Impact of the circulation system on the energy balance of the building

Iwona Polarczyk[1,*], and *Michał* Fijewski[1]

[1]Wroclaw University of Science and Technology, Faculty of Environmental Engineering, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw

Abstract. The efficiency of the hot water system is one of the factors necessary to determine the overall efficiency of the building. From the calculative point of view, it is easy to make. The article presents how working of the circulation system has an influence on the efficiency of domestic hot water system. The differences in the results was presented and based on calculations of various methods, the measurements results was also taken into account. The attention was especially paid to the possibility of using ultrasonic flowmeter for measuring the flow and energy.

1 Introduction

Referring to hot water installations, according to the Regulation of the Minister of Infrastructure with regard to technical conditions which buildings and their location should conform to, should ensure that the water temperature is not lower than 55°C and not higher than 60°C at the water points, which should allow for the periodic thermal disinfection at temperatures in the range 70°C–80°C. A correctly designed and insulated hot water system allows the recipient to obtain water at the correct temperature at the outlet point. Otherwise, not only will the warming-up time increase, but also the water consumption will increase, which in turn will result in increased energy consumption charges borne by the user/recipient.

2 Measurements

The selection of facilities was not accidental. Two buildings of collective residence – student houses T-15 and T-16 were selected for the measurements, characterized by "twin" construction and equipped with heating hubs with the same power and operating parameters. The circulation system did not work in one of the buildings (T-16). In the building with efficient circulating installation, its work was "nonstop".

The parameter characterizing the system of domestic hot water preparation can be the utility efficiency factor. The efficiency factor η is defined as the ratio of heat energy

* Corresponding author: iwona.polarczyk@pwr.edu.pl

consumed in hot water by the recipients to the heat needed to prepare it and maintain a suitable temperature.

$$\eta = \frac{Q_{CWU} + Q_{CYRK}}{Q_{DOST}} \tag{1}$$

where:
Q_{CWU} – The heat flux required to heat cold water to the required temperature
Q_{CYRK} – The heat flux needed to maintain the correct hot water temperature
Q_{DOST} – The heat flux supplied to hot tap water

Photo 1. T15 Heating station.

Photo 2. T16 Heating station.

Study work of the hot water installation was undertaken using three non-invasive measuring devices mounted in the heating node of the buildings. This was:

- Flexim's FLUXUS F601 portable ultrasonic flowmeter,
- Fuji's Portaflow C portable ultrasonic flowmeter,
- Wisensys wireless measurement platform.

3 Analysis of measurement results

In order to analyze the operation of hot water installation and circulation in the T-15 and T-16 dormitories, the results of measurements of corresponding days from both buildings were compiled, i.e. from 30.04.2013 to 24.07.2013. Due to the lack of reading from the measurement equipment, several data from the T-15 building are missing from 14.06 to 19.06 and 5.07 to 10.07.

3.1 The efficiency of the installation

3.1.1 Comparing daily efficiency

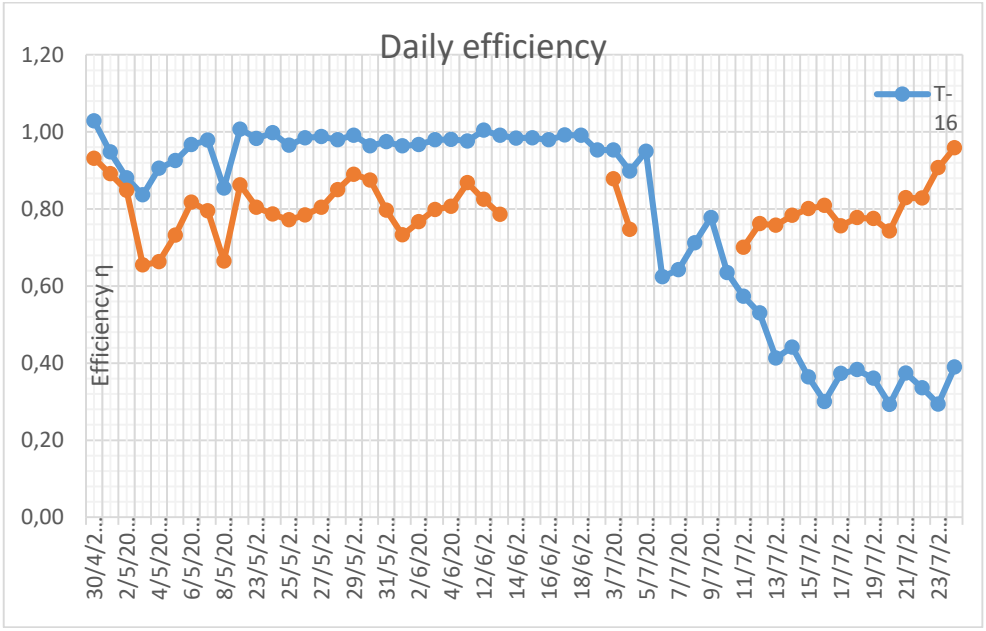

Fig. 1. Comparing T-15 and T-16 daily efficiency.

3.1.2 Comparing weekly efficiency

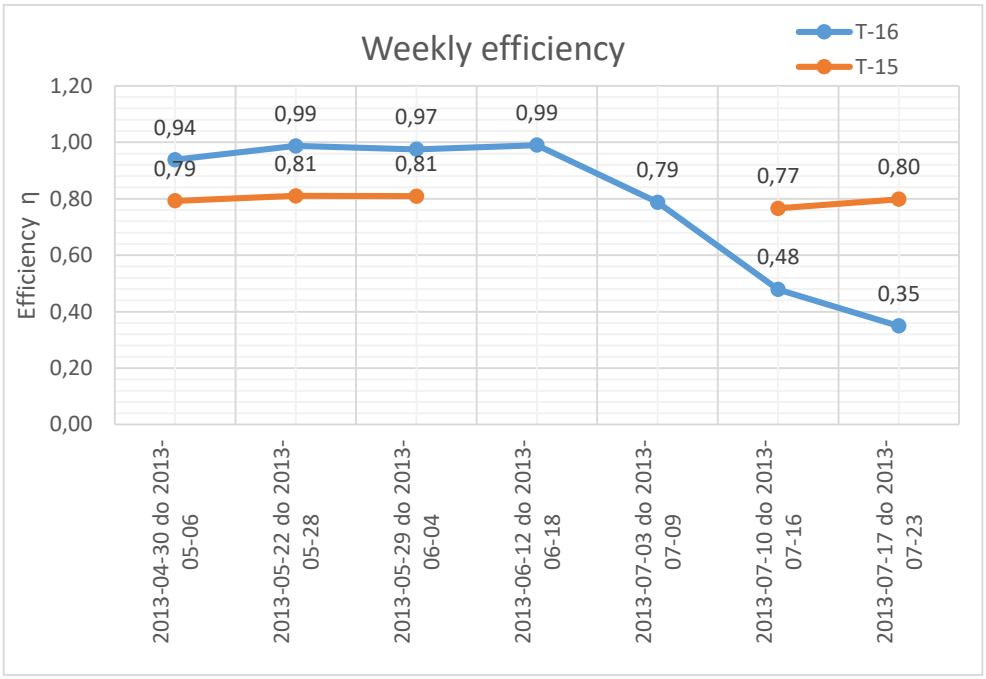

Fig. 2. Comparing T-15 and T-16 weekly efficiency.

3.1.3 Comparing monthly efficiency

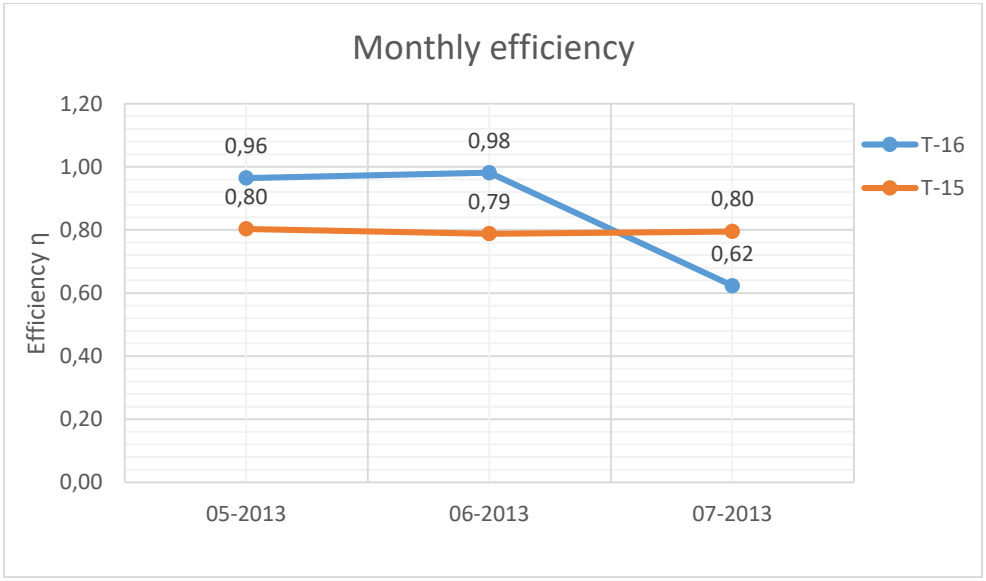

Fig. 3. Comparing T-15 and T-16 monthly efficiency.

3.2 Conclusions from the analysis of the efficiency of the installation

Two distinctly different result areas can be noted for the T-16 building on the diagrams showing the efficiency of the hot water system. This is due to the drastic change in the number of dormitory users – the holidays start in July. Consequently interpretation of the results should be carried out for two periods – full and partial residence. In addition, the nature of the water intake for a more periodic change is also changing in a facility such as a student dormitory with the change in the number of hot water recipients.

In times of full occupancy, the T-16 building paradoxically achieves a higher efficiency where the circulation system does not work, while there is less efficiency in the T-15 building:

- T-15 average total efficiency of the hot water installation. – 0.80
- T-16 average total efficiency of the hot water installation – 0.93

This situation should be explained by the presence of continuous water consumption and bad control of the circulation pump operation (nonstop work). In long periods of hot water consumption, the work of the circulating system is unnecessary, resulting in energy losses – lower efficiency of the hot water installation.

During the period of partial residence, in July the efficiency is kept constant, similar to the period of full residence in the T-15 building, while the T-16 building is clearly falling. During this period there are significantly fewer users using hot water in both buildings. The heat output taken at the T-15 is mainly used to maintain circulating water temperature (low domestic water consumption). On the other hand, for the T-16 building, the heat consumption depends on the instantaneous demand for hot water and the need to prepare it for the correct temperature parameters. Clearly this is the lack of circulating installation confirmed by the decline in efficiency of the hot water system.

4 Summary

The circulating system used in the building affects the efficiency of hot water installation.

The efficiency of the domestic hot water installation depends to a large extent on the operation of the circulation system. The analysis showed that in the building with an operating efficiency of circulation, the hot water installation is lower than in a building with circulation off. Of course this is the case if there are a large number of users in the building and they use hot water. When hot water is collected sporadically, the situation is different, and then the efficiency of such installation is about 80%. All the collected power is then intended to maintain the temperature of the circulating water.

Buildings that do not have a circulation system at the time of limited domestic hot water consumption show efficiency of about 60%, and with increased use of water, efficiency is at the level of 90–95%. For large domestic hot water partitions the efficiency factor reaches the highest value.

According to the Ordinance of the Minister of Infrastructure and Development the circulation installation is required in every building, except for single-family houses, farm buildings and individual recreation. According to the analysis, it is important because it maintains the level of energy consumption at a reasonably low level. However, efforts should be made to reduce energy and heat losses, for this purpose use of night and summer circulation limits (for buildings such as dormitories and other buildings used periodically). This will reduce the energy costs of heating circulating water during these periods and will result in lower tap water consumption.

References

1. I. Polarczyk, M. Fijewski, Research project: Evaluation of the condition and efficiency of the plant of domestic hot water by method of direct measurements, Reg. No. N N523 617839 (2016)
2. Ordinance of the Minister of Infrastructure of 12 April 2002 on the conditions to be met by buildings and their location, Journal of Laws No. 75, item 690 (2002–2015)
3. Ordinance of the Minister of Infrastructure and Development of 3 June 2014 on the methodology for calculating the energy performance of a building and a dwelling or a part of a building constituting a whole independent technical and utility as well as the method of drawing up and specifying certificates of their energy performance, Journal of Laws, item 888 (2014)
4. Ordinance of the Minister of Infrastructure of 6 November 2008 on the methodology for calculating the energy performance of a building and a dwelling or part of a building constituting a whole independent technical and utility as well as the manner of drawing up and specifying certificates of their energy performance, Journal of Laws, item 1240 (2008)