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Comparsion between Diffirent Designs of Solar Colector in Basrah City

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Abstract: *The idea of basic research is a comparison between (6) solar collectors with different design (Box , Circle 1 , Circle 2 , Zigzag 1 , Zigzag 2 , H - section) and similar in the form in the outer materials and a cost but they differ in the engineering design by expose them to the same ambient environmental conditions for a period of (9) months in the province of Basrah which lies on the longitude ($47^o45'$) and latitude ($30^o33'$) to see the optimum solar collector .*

Keyword: *solar collector , solar energy , solar water heating .*

I. Introduction

In recent years, the world turned to the study of solar energy as an alternative energy source by converting solar rays into heat, A clean energy do not affect the environment and can be easily used indoors.

In order to devise models and devices the advantage of this energy must be taken by the scientists and resorted researchers .

In the Middle East, the sun's ray is high where the Arab nation is located between the equator and latitude (37), and between longitude (17) west longitude of Greenwich (60) east of Greenwich, so the demand for energy has increased [1] .

A typical flat-plate collector consists of an absorber in an insulated box together with transparent cover sheets (glazing) [2] .

The absorber is usually made of a metal sheet of high thermal conductivity, such as copper or aluminum, with integrated or attached tubes. Its surface is coated with a special selective material to maximise radiant energy absorption while minimizing radiant energy emission. The insulated box reduces heat losses from the back and sides of the collector [3].

A selectively coated absorber under sunlight will get hotter than a simple matt black one. Selective coatings enable the collector to operate better in weak sunlight . Water temperatures in collectors coated with black chrome can rise above 80 ºC after a few hours of sunlight. The temperature that drops over the night, or the heat loss after cloudy spells, are relatively small [4]. This is a result of the coating's high absorbptance and low emittance , The absorber coating on glazed solar collector absorber plates must be able to withstand stagnation temperatures and they must be stable and resilient to endure the weather exposure of unglazed collectors. The most secure paint and primer bonding is obtained in high quality collectors by using an electrostatic painting process. Common methods for selective surfaces are used in the production of absorber plates: Oxide, Chemical, Electroplated and vapour deposited [5].

A normal matt black paint have been used in this research because its cost was cheap and available in the local markets .

Experimented Setup And Procedure

II. Materials :

The materials which used in the solar collectors industry under discussion are : wood , nails , glass wool , copper tube , copper sheet and silicon which have available commercially in the local markets of Basrah , and these materials are assembled in the laboratory of Solar Energy in Physics Department .

Solar Collectors Models used :

Flat-plate collectors are the most common for residential water-heating and space heating installations. A typical flat-plate collector consists of an absorber, transparent cover sheets and an insulated box. The absorber is usually a sheet of high-thermal conductivity metal with tubes or ducts either integral or attached. Its surface is painted or coated to maximise radiant energy absorption and in some cases to minimize radiant emission. The insulated box provides structure and sealing and reduces heat loss from the back or sides of the collector as in diagram (1) [6].

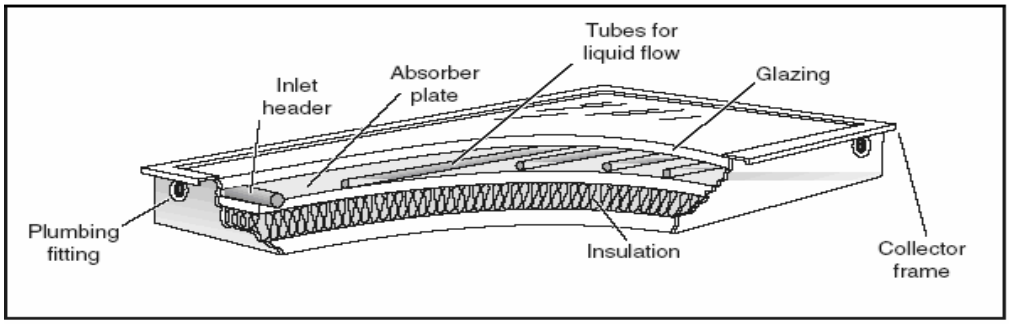


Diagram (1) Schematic diagram for insulated box .

To do a comparison between solar collectors outlined in the previous table each collector linked with insulated tank through a tube coming out of the bottom of the tank to equip solar collector and then the water back from the collector to the top of the tank and be the link beneath the surface of the reservoir level as in figure (1).

Figure (1) Fabrication method a tank which to connected with the solar collector .

The amount of water in the tanks is (5 L) added to the water inside the solar collector (0.54L) where the total (5.4L) . The tank must be at a height of (30) cm from the highest point of the solar collector to ensure water circulation naturally by Siphon .

The solar collectors have been tilted at an angle of (15^o) from the horizon in summer and (45^o) in winter to be facing the sun as in figure (2) .

(15^o) in summer **(45^o) in winter**

Figure (2) Solar collector angle in the summer and winter facing the sun .

The tank temperature of each collector was recorded every half hour starting from seven o'clock Am until evening seven o'clock Pm , in order to compare the readings of each solar collectors and thus determine the most efficient solar collector to take advantage of it in the future as in figure (3) .

Figure (3) A photograph describes the work of the solar collectors .

In our project and in order to get the best and optimum solar collector , this six solar collectors which are similar in outer materials form but differ in the design must be comparing under the same weather conditions when they expose to the sun ray . Six wooden boxes were manufactured , each box has a length of (112) cm , width of (62) cm and high of (15) cm without cover , and six wooden frames were manufactured each one has a length of (100) cm , width of (50) cm , high of (5) cm and thickness (3) cm to install them in the middle of the boxes , these frames were used as a base to fixed the absorber copper plate which has a dimensions of (100) cm length and (50) cm width and (0.05) cm thickness and the copper tubes lies on the copper plate by welding to increase heat exchange between the copper plate and copper tube which contain the water .

To keep more heat inside the solar collector glass wool with a thickness of (5) cm was used under the copper plate as shown in Figure (4).

Figure (4) Show the how to put the glass wool under the copper plate.

After the installation of the tubes on the copper plate by welding and painting them with matt black paint to increase the absorbency , a wooden box used to collect them for each type (Box , Circle 1 , Circle 2 , Zigzag 1 , Zigzag 2 , H - section) . A glass cover window type with a length of (112) cm , width of (62) cm and thickness of (0. 4) cm was used for each collector in order to keep the heat generator by the transmit sun light from escaping to the outside of solar collector as shown in Figure (5) .

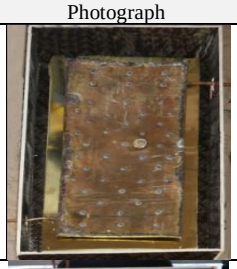
Figure (5) Show the installation of the glass cover on the wooden box .

III. Summary For A Used Solar Collectors

Six types of solar collectors have been manufactured . Each collector consist of wooden box made of plywood of (1) cm thickness , length of (112) cm , width of (62) cm and high of (15) cm . Inside each wooden box there is a copper plate as absorber material with length of (100) cm , width of (50) cm and thickness of (0.05) cm . A glass wool thickness of (5) cm have been used under the absorber plate as insulator . A glass type window thickness of (0.4) cm , width of (62) and length of (112) cm have been used as a cover to each collector

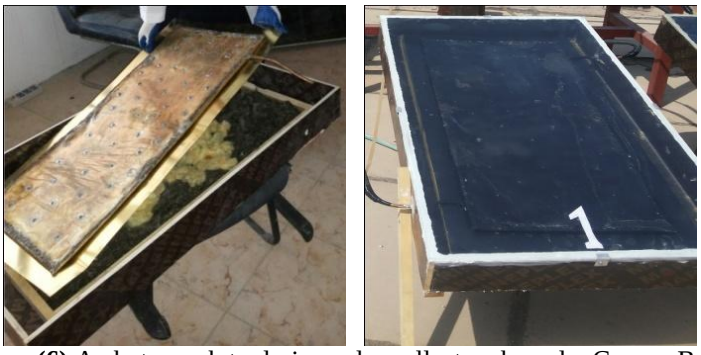
The six collectors are similar in the materials used in Fabrication and in their dimensions but they differ in the way of containing the water . Also the capacity of each collector is (0.54) Litter of the water as shown in table (1) and more bellow details .

Table (1): Flat plate collectors and their water container

Sample no.	Photograph	Name	Water Container Inside the Collector
1		box	Copper tank (Parallel Rectangles) L= 90 cm w= 40 cm H= 0.15 cm
2		Circle1	Copper tube Length tube = 757 cm Diameter = 0.9525 cm
3		Circle2	Copper tube Length tube = 757 cm Diameter = 0.9525 cm
4		Zigzag1	Copper tube Length tube = 757 cm Diameter = 0.9525 cm
5		Zigzag2	Copper tube Length tube = 757 cm Diameter = 0.9525 cm
6		H - Section	Copper tube Length tube = 540 cm Diameter 1 = 0.9525 cm Diameter 2 = 1.27 cm Length = 60 cm × 2

1- Box

A Parallel Rectangles was manufactured from copper plate thickness of (0.05) cm with a length of (90) cm , width of (40) cm and high of (0.15) cm . This box provided with two copper tube with diameter of (0.95) cm and length of (20) cm , one of them linked at the bottom side to inlet water and the other linked at the top side to outlet water to the external tank as shown in figure (6) .



Figure(6) A photograph to design solar collector shaped – Copper Box .

2- Circle 1 (C1)

In this type ; the container of water inside the collector is a copper tube with a diameter of (0.95) cm and a length of (757) cm which contain (0.54) Litter of water .

This copper tube was coiled in circular form and fixed on the absorber copper plate by welding from many points . The first end of the copper tube passes through the center of the circle as outlet water to the external tank and the other end to inlet the water from the external tank as shown figure (7) .

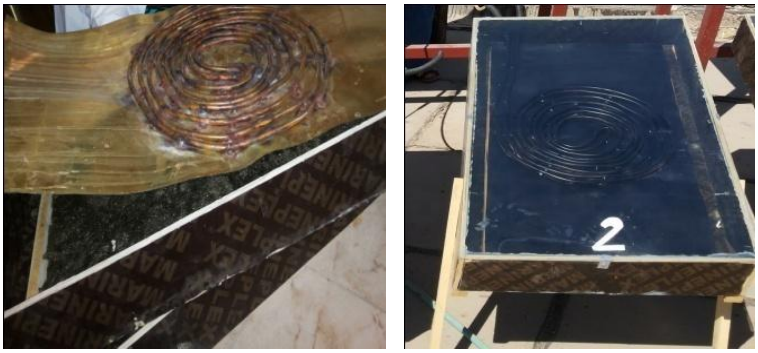


Figure (7) A design solar collector shaped – 2 copper tubes parallel a circular path connected and starts from the center

3- Circle 2 (C2)

This type is similar to the second type (C1) but differs in the way of coiled , which was coiled in oval shape as shown in figure (8).

Figure (8) A photograph to design solar collector shaped – Circular path starts from the center .

4- Zigzag 1 (Z1)

This type is similar to the previous type but differs in the way of coiled as shown in figure (9).

Figure (9) A photograph to design solar collector shaped - Zigzag (sin wave).

5- Zigzag 2 (Z2)

Also , This type is similar to the previous type but differs in the way of coiled as shown in figure (10).

Figure (10) A photograph to design solar collector shaped - Zigzag (sin wave) parallel .

6- type H - Section

Six parallel copper tube diameter of (0.95) cm and length of (90) cm have been linked with horizontal copper tube diameter of (1.27) cm and length of (60) cm from each end by made six holes diameter of (0.95) cm in the horizontal tube and fixed them by welding .

One end of the lower horizontal tube was used to inlet the water from external tank while the other end of it was closed by welding . Also , the one end of the upper horizontal tube was used to outlet the water to the external tank while the other end of it was closed as shown in figure (11) .

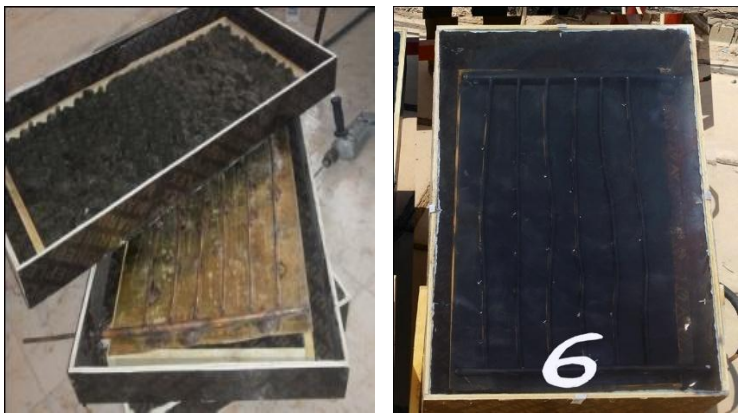


Figure (11) A photograph to design solar collector shaped – H .

IV. Results And Discussion

Figure (12) shows the monthly mean temps , in (C^o) for all solar collector designs , the period of measurements is begin from (September) to (May) it is clear from that figure that .

Where it was found that the formation of the pipeline of the Solar collector shown in Figure (9) for (Z1) is the best type , and gives the better results than the rest of the types in the province of Basrah . Followed by the formation of the pipeline in the form of (H), which gives less than the model results (Z1).

Then followed by the type (H) , (Z2) , (box) , (C2) and (C1) .

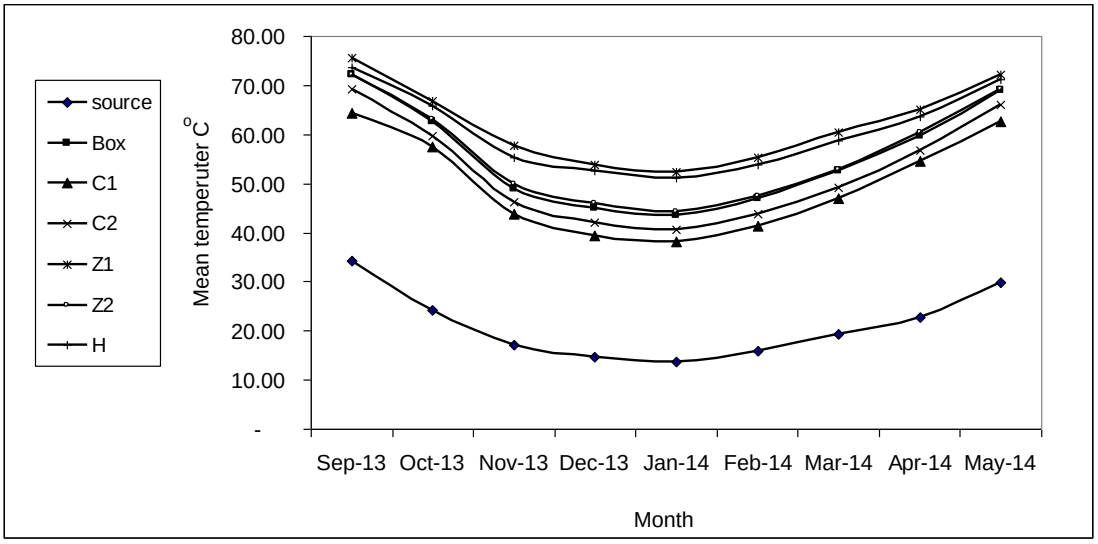


Figure (12) A diagram shows the behavior and efficiency of each solar collector during the nine months .

V. Conclusion

1- type (Z1) of solar collector is the best type to be use in the province of Basra for solar heating water advantage of it in projects and research.

2 type (H) of solar collector is the second beast one for solar heating water .

3- To reduce the cost of solar collector , it is possible to use aluminum plate and tubes instead of the copper material .

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