COGENERATION PLANTS SOLAR CONCENTRATOR HEAT-ELECTRIC POWER SUPPLY

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In recent years, the market of renewable energy began to appear solar installations to ensure the simultaneous production of heat and electricity. When this is used as a planar photoelectric thermal (FEE) modules, and the modules which use concentrated solar radiation concentrator photovoltaic thermal-water cooling system (PVT / w).

Among these systems should distinguish between plants with high (≥500) and low (≈10) concentration of radiation. In both cases, these plants produce heat transfer fluid is given.

Additional costs for the introduction of hubs and tracking systems for the Sun justified decrease in the number of relatively expensive solar cells and an increase for the year generated electricity and heat.

The purpose of research - development of a new design of hybrid concentrator plant, providing maximizing power output characteristics of photovoltaic cells and thermal collectors.

Materials and methods of research. The design used the single-carrier placement on the platform in the optical field concentrator PV modules and two bilateral collectors there between. Temperature of the coolant channels PV modules is less than 50 °C, and the manifold ducts can be brought to a boil. Provided the density of the focused on the regulation of photodetector surfaces of solar radiation in accordance with the seasonal variation of insolation of the sun.

Optical diagram of the apparatus and process of the installation shown in Fig. 1. In the metal carrier are placed modular platform of concentrators mirrors (facets), focusing the reflected solar radiation onto solar cells operating with more than five times the concentration of the solar radiation, as well as the selective collector surface mounted there between in the plane of symmetry of the support base.

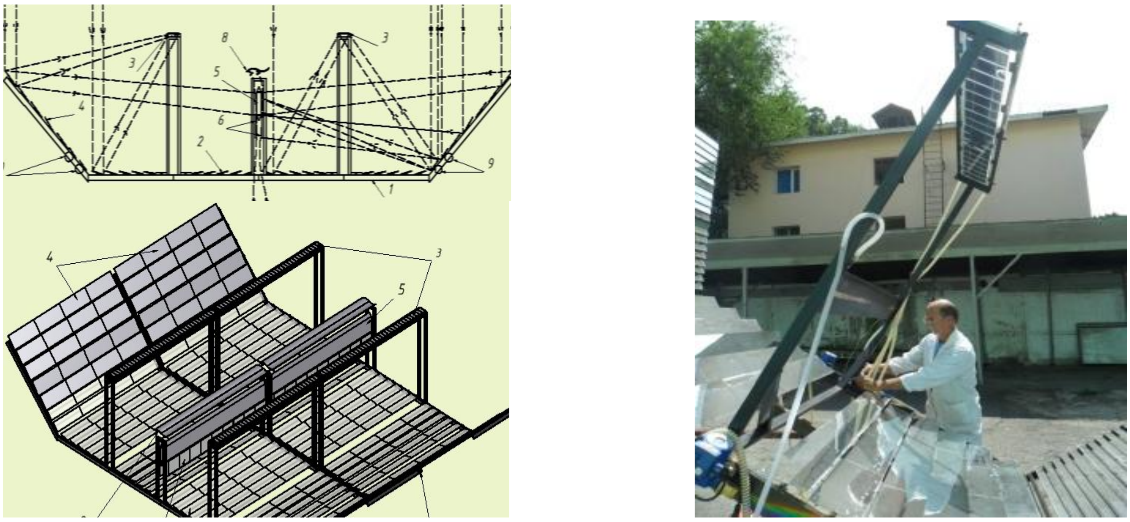

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Fig. 1. Optical scheme PVT / w installation (a) and photograph the installation (b)

In this new design is the placement of the collector below a row of photocells relatively large area of working with single, double concentration of the reflected radiation. Almost 95 % of the total surface of the collector is working and is covered by a selective film, so there is no need for thermal insulation. Flat collector made of aluminum or copper. Can also be used commercially available vacuum tubes that have been upgraded to improve performance on heat dissipation.

Options for solar installations with a metal collector and vacuum tubes have a design and technological features and optimized solutions for special range of tasks. In proportion to the concentration of solar radiation absorbed by the reduced space required collector surface and thus reduces the cost of selective film, glass, hardware, insulation and other materials. With a decrease in the area of channel reservoir coolant velocity increases, which intensifies the heat transfer to the walls. A flat wall of a collector of aluminum foil covered by the selective aluminum 0.3 mm thick TINOX.

We examined the effect of thermal protective layer on the efficiency of the collector.

It is known that any heated object creates a natural convection along its surface. In our case, we introduce an additional source of energy in the form of heat plates solar cells, which by natural convection flows collector adds thermal convection from the solar cells. At the same time due to the temperature rise above the walls of the reservoir temperature of solar cells, there is a physical effect of increasing the air flow natural convection solar cells themselves, which increases the intensity of cooling.

Describe theoretically the formation of non-isothermal flow in a continuous two-dimensional environment at the surface of the collector is quite difficult. We conducted a pilot study of the processes involved in a special laboratory bench.

The process of converting solar energy into thermal energy is as follows. Solar radiation through the glass layer and the air is supplied to the selective thin film which is absorbed and converted to heat transferred through the wall further coolant channel. In assessing the outcome, it is important to evaluate the integral value allocated to the surface of the channel and transmit the coolant heat energy, as well as the part that is lost to the environment by radiation and convection.

On the test bench with the help of a thin foil of nichrome glued to the surface of the channels through the layer of thermal paste, simulated thermal processes occurring during operation of the unit under realistic conditions. Get the same average temperature of the walls at the same external environment parameters, we simulate the processes of heat exchange with the coolant channel walls and the environment. In this case, heat conduction and radiation between the walls of the studied channel and the environment will be similar to full-scale experiments with the sun. Fig. 2 shows a manifold mounted on the stand of the stainless steel, temperature sensors and airflow along the walls of the reservoir and below it - nichrome foil. Fig. 2b shows the process of measuring the temperature of the walls of the collector foil and pyrometer when testing collector test bench in the winter season.

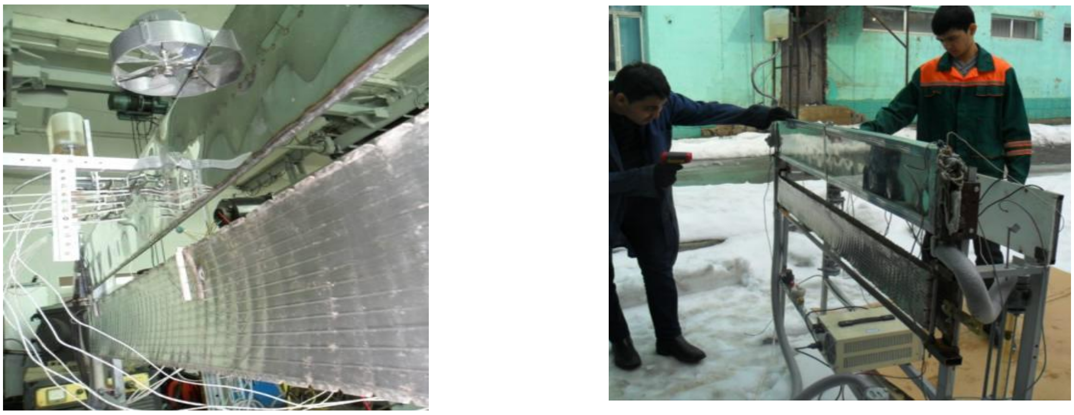

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Fig. 2. Collector plates made of nichrome and temperature sensors and flow rate in the laboratory (a) and when tested outdoors collector (b)

Food stand by using low voltage welding rectifiers, which are connected to the collectors studied through a copper adapter that allows you to distribute evenly across the width of the electric current. The current value measured with the use of current shunts millivoltmeters and with an accuracy of ± 5 %. The temperature of the generated heat flux at different distances from the walls of the reservoir measured six Chromel-Copel thermocouples with an accuracy of ± 5 °C. The flow velocity along the walls of the thin plate and the reservoir - hand anemometer (GOST 6376-52) with an accuracy of ± 15 %. Coolant temperature, the walls of the reservoir inlet and outlet and nichrome foil is measured by chromel-Copel thermocouples c accuracy of ± 7 °C and pyrometer UT 300A with an accuracy of ± 15 °C.

The methodology of the research includes pre-setup and calibration of sensors measured parameters, the output of the studied heat transfer processes in the stationary mode, processing of the measurement results in this mode, using the reference data.

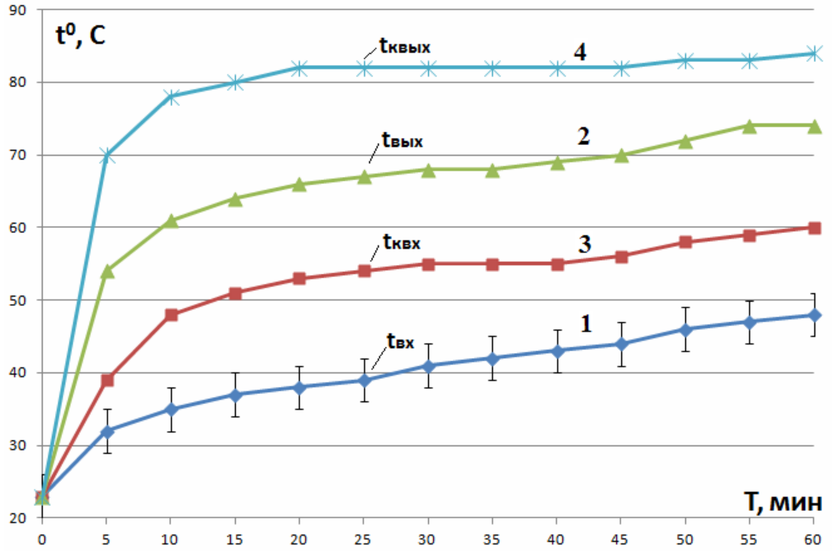

Fig. 3. Change the temperature of the coolant (water) tvh (1) and outgoing gas (3), the collector walls tKvh (2) and tKvyh (4)

The results of research. Fig. 3 shows the averaged results of several experiments designed to measure the temperature at the inlet and outlet of the reservoir at a flow rate of coolant G = 12,6 · 10-3 kg / s, and the power released in the walls of the collector RK = 1780 watts. On the lower curve shows the temperature measurement accuracy. As seen from the graphs, after about 10 minutes after the current sources and the temperature difference circulating pumps on the inlet and outlet channel is stabilized. According to the initial growth rate was estimated temperature thermal inertia circulation circuits, which for reservoir parameters L / b ≥ 15 (length to width ratio) is less than twenty minutes.

Fig. 4 is a graph plotting the efficiency of the power released collector foil. It can be seen that the thermal energy generated by the lower walls of the reservoir increases its efficiency. Quantitatively, the effect reaches 25 % when the heat generated by the power of 400 W, which corresponds to the power of solar cells with twice the concentration of radiation.

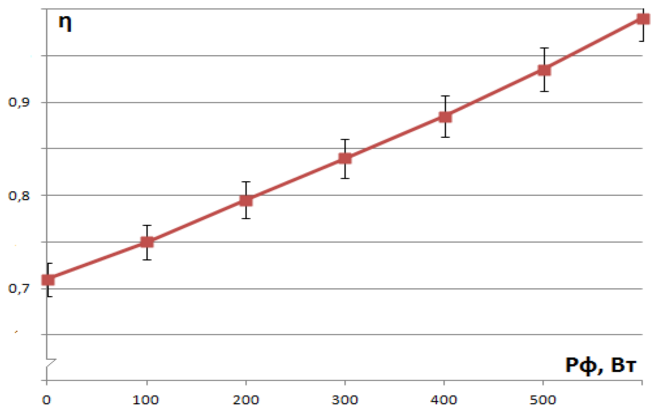

Fig. 4. Increased efficiency of the collector plates generated by thermal power. G = 10,2 · 10-3 kg / s, RC = 510 watts

Conclusions

The proposed design of the hybrid solar plant with installed PV modules between bilateral collector expands the scope of the large-area silicon solar cells as a source of heat for the formation of a thermal protective layer along the walls of the reservoir. In the field of photovoltaic plates are allocated to thermal power (≈400Vt) the effectiveness of the collector due to the protective thermal layer is increased by 25%. Sharing and collector cells with higher surface temperature reservoir flow enhancement effect creates an air flow along the plates photocells, which increases the intensity of cooling and the amount of photovoltaic electricity generated by them.

The results of measurements of thermal parameters of the collector on teplotechnical stand with electric shocks as heaters can be transferred to natural conditions collector interaction with the environment and the incoming solar radiation.