Thermal Solar Installation With High Efficiency That Utilize Plane Solar Collectors

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The share of the energy obtained from renewable sources is constantly increasing, mainly cause of the reduction of the fossil fuels.

*Besides other kinds of renewable energy – wind, waves,river or thermal energy – the solar energy has a wide range of uses, for generating **electricity** by means of photovoltaic panels or **heat** by means of solar catchers.*

The foundation of a research consortium led by ROMFLUID SA Bucharest company made as its objective to realize an installation for producing household hot water using highly performant plane solar catchers, after its own original solution, objective which has been already put into practice. The present article presents the basic principles of this installation, the prototype installation and data obtained at its testing.

Keywords: solar energy, thermal, panel

1. Introduction

The use of solution for producing energy based on renewable resources has increased in the latest years, simoultaneously with a decrease in production price. This represents an alternative to the production of energy using fossil fuels which is superior due to the fact that does not harm the environment.

Solar energy is one of the safest and cheapest forms of energy. It is found in the radiation generated by Sun and by various methods may be converted in another kind of energy useful for human activity, mainly in heat or electricity.

One of these solutions is to produce thermal energy using solar thermal collectors. The water heated in this way can be used as domestic hot water but also as a means of heating residences, reducing the consumption of common fuels.

Romania benefits by excellent geographical conditions in order to collect solar radiation, having a level of solar radiation for most of the country regions which rises above 1250…1350 kWh/m^2/year, in some areas from its south reaching 1450…1600 kWh/m^2/year; by comparison, Germany, which had at the end of 2008 over 10 millions m^2 where solar collecting panels were mounted, with power output amounted to some 7300 megawatts, has an annual average quota of solar radiation from 876 to 1250 kWh/m^2/year. Some other values in European cities are: Liege – 840, Hamburg – 870, Munich– 950, Madrid – 1400, Seville – 1470 kWh/m^2/year.

Taking these reasons into account, the company SC ROMFLUID SA Bucharest started to produce solar thermal installations based on plane collecting panels developed according to its own constructive solutions that can be used to produce domestic hot water (DHW) and also can be used in combination with classic home heating systems; the basis of putting these systems into manufacturing was represented by the results of scientific research carried out during 2007-2009, while developing a project within the framework of INNOVATION Programme.

2. Instalations for obtaining solar thermal energy

Objectives of this paper consist in presenting possible schematic diagrams to be applied at solar thermal installations, as well as results achieved during testing stage. Installation under tests is based on 2 thermal solar panels, wherein a special fluid is heated; this one conveys heat to cold water by means

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of a serpentine pipe in a monovalent solar boiler. This installation was designed to meet the requirements for DHW of a 3-4 person family.

The first type of instalation is designed only for obtain domestic hot water, 100% in the warm season, si partial in sezonul rece.

The installation for heating water ACM with the hydraulic scheme presented in figure 3 makes the fluid from the solar panel flow to a serpentine placed inside the special solar boiler (5) for solar installations. The fluid which flows through the serpentine of the boiler generates the heat received from the solar panel to the cold water from the boiler heating it. The flow is realized by means of a pump type WILO ST purposefully designed for solar installations. The actuation of the pump is performed by means of a controller (3) type Deltasol AX which compares the temperature values supplied by the two temperature sensors, one placed in the hottest point of the installation at the upper edge of the solar panel, respectively in the coldest point - on the bottom of the solar boiler (6). The controller activates the pump as long as between the 2 points there is a difference of temperature higher than 2....16 K adjustable, at the lowering of this difference below the fixed threshold, the pump is set off and the thermal transfer stops.

This kind of controller is the simplest one from the 3 integrated in the schemes having 2 inputs of temperature sensors and has a small price.

For all variants, the fluid consists of a mixture of water/propylene glycol in a proportion of 60/40 or 45/55 depending on the minimum environmental temperature during the cold seasons, the mixture 45/55 being active up to – 26 C.

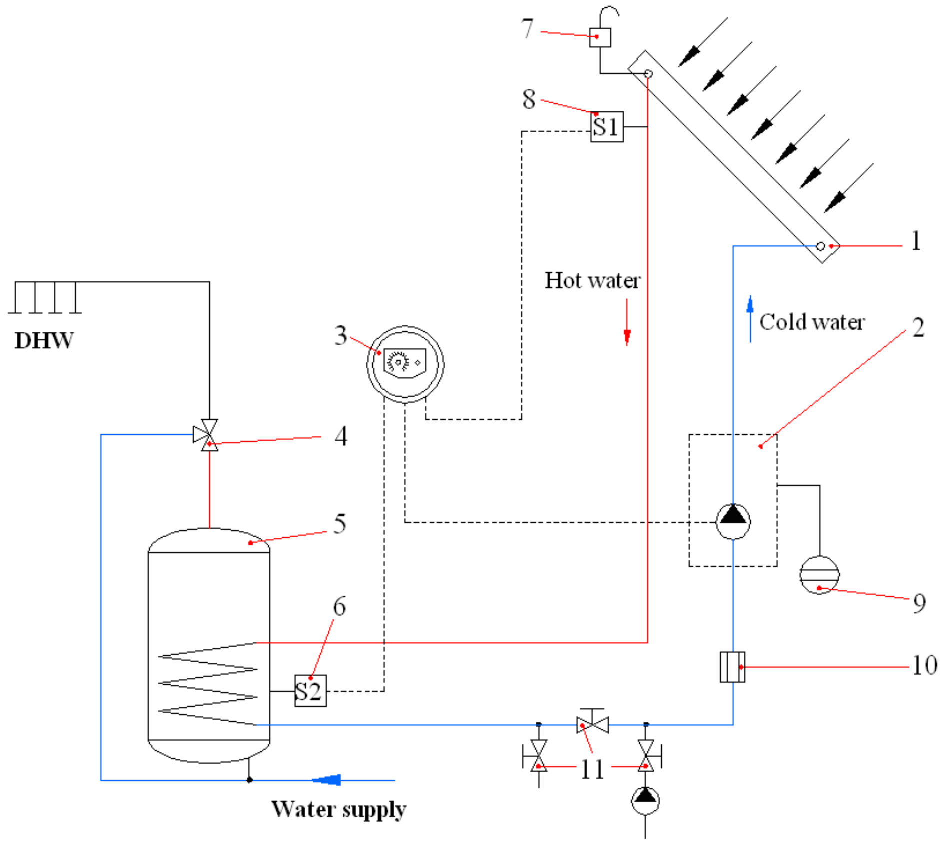

Figure 1 - Installation for producing domestic hot water

The flow pump is integrated in a solar installation 2) which includes hydraulic components necessary for the system to work efficiently – direction valve on return, manometer, safety valve, installation filling and washing taps, flowmeter (which measures the amount of energy produced) On the solar panel can be fixed the controller too. For this kind of solar station just the return (the direction from the boiler serpentine to the panel) passes through the station.

The installation also includes a mixing valve 4) which limitates the DHW temperature, an automatic air vent 7), a vessel of expansion specific for the solar installations 9), a filter 10) and filling and emptying taps 11).

The second variant figure 4 represents a solar installation integrated to a system which provides hot house water all the year round, the thermal energy supplied by the solar panel being supplemented during the periods when it is not enough with additional thermal energy for heating the water from the boiler from a classic heating system (central heating, boiler with gas or solid fuel etc.). In this case it is used a boiler with 2 serpentines through the second passing the water heated in the thermal power system the 2 temperatures are compared by means of 2 sensors placed in the 2 points the sensor 12) on the thermal system and the sensor 15) on the solar boiler and another sensor 8) placed on the solar panel. The data from the 3 sensors are compared two by two by a solar controller type DeltaSol BS with 3 inputs of sensors which can control more output devices. In this case in the circuit is integrated a second pump 14) similar with the first, which provides the flow between the thermal system and boiler. The pumps work like in the previous case as long as between the 2 points there is an adjustable temperature difference of 2.....16K.

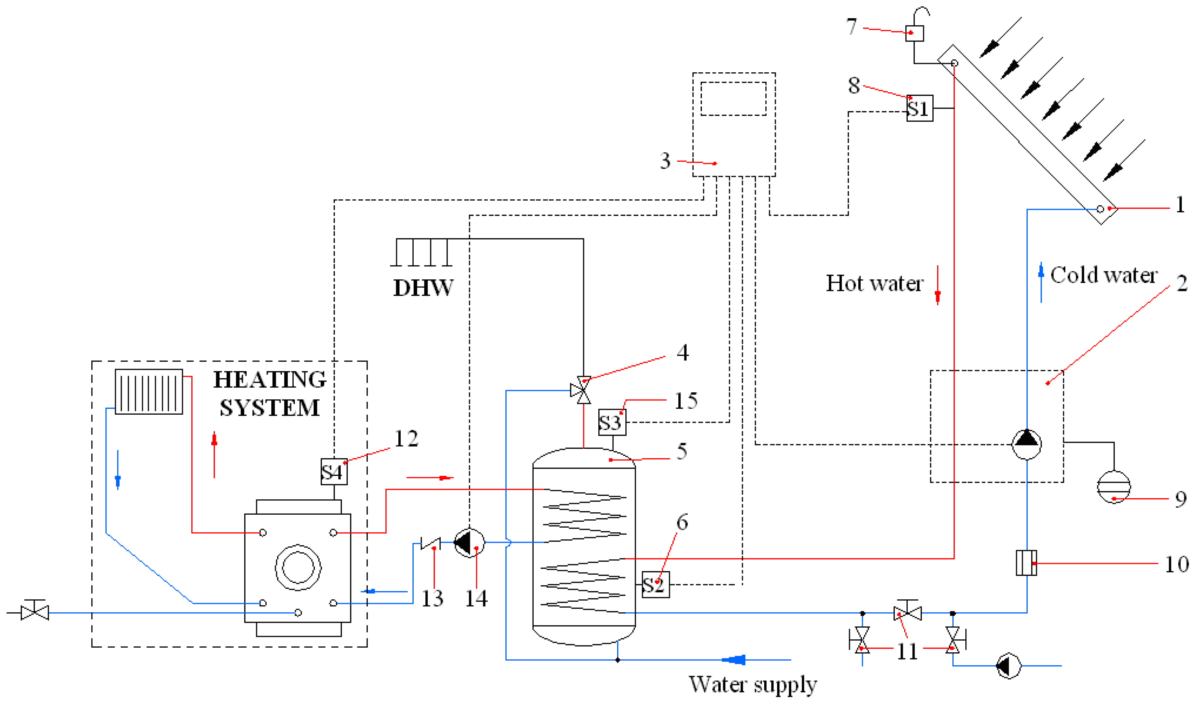

Figure 2 - Installation for producing domestic hot water all the year round

The solar station includes additionally to the previous variant 2 thermometers placed on the 2 directions turn, return which are both passing through the solar station in this case.

The third variant figure 5 allows in addition to the previous, the water heating from the return of a classic home central heating installation, reducing in this way the role of the thermal heating system and implicitly of the fuel consumption for this purpose are added 2 temperature sensors S3 and S5 on the hydraulic scheme which compare the water temperatures from the upper side of the boiler with 2 serpentines with the one from the return of the heating installation. If the temperature of the water from the boiler is higher, a motorized valve with 3 inputs 15) allows the input of this water in the return circuit of the heating installation, reducing the amount of energy needed. The temperature controller 3) is type ES allowing the connection of the 5 sensors and the control on 3 outputs.

All the components of the installations are purposefully designed for solar systems.

For respecting the normatives regarding the maximum temperature of the water supplied for avoiding the risk of an overheated water over 60^0 C it was mounted an automatic mixing valve in all the schemes 4); this allows mixing hot water from the boiler with cold water.

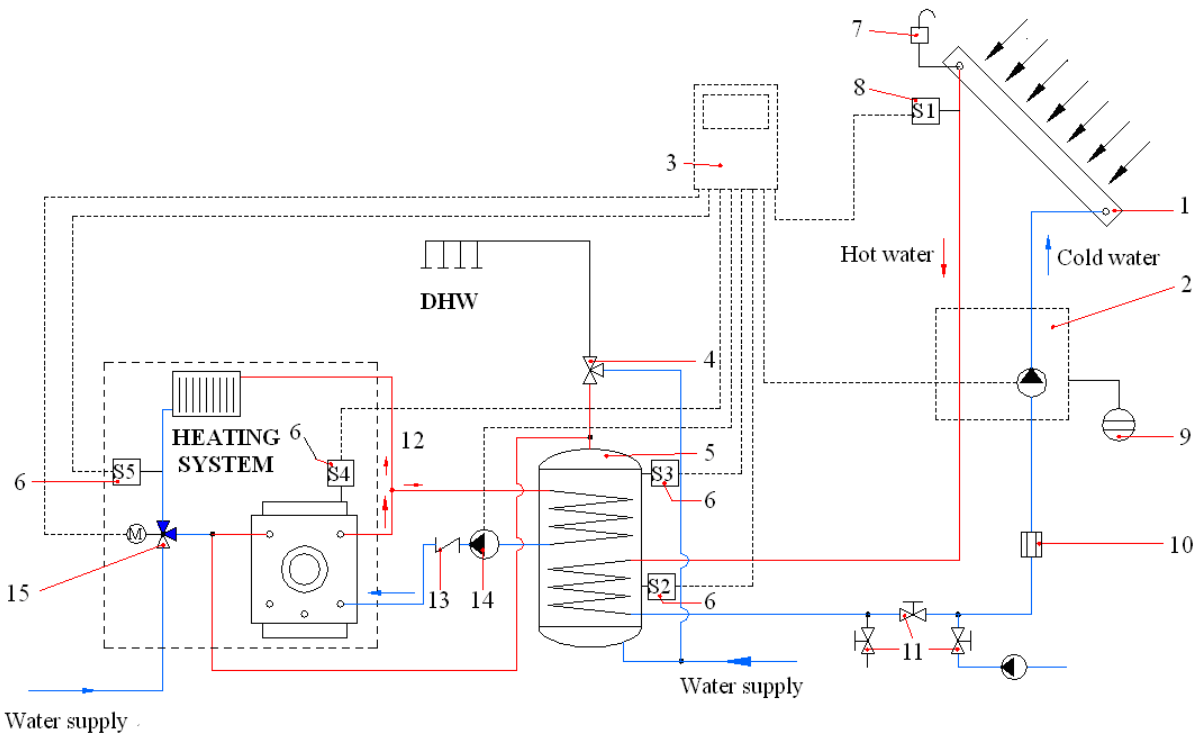

Figure 3 - Installation for producing domestic hot water and heating

3. The realised installation

The first scheme was materialiazed into an intallation for producing DHW. The installation was connected to the cold water supply network, at the entry in the solar boiler and at its exit was linked to the existent consumers, initially supplied with hot water by an electric boiler as it is shown in figure 4.

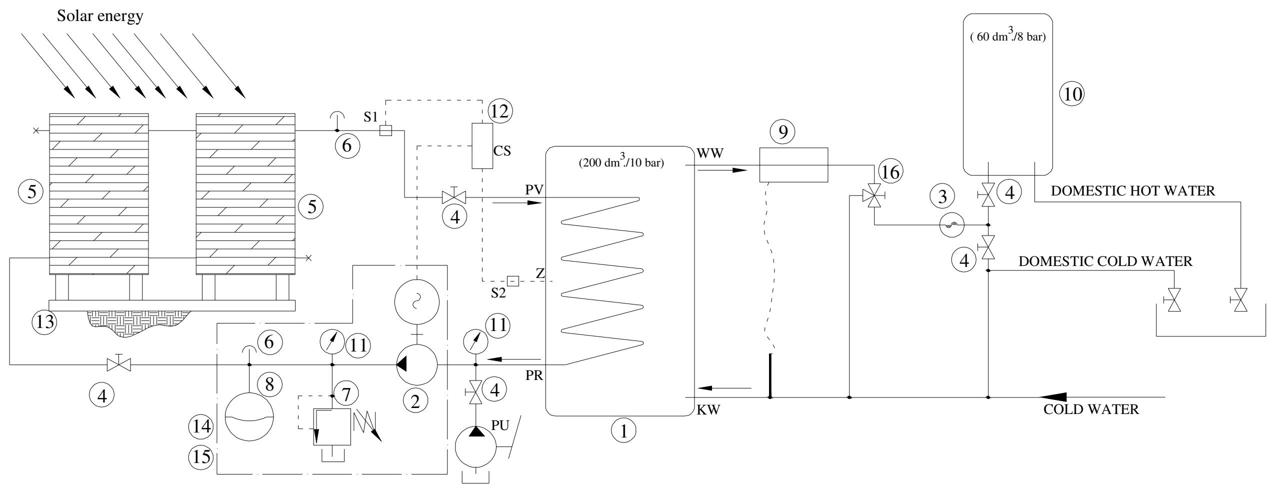

Figure 4 – Diagrame for connection of the solar instalation with the classic source for DHW producing

The solar circuit includes the 2 panels 5) grouped in series, the solar boiler 1) with plain curve, the pumping unit which includes the pump 2) the manometer 11) for displaying the operational pressure, the pressure valve 7) and the expansion tank 8). Beside these there are also isolation taps, mounted on tour and return.

The electropump 2) is controlled by the solar controller 12) which is constantly making a difference of temperature between the sensor S1 mounted at the exit from the group of solar panels and the sensor S2 mounted on the solar boiler. When this difference exceeds a fixed threshold, ranging between 2...16 K is prompted the supply of the electropump.

As it may be seen from fig. 2 the hot water generated by the installation DHW goes out on top of the solar boiler under the pressure of the cold water from the common supply network, it is mixed with cold water from the network for impeding overheated water to flow on taps and goes into a classic electric boiler, as cold water which must be reheated. If the temperature of the water coming from the solar boiler is higher than the one of the electric boiler, this does not start. If the temparature is lower the water heating is made reaching a range of temperatures equal with the difference betwen the desired one and that obtained in the solar boiler.

In both cases it is reached a good saving of electric energy, depending on the temperature obtained in the solar boiler and the needs.

4. Results

In order to test performances of this installation, we measured thermal energy quantity resulted, by means of an energy meter – position 9), figure 4; simultaneously we measured input and output temperatures of solar fluid, input and output temperatures of water inside this installation, as well as temperature decrease inside the solar boiler over a 48 hour period, with no energy supply from the panels and without any DHW compsumption.

Figure 5 shows the energy meter tip Kampstrup 401, which allows the measurement of temperature (input – output), flow, total produced energy, etc; in figure 6 is presented the solar boiler.

Figure 5 – The energy meter

Figure 6 - The solar boiler

For measuring the quantity of energy it was produced a consumption cycle consisting of 10 sections of 20 l each with a 200 l overall, during a 10 hours interval between 8 am and 6 pm starting from a temperature of 55°C. After the 200 l were consumed it was continued the consumption until the drop of temperature till 55°C, measuring the overall amount of hot water used. The temperature of the heated water was measured at the mixing tap fixed on 55°C The results are shown in the graphic from figure 7.

The test was performed in May 2009.

The average entry temperature of the cold water was of 21°C.

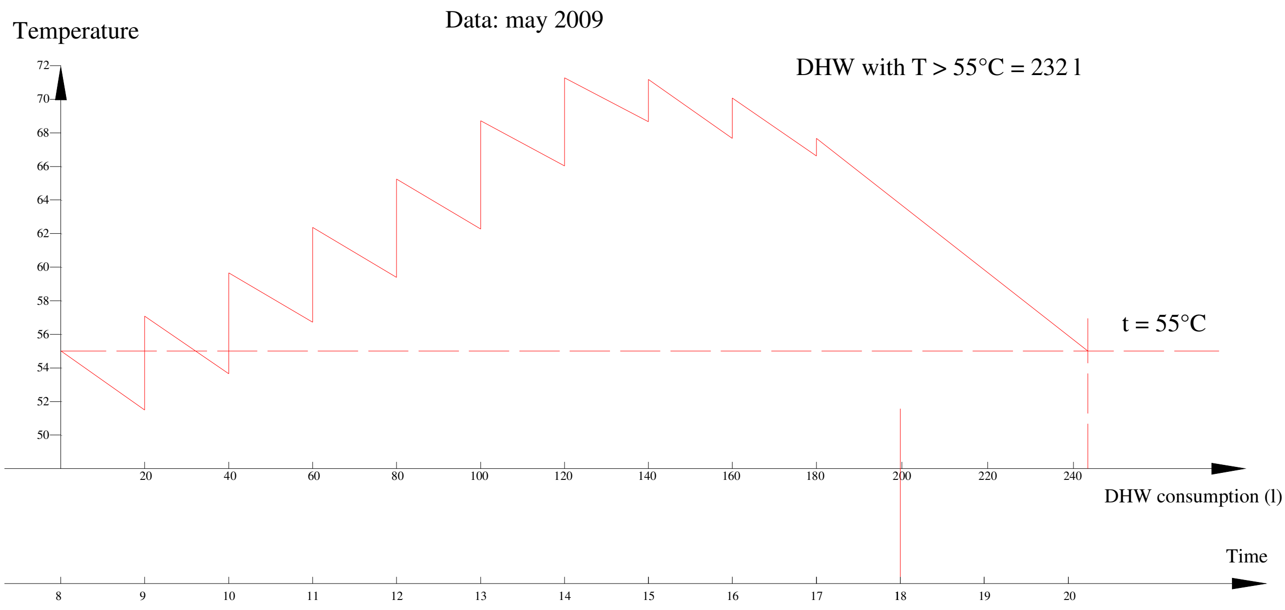

Figure 7 – Diagrame for DHW produced in warm season

The solar radiation measured during the entire test performing was of:

Table 1

Solar power in time, in warm season

Time	8	9	10	11	12	13	14	15	16	17	18
Solar power	462	683	821	964	1012	1102	933	768	563	329	218

The measurement of the quantity of water produced in the cold season

For measuring the quantity of energy was simulated a consumption cycle consisting of 10 sections of 10 l each with a 100 l overall during an interval of 5 hours starting from a temperature of 40^{o}C. After consuming the 100 l it was continued the consumption until the temperature decreased to 40^{o}C, being measured the total amount of hot water used. The temperature of the heated water was measured at the mixing tap fixed on 40^{o}C The results are shown in figure 8.

The test was performed in March 2009.

The average entry temperature of the cold water was of 9^{o}C.

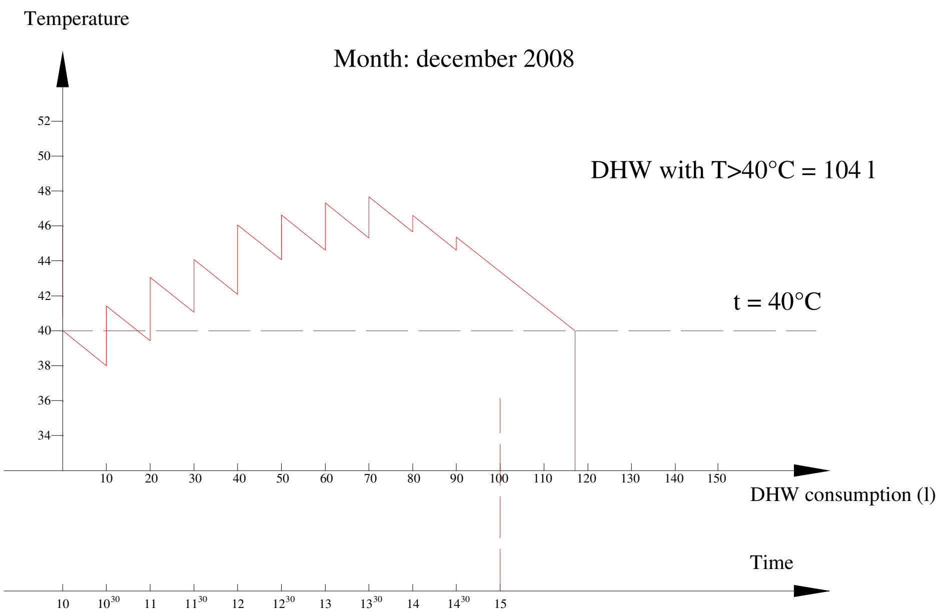

Figure 8 – Diagrame for DHW produced in cold season

The values of the solar radiation measured at the end of the test were of:

Table 2

Solar power in time, in cold season

Time	10	11	12	13	14	15
Solar power	267	394	563	858	688	424

The drop of temperature in the solar boiler was of about 5^{o}C in 48 h as it may be seen in the following graphic:

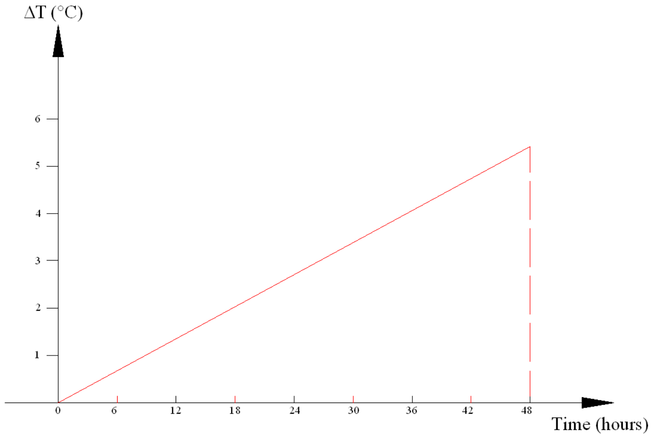

Figure 9 – Temperature decreasing in solar boiler, in 48 hours

5. Conclusions

Results presented prove that this installation, which uses 2 solar panels, each one with an area of about 2 m^2, meets the requirements for DHW of a 3-4 person family, to a percentage of 100% during hot season and 50% during cold season; undertaking several changes, this installation can also be combined with other sources of generating DHW or house heating sources, with significant savings.

Last but not least this method for producing thermal energy is completely non aggresive for the environment which imply positive effects upon its safety and good preservation and also upon the saving of fossil fuel resources.

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