IMPROVING THE EFFICIENCY OF POWER PLANTS ON THE BASIS OF HEAT PHOTOVOLTAIC MODULES

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At present, solar energy is one of the most widely used types of renewable energy sources (RES). It is mainly used to produce heat (hot water), which is produced in solar collectors (SC) and to generate electricity using photovoltaic modules (FEM).

Photovoltaic modules have proven to be reliable and easy-to-use devices, and solar thermal collectors as a reliable means of generating thermal energy. Theory and Practice as solar water heaters (UK) and photovoltaic solar radiation (FEM) in detail and extensively described in the literature. In organizing the supply of objects (mostly independent) are commonly used, and solar collectors (for heat) and photovoltaic panels (for electricity generation). Both can be mounted either on a nearby free sites, or on the roofs of buildings.

In recent years, in the world began to be used more convenient, integrated systems that combine and FM, and the UK, operating in one energy unit produced by the so-called FEE technologies (photovoltaic-thermal technology) [4].

A distinctive feature of FEE modules is the fact that its design is inherently a contradiction. To provide the necessary parameters of hot water used in hot water and heating, are expected to reach the highest possible temperature (60 ° or 90 °). But the increase in temperature results in a decrease efficiency of solar cells. For this reason, based on the installation FEE modules can not always satisfy the needs of consumers.

The purpose of research - the study of the functioning of the photovoltaic thermal module (PV-Thermal module) and on this basis the development of approaches and techniques to ensure maximum efficiency of cogeneration units.

Materials and methods of research. To create the most suitable FEE module Solar collector appears flat because it is the most convenient structure for combining with the photoelectric converters which are easily located at its receiving surface.

The literature describes a number of designs such aggregate devices (Figure 1) and the results of theoretical estimates of the effectiveness of the FEE modules.

In carrying out theoretical calculations it was assumed that the module works with forced circulation of coolant, solar radiation (R) was assumed to be 800 W / m2, the ambient temperature of 20 ° C, wind speed - 1 m / s, the temperature of the sky - 4 ° C, and the angle collector inclination correspond to the value 45.o

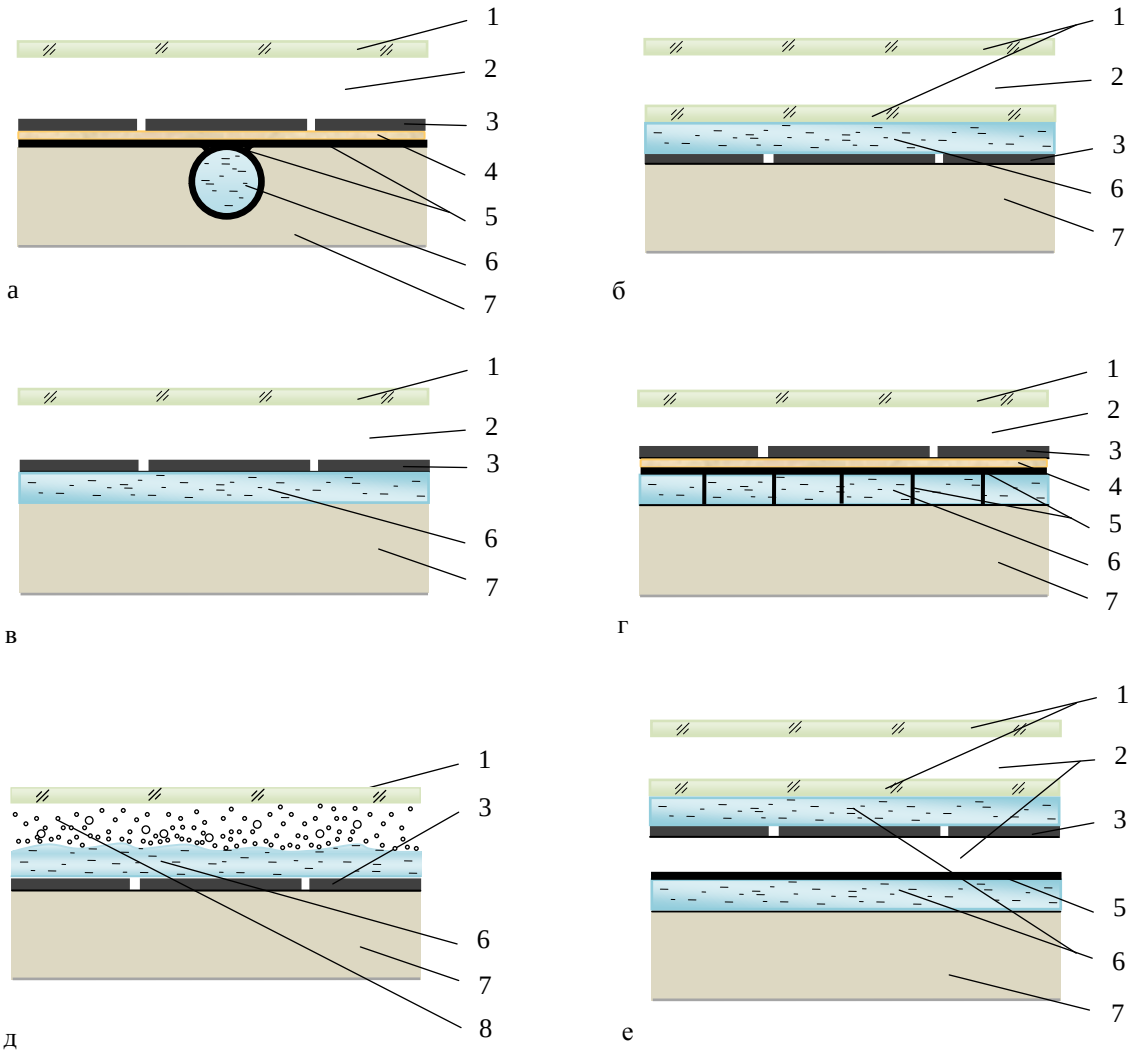

Fig.1. The most common design FEE module:

and - with the absorber type "leaf-pipe"; b - with the absorber in the form of a liquid channel on the PV panel; a - in the form of an absorber liquid channel for the PV panel; g - with an absorber of rectangular channels; d - with the absorber in the form of a channel partially filled with water, positioned above the PV panel; e - double the absorber and the air gap; 1 - Translucent coating; 2 - air; 3 - photovoltaic panels; 4 - thermally conductive electrically insulating bonding agent; 5 - the heat absorber; 6 - coolant (liquid); 7 - heat-insulating material; 8 - a pair of fluid

It was shown that promising is the structure with fluid channels, located behind the photovoltaic panels, because in addition to the simplicity and reliability in operation when it is a significant advantage for power generation is slightly smaller on the heat generation in comparison with other designs. Similar conclusions have led and our studies.

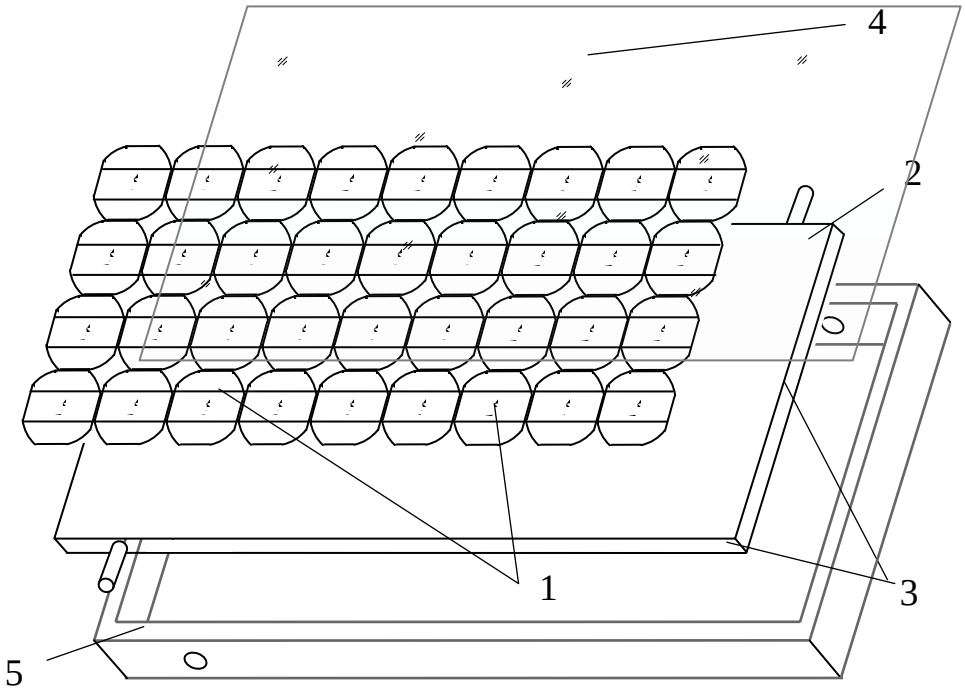

Fig.2. Design FEE module developed in VIESH:

1 - photovoltaic panels (solar cell battery); 2 - the heat absorbing member (absorber); 3 - tank with coolant; 4 - transparent insulation (glazing); 5 - thermal insulation pencil case

The results of research. We have developed a module layout FEE above structure, concept and appearance of which are shown in Figures 2 and 3.

When manufacturing unit, special attention was paid to the creation of good thermal contact between the back side of solar cells and the surface of the host, while ensuring reliable isolation between them.

Figure 3. Appearance-designed layouts FEE module

FEE module was investigated in field conditions under different operating conditions. To do this, we developed a special system of simultaneous monitoring of meteorological parameters, checking electrical and thermal parameters FEE module temperature and a variety of points of the module.

Proper installation for field studies designed layouts FEE module is shown in Figure 4.

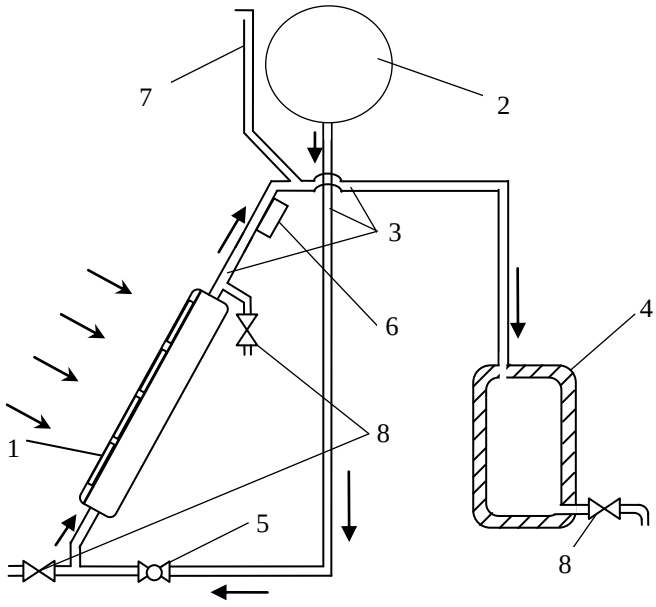

Figure 4. Apparatus for study layout FEE module:

1 - FEE module; 2 - pressure vessel; 3 - the pipeline; 4 - tank batteries; 5 - solenoid valve; 6 - thermostat; 7 - air vent; 8 -ventil

Was conducted complex research FEE module characteristics under different operating conditions, different levels of incoming solar radiation and meteorological parameters changing. It has been shown that the changes in the level of solar radiation during the day significantly affect the output of the module FEE. For example, in Figure 5 presents data on the correlation of the maximum power of the photovoltaic module to the level of the incoming solar radiation. This figure clearly shows that the reduction in the level of solar radiation entails changing Radiant electric power module.

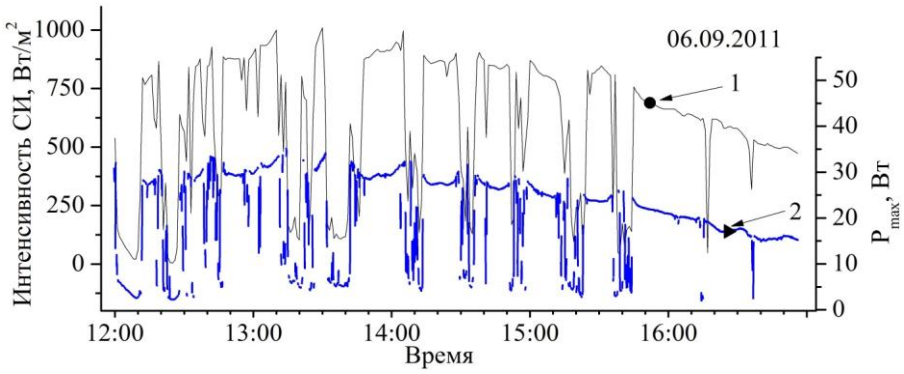

Figure 5. Changes in the intensity of solar radiation and the maximum power of the photovoltaic module FEE during the day:

1 - the level of solar radiation; 2 - electric power module FEE

Quite differently fluctuations in the intensity of solar radiation affect the temperature of the working surface FEE module and temperature of the coolant (water) in the tank FEE module. If the surface temperature changes considerably in synchronism with the oscillations of the radiation, the temperature of the coolant in the tank is almost FEE module does not respond to these short term fluctuations (Figure 5). At the same time in one and in the other case the temperature tends to increase.

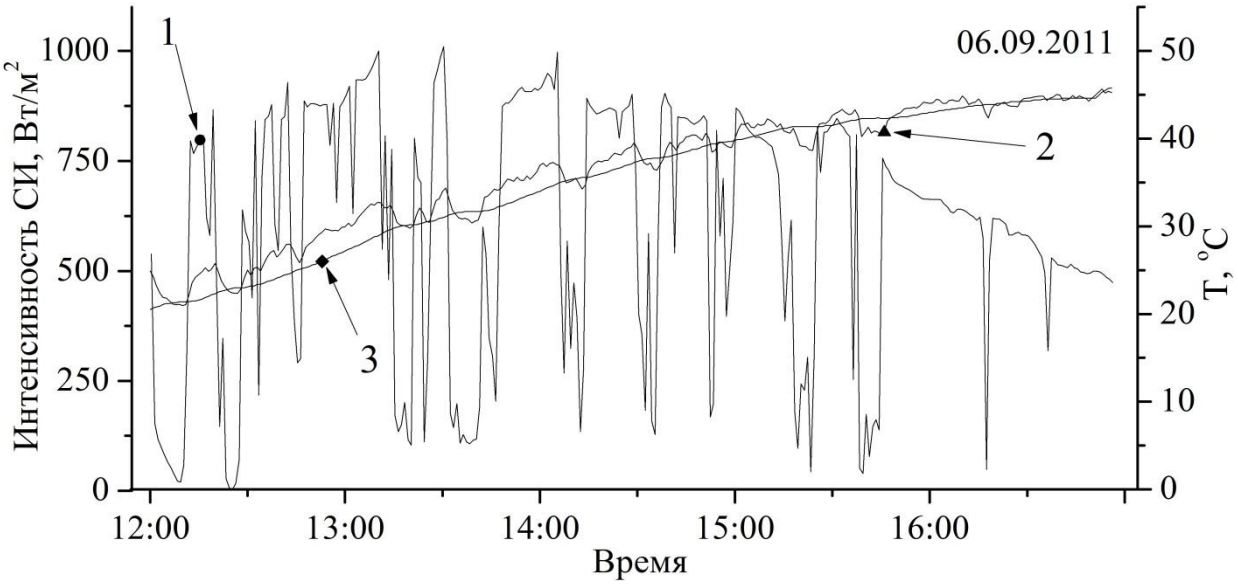

Fig.6 Effect of fluctuations in the intensity of solar radiation during the day (1) on the working surface temperature FEE module (2) and the temperature of the coolant in the reservoir FEE module (3)

The test circuit is shown sufficiently high performance. Based on the results of her test was proposed and patented photovoltaic water plant. However, this system has serious deficiencies, because its efficiency significantly decreased when increasing the temperature of water produced.

We have concluded that the modes of operation of such an installation should be selected in accordance with the request of the end user. In particular, the modes can be selected in such a way as to ensure: maximum power generation, maximum heat output, or maximum production of heat and electricity in total (maximum exergy efficiency of the plant). Apparently, the most popular system may become corresponding first and third operating modes.

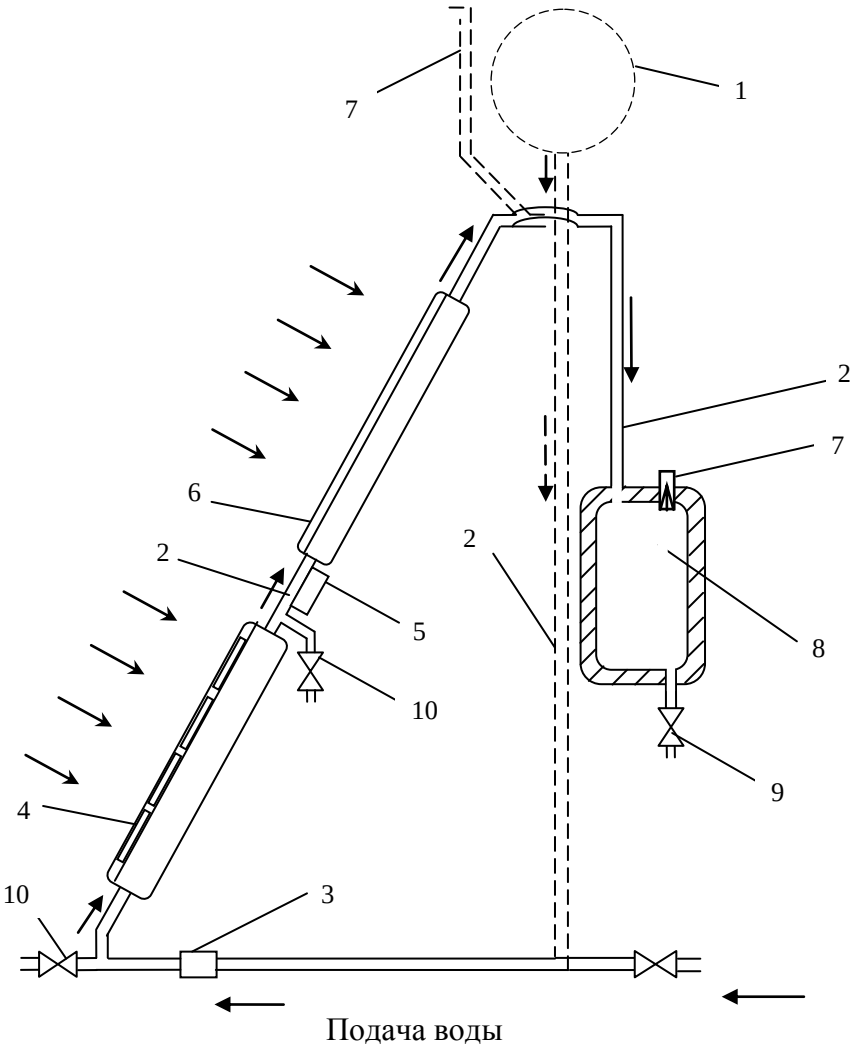

Fig. 7. Scheme upgraded solar station with FEE module:

1 - pressure vessel; 2 - the pipeline; 3 - solenoid valve;

4 - FETM; 5 - thermostat; 6 - SC; 7 - air vent; 8 - storage tank;

9, 10 - valves

If necessary to provide maximum power generation, but a sufficiently high temperature to obtain hot water it is expedient to use the installation, a schematic diagram is shown in Fig. 7. This arrangement has several advantages, since the delivery of water with high temperature of permitted FEE module 4, its heating to a predetermined temperature can be carried out in the additional cylinder 6. The above device is protected by patent RF.

In Western Europe FEE modules are used widely enough, while in Russia at the present time, these devices are not practically used, despite the apparent effectiveness of their use. In addition to general factors restraining the

development of renewable energy in Russia, this is due to the lack of experience of such systems and research in this area.

Conclusions

To facilitate the rapid introduction FEE modules in practice it is advisable to develop and master the production release of serial samples FEE modules of its own design and implement demonstration projects on the use of FEE modules in large systems heat- electric power supply consumers.