HEAT IT UP

Innovation proposal - ENGINE HUBS, 2023

eng. Radoslav Zhekov Tonev

1. Innovation description

Climate change, increasing CO_2 emissions in the atmosphere and rising prices of natural gas and electricity bring more and more people to look for savings in the energy consumption in their households. Water heating is one of the biggest entries of the energy bill, whether it is done by an electrical or gas heating unit.

The current proposal is to cut down the consumed energy for water heating by preheating cold water before it gets into the heating unit on a household level. This can be done by using the temperature of the generated wastewater. The main concept is shown in Figure 1.

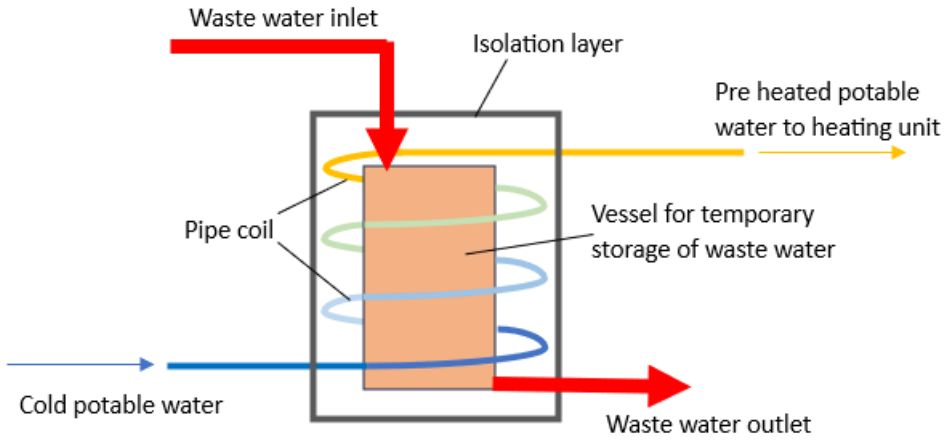

Figure 1: Working principle of pre-heating vessel

The temperature of the water, distributed through the water supply network is up to 10 ºC. The household heating units need to heat the water at least up to 60 ºC, which means that the rise of the water temperature is at least 50 ºC. Keeping in mind that for the rise of temperature with 1 ºC of 1 g (ml) of water around 4.2 Joules are needed, that means that the input energy (without losses) for 1 m^3 to be heated from 10 ºC up to 60 ºC is around 210 MJ or 58 kw/h. Recent studies[1] concluded, that in Bulgaria the greenhouse emissions from 1 kw/h are around 755 gCO_2.

The proposed solution is to reduce the input energy for heating the potable water by temporarily storing wastewater in a vessel, before releasing it into the sewer systems. Usually, the consumers use water for bathing and washing at a temperature, similar to body temperature (around 40 ºC). Other households' processes (laundry, dishwashers, etc.) also use water at similar temperatures. All this heat is going into the drain. To use it, a temporary storage vessel can be developed. The main idea is the pipe for cold water to go around the vessel in a loop,

[1] https://unfccc.int/sites/default/files/resource/IFITWG_Methodological_approach_to_common_dataset.pdf

before entering the heating unit of the households. In that way, it can be expected, that the cold water will reach a greater initial temperature before the heating process, so the consumed energy will lower. This will reduce the environmental impact also.

The pre-heating vessel can be placed in communal buildings and houses connected to centralized sewer networks. It can be also used in homes, where septic tanks are installed. However, in those cases, the efficiency might be questionable, because of the long retention times of the sewerage water into the vessel (usually around 2 weeks), which might result in drops in wastewater temperatures over time. Also, after the discharge of the septic tank content via truck, the vessel will stay empty, which also can reduce the efficiency.

To reduce the heat losses during the process, an outside isolation layer needs to be placed. The used materials of the vessel and pipe loop must be durable and have good heat transfer properties (i.e., copper, stainless steel or others). Also, the vessel needs to have good ventilation and not spread sewer gasses into the building or surroundings of the households. This might require the installation of air filters (for example with granulated active carbon). Another challenge will be the temporary storage of the wastewater, however, this can be done by placing a release valve (stop valve), controlled by a float. After reaching a certain level in the vessel, the float will activate the release valve and the wastewater to be drained. The last possible issue is with clogging and building deposits on the bottom of the vessel. This problem can be solved if the bottom is arranged in a conical shape.

2. Financial aspects

To develop a sustainable product, the following steps are proposed:

1. Design and build a prototype;
2. Testing in controlled conditions;
3. Improving the prototype and performing tests in real conditions;
4. Optimization and development of final ready-to-use product.

The overall budget for those steps is hard to precisely estimate but has to be in the range of 30000 to 45000 eur. The expected time required will be around 1.5 – 2 years.

3. SWOT analysis

Strength:

- Reduces energy costs of households;
- Applicable in new and old buildings;
- Environmentally friendly;

Weaknesses:

- Expected relatively high price – long period for returning of the investments for the consumers;
- Still on the development scale – need of prototype, testing and proving of the concept;

Opportunities:

- Can be purchased and installed to serve the whole community building;

Treats:

- Depending on the legislation it might have legal issues for implementation.