MODERN MANAGEMENT METHODS FOR MANAGING THE WASTE WATER AND RECOVERING THE HEAT FROM WASTE WATER

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ABSTRACT: The management of waste water had become a real issue for the EU in the last years. Specialists have been trying to conceive a way to address all the processes and to optimise it. For the waste water the concept is known as Waste Water Management featuring high originality and brings new ways to build, maintain, supervise and repair the sewage. Also, it is a fact that the water temperature in the sewage is varying from 8 to 18 degrees. The solution for using this heat is to put on the sewage pipes heat exchangers able to recover a certain amount of heat. Therm Liner is easy to apply and less costing comparing with other methods. Our challenge was to reduce the heating costs for an apartment building cluster in Pitesti. Because the cluster is heated by a few fairly new heating plants, our idea was to supply the heating plants with warm water. Warming the water will be done using a mix of technologies leading to a significant cost reduction and a world première.

Keywords: management; waste water; methods

JEL codes: M11

The Romanian Company Aquatech Solutions, together with the German Group Uhrig – European leading company in waste water management – is acting in the field of designing and implementing new and original technical solutions especially for waste water sewage. The above mentioned activities are featuring a modern approach for the total operations composing the concept of Waste Water Management.

This concept features high originality by mixing a lot of modern solutions for building, maintenance, surveying and repairing the sewage pipes. We are talking about applying the latest technologies which gives us 20% off in building cost and 50% off in operating costs. The system is based, primarily, on implementing mobile dams, coordinated by central software in order to ensure the retention of the waste water, sewage cleaning by controlled floods, and constant amounts of waste water in the processing plant.

Waste Water Management means:

- efficient management
- cheap building and operating
- new methods for repairing and replacement of sewage pipes
- sewage pipes cleaning by controlled floods
- recovering the heat from the waste water sewage

The activity of waste water management represent a new approach referring directly to a better managing of waste water by implementing new and original technologies such as:

a. using mobile dams for sewage, especially for the main ones. The damns are made of concrete box containing a stainless steel made mobile dam. Thus, we are eliminating form the sewage system

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the laying up basins which are expensive and difficult to maintain (see figure 1).

b. coordinating the dams using a central software. This features is implementing for getting controlled floods in order not to affect the final discharge for the treatment plant.

c. controlled flooding of sewage pipes sections for self cleaning.

Figure no. 1 – The installation of a mobile dam

d. activating the spare volume of sewage. The system is using the main sewage pipes spare volume as laying up basins by setting up the above described dams. For example, for a main sewage pipes featuring 3000 mm in diameter, such as the pipes in Alba Iulia City, Romania, and a length of 12 kilometers we have proposed the setting up of 6 dams. The distance between dams is 2 kilometers. Considering that the dam allows us to use 85% out of the total pipe volume, we will be able to retain approximately 12.000 cubic meters of waste water.

e. Managing the discharge from the sewage to the river. This feature is provided only for exceptional situations, such as natural calamities with extreme rains and the sewage overflows. We will set up transverse dams which will discharge the overflow into the river.

f. Floods protection. Where the level difference between the sewage system and the river is small and the river can grow over, we are proposing floods protection dams. These dams are design to protect the treatment plant and the entire sewage system. (see photo).

g. providing a constant waste water discharge to the treatment plant.

Based on the size of the pipes, we are using two types of mobile dams:

a. hydraulic, for pipes over 1400 mm diameter

b. pneumatics, for pipes below 1400 mm diameter

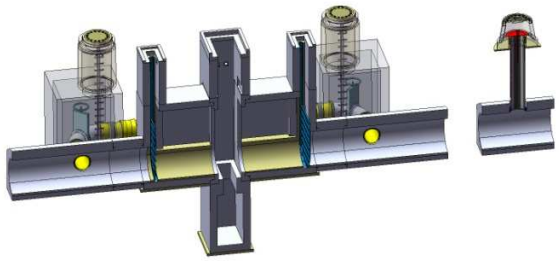

Figure no. 2 – Transversal section of a mobile dam

Based on there role in the system, we have:

a. dams for water retention, sewage cleaning and discharge control

b. dams for direct discharge

c. dams for preventing the flooding of pipes by the river overflows

Comparing with the classic system, the newer systems features the below mentioned advantages:

a. is not using laying up basins because is activating the sewage pipes spare volume

b. due to the pipes controlled flooding, the pipes are constantly washed

c. we are avoiding the sulphuretted hydrogen emanation generated by the waste deposits which is responsible for a significant lower pipes lifespan

d. we are ensuring a constant discharge of waste water in the treatment plant and thus the treatment plant can be design up to three time smaller.

Based on priorities and financial possibilities the system is accessible, in stages, for every town. The induction diagnose is free of charge. The implementing costs are at least 20% smaller than of other systems and the operating costs are at least 50% smaller.

The dams integrated pumping systems is one of the most efficient way to prevent floods. The system has a high efficiency pumping cluster which is working when the pipes are fully filled and is discharging the waters over the dam, thus avoiding the city flooding by sewage overflow.

Sewage system maintenance and repairing is easy. Using a pneumatic driven robot one can perform a video survey of the pipes. In case of breakthrough, the repairing is perform by the same robot, easy, by installing a stainless steel sleeve inside the pipe, covering the perforated area. This is the Quick Lock System.

Figure no. 3 – Perforated sewage pipe

Figure no. 4 – Repaired sewage pipe

For replacing the old pipes with new ones, we can use, when needed, a hydraulic system that pulls the new pipe over the old ones without digging, by using the Grundoburst method.

Using waste water for efficient heating solutions – Therm Liner System. This system is made of heat exchanger placed on the bottom or on the walls of the pipes and a heat pump. The pump is recovering part of the residual energy of the waste water and transfers this energy to a heat exchanger liquid (water). The liquid will transfer the heat the the building heating system. The system can be adapted to any sewage pipe shape, can be put into place very quickly and without interfering with the normal sewage functions and is extensible. The heat recovering is set to be made in such way in order not to chile the waste water too much and to affect the bacterias performing the biological cleaning stage in the waste water treatment plant.

- Investment cost – 800 to 1800 euro / kw
- heating cost economy – 40 to 50% annualy
- CO2 reduction – 70%
- Amortization – 3 to 12 years.

Energy Management Applications for Recovering the Heat from Waste Water

Our method is to recover the heat of the waste water from city sewage. The yearly average temperature of the waste water in the sewage is up to 12-13 degrees and the water can be used to recover a ratio of there heat and to transfer it to buildings. On the other hand, the waste waters' temperature is transferred to the environment and this is leading to (especially when the waste water is dumped into lakes or rivers) a significant alteration of the temperature of the recipient environment, affecting the ecosystems. In industrial areas, especially where there are heat generating processes the impact over the environment is more significant because the heated water is dumped directly into the environment or into the sewage.

The method is to put on the bottom of the sewage pipe the heat exchangers. The heat exchangers (see figure 5) will be submerged under the waste water and thus will be able to capture a part of the waste water heat using water-water heat pumps. We must emphasis that during the summer the system can act as cooling system, due to its reversing features, only with small adjustments.

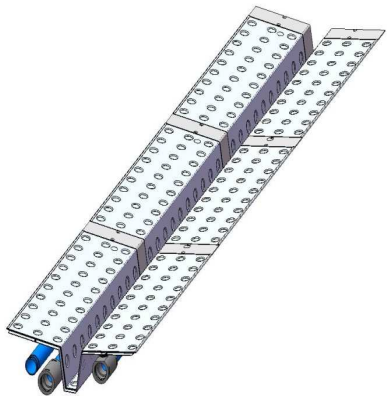

Figure no. 5 – Therm Liner heat exchanger

As advantages of the system we have to mention:

1. it is easy to adapt to any pipe shape section
2. it is easy to et up and is expandable
3. is not interfering the normal sewage works
4. long lifespan (over 50 years)

The data we have gathered after using this method are encouraging and are recommend it as an alternative to other systems, in order to stop the waste of energy:

a. waste water energy extracted – 1-4 kwh/ m
b. investment cost – 800-1800 euro/kw
c. CO2 annual saving - 60-70%
d. heating cost saving - 40-60%
e. amortization – 4-10 years

Equipment technical data and working principles

Therm Liner system is using the existing heating equipments of a building, thus being connected directly to the building heating system and provides 50 to 60 degrees hot water. The system features the following modules:

a. existing heating network of a building
b. heating pump, replacing existing heating source

recirculating pump for transporting the heat exchange liquid from the heat pump to heat exchanger and back

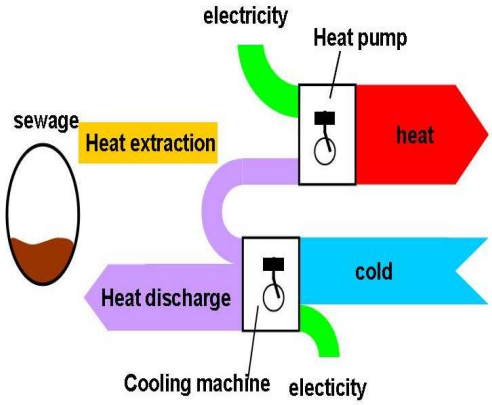

Figure 6 – Working principle

d. the heat exchanger placed in the sewage

The working principle is presented in figure 6.

The heat exchanger is made of 800 mm long sections of stainless steel that can be put together easy using a lego type system. There shape and transversal section are custom made using the diameter and shape of the pipe where is going to be placed. The objective is to have a lower flow resistance and to ensure a higher heat exchange surface. The dimensioning of the total length of the heat exchanger modules is made based on the following data:

a. waste water flow (a minimum of 15 litres/second is recommended)
b. diameter of pipe (a minimum of 500 mm is recommended)
c. pipe gradient

d. waste water yearly average temperature.

Considering the above mentioned features, one can see that a cluster of heat exchangers with a certain length can actually chill the waste water too much. This conclusion will be entered in our computing in order not to deactivate the bacteria performing the biological stage in the treatment plant.

Therm Liner System applied to a school campus in Sebes City Romania – project to be financed with European funds.

The project was designed by the Uhrig team, the patent owners., together with a group of specialists form the 1 Decembrie 1918 University in Alba Iulia.

For the given situation, two of the necessary prerequisites were missing, namely the pipe diameter was below 500 mm and the pipe gradient was below 1/1000. Considering this, we have decided to replace the existing pipe over a distance of 70 meters with a new pipe featuring a higher diameter (700 mm) and to assemble the heat exchanger into this section. Due to the very small speed of the waste water flow, because of the small gradient, our solution was to put a pneumatic controlled mobile dam in front of the heat exchanger. The role of the dam is to release the water 5 to 7 times a day in order to flood the the heat exchanger, thus washing and avoiding waste accumulation and, also, to ensure a constant flow in the pipe be fixing it to a certain height.

The school campus comprise of four buildings as follows:

a. C1 – building for primary school
b. C2 – building for secondary school
c. C3 – building for kindergarten
d. C4 – sport hall

Foreseen solution:

a. waste water heat recovering system
b. water-water heat pump for heating the four buildings
c. heating network with static radiators for school and kindergarten

Sewage characteristics

a. form - ovoid
b. dimensions – 500x700 mm
c. gradient – 1/1000
d. dry weather flow – 68 l/s (minimum), 140 l/s (average)
e. waste water temperature – 12 degrees minimum
f. available length – 100 meters
g. heat transfer surface, fully submerged – 0,58 sqm/m
h. microbiological deposit layer influence - 40%

Heat exchange characteristics:

a. total length – 80 meters
b. minimum extraction capacity – 114 kw
c. heat pump power - 31 kw
d. heating capacity – 145 kw
e. heating pump performance factor – 4,7

Table no.1

Economic features

usage	**unit**	**Therm Liner**	**Classic**

power	kw	145	145
Year usage for heating	h	3950	3950
Cold weather heating energy conventional	kwh	73250	293000
Cold weather heating energy Therm Liner	kwh	219750	
Heat exchanger cost	euro	248805	
Drying cost	euro	9520	
Heat pump cost	euro	35105	
Conventional system cost	euro		41412
Installation cost	euro	32904	36282
Total cost	euro	325524	77694

Table no.2

Annual savings in comparison

features	**unit**	**base**	**Therm Liner**	**classic**
Annual operating cost	euro		952	952
Electricity cost	euro	35	35	35
Gas cost	euro	345		345
Electricity charge	ct/kwh	12	6201	
Gas charge	ct/kwh	31	22708	90830
Total annual operating cost	euro		29896	92162
Annual economy	euro		62266	
	%		68	

Natural gas reduction – 219750 kwh
CO2 reduction – 48931 kg/year
Amortization with no incentives – 4 years

We must emphasis that this project is finished in terms of design and is ready to be submitted for financing. Also, worth mentioning that our project is modern, reliable and efficient by featuring:

a. the use of renewable energy with the help of the most modern heating source – the heat pump

b. lack of CO2 emissions, thus is contributing to the actions of reducing the global worming

c. we are making a mixing of high capacity of capturing the residual heat from sewage with low costs for investing and operating

d. comparing with a classic heating gas using system, our system reduces the heating costs with

55%

e. the project provides for the beneficiary a long lifespan and reliability

f. the amortization period is short

g. the system is reversible, thus being able to provide cool air with minimum of supplemental investment

h. the system allows other combination – it can be used as heating system or as worm water supplier for other heating systems.

Energy Management for eficientize the energy consumption for house heating

The challenge was based on the necessity of using a mix of heat generating technologies able to adapt to existing preconditions with optimal outcome. The selected apartment building cluster is nearby the city waste water treatment plant. Thus, the location is featuring:

a. high quantity of waste water discharge (700 l/s) with an yearly average temperature of 7 degrees

b. solid waste as an outcome of waste water clarification process and filtering process in the treatment plant

c. sufficient land for implementing the new technologies

d. existing prerequisite for implementing the project

In designing the solution we have started with the idea of not replacing the existing fairly new and modern gas burning heating plan due to the costs. The optimal solution was to supply the heating plant with warm water with the input temperature of 40-45 degrees, thus reducing the selling price at the final consumer. We have decided to use the following technologies in order to have a cheap warm water supply:

a. Therm Liner technology for capturing the heat of the waste water in sewage. This technology consists in placing heat exchanger on the bottom of the sewage pipe, over a length of 201 meters (see figure 7, 8, 9).

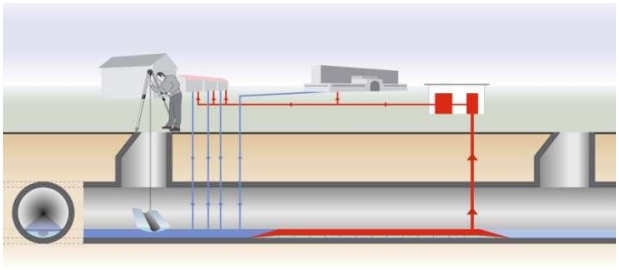

Figure no. 7. How to place Thermliner

Figure 8. Sewage without Therm Liner

The heat exchangers will circulate the heat exchanging liquid which will capture the heat and will transport the heat to a heat pump system. The heat, then, will be transported to a heating plant.

Figure no. 9. Sewage with Therm Liner

b. High efficiency co-generation is the technique of burning a fuel (natural gas or biogas) using engines with the output of electricity and burned gases with a temperature of 550-560 degrees. The gases will going to be circulated inside of a heat exchangers and will supply warm water to the heating plant.

c. For the second stage, we proposed that all the solid waste produced by the waste water treatment plant to be processed in the sludge digestion process in order to produce biogas. Until this stage will be implemented, the co-generation plant will burn natural gas

Thus, the area of the waste water treatment plant will become energy self sustained and will provide pre worm water for heating the apartment building cluster.

Functioning principles and methods efficiency.

Using this mix will generate a fusion of classic and green technologies, as foreseen by the Uhrig team and the team of the 1 Decembrie 1918 University in Alba Iulia. The system functioning is based on the interdependence of the component as follows:

a. Therm Liner will need electricity for the heat pump. The electricity will not come from the national energy system but will be provided by the co-generation engines.

b. The co-generation engines will burn natural gas and will provide heat to the heating plant. Also, the same engines will provide electricity to the heat pump and to the waste water treatment plant, making them energy autonomous.

c. for the second stage, when we going to when the biogas plant will be operational, the co-generation plant will burn biogas and become energy independent and the cost of heat and electricity will be 10 to 12 times lower.

d. finally, the heating energy generated by the co-generation plant and by the therm liner system will be transported to the heating plant. This area (known as heat point) will have the purpose of generating and providing warm water up to 40-45 degrees using a mix of heat exchangers and blenders

and to supply the warm water to the heating plant of the building cluster. The cluster is 800 meters away from the waste water treatment plant area.

Advantages quantified:

a. electricity provided by co-generation – 228.318,2 Euro/year
b. heat provided by co-generation – 116.470,59 Euro/year
c. heat provided by therm liner – 134.155,48 Euro/year
d. total – 478.155,27 Euro/year

Costs

a. natural gas - 228.064,32 Euro/year
b. maintenance – 60.183,64 Euro/year
c. total costs - 288.247,96 Euro/year

Profit with natural gas technology – 190.696,31 Euro/year
Profit with biogas technology – 395.165,2 Euro/year

Pricing for Therm Liner and co-generation mix

a. Therm Liner – 280.000 euro
b. co-generation plant – 265.000 Euro
c. heat pumps (2 pcs.) - 130.000 Euro
d. furniture for heating point – 25.000 Euro
e. feasibility study and technical drawings – 70.000 Euro
f. project management and financing due diligence – 63.000 Euro
g. works – 93.000 Euro
h. total – 873.000 Euro

Amortization – natural gas option – 4,5 years
Amortization – biogas option – 2,2 years

Conclusions

Putting to work the concept of Waste Water Management means a leap forward in the activity of managing the waters. The theoretical approach was transferred into practice and it builds a general overview over the activities of:

a. investing in sewage
b. operating the sewage
c. maintaining and repairing the sewage
d. waste water controlled discharge and optimizing the waste water treatment plant input.

By using this management strategy, the local authorities can have a unified overview and, also, cost reductions. Beside this, the cost savings will benefit to there local budgets. Examples of direct advantages are:

1. sewage self cleaning
2. eliminating the laying up basins
3. eliminating waste deposits, thus avoiding the sulphuretted hydrogen emanation
4. 3 times smaller waste water treatment plant
5. flood protection

We must emphasis that this project is finished in terms of design and is ready to be submitted

for financing. Also, worth mentioning that our project is modern, reliable and efficient by featuring:

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h. the system allows other combination – it can be used as heating system or as worm water supplier for other heating systems.

We have to conclude that in some cases is useful to mix both classic and modern technologies. The final outcome we are interested for is a cheap heating able to solve the necessity of citizens.

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