

HEAT EXCHANGERS IN SEWAGE PIPES

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The article discusses utilization of heat from waste water in sewage. During the year, temperature of water in sewage ranges between 10 °C and 20 °C and the heat from sewage could be used for heating, cooling and hot water preparation in building. The heat is extracted through a transfer surface area of the heat exchanger into the heat pump, which is able to utilize the low-potential energy. Different design and types of the heat exchangers in sewage are dealt with: heat exchangers embedded in sewage pipe, heat exchanger integrated in concrete wall of a sewage pipe, sewer pipe with special double jacket as well as double pipe heat exchanger. Technical data about usage of the heat exchangers is also specified.

Key words: heat exchangers, sewage pipes, utilization of heat.

Izmjenjivači topline u kanalizacijskim cijevima. U radu se razmatra korištenje toplinske energije iz otpadne vode u kanalizacijskom sustavu. Tijekom godine temperatura vode u kanalizacijskom sustavu varira između 10 °C i 20 °C, a unutarnja energija te otpadne vode može biti uporabljena za grijanje, hlađenje i zagrijavanje vode u zgradarstvu. Toplina koja se realizira na ogrijevnoj površini izmjenjivača topline može se pomoću toplinskih pumpi iskorištavati kao nisko potencijalna energija. Razmatrane su različite izvedbe i vrste izmjenjivača topline u kanalizacijskim sustavima s: izmjenjivači topline ugrađeni u kanalizacijske cijevi, izmjenjivač topline ugrađen u betonski zid kanalizacijskih cijevi, kanalizacijska cijev s posebnim dvostrukim plaštem te dvostruko cijevni izmjenjivač topline. Tehnički podaci izmjenjivača topline su također specificirani.

Ključne riječi: izmjenjivači topline, kanalizacijske cijevi, utilizacija topline.

INTRODUCTION

Grey water flows out from the sewage with average temperature of 10 °C to 25 °C. Heat from waste water can be optimally used for heating, cooling and hot water preparation in low-energy houses. Waste water sources with higher flow are suitable for those systems, such as for example multiple family dwellings, groups of residential buildings, communal build-

ings, hotels, swimming pools, thermal baths and industry.

The main parts of the heat recovery system are heat exchanger and heat pump. Disposition and design of heat exchangers are determining for transmission of heat. Design of heat exchangers depends on different requirements and on suitability of sewage system itself.

THE CONDITIONS FOR DESIGN OF HEAT EXCHANGERS

The critical factors of correct design and implementation of heat recovery systems in the sewer pipes are:

- short distance between the consumer (administration, swimming pools, industry, multiple family dwellings) and location of recovery,
- temperature of the waste water, preferably constant approx. 10-15 °C or above,
- minimum effluent flow of waste water 10 l/s,
- sewage pipe diameter min. DN 1000 for the installation of additional heat exchangers, for prefabricated drainage elements with integrated heat exchangers diameter min. DN 400,
- low temperature of heating water (heating system in the house) and

heat recovery system designed as a bivalent,

- sufficient pressure conditions in pipelines,
- flowage of waste water, its fluctuation, contamination in the sections, and the temperature of waste water is very important for design and should be preset,
- velocity of flowage of waste water in the pipe should be as high as possible (min. 1,0 m/s) so that the shear forces keep the biofilm at a low level.,
- pollution of the heat exchanger is determined by continuous control of the output data (flow rate range, the temperature of the inlet and return water in the heat exchanger, the temperature of wastewater in sewers). [1]

TYPES OF HEAT EXCHANGERS

The type and method of installing heat exchanger in sewage pipe depends on properties of sewage system. Heat exchangers can be built into existing or new pipelines. They can be used for all kinds of waste water. Position of heat exchanger depends on the parameters of sewage system. Due to the increased accessibility it is advisable to plant heat exchangers to the top edge of the sewage pipe. Different design and types of the heat exchangers in sewage are dealt with, e.g.:

- heat exchangers embedded in sewage pipe,
- heat exchanger integrated in concrete wall of a sewage pipe,

- sewage pipe with special double jacket,
- double-pipe heat exchanger.

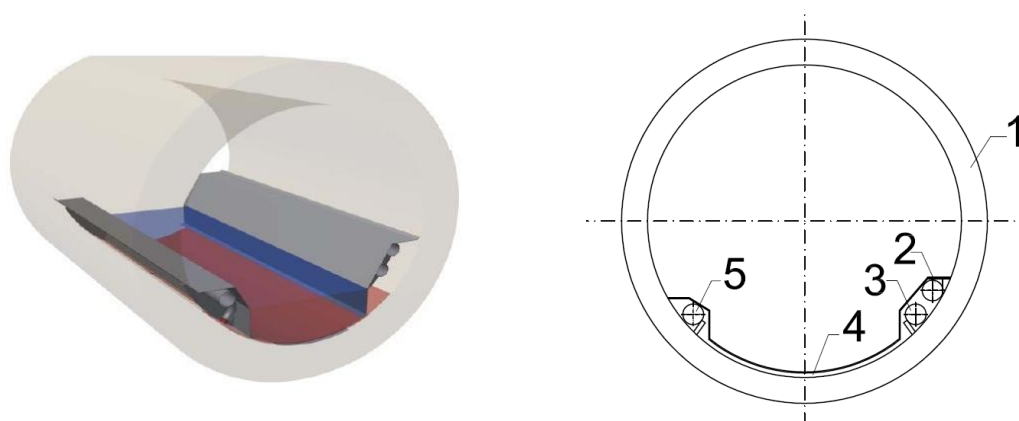
For the correct design of heat exchangers, we take into account these requirements:

- eliminate the need for cleaning the heat exchanger (except for cleaning sewage pipe)
- no or little maintenance exchangers throughout the life of the system,
- conomically viable oversizing heat exchanger (area) to ensure the performance reserve,
- achieving of optimal power values of heat exchanger [1].

Heat exchangers embedded in sewage pipe

Elements of the heat exchanger can be installed in newly laid and also in existing pipelines. It can be inserted at the bottom of the pipe and at the upper edge. The heat exchanger located at the upper edge has the advantage of monitoring and review. Installation is capital-consuming.

The heat from the waste water is discharged and transferred through the heat transfer surface of heat exchanger. Under exchanger are located distribution pipes (supply, return) to ensure the transfer of heat to the heat pump (heating system, hot water system, cooling system).



1 – sewage pipeline, 2 – cold water supply to the heat exchanger, 3 – supply, 4 – heat exchanger, 5 – output of the heated water from the heat exchanger [3]

Figure 1. Stainless steel heat exchanger embedded in sewage pipeline

Slika 1. Izmjenjivač topline od nehrđajućeg čelika ugrađen u kanalizacijski cjevovod

Table 1. Parameters of stainless steel heat exchanger embedded in sewage pipeline

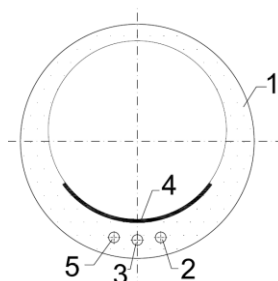
Tablica 1. Parametri izmjenjivača topline od nehrđajućeg čelika ugrađenog u kanalizacijski cjevovod

Specifications	
Material of heat exchanger	stainless steel, copper
Material of pipelines	stainless steel copper, PE
Length of segment	1 – 3 m
Utilization	heating, cooling
Waste water	waste water (industrial, communal)
Embedding	existing and newly laid pipelines
Performance data	
Diameter (mm)	Capacity of heat exchanger (heating) (kW/m)
1200	3,2
1400	3,7
1600	4,2
1800	4,8
2000	5,3
Required conditions	
Temperature of waste water	13 °C
Temperature of inlet cold water	6 °C
Wetted surface of circumference	120°

Heat exchanger integrated in concrete wall of a sewage pipe

The integrated heat exchangers can be used for the newly laid pipelines. The advantage is the quick installation and heat

exchanger does not detract from the diameter of pipe. The disadvantage is poor accessibility for inspection and review.



1 – concret pipe, 2 – cold water supply to the heat exchanger, 3 – supply, 4 – heat exchanger, 5 - output of the heated water from the heat exchanger [2]

Figure 2. Heat exchanger integrated in concrete sewage pipe

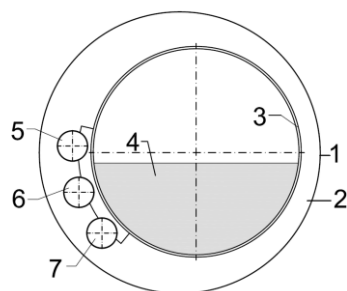
Slika 2. Izmjenjivač topline integriran u betonski zid kanalizacijske cijevi

Sewage pipe with special double jacket

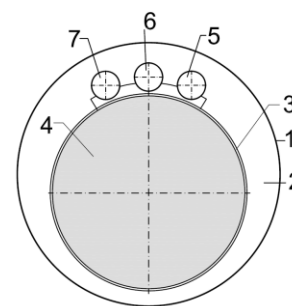
Whole circumference of sewage pipe is heat transfer surface. This surface transmits heat to distribution pipe installed in thermal insulation. Sewer pipe with special double jacket can be used just as newly laid pipeline or for replacement of old sewage pipeline. It is suitable for gravity systems and pressure

systems. For gravity systems are flow and return pipelines located on the side of a steel sewage pipe. The heat transfer depends on the flow rate (level of waste water) in pipe. For pressure pipe distribution systems are located at the upper edge of the sewage pipe.

a)



b)



1 – outer jacket from polyetylen, 2 – heat insulation, 3 – sewage pipeline – heat exchanger, 4 – waste water, 5 – cold water supply to the heat exchanger, 6 – supply, 7 – output of the heated water from the heat exchanger [1]

Figure 3. Sewage pipe with special double jacket: a)for gravity system b) for pressure system

Slika 3. Kanalizacijska cijev s specijalnim dvostrukim plaštem: a) za gravitacijski sustav b) za tlačni sustav

Table 2. Parameters of sewage pipe with special double jacket [1]**Tablica 2.** Parametri kanalizacijske cijevi s posebnim dvostrukim plaštem

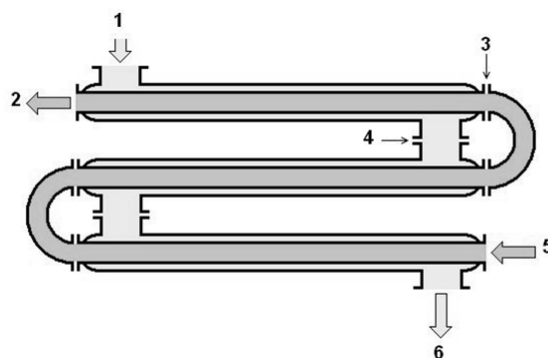
Specifications		
Material of heat exchanger	stainless steel	
Material of outer jacket	heat insulation and PE	
Length of segment	2 - 6 m	
Utilization	heating, cooling	
Waste water	waste water (industrial, communal)	
Embedding	newly laid pipeline, replacement of old pipe	
Location for instaling	underground, open	
Performance data		
Diameter (mm)	Capacity of heat exchanger (heating) (kW/m)	
	gravity system	pressure system
200	0,6	1,6
400	1,1	3,2
600	1,6	4,8
800	2,1	6,3
1200	3,2	-
Required conditions		
Temperature of waste water	13 °C	
Temperature of inlet cold water	6 °C	

Double pipe heat exchanger

The heat exchanger consists of two pipes embedded into each other. The waste water flows through internal pipe, where it is used as a heat source. Between inner and outer pipe is interspace, where flows clean water. Surface of internal pipe transfers heat from wastewater to clean water. Double pipe heat exchanger offers many advantages over

conventional pipelines in connection with entrained solids in the wastewater. Such a system is suitable for gray and black water.

The heat exchanger is not integrated directly into the sewer pipe. Pump blows waste water from the sewage to the heat or is pumped through the storage tank.



1 – cold water supply to the heat exchanger, 2 – waste water, 3, 4 – flange, 5 – waste water supply, 6 – output of the heated water from the heat exchanger, [3]

Figure 4. Double pipe heat exchanger**Slika 4.** Dvostruko cijevni izmjenjivač topline

Table 3. Parameters of double pipe heat exchanger [1]**Tablica 3.** Parametri dvostruko cijevnog izmjenjivača topline

Specifications	
Material of heat exchanger	stainless steel
Length of segment	3 – 6 m
Utilization	heating, cooling
Waste water	all kinds of liquids
Embedding	-
Location for instaling	open, inside
Required conditions	
Temperature of waste water	13 °C
Temperature of inlet cold water	6 °C

CONCLUSION

These systems are still not implemented in Slovakia, but due to significant energy savings, it would be appropriate to apply

them in practice in Slovakia. These systems are most realized in Western Europe, for example in Germany and Switzerland.

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[3] Wikimedia commons
http://commons.wikimedia.org/wiki/File:Double-Pipe_Heat_Exchanger.png