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ON THE ISSUE OF INCREASING THE EFFICIENCY OF FLAT SOLAR COLLECTORS IN HEAT SUPPLY SYSTEMS BY OPTIMIZING THEIR OPERATING PARAMETERS

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Abstract
The article discusses the issues of improving the efficiency of solar heat supply systems with flat solar collectors by optimizing their circuit solutions and parameters.

Keywords: solar collector, solar water heating plant, specific flow rate, heating capacity, efficiency.

Introduction

Solar heating systems (SST) are one of the areas in which large-scale practical use of solar energy has actually been achieved. From 2000 to 2023, the total area of installed solar collectors (SCs) in various FTAs increased by 7.6 times and reached 725 million m2 worldwide [1,2].

Body

Recently, however, the growth rate of adoption has been decreasing [2,3], and the production of stem cells in China, Australia, and the Middle East has fallen for the fourth year in a row. At present, due to a sharp drop in the cost of photovoltaic modules [4,5], SSTs have begun to be replaced by photovoltaic installations (PMTs), which have certain advantages [4,7,8] compared to thermal installations: the absence of a coolant in the generating circuit, pipeline network, intermediate heat exchangers, circulation pumps, the need for measures to protect the circuit from freezing in winter and overheating in summer, convenience and simplicity of installation, and increased efficiency photovoltaic modules with a decrease in ambient temperature, independence of the efficiency of water heating by an electric heater from water temperature, etc. [9,10,11].
For a number of years, the European market of solar reactors has been stagnating: the volume of reservoir commissioning has been falling since 2009.
Of particular relevance in the context of the stagnation of the market of modern water heaters, which have parameters close to their limit values, and the displacement of traditional solar water heating installations by photovoltaic installations, the issues of identifying the main reserves for improving the efficiency of the use of solar thermal energy in FTAs are of particular relevance.
From this point of view, when designing pumping stations, an important point is to determine the optimal specific flow rate of the coolant through the SC [14,15]. The flow rate of the coolant

through the SC is one of the main operating parameters affecting its efficiency and the operational readiness of the solar hot water supply system.

It is known [16] THAT UNTIL 1980 IN THE PUMPING SYSTEMS OF SOLAR HOT WATER SUPPLY, THE FLOW RATE OF THE COOLANT WAS SELECTED AT THE LEVEL OF 0.015 KG/(M2•S) OR 54 KG/(M2•H). AT THAT TIME, THIS WAS JUSTIFIED BY THE NEED TO ENSURE A HIGH VALUE OF THE HEAT DISSIPATION COEFFICIENT FR FROM THE SC [16,17]. In recent years, installations with a significantly lower specific flow rate have been used, which provides better temperature stratification of water in the accumulator tank and high operational readiness of the system, which in 1÷1.5 hours after the start of coolant circulation in the solar circuit, allows supplying hot water to the consumer at the required temperature. For example, in Sweden, typical unit flow rates range from 0.002 to 0.006 kg/(m2•s) or from 7.2 to 21.6 kg/(m2•h) [18,19].

The design practice of the German company VIESSMANN PROVIDES FOR THREE MAIN MODES OF COOLANT CIRCULATION THROUGH THE SC [7]: MODE with a flow rate of up to 30 l/(m2•h) (low flow); mode with a flow rate of more than 30 l/(m2•h) (hihg flow) and mode with adjustable flow rate of the coolant. The optimal value for solar systems with flat plate collectors is 25 l/(m^2•h) at full pump power. With the development of solar technology, the optimal value of the coolant flow rate has changed, For example, 10 years ago, 40 l/(m^2•h) was considered optimal for flat plate collectors [17,20].

It is interesting to note that over the course of almost 40 years of world experience in the design and implementation of CCTs with flat ICS, the value of the optimal specific flow rate of the coolant through the SC has been periodically adjusted and reduced from 54 kg/(m2•h) to 25 l/(m^2•h), i.e. more than twice, and in Sweden – 2.5÷7.5 times. This is happening against the background of the fact that the parameters of thermal perfection of the SC are constantly improving and are currently close to their limit values [21-25]. It would seem that the value of the optimal specific flow rate through the SC should also have increased along with the increase in its thermal engineering perfection to ensure greater heat dissipation. In practice, however, the opposite is true. This indicates that there is still no sufficient scientific justification for determining the value of the optimal specific flow rate of the coolant through the SC for various circuit solutions of the CCT (single-circuit, double-circuit, without a duplicate heat source, from a duplicate heat source, etc.) taking into account the climatic conditions of the construction area.

Inference

Serious studies of the effect of coolant flow on the efficiency of the solar collector could not be found in the literature. For this reason, the design of HFTs is carried out mainly by the traditional approach used in conventional heat supply systems, where the thermal and hydraulic processes occurring in the system are considered separately in stationary mode for simplicity. At the same time, it does not take into account the heat-hydraulic dynamic effects that occur in the CCT and its elements with non-stationary incoming solar energy, which, under certain conditions, can be accompanied by synergetic effects of self-organization and self-regulation.

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