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DEVELOPMENT OF 2D COMPOUND PARABOLIC CONCENTRATING SOLAR COLLECTOR FOR ITS DIFFERENT SURFACE TEMPERATURE ANALYSIS

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ABSTARCT:
A device which absorbs radiation from Sun is known as solar collector. Concentrating collectors are used when the temperature requirement is more than 100˚C. A 2-D (Two dimensional) CPC (compound parabolic concentrator) solar collector with flat Mild steel sheet absorber plate has been built. This CPC is consist of two Stainless steel parabolas which is located at left and right end of the absorber plate. Other two sides are enclosed with acrylic sheet to make the device enclosed. After the calculation for the dimensions of this CPC, truncation is done which saves a large amount of reflector material with a negligible loss of concentration ratio. As the top most part of the device does not collect much radiation by truncation we can reduce the height as well as the cost of device. This 2-D CPC is designed having CR (concentration ratio) of 4.3.The temperature analysis for the flat Mild steel absorber plate, aperture surface and two Stainless steel reflectors is carried out for this 2D CPC. It has been observed that higher temperature is achieved at blackened Mild Steel absorber plate.

Keywords: *2D, cpc, absorber.*

1. THE MAIN TEXT

The device which is used to collect the heat from the sun in the form of radiation and transfer this collected heat to the fluid passing in contact with it is known as solar collector.
Solar collectors are mainly classified into two types: [1] Flat plate collectors, [2] Concentrating collectors.
When higher temperature (>100˚C) are required, it becomes necessary to concentrate the radiation. Compound parabolic concentrator is of the non-imaging type concentrating solar collector. CPC consist of two parabolic reflectors at the two ends (left and right) of the absorber plate and hence it is known as compound parabolic concentrator. The major advantages of 2-D CPC are that, it can receive radiation arriving with large angular spread and yet concentrate it on to linear receivers of small transverse width. Here the incident rays after reflection from the reflector are not focused at a point, but are simply collected on a absorber surface. Winston (1974), First of all developed the CPC with flat plate absorber in 1974.
The CPC could be used in a great variety of solar applications such as solar water heating; space heating and hot water production, heat pumps, industrial air and water systems for process heat; desalination (multistage flash, multiple effect boiling, vapor compression); and solar chemical systems for thermal power systems.
The present work is focused to build a new type of 2-D CPC with flat absorber for temperature analysis.

2. DEVELOPMENT OF 2D CPC

This 2-D CPC contains major three components:
[1]Aperture: Made from toughened glass of 4 mm thickness.
[2]Reflector: Two numbers of reflectors in the shape of parabolas are made of SS mirror image sheets.

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[3]Absorber: It is the component of CPC where the whole amount of heat after reflection is absorbed. It is made of MS (16 gauge) thick sheet with blackened coating on it.

With the help of different formulas a truncated CPC has been developed having dimensions:
Height of CPC: 98 cm
Absorber width: 20 cm
Aperture width: 86 cm
Concentration Ratio: 4.3

3. EXPERIMENTAL PROCEDURE:

The fabricated CPC is than tested for several days in different months under outdoor conditions. The constructed CPC was installed and tested. Temperature readings were taken for the surface of absorber, aperture and reflectors. Also solar radiation intensity is measured throughout the day on which the readings were taken.

Fig. 1. Experimental set up

Instruments used for experiment:

1. Thermocouples: A thermocouple is a sensor for measuring temperature.The thermocouple alloys are commonly available as wire. Here Iron constantan type thermocouples are used to measure the temperature of absorber, reflector and aperture.

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2. Digital Temperature Indicator: This instrument display the temperature (in degree centigrade)of the surface to which thermocouple is attached

3. Pyranometer : It shows the intensity of solar radiation in W/M^2 at different IST.

4. RESULTS AND DISCUSSION

Different temperature analysis is made here for the different surfaces.

Fig. 2. Surfaces of CPC

Table.1. represents the observation table for a day on which the readings were taken .

Table 1. Observation Table

Sr no	IST	Intensity of Solar Radiation (W/M^2)	Aperture Surface Temperature(˚C)	Reflector surface Temperature(˚C)	Absorber Surface Temperature(˚C)
1	10	625	42	52	67
2	11	790	43	59	82
3	12	1030	43	63	103
4	13	1200	41	65	120
5	14	890	38	52	107
6	15	750	32	49	90
7	16	725	32	43	70

Observation table shows that the radiation or heat from the sun is very low up to noon and goes on increasing after noon. Here aperture surface has transmitivity so it transmits all most radiation on to the reflector and absorber plate surface. Both the reflectors surface reflects the radiation on the absorber surface .This leads to the maximum radiation from the sun is absorbed at absorber resulting into higher temperature at absorber surface.

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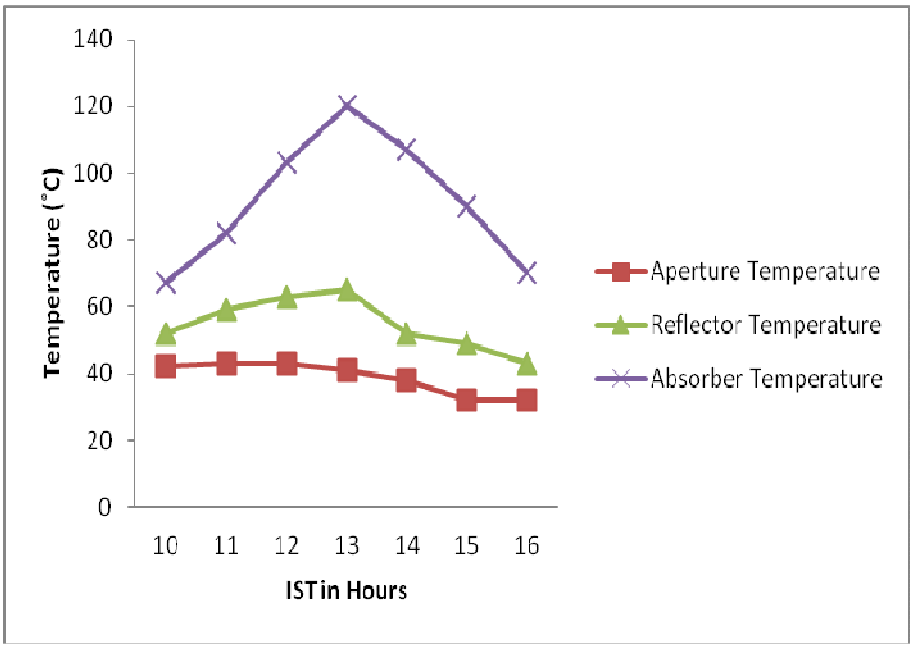

Chart.1.Temperature of Surfaces versus Time of the day

5. CONCLUSION

Mild steel sheet absorber plate with mat finish black coating absorbs the maximum amount of radiation from the sun which results into maximum temperature achievement at absorber plate surface compare to both the reflector and aperture surface of the fabricated 2-D CPC.

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