Experimental studies of combined heat supply system in the flow mode during the summer period for Lviv

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Abstract – Experimental model of a combined solar collector (SC) in the flow mode is effective in seasonal (summer) period of application. The article presents the analysis of thermal energy, accumulated by solar heat supply system (SST), and energy that were received on the plane of the solar collector in the course of the experiment.

Key words – renewable energy, solar energy, the flow mode, southern orientation.

I. Introduction

Priority and qualitatively new direction in the energy sector are renewable energy sources. The need for energy use of alternative fuels in the economy of leading countries is due not only to limited amounts of organic energy sources, but also by the laws which regulate the reduction of the harmful emissions of oxides of nitrogen and sulfur, soot, ash, products of incomplete combustion of carcinogenic substances.

Solar energy is developed branch in the world in the field of renewable energy. The most widespread use of solar energy is in heat supply systems, in particular for hot water supply.

II. The main material

Experimental model of the solar system in the flow mode relates to low-temperature single-circuit heating systems. The proposed model of solar collector is aligned with the roof of the building in which the function of the roofing material performs the sink which is colored black (e.g., galvanized steel). This solar heat supply system in the flow mode can be used for seasonal water pre-heating for pools and showers, solar-fuel boiler-houses, for domestic purposes, etc.

The lack of experimental operation of a solar system in the flow mode is that it can function in the summer months and transitional months, during periods with positive temperatures.

The experimental setup works as follows. At the initial stage, the heat carrier flows into the tank of cold water. When you open and set the shut-off control valve the water enters the solar collector, in which a preset flow rate of the heat carrier moving in the tank of heated water. The selection of the heated heat carrier implemented through the pipe to the tank of heated water. Measurements of water temperature in the lower and upper tanks were conducted with mercury thermometers.

The thermal energy that was accumulated in the tank of heated water was determined by the formula:

$$Q_{\text{tank}} = G \cdot c \cdot (t_{outlet} - t_{inlet}) \qquad (1)$$

where G – the flow rate of heat carrier, l/s; c – specific heat capacity of heat carrier, J/(kg·K); t_{inlet}, t_{outlet} – accordingly, the temperatures of the heat carrier on the inlet and outlet of capacitive tanks, K.

Experimental results of heat carrier's temperature are shown in Fig.1. It's investigated, that the temperature of the heat carrier of the solar system in the flow mode has reached to 23.5 ºC, which is 32% higher than the inlet temperature of the heat carrier.

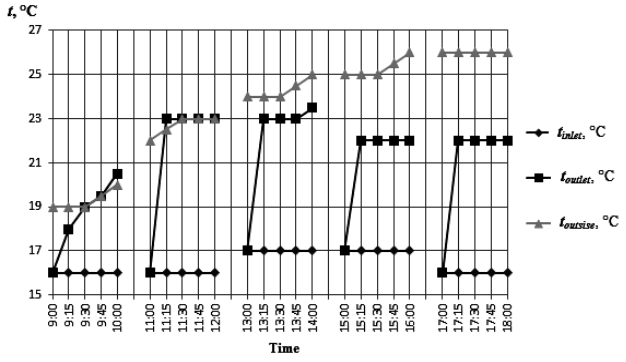

Fig. 1. The temperature change of the heat carrier and the temperature of the environment during the experiment in the southern orientation

The average temperature of the heat carrier during the experiment in the tank of heated water with southern orientation is presented in Fig.2.

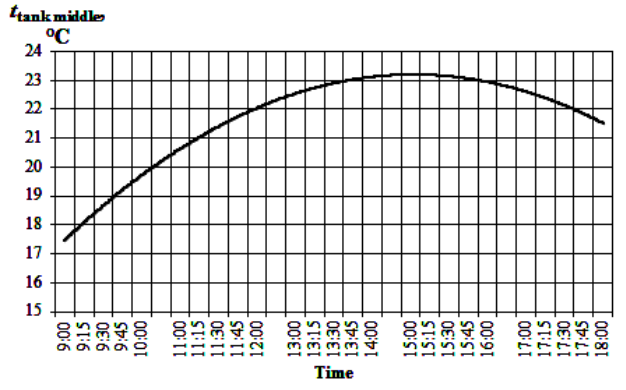

Fig. 2. The average temperature of the heat carrier in the tank of heated water during the experiment in the southern orientation

It is found that the solar collector in the flow mode in the southern direction of the horizon allows you to save up within the hour to 500 W/m^2, changing the location of radiation intensity from 986 to 874 W/m^2. The instant specific capacity of the solar collector in the southern orientation during the day has a variable nature of the fluctuations. Particularly in the morning period, the system heats up rapidly, but this period in the system can

be attributed to the period of stabilization of the heat carrier in the collector. Regarding lunch and evening time of day, the change is significant if to compare with the morning, and differs from the latter respectively by ≈70%.

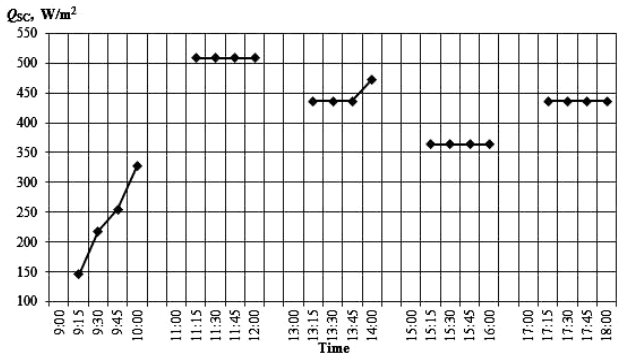

Fig. 3. Specific instantaneous power of solar collector (SC) in the southern orientation

For analysis of the number of arrivals of thermal energy in the plane with a pyranometer was measured the intensity of solar radiation during the experiment. Analyzing the amount of thermal energy on the solar collector of Fig.4, which came from radiation in the southern orientation we can say that the nature of the change is rapid with a significantly increasing trend within the hour. This trend is related, primarily, with a parabolic change in the intensity of solar radiation.

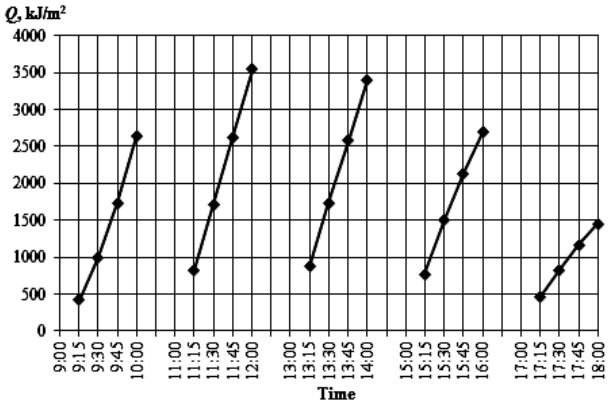

Fig. 4. The amount of heat that comes from the radiation on a combined solar collector in the southern orientation

Conclusion

In Lviv the experimental model of the combined solar collector in the flow mode is effective to ensure the building of low-temperature heat carrier. Heating of the heat carrier within the hour is on average 6.5 ºC. In the evening time specific instantaneous power of solar collector in the southern orientation is 436 W/m^2, which is different from morning time by 77%.

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