Global Scientific JOURNALS

GSJ: Volume 7, Issue 8, August 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

DESIGN AND MANUFACTURE A SOLAR WATER HEATER BY USING PLASTIC PIPES UNDER DIFFERENT ATMOSPHERIC CIRCUMSTANCES OF BASRA CITY. IRAQ

Ahmed. J. Mohammed

Polymer Research Center / University of Basra / Basra / Iraq.

Abstract:

In this research, a solar water heating has been constructed and it's performance has been evaluated under different atmospheric circumstances of Basra city, (Latitude 30° 33' 56.55"N, Longitude: 47° 45' 5.86"E). This region is well known of its plentiful solar radiation. An experimental investigation was carried out on solar water heater (type H-Section) under the same conditions. The solar water heater consists of seven parallel plastic tube diameter of (1.5 cm),and the total area of solar water heater is (0.45 m^2) . The maximum efficiency of the experimental solar water heater (type H-Section) varies from (5% - 29%).

Key words: Energy, water, Solar energy, Solar water heater, plastic tubes, Pipes.

1.Introduction:

The remote arid warm places in the Middle East and North Africa and other regions in the world are suffering a sharp shortage of fresh water. These regions are characterized by high salinity of ground water, lack of rains and a good solar energy in Iraq (specific Basra). It is an international problem and the best solution, is the use of solar energy for desalination of salt water[1]. Saline water (brackish water) represents very high percentage of the total water on the surface of the earth, (97% - 97.5%), and the rest is fresh water (3% - 2.5%), so the fresh water which is available for use is very small fraction [2-5]. Water is considered one of the prime elements responsible for life on earth. It covers three-fourths of the surface of the earth[6]. Hot water is essential both in industries and homes. It is required for taking baths, washing clothes and utensils, and other domestic purposes in both the urban and rural areas. Hot water is also required in large quantities in hotels, hospitals, hostels, and industries such as textile, paper, food processing, dairy, and edible oil[7]. In fact, hot water is required mainly for purposes of hygiene and bathing in homes. Hot water demands appear to be highest within the periods of the day when electric energy demand for other purposes is high[8]. The general objective of this work is to design and manufacture a solar heater by using plastic pipes and a water bottle under different atmospheric circumstances of Basra city. Iraq.

2. Experiment Side:

2-1. System Description:

In this work a construction of solar water heater (type H-Section) consisting from Seven parallel plastic tube diameter of (1.5 cm), length (105 cm), thickness (1 mm), and symbol (T1), have been linked with horizontal plastic tube diameter of (2 cm), and length of (60 cm), and symbol (T2), from each end by made seven holes diameter of (1.5 cm) in the horizontal tube and fixed them by silicon rubber . 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 silicon rubber . 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. A solar water heater has been constructed and it's performance has been evaluated under different atmospheric circumstances of Basra city (Iraq) (Latitude 30° 33' 56.55"N, Longitude 47° 45'

5.86"E) . A matt black paint was used to paint the plastic tube to absorb maximum solar radiation. and the plastic pipes (T2) and (T1) were insulated with a thermal insulation to reduce the thermal losses of water inside the solar heater, and the work of small holes with diameter (15.5 mm) in pipes (T2) to insert plastic tubes (T1) through the two sides. Silicon rubber sealant is used to prevent leakage from any gap between the both plastic pipes, and the total area of solar water heater is (0.45 m^2) . The schematic diagram of the solar water heater unit is shown in Figure (1).

2-2. Testes:

The solar water heater directed to the south geographic, the direction geographical advantage from solar radiation and to be the first side towards the sunrise and the other side heading towards the sunset. The experiments on the solar water heater was carried out during some days of (September 2016, December 2016) to study their performance under different field conditions. In each work experiment, was measured every hour the temperature of water inside the pipes, temperature of hot water out from solar heater and ambient temperature.

Figure (1) Schematic diagram of the solar water heater (type H-Section).

3.Theoretical Side:

The storage energy for the solar water heater and the supplied tank is calculated by the following equation[9]:

$$Q_u = \rho c(T_{av} - T_i) \quad (1)$$

Q_u: The storage energy per unit volume (W).

ρ: Water density (kg / m^3).

T_{av}: Average of the temperature of water (^oC).

T_i: Water temperature (^oC)

C: Specific heat at constant pressure (kJ / kg. ^oC).

The storage energy for the solar water heater and the supplied tank is calculated by the following equation:

$$Q_u = \frac{MC(T_{av} - T_i)}{t} \quad (2)$$

M: Water mass (kg).

t: Operating time (Sec).

The amount of energy absorption by the solar water heater is calculated by the following equation:

$$Q_{abs} = I_b A_p F_t(\tau_g \alpha_p) \quad (3)$$

Q_{abs}: The amount of energy absorption (W).

$I_{b:}$ Solar intensity (W/m^2)

A: Area of the solar water heater (m^2)

$\alpha_{p:}$ Absorptivity = 0.97

$\tau_{g:}$ transmissivity = 0.95

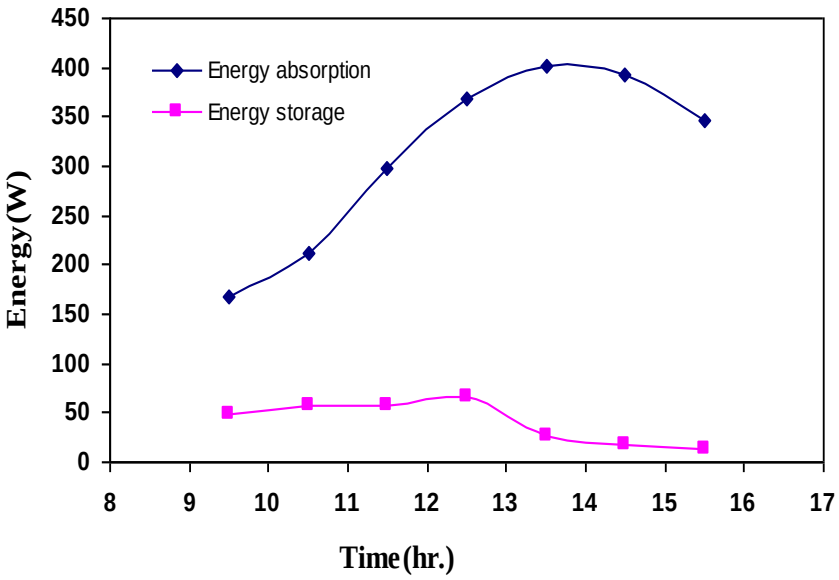
Ft: Total coefficient of shadow and dust effect on the received solar radiation .

The thermal performance of an solar water heater is calculated using the thermal efficiency (η). It is defined as the ratio of the storage energy per unit volume ($Q_{u)}$ to the product of solar radiation incident on the collector and area of the collector (A) [10].

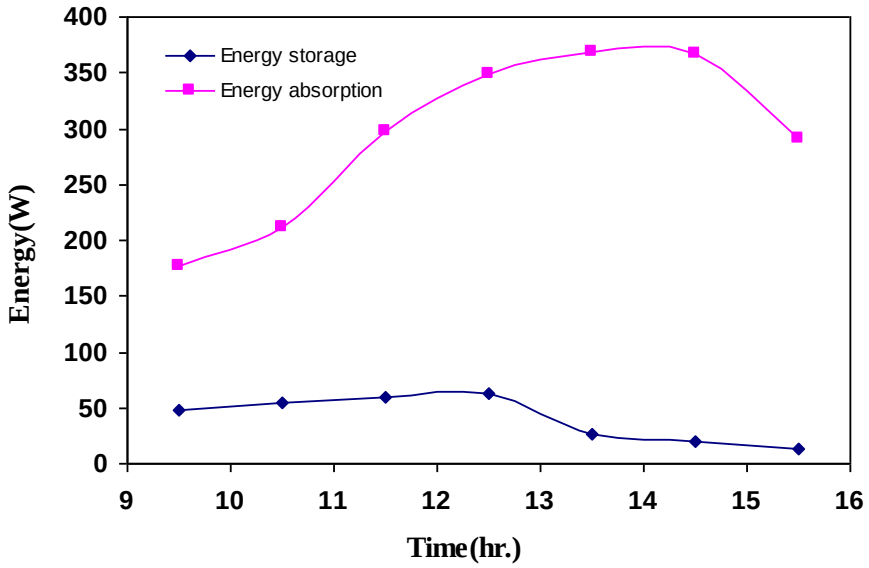
$$\eta_s = \frac{Q_u}{Q_{abs}} \quad (4)$$

3. Results and discussion

Fig.2 and Fig.3 illustrates the amount of the energy of absorption by the water at different ambient temperatures and the storage energy with daylight hours for days (1/11/2016) and (15/11/2018). To investigate this effect, the ambient temperature is varied from 28 to 34 °C that can be obtained during high solar intensities. The energy of absorption increase for increasing of the ambient temperature. The higher the solar intensity yields the greater rate of heat absorption by a plastic tube. This is due to the fact that when the ambient temperature decreases, the heat transfer rate from the outer surface of the plastic tube to the water decreases[10]. This implies that, with decrease in solar intensity, there is a significant decrease in radiative heat transfer between the outer plastic tube and hence there is a decrease in net heat energy absorbed by the water. The ambient temperature causes significant variation in the net heat absorption capacity at higher solar intensity.

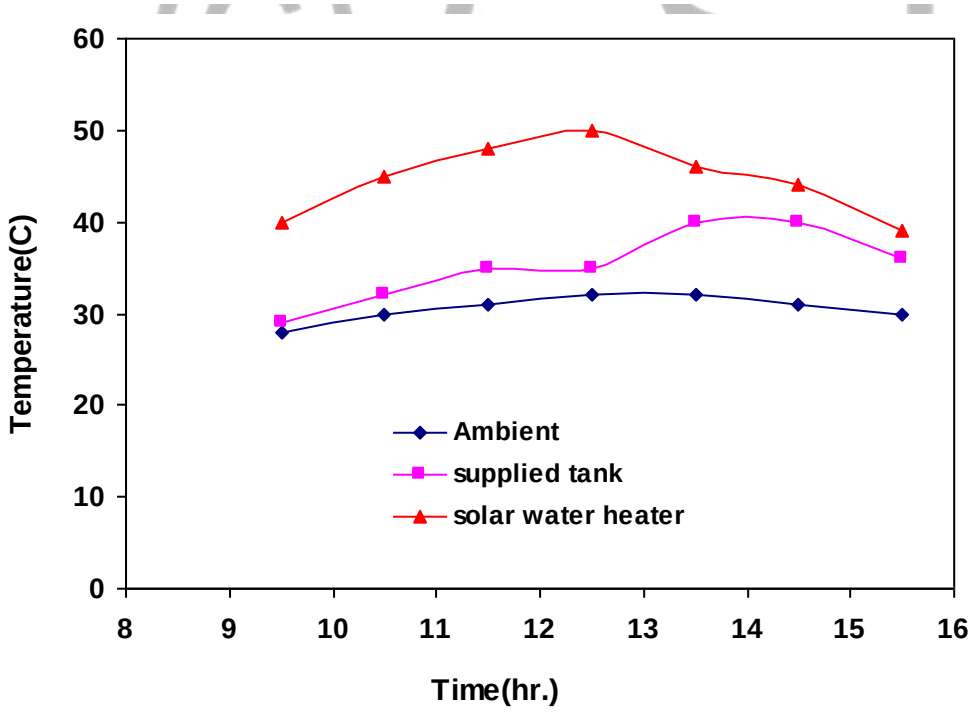


Figure(2): The energy of absorption by the water at different ambient temperatures and the storage energy with daylight hours for day (1/11/2016).



Figure(3): The energy of absorption by the water at different ambient temperatures and the storage energy with daylight hours for day (15/11/2016).

The temperature of solar water heater, supplied tank and ambient air was recorded continuously for every hour at 1 November 2018 show in Fig. (4).



\

Figure (4): The change in the temperature of the solar water heater, supplied tank and ambient along the daily hours at 1 November 2018.

From Fig.(4) we observe that the solar water heater temperature has a highest value at mid day ,this is because of the effect of higher the solar intensity, also the maximum value of the temperature solar water heater arrived to (50 ^{o}C),while the maximum value of the temperature of ambient arrived to (32 ^{o}C), and the maximum value of the temperature for supplied tank arrived to (35 ^{o}C).

The thermal efficiency (η)of the solar water heater was calculated for the day 1 November 2018, by using the following equation.

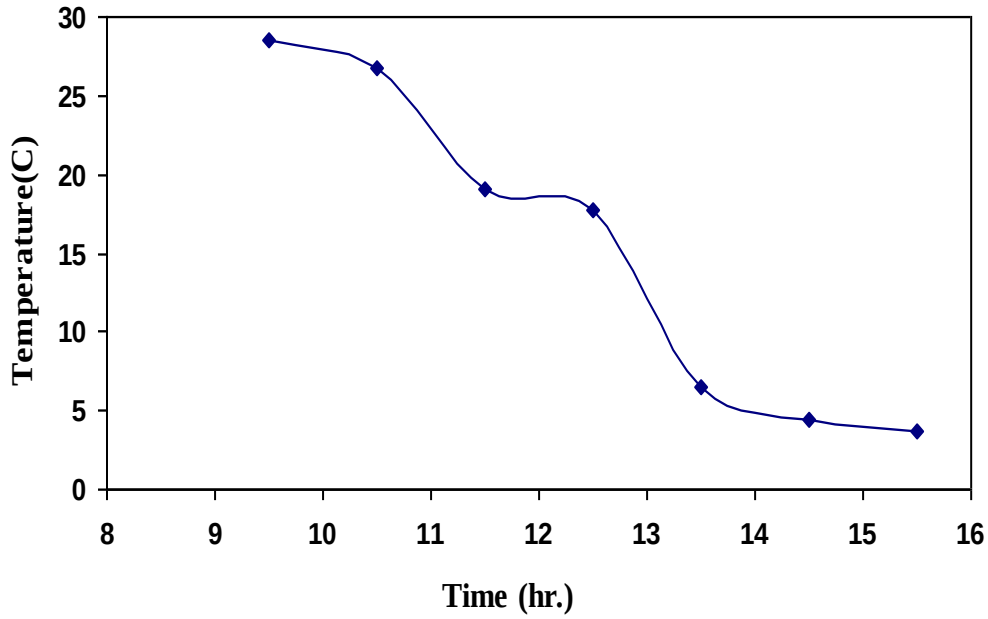
$$\eta_s = \frac{Q_u}{Q_{abs}}$$

where:

Q_u: The storage energy per unit volume (MJ/m^3) .

Q_{abs}: The amount of energy absorption (MJ/m^3).

The thermal efficiency (η) of the solar water heater was recorded for every hour at the day 1 November 2018 show in Fig. (5).



Figure(5): The change in the thermal efficiency (η) of the solar water heater along the daily hours at 1 November 2018.

conclusions

A solar water heating systems has been undertaken. From this study, the following are evident:

The saturation temperature and pressure in the collector and condenser increase continuously during the day with increasing tank temperature at the no loading condition. Water withdrawal causes a marked effect on the collector and condenser saturation temperatures. The variation in flow rate during the day follows the insolation pattern with a noticeable increase with increased loading. The maximum plastic pipes water temperature of a solar heater is (51) ^{o}C, while the minimum plastic pipes water temperature of a solar heater is (40) ^{o}C. The maximum water temperature of the tank is (40) ^{o}C, while the minimum water temperature of the tank is (29) ^{o}C. The maximum for the thermal efficiency arrived to(29 %) for the day (1/11/2018) .

.

Reference:

[1] H.M.Qiblawey and B.Fawzi, Desalination 220 (2008) 633–644.

[2] E.Kuusisto , " World water resources and problems ", part four , p (153) , Hydrologist, Finnish Environment Institute (SYKE),lectures given by the author on 26 August 2004.

[3] V.Velmurugana and K. Srithar , Desalination 216 (2007) 232–241.

[4] I.Mahamud ,"Prospects of Water Desalination in the Gaza Strip", TRITA-LW MSC. Dep. of Land and Water Resources Engineering, Royal Institute of Technology, Stockholm 2003.

[5] H.T. El-Dessouky and H. M. Ettouney, "Fundamentals of Salt Water Desalination", Dep. of Chemical Engineering , College of Engineering and Petroleum , Kuwait University, Printed in The Netherlands, 1st edition 2002.

[6] A.E. Kabeel , A. Khalil , Z.M. Omara and M.M. Younes, , Desalination 289 (2012) 12–20.

[7] N. M. Nahar, Renewable Energy, Vol.26, pp.623,(2002).

[8] P. B. Taylor, “Energy and thermal performance in the residential sector,” Ph.D. thesis, Potchefstroom University, (2001).

[9] A. J. Khalifa “On the Verification of one Dimensional Heat Flow in a Horizontal Thermosyphon Storage Tank " Energy Conversion. & Management, Vol.40 , pp. 961, 1999.

[10] B. Kiran Naika , A.Varshneya , P.Muthukumara, C. Somayajia,"Modelling and Performance Analysis of U Type Evacuated Tube Solar Collector Using Different Working Fluids", Energy Procedia 90 (2016) 227 – 237.