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Application of Solar Collectors in Greenhouses

Mullaev Ikromjon Isroiljonovich
Senior teacher, Fergansky Polytechnic Institute

Solijonov Muslimbek Vohidjon o'g'li
Fergansky Polytechnic Institute

Abstract: *The article discusses the issues of using solar collectors in greenhouses.*

Keywords: *solar collector, heat exchangers, solar water heater, heat pump, heat accumulator, greenhouse.*

Introduction.

The Law of the Republic of Uzbekistan "On the Use of Renewable Energy Sources" (URES), adopted on May 21, 2019, reflects the production of electricity, including other types of QTEM for personal use.

In other words, it is possible to generate electricity (via solar, wind, etc.) using URES.

On August 22, 2019, the decision of the President of the Republic of Uzbekistan No. PQ-4422 "On rapid measures to increase the energy efficiency of economic sectors and the social sphere, deploy energy-saving technologies and develop renewable energy sources" was adopted. This decision provides additional benefits for users of renewable energy sources.

The above-mentioned and a number of other measures, concessions and preferences have shown their effectiveness.

The QTEM development process is accelerating. One of the solutions to these problems is the conversion of solar energy into low-potential energy using a solar collector (SC). The solar collector is the main element of the solar water heater. A solar collector is a unique heat exchange device. In conventional heat exchangers, heat is transferred from one heater to another. In the solar collector, the heat to the heat carriers (liquid, gas) comes from a distant source - the sun. The main element in a solar water heater is the solar collector. In the winter season of the year, when the ambient temperature and the intensity of sunlight are low, the solar collector cannot independently supply consumers with hot water. Therefore, during the winter, the solar collector is additionally connected to the boiler room or to the heat pump device.

A combined solar water heater - heat pump device is more efficient than conventional heating systems.

Considering that the price of solar water heater - heat pump devices is decreasing today, this method can be considered as having a bright future.

A solar water heater connected to a heat pump device collects thermal energy from a solar collector in the ground in spring and summer, as a result of which the temperature of a low-potential heat source increases. As a result, the efficiency of the heat pump increases. In the summer months, the UWC of the solar collector is the highest and no heat is used for heating. Heat accumulates at a certain depth. Accumulated heat can be used in greenhouses. For rational use of heat, the heat accumulator can be equipped with a protective screen.

The percentage of heat load covered by the solar water heater is determined by the ratio of the efficiency of the solar water heater (Q_1) to the total energy consumption (Q_d):

$$\varphi = \frac{Q_1}{Q_d}$$

Therefore, the energy obtained from the solar water heater in the summer months is much greater than the total energy consumption.

The advantage of this model:

First, the U.W.C. of the solar water heater increases by using excess heat.

Secondly, when equipping greenhouses, additional complex equipment will not be needed.

The construction of greenhouses and their effective use for the conditions of Uzbekistan will bring great economic benefits. Greenhouses without a heating system are practically useless.

The main function of a solar water heater is to provide heating and hot water to residential premises.

Excess heat from the solar collector is sent to the soil of the greenhouse. As a result, different products can be grown in greenhouses throughout the year.

This device is indispensable for greenhouses and private houses.

The advantages of a solar collector are:

1. Almost free energy. The cost of electricity is equal to the cost of 1 light bulb.
2. The costs for installing the device are not high, and the costs during its use are almost non-existent. The device pays for itself for several years.
3. The device easily connects to an existing system or a new one.
4. Price - increase in prices does not affect the device.
5. Long service life. The guaranteed service life of the solar collector is 25-30 years.
6. The device is easy to assemble.
7. Atmospheric air is not polluted.

A solar collector is an environmentally friendly way to get heat.

The main method of heat supply in the European Union in 2020-2030 is to obtain heat using a solar collector.

The maximum efficiency of the solar collector occurs when the rays fall perpendicular to the surface of the collector. But during the day, the position of the sun changes, as a result, the efficiency of the collector also changes. It is very expensive to ensure that the collector is always perpendicular to the sun, so this method is rarely used.

The main task of calculation books is to determine the optimal direction and angle of inclination of the collector.

It is easy to determine the optimal direction, the collector should face south. Determining the slope angle of the collector is complicated. For example: Let's take the city of Fergana, at $40^0$23,3'N latitude. The maximum solstice (June 21) is 49^0. The winter solstice is 9^0. So, if we place the collector at $(40+9)/2=29^0$, we will achieve maximum efficiency. However, in real conditions, it is necessary to take into account the "thickness" of the atmosphere and the spread of light. There is a simple recommendation, for year-round systems, the slope angle should be equal to the width of the site. If the collectors work only in summer, the slope angle is 150 less than the width of the site.

The above parameters are approximate. It is necessary to calculate the parameters as much as possible. The collector is also not fully developed. Therefore, the device can use a part of the rays, but not all of them. Hence, there is a useful work factor of the collector.

If we do not take into account the waste of the collector itself, then the collector "Optik U.W.C." or "possible U.W.C." can be determined. The best collectors' optical U.W.C. approximately 80%.

We determined above that 1000 W/m^2 of rays fall on the ground. So, the collector converts 800 W/m^2 of light into heat. The number above is used to ensure safe operation of the device.

The temperature of the collector is higher than the ambient temperature. The collector itself has heat losses. These wastes lower the collector's U.W.C.

At a certain temperature of the outside air, the heat loss equals the heat produced, that is, the collector becomes unnecessary.

The collector located in Germany produces 600 W/m^2 of heat. This number can be used for estimation calculations, pipe and circulation pump selection.

It is important to us how much heat the collector gives during the day/month/year.

For Germany it is as follows:

- ✓ in summer, when the sun rises, 8 kWh/m^2 of heat is taken from the collector;
- ✓ in winter, for a sunny day, 3 kWh/m^2 of heat is taken;
- ✓ annual heat radiation is 950 to 1200kWh/m^2 (800 in the world, 2200kWh/m^2 in Scandinavia, Sahara desert).

We determine the real F.I.K. of the solar collector for the conditions of Fergana. For this, we use the manufacturer's methodology.

For Vitosol 300 - TSP3A brand collector (Viessmnn), the main characteristics are as follows: absorber surface - 3.02 m^2. Optical U.W.C. – 80.4%, heat loss coefficient K_1=1.33 W/m^{2}K^2, heat loss K_2=0.0067 W/m^{2}K^2. These sizes are taken from the technical passport of the collector.

U.W.C. is determined from the following formula:

$$\eta = \eta_0 - \frac{K_1 \Delta T}{E_g} - \frac{K_2 \Delta T^2}{Eg}$$

where ΔT is the difference between the temperatures of the outside air and the heat carrier; E_g is the heat flow density of solar radiation.

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