.1. Conduit pipe - GRP

The main advantages of GRP conduit pipes are:

- high chemical resistance
- long service time
- mechanical strength
- low weight
- high resistance to abrasion
- wide range of operating temperatures

The pipes and fittings are produced based on **DIN 16965 and 16966** standard guidelines.

The pipes are manufactured in the process of cross-winding of resin-oversaturated glass fibers on numerically controlled CNC winding machines.

The fittings are manufactured in the process of glass mat and textile lamination, manually.

Standard production range:

- Diameters between **DN25 and DN2000**
- Pressure range between **PN4 and PN40**
- Temperature range up to **120°C**

The design of GRP pipelines depends on three basic pipeline parameters:

- medium to be transported by the pipeline
- operating pressure inside the pipeline
- operating temperature

These parameters were taken into account during the designing of out pipe production systems. However, it is possible to produce a non-standard order at the client's request - individual selection of resins, pipeline layer thicknesses and other components to obtain required physical and chemical properties.

3.2. Thermal insulation

Insulation in the form of PUR polyurethane foam is characterized by very good thermal insulation properties which also greatly increases composite material stiffness.

Basic parameters:

- thermal conductivity ratio **λ<0.027W/mK** at 50°C
- foam core density **ρ>45kg/m^3**

3.3. Sleeve pipe

Depending on the type of system and user preference, 3 types of sleeve pipes are possible:

- hard polyethylene (PE-HD) pipe of density of ρ>944kg/m^3 and corona-treated internal surface meeting the requirements of ***PN-EN 253*** standard.
- SPIRO spiral wound pipes of galvanized sheets as per ***PN-81/H-92125***
- SPIRO spiral wound pipes of aluminum sheets as per ***PN-87/H-92833***

4. DESIGN GUIDELINES

When designing pipelines, two issues shall be taken into consideration. Firstly, adequate distances between pipeline supports should be planned and ensured. Secondly, a system with natural compensation characteristics should be designed or application of expansion joints stipulated.

Due to the material of which the conduit pipe is made - **GRP** - one should act in line with optimum medium flow speed and select pipeline diameter based on this value.

4.1. Linear thermal expansion

Preface.

Thermal expansion is an important operating parameter of pipeline systems. It is caused by excitation of movements of atoms constituting a given substance as a result of thermal energy supply. This results in linear expansion of the material. Incorrectly adopted compensation of this parameters in the operated system may lead, among others, to excessive stress in the pipe, cracks, misalignment and even leaks leading to pipeline damages. To prevent this phenomenon, following steps may be undertaken:

- build a pipeline with low thermal expansion rate
- apply a system for compensation of linear thermal expansion

Considering the production process of TERMOTECH system, it should be noted that the conduit pipe, sleeve pipe and the foam filling the space between these pipes form a uniform piping system for which the thermal expansion for design calculation purposes is as follows:

- **α = 0.015 mm/mK = 15 x 10^{-6} K^{-1} -** for GRP conduit pipeline - cross laminate with glass content of 60%
- **α = 0.025 mm/mK = 25 x 10^{-6} K^{-1} -** for GRP conduit pipeline - laminate prepared manually

Calculation methods.

Prior to commencement of pipeline thermal expansion calculations, a very important question should be asked: "What is the temperature at which the pipeline will be erected?" This temperature is the basic temperature in reference to which the ΔT for two variants shall be calculated.

Variant I

The pipeline is not in operation but is subject to action of external factors (extreme possible high and low temperatures should be considered).

Variant II

The pipeline is in normal operation; the temperature of the medium to be flowing in this pipeline should be considered together with the influence of external factors on the entire "system".

"System" thermal expansion.

$$\Delta L = L \cdot \Delta T \cdot \alpha$$

ΔL - length change for the entire system, mm
L - basic system length, m
α - unit expansion rate of the system, mm/mK
ΔT - temperature difference, K

4.1. Linear thermal expansion

Calculation example .

We shall examine the linear expansion rate for a 1000 meter pipeline made of various materials for temperature increase of $\Delta T = 50^{0}C$.

Materials to be tested ar as follows:

- cross laminate with glass content of 60% - $\alpha = 15 \times 10^{-6} K^{-1}$
- hand-made laminate - $\alpha = 25 \times 10^{-6} K^{-1}$
- steel - $\alpha = 12 \times 10^{-6} K^{-1}$

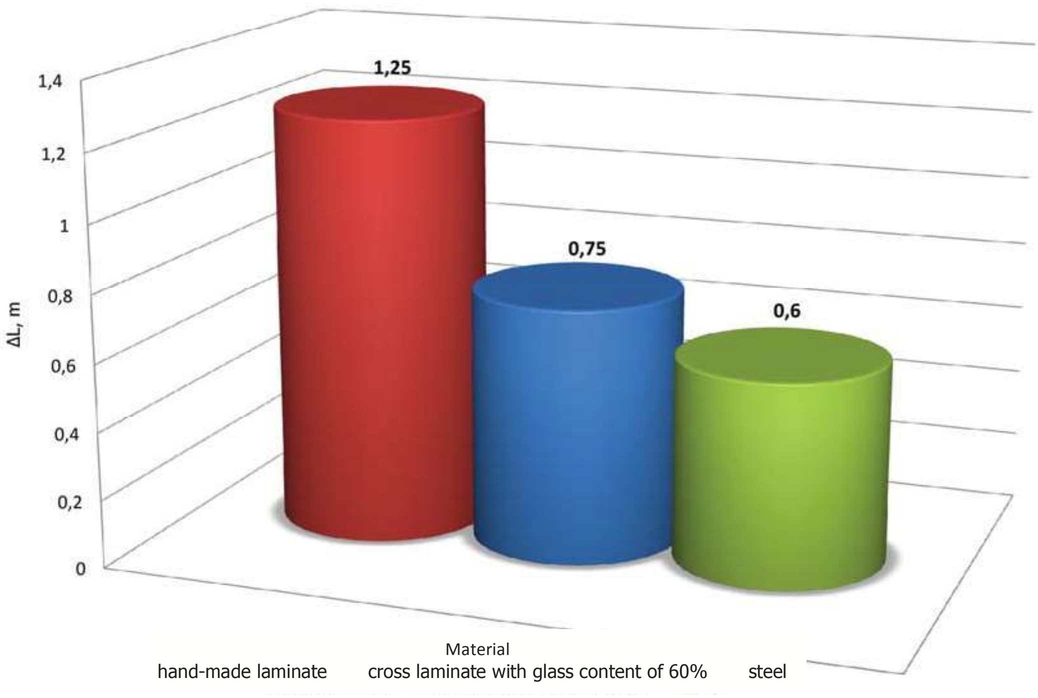
Assumption data:

- $L = 1000$ m
- $\Delta T = 50$ K

Results:

- cross laminate with glass content of 60% - $\Delta L = 0.75$m
- hand-made laminate - $\Delta L = 1.25$m
- steel - $\Delta L = 0.65$m

Linear expansion L=1000m, dT=50K



If our goal is to obtain good thermal expansion values, the steel pipeline is an acceptable solution. However, due to durability, resistance to corrosion, resistance to chemical agents and atmospheric conditions, GRP pipes are much better than steel pipes. It clearly follows from the above diagram that linear expansion for GRP pipes is only slightly higher than steel pipes.

Laminate pipes can be installed in a **self-compensation** system, as the largest allowed deformations for a 1000 m pipeline cannot exceed 2.0m, i.e. 0.2%. In connection with the above, when rebuilding pipelines, the existing supporting structures can be used.

4.2. Support points

The TERMOTECH above-ground pipeline must be installed on supports. To reduce the stress in the pipeline, the supports should be installed at adequate distances. The hanging supports should be installed on rigid structures to prevent additional stress in the pipeline. Following three basic support points can be differentiated:

- **permanent support** – permanently attached to the ground and pipeline. It cannot move in any axis.
- **directional support** – this is a pipeline fastening method to enable pipeline movement along pipeline axis. It moves on a roller or sliding base.
- **moving support** – this is a pipeline fastener which can move both along and perpendicular to the pipeline axis (obviously in a limited range). It is based on a sliding plate in a special casing .

The TERMOTECH Duroplasty ® system can be designed in two manners:

- with application of traditional compensation measures
- with application of self-compensation

The selection of pipeline routing type (natural or artificial expansion joints) is an individual matter requiring a case -by-case analysis. One should always consider which of the methods is better justified for a given application. The decisive criteria can be as follows:

- number of supports - to be considered for cases of new applications and upgrades of steel pipelines
- conditions at the installation location - possibility or lack of possibility for installation of a given number and type of supports

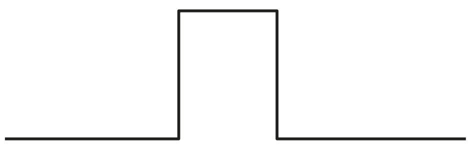
4.2.1. Linear expansion compensation - TRADITIONAL

When designing linear expansion compensation for TERMOTECH pipeline systems in a traditional manner, following two basic issues should be considered:

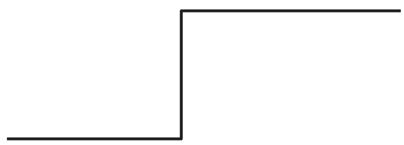
- correct calculation of **ΔL** expansion
- proper planning of fixed point arrangement - **P.S.**
- proper designing of **Lp** spacing between moving supports - **P.R.**
- ensuring minimum compensation arms **H**

The traditional linear expansion compensation methods include:

a. "U-shape" expansion joint



b. "Z-shape" expansion joint



Calculation example is in the further part of this study.

4.2. Support points

4.2.1. Linear expansion compensation - TRADITIONAL

TAB. 1. Spacing of **Lp** moving supports for traditional compensation, m

PIPE DIAMETERS			PE-HD SLEEVE PIPE				SPIRO SLEEVE PIPE			
Conduit	Sleeve		MEDIUM DENSITY				MEDIUM DENSITY			
DN	**Dz (PE-HD)**	**Dz (SPIRO)**	**0,0**	**1,0**	**1,5**	**1,8**	**0,0**	**1,0**	**1,5**	**1,8**
25	90	100	3,4	3,1	2,6	2,1	3,6	3,4	2,9	2,4
32	110	100	3,7	3,5	3,0	2,5	3,9	3,7	3,2	2,7
40	110	125	4,0	3,8	3,3	2,9	4,2	4,0	3,6	3,2
50	125	125	4,5	4,2	3,7	3,3	4,8	4,5	4,0	3,5
65	140	140	5,1	4,8	4,2	3,6	5,4	5,1	4,5	3,9
80	160	160	5,5	5,2	4,5	3,7	5,8	5,5	4,8	4,0
100	200	200	6,2	5,8	4,9	4,1	6,6	6,2	5,3	4,4
125	225	225	6,8	6,4	5,5	4,7	7,3	6,8	5,9	5,0
150	250	250	7,4	6,9	6,1	5,2	7,9	7,4	6,5	5,6
200	315	315	8,4	7,8	6,8	5,7	8,9	8,4	7,2	6,1
250	400	400	9,1	8,5	7,4	6,2	9,7	9,1	7,9	6,6
300	450	450	11,1	10,3	8,5	6,7	11,7	10,9	9,0	7,2
350	520	500	12,0	10,8	9,0	7,3	12,0	11,2	9,4	7,7

TAB. 2. Length of compensation arm **H** depending on expansion, m

DN	Pipeline expansion **ΔL**, mm									
	25	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**
25	1,2	2,0	1,8	2,1	2,4	2,7	2,7	3,0	3,3	3,4
32	1,5	2,0	2,4	2,8	3,0	3,4	3,5	3,8	4,1	4,3
40	1,8	2,0	3,0	3,4	3,6	4,0	4,2	4,6	4,8	5,2
50	2,1	3,0	3,4	4,0	4,6	4,9	5,1	5,5	5,7	6,1
65	2,3	3,5	4,0	4,6	5,2	5,7	5,9	6,4	6,7	7,0
80	2,4	4,0	4,6	5,2	5,7	6,4	6,7	7,3	7,6	7,9
100	3,7	5,0	6,1	7,0	7,9	8,5	9,1	9,8	10,4	11,0
125	3,9	5,5	6,6	7,5	8,4	9,2	9,9	10,4	11,2	11,5
150	4,0	6,0	7,0	7,9	8,8	9,8	10,7	11,0	11,9	12,0
200	4,9	7,0	8,2	9,4	10,7	12,0	12,5	13,0	14,3	15,0
250	5,8	8,0	9,8	11,0	12,5	14,0	14,6	16,0	16,8	18,0
300	6,1	9,0	10,0	12,0	13,4	15,0	16,0	17,0	18,0	19,0
350	6,5	10,0	10,9	13,0	14,3	16,0	17,0	18,0	19,0	20,0

4.2. Support points

4.2.1. Linear expansion compensation - TRADITIONAL

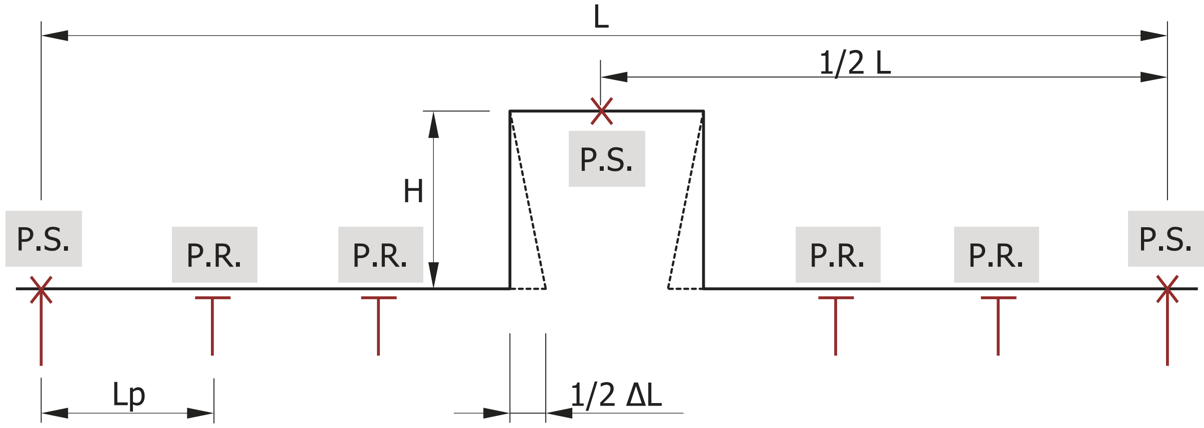
Calculation example:

Assumption data:

- pipeline type - **DN100** SPIRO
- lenght of pipeline section - **L=100 m / L_1=40m i L_2=60m**
- trasnsported medium denisity - **1,0**
- expansion rate - **$\alpha = 15 \times 10^{-6}$ K^{-1}**
- temperature difference - **ΔT= 30 K**

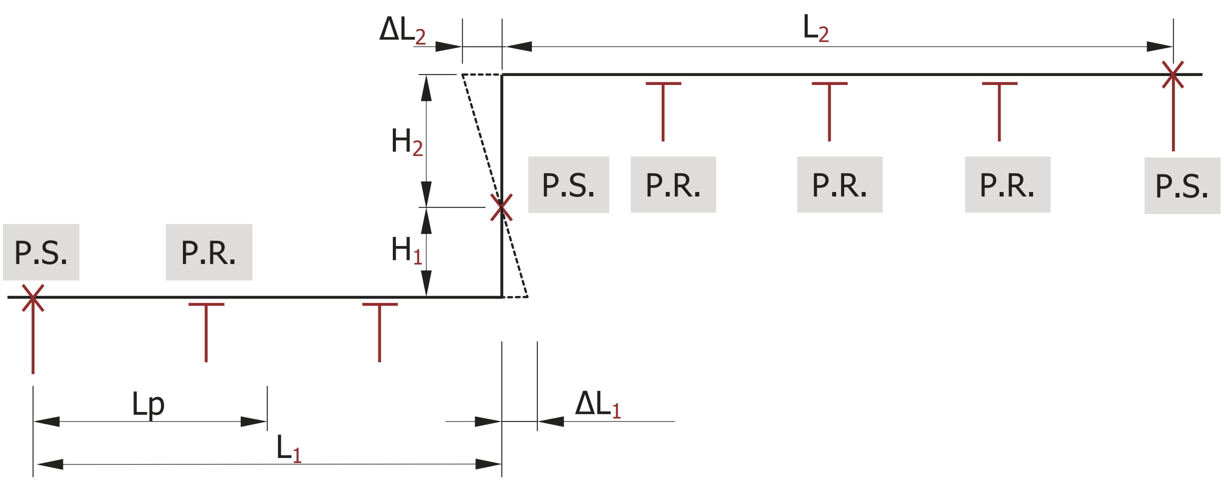
Example 1. "**U**-shape" expansion joint

- **ΔL** = 0,015 x 30 x **100** = **45,0mm**
- from **TAB. 1.** for assumption data - **Lp** = **8,1m**
- from **TAB. 2. DN** i **1/2ΔL** - **H** = **3,4m**



Example 2. "**Z**-shape" expansion joint

- **ΔL_1** = 0,015 x 30 x **40** = **18,0mm** / **ΔL_2** = 0,015 x 30 x **60** = **27,0mm**
- from **TAB. 1.** for assumption data - **Lp** = **8,1m**
- from **TAB. 2. DN** i **ΔL_1/ΔL_2** - **H_1 = 3,1m / H_2 = 3,8m**



4.2. Support points

4.2.2. Linear expansion compensation - SELF-COMPENSATION

Self-compensation is a relatively new term and refers only to pipelines built in this method. Our conduit pipes made of GRP are wound by cross method which results in linear contraction of pipes. Thanks to this phenomenon, they are highly resistant to hammering and can be used for building self-compensating pipelines. One should remember about application **of only guide and fixed supports.**

The highest permitted expansion for a pipeline with self-compensating characteristics cannot exceed **0,2%**.

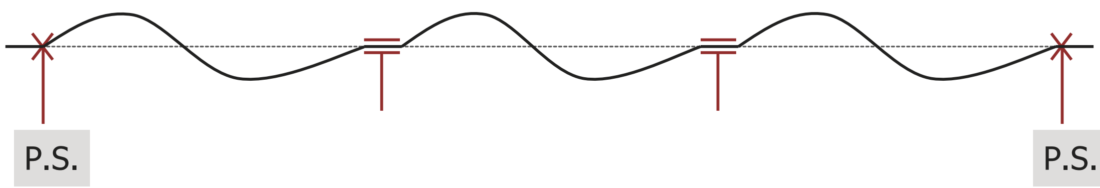
TAB. 3. Spacing of guide supports **Lps** for a self-compensation application, m

ΔT	CONDUIT PIPE DIAMETER , DN												
	25	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**	**250**	**300**	**350**
14	5,2	5,2	5,2	6,6	4,6	9,9	12,0	12,0	12,0	12,0	12,0	12,0	12,0
28	3,6	3,6	3,6	4,7	4,9	7,0	9,1	10,3	11,4	12,0	12,0	12,0	12,0
42	3,0	3,0	3,0	3,8	5,1	5,7	7,5	8,4	9,3	10,1	10,9	11,7	12,0
56	2,6	2,6	2,6	3,3	5,6	4,9	6,5	7,3	8,1	8,9	9,7	10,5	11,3
69	2,3	2,3	2,3	3,0	6,5	4,4	5,8	6,5	7,2	8,0	8,8	9,6	10,4
83	2,1	2,1	2,1	2,7	7,1	4,0	5,3	6,0	6,6	7,4	8,2	9,0	9,8
97	2,0	2,0	2,0	2,5	8,5	3,8	4,9	5,5	6,1	6,9	7,7	8,5	9,3
111	1,8	1,8	1,8	2,4	9,4	3,5	4,6	5,2	5,7	6,5	7,3	8,1	8,9

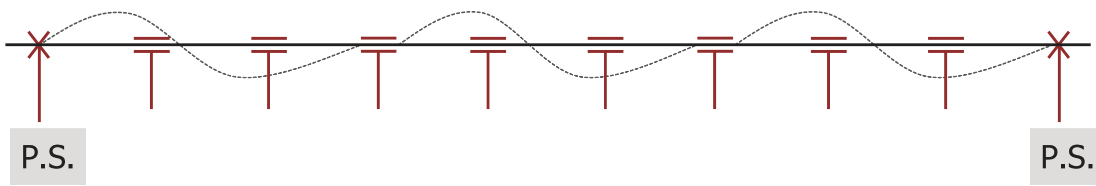
In case of self-compensation, adequate selection of support spacing is of crucial importance. Incorrect approach to this phenomenon may result in the incorrect operation of a pipeline leading to its destruction.

Below are some drawings to illustrate the importance of this issue.

CAUTION! **Incorrectly** adopted spacing between guide supports



CAUTION! **Correctly** adopted spacing between guide supports.



4.2. Support points

4.2.2. Linear expansion compensation - SELF-COMPENSATION

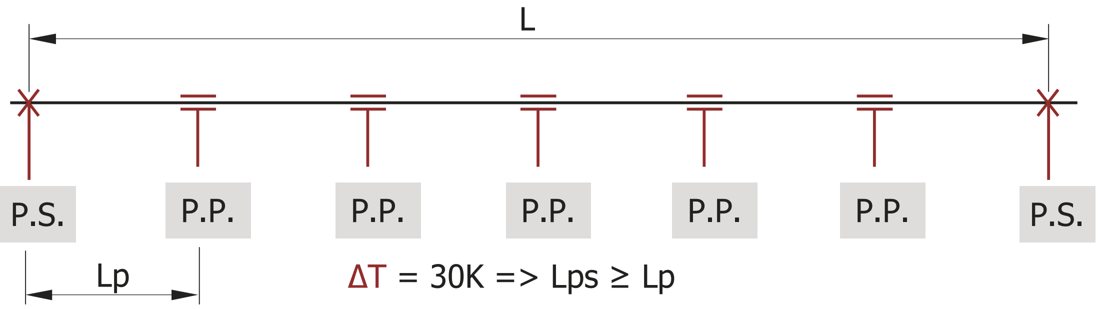
Calculation example:

Assumption data:

- pipeline type - **DN100** SPIRO
- lenght of pipeline section - **L=100 m**
- trasnsported medium denisity - **1,0**
- expansion rate - **α = 15 x 10^{-6} K^{-1}**

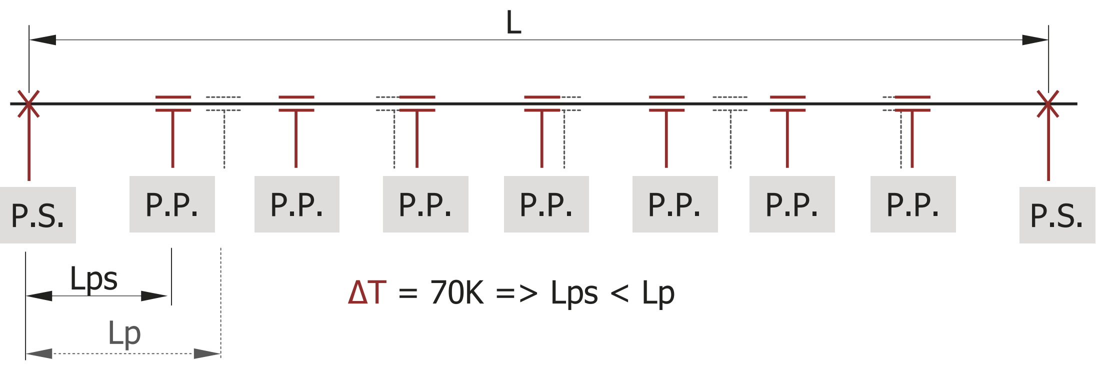
Example 3. Self-compensation ΔT = 30K

- from **TAB. 1.** for parameters and assumptions - **Lp = 8,1m**
- from **TAB. 3.** for **DN**100 and **ΔT**=30K - **Lps = 9,1m**
- **CAUTION!** Always take **smaller** value for spacing of guide supports- in this case it is **Lp**
- for **DN**100, **ΔT**=30K and **L**=100m number of guided supports is - **12 pcs.**



Example 4. Self-compensation ΔT = 70K

- from **TAB. 1.** for parameters and assumptions - **Lp = 8,1m**
- from **TAB. 3.** for **DN**100 and **ΔT**=30K - **Lps = 5,8m**
- **CAUTION!** Always take **smaller** value for spacing of guide supports- in this case it is **Lps**
- for **DN**100, **ΔT**=50K and **L**=100m number of guided supports is - **18 pcs.**



4.3. Chemical resistance of a duct pipe

Depending on the duct pipe technology:

System 1000

Water, salt solutions, wastewater, non-aggressive gases

System 2000

Aggressive agents such as chlorine and ozone as well as liquids saturated with such agents. Durolaminates in the presented system combine chemical resistance of thermoplastic materials and high mechanical strength of composites

System 3000

Virtually all chemical substances except for concentrated oxidizing acids and chlorophenols.

With addition of SiC, increased abrasive resistance, agents e.g. gypsum slurry, example: Flue Gas Desulphurization Plants, Gypsum Dewatering Plants

System 5000

Virtually all chemical substances except for concentrated oxidizing acids and chlorophenols. Most often used for aggressive agents such as chlorine and ozone as well as liquids saturated with these gases .

NOTE! Chemical resistance tables - page 23.

4.4. Recommended flow speed for GRP pipes

Nominal diameter DN	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500
Flow in m^3/h at 1,0m/s speed	1,8	2,9	4,5	7,0	11,8	17,9	28,0	43,8	63	112	175	252	343	448	700
Flow in m^3/h at 1,5m/s speed	2,6	4,3	6,7	10,5	17,7	26,9	42,0	65,6	95	168	263	378	515	672	1 050
Flow in m^3/h at 2,0m/s speed	3,5	5,7	9,0	14,0	24,0	36,0	56,0	88,0	126	224	350	504	686	896	1 400
Flow in m^3/h at 2,5m/s speed	4,4	7,2	11,2	17,5	30,0	45,0	70,0	109,0	158	280	438	630	858	1 120	1 750
Flow in m^3/h at 3,0m/s speed	5,3	8,6	13,4	21,0	35,0	54,0	84,0	131,0	189	336	525	756	1 029	1 344	2 100
Flow in m^3/h at 3,5m/s speed	6,1	10,0	15,7	24,5	41,0	63,0	98,0	153,0	221	392	613	882	1 201	1 568	2 450
Flow in m^3/h at 4,0m/s speed	7,0	11,5	17,9	28,0	47,0	72,0	112,0	175,0	252	448	700	1 008	1 372	1 792	2 800

Recommended flow speeds for GRP pipes

Acceptable flow speeds for GRP pipes

Not recommended flow speeds for GRP pipes

5. ELECTRIC HEATING CABLE

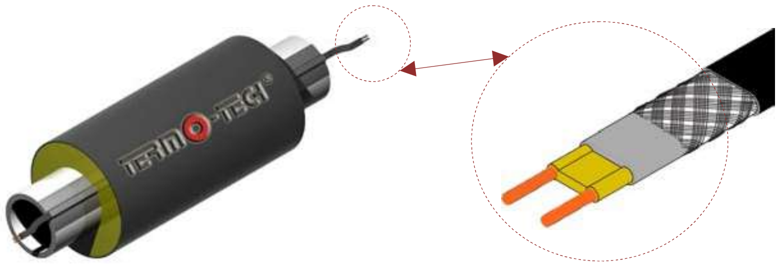
Self-regulating electric heating cable comprises two wires embedded in a semiconductor self-regulating matrix. It means that the cable automatically reacts to external conditions. When the temperature rises, the synthetic materials expands at the molecular level. The bonds between carbon atoms weaken and reduce electric resistance, whereas when the temperature decrease, molecular bonds become strengthened, thus leading to resistance increase. Thus, the heating power changes proportionally to the cable surface temperature. The self-regulating heating cable does not overheat or burn even in places in which two cable sections contact each other.

The self-regulating heating cable is used in the TERMOTECH system in the following cases:

- anti-freezing function - the thermostatic devices has set constant temperature, e.g. +5.0°C
- constant temperature maintenance function for the pumped agent

The cables in a certified version are also available **Ex** - explosion-safe design.

To obtain elements with a heating cable, upon placing an order, please enter **KG** in the **OPTION** field in the order form together with target setpoint temperature, e.g. **+5°C**.



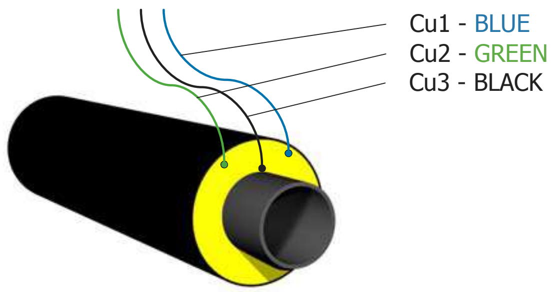
6. TIGHTNESS MONITORING - IMPULSE SYSTEM

TERMOTECH system can also be equipped with a leak alarm system. It is intended to signal the occurrence of moisture in the PUR foam and allows for checking the moisture level inside the pipes and connections. Currently, two systems are applied:

- **IMPULSE** - with 2x1.5mm² copper wires plus an additional wire due to the fact that the pipe is made of plastic - **standard** solution
- **BRANDES resistance** - based - with a NiCr sensor cable in a perforated Teflon insulation and copper wire in Teflon insulation plus an additional wire due to the fact that the pipe is made of plastic - **optional solution**

In both systems, the supervision of the alarm system can be effected using hand held mobile testing devices or stationary failure / leak detection and localization devices

To receive elements with heating cable, place order according to instructions (under catalogue positions and on next page) and enter **M** in the **OPTION** field.



7. SELECTION AND INSTALLATION

Detailed selection of respective TERMOTECH system elements shall be carried out after following details have been taken into account:

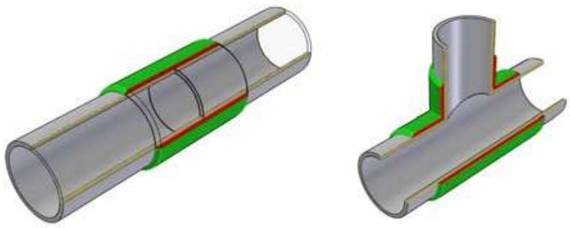
- type of pumped agent
- concentration of pumped agent
- temperature of pumped agent
- system type (above ground, underground)
- if constant temperature of pumped medium is required, also the required temperature range
- designed length of preinsulated pipeline system

NOTE!

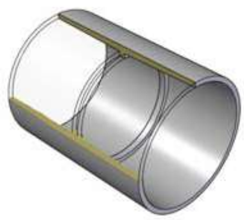
We provide full assistance in designing support arrangements for our pipelines.

GRP conduit pipe joining methods:

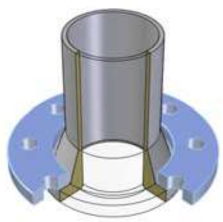
- **laminated front-face or cross connection** – it is a non-detachable connection of pipeline elements consisting in lamination of joined elements. This method of joining is suitable for pipelines of any diameters.



- **glued coupling connection** – it is a non-detachable connection consisting in gluing a pipe end to a specially formed fitting resembling a spigot with a dedicated glue. This method of joining can be used for any pipeline diameter manufactured by us.



- **flange** connections - pipes and fittings are supplied with flanged ends



GRP conduit pipe joining and laminated front-face method is discribed in separate study: „Technika łączenia systemu - TERMO-TECH® Duroplasty”

8. MARKING - HOW TO ORDER

CONDUIT PIPE DIAMETER
e.g. 025, 065, 150...

Fields described for respective elements in production scope part.

OPTIONS
KG - HEATING CABLE
M - TIGHTNESS MONITORING

TR . ☐ . ☐ . ☐ . ☐ . ☐

TYPE
1. **TR** - TERMO-TECH® PIPE
2. **TK** - TERMO-TECH® ELBOW
3. **TL** - TERMO-TECH® BEND
4. **TT** - TERMO-TECH® TEE
5. **TZ** - TERMO-TECH® REDUCER
6. **TV** - TERMO-TECH® VALVE

CONDUIT PIPE MATERIAL
0. GRP

SLEEVE PIPE MATERIAL
1. **PE-HD**
2. GALVANIZED STEEL
3. ALUMINIUM

Materials 2 and 3 - on request.

NOTE!

Diameters exceeding **DN300** - **PLEASE INQUIRE**.

9. EXAMPLE EXECUTIONS

GRP CONDUIT PIPE

Advantages of a **GRP** conduit pipe.

Abrasion-resistant pipelines are applied where pipelines made of steel or other materials do not perform their required function, e.g. in the transport of ash in power plant and combined heat and power plants, for the transport of mining water containing chlorides and sand and for the transport of various slurries in the energy sector (gypsum crystal slurry in the flue gas desulphurization plants), chemical industry and others.

Currently, the slurries are predominantly transported by thick-wall steel pipelines. In many case, internal pipeline abrasion and corrosion occurs. Such pipelines require relatively frequent replacement. Due to steel price increase, a necessity arose for a cheaper and better solution. One of such alternatives are our abrasion-resistant GRP pipelines.

Abrasion resistance, i.e. resistance to abrasion of the internal pipeline layer is achieved by addition of hard fine-powdered materials to the resin. These materials include silicon carbide (SiC). Silicon carbide is added in the amount of 15-25% of weight of the resin used to produce the chemically resistant layer. The thickness of chemically resistant layer ranges between 2.5 and 5.0 mm. Type E pipelines are made entirely of resin with admixed anti-abrasive material.

An additional advantage of GRP pipelines is low surface roughness, several times lower than that of steel which results in lower susceptibility to abrasion. It also possible to use GRP pipes with thermoplastic material internal layer as abrasion-resistant pipelines. These pipes are of structure and mechanical properties identical to those of pure GRP pipes. The abrasion resistance is achieved due to high smoothness of thermoplastic material. Thermoplastic materials used are polypropylene - PP, polyethylene - PE and polyvinyl chloride - PVC..

Examples of industry sectors in which the TERMOTECH DUROPLASTY GRP pipelines can be used:

Power Plants

- water transfer (process water, cooling water, boiler feed water)
- gypsum and limestone slurry pipelines
- hydraulic transport of fly ash
- washing water (process water)
- injection lances and aeration systems
- pipelines for acidic and basic media
- process pipelines
- process wastewater pipelines
- condensate pipelines

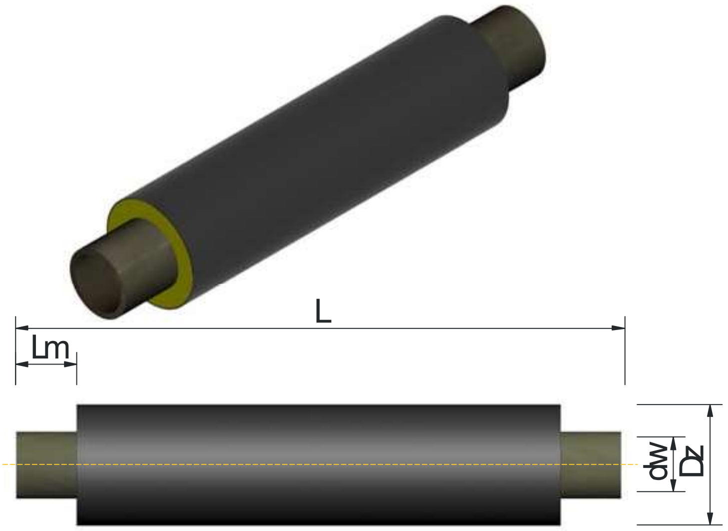
Paper industry

- water transfer
- industrial wastewater systems
- process wastewater pipelines
- pipelines for acidic and basic media
- agents with high chlorine concentration
- salt solution pipelines
- paper pulp pipelines
- condensate pipelines

Chemical industry

- slurry pipelines
- pipelines for acidic and basic media
- highly chlorinated agents
- brine pipelines
- process wastewater pipelines
- condensate pipelines
- aggressive gas and flue gas pipelines

COMPOSITE PIPE - TR



	dw	Dz	CAT. NO.	Lm	kg/m
DN25	25	90/ 100*	TR.025.0.	100	0,73
DN32	32	110/ 100*	TR.032.0.	100	0,99
DN40	40	110/ 125*	TR.040.0.	100	1,05
DN50	50	125	TR.050.0.	100	1,25
DN65	65	140	TR.065.0.	100	1,66
DN80	80	160	TR.080.0.	100	2,02
DN100	100	200	TR.100.0.	100	2,81
DN125	125	225	TR.125.0.	100	3,26
DN150	150	250	TR.150.0.	100	3,62
DN200	200	315	TR.200.0.	150	6,99
DN250	250	400	TR.250.0.	150	9,79
DN300	300	400	TR.300.0.	150	11,17

STANDARD LENGTHS:

<DN65 - L=6,0m
DN80 - L=5,0m
>DN100 - L=6,0m

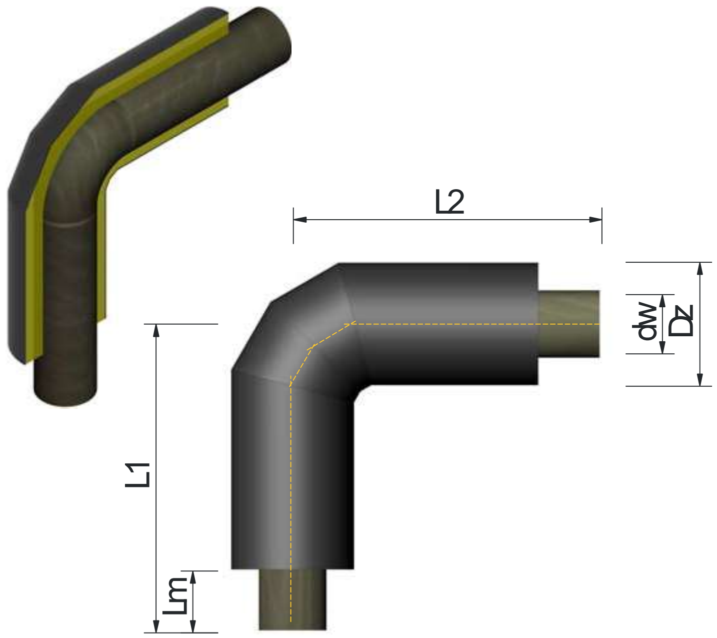
** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

TR . ___ . 0 . ___ . ___ . ___

DIAMITER **DN**, e.g. 025
SLEEVE PIPE MATERIAL- **1, 2 or 3**
LENGTH **L**, mm
OPTION – **KG** - heating cable or **M** - monitoring

COMPOSITE ELBOW - TK



	dw	Dz	CAT. NO.	Lm	kg
DN25	25	90/ 100*	TK.025.0.	100	0,92
DN32	32	110/ 100*	TK.032.0.	100	1,24
DN40	40	110/ 125*	TK.040.0.	100	1,32
DN50	50	125	TK.050.0.	100	1,56
DN65	65	140	TK.065.0.	100	2,07
DN80	80	160	TK.080.0.	100	2,53
DN100	100	200	TK.100.0.	100	3,52
DN125	125	225	TK.125.0.	100	4,08
DN150	150	250	TK.150.0.	100	4,52
DN200	200	315	TK.200.0.	150	12,23
DN250	250	400	TK.250.0.	150	17,14
DN300	300	400	TK.300.0.	150	19,54

Note

STANDARD LENGTHS:

- d ≤ DN150 - L1,L2=500mm
- d > DN150 - L1,L2=700mm

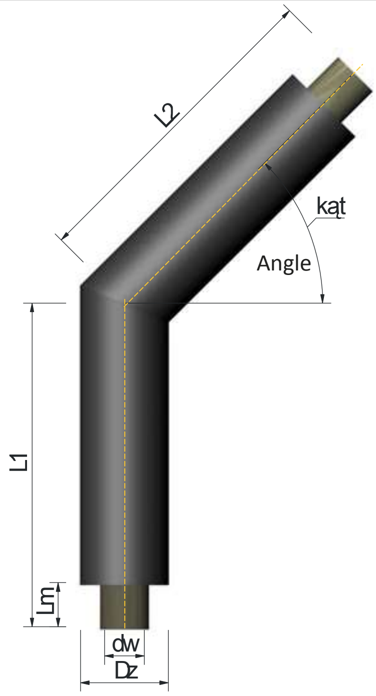
** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

TK . ___ . 0 . ___ . ___ . ___ . ___

DIAMETER **DN**
SLEEVE PIPE MATERIAL- **1, 2 or 3**
LENGTH **L1** mm
LENGTH **L2** mm
OPTION – **KG** - heating cable or **M** - monitoring

COMPOSITE BEND - TL



	dw	Dz	CAT. NO.	Lm	kg
DN25	25	90/ 100*	TL.025.0.	100	0,73
DN32	32	110/ 100*	TL.032.0.	100	0,99
DN40	40	110/ 125*	TL.040.0.	100	1,05
DN50	50	125	TL.050.0.	100	1,25
DN65	65	140	TL.065.0.	100	1,66
DN80	80	160	TL.080.0.	100	2,02
DN100	100	200	TL.100.0.	100	2,81
DN125	125	225	TL.125.0.	100	3,26
DN150	150	250	TL.150.0.	100	3,62
DN200	200	315	TL.200.0.	150	9,79
DN250	250	400	TL.250.0.	150	13,71
DN300	300	400	TL.300.0.	150	15,63

TL . [ ] . 0 . [ ] . [ ] . [ ] . [ ] . [ ]

Note

STANDARD LENGTHS:

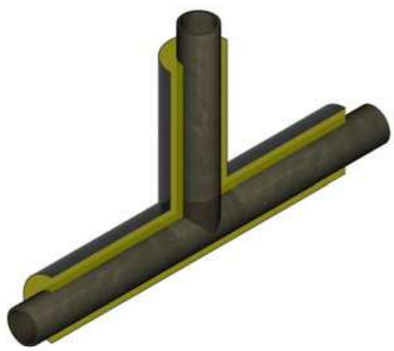
- *d ≤ DN150 - L1,L2=500mm*
- *d > DN150 - L1,L2=700mm*

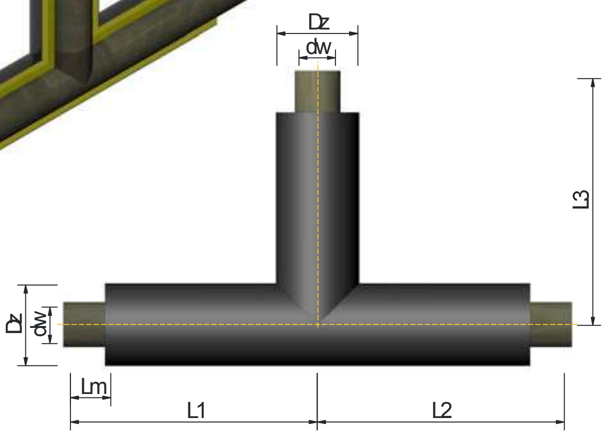
** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

DIAMETER **DN**
SLEEVE PIPE MATERIAL- **1, 2 or 3**
ANGLE °
LENGTH **L1** mm
LENGTH **L2** mm
OPTION – **KG** - heating cable or **M** - monitoring

COMPOSITE TEE - TT





	dw	Dz	CAT. NO.	Lm	kg
DN25	25	90/ 100*	TT.025.0.	100	1,10
DN32	32	110/ 100*	TT.032.0.	100	1,49
DN40	40	110/ 125*	TT.040.0.	100	1,58
DN50	50	125	TT.050.0.	100	1,87
DN65	65	140	TT.065.0.	100	2,49
DN80	80	160	TT.080.0.	100	3,04
DN100	100	200	TT.100.0.	100	4,22
DN125	125	225	TT.125.0.	100	4,89
DN150	150	250	TT.150.0.	100	5,43
DN200	200	315	TT.200.0.	150	14,68
DN250	250	400	TT.250.0.	150	20,57
DN300	300	400	TT.300.0.	150	23,45

TT . [ ] . 0 . [ ] . [ ] . [ ] . [ ] . [ ]

NOTE

STANDARD LENGTHS:

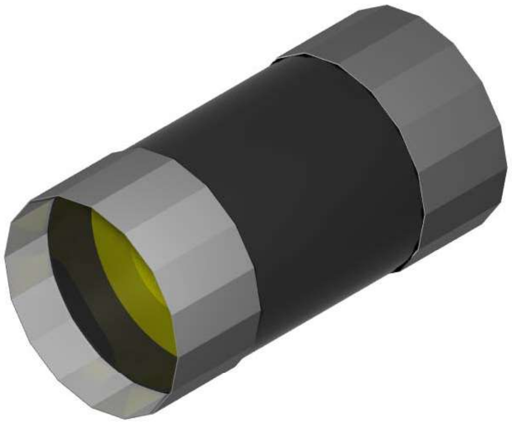
- *d≤ DN150 - L1,L2,L3=500mm*
- *d>DN150 - L1,L2,L3=700mm*

** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

DIAMETER **DN**
SLEEVE PIPE MATERIAL- **1, 2 or 3**
LENGTH **L1** mm
LENGTH **L2** mm
LENGTH **L3** mm
OPTION – **KG** - heating cable or **M** - monitoring

"DRY" CONNECTOR - **TS**



	D	CAT. NO.	Lm
DN25	90/ 100*	TS.025.0.	200
DN32	110/ 100*	TS.032.0.	200
DN40	110/ 125*	TS.040.0.	200
DN50	125	TS.050.0.	200
DN65	140	TS.065.0.	200
DN80	160	TS.080.0.	200
DN100	200	TS.100.0.	200
DN125	225	TS.125.0.	200
DN150	250	TS.150.0.	200
DN200	315	TS.200.0.	300
DN250	400	TS.250.0.	300
DN300	400	TS.300.0.	300

** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

TS . [ ] . 0 . [ ] . [ ]

DIAMETER **DN**
CONDUIT PIPE MATERIAL
SLEEVE PIPE MATERIAL- **1, 2 lub 3**
OPTION – **KG** - heating cable or **M** - monitoring

"WET" CONNECTOR - **TM**

	D	CAT. NO.	Lm
DN25	90/ 100*	TM.025.0.	200
DN32	110/ 100*	TM.032.0.	200
DN40	110/ 125*	TM.040.0.	200
DN50	125	TM.050.0.	200
DN65	140	TM.065.0.	200
DN80	160	TM.080.0.	200
DN100	200	TM.100.0.	200
DN125	225	TM.125.0.	200
DN150	250	TM.150.0.	200
DN200	315	TM.200.0.	300
DN250	400	TM.250.0.	300
DN300	400	TM.300.0.	300

** - **SPIRO** sleeve pipe diameter*

- DN>300 - on request

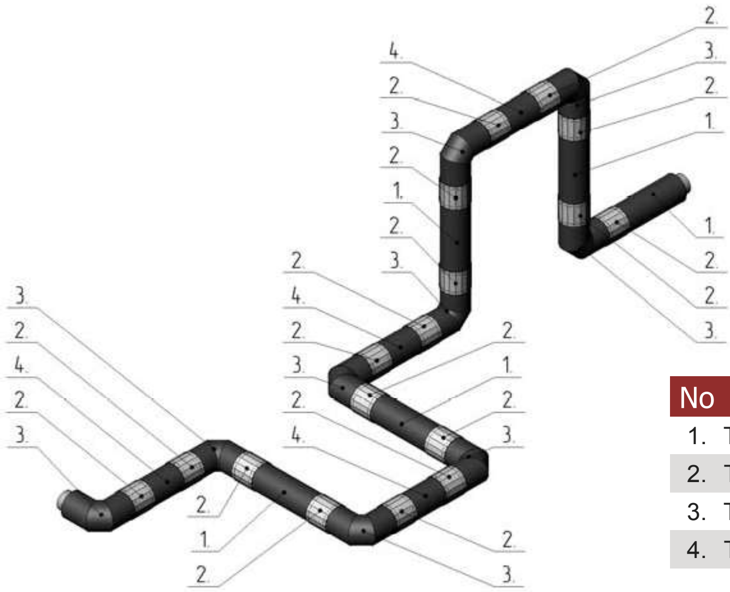
TM . [ ] . 0 . [ ] . [ ]

DIAMETER **DN**
CONDUIT PIPE MATERIAL
SLEEVE PIPE MATERIAL- **1, 2 lub 3**
OPTION – **KG** - heating cable or **M** - monitoring

10. COMPARISON

PRICE COMPARISION BETWEEN INSTALATION MADE OF STANDARD ELEMENTS AND CU-STOM-MADE ELEMENTS.

Instalation made of standard elements - standard variant

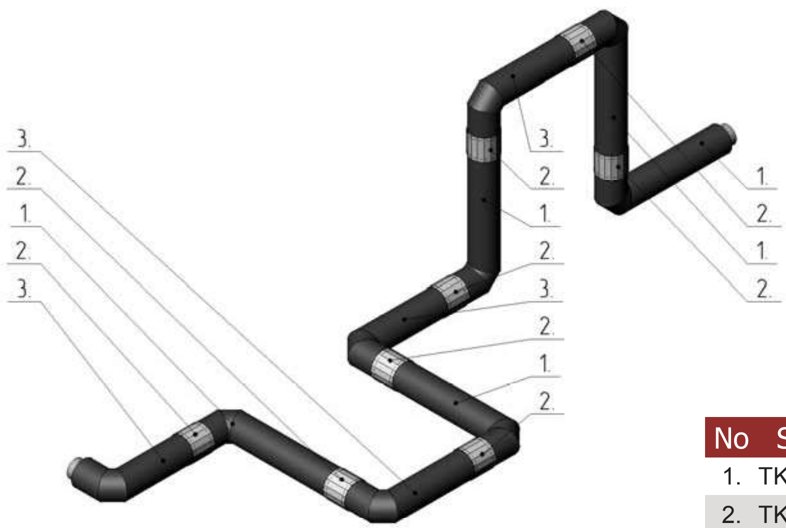


No	Symbol	Qty.
1.	TK.300.0.1.	9
2.	TR.300.0.1.1500.	5
3.	TR.300.0.1.1000.	4
4.	TS.300.0.1.	17

Standard variant cost:

- Labour cost - 100%
- Material cost - 100%

Instalation made of custom-made elements - custom variant



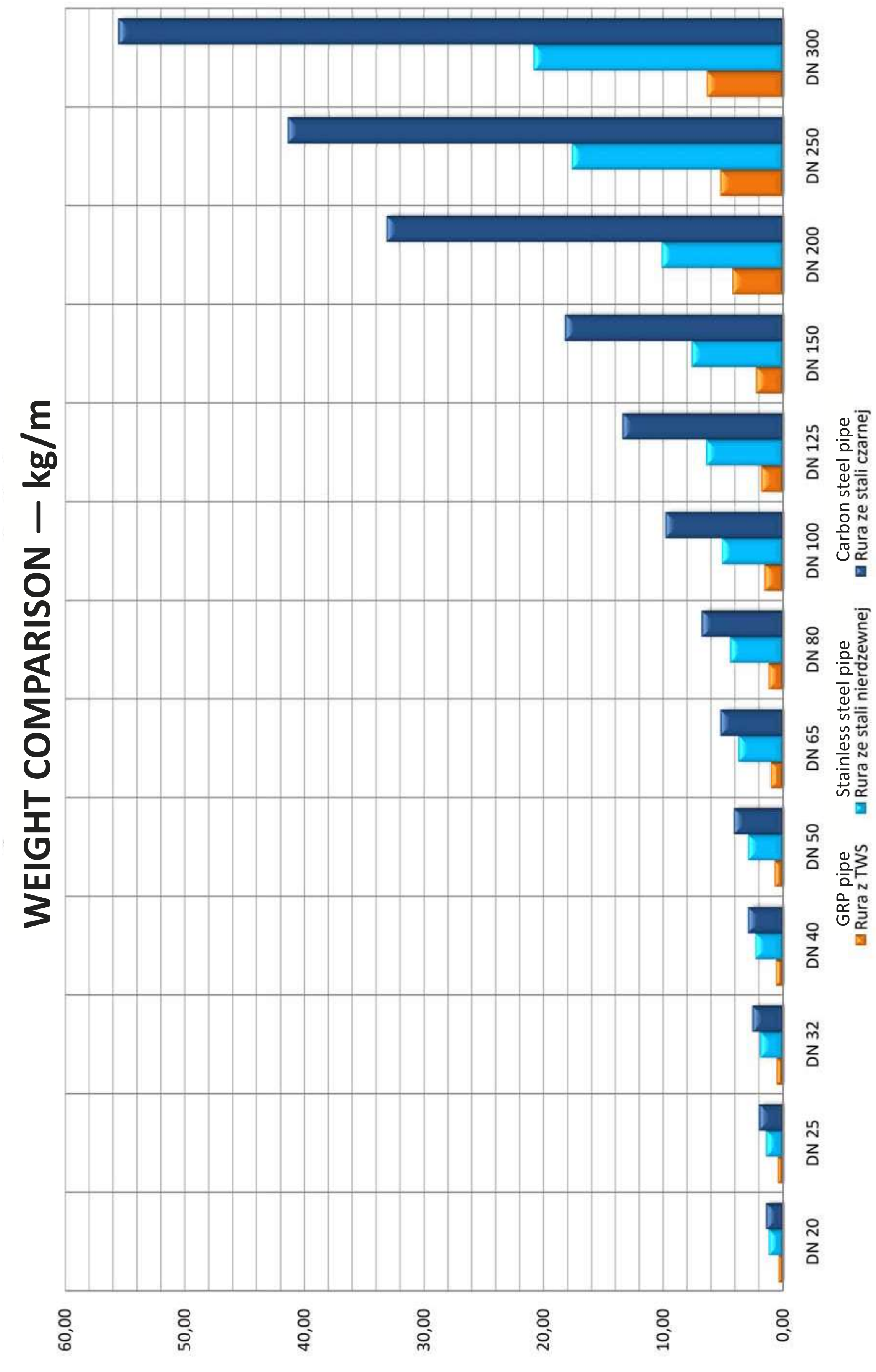
No	Symbol	Qty.
1.	TK.300.0.1.1700.700.	4
2.	TK.300.0.1.2200.700.	5
3.	TS.300.0.1	8

Cost compared to standard variant:

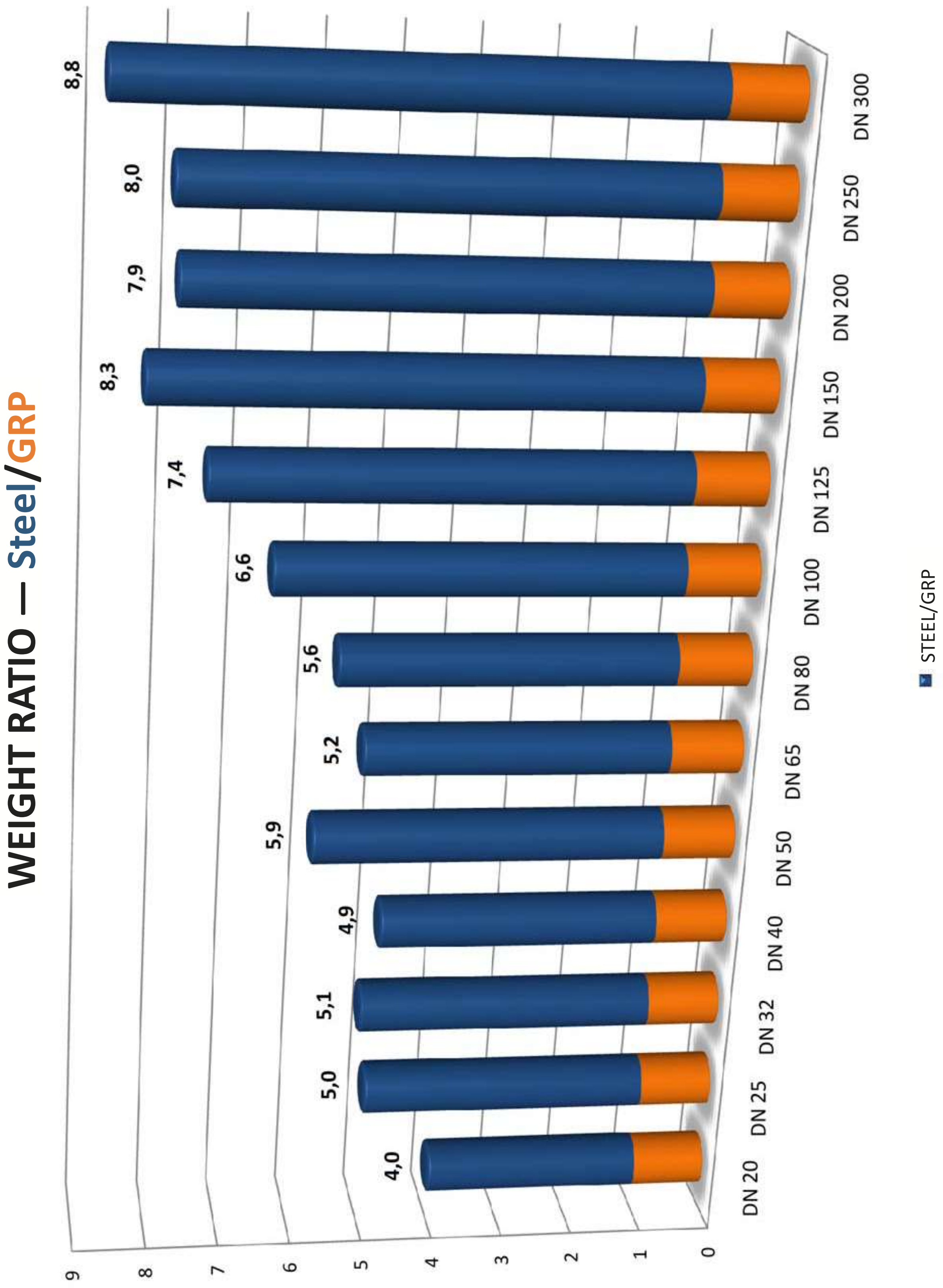
- Labour cost - 78%
- Material cost - 73%

Estimated savings ~29%

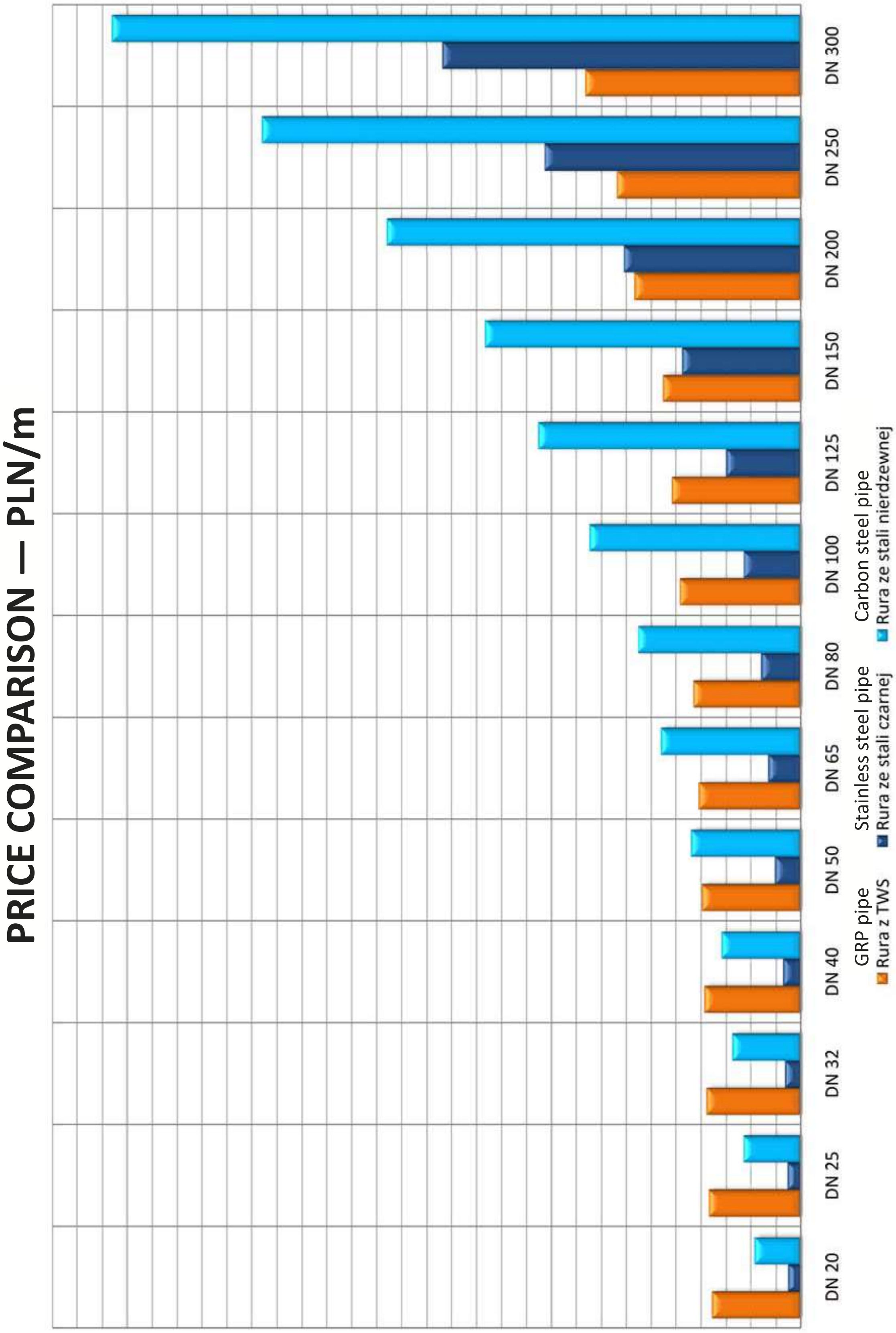
10. COMPARISON



10. COMPARISON



10. COMPARISON



11. CHEMICAL RESISTANCE - examples of transported agents:

CHEMICAL ENVIRONMENT	CONCENTRATION, %	MAX TEMP. °C
BASES		
Calcuium hydroxide $Ca(OH)_2$	100	95
Sodium hydroxide NaOH	50	80
Sodium carbonate Na_2CO_3	35	80
Potassium hydroxide KOH	10	65
Potassium hydroxide KOH	25	65
ACIDS		
Nitric acid HNO_3	20	65
Nitric acid HNO_3	40	25
Sulphuric acid H_2SO_4	10	45
Sulphuric acid H_2SO_4	25	95
Sulphuric acid H_2SO_4	70	80
Hydrochloric acid HCl	20	110
Hydrochloric acid HCl	37	80
Chromic acid H_2CrO_4	20	65
Perchloric acid $HClO_4$	30	35
OXIDIZING AGENTS		
Potassium permaganate $KMnO_4$	all	95
Sodium chlorate $NaClO_3$	50	95
Hydrogen peroxide H_2O_2	30	65
SALTS		
Ammonium nitrate NH_4NO_3	all	110
Ammonium sulphate $(NH_4)_2SO_4$	all	110
Zinc chloride $ZnCl_2$	70	110
Calcium sulphate $CaSO_4$	all	110
Sodium chromate Na_2CrO_4	50	95
Sodium octane $NaCH_3COO$	all	95
SOLVENTS		
Acetone CH_3COCH_3	10	80
Xylene $C_6H_4(CH_3)_2$	100	45
Styrene $C_6H_6CH{=}CH_2$	100	45
Benzene C_6H_6	100	35
Toluene $C_6H_5CH_3$	100	45
Water		80

NOTES: