STUDY OF STRUCTURE AND WORKING PROCESS OF VACUUM TUBE COLLECTOR

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Abstract

If the vacuum solar collector is manufactured by hand, galvanized containers for water should be prepared. Its volume can be from 100 to 200 liters. The container should be placed on the roof. If the barrel is installed on the south side of the roof, 100 liters of liquid can occupy up to 60 degrees. The second should be coated with a metallic shiny layer. In this case, the efficiency coefficient is much higher, because the heat exchange area with the air is minimal. It is recommended to use such a simple solar collector in places where ecology is sufficiently preserved, it is better to operate such a system away from polluted places. It should be noted that in the winter months such units are able to produce less heat.

Key words: Vacuum tube collector, efficiency, monobloc, thermos, Zmeevik, solar radiation

Indroduction

A solar water heater is a device that heats, stores and delivers water to the consumer due to absorbed solar radiation energy. The main part of the solar water heater is a solar collector and a tank-accumulator. The main task of solar collectors is to absorb solar radiation as much as possible, collect it as thermal energy and transfer it to a heat-carrying substance (water, antifreeze, etc.) [1-3].

Solar water heating (collector) devices are divided into 2 types: whole and separate constructions.

The whole type of collector (monobloc) consists of vacuum flasks, a tank (thermos) - a hot water reservoir, as well as a system fixed to a single structure with the help of a metal frame with a galvanic coating.

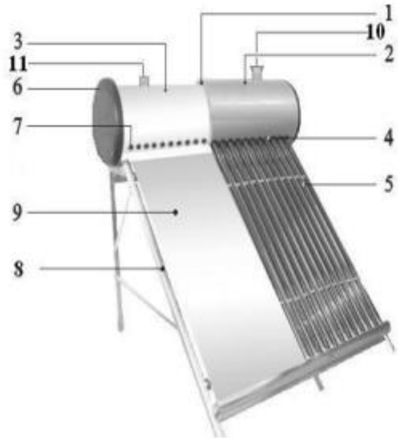

Figure 1. All kinds of vacuum tube collector.

1 – Water tank; 2 – the outer layer of the tank; 3 – the inner layer of the tank; 4 – external fastener; 5 – vacuum tubes; 6 – water tank covers; 7 – rubber fastener; 8 - frame under the support, material - steel with galvanic coating or stainless steel; 9 - reflective plate - additional option; 10 – emergency air valve; 11 – controller sensor.

WORKING PROCESS OF VACUUM TUBE COLLECTOR

The monobloc-collector is mainly installed on the roof of the house or building and provides the necessary hot water pressure to the source of consumption. Circulation in the interior of the tank is carried out due to natural processes. The package also includes a frame-support system, a smart controller, an electromagnetic valve and an electric tank. There are 2 types of tanks to choose from: normal and zmeevik heat exchanger types. The efficiency of the collector provided with the Zmeevik heat exchanger is ~30% higher than the normal one, and the hot water in the tank is also heated due to solar energy [4-6]. Depending on the level of consumption, the amount of water in the tank is 100l, 150l, 200l, 250l, 300l.

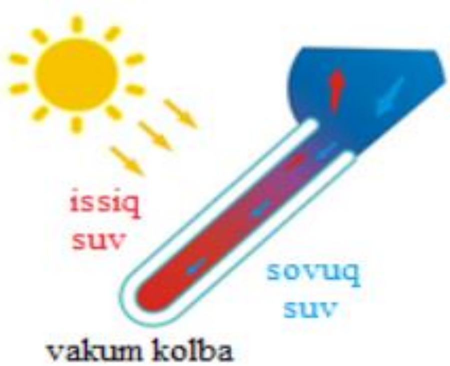

Figure 2. External view of the vacuum tube collector.

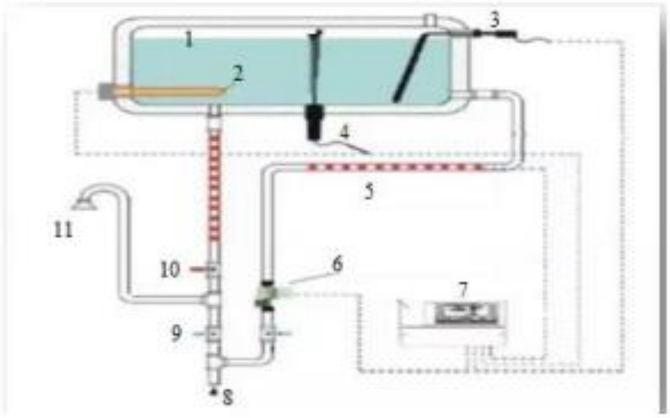

Figure 3. A schematic diagram of a vacuum tube collector.

1-Water tank, 2-Electric heater, 3-High level sensor, 4-Low level sensor, 5-Heating cable, 6-Solenoid valve, 7-Smart controller, 8- Cold water inlet, 9- Cold water faucet , 10-Hot water faucet, 11- Consumer.

Buck battery consists of 3 layers:

1. The inner part of the tank is made of M-304 stainless steel, which ensures its high safety in hygienic plans, as well as corrosion resistance, durability in long-term practical use.

2. To maintain the temperature of hot water in the middle layer of the tank for a long time

It consists of high-quality polyurethane, 55 mm thick uteplitel with a high accumulation function. In winter, when the ambient temperature is below 0 C, the total heat loss is ~3-60 C. For example, if the water temperature in the collector is 600 C in the evening, then in the morning this temperature will decrease by 50 C, i.e. it will be 550 C [7-8].

3. The outer metal coating of the tank has a special protective paint and provides protection against external influences (sunlight, precipitation, i.e. snow, rain and hail).

The rest of the parts are made of rubber and plastic, taking into account the external effects. Vacuum flasks are made of strong borosilicate glass with a light-absorbing layer, which heats water by converting solar radiation into heat energy. Due to natural circulation, water heated in the tube rises up and accumulates in the tank. The smart-controller controls all working processes of the collector (temperature of water in the tank, level of water in the tank, operating mode of the electromagnetic valve for pouring water into the tank, adding and disconnecting the

1.5 kW heat if necessary). Using this collector, it is possible to save 100% of energy for heating water for 9 months [9-12].

Figure 4. Components of a vacuum tube collector.

The efficiency of solar collectors depends on the amount of solar radiation falling on the surface of the collector, the temperature of the environment and the temperature of the heat carrier passing through the collector [13-15].

n our experiments, the efficiency of the vacuum solar collector is equal to the ratio of the useful thermal energy received from the device to the solar radiation power falling on the collector surface unit:

$$\eta_{v.t.k} = \frac{Q_k}{I_T F_k} \qquad (1)$$

Figure 5. A special type of solar vacuum tube collector.

Conclusion

The useful energy obtained from the solar collector can be written as follows, taking into account heat losses and the effect of optical efficiency:

$$Q_k = I_T \cdot (\tau\alpha) F_k - U_k F_k (T_k - T_a) \qquad (2)$$

Based on the relationship (1) and (2), the expression for calculating the efficiency of the solar collector can be written in the following form:

$$\eta_{v.t.k} = (\tau\alpha) - \frac{U_k(T_k - T_a)}{I_T} = G \cdot c_p \cdot (T_k - T_{ch}) \quad (3)$$

here is the current density of solar radiation falling on the area of the IT-collector absorber m2; (ta) effective optical FIK of the collector, i.e. t is the light transmission coefficient of the vacuum tube; a - absorption capacity of the absorber; Fk is the area of the collector; Uk is the total coefficient of heat loss in the collector; the temperature of the heat carrier at the time of entry; Ta - ambient temperature; G - heat carrier mass consumption (kg/s), CP - heat carrier heat capacity (J/kgK); Tch is the temperature of the heat carrier at the outlet [16-19].

In several cases, the performance of different types of solar collectors is evaluated by the cumulative coefficients of heat losses. In some literature, Uk ≈ 21 W/(m²·K) for glassless solar collectors, Uk ≈ 4 W/(m²·K) for glass flat solar collectors, and Uk ≈ 1.5 W/(m²·K) for vacuum type solar collectors. is said to be.

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