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QUALITY EVALUATION OF DOMESTIC HOT WATER SUPPLY DEPENDING ON LOCATION OF THE APARTMENT IN APARTMENT BUILDING

The paper compares temperature of domestic hot water in households with various ascending pipes located on different floors in two residential buildings of the same structural system. It describes household expenses for the consumption of hot water depending on its temperature. The article also contains subjective evaluation of domestic hot water supply's quality depending on the location of the flat in an apartment building.

Keywords: domestic hot water supply, temperature of domestic hot water

INTRODUCTION

Achieving steady hot water supply for all households in large apartment buildings could be a big problem. The households farther away from the source of heat have cooler effluent of domestic hot water than the households closer to the heat source. Therefore, these households spend a larger volume of hot water to achieve the desired temperature of water.

This paper compares temperature of domestic hot water in households with various ascending pipes located on different floors in two residential buildings of the same structural system.

It describes household expenses for the consumption of hot water depending on its temperature. The article also contains subjective evaluation of domestic hot water supply's quality depending on the location of the flat in an apartment building [1-6].

1. BUILDINGS DESCRIPTION

Two apartment buildings in Bratislava, built in structural system BANK-S, are the subject of measurements. Each apartment house has 2 separate entrances, 10 floors with the apartments and the ground floor. In each apartment building there are located 8 ascending pipes leading to 10 floors. The energy for heating and DHW preparation is supplied by a central heat source in the heat exchange station. The DHW distribution system is not balanced. All horizontal and vertical pipelines

are completely renovated in the apartment building No. 1 and all pipelines are in their original state in the apartment building No. 2.

Scheme of the hot water distribution system in apartment buildings is depicted in Figure 1.

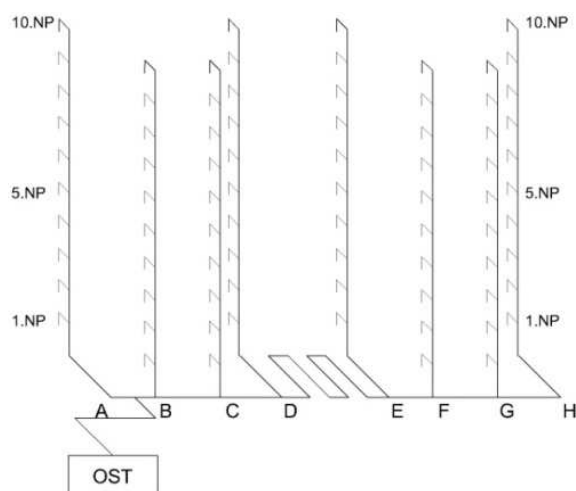


Fig. 1. Scheme of the hot water distribution system in apartment buildings

2. MEASUREMENT OF DOMESTIC HOT WATER TEMPERATURE DEPENDING ON LOCATION OF THE APARTMENT IN THE APARTMENT BUILDING

In both apartment buildings domestic hot water temperature at the sampling point on the 1st, 5th and 10th floor was measured. Measurements were realized during work-days from 5 p.m. to 8 p.m. Table 1 shows DHW temperature in apartments on different floors and in different ascension pipes.

Table 1. Temperature of domestic hot water in apartments

Apartment building No. 1	Ascending pipes							
Floor No.	A	B	C	D	E	F	G	H
10	48.5°C	48.6°C	48.4°C	48.2°C	48.1°C	48°C	47.8°C	46.7°C
5	50.6°C	50.5°C	50.3°C	50.1°C	50°C	49.8°C	48.3°C	47.3°C
1	52.3°C	52.2°C	52°C	51.8°C	51.4°C	49.8°C	49.3°C	48.4°C
Apartment building No. 2	Ascending pipes							
Floor No.	A	B	C	D	E	F	G	H
10	53°C	52.8°C	51.7°C	51.4°C	51°C	50.9°C	35°C	50.2°C
5	53°C	53.5°C	54°C	52.8°C	53°C	52.4°C	50.1°C	50.9°C
1	54.7°C	54.5°C	54.2°C	54.1°C	53.8°C	53.6°C	53.3°C	53°C

The measurements show that although both apartment buildings are in the same structural system, there are differences in DHW temperature at the sampling point between the apartment buildings. In the apartment building No. 1, in the apartment “1A”, which is the closest to the heat exchange station, the temperature of hot water at the sampling point 52.3°C was measured. In apartment building No. 2 in the apartment “1A” temperature of hot water reached 54.7°C. The temperature difference between the highest DHW temperature at the sampling point (apartment “1A”) and the lowest DHW temperature (apartment “10H”) was 5.6 K in the apartment building No. 1 and 4.5 K in the apartment building No. 2.

3. THE EXPENSES FOR DOMESTIC HOT WATER IN DIFFERENT APARTMENTS

The measurements show that DHW temperature is different in every apartment. When allocating the cost of hot water, only the quantity of hot water is taken into consideration, while the temperature of hot water is not considered. Reaching the desired temperature is made by mixing cold and hot water. It means that the households with lower DHW temperature must use a larger volume of hot water and less cold water to reach the desired water temperature. It means that residents of the apartments with lower DHW temperature must pay more money for the same water supply, because their consumption of DHW is larger.

For a better cost comparison of domestic hot water in different households the unit price for 1 m³ of water mixed at temperature 40°C was calculated. In order to reach desired temperature it is necessary to mix certain volume of hot and cold water - depending on its temperature. When calculating the temperature of cold water was considered to be 12°C and the DHW temperature was measured. The DHW temperature from the heat exchange station is 55°C.

Table 2. The expenses for domestic hot water in apartment building No. 1

Apartment No.	Temperature of DHW [°C]	Volume of cold and hot water for preparation of 1 m ³ water with temperature 40°C		Price of 1 m ³ water with temperature 40°C		The final price of 1 m ³ water with temperature 40°C [€]	The final price of 50 m ³ water with temperature 40°C [€]	The price difference for 50 m ³ water with temperature 40°C between apartments [€]
		Volume of cold water [m ³]	Volume of DHW [m ³]	Price of cold water [€]	Price of hot water [€]			
1A	52.3	0.305	0.695	0.67	5.68	6.35	317.51	–
5A	50.6	0.275	0.725	0.60	5.93	6.53	326.66	9.15
10A	48.5	0.233	0.767	0.51	6.27	6.78	339.15	21.64
1H	48.4	0.231	0.769	0.51	6.29	6.80	339.78	22.27
5H	47.3	0.207	0.793	0.45	6.49	6.94	346.95	29.44
10H	46.7	0.193	0.807	0.42	6.60	7.02	351.05	33.54

An average volume of warm water consumption for an ordinary household with two residents is 50 m³ per year. Therefore, the unit price of 1 m³ of water with temperature 40°C was multiplied by 50. The price of 1 m³ cold water is 2.19 €, the price of 1 m³ of domestic hot water with the temperature 55°C is 8.18 €.

Tables 2 and 3 show the difference of costs between apartments with different DHW temperature.

Table 3. The expenses for domestic hot water in apartment building No. 2

Apartment No.	Temperature of DHW [°C]	Volume of cold and hot water for preparation of 1 m ³ water with temperature 40°C		Price of 1 m ³ water with temperature 40°C		The final price of 1 m ³ water with temperature 40°C [€]	The final price of 50 m ³ water with temperature 40°C [€]	The price difference for 50 m ³ water with temperature 40°C between apartments [€]
		Volume of cold water [m ³]	Volume of DHW [m ³]	Price of cold water [€]	Price of hot water [€]			
1A	54.7	0.344	0.656	0.76	5.36	6.12	305.83	–
5A	53	0.317	0.683	0.70	5.58	6.28	313.96	8.13
10A	53	0.317	0.683	0.70	5.58	6.28	313.96	8.13
1H	53	0.317	0.683	0.70	5.58	6.28	313.96	8.13
5H	50.9	0.280	0.720	0.61	5.89	6.50	324.99	19.16
10H	50.2	0.267	0.733	0.59	5.99	6.58	328.94	23.10

4. SUBJECTIVE EVALUATION OF THE DOMESTIC HOT WATER SUPPLY QUALITY

In addition to the measurements the subjective evaluation of quality of domestic hot water by the residents in each apartment building was carried out. A questionnaire survey was filled in by the residents of the building, containing questions regarding various aspects of quality of their hot water supply.

The questionnaire was used to evaluate the residents' satisfaction with the temperature of hot water, water pressure and with the quality of hot water supply. For a better evaluation, the flats were divided into 4 groups according to distance of the ascension pipes from central heat source (A, B, C, D and E, F, G, H) and floors (1st-5th floor and 6th-10th floor).

Table 4 shows the percentage evaluation of questionnaire for each group of apartments.

The subjective evaluation pointed out that the residents living on the lower floors and close to the heat exchange station are more satisfied with the quality of domestic hot water than the residents living on the upper floors and far away from the heat exchange station.

The residents from upper floors of building complain that their DHW temperature is not warm enough. They have to drain a lot of water from the water taps until they get the desired temperature of hot water. The water pressure is also very low in some households on upper floors.

CONCLUSION

Location of the apartment in an apartment building has a significant impact on the quality of hot water. The DHW temperature in apartments on the upper floors was lower than the temperature in apartments on the lower floors.

This imbalance is also adversely reflected on costs of domestic hot water. The residents with lower DHW temperature must pay more money, because they have to spend a larger volume of hot water to achieve the same final temperature at the sampling point.

The subjective assessment of DHW quality also pointed out that the residents living on lower floors of apartment building and closer to the heat exchange station are most satisfied with the quality of supplied hot water. On the other side, the residents, living in apartments on the upper floors, were not very content.

Achieving the steady domestic hot water supply for all households in large apartment buildings could be a big problem. Ensuring optimal quality of hot water in each apartment, it is necessary to provide hydraulic balancing of hot water distribution system. It is also very important to ensure continuous operation of the circulation pump. To maintain the desired temperature of hot water it is necessary to insulate the waterpipes.

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OCENA JAKOŚCI CIEPŁEJ WODY UŻYTKOWEJ W ZALEŻNOŚCI OD LOKALIZACJI MIESZKANIA W BUDYNKU MIESZKALNYM

W artykule porównano temperaturę ciepłej wody użytkowej w mieszkaniach zlokalizowanych na różnych kondygnacjach w dwóch budynkach mieszkalnych wzniesionych w tym samym systemie konstrukcyjnym. W artykule opisano koszty dla indywidualnych gospodarstw domowych związane z zużyciem ciepłej wody w zależności od jej temperatury. Zawarto w nim również subiektywną ocenę jakości ciepłej wody w zależności od położenia mieszkania w budynku.

Słowa kluczowe: zaopatrzenie w ciepłą wodę użytkową, temperatura ciepłej wody użytkowej