SOLAR INSTALLATION FOR HOT WATER FOR A FAMILY HOME

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Abstract: *In this paper, we present a solar thermal system for hot water supply of family housing to be functional and o exploit solar heat all year round: in summer for hot water and cold season contributes to heating the water in the storage tank. For this purpose we chose a storage tank with two coil type heat exchanger (exchanger for solar circuit and the other for connecting to a boiler) and a 2 kW electric resistance (to heat water in the boiler when any of the two sources is not available. We determined the average monthly temperatures accumulated water storage tank in summer.*

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

1. Introduction

This paper is part of the new technological approach that takes account of capitalization "clean sources" which provide effective protection of the environment. Solar energy is available worldwide. Solar energy is the only form of clean energy that does not create harmful by products, as in classical and nuclear fuels, solar energy does heat release in other forms of energy, but heat transport from the place of capture to the user. The traditional system for domestic hot water production, harnessing, always use a collector containing heat (liquid or gaseous working fluid) with or without accumulation system.

The principle of operation of these facilities is relatively simple and is based on the conversions of solar radiation into heat energy used to heat domestic water. Installation of solar energy conversion into heat is the main equipment solar collectors that convert solar radiant energy into thermal energy, solar heat storage devices, network transmission and distribution pipelines solar heat to consumers and automation elements whole process of production, storage, transport and distribution of solar heat. Typical, application systems for producing solar water heating provides hot water supply temperature of 45 ^{0}C in summer. In March-April and September-October the system can take only part of the thermal load required to produce hot water.

In practice it was found that the production of hot water at a temperature of 45 ^{0}C, considering the cold water temperature of 10 ^{0}C, 35 ^{0}C water temperature must be raised. Under these conditions the collector absorbing surface must reach a temperature of 50-70^{0}C to transfer heat to the heat and domestic hot water then an acceptable efficiency [4,5].

Systems for domestic hot water still running and in winter, because they can provide even sunny winter days the amount of heat to be transferred to the domestic hot water.

All the practice has been established that a person consumes 50 litters per day hot water. This requires an area of 1,5 m^2 of collector covering domestic hot water needs a rate of 90-100%.

Average solar radiation is considered 1000 kW/m^2 per year.

Depending on the size of the solar hot water preparation and constructive solution adopted to obtain 300-500 kW/m^2 per year [6,7,8].

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 45^0C. 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.
On this basis we determined that the volume of storage tank which should cover domestic hot water scarcity at peak hours, you must be at least 120 litters. Therefore we chose a boiler with a capacity of 200 litters.
Cold water temperature used in hot water take into account the value of 10^0C. Hot water will be prepared so that the user can reach a temperature of 45^0C. To ensure that temperature is required at the point of storage temperature is higher, setting the value of 45^0C Achieved by means of mixing valve placed on the grid, leaving the boiler. Typically, the point of storage is practiced temperature 60^0C [1], which provides safe disinfection of hot water from Legionella bacteria.
In terms of health it is recommended that the hot water system to intervene household disinfectant at least once a year by raising water temperatures above 60^oC stored for a period of time.
- The solar system object of this study will be operational throughout the year, in summer for hot water and cold season to contribute to preheat cold water in the boiler, following the rise in temperature of water use by at 45^oC is achieved by heating boiler (gas and condensation) or a 2-kW 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 recovery throughout the year.
For this purpose we analyzed three offers of technically all three offerings using the same schematic structure of the solar system, all using vacuum tube panels, constructive solutions are relatively similar, which makes choosing the lowest bid price, respectively HELIS solar system.
It provides heating to 200 liters of water at t_0 = 10^oC (cold temperature) to t_{acm} = 45^oC (temperature hot water consumption).

3. Results and discussion

● The amount of solar heat (Q_n) for heating water volume of 200 l is given by:

$$Q_n = m_a \cdot c_a \cdot \Delta t \quad (1)$$

- m_a - mass of water in kg corresponding to a volume of 200 l (m_a = 200 kg);
- c_a = specific heat of water ($c_a = 4{,}173 \cdot 10^3$ J/kg·^{o}C);
- Δt = temperature difference in °C (Δt = 35^oC C).

● The area calculated as required solar collector:

$$S_{col} = \frac{Q_n}{\eta_{col} \cdot G_{\beta\, med}} \quad (2)$$

- η_{col} - collector efficiency HELIS (η_{col} = 0,83 %);
- $G_{\beta\ med}$ - global radiation on collector plane averaged from March to October; $G_{\beta\ med}$ = 16,6 MJ/m^2·zi.

$$S_{col} = \frac{29{,}21}{0{,}83 \cdot 16{,}6} = 2{,}12\ \mathrm{m}^2.$$

● Actually used a solar collector area of supply is 3.7 m^2 favorable situation because it has reserves to compensate for the heat losses along the primary circuit and the heat exchanger S_1. Theoretical explanations:
Solar circuit heat transfer in the boiler is achieved by S_1 which is heated in the heat exchanger fluid. Solar system with heat exchanger circuit S_1 form a closed system in which the movement is made by heating liquid.
The process can take place so that natural circulation and forced circulation as (solar circuit pump that increases the productivity of exchange). Heat load of the heat exchanger is determined from the heat balance equation [3,9]:

$$\dot{Q} = G_1 \cdot c_1 \cdot \Delta t_1 = \frac{1}{\eta_{sc}} \cdot G_2 \cdot c_2 \cdot \Delta t_2$$

where: $\dot{Q}$ [W] is the flow of heat from the solar circuit;

G_1, G_2 [kg/h] is the mass flow of liquids;

c_1, c_2 [J/kg·°C] is the specific heat of liquids

The heat transfer due to a temperature difference occurs by conduction and radiation through the surface S_1 by the equation:

$$\dot{Q} = k \cdot S \cdot \Delta t_{med} \text{ [W]}$$

where k is the overall heat exchange coefficient [W/m²·°C]

To simplify assessment levels recorded in stored water temperature in the boiler use:

• The relationship of heat quantity:

$$Q_a = m_a \cdot c_a \cdot \Delta t$$

where: Q_a [J] is the amount of heat (thermal energy) received water from the boiler during the exchange, which is equal to the change in internal energy.

• expression exchanger efficiency:

$$Q_a = \eta_{sc} \cdot Q_d \quad [2]$$

where: Q_d [J] is the amount of heat absorbed by the solar collector heat solar heating cycle.

• Heat quantity Q_d:

$$Q_d = S_{col} \cdot \eta_{col} \cdot G_{\beta\, med} \tag{3}$$

• The amount of heat Q_a:

$$Q_a = \eta_{sc} \cdot Q_d$$

• The relationship determine the amount of heat stored in the boiler water temperature t_{sb}:

$$Q_a = m_a \cdot c_a \cdot (t_{sb} - t_0) \tag{4}$$

$$t_{sb} = t_0 + \frac{Q_a}{m_a \cdot c_a} \ ^{o}\text{C} \tag{5}$$

$$t_{sb} = 10 + \frac{45{,}88 \cdot 10^6}{200 \cdot 4{,}173 \cdot 10^3} = 64{,}97 \ ^{o}\text{C}$$

This temperature is the average temperature of the water stored in the tank during the hot season.
• To determine the monthly average temperatures during each month of the hot season, from relations (3) and (4) calculate the amount of heat taken from the water heater:

$$Q_a = \eta_{sc} \cdot Q_d = G_{\beta\, med} \cdot \eta_{sc} \cdot \eta_{col} \cdot S_{col}$$

$$Q_a = G_{\beta\, med} \cdot 0{,}9 \cdot 0{,}83 \cdot 3{,}7 = 2{,}76 \cdot G_{\beta\, med}$$

The value of q is introduced in relation (5) becomes:

$$t_{sb} = t_0 + \frac{2{,}76 \cdot G_{\beta\, med}}{m_a \cdot c_a}$$

Table 1 Monthly average temperatures in the months of March to October

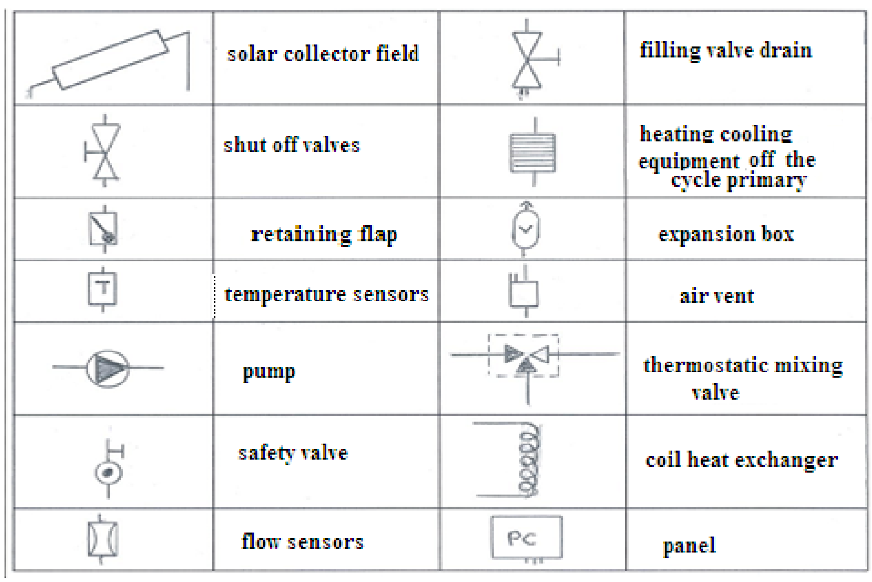
t_{sbIII} ^{0}C	t_{sbIV} ^{0}C	t_{sbV} ^{0}C	t_{sbVI} ^{0}C	t_{sbVII} ^{0}C	t_{sbVIII} ^{0}C	t_{sbIX} ^{0}C	t_{sbX} ^{0}C
47,91	60,82	68,31	75,44	73,92	72,50	66,40	42,97

Level during April-September temperatures of over 60^{o}C will ensure sterilization of water stored in the tank against Legionella bacteria.

Hot water temperature of 45^{o}C will ensure the automatic mixing valve is placed at the exit of the boiler. The calculated values for cylinder temperature which explains the company MEGASUN as typical boiler cold water temperature = 10^{o}C, cylinder temperature = 60°C and hot water temperature prepared by mixing = 45^{o}C. Heater coil is calculated so that the solar circuit is circulated heat with temperatures between 55^{o}C and 80^{o}C.

Schematic structure of the solar system HELIS

Solar system presented consists primarily of the following components:



Conclusions

In this paper, we chose a solar thermal system for hot water supply of family housing to be functional and to exploit solar heat all year round: in summer for hot water and cold season contribute to the heating of water in the storage tank.

For this purpose we chose a storage tank (tank) with two coil type heat exchanger (exchanger for solar circuit and the other for connecting to a boiler) and a 2 kW electric resistance (to heat water in the boiler when any of the two sources is not available).

To purchase equipment solar system components we considered that most companies that have manufacturing and marketing concern such facilities supplied equipment packages and electronic components integrated for different types of applications that use solar thermal. As a result, the three

bids considered that the technically used the same schematic structure of the solar thermal system we chose the one with the lowest price.
We determined the average monthly temperatures accumulated water storage tank in summer. Especially solar panel scheme used HEAT-PIPE Helis presents a major advantage to be taken into account in that outside a maximum efficiency of 80% has the advantage that installs with simple installation procedures. It is worth noting that the entire solar installation can be installed and functionally tested prior to actually mount the solar collector vacuum tubes. They can be mounted at the end of trial operations of the solar system in a very short and very simple installation procedure

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