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Experimental steady to produce steam by solar energy using solar dish concentration with copper coil receiver

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***Abstract*— This work deal with utilization of solar energy to produce steam, by using solar concentrated dish. The solar radiation incident upon the dish and reflected to absorbed vessel, which contain the helical coil which carrying the water. The results of this experimental work are given good indication to produce steam through short time from solar in Iraq.**

***Index Terms*— solar dish, coil receiver, steam production.**

Nomenclature

A_a	Aperture area (m^2).
A_r	Receiver area (m^2).
ar	Constant depends on the material used.
CR	Concentration ratio.
D	Diameter of dish (m).
d	Diameter of coil (m).
I_a	Incident radiation (W/m^2) at 11:00 am, 7-september, 2014 in Iraq/Baghdad.
p	Specula reflectance of concentrating foil.
Q_{abs}	Energy collected by the absorber (W).
Q_{loss}	Receiver energy losses (W).
Q_u	Useful energy transferred to working fluid (W).
S	Receiver shading factor (fraction of collector aperture .Not shadow by the receiver).
T_a	Ambient temperature (°C.).
T_c	Collector temperature (°C.)
U_r	Absorber heat losses coefficient ($W/m^2.°C$).
$\eta_{collector}$	The efficiency of collector.
$\alpha\tau$	Transmittance of any glass envelope covering the receiver.

I. INTRODUCTION

Solar energy it is a source of energy which have high intensity in Iraq (latitude 32^o – 36^oN). The average solar radiation is (7 kWh/day) incident on it. This high solar radiation could be utilized to produce the steam and then could be used to produce electricity; because of the climate of Iraq is hot desert region. The major of electrical produce goes for A/C system in the house.

The basic principle of solar thermal collection is that when solar radiation is incident on a surface part of this radiation is absorbed and causes to increase the temperature of the surface [1]**.** The typical solar flux concentration ratio typically obtained is at the level of 30 – 100, for dish system, [2]. The Australian National University has re-engineered its Big Dish design for commercialization and mass production, building the $500m^2$ Big Dish solar parabolic concentrator for solar-thermal to electric energy conversion using direct-steam generation [3 – 5].

In this steady build experimental unit consist of solar dish 1.7m in diameter and helical coil receiver (12.5mm*3m) inside cylindrical vessel, the working fluid inside the coil is water.

II. MATHEMATICAL MODEL

To determine the useful energy obtained from solar dish, which is given as, [6]:

$$Qu = Qabs - Qloss \quad (1)$$

$$Q_u = (A_a \cdot p_{s\text{-}m} \cdot \alpha\tau \cdot ar \cdot S \cdot I_a) - A_r U_r (T_c - T_a) \quad (2)$$

Where:

$$A_a = \frac{\pi}{4} D^2 , \quad A_r = \frac{\pi}{4} d^2$$

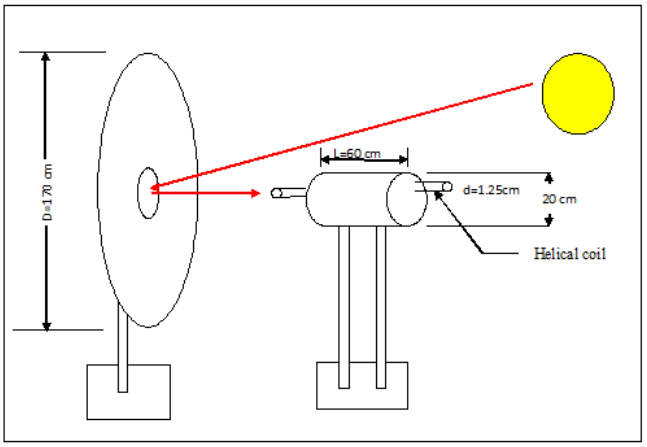

Fig (1) schematic diagram of concentrated solar dish.

The efficiency of the collector can be obtained from

$$\eta_{collector} = \frac{Q_u}{Ia \cdot Aa} \quad (3)$$

Concentration Ratio (CR) is the area of the collector Aperture (Aa) divided by the surface area of the receiver (Ar).

$$CR = \frac{A_a}{A_r} \quad (4)$$

III. EXPERIMENTAL WORK

In this experimental steady use the solar dish (1.7m) diameter, which is made from aluminum, covered by a pieces of mirror fixed in concentrated dish by glue, as shown in figure (2), it is supported by steel structure.

The dish is concentrated the solar radiation and reflected it to the receiver coil, which consist of helical copper coil (12.5mm in diameter and 3m length) that put inside vessel as shown in figure (3), that made from aluminum sheet in cylindrical shape (20cm diameter and 60cm length). The copper coil filled with water (1.47 liter).

This experimental work was run in 7-september / 2014, at 11:00 am. When the solar radiation reflected from the solar dish to the coil receiver, the temperature of the water is 38^oC

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at the first time, gradually increased until all the water is changed to the steam in the part of the coil, after that the steam is become superheated in the remained part of the coil, the temperature of the produced steam reach up to 115.7°C.

Fig (2), experimental work during the run.

Fig (3), Experimental cylindrical receiver.

IV. RESULT S AND DISCUSSION

The results of this experimental work shown in the following figures. Figure (4), show the variation of solar radiation during the day (7- September / 2014). We notice from the figure that intensity of solar radiation it is high (750 W/m^2).

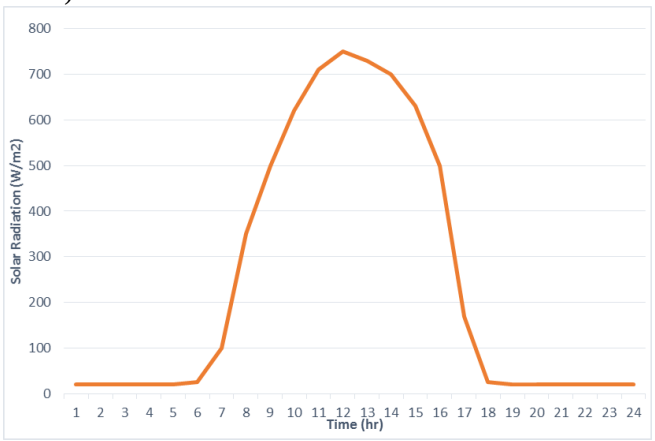

Fig (4), show the solar radiation during 7-september/2014 in Iraq.

Figure (5), show the variation of temperature with time for the water inside the receiver and the ambient, in clear day where ambient temperature semi constant and the temperature of the water increasing with the time.

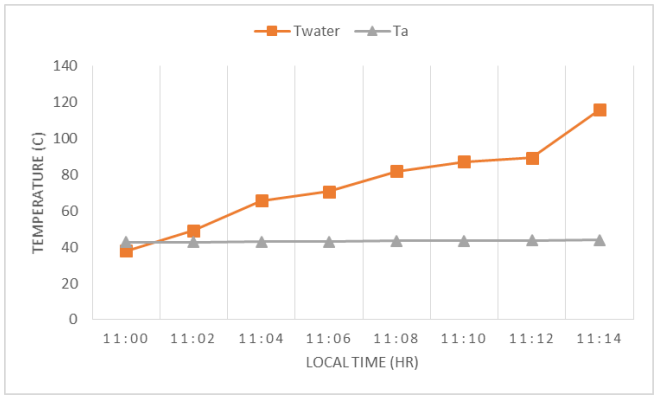

Fig (5), Variation of temperature with time.

The ambient temperature contributes in quantity of heat loss of the receiver. This experimental fact is demonstrated in Figures (6), This Figure shows a decreasing in heat loss coefficient by convection with increasing of receiver temperature.

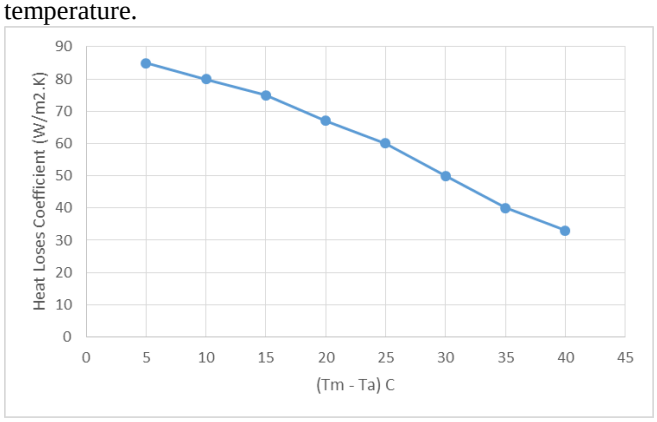

Fig (6) variation of heat loss coefficient by radiation with operating temperature of receiver.

V. CONCLUSION

We conclusion from this experimental work:

1- It is produce steam from solar energy.
2- Could be produce superheated steam when increase the length of the receiver coil.

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