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Solar Water Heater From plastic Bottles and Beverage carton

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Abstract

A solar water heater design made from plastic bottles of Pepsi or Miranda. And plastic pipes run up the center of each row of bottles. These bottles act as glazing, and also hold reflectors made from beverage cartons.

The research aims to take advantage of things that exist around us and dedicated to use for once, instead of throwing them think that the benefit from them in the manufacture of solar-powered equipment suitable for domestic hot water.

In summer (April) , the solar heater , heats the water to 52 º C, But in winter, the temperature of cold water in the tank of the house , is around 16 º C to 18 º C, against 22 to 25 º C in summer, and that due to the difference between the seasons, in addition to the reduction of solar radiation in winter, the thermal efficiency drops from 52 º C in summer to a maximum of 38 º C in winter, This points to obtain a difference in temperature between inlet and out let of water .

المقدمة

سخان شمسي صنع من قناني البيبسي والميرندا الفارغة وأنابيب بلاستيكية تمر من مركز كل عمود من هذه الزجاجات , القناني في هذه الحالة تعمل عمل الغطاء الزجاجي في سخانات الماء الشمسية التقليدية واستعمال علب المشروبات (الحليب ، العصير) كسطح ماص لأشعة الشمس , العلب يتم طيها وإدخالها في كل قنينة . الهدف من البحث هو الاستفادة من الأشياء المخصصة للاستعمال مرة واحدة فبدلا من رميها في النفايات يتم استخدامها في صنع سخان لتسخين الماء للاستعمال المنزلي .تم تشغيله صيفا (في شهر نيسان) ارتفعت درجة حرارة الماء في السخان إلى 52 درجة مئوية أما في الشتاء فان درجة الحرارة وصلت إلى 38 درجة مئوية .بمعنى انه تم الحصول على فرق في درجات حرارة دخول وخروج الماء .

Introduction

A thermo siphon solar water heater is the one that operates passively (through natural convection), circulating water through a solar collector and into an insulated storage tank situated a above the collector. In this water heater, pumps and controls are not required.

It basically takes advantage of the fact that hot water rises and cool water sinks. As water is heated it expands and so, as gravity pulls down the relatively heavier cool water molecules, the warmer molecules rise up. This phenomenon is known as natural convection. In this type of installation, the tank must be above the collector. As water in the collector heats, it becomes lighter and rises naturally into the tank above. Meanwhile, cooler water in the tank flows down pipes to the bottom of the collector, causing circulation throughout the system. The storage tank is attached to the top of the collector so that thermo siphoning can occur. Thus, the intended purpose of a thermo siphon is to simplify the pumping of water and/or heat transfer, by avoiding the cost and complexity of a conventional water pump. In a thermo siphon solar water heater, the water is heated passively by solar energy and relies on heat energy being transferred from the sun to a solar collector. The heat from the collector can be transferred to water in two ways: directly where water circulates through the collector, or indirectly where an anti-freeze solution carries the heat from the collector and transfers it to water in the tank via a heat exchanger.

Convection allows for the movement of the heated liquid out of the solar collector to be replaced by colder liquid which is in turn heated. Due to this principle, it is necessary for the water to be stored in a tank above the collector.

In comparison to conventional hot-water heating systems, solar water heater (SWH) can represent an alternative with moderate costs in countries with high energy costs and sufficient irradiation. While having significance for the supply of energy in these countries, the introduction of these new but simple techniques also opens up possibilities for sustainable heat carrying fluid in the SWH describe socio-economic development.

Solar collector under study & compared with conventional other solar water heaters

1. The solar collector is the component that deserves special attention, being the same, is directly responsible for performance of a solar heating system. solar collector in this research differs from the conventional, in terms of materials used in its construction and thermal efficiency, because as a matter of lowering costs, the columns to absorb heat made from, plastic pipe less efficient than the copper tubes used in collectors conventional market, while limiting the temperature to levels that maintain the rigidity of plastic , without causing the softening of these, and consequently, undermine the structure of the solar heater on the upper part, causing leaks.

Without forgetting the box or container, if they are of materials with the temperature limits for accumulation.

Bottles and cartons fit properly are the role of the box, the absorption of solar panel and glass in conventional collectors **fig. 1**, which is designed to both protect the inside of the collector of external interference, especially the winds and variations of temperature, creating the greenhouse effect. Although simple, it contains details required in the process. Below details of making all parts of my solar collector.

Fig.1 : bottles of (Pepsi , Miranda) & can of 1 liter of milk that used to make the collector

2. The system is the same than the one used by commercial solar heaters, known as thermos phone and it can heat water up to 38º in winter and over 50º in summer

Component of solar collector

Solar collector of area 1.25 m^2 consist the following component

1. The absorptive surface.
2. The column of plastic pipes.
3. The plastic bottles of Pepsi or Miranda in each column
4. The tank.
5. The container & thermal insulation.

1- The absorptive surface

50 cans of 1 liter of (milk, juices, etc.) are used fig.2a, fig2b**.** These cans have in their composition, 5% aluminum, 20% polyethylene and 75% of cellulose **[1]** ,the application of them

in my project offers excellent results, since the combination of such materials, avoids the bend in the temperature that will be submitted to the contrary is to use paper.

For a perfect fit inside the bottles of Pepsi or Miranda, cut the can with 30 x 21 cm. And just fold it in a simple way, using the lateral bending of the same, and two diagonal folds in on top **fig. 2c**, which will follow the curvature of the bottle top, act as support to sustain the housing. I paint it with matte black synthetic enamel paint drying quickly to external and internal, used to iron, wood, etc.

a ***b*** ***c***

fig.2 (a,b,c) absorption surface from can of milk

2-column of plastic pipe

Before painting the tubes of the columns with the same ink used in the cans, I must isolate with duct tape the 2 ends approximately 2 cm, after which it is painted cut the ribbon due to the type you plug in the connections.

The tubes of distance between columns should be 8.5 cm and without paint, standard measurement for all collectors, no matter the types of bottles.

The assembly becomes simple to follow an order to put the components, taking care to use the adhesive only in the tubes and connections, the top of the collector where the hot water circulates. At the bottom should just fit them with the help of a rubber hammer, without compromising the size of the column., To avoid leaks, the quality of the pipes and connections is essential.

To simplify the assembly of solar collector, we need to glue the three pieces of **fig.3a** , from the top repeating the operation in the number of columns of solar collector. Conjunction all parts one another to form the 10 columns **fig.3b**.

a   b

Fig. 3(a,b): columns of plastic pipes

3- Bottles in column of pipes

Two are the bottles are used in the construction of solar collector , by giving preference to the transparent (glass) in the formation of columns of thermal absorption: bottles of Pepsi and bottles of Miranda . Length of bottles 35 cm cut 5 cm from its end allowing 10 cm of the bottle to enter in the next bottle , repeating the operation in the number of columns of solar collector .
Then insert the bottles and absorber **(fig.4**) in 10 columns of pipes, not forgetting to close the last bottle of each column, cutting off another bottle, but on top of the side cover. In conclusion, the fit of the bus below, closing this module.
I **should** seal the 1st bottle of each column, with strips of rubber or tape auto merger. This prevents the escape of heat from inside the column, and prevent the wind turn the cylinders fig. 4

Fig .4: Bottles in the column of collecto

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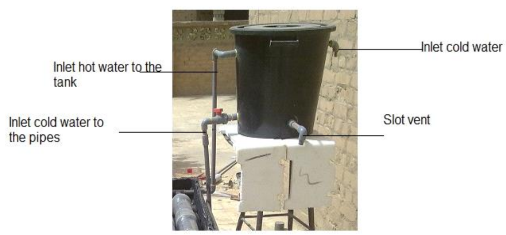
4-The tank

Even the water tank may be used in the supply of hot and cold water, but in my project the tank is used in the supply of hot water, since it has a minimum capacity of 50 liters,. The ideal and recommended, it would be a reservoir for hot water only, with the size corresponding to the daily of two people. The use of basic materials available in all regions, is of extreme importance. Applied in the project a plastic cans as a reservoir of 50 liters, , I painted outside of the tank with the same ink used in the pipes **fig, 5 (a,b)** and had isolated the tank with glass wool insulation.



a

b

Fig. 5 (a,b) the tank

5- The container and thermal insulation

Assemblage all component of collector and I put it in a container (1.25 x 1.25) m ^{2} and 0.02 m thick made of wood material , Styrofoam have used to isolate the box or container painting the container and the insulation with the ink that used for painting the pipes and tank . The distance between the collector and the container the closest possible in order to minimize thermal losses while taking into account also the distances of the points of consumption, thus avoiding the waste until the water hot. fig. 6

Fig. 6: the collector in the can or container

The installation of solar collector

Solar collector installed on the roof of a house in Baghdad , inclination angle of 30 ° depending on the latitude of Baghdad, which is equal to 33.33 °.**[3]**

Give a preference by the thermo siphon movement, it is mandatory that the bottom of the tank, is always up on the top of the solar collector about 30 cm .**Fig. 7**

Fig.7: The solar collector

Results obtained from the solar collector

1-Temperature of the water in the tank during daylight hours for the different months Of the year are measured by (thermometer) as shown in. fig (8)

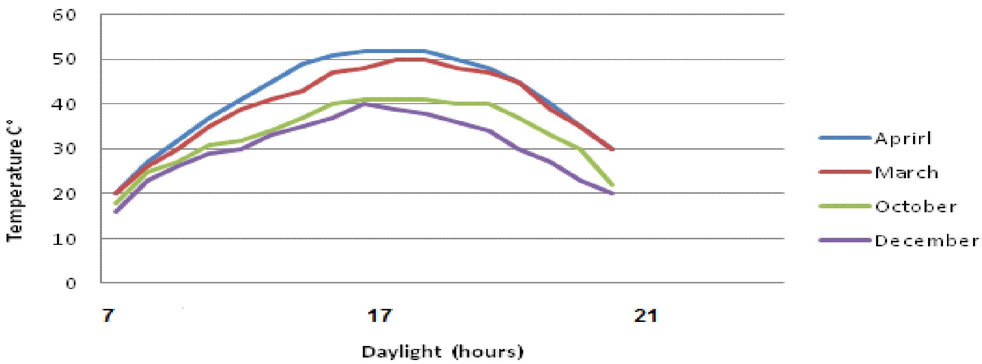


Fig.(8) Temperature of the water during daylight hours For the different months of the year

2- The amount of energy which is required can be calculated from the hot-water consumption for a year, the difference in temperature between cold and hot-water and the heat capacity of water (eq.1): **[2]**.

$Q_{HW} = m° .cp . T$

$Q_{HW} = m° .cp. (T_{fout} – T_{fhn})$ …………..(1)

m°=0.08 kg /sec

cp=4180 kJ/kg ° C

The results of energy calculated are shown in table (1) and fig.9

Table (1) energy gained during daylight hours

Daylight hr	Energy gained w			
	April	March	October	December
7:0	116	116	0	0
8:0	406	290	174	174
9:0	696	580	280	232
10:0	928	812	406	348
11:0	1161	928	522	464
12:0	1393	1045	696	638
13:0	1509	1277	986	928
14:0	1567	1335	1045	986
15:0	1567	1451	1161	1161
16:0	1567	1451	1161	1045
17:0	1451	1335	986	928
18:0	1335	1277	986	928
19:0	1161	1161	870	696
20:0	870	812	754	522
21:0	580	580	600	406

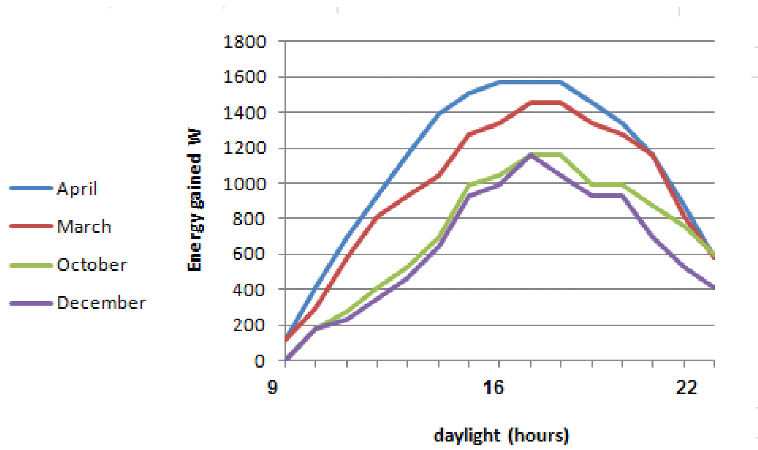


Fig (9) The amount of energy gained during the hours Of day for the different months of the year

Discussion

-When put into practice the project in February 2010 until April 2011, built a solar collector with 50 pet bottles, 50 boxes of 1 liter of milk arranged in 10 Columns with 5 bottles each, totaling a floor area of absorption of 1.25 m^2, and a plastic can or container of 50 liters , coated with glass wool of 20 mm thick. It is noteworthy that the thickness of insulation is sufficient to maintain or store the hot water longest possible period of the night.

-As installed in summer (April) , and that with the sun around 8 hours , heats the water to 52 º C, being necessary to mix with cold water. But in winter, the temperature of cold water in the tank of the house, is around 16 º C to 18 º C, against 22 to 25 º C in summer, and that due to the difference between the seasons, in addition to the reduction of solar radiation in winter, the thermal efficiency drops from 52 º C in summer to a maximum of 38 º C in winter.

-In April and when the air temperature of 25 ˚C measured in the shade, temperature of the water in the reservoir has reached to 52˚C after 11: am.

-Hot water was withdrawn from the tank and replacing it with cold water at 13 noon, the higher the temperature of the reservoir to 45 ˚ C in the remaining hours of operation .

- Fig .8 shows that the water temperature increased gradually during the daylight hours to reach the maximum value in the middle of the day and then less then up to the lowest value in the last day with a lower air temperature

-Fig. 9 shows that the energy gained increased gradually during the daylight hours to reach the maximum value in the middle of the day and then less after reaching its lowest value in the last day with a lower air temperature Economic cost of the solar heater

The alternative water heater differs from the conventional, in terms of materials used in its construction and thermal efficiency, this cause lower costs and can provide power savings of up to 30 percent by reducing electricity usage and exploit of solar.

This type of heaters can be used in poor areas and people that could not pay the electricity bill

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Nonnenclatnre

Q_{HW}	Energy needed for water heating [kWh]
m°	Consumption of hot-water per day [kg]
Cp	Heat capacity of water [kWh/C˚ kg]
T	Temperature difference for water heating [C˚]
T_{fout}	Outlet water temperature [C˚]
T_{fhn}	Inlet water temperature [C˚]