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Performance Analysis of Parabolic Solar Trough Concentrator for Various Reflecting Material

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Abstract: The Parabolic Solar trough Concentrator is very helpful because it is used for nearly all applications of solar energy like water steam and hydro power generation, solar water heating, solar air heating, etc. In this research work, the parabolic solar trough concentrator's performance analysis is performed using various reflecting materials. A Parabolic trough solar concentrator for hot water production system is analyzed by using various reflecting materials. Here, water is used as a working fluid and is recalculated through the copper tube with the help of a water pump from the storage tank to the absorber tank. The main objective of the work is to increase to a maximum value the temperature of water in the storage tank and tube. An assessment focuses primarily on the material of the reflector.
Keywords: Parabolic solar trough, reflecting materials, heat gain, efficiency.

I. INTRODUCTION

The design and development of a parabola solar water heater for domestic hot water applications was reported. He found that the heater provides a family of four members with 40 liters of hot water a day, assuming that every family member requires10 liters of hot water a day[1]. He initially expected the model to achieve 50 percent thermal efficiencies, but he achieved 52 percent-56 percent thermal efficiencies and this range of efficiencies is higher than the planned designed quality. With the growing population and rapid development pace, energy is becoming more costly to produce and our towns and cities are facing a major power crisis. The truth is that resources such as coal, oil and natural gas are not going to be around forever [2]. Today we all realize that we need renewable energy alternatives. The source of renewable energy is natural resources such as sunlight, wind energy, tides and geothermal heat. Recent increase in energy demand and constraints in supply of energy becomes a priority for the different industry [3]. Very few research attempts have been done to estimate the significance of energy required for the different process. In this experimental study alternative use of solar energy has been studied. Solar energy is a high temperature, high-energy radiant energy source, with tremendous advantages over other alternative energy sources. It is a reliable, domestic, robust renewable resource with large undeveloped potential, and it emits essentially none of the atmospheric emissions that are of growing concern. The design and fabrication of parabolic trough solar water heater for water heating was executed. The procedure employed includes the design, construction and testing stages. The equipment which is made up of the reflector surface (curved mirror), reflector support, absorber pipe and a stand was fabricated using locally sourced materials. This work presents a reproducible parabolic trough solar water heater as a suitable renewable technology for reducing water-heating costs and solar water heating systems with optical concentrating technologies as important entrants for providing needed bulk solar energy [4]. Parabolic trough power plants are the only types of solar thermal power plant technology with existing commercial operating systems. Parabolic- trough concentrators are frequently employed for solar steam- generation because temperatures of about 300 can be obtained without any serious degradation in the concentrator's efficiency. The incident solar-radiation falling on the concentrator is utilized for pipe heating. Inside the pipe, the thermal fluid flows and its temperature increases due to the incoming radiation.

II. DESIGN

A parabolic trough is shaped as a parabola in the x-y plane, but is linear in the z direction. A parabolic trough is made of a number of solar concentrator modules (SCM) fixed together to move as one solar concentrator assembly (SCA). A SCM could have a length up to 15 meters (49 ft 3 in) or more. About a dozen or more of SCM make each SCA up to 200 meters (656 ft 2 in) length. Each SCA is an independently-tracking parabolic trough .In 2009, scientists at the National Renewable Energy Laboratory (NREL) and Sky Fuel teamed to develop large curved sheets of metal that have the potential to be 30% less expensive than today's best concentrators of concentrated solar power by replacing lass-based models with a silver polymer sheet that has the same performance as the heavy glass mirrors, but at a much lower co stand weight. It also is much easier to move and install. The glossy film uses several layers of polymers, with an inner layer of pure silver. As this renewable source of energy is inconsistent by nature, methods for energy storage have been studied, for instance the single-tank (thermo cline) storage technology for large-scale solar thermal power plants. The thermo cline tank approach uses a mixture of silica sand and quartzite rock to displace a significant portion of the volume in the tank. Then it is filled with the heat transfer fluid, typically a molten nitrate salt.

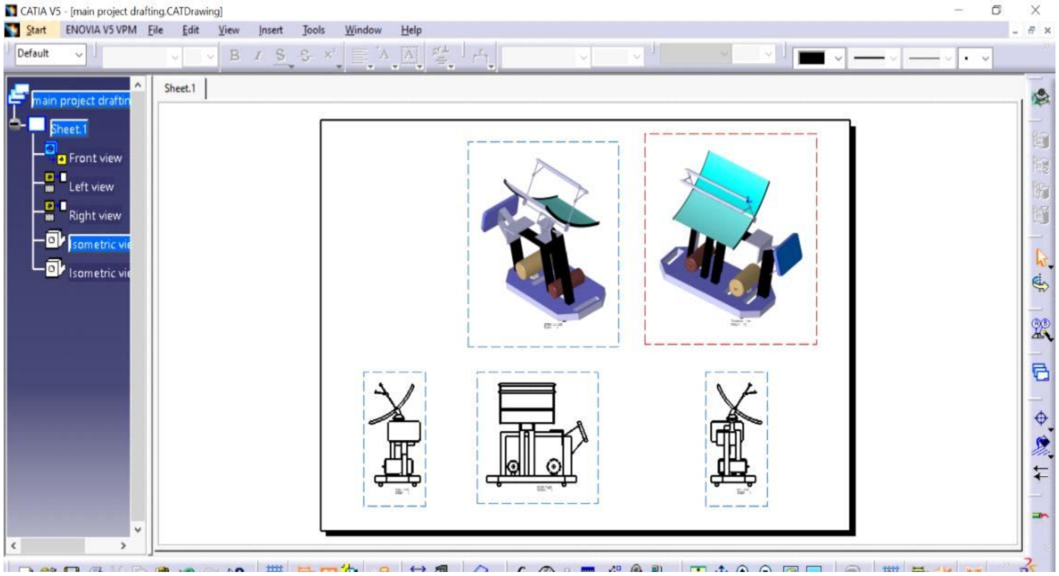

Fig 1. CATIA DESIGN for the experimental setup

III. WORKING PRINCIPLE Of PTSC

It is having a reflector of parabolic shape to replicate the direct solar radiation and focused them on top of the focal line of the parabola. A receiver tube is employed on this focal axis, to absorb the focused solar radiation flux. It is prepared with stainless steel, iron or copper and coated with a careful coating on the outside surface. The coating is having a high absorption power for entering radiations but low emitting power for the infrared radiations in the solar energy spectrum to decrease the thermal radiation losses. Inside the receiver tube, heat transfer fluid (HTF) flows which is nano fluid here in this study, takes up the focused radiation which drops on the tube and changes the solar radiation into thermal energy. Receiver tube is surrounded by a Pyrex glass cover to decrease the thermal losses to the surroundings.

A. Parabolic Trough

The trough is fabricated with FRP (Fibre Reinforced Plastic) plate in parabolic shape, FRP material is preferred to withstand wind force and also extended life of setup. The setup is mounted on a stand which is fabricated with mild steel angles. The trough is mounted on the support in such way that the trough can be tilted over a wide range of angle, this is for manual tracking to the sunlight angle represents a parabolic trough.

B. Concentrator Plate

A rectangular shaped concentrator plate is fabricates for the experimental setup, providing a larger surface area for solar rays enhance the workability of the concentrator.

C. Focusing Mirror

The parabolic trough is fitted with focusing mirror. The focusing mirror is cut into small square pieces, which is fitted over the parabolic trough by means of applying adhesive over the trough. represents a focusing mirror.

D. Thermocouples

A thermocouple is a device consisting of two different conductors (usually metal alloys) that produce a voltage proportional to a temperature difference between either ends of the pair of conductors. In this experimental setup thermocouple is to measure the temperature of the concentrator and glass plates. In this setup K-type or J type bimetallic thermocouples are used a thermocouple.

E. Concentrator

Solar radiation is collected by a combination of parabolic length 6m diameter 3m. So the aperture area will be 15.6m^2.alumnium foil used to reverse sunlight because characterized by high IOP conf series. Reflexivity 90%, cheap price and easy to use .where it was pasted on the inner surface of the inverter . Focus center is calculated using the program.

F. Tracking System

Because of the process of solar complexes type PTCS need an effective solar tracking the system is placed on a circular axis on wheels that can be easily move manually by an angle (360degree).It can also be moved vertically at an angle (45 to 90 degree)

Fig 2. Photograph of the experimental setup.

IV. RESULT AND DISCUSSION

Graph shows diurnal variation in the acrylic mirror sheet reflector's hourly performance over time. It is evident from the above graph that the output was initially gradual increase up to 11:30 a.m. after 3 p.m. it rises and reaches its maximum value of at 1.30 p.m. and is slowly decreasing after 2.30. It is due to the increase in solar intensity over the same period.

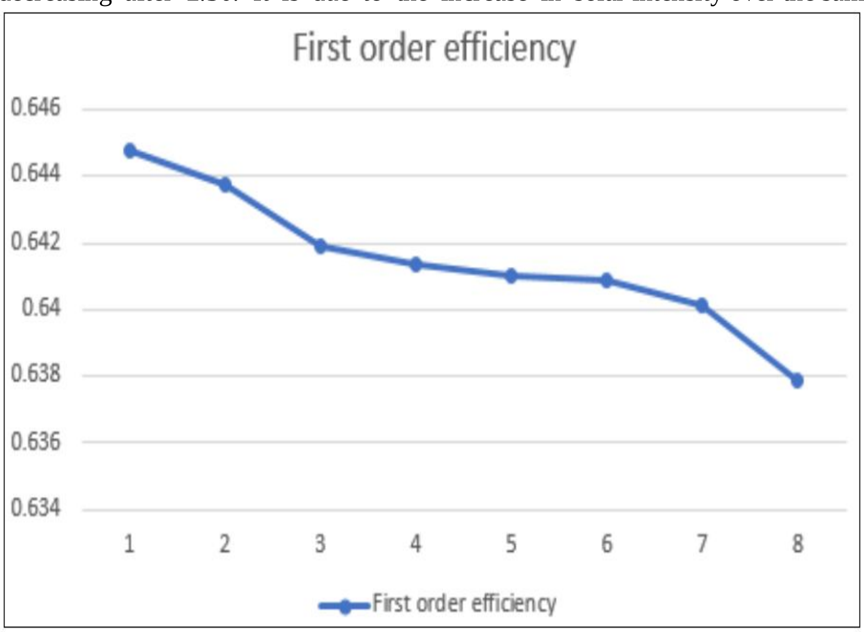

Fig 3. First order efficiency

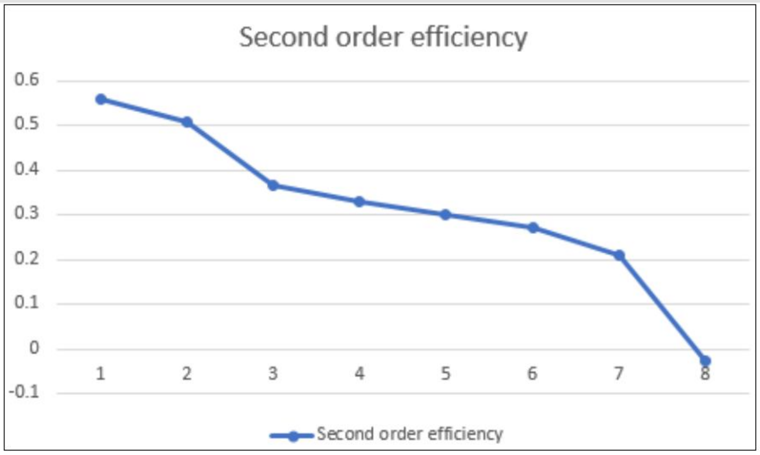

Fig 4. Second order efficiency

V. CONCLUSIONS

In this work, the dual axis parabolic solar trough concentrator's experimental and performance evaluation was carried out using acrylic mirror sheet, silver foil and aluminum sheet as reflecting materials. Here we analyzed the useful heat gain, instantaneous performance, hourly efficiency of these two different reflecting materials.

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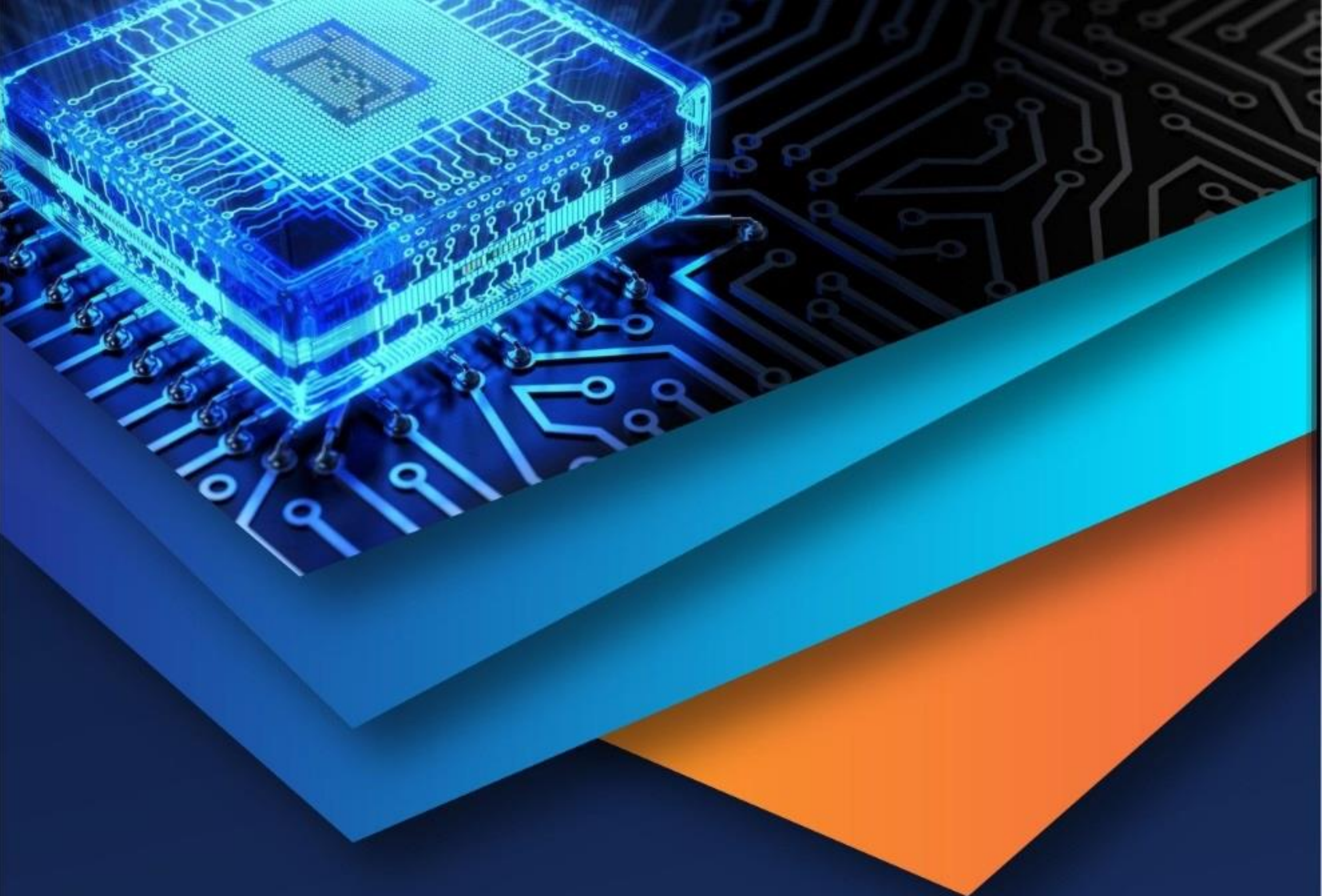

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