Comparison of Two Technologies in Hot Water Preparation in Terms of Source Location

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Abstract - *The present article describes two different types of technology used in hot water preparation, their advantages and disadvantages, spatial requirements and measuring technology. The facts described herein may be used when deciding on which technology should be used for which type of hot water supply and central heating.*

Keywords - centralised heat supply, water heating, optimisation of take-off point connection.

I. INTRODUCTION

Efforts of heat and hot water (HW) producers and distributors are focused on providing those media for customers in the highest possible quality and with minimum energy losses during the transportation. That is why producers modernise their technological equipment for the preparation of such media. The scope of reconstruction, however, largely depends on factors specific for individual areas of the Centralised Heat Supply System (CHSS). Equipment modernisation is aimed at optimising the take-off point connection, with regard to new conditions applicable to the offtake of the above mentioned media, with the aim to full satisfy the customer requirements. Technologies used for hot water heating include the so-called *storage heating* and *rapid heating*. Other technologies represent only the combinations of the two.

II. STORAGE HEATING

Storage heating is used mainly in older types of water heating technologies. In this type of heating, certain amount of water is heated in a storage tank by a radiator through which the primary medium flows. Once the water in the storage tank is heated to the required temperature, the primary medium supply pipe is closed until the temperature of the heated water decreases again below the set value. Storage tanks are connected into batteries so that at the peak offtake a sufficient amount of hot water of the required temperature is available. Heating start and end times depend mostly on the amount of heated water collected from the given storage tank and on the temperature to which the circulating water, returned for reheating, was cooled. To describe a working cycle of a storage water heater, a 24-hour experiment was carried out during which the changes in temperatures were monitored for this type of water heating, i.e. the primary medium temperature at the entry into the heater (t_{entry}) and at the output from the heater (t_{output}), the cold water temperature ($t_{c,w}$), and the circulating water temperature ($t_{cir,w}$). Records from the measurements are presented in Fig. 1. The figure shows that the difference in temperatures of the heating medium is at the time of heating approximately constant and changes in these temperatures in time are slow. Such state is appropriate for the measuring technology used at present. Table 1 contains the data on measuring devices currently used for water temperature measuring. For more accurate measurements it is recommended to use the CALMEX VKP meter.

TABLE 1
TYPES OF MEASURING DEVICES USED FOR THE MEASUREMENT OF ENERGY CONSUMPTION FOR HW PREPARATION

Measuring device name	Minimum measured temperature difference	Measuring device name	Minimum measured temperature difference
CALMET 20-KMH 20	3°C	SONO 1000	3°C
SUPER CALL 2	3°C	CALMEX VKP	2°C
SONO 2000	3°C	SCHLUMBERGER CF50	3°C

At present, the main factor affecting the choice of the given technology is the space necessary for the installation thereof. In the storage heating, the storage tank volume is determined while using the formula:

$$V_z = (40 \div 54) \cdot i^{0.75} \cdot z \cdot \psi \cdot \varphi \cdot \vartheta \qquad (m^3) \tag{1}$$

V_z is the volume of storage tanks (m^3), i - number of persons (1), z - heating time (h), ψ - structure impact coefficient (1), φ - hot water preparation method coefficient (1), ϑ - operating impact coefficient (1).

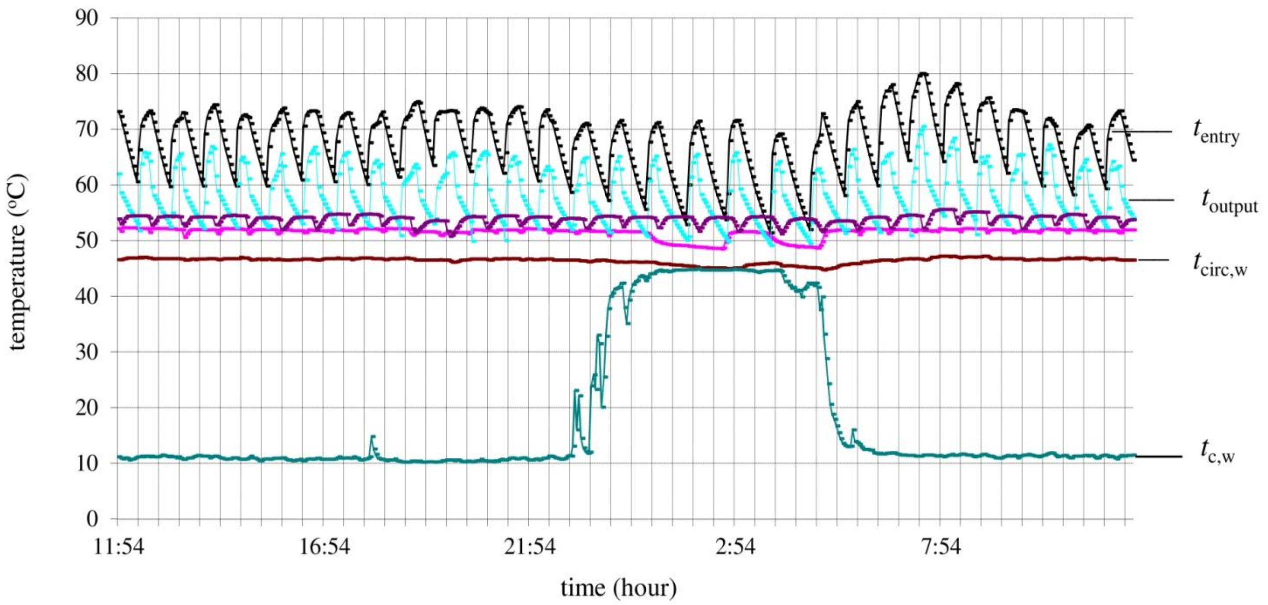

FIGURE 1: Working cycle of a storage water heater

Technology for the storage heating for example for 480 persons requires, with the water heating time of 2 hours, the storage tank volume of approximately 12 m^3. An approximate layout area necessary for placing a heater (best two heaters) with the volume of 6 m^3 is as much as 10 m^2. Particularly these facts regarding the storage heating technology make it less beneficial than the rapid heating technology. The main advantage of storage water heating is the reserve of hot water even in the case of short-term outage of the primary medium, or covering the circulation losses in time at the minimum offtake. Water temperature at the outlet from the storage tank has a liner decreasing nature.

III. RAPID HEATING

In the so-called rapid heating technology, water is heated at one or two levels. Primary water as well as heated water flow concurrently through the exchanger in very small volumes. This method of water heating ensures immediate water heating. To describe a working cycle of rapid water heating, the measurements of changes in temperature were carried out with the same duration (24 hours). The measurements were focused on the temperature of water as the primary medium at the entry into the heat exchange (t_{entry}) and at the output from the heat exchanger (t_{output}), the temperature of heated water ($t_{t,w}$), and the temperature of circulating water ($t_{cir,w}$). The records from these measurements are presented in Fig. 2. As the figure indicates, the temperature of primary medium is not constant and changes in temperature in time are very fast; this has a negative impact on the consumed energy measurements. Spatial requirements for this type of technologies are significantly less demanding than for storage heating, which makes them much more appropriate for the use than storage heating. Another advantage of rapid heating is practically immediate heating of the medium to the required temperature and consequent possibility of using different hot water supply modes. A disadvantage of this water heating method is the need to ensure sufficient heat output at peak hours, which makes the technology overdimensioned during the minimum offtake and produce thus great losses. This technology appears to be equally disadvantageous also in short-term primary water shortage in the network when the heated water is immediately subcooled.

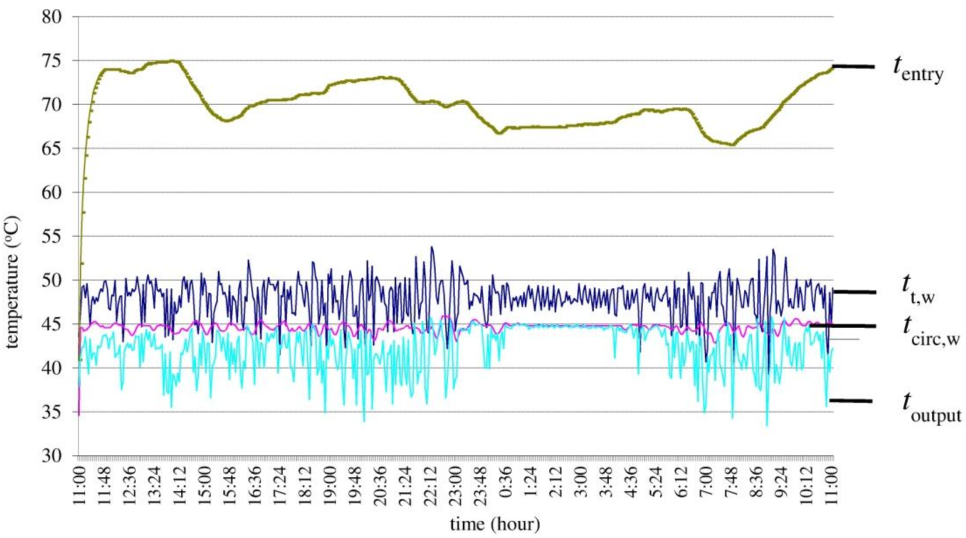

FIGURE 2: Working cycle in rapid water heating

A combination of both technologies facilitates elimination of their disadvantages and combines their advantages. However, there is still a question of placement of the technology for hot water preparation. In order to reduce the losses incurred in hot water distribution, its sources are atomised and moved up to individual sections - to footings of buildings (houses), or are situated so that they supply the media to a small number of buildings within certain, usually short distance. With regard to spatial requirements, the rapid heating technologies are preferred.

In the real practice, two solutions are applied. In the first case, the primary water (of high temperature) enters the heat exchanger station (HES) where it directly transfers the heat to cold water through the heat-transfer surface. These stations are usually outside a consumption building, or at the footing thereof. Such connection is depicted in Fig. 3.

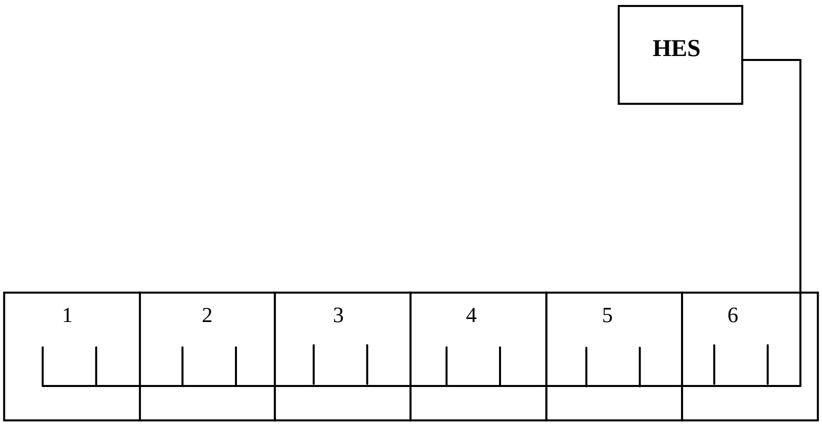

FIGURE 3: Connection of HES outside the consumption building (1, 2, 3, 4, 5, 6 – consumption buildings).

An advantage of the hot water supply solution described above is the reduction of circulation losses. The control system evaluates the hot water output temperature and adjusts the primary medium parameters to such temperature.

Another solution of water heating is placing the hot water preparation system directly at the customer's premises, i.e. in one or several sections. By placing heat exchanger stations directly in individual sections, due to the primary media parameters (p = 2.5 SPUa, t = 200 °C) it would be necessary to create a so-called nested circuit (small primary unit - SPU) with parameters adjusted so that the produced noise is not of high level. A disadvantage of such solution is the equipment placement directly in the customer's building. Another disadvantage is limited space for placing heat exchangers, regulation components, and cooperation of control systems. The technology with such connection is shown in Fig. 4.

In this technology, the central control system adjusts the parameters of the nested circuit (SPU1, SPU2) according to the requirement of the station with the highest immediate energy consumption. Other stations adjust these parameters according to their own requirements that are obviously lower. The result is that the nested circuit prepares the medium with the maximum parameters practically all the time. This statement is confirmed also by the records from the 24-hour experiment (Fig. 5). They contain the development of temperature changes in time for one of the two pressure-dependent stations (for the small primary unit SPU1) which supplies hot water to three sections (1, 2, 3). It has its own regulation station. The second small primary unit (SPU2) supplies hot water to sections (4, 5, 6) and has its own regulation station, too.

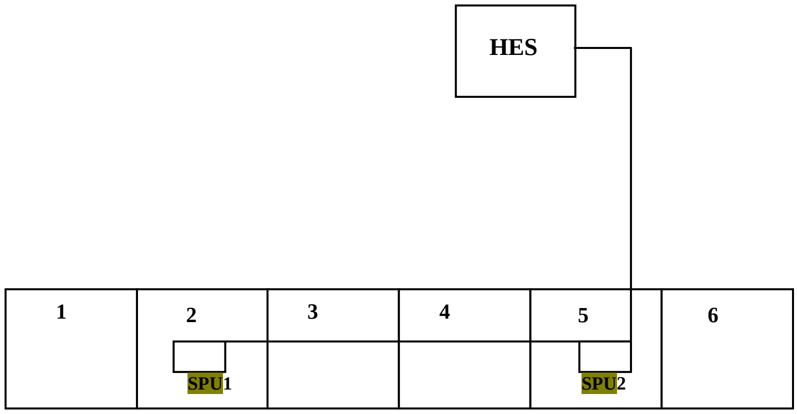

FIGURE 4: Connection of HES in the consumption building (SPU1, SPU2)

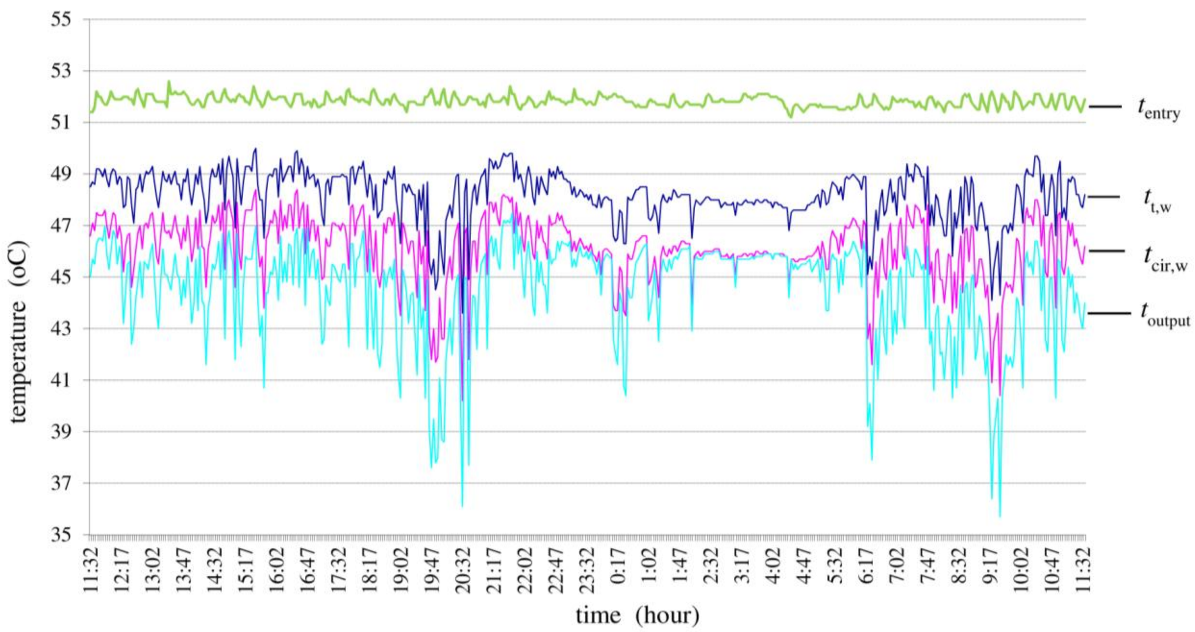

FIGURE 5: Measurement in the nested circuit of SPU1

IV. CONCLUSION

Time irregularity of the heat demand results in heat losses incurred to a supplier, representing as much as 30%. Such losses may be reduced by reducing the flow quantity of water in the nested circuit; this, however, is difficult because heating in such HES is also pressure-dependent.

The comparison of the two above described methods of hot water preparation (in terms of hot water supply quality, i.e. the temperature) indicates that the quality is high in both methods. The supply comfort is higher in pressure-dependent stations, mainly in terraced houses where various supply modes may be applied, depending on customer needs.

As for the comparison of the two technologies in terms of cost-efficiency, the second method (rapid heating with a nested small primary unit) with pressure-dependent stations is much more expensive and the losses caused by consumption irregularity are higher. It follows from the facts above that the heating method without a nested small primary unit is more advantageous.

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