

Design and fabrication of Solar dish array and study it characterization

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Email: yaseen.hameed67@gmail.com**Abstract**

Designed and fabricated a (3.25m) solar dish array ,by using (52) plane mirror. These mirrors are level and fixed to reflect the radiation in one area (focus) and after distance (1.5 m). In addition, it was found that the heat concentration (217.79 W) the useful energy (1416.125W) and the center efficiency were 55% at (400-700W/m²). The solar dish array is relatively suitable for solar thermal applications.

Keywords: Renewable energy, solar energy , solar thermal, solar dish array, solar concentration,

Introduction

Due to the shortage of conventional energy as well as the proliferation of environmental pollutants, the trend towards renewable energy, especially solar energy, was adopted where several research has been conducted to take advantage of solar energy in the sinks of energy and to reduce the pollutants that affect the layer of ozone, several works including designing by several authors and researcher were performed [1,2,3,4,5] and fabrication.

"a solar parabolic dish collector prototype for rural areas with high solar resource availability in Colombia, which have no access to electricity service or budget resources to purchase a stove (electric or gas).

which have no access to electricity service or budget resources to purchase a stove (electric or gas)." [6] , "parabolic dish collector is designed for generation of hot water which can be used for domestic applications. The simulation of dish collector is done in mat lab software" [7]. "A parabolic solar concentration dish has been modulated to solar water heater up 100 °C for an effective performance, the system required both continuous exposure of the dish to sunlight during the day time [8]. "Analysis Methodology developed for a PDSC system used for heating thermic fluid for process heating application. Keywords: Solar Concentrators, Performance Analysis, Solar Process Heating Application, Parabolic Dish" [9], "study and design of a solar collector, and of its cavity receiver, require solving a mathematical model that take into account the geometric, optical and thermal behavior of all components. The results of the simulation disclosed a model able to predict, adequately, the optical and thermal behavior of the described system, so that the model can be used to study the operation and also to design" [10].

Theoretical part**Reflectivity**

$$G_{tot} = \sqrt{(2 \times G_{conc})^2 + (G_{tracking})^2 + (G_{refl})^2 + (G_{abs})^2 + (G_{sun})^2} \text{ -----(2)}$$

Where angular errors are due to

- G_{sun} -sun ray not being perfect parallel
- G_{track} – concentrator alignment with sun
- G_{conc} – concentrator surface irregularities
- G_{refl} -non specular reflector
- G_{abs} - receiver alignment with focal point

"The manipulation of light and other EM waves can be achieved in a number of ways; it can reflect of a surface, transmit through a material without any effect, or be absorbed by the surface according to Equation (1)[11]:

$$\rho + \tau + \gamma = 1 \text{ -----(1)}$$

Reflectivity ρ , transmittance τ , and absorptivity γ .

Each coefficient describes the relative effect the surface has on the radiation that impinges upon it With absorption, the EM waves increase the energy of the impinging surface. Figure (1) shows the path of light striking a mirror for a specular reflecting surface the angle of incident equal to angle of reflecting" [11].

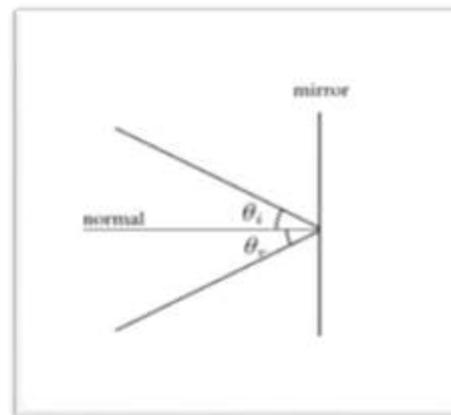


Figure (1) Show the Specular reflection surface.

Optical efficiency

To get the ideal concentration focuses all the light strike on the surface must reflect in to a single point focus. In fact, errors in dish optics lead to light deflection and increase the size of the beam. The total angular deviation can be calculated by Equation (2)[12]:

In solar dish array the reflect surface by plane mirror, the boiler consists of an absorbent, heat exchanger and possibly a heat tank. the radiation is absorbed by the absorption material in the form of heat, and the heat exchanger transfers thus energy to the outside of

the receiver '. Equation (3) Shows the energy balance of the receiver

$$Q_{out} = Q_{abs} - Q_{loss} \text{ ---- (3)}$$

Where Q_{out} is the output energy transferred to the working fluid

Q_{abs} The energy collected by the absorber

Q_{Loss} The energy lost in the receiver

The total recipient efficiency is given in equation (4) [12].

$$\eta_{rec} = \frac{Q_{out}}{Q_{abs}} \text{ ----- (4)}$$

Experimental work

The design and fabricated system were shown in Figure (2).



Figure (2) Show the fabricated solar dish array system.

A- Concentration

The solar dish concentrator, which consist of (52) piece of plane mirror with reflectivity of (95%) and all mirror is squared shape with area $(25 \times 25) \text{ Cm}^2$, Figure (3) show the concentrator After fixing the mirror.

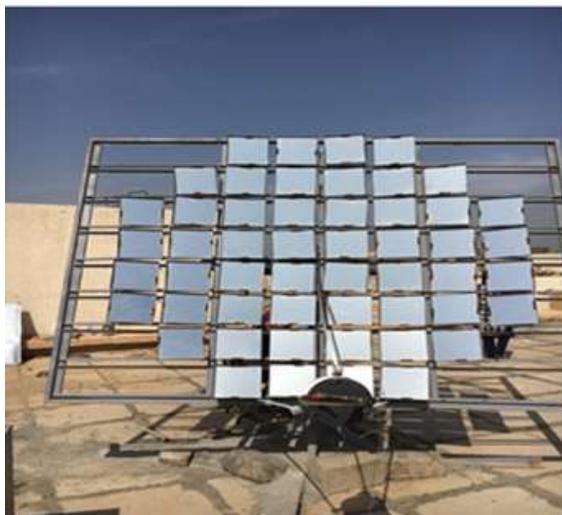


Figure (3) After fixing the mirror

B- Frame

The base of the mirrors is composed of iron in the shape of a rectangle with a dimension of (2.5×3) meters. It is divided into eight horizontal sections and three vertical sections. All square mirrors are fixed on a square metal base, which is fixed on the rectangular base by four screws length of (15) cm bolts fixed in each side So that the movement of mirrors can be controlled up, down, right and left, In this way it is possible to direct all the mirrors so that the radiation falls on one area, the focus Figure (2,3)

C- Based

The base of the dish consists of a base consisting of 3 parts, an upper part of the dish's length. The height of this part is 50 cm. The length of the arm is 87 cm. This arm is connected to it. Half a rotary disk with a radius of 30 cm. (78 cm) and half a rotary disk (30 cm) to move the dish to the right and left by large bolts. The upper part is connected to the bottom by (4) joints (3 cm) and (7 cm) length, the bottom and the last height is about 64 cm. It has 4 arms to hold the dish firmly in the ground, the length of each arm (130 cm) Figure (4).



Figure (4) Show the base of concentrator.

D- Receiver

A cylinder metal with a thickness of (5) mm, diameter of the face of the (20) cm and a length of (22) cm rolled copper tube length of (5) m and

diameter (0.6) mm in the shape of a helically like, the final edge of the tube is removed from the rear of the cylinder Figure (5).



Figure (5) Show the front and back of the receiver (boiler) face and piping

E- Storage tank and Piping: by using tank for Freon gas with volume (10) litter , and modification

by fixed inlet and outlet faucet for water Figure (6).



Figure (6) Show storage tank modification

Result and discussion

The Solar Radiation in Tikrit was recorded and measured at clear day–March 2017 we see increasing in solar radiation with time from sun shine to mid

noon and decreasing after that, the peak of solar radiation is (800 w/m²) at (1a. m) ,so the temperature increasing at this time Figure (7) .

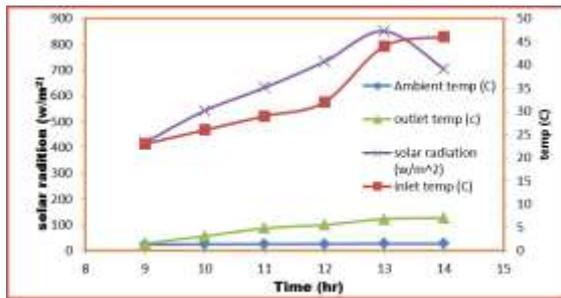


Figure (7) show the variation of solar radiation and temperture with time

When solar radiation increased the temperture and Useful energy increased table (1) .

Table (1) characterization of array concentration

Surface collecting	3.25 m ²
Focal distance f	1.5 5 m
Efficiency	55 %
Heat lose energy	217 W
Useful energy	1416W

Figures (8) shows a increasing in heat loss coefficient by convection with increasing wind speed because receiver temperature decreasing The heat moves around the boiler into the atmosphere this result agree with resercher. When low speed wind the temperatuer of boiler is too high like(black body Radiation) the flow rate of water is low so as the heat travels to the water and rises rapidly until it turns into steam , thus increasing of the heat transfer as shown in Figure (9) this result agree with resercher [12, 13].

This increase in temperature leads to heat transfer speed and increasing the efficiency of [11]

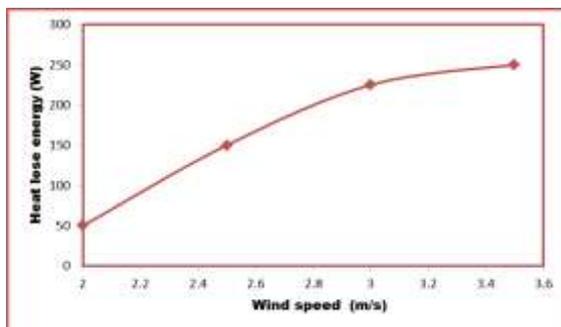


Figure (8) show the relation between wind speed and heat loss energy of receiver

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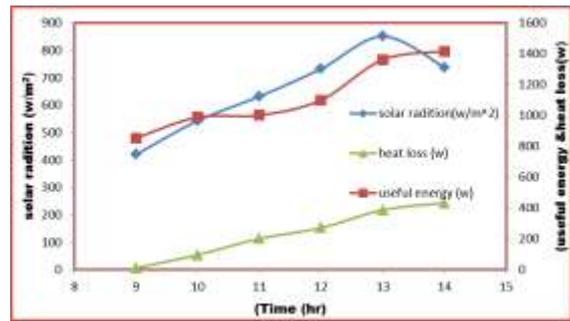


Figure (9) shows the variation of solar radiation , useful energy and loss energy, with time .

The amount of thermal energy that was being transferred from the concentrator to the receiver, which results in a collector efficiency of (65) percent .From the equation (3), The efficiency has been the utmost at the beginning of the operation. However, it gradually decreased with the time. The temperature of the operation system was dropped to(T⁴) to receiver’s temperature of the cylindrical boiler as the radiation losing energy operates proportional. The latter confirms its suitability for operation as shown in (Figure10) [12,13]

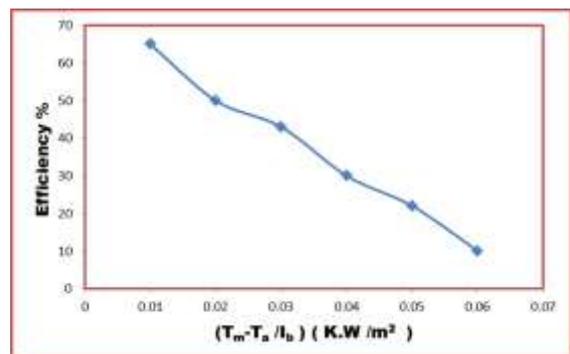


Figure (10) Variation of instantaneous efficiency with temperature.

Conclusion

Array solar dish concentration is a good example for solar thermal, there are many applications for this dish . one of this application for water heating and drive for steam and stirling engine .Also study the solar radiation in Tikrit we find out that the solar radiation is suitable for Solar thermal application and a so as. The concentration is relative perfect with fast wind speed otherwise high income temperature with increasing solar radiation, and when increasing the area for solar array the temperature increasing faster to super temperature, easy and chip.

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تصميم وتصنيع مركز شمسي طبقي بشكل مصفوفة ودراسة خصائص

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الملخص

تم تصميم وتصنيع مركز شمسي طبقي بمساحة (3.25 متر) على شكل قطع من المرايا بعدد (52) وهذه المرايا مستوية وثبتت بحيث تعكس الاشعاع في منطقة واحدة (البؤرة). وعلى بعد (1.5) متر. كما تم استخدام مستلم اشعاع اسطواناني (كمسخن) ووضع بالبؤرة , حيث وجد عامل ان التركيز(58), اما عمليا فقد وجد ان خسائر الحرارة تقريبا (17.79 W) والطاقة المفيدة (1416.125W) وكفاءة المركز 55% عند (400-700W/m²). المركز المصنع مناسب نسبيا للتطبيقات الشمسية الحرارية.