Vilniaus šilumos tinklai

THE MAIN FACTORS AFFECTING DIFFERENT DH PIPELINES LIFETIME.FAILURES AND DEGRADATION MECHANISMS

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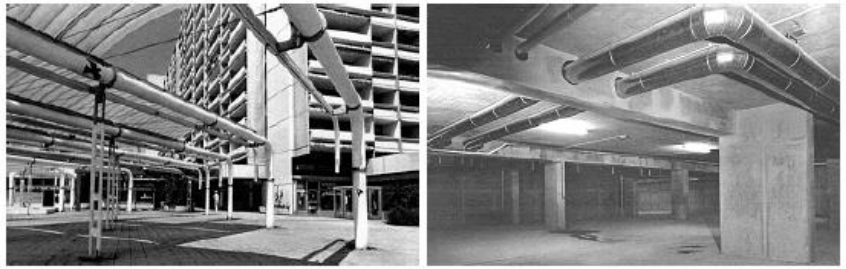
THE MAIN TYPES OF DH PIPING SYSTEMS

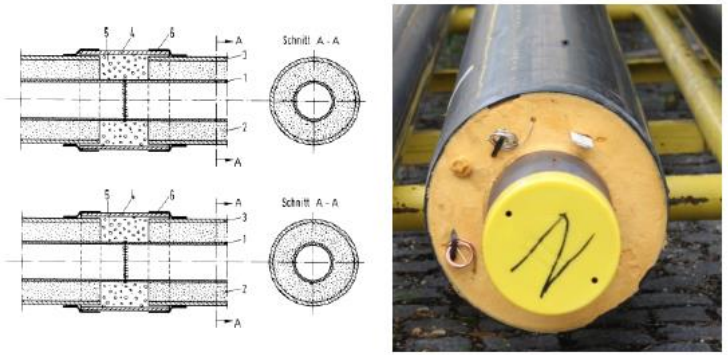
Overland pipelines (1)

Underground-laid pipelines

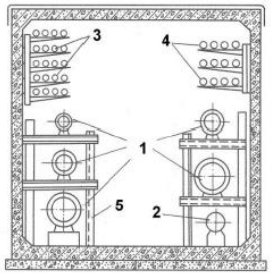
- **Directly buried plastic jacket pipes (2)**
  - Plastic – steel jacket pipes
  - Plastic Jacket pipes (PJP)
  - Steel Jacket pipes
- **In-duct laid pipelines**
  - Transitional Hooded channels (3)
  - Semi-transitional hooded channels (4)
  - Non transitional hooded channels(5)



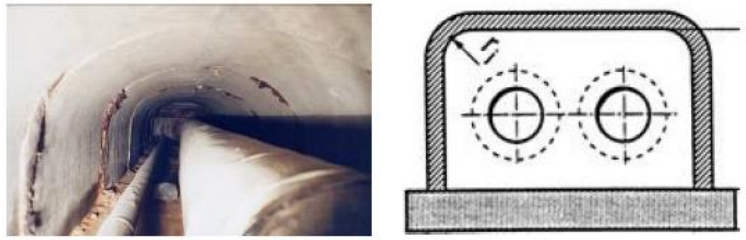
1 fig. Examples of above ground and overhead pipelines (Source: AGFW, 1987)



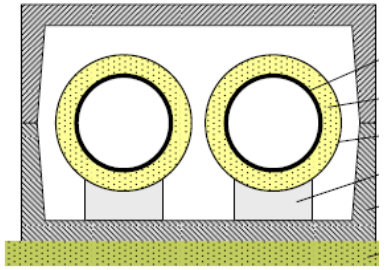
2 fig. Section drawing of PJP and PJP connection (Source: AGFW, 1993) (left) and PJP pipe (Source: D. Rutz) (right)



3 fig. Transitional hooded channels (Source:ANALYSIS OF TECHNOLOGICAL HEAT ENERGY LOSS NORMATION FOR HEAT PRICING PURPOSES, UAB Ekotermija, 2014)



4 fig. Underground-laid pipeline, picture of a hooded channel (Source: AGFW, 2013) (left) and a rectangle hood according to DIN 18178 (Source: AGFW, 1993) (right)



5 fig. Non transitional channel made of trough elements (Source:ANALYSIS OF TECHNOLOGICAL HEAT ENERGY LOSS NORMATION FOR HEAT PRICING PURPOSES, UAB Ekotermija, 2014)

THE MAIN FACTORS AFFECTING DIFFERENT DH PIPELINES LIFETIME

The main factors of risk

Internal

External

What are the main external factors that cause DH pipelines disturbances and influence pipelines lifetime?

- External pipelines corrosion;
- Defects of pipes production;
- Defects of pipelines installation;
- Mechanical effects.

THE MAIN EXTERNAL FACTORS: CORROSION

The main factors causing external pipes corrosion:

- Water leakage (Poor hydraulic insulation);
- High groundwater;
- Drainage system problems;
- Outdated compensation equipment;

* In 2020 according to Vilnius District Heating Company experience we had even 78 occasions related with external corrosion factors (6 fig.)

6 fig. Examples of external corrosion which was occurred in 2020

THE MAIN EXTERNAL FACTORS: WATER LEAKAGE (POOR HYDRAULIC INSULATION)

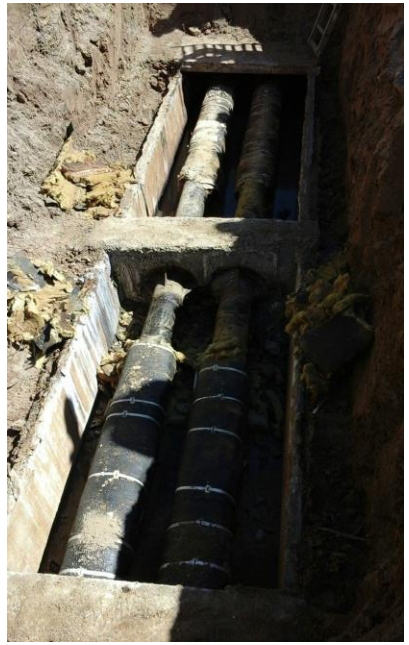
- Poor waterproofing, water leakages cause the external corrosion of various pipelines. In 2020 in Vilnius District Heating Company these factors occurred **in 5 places** at the technical collectors (7 fig.).
- According to Vilnius District Heating experience the biggest amount of accidents was in the **in-duct laid pipelines** at the non transitional hooded channels. In 2020, due to poor waterproofing properties and water leakages there were even **48 defects** with external corrosion of pipelines.

The main causes of occurrence:

- Water enters the pipeline through the channel joints;
- Broken channels (8 fig.);
- Water enters the attachment points of the underground channels through a stacionary support (9,10 fig.);
- The connection between the duct and the foundation of the building is non-hermetic (11 fig.).

7 fig.

11 fig.



10 fig.

9 fig.

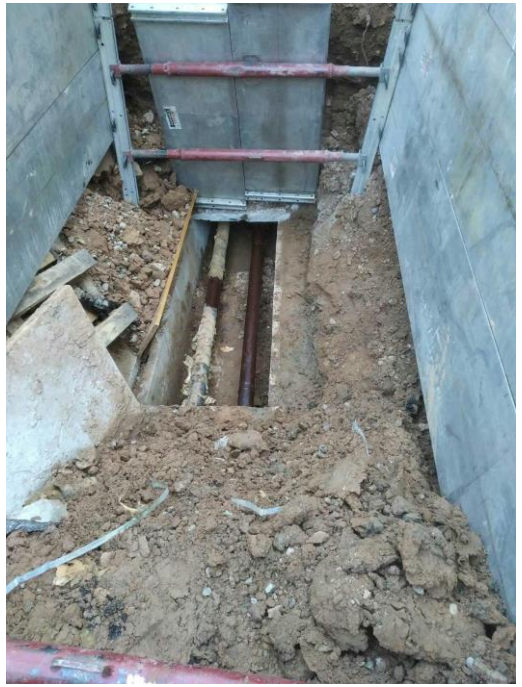
8 fig.

THE MAIN EXTERNAL FACTORS: HIGH GROUNDWATER

- Very often channel type pipes are flooded due to corrosion, or because of the channel has been flooded through high groundwater or rain water.
- In 2020, due to high groundwater there were 3 defects with external corrosion of non transitional channel type pipelines (12,13,14 fig.).

12 fig.

13 fig.



14 fig.

THE MAIN EXTERNAL FACTORS: DRAINAGE SYSTEM PROBLEMS

- External corrosion factors very often happens due to drainage systems problems.
- Regarding to clogged drainage lines, the rainwater level increase and the water floods the channels of the heating networks.
- In 2020, due to drainage system problems there were 3 defects with external corrosion of non transitional channel type pipelines (15, 16 fig.).

15 fig.

16 fig.

THE MAIN EXTERNAL FACTORS: OUTDATED COMPENSATION EQUIPMENT

- Existing heat networks compensation equipment is physically outdated (operated for more than 30 years) and leaky, poorly compensated for temperature changes in network sections.

- One of the largest heat network reconstructions was completed in 2018 in just 10 days, during which 16 units were replaced with DN 700 compensators (18 fig.)

Shortly about advantages of lens compensators (17 fig.):

- These compensators do not require service and maintenance;
- It saves people time due to service non-drained pipelines;
- Great savings on drained water;
- This technology shortens the disconnection time for consumers.

17 fig. lens compensators

18 fig. New installed lens compensators in non transitional hooded channels

THE MAIN EXTERNAL FACTORS: DEFECTS OF PIPES PRODUCTION

- **Outward Fold**

Features: A spiral layered fold on the outer surface of the steel pipe.

The main causes of occurrence:

1) There are folds or cracks on the surface of the tube blank.

2) The surface of the tube blank is poorly cleaned;

3) During the rolling process, the surface of the steel pipe is scratched, and then pressed onto the base of the steel pipe by rolling to form an outer fold.

- **Scratches**

The main causes of occurrence:

1) Mechanical scratches are mainly caused by roller table, cooling bed, straightening and transportation.

2) The rollers are not processed well or are worn seriously or there are foreign objects between the rollers.

THE MAIN EXTERNAL FACTORS: DEFECTS OF PIPELINES INSTALLATION

The main causes of occurrence:

- Poor welding technique;
- Substandard materials;
- Dents;
- Poorly matched pipes.

- In 2020, due to welding defects there were 4 defects with external corrosion in non transitional channel type pipelines (19,20,21 fig.).
- In 2020 weld seam defect occurred in 2 places at the technical collectors (22 fig.).
- In 2020 weld seam defect occurred in 3 places at the directly buried plastic jacket pipelines(23 fig.).

19 fig.

20 fig.

21 fig.

22 fig.

23 fig.

THE MAIN EXTERNAL FACTORS: MECHANICAL EFFECTS

Mechanical effects due to external factors:

- In 2020, regarding to mechanical effects there were 3 accidents in channel type pipelines (24,25,26 fig.)

The main causes of occurrence:

- Other communications works are implementing at the heating networks without the permission of the established procedure.

24 fig.

25 fig.

26 fig.

THE MAIN INTERNAL FACTORS THAT INFLUENCE DH PIPELINES LIFETIME

Vilniaus šilumos tinklai

What are the main internal factors that influence DH pipelines lifetime?

- Internal pipelines corrosion;
- DH water quality;
- DH water chemical preparation;
- Velocity of DH water

THE MAIN INTERNAL FACTORS: CORROSION DETERIORATION MECHANISMS

Internal corrosion is caused by different characteristics of transported water. Poor water quality, different level of water pH-value, oxygen content or bacteria can be the reasons for this process.

- The another reason for the occurrence of internal corrosion is due to untreated water entering the systems through leaking heat exchangers.
- In 2020, in Vilnius were 9 defects with internal corrosion at non transitional channel type pipelines (27-30 fig.).

27 fig. example of internal corrosion

28 fig. example of internal corrosion

29 fig. example of leaking heat exchanger

30 fig. example of leaking heat exchanger pipes

THE MAIN INTERNAL FACTORS: DH WATER QUALITY

- Controlled indicators of DH water quality of water replenishment and returned water of heat networks.

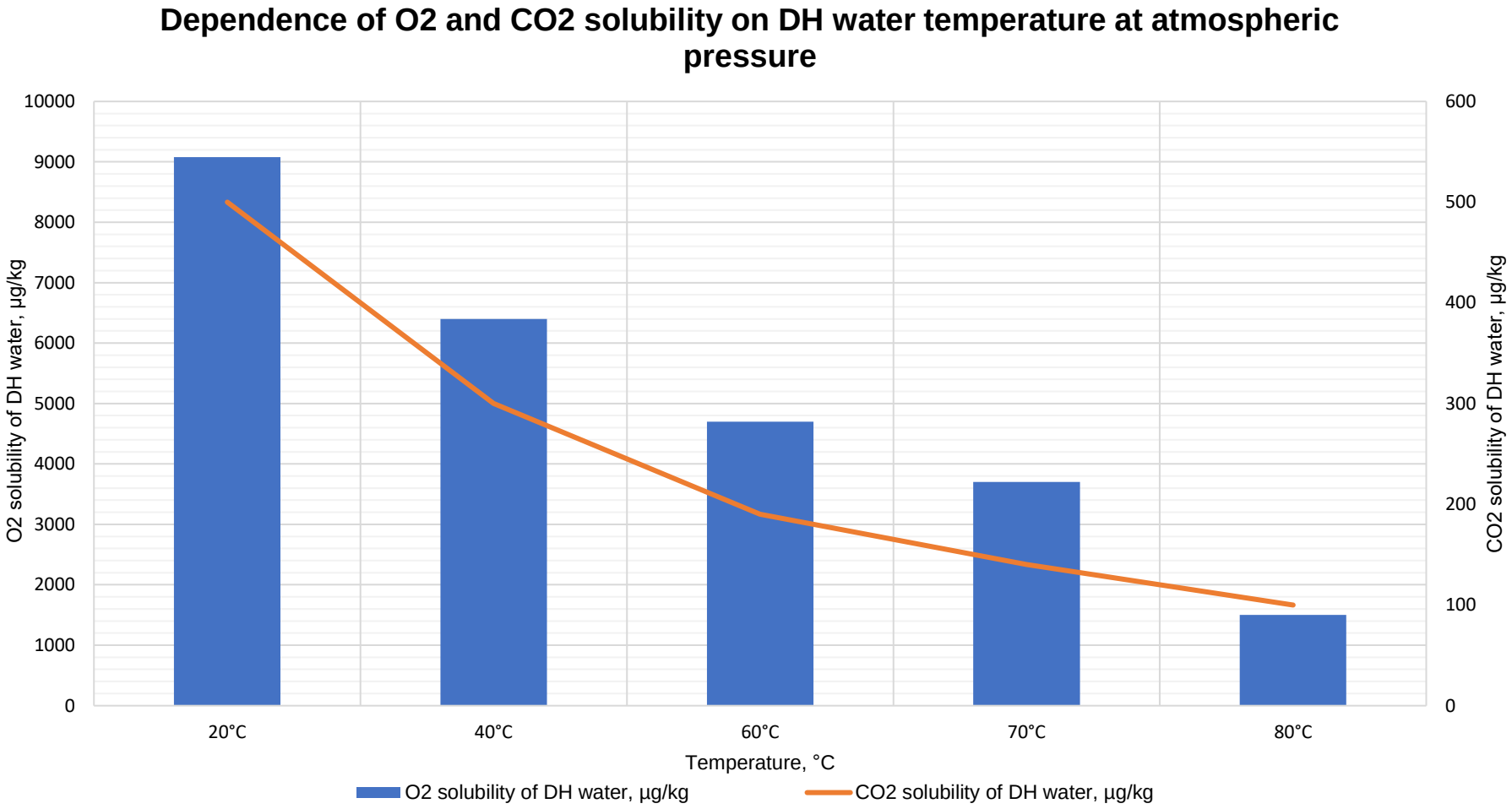
- Oxygen	mg/l	0,05
- Carbon dioxide (CO_2)	mg/l	It does not have to be
- pH (25°C)		9,0-9,8
- Total water hardness	mg-ekv/l	0,1
- Alkalinity of water (f-f / mutual)[2.]	mg-ekv/l	In control/0,7
- Carbonate index	$(mg\text{-}ekv/l)^2$	0,06
- Iron	mg/l	0,2
- Coppper	mg/l	In control
- Aluminum	mg/l	In control
- Zinc	mg/l	In control
- Chlorides	mg/l	25
- Sulfates	mg/l	40
- Permanganate oxidation	mg/l O_2	In control
- Suspended materials	mg/l	0,2
- Oil products	mg/l	0,2

These indicators are controlled by AB VŠT in the water replenishment of heat networks (these figures are from the regime cards approved by VŠT)

- Oxygen	mg/l	0,02
- Carbon dioxide(CO_2)	mg/l	It does not have to be
- pH (25°C)		9,0-9,8
- Total water hardness	mg-ekv/l	0,4
- Calcium hardness	mg-ekv/l	In control
- Alkalinity of water (f-f / mutual)	mg-ekv/l	0,2/1,5
- Carbonate index	$(mg\text{-}ekv/l)^2$	0,5
- Iron	mg/l	0,5
- Suspended materials	mg/l	5,0
- Oil products	mg/l	1,0

These indicators are controlled by AB VŠT in the return water of heat networks (these figures are from the regime cards approved by VŠT)

THE MAIN INTERNAL FACTORS: DH WATER QUALITY



THE MAIN INTERNAL FACTORS: CHEMICAL PREPARATION

- Various materials are used to prevent corrosion and prolong lifetime of district heating pipes. Vilnius District Heating Company uses a caustic soda (NaOH).
- Caustic soda is used to increase the pH of heat network water to the required value of 9.0-9.8. By raising the pH of the heat water to the specified value, all the free carbon dioxide is bound and thus the carbon dioxide corrosion of the steel is stopped.
- Corrosion indicators are periodically used to determine the corrosion intensity in Vilnius heating networks.

31 fig. The indicator was removed from the pipeline after 3 years of use

32 fig. The indicator was removed from the pipeline after 3 years of use

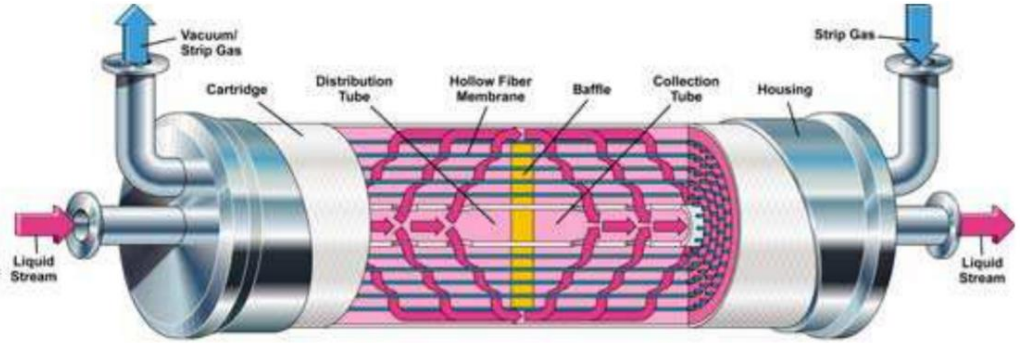
33 fig. The new indicator

34 fig. The new indicators composition

THE MAIN INTERNAL FACTORS: CHEMICAL PREPARATION

The process of preparation of water used for heat networks during the whole year:

- Mechanical filtration;
- Ultrafiltration;
- Reverse osmosis;
- **Membrane deaeration**



35 fig. Membrane deaerator construction

36 fig. Membrane deaerator located in the E-2 chemical department.

37 fig. Membrane deaerator located in the E-2 chemical department.

38 fig. Membrane deaerator equipment

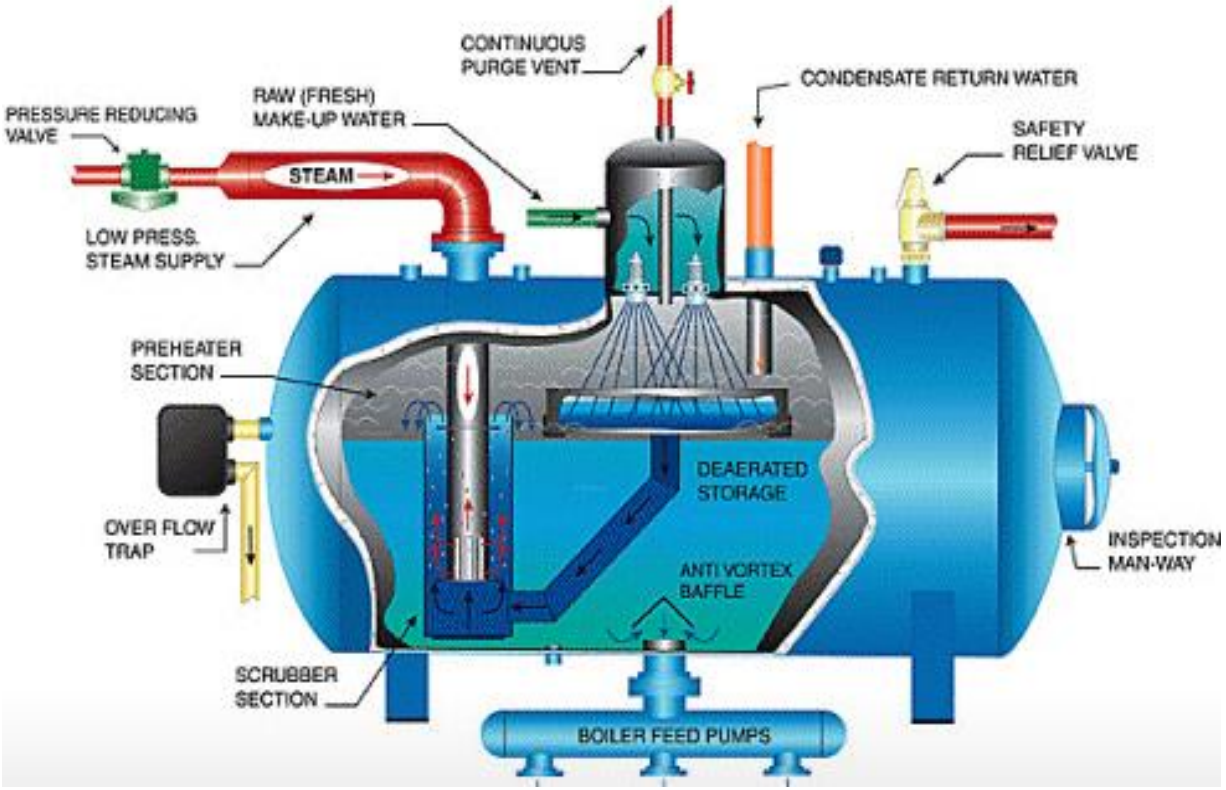
THE MAIN INTERNAL FACTORS: CHEMICAL PREPARATION

Preparation of district heating water for emergency replenishment of heating networks:

- Mechanical filtration;
- Chemical water filters:

Na cationic one degree

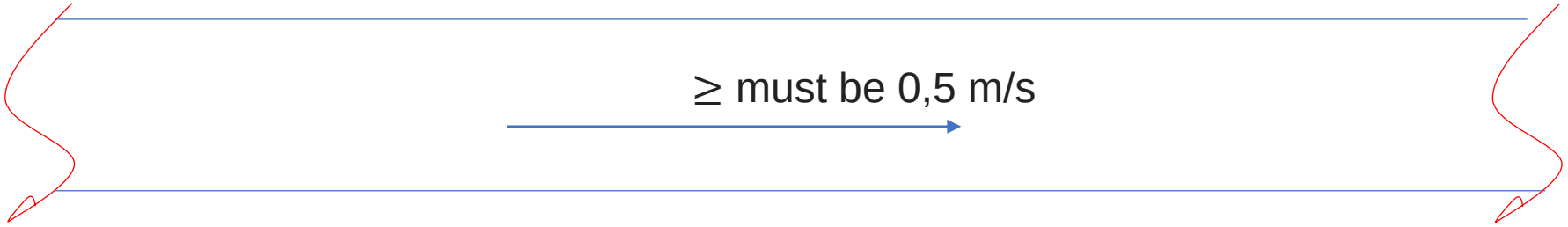
- Atmospheric steam deaerator



39 fig. Membrane deaerator construction

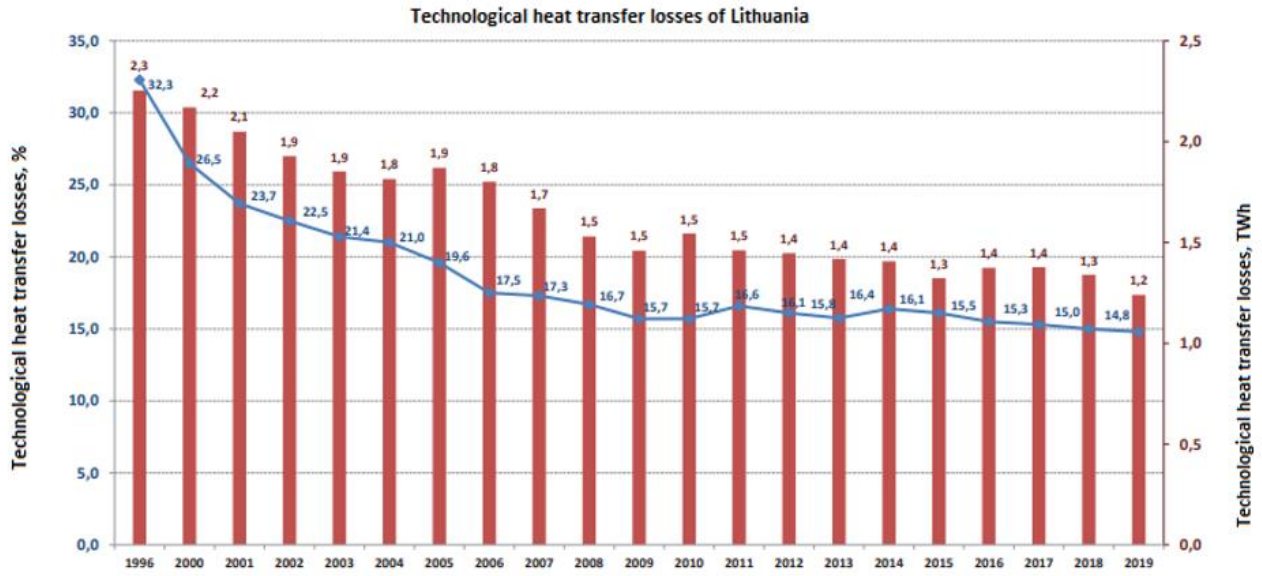
THE MAIN INTERNAL FACTORS: VELOCITY OF DH WATER

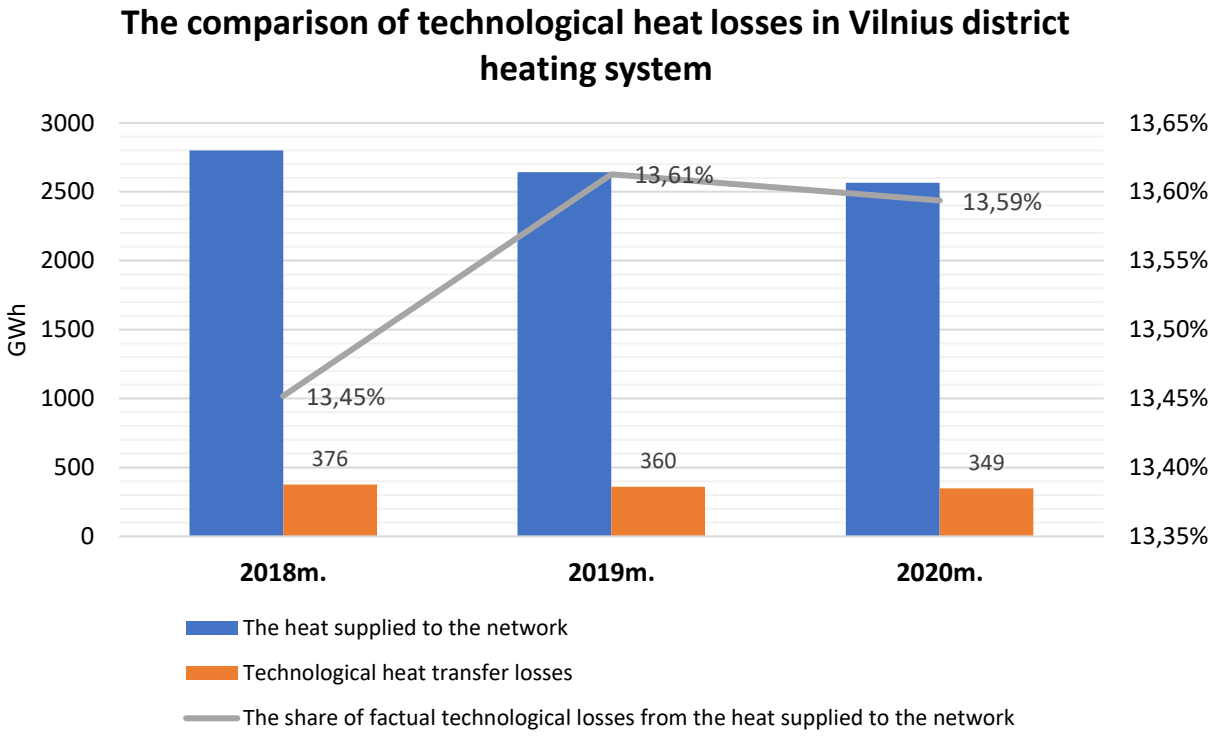
- Velocity of DH water less than 0,5 m/s increase probability of microbiological corrosion.
- From practical experience low water speeds were relevant in the last decade of the 20th century, when the sudden disconnections of some industrial enterprises reduced the need for heat. However, changes to the network operating temperature schedule allowed the problem to be resolved fairly quickly.



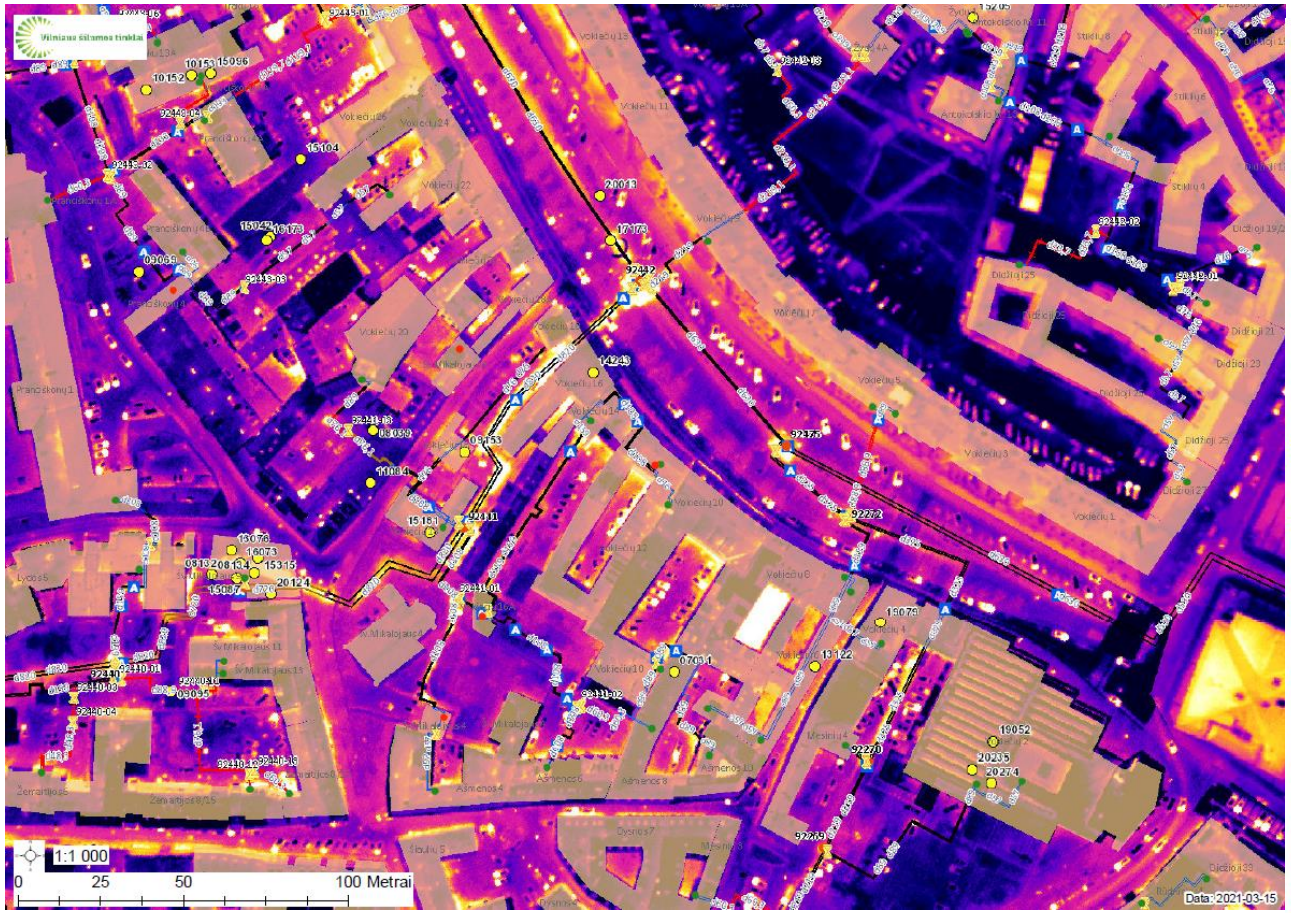
THE METHODS THAT CAN EXTEND LIFETIME OF DH PIPELINES. HEAT LOSSES REDUCTION

- It is necessary to reduce heat loss from networks by replacing old-type pipelines with new pre-insulated pipes with significantly lower heat losses than old pipes.
- In 2019 (in Lithuania), about 1,200 GWh of heat was lost during the transfer of heat to consumers, which accounted for 14.8% of the amount of heat supplied to DH networks, or 100 GWh less than in 2018.

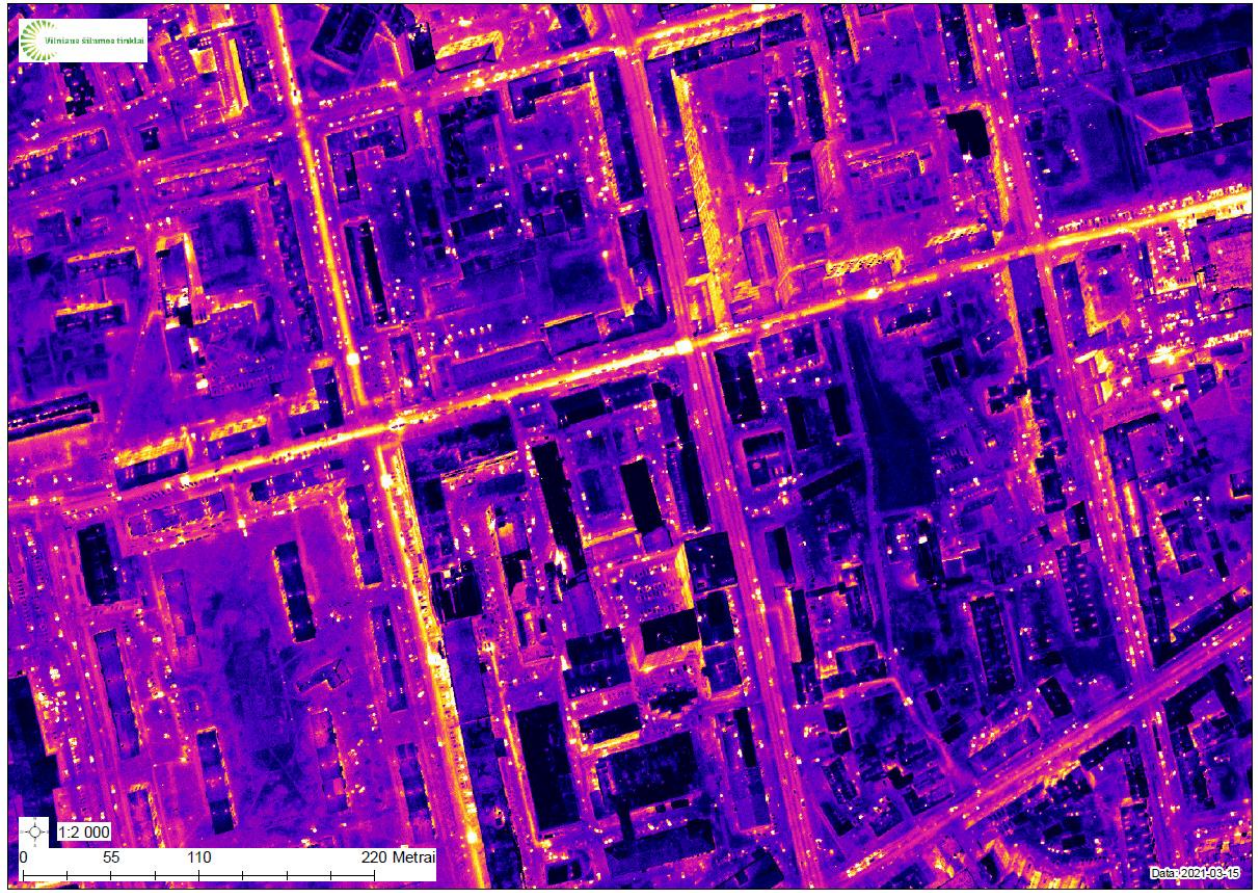




THE METHODS THAT CAN EXTEND LIFETIME OF DH PIPELINES. HEAT LOSSES REDUCTION .CURRENT SITUATION



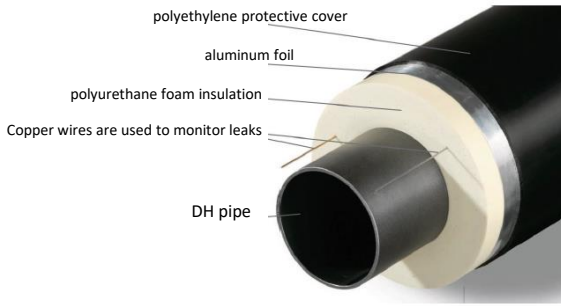
40 fig. Existing in-duct laid pipelines in Vokiečių st, Vilnius



41 fig. Existing Non transitional hooded channels in Ševčenkos –Vytenio st., Vilnius

THE METHODS THAT CAN EXTEND LIFETIME OF DH PIPELINES. HEAT LOSSES REDUCTION . PIPELINES INSULATION

- Industrially insulated pipes that are produced for district heating for an expected service life of 30-50 years. Such a long service life can only be achieved if the construction of the networks is of good quality and all requirements are met during operation, especially for water quality and temperature regime.
- In order to achieve the lowest heat losses it is necessary to develop low temperature district heating with plastic Jacket pipes (Pre-insulated plastic pipes) in not higher than DN 100 piping diameters.



42 fig. Industrially insulated plastic jacket pipe

43 fig. Directly buried plastic jacket pipes

Source: ANALYSIS OF TECHNOLOGICAL HEAT ENERGY LOSS NORMATION FOR HEAT PRICING PURPOSES, UAB Ekotermija, 2014

The Pre-insulated plastic pipes have many benefits:

- High flexibility;
- Long lifetime expectancy (minimum 30 years)
- Wide temperature range: (Minimum -15°C- Maximum 95°C)
- Easy quick and safe to weld;
- 100% recyclable;
- Safe and secure operation;
- Available in long lengths on coils (Pipes in coils of up to 300m)

44 fig. FLEXALEN 600 Pre-insulated plastic pipes

Pressure rating	• up to OD110 20°C/16bar	≥ OD125 20°C/10bar
	• up to OD110 70°C/10bar	≥ OD125 70°C/8bar
	• up to OD110 95°C/8bar	≥ OD125 95°C/5bar

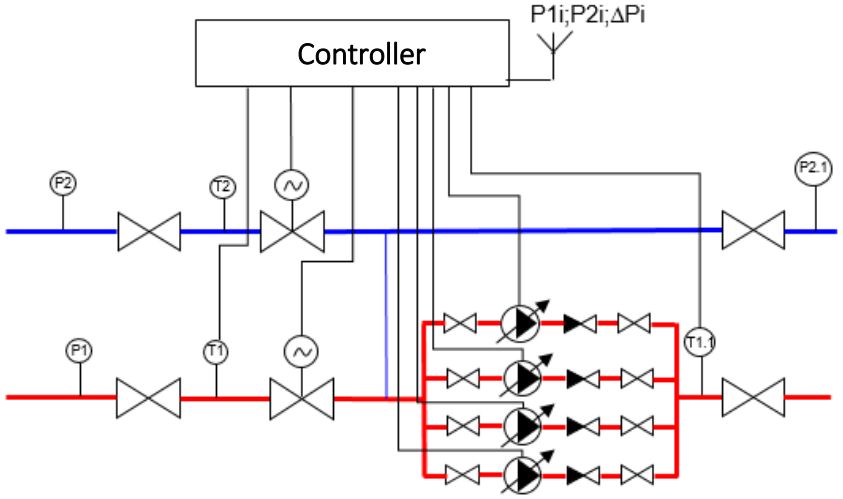
Connection of Vilnius Pavilnionių area to low temperature district heating networks

Accepted decision to develop:

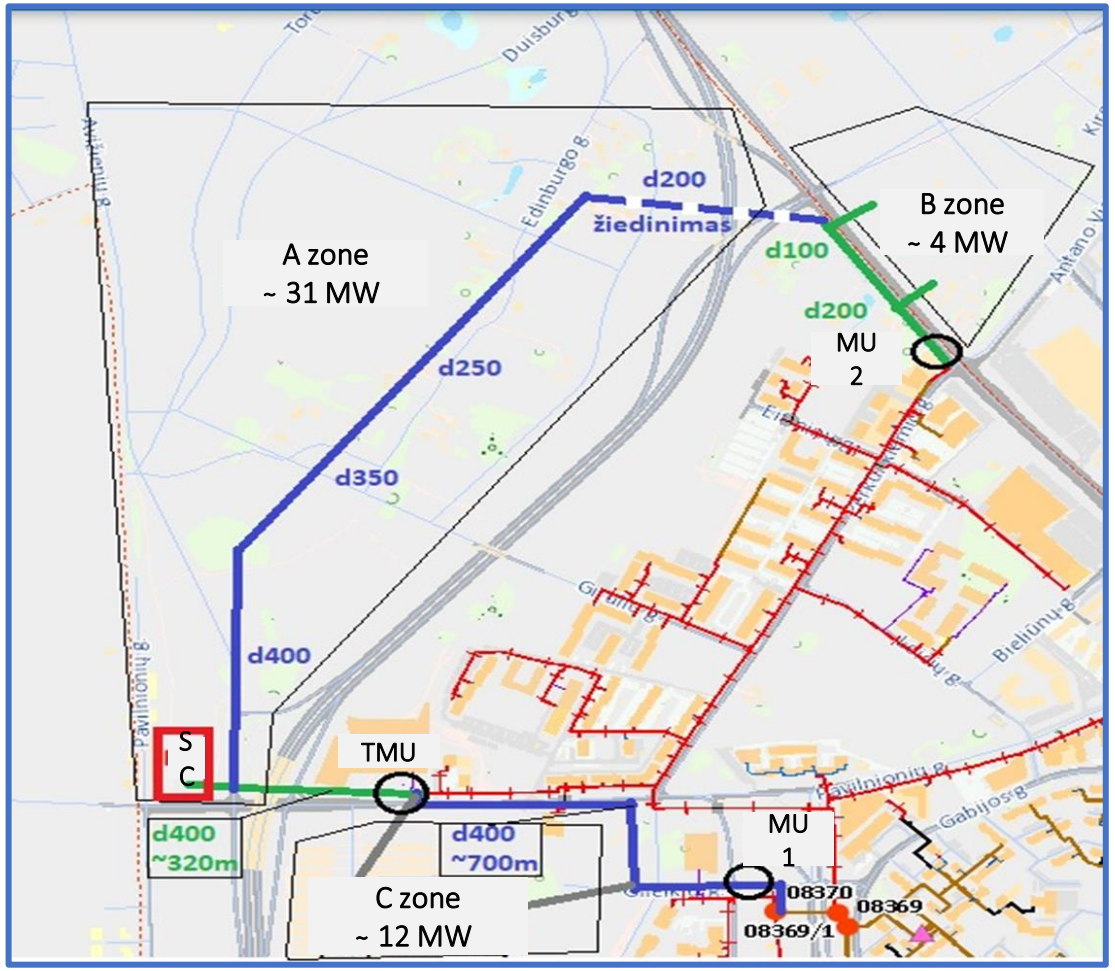
Low temperature district heating (65-45 ºC)

Principal scheme

- **Temporary mixing unit.** In the first stage, heat energy will be supplied to Pavilnionių st. 63 Shopping Center and for the new customers up to 6 MW in the southern part of zone A.
- **Mixing unit no. 1** will be able to serve zones A and C together up to 43 MW
- **Mixing unit no. 2** will be able to serve up to 4MW in zone B.



45 fig. water mixing unit principal scheme



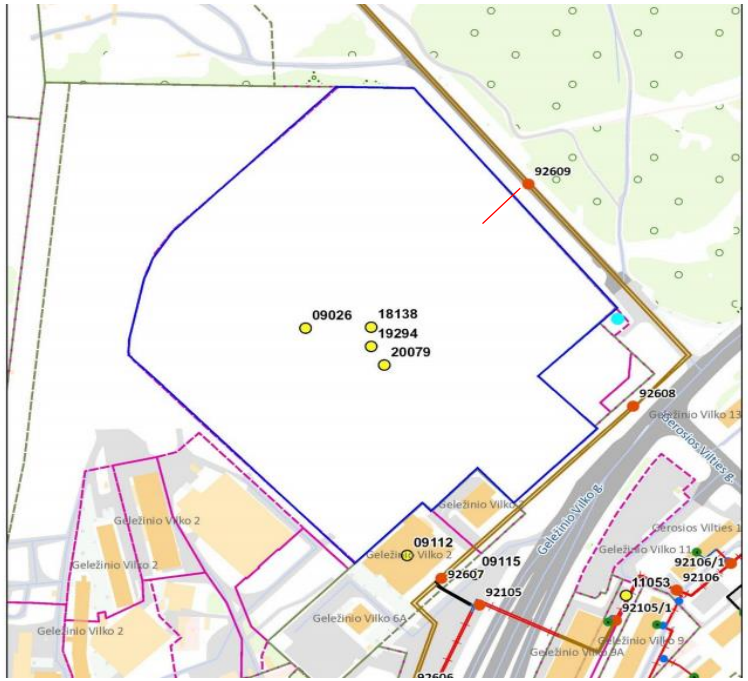
46 fig. Pavilnionių area connection to low temperature district heating

Development of low temperature district heating networks in the complex of administrative, commercial and multi-apartment residential buildings in Geležinio Vilko str.2, Vilnius.

Accepted decision to develop:

Low temperature district heating (65-45 ºC)

- Total heat demand of the commercial buildings (shopping and entertainment center “AKROPOLIS VINGIS”) **9,8 MW**



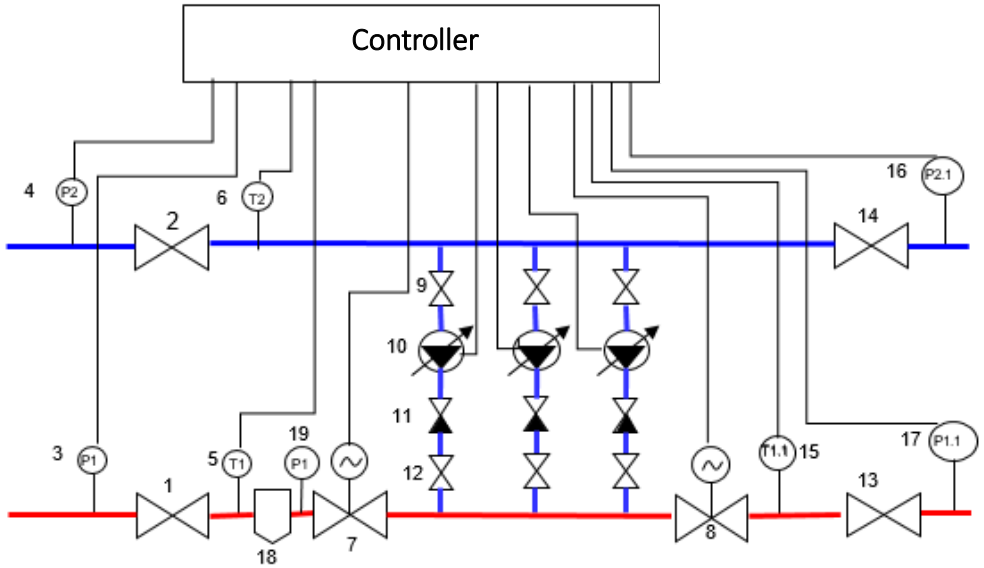
47 fig. Akropolis VINGIS connection to low temperature district heating

48 fig.

49 fig.

Advantages:

- Longer service life of heat supply networks (especially when using plastic pipelines);
- Lower heat loss in the network;
- The increased efficiency of production sources;
- Accelerates the integration of RES into DH systems;
- Opens the way for the development of new generation technologies.



50 fig. scheme of pumping system for lowering the water temperature of the supply network

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Thank You for attention

Sustainable, clean and responsible