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SIZING SOLAR CIRCUIT CORRESPONDING TO A SOLAR INSTALLATIONS FOR PREPARATION HOT WATER SYSTEMS

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Abstract: *In this paper, I present the appropriate sizes for sizing solar circuit a solar system hot water such as the required flow forced circulation pump for each square meter of solar collector installed, the flow area through the pipes solar circuit, the amount of antifreeze used for filling the solar circuit entire length of the pipes that form the solar circuit, the speed of the water in the solar circuit pipes, hydraulic power pump power absorbed by the electric motor pump.*
The solar system object of this study is functional throughout the year, in summer for hot water and the cold season to contribute to preheat cold water in the boiler, followed by raising the temperature up to 45°C water use to be carried out by heating the boiler (and the condensing gas), or by a 2kW electric resistance heater mounted
For this purpose, choose a bivalent boiler with two coils and electrical resistance of 2 kW. Basic options for choosing solar thermal system for domestic hot water is to optimize the investment and operating costs. For this purpose we adopted the solution of solar thermal energy production throughout the year

Keywords: *solar system, solar heat, solar collector field*

1. Introduction

Solar energy is the ultimate source that is external to Alternative energy resources currently exploited [1].
The sun is a star with its own light, formed of 95% hydrogen and helium. Sun temperature at the surface is of 6000 K, and its center 15m is K. The energy produced by the Sun in one second is 4 • 10^{33} ergs. It is produced by thermonuclear reactions, in particular proton-proton type, in which the atomic nuclei of hydrogen are converted to 4 million tons of helium, releasing energy, the second mass.
Earth receives only part of the energy of two billion cut from the sun. Derived from direct solar radiation and diffuse radiation snapshots can be used to produce heat or electricity. Some authors have studied their works to determine the angles used in monitoring the sun in the sky [2].
Production of low temperature heat (below 100°C) is based on technology that uses low-temperature solar thermal collectors. Low temperature solar panel is made from a high surface laminar enclosure at the top is covered with a glass film, and on the bottom with a black absorbing layer (black body) which is designed to absorb light that passes through the glass plate [12].
The thermodynamic conversion of solar energy is made up of: a concentrated solar radiation collector, a suction device and storing the collected thermal energy and a heat transfer device, all connected to a turbogenerator group which operates according to an more or less classical [5,7].
The power of such plants can reach up to hundreds of MW fraction [3].
Solar collectors which converts solar energy into thermal energy is classified into two categories:
- collectors without concentrating solar radiation, characterized in that the absorber is equal to the surface to intercept sunlight;
- collectors to concentrate solar radiation, characterized in that the surface of well has different forms based on reflection and refraction to increase as much radiation flux density. Fields of application are the main types of sensors:
- temperature range up to 100°C. Plane collectors are used without concentration in heating and domestic hot water in drying and desalination plants, etc.;

-the temperature of the order of 300-500°C. Sensors are used with cylindrical-parabolic concentrator in hot water production plant or steam at high pressure;
-600-900 ° C temperature range. They are used paraboloid of revolution sensors concentrator in the technological processes for the thermal decomposition of substances, and to produce mechanical work and electrical energy;
-Very high temperature range 3000-5000°C. Sensors are used to focus radiation with heliostats and receiver tower in research material.
For hot water collectors are used without radiation concentration.
Some authors have presented their work in detail in monitoring weather station atmospheric parameters including sensor for measuring solar radiation intensity [6,11].
Operation of the solar collector can be explained simply considering a plan collector, like that shown in figure 1:

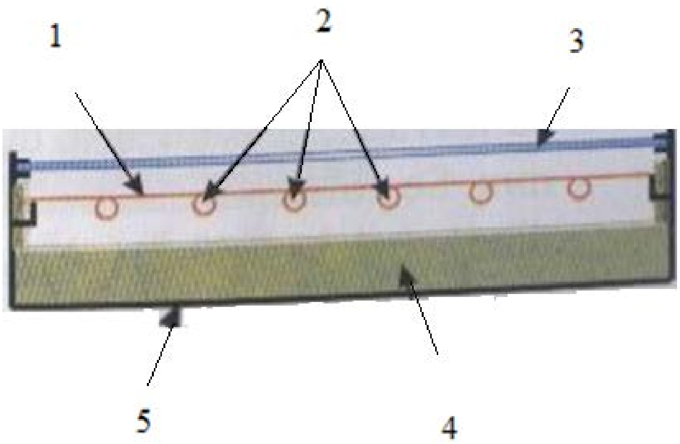

Figure 1 Plane collector [7]

Plane collector consists of the following main parts:

1 - absorbent surface which is generally made of a metal plate coated with black paint in order to increase the absorption of solar radiation and a lower emissivity;

2 - piping system through which the heat carrier agent;

3 - the transparent area made of one or more layers of glass plate with a thickness of 3-4 mm;

4 - thermal insulation is to reduce heat losses of the collector, is made of materials having poor conductivity;

5 - housing that protects the entire set of sensor against mechanical shock.

Heat carrier fluid is usually made of water, ethylene glycol or air.

2. Materials and methods

When choosing a solar system for hot water, you firs need to set the preferred temperature hot water usage and quantity and distribution needs throughout the day. Temperature of hot water use in most practical installations in operation temperature is 45°C. Hot water needs, depend on the attitudes and habits of consumers and the characteristics and specific features of each application.

The study concerns a family home consists of four that has a fuel consumption of 50 litters / person / day, so the solar system will need to produce 200 litters of hot water daily.

Distribution of daily consumption of hot water, over 24 hours is considered statistically consistent with values determined by measurements.

Scheme of the solar system and equipment package consisting of components is shown in figure 2:

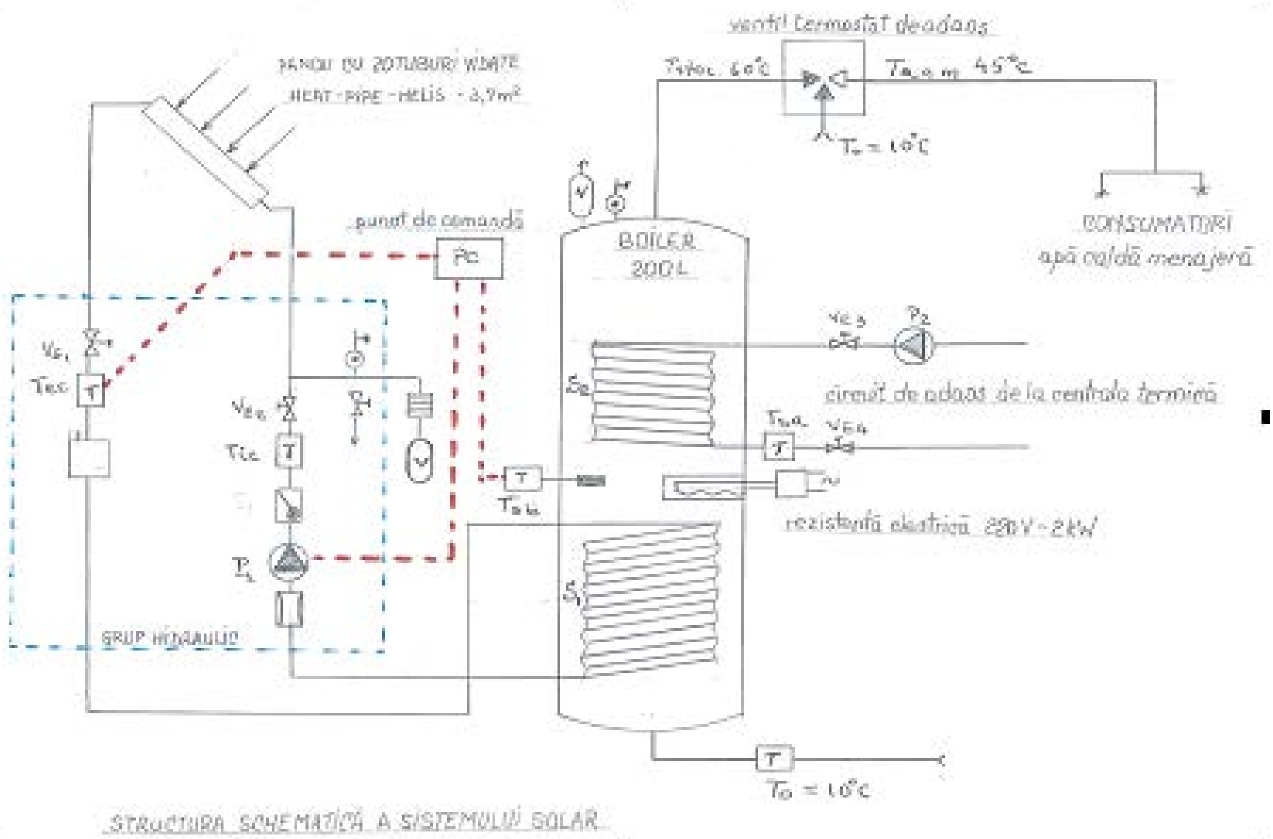

Figure 2 Schematic structure of the solar system [10]

3. Results and discussion

Sizing solar circuit

Required flow circulating pump P_1 between 40 and 80 l / h per square meter of solar panel installed [4]. Choose an average flow of 60 l / h so that the pump that circulates the heat flow through vacuum tube collector panel is:

$$D_{P1} = 60 \cdot 3{,}7 = 222 \text{ l/h} = \frac{222 \cdot 10^{-3}}{3600} = 61{,}67 \cdot 10^{-6} \text{ m}^3\text{/s}$$

$D_{P1} = 61{,}67 \cdot 10^{-6}$ m³/s.

Tube solar collector panel has diameter ϕ = 22 mm, so the cylinder S_1 and connecting pipes between the solar collector and the tank coil.

obtained d = $22 \cdot 10^{-3}$ m.

The flow through the pipe section solar circuit:

$$A = \frac{\pi \cdot d^2}{4} = \frac{\pi \cdot 22^2 \cdot 10^{-6}}{4} = 380 \cdot 10^{-6} \text{ m}^2.$$

Pipe section is:

A = $380 \cdot 10^{-6}$ m².

Volume of antifreeze used to fill the entire solar circuit offered to solar system is 20 liters. Obtained heat volume V = $20 \cdot 10^{-3}$ m³.

Length of pipelines that form the solar circuit is:

$$l = \frac{V}{A} = \frac{20 \cdot 10^{-3}}{380 \cdot 10^{-6}} = 52{,}63\,\text{m.}$$

obtained l = 52,63 m.

It follows that the length of pipe between the collector and the tank is 52.63 / 2 = 26.31 m Speed of heating by solar circuit pipes:

$$\text{v} = \frac{D_{P1}}{A} = \frac{61{,}67 \cdot 10^{-6}}{380 \cdot 10^{-6}} = 0{,}16\,\text{m/s.}$$

The same result is obtained, and if we calculate the Reynolds number, given the kinematic viscosity of the water, respectively ν = 2,3·10^{-6} m^2/s [8].

$$\text{Re} = \frac{4 \cdot D_{P1}}{\pi \cdot d \cdot \nu} = \frac{4 \cdot 61{,}67 \cdot 10^{-6}}{\pi \cdot 22 \cdot 10^{-3} \cdot 2{,}3 \cdot 10^{-6}} = 1552$$

For Re <2300 shows that in the solar circuit heat flow is laminar.

Speed of heating by solar circuit pipes:

$$\text{v} = \frac{\text{Re} \cdot \nu}{d} = \frac{1552 \cdot 2{,}3 \cdot 10^{-6}}{22 \cdot 10^{-3}} = 0{,}16\,\text{m/s}$$

So the speed of the water is v = 0,16 m/s.

During the circulation of the 20 liters of freezing resulting from the relationship

$$t = \frac{l}{v} = \frac{52{,}63}{0{,}16} = 329\,\text{s} = \frac{329}{60} = 5{,}5\,\text{min.}$$

Hydraulic power of the pump is given by

$$P_H = \rho \cdot g \cdot D_{P1} \cdot H$$

- ρ = density of heat [kg/m^3];
- g = acceleration of gravity (g = 9.81 m/s^2);
- D_{P1} = flow circulating pump;
- H is the height of head hydraulic or equal to useful work in N•m or mm of water relative to the weight force of the liquid transported by the pump shall transmit liquid. Această mărime este proporţională cu pătratul vitezei de rotaţie a turbinei şi este independentă de densitatea lichidului transportat. This amount is proportional to the square of the speed of rotation of the turbine and is independent of the density of the liquid transported.

If we consider H = 25 m, the strength of the hydraulic pump is set to

$$P_H = 1000 \cdot 9{,}81 \cdot 61{,}67 \cdot 10^{-6} \cdot 25 = 15{,}12\,\text{W.}$$

The power absorbed by the electric motor of the pump is:

$$P_a = \frac{P_H}{\eta} = \frac{15{,}12}{0{,}85} = 17{,}79\,\text{W.}$$

Solar circuit pump hot water is VORTEX type and has a rated output of 25 W.

Conclusions

For the chosen solution (vacuum tube collector bivalent and electrical resistance), I sized solar circuit of the hydraulic (geometric dimensioning of pipes, the speed of the water, hydraulic power pump).

Especially solar panel presents a major advantage to be taken into account in the sense that outside a maximum efficiency of 80% the advantage that installs with very simple installation procedure. The entire solar system can be installed and functional tests before actually mount the solar vacuum tubes. They can be mounted at the end of trial operations of the solar system in a very short time and very simple installation procedure.

Sizing collector was chosen so that the water temperature in the storage cylinder to fall during the warm season the average value of over 60°C, which ensures sterilization of the water stored to the Legionella bacteria.
Since the boiler provides hot water at a temperature of 60^oC for hot water at a temperature of 45^oC have provided a mixer located at the outlet of performing mixed water boiler, ensuring a constant flow regardless of changes in temperature and pressure cylinder.

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