ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 7| Issue: 10| October 2021|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2021: 8.047 || ISI Value: 1.188

DETERMINATION OF FLOW SPEED THROUGH THE SOLAR HEAT COLLECTOR

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Article DOI: https://doi.org/10.36713/epra8732
DOI No: 10.36713/epra8732

ABSTRACT

This article shows how to determine the speed at which current flows through a solar heat collector. The results were studied with the help of modern laboratory equipment and the results were analyzed graphically. It also covers the origins of solar heat collectors, their current importance, types of solar collectors, and solar water heating systems.

KEY WORDS: ***solar collector, solar heating system, electricity, lighting module, pump module, Power module, real efficiency, flow rate.***

INTRODUCTION

Nowadays, more and more attention is paid to the use of energy-saving sources. Demand for solar panels is also growing. As the population grew and the amount of energy needed to meet its needs increased dramatically. However, as a result of the sharp decline in these energy sources, an energy crisis is emerging on the entire planet. This is due to a sharp decline in non-renewable energy sources - dry and liquid fuels. As a result, the planet is experiencing dramatic changes in temperature and an increase in various natural disasters. In addition, the use of these energy sources is causing an environmental problem - acute air pollution. Mankind is in need of renewable energy sources to prevent global energy and environmental problems. These are running water, wind, nuclear, solar and biogas energy.

The first model of a solar collector was created in the late 18th century by the Swiss scientist Horatio Saussure, a device consisting of a glass and wooden box with a layer of heat inside. Such devices began to be used in practice in the late 19th century to heat hot water in Southern California. The production of a simple solar collector in the form of a water tank covered with black paint, covered with a closed glass on a sunny side and mounted in a wooden box, began. In such collectors the water was not hot in the evening, it was necessary to wait the next day for it to heat up. By the end of the 1940s, the solar collector manufacturing industry was at its peak in the southern states of California and Florida. Shortly afterwards, the use of electricity and gas, the cost of hot water production fell, and the production of solar collectors stopped. The second phase of production of solar collectors dates back to the 1970s. As the global oil crisis erupted and energy prices soared, many countries around the world, including the United States, Japan, Australia, and the Mediterranean, began to use solar panels. Production in quantities has been set up. By 2000, rising energy prices had ushered in a new phase in the use and production of solar collectors. By the beginning of 2010, 150GW of solar collectors had been installed all over the planet, excluding solar pools and air collectors.

Solar collectors with a capacity of more than 30 GW are installed every year, and today the total capacity of solar collectors in the world produces more than 250 GW of thermal energy, and this figure continues to grow. In particular, in China in 2012, the total area of solar collectors was 145 million m², and the total amount of heat energy they provide exceeded 100GW. In comparison, the combined capacity of all nuclear power plants in Russia is four times higher. The use of a solar collector is very cost-effective, and during its service life, the solar collector produces such an amount of energy that the cost of building the device is several times higher [1]. Solar collectors have become the most efficient device for using solar energy. If photovoltaic panels use 14-18% of the solar energy they receive, this efficiency in the solar collector will reach 70-80% [2]. Mankind is in need of renewable energy sources to prevent the global energy and environmental problems mentioned above. The main purpose of this work is to study the speed at which the current flows through the solar heat collector as a function of modern laboratory equipment. This includes a general analysis of how to use solar energy, the structure and principles of operation of solar collectors, water heating systems using solar energy.

METHODS

Solar heating systems are systems that use solar energy as a heat source. Solar heating systems differ from other low-temperature heating systems by the presence of a special element-solar collector, which serves to receive solar energy and convert it into heat energy. A solar collector is a device designed to store solar thermal energy (in solar installations) using light and infrared radiation. Unlike solar panels, which generate electricity, a solar collector is powered by a heat-insulating material.

Depending on the temperature, we consider the following types of solar collectors:

1. Low temperature collectors - such collectors produce a temperature not exceeding 50ºC. They are used in situations where high temperatures are not required, such as heating pool water.
2. Medium temperature collectors - this can heat water to 50 - 80ºC. Most often, such a collector is a flat glass plate, which is a device consisting of a liquid as a heat carrier.
3. High-temperature collectors are often in the form of a parabola, often operating in relatively larger systems, which collect electricity and distribute it throughout the city electricity [3]. The solar collector absorbs solar radiation and heats itself and the filled water. The efficiency of a solar collector ē is measured by the ratio of the heat energy absorbed by the water to the radiant energy DE entering the collector DQ

$$m = \Delta Q / \Delta E$$

Here the radiant energy is determined from:

$$\Delta E = \Delta t P$$

In this case, R is the radiation power. When the collector is warmer than the environment, it releases heat into the environment through radiation, convection, and heat conduction. Due to these losses, the efficiency of the collector is reduced. The laminar or turbulent motion of a collector depends on the temperature, velocity, and kinematic viscosity of this magnitude, which is determined by the Reynolds number [4]. In the experiment, the forced circulation of the liquid is carried out by means of a pump. Since the heat energy absorbed by the system (collector, pipes, and tank) is mainly concentrated in water, the temperature of the solar collector cannot be too high. In experiments, the solar collector is used with or without thermal insulation. In this case, the temperature characteristics of the water in the tank are measured.

Necessary tools and equipment; digital measuring device with main base, Lighting module, pump module, expansion tank, Solar collector, liquid thermometer, PowerModule, temperature sensor

Figure-1. Experimental experimental device.

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The work was performed in the following order:
1. As shown in the figure, the solar collector and pump module are placed in the expansion tank in the main block and the left pump connection is connected to the modules with closed hoses for proper connection of the collector bottom and bottom outlet (expansion tank connected). The upper connection of the expansion tank is then connected to the upper connection of the collector to close the water circuit.
2. Now pour water into the water expansion tank and connect the PowerModule to the pump (9V). Now this water leads to corrosion of the contacts. If necessary, the measuring cup was filled with water until a stable water chain was established with about 200 ml of liquid. You need to turn carefully to remove the remaining air pockets from the collector.
3. To begin the test, a liquid thermometer was placed in the expansion vessel and a ready-made clock was set to measure the time. Now the pump is set to 5V.
4. The lamp was placed in front of the collector (distance 15 cm) and turned on. When the collector was heated, the temperature in the expansion vessel was measured and the values corresponding to the table were entered. The water chain was emptied and refilled with cold water.
5. The experiment was repeated with a voltage of 9V. These values were recorded in the table.

RESULTS AND DISCUSSIONS

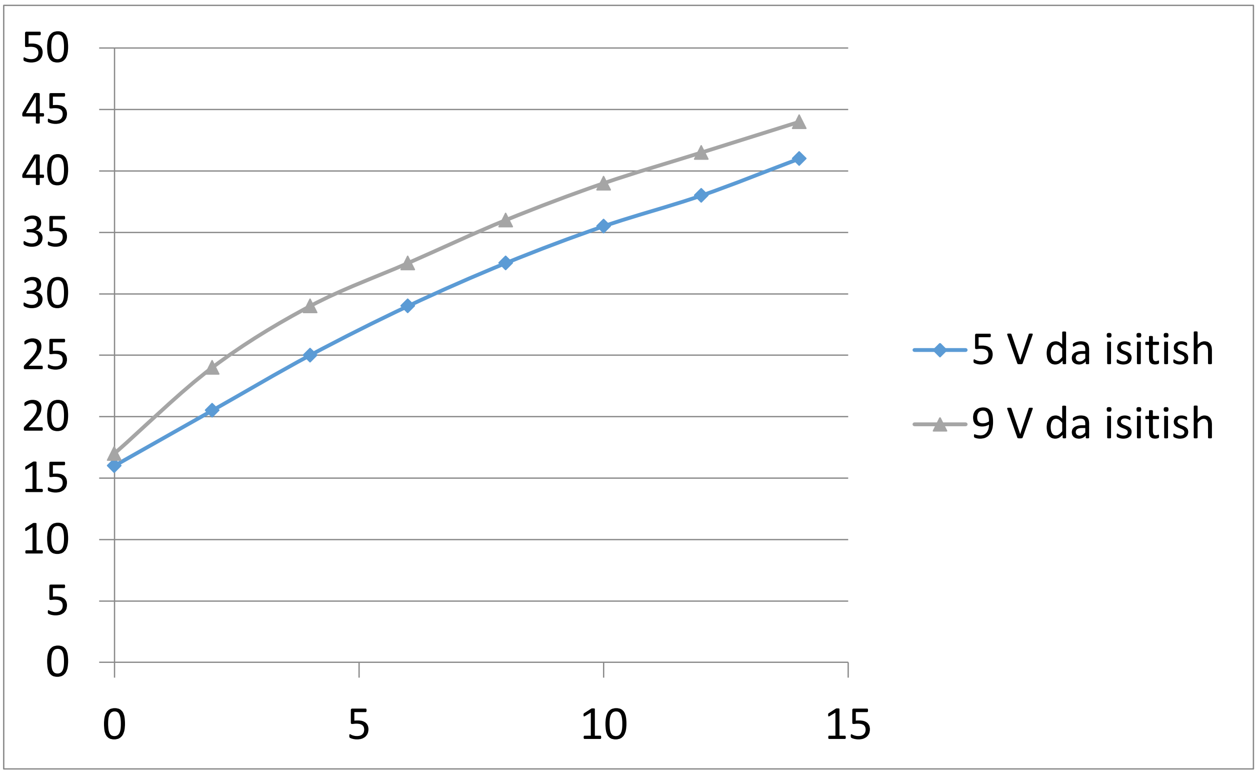
Table-1. Heating at 5 V.

Time	0	2	4	6	8	10	12	14
Temp	16	20,5	25	29	32,5	35,5	38,5	41

Table-2. Heating at 9 V.

Time	0	2	4	6	8	10	12	14
Temp	17	24	29	32,5	36	39	41,5	44

Graph-1. Graph of the change in water flow in the collector depending on the flow rate.



It is clear from the graph that the temperature rises linearly with time. As the flow rate increases, the temperature rises faster, because in this case the water receives more light energy. Thus, in this case,

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the share of heat energy obtained from light energy is greater. At low flow rates, the temperature at the direct output of the solar collector is high. Due to the high temperature of the solar collector, more heat energy is lost.

The amount of heat energy absorbed by water can be calculated by the following formula using Q, mass m and specific heat capacity coefficient:

$$\Delta Q / t = c \cdot m \cdot \Delta T / t$$

The rest of the absorbed radiant energy is used to heat the system.

Example of small value speed:

4.2 kJ / kgK 1kg 1.52 K / min = 100 J / s = 100Vt

The efficiency of the system is in the order of 0.1 at low flow rates and in the order of 0.12 at high flow rates.

The actual efficiency (the ratio of the energy used to the incident radiant energy) is usually much larger than these quantities. Up to 80% efficiency is achieved in a real solar collector system.

CONCLUSION

When we heat water using a solar collector, it is important to deliver the water inside the collector to the consumer faster and without a large temperature difference. Therefore, a pump is used to accelerate the movement of water. The higher the pump, the faster the water circulates and the faster the water reaches the consumer. As the flow rate in a solar collector increases, the temperature rises faster, because in this case the water receives more light energy. Thus, in this case, the share of heat energy obtained from light energy is greater. In our experiment, we can see from the results that a pump operating at 9 V delivers hot water better than a pump operating at 5 V. At different time intervals, it can be seen from the graph that the temperature difference of the water supplied by the pumps is different. However, care must be taken not to increase the voltage, as the water in the collector may not have time to rise to a sufficient temperature.

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