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Design and Development of Parabolic Trough Solar Concentrator

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Abstract:
As the conventional sources are depleting day by day it is essential to introduce alternative sources of energy to meet future demands. With this an attempt has been made to utilize solar energy by introducing parabolic trough concentrator. It is an advanced version of solar collector which minimizes all kinds of heat losses, those are possible in case of flat plate collectors. In this project a parabolic collector is to be designed for water heating system by placing it in a required position. ficiency than non-tracking system, the percentage of efficiency increased of average 37%. There is a considerable scope for increase in efficiency for automatic tracking mechanism. Abdul jabber et. al. [2] worked on effect of 2-axis sun tracking on the performance of compound CPC. An experimental study was performed to investigate effect of two axis sun tracking system on performance of CPC; the tracking collector showed a better performance with an increase in collected energy up to 65% compared with identical fixed collector.

II. EXPERIMENTAL SETUP:

In Experimental setup, parabolic trough collector having an

Keywords: aperture area 0.5 m and focal length 0.305m, is used for solar air CPC, non-tracking system, solar energy

I. INTRODUCTION:

Development of single axis universal automatic tracking system for used in solar devices like flat plate collector, Cylindrical Parabolic Collector and photovoltaic module will increase solar collection as well as efficiency of devices. In this work two experimental setups used simultaneously are tracking and non-tracking arrangement systems. Tracking system with CPC tracks according to sun movement from east to west direction. But in the non-tracking system of CPC no tracking takes place with sun movement. Two identical CPC with same specifications were used for conduction of experiments and observed the output of cylindrical parabolic collector with tracking and non-tracking arrangement systems with the variation of time. P. Rhushi Prasad et. al. [1] conducted an experiment on cylindrical parabolic collector with and without tracking system in winter and partly cloudy days, it was found by tests that collector with tracking system was of higher heating. The schematic diagram and experimental setup of parabolic trough collector are deseribed as follows

A. Reflector:

Reflector is one of the vital part of the parabolic trough collector as it decides the fraction of solar irradiance to be collected by the absorber tube.

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A parabolic reflector reflects and concentrates all the sun rays on the absorber tube. The reflector is a parabolic shaped galvanized stainless steel sheet

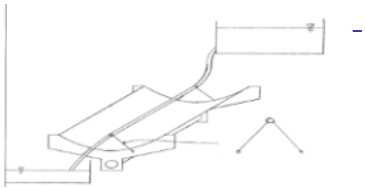

Fig. (a) Experimental set up Line – Diagram.

perpendicular to the plane of aperture area. When the solar radiations fall on the aperture area of the parabolic trough collector, these radiations are concentrated on the absorber tube. This causes the heat transfer from the surface of the absorber tube to the air flowing inside the absorber tube and air gets heated up. The copper coil increases the obstruction to the water flow due to which contact time (residence time) of water with in the absorber tube is increased and it increases the temperature of the outlet water . Two water flow rates are considered categorized as high water flow rate and low water flow rate.

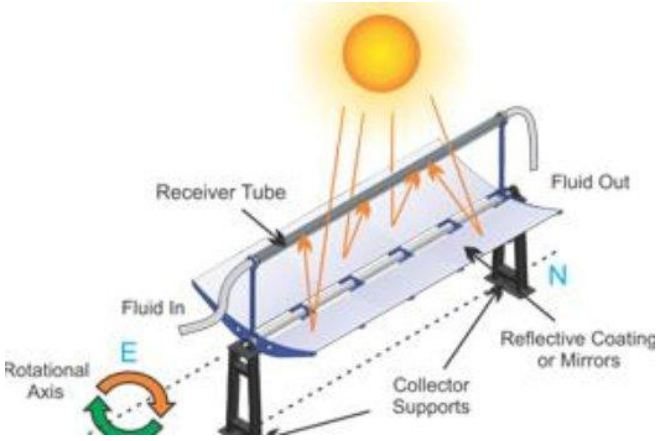

Fig.(b)Drawing of the experimental setup

B. Absorber Tube:

The absorber tube is placed at the focal length of the parabolic trough collector. The outer diameter and inner diameter of absorber tube are 12.7 mm and 13.4 mm respectively along with a length of 1.22m. The solar radiations reflected by the parabolic trough collector are collected by the absorber tube. Water is used as working fluid in the absorber tube.

III. MEASURING DEVICES:

An infrared thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called blackbody radiation emitted by the object being measured. They are sometimes called laser thermometers if a laser is used to help aim the thermometer, or non-contact. Thermometers or temperature guns, to describe the device's ability to measure temperature from a distance. By knowing the amount of infrared energy emitted by the object and its emissivity, the object's temperature can often be determined. Infrared thermometers are a subset of devices known as "thermal radiation thermometers".

Fig.(c)An infrared thermometer.

IV. SYSTEM OPERATION:

The parabolic trough collector is manually non tracking system on each day before the reading starts so that the solar radiations fall on the reflector which reflects these radiations to the absorber thus this absorber absorbs the heat through absorbs and this heat is carried through the fluid which flow through the absorber.

V.EXPERIMENTAL RESULTS AND DISCUSSION:

Cylindrical parabolic collector was formed in Kurukshetra and used to heat the air by manual tracking. Using this parabolic trough collector,

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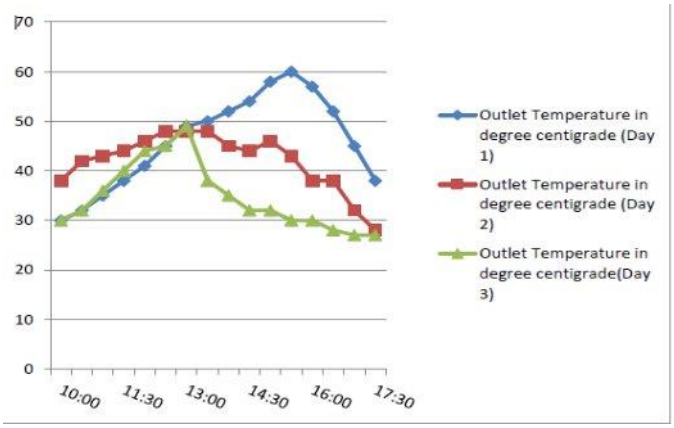
thermal performance of various reflectors is found out. Various experiments are performed to check the thermal performance of various reflectors on parabolic trough collector. The concentrator has an aperture of a length of 1.22mm, while the absorber tube (12.7mm inner and 13.4mm outer diameter) Such a parabolic trough collector is used to check the thermal performance of various reflecting sheets. When the radiation falls on parabolic trough collector reflector then whole of the radiations will be collected on a line of absorber where the absorber is placed.

A. Variation of solar intensity temperatures with time for stainless steel sheet as reflector.

The collector was exposed to solar radiation for half hour before the start off reading and experimental data recorded after regular intervals of half hour during the day time (10:00 hour to 18:00 hours)



Graph.(d) Variation of temperature with time for daily wise

From the graph it is analized the out let temperature of water is 10:00 hours which increases gradually with time and reaches its maximum 60^0c 14:00 hours after that temperature starts decreases gradually this is because solar radiation falls perpendicularly and the trough and most of radiations are collected on given length of absorber.

VI. Advantages, Limitations and Applications of solar:

ENERGY:

Advantages and Limitations of Solar Energy Renewable energy sources in general, and Solar Energy source in particular, has the potential to provide energy services with zero or almost zero emission. The solar energy is abundant and no other source in renewable energy is like solar energy. Every technology has its own advantages and disadvantages. As the solar insolation and atmospheric conditions vary significantly from place to place, efficiency of solar energy also differs accordingly.

(a) Advantages:

- ∑ It is an abundant Renewable Energy
- ∑ This technology is Omnipresent and it can be captured for conversion on a daily basis.
- ∑ It is a Non-polluting technology, which means that it does not release green house gases.
- ∑ It is a Noiseless technology as there are no moving parts involved in energy generation.
- ∑ This technology requires Low-maintenance because of lack of moving parts.
- ∑ It can be installed on modular basis and expanded over a period of time.
- ∑ Most viable alternative for providing electricity in remote rural areas as it can be installed where the energy demand is high and can be expanded on modular basis.

(b) Limitations:

- ∑ As the technology is in an evolving stage, the efficiency levels of conversion from light to electricity is in the range of 10 to 17%, depending on the technology used.
- ∑ The initial investment cost of this technology is high. At present the technology is basically surviving because of subsidy schemes available by the government.

∑ Solar energy is available only during daytime. Most load profiles indicate peak load in the evening/night time. This necessitates expensive storage devices like battery, which

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need to be replaced every 3 to 5 years. Generally, the cost of the Battery is 30 to 40% of the system cost.

∑ As the efficiency levels are low, the space required is relatively high. For instance, with the existing levels of technologies, the land required for putting up a 1 MW solar PV power plant is between 6 to 9 acres. However, research is going on to increase the efficiency levels of the cell.

∑ Solar energy is heavily dependent on atmospheric conditions.

∑ Solar isolation varies from location to location, so there are certain geographic limitations in generating solar power.

∑ With the existing module and inverter manufacturing technologies, it may not be worthwhile in terms of costs to deploy solar energy for certain loads which require very high starting power (e.g. air conditioners).

(c) Applications of solar energy:

Power plants: In conventional power plants non-renewable energy sources are used to boil water and form stream so that turbines can rotate and water to produce electricity. But with application of solar energy heat of sun can boil that water to create steam and rotate turbines. To convert sunlight into electricity solar panels, photoelectric technologies and thermoelectric technologies etc are used.

1. **Homes:** Use of solar energy is increasing in homes as well. Residential appliances can easily use electricity generated through solar power. Besides this solar energy is running solar heater to supply hot water in homes. Through photovoltaic cell installed on the roof of the house energy is captured and stored on batteries to use throughout the day at homes for different purposes. In this ways expenditure on energy is cutting down by home users.
2. **Commercial use:** On roofs of different buildings we can find glass PV modules or any other kind of solar panel. These panels are used there to supply electricity to different offices or other parts of building in a reliable manner. These panels collect solar energy from sun, convert it into electricity and allow offices to use their own electrical power for different purposes.
3. **Ventilation system:** At many places solar energy is used for ventilation purposes. It helps in running bath fans, floor fans, and ceiling fans in buildings.
4. **Power pump:** Solar power not just help in improving ventilation system at your homes but with that it can also help in circulating water in any building. You can connect power pump with solar power supply unit but you must run it on DC current so that water circulate throughout your home.
5. **Swimming pools:** swimming pools are great joy for kids and adults in all seasons. But during winters it is tough to keep water hot in these pools with minimum power usage. Solar energy can help many in this matter as well. You can add a solar blanket in the pool that will keep the water hot with energy generated from sunlight. Besides this you can install a solar hot water heating system with solar hot water heating panels.
6. **Solar Lighting:** these lights are also known as day lighting, and work with help of solar power. These lights store natural energy of sun in day time and then convert this energy into electricity to light up in night time. Use of this system is reducing load form local power plants.
7. **Solar Cars:** it is an electrical vehicle which is recharged form solar energy or sunlight. Solar panels are used on this car that absorb light and then convert it into electrical energy. This electrical energy is stored in batteries used with the car, so that in night time as well we can drive these vehicles.
8. **Remote applications:** Remote buildings are taking benefit of solar energy at vast

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scale. Remote schools, community halls, and clinics can take solar panel and batteries with them anywhere to produce and use electric power.

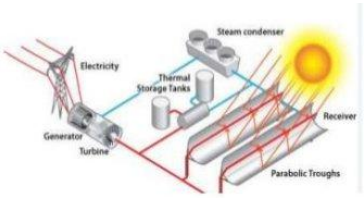

Fig.(e)Application layout of solar parabolic trough concentrator.

VII. Existing Solar Collector Technologies:

A solar collector can generally be described as an element which concentrates the solar energy incident over a large surface onto a smaller area. Using reflecting elements, the flux density onto an absorber surface is increased compared to that of the concentrator. In addition, the shapes of the concentrator will define whether the area of incoming solar energy is focus onto a line or a point. In order to quickly develop new collector technologies, it is important to understand what has already been achieved in the field of large scale solar. Developments in smaller designs may also become relevant to larger designs with the right modifications. This section provides an overview of solar collector types, which can be categorized by the method of concentration, whether the collector is tracking or non-tracking, and whether the mirror elements are monolithic curves or faceted in a Fresnel-type construction. Advantages of each focusing concept are discussed below.

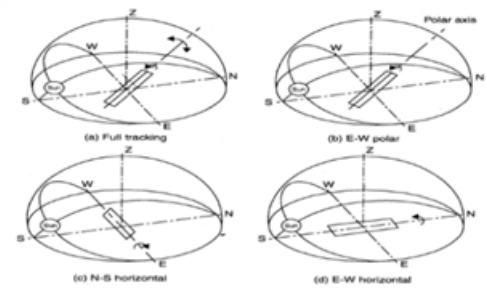

Fig.(f)Solar Tracking Scheme

VIII. Future work:

- ∑ Optical design and fabrication of solar concentrator for photovoltaic.
- ∑ The PTSC can be analyzed with several types of operation fluids as a working fluid.
- ∑ Design and fabrication of a new trough, possibly made from composite materials, to make lighter and more durable.
- ∑ Parallel to the experimental work, a numerical analysis can be used to compare the results of both theoretical and experimental investigation to optimize the collector design.

IX. Conclusion:

It is concluded that the experiment on performance analysis of parabolic collector with tracking and non-tracking system. The efficiency of both tracking and non-tracking is calculated and it is found to higher for the tracking system. Due to unusual weather condition, less radiation was obtained, as it was cloudy and windy. The efficiency would have been further increased if these climatic conditions didn't prevail. There is a consider scope for increase in efficiency for automatic tracking system. From above calculations, tables and graphs it was observed that the efficiency for the tracking system was higher than that of non- tracking system, The result has calculated on daily, weekly and monthly basis. The temperature readings were taken from morning 9.30am to evening 5.30pm for both tracking and non-tracking systems. The efficiency calculations were done as above. Here we considered the average readings for daily, weekly and monthly result.

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X. REFERENCES:

[1] obviously Rapp, Donald, Solar Energy. Prentice-Hall, Englewood Cliffs, NJ, 1981.

[2] Gavin D. J. Harper, "Solar Energy Projects", Copyright © 2007 by the McGraw-Hill Companies, Inc. All right reserved. Manufactured in the USA.

[3] Duffie John A., and Beckman W. A., "Solar Engineering of Thermal Processes", 2nd edition. Wiley, New York, 1991.

[4] Pablo F. Ruiz, "European Research on Concentrated Solar Thermal Energy", \European Communities, 2004

[5] Philibert C., "The Present and Future Use of Solar Thermal Energy as a Primary Source of Energy", Copyright 2005 by Inter Academy Council All rights Reserved.