
ENERGY SAVING, NEW, AND RENEWABLE ENERGY SOURCES

Results of the Development of a Solar Accumulation-Type Water Heater Made of Polymer and Composite Materials

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Abstract—Results of the development and preliminary tests of a solar water heater completely made of polymer and composite materials are presented. The combination of a solar collector and storage tank into a united construction in combination with the application of modern fabrication technologies of bulk units made of polymer materials makes it possible to considerably decrease the expenses per area unit of the receiving surface of the heater with maintaining high-energy conversion characteristics of the solar energy into low-potential heat. This increases the competitiveness of such installations in comparison with conventional solar water heaters with separate solar collectors and a storage tank.

Keywords: solar water heater, polymer materials

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The total heat power of solar water heaters (SWHs) acting in the world in 2011 exceeded 200 GW (more than 350 million m² of solar collectors) [1]. In Russia, according to the evaluations of experts, no more than 30 000 m² of solar installations (preferentially in the Krasnodar krai, Buryatiya, Dagestan, and Primor'ye), which were made preferentially due to the initiative of some specialists and private companies, are used. The industrial production of SWHs in our country is almost absent. Orientation to foreign wares restrains the development of the market in this field and lowers the competitiveness of this promising technology, which has found a wide application in many countries of the world including those with climatic conditions similar to Russia, because of their elevated cost.

In our previous articles, we showed that despite the arrangement of a considerable part of the territory of our country in medium and high latitudes, the arrival of solar radiation energy to the surfaces optimally oriented in space in many regions of our country is rather high, namely, 3.5–5.5 (kW h)/(day m²) on average, and up to 7 (kW h)/(day m²) in some places in summer [2]. Thereby, many regions in Russia are no worse than the countries, where solar energy is already actively used, in the arrival of solar radiation.

SWHs, in which the converter of solar radiation into heat (the plane or evacuated solar collector) and a storage tank, which accumulates water heated by the solar radiation, are spatially separated from one another and coupled hydraulically using natural or forced circulation of the heat carrier, became most spread worldwide. This solution was formed histori-

cally because of the development of industrial fabrication technologies of solar collectors of metal (heat-receiving panel) and glass (the collector coating transparent for solar radiation).

Despite the apparent design simplicity, the fabrication of SWHs with the combination of a solar collector and a storage tank with the application of metal and glass is more complex in production. In addition, it is considered that increased heat losses from the tank through a transparent isolation at night are a clear disadvantage of a combined design. On the contrary, the tank can be heat-insulated well and store warm water for a long time in separate designs. A short review of the historical development of designs of SWHs is presented in [3].

However, it was shown in [3, 4] based on comparative calculation—theoretical investigations that the integrated heat efficiency of combined designs of SWHs in the non-heating season in the larger part of the territory of Russia with heating the heat carrier to 40–50°C not only surpasses but even can somewhat exceed the efficiency of separate solar heaters. This can be associated with the specifics of heat-and-mass transfer and, particularly, with considerable thermal stratification of water in the tank of the combined installation over its height.

Thus, the combined SWH designs, with their use in a relatively warm period of the year, can be quite energy efficient. The appearance of new polymer materials with acceptable thermal stability and optical characteristics as well as technologies of fabrication of large units made of them in recent years has opened