Performance analysis of Asymmetric Compound Parabolic Concentrator

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Abstract *- Compound parabolic concentrator can accept incoming radiation over a relatively wide range of angle by using one or multiple internal reflections. Any radiation that is entering the aperture, within the collector acceptance angle, will hit the absorber surface located at the bottom of the collector. In this asymmetric compound parabolic collector, the stored water is heated by means of solar radiation. The design is according to the reflection of the sun rays is fall in the reflector and the reflector which reflect the sunrays to the absorber and water is heated. Here, polished stainless steel is used as the reflecting medium and tin cylindrical drum is the absorber which absorbs the heat and light from the reflector and then the water is started to heat. The whole set up is placed in the direction of North and South because the sunlight always hit the reflector to give the greater heating temperature of the water. The polished stainless steel plate 8 feet length and 4 feet breadth is bended according to the design for greater efficiency. The thickness of the polished stainless steel plate is 2mm. The tin cylindrical drum is the absorber which used to store the water. In this two small drum is used rather than the big one because the water is easily heated within the short duration of time than the big drum. After fabrication of the project as per the design, then it is ready to take a reading. While taking the reading, polished stainless steel surface temperature, both drum surface temperature, radiation of the sun, storage water temperature is to be considered. Approximately 50 degree celcius to 80 degree celcius is to be obtained.*

Keywords **– Parabolic concentrator, Internal reflections, Absorber plate, Solar water heating.**

I. INTRODUCTION

The efficiency of solar collection is considered to be dependent upon design of the concentrator and the operation to harvest concentration of the incident solar radiation. Asymmetric compound parabolic concentrator is used to reflecting the wide range of the solar radiation to the absorber. The symmetrical version of compound parabolic collector is further modified to increase the efficiency of heating the water as the name of the asymmetric compound parabolic concentrator. Alternative to asymmetric compound parabolic concentrator (ACPC) has been further developed make the solar radiation to concentrate more on the collector when performing on the same acceptance angle. The efficiency of the upgraded asymmetric compound parabolic concentrator (ACPC) could be upto approximately 3.6 times higher than the symmetric design. The system operation of asymmetric compound parabolic concentrator (ACPC) is capable of boiling water, convenient and there is no need to adjust the (ACPC) unit to accommodate the changing orientation of sunray over the operating time.

Non-uniform distribution of the solar radiation in the reflector may be varied due to the misaligned collector is the problem leading to reduce the collector efficiency. The mathematical calculation is used to identify the absorb thermal energy, and know the heat loss during the operation, and to identify the effect of heat capacity on the performance of the collector. This methods are used to predict the thermal efficiency of the project. Solar driven technology is the attractive technology due to the cost effective. The water disinfection is the technology which is studied to prevent the water from the infection. In many countries this technology is used to produce the clean water and to reduce the disinfection contaminated in the water. Asymmetric compound parabolic collector is used the copper tube in the backside of the reflecting plate to absorb heat from the reflector and the flow of water is to be measured by the rota-meter, finally the heat is absorbed from the reflector and it is absorbed by the copper tube and heated water is stored in the tank for the further application.

The basic of compound parabolic collector in the design. Still there is no updation of the design of the compound parabolic collector by the scientist. However, it is hard to find the review and to discussing the basic of the compound parabolic collector studies in recent years. This paper aim to summarise the compound parabolic studies to update the design changes and to increase the radiation reflecting from the reflector and finally increase the overall efficiency of the compound parabolic concentrator.

II. EXPERIMENTAL METHODOLOGY

A. Assumptions

1) One dimensional heat conduction;
2) The system is in quasi-steady state;

B. Experimental Setup

The experimental set-up is illustrated in Fig.2, which is a water collector. The specifications of the set-up are as follows:

1. Polished stainless steel plate
   Size = 8*4 feet

Thickness = 0.8 mm

2.Ferrous flat plate bar
Length = 40 m
Thickness = 5 mm

3.Ferrous angle bar
Length = 30 m
Thickness = 5 mm

4.Tin cylindrical drum
Diameter = 8.5 inch
Length = 4 feet
No.of drum = 2

C. Working Principle

The bore well water is filled in the two cylindrical drum of capacity 30 litres each. The sun rays from the sun which fall on the polished stainless steel plate which is used to reflect the sun rays to the cylindrical drum. The thermocouple is placed in the cylindrical drum to measure the temperature of the water as well as the temperature of the surface of the cylindrical drum. The polished stainless steel plate surface temperature is also measured by using thermocouple and infrared thermometer. The whole set up is placed in the direction of north-south, hence the sun light falls throughout the day without adjusting the setup. Then the temperature is measured throughout the day .

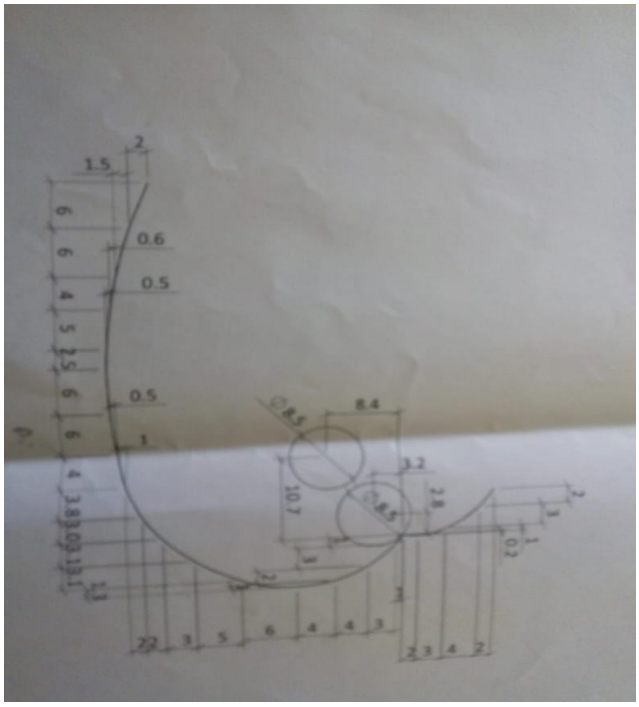

Fig. 1 2D Layout

Fig. 2 Experimental set-up

III. RESULTS AND DISCUSSION

TABLE 1: READING

Time	Atm Temp	Drum 1 Temp	Drum 2 Temp	Surface Temp
10:30	34.5	39.9	39.5	59.6
10:45	31.2	38.8	40.3	59.2
11:00	36.6	39.8	40.8	59.8
11:15	38.0	39.0	40.0	60.7
11:30	34.0	40.2	39.9	62.3
11:45	37.1	41.8	41.1	65.0
12:00	38.9	43.0	42.3	68.9
12:15	38.9	43.7	42.4	66.1
12:30	38.8	44.9	43.4	68.6
12:45	37.5	46.7	44.2	67.9
1:00	38.4	48.2	44.8	68.3
1:15	38.5	46.7	44.2	68.8
1:30	37.4	39.5	46.2	65.0
1:45	38.7	35.5	47.3	66.8
2:00	38.6	33.8	47.7	68.2
2:15	37.5	32.1	48.4	62.4
2:30	37.1	33.1	49.1	63.5
2:45	39.1	33.0	50.6	63.6
3:00	39.5	33.0	50.4	65.5
3:15	40.0	33.0	51.3	58.0
3:30	39.2	32.7	53.7	60.3
3:45	39.0	32.2	56.6	58.1
4:00	39.2	34.1	54.7	52.3

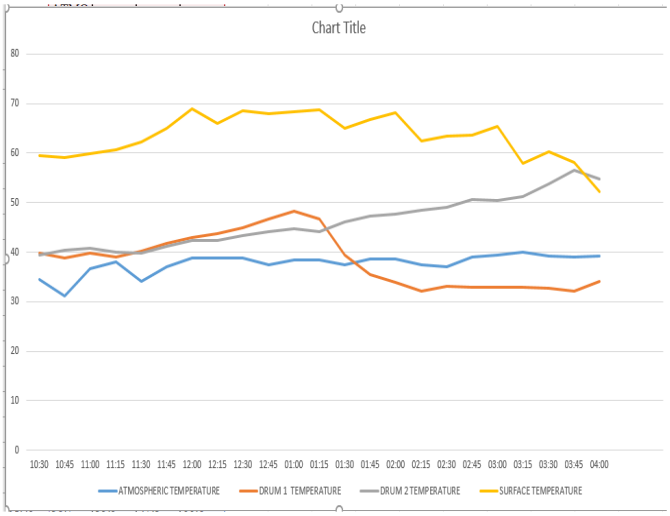

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Fig 3: Variation of Temp of water w.r.t Time

Fig 5: Variation of Temperature w.r.t Time for Air collector

The temperature is obtained from thermocouple and infrared thermometer. The normal bore water is filled in the drum, during day time the water is heated by the reflecting medium of polished stainless steel plate. The reflection of the rays are used to increase the temperature of the water which is filled in the two seperate drums.

The readings were taken after attaining steady state conditions. Data such as Temperature for water, surface temperature of both drum and polished stainless steel respectively are taken on March 01 of 2020 and average readings were noted down. Experimental results show that, the values temperature of water collector is found to be increasing from 39 degree celcius to 54 degree celcius and then decreases gradually from 14.00 to 16.00.

IV. CONCLUSION

Hence, the purpose of solar energy is used for producing hot water and power all the requirements are fulfilled within a single frame. The differently configured model for the production of hot water has been constructed and it is experimentally investigated successfully.

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