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STUDY OF DESIGN AND FABRICATION OF SOLAR PARABOLIC TROUGH AND EXPERIMENTAL ANALYSIS

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ABSTRACT

In this postulation the use of sunlight-based vitality utilizing explanatory trough is investigated. Allegorical trough innovation is as of now the most expanded close planetary system for power creation or steam age for modern procedures. A trial setup has been created to research the execution of the allegorical trough. Estimations of add up to coordinate radiation on the plane of the gatherer, surrounding temperature, wind speed, water stream rate, and channel and outlet temperatures of the water inside the safeguard tube are gathered and utilized in concentrate the execution of the illustrative trough. The material utilized is tempered steel sheet as a reflector and pressed wood aterial as a sub outline; The Different sort of pipe use for water course that is tempered steel pipe, press pipe, Mild steel pipe, Aluminum pipe that is secured with glass tube and furthermore comparers which of the productivity High in every one of the materials use in this.

Keywords: Cre-O Design, Stainless steel pipe, iron pipe, mild steel pipe, aluminium pipe, 304 stainless steel reflectors

INTRODUCTION

People dependably utilize the beams of the sun to accumulate their vitality needs. Vitality needs of today with expanding ecological concern, elective frameworks to be explored to diminish the utilization of non-sustainable and dirtying fossil fills. One such plausibility is sun-oriented vitality, which has turned out to be progressively mainstream as of late. Presently a-days sun powered vitality has been firmly advanced as accessible vitality source. One of the least complex and generally immediate uses of this vitality is the change of sun-oriented radiation into warm. Thus, the local area can reduce its effect on the earth is by the establishment of sunlight based explanatory trough authorities for warming water. Although it ought to be said that a portion of these gatherers have been in benefit for the last 40-50 years with no genuine critical changes in their outline and operational standards.

The utilization of sun powered vitality is focused at show on photovoltaic and warm sun-oriented vitality change frameworks. In the first named, sun powered vitality is changed over into power specifically by a photoelectric cell. The possible yields are, be that as it may still have restricted. Higher yields can be accomplished by sun powered warm transformation. In this procedure sun-oriented vitality is gotten and exchanged by a gatherer framework to a working liquid. Today with increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels must be investigated. One such possibility is solar energy, which has become increasingly popular in recent years. Solar energy is the radiation produced by nuclear fusion reactions in the core of the sun. This radiation travels to Earth through space in the form of energy called photons. Even though only 30% of the solar power reaches the Earth, every 20 minutes the sun produces enough power to supply the Earth with its needs for an entire year.

Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector collects the radiation that falls on it and converts it to other forms of energy (electricity, heat). Whilst the storage unit is required because of the non-constant nature of solar energy, as during cloudy days the amount of energy produced by the collector will be quite small. The storage unit can hold the energy produced during the periods of maximum radiation and release it when it is needed or the productivity drops.

RESEARCH OBJECTIVE

The general goal of this exploration is to configuration, make and by experimentation research the execution of the model explanatory trough sunlight-based vitality age framework. The exploratory examination decides the temperature varieties of the present liquid, the sun-based vitality assimilation rate, the temperature varieties of the

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encompassing temperature and along these lines the moment effectiveness of the framework as a perform of time. The particular targets of the task are:-

- Design and modelling of Parabolic Trough solar energy Generation System victimization acceptable software system.
- Manufacturing the system victimization acceptable materials.
- Experimental investigation of the system considering totally different parameters

DESCRIPTION OF THE SYSTEM UNDER STUDY

This is providing an outline of the system being tested and investigated during this study that is put in on the ground area, in Indore. Geographically, the system site is located at latitude 22.717-degree N and meridian 75.868-degree E, the location elevation is 396 below water level.

Parabolic trough work on constant principle because the magnifying glass held in the sun, the lens concentrates the rays to produce temperatures high enough to ignite paper, however here parabolic trough concentrates the sun's rays with huge curved stainless-steel trough. The 3-metre-long and 1-metre-wide parabolic trough focus the sunlight onto an absorbent tube, the 'receiver'. Within this vacuum-insulated tube flows a heat transfer fluid, sometimes oil or water that the sun will heat to temperatures of up to 300 degrees Celsius.
The solar field continuously tracks the sun (using manually-driven following system) and transfer the collected energy to the HTF that is that the water that flows through the receivers of the solar collectors. The water is circulated within the system by means that of flow-controlled burette.

Table 1: The Parabolic Trough Dimension

Parameter	Dimensions
Length	300 cm
Focal length	30 cm
Width	100 cm
Diameter of tube (OD)	25 cm
Aperture area	30000 cm^2

Table 2: Details of Absorber Tube

Material	Stainless steel
Coating	Black chrome
External Dia.	25mm
Wall thickness	1mm

DESIGN FEATURES

a) Roof Top

Roof top primarily based solar Thermal Parabolic trough collectors are a low-price implementation of focused solar energy technology that focuses incident sunlight onto a tube filled with a heat transfer fluid. The efficiency and price of the parabolic trough collector designs is influenced by structural stiffness, selection of materials, assembly tolerances, material cleanliness and wear.

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b) Small size

Parabolic trough features a little in size in order that the handling of this parabolic trough is simple. Little area needed for mounting of this system. in order that price of land is minimize as a result of his tiny size designing. Also, this method will use on top of roof.

c) Direct steam generation

Parabolic trough work likes a once through boiler. It is used to produce steam directly. We enter water at room temperature from one end and get steam at the end of receiver tube, thus we are able to use this technique where steam is needed or use steam in mechanical useful work.

d) Stainless steel-304 reflectors

In parabolic trough main costly half is reflector; the life of reflector should be long and handling should be simple in order that the maintenance cost and therefore the system cost can be reduced. Stainless-steel features a long life and low handling as compare to glass.

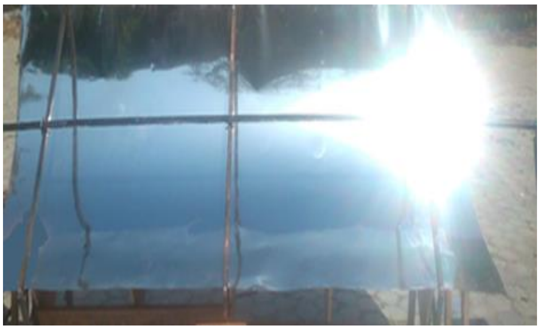

Figure 1: setup of Solar Parabolic trough

THEORETICAL CALCULATIONS

Capacity of one parabolic trough and how many panel required for generating 1MW

1215.36 m^2 land is required (sometimes there are exceptions).I can say this from experience as we have worked on actual MW power projects.

Let's see, if you are talking about 1 MW capacity plant

1MW = 1000 KW = 1000000 W

IF 405 MODULES are used

Total power output = Total area * Solar radiation * Conversion efficiency

TPO = 3*968*0.85

TPO = **2468.4 w**

Required for generating 1MW

1000000/2468 = 405 panel use

For generation of 1MW need 405 parabolic trough

DESIGNING AND DEVELOPMENT

Production of a parabolic trough model is that the major work of this thesis work. The analyses of the test results are dependent on reliable measurements. However, if all the proper procedures of design in addition as machine-driven production ways are thoroughly followed, the accuracy of the test can converge to the theoretical expectation. Standard design procedures are implemented to return up with a correct design, the maximum amount as possible, as discussed below. [22]

As so much recent tools in design and simulation, the prototype is designed using Pro-e software that provides modeling. Production of the model required a coordinated step that may inferred to the limited recourse available in the workshop of the technology Department, available machines, work force, each skilful and labor, and consumable materials. Money constraints are the major hindrance that induced an inevitable consideration on the production set up starting from the infancy. The major parts of the designed and manufactured parabolic trough system consist of the trough support and parabolic trough. Every of these parts is in brief discussed, with regards to their use, operating mechanisms and methods enforced on the production.

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$$y = \frac{x^2}{4f}$$

f = 30cm

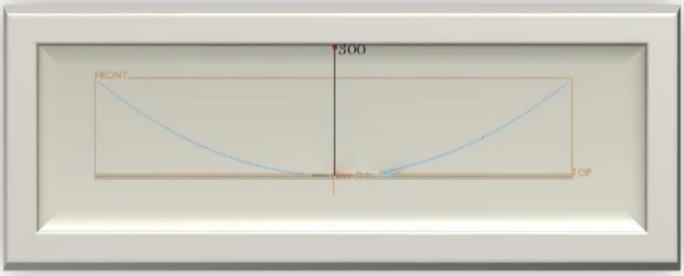

Figure 2: Parabolic curve

INSTRUMENTATION (APPARATUS) AND METHODS OF TESTING

a) Solar Radiation Measurement

A pyranometer (Radiometers) is used to measure the global shortwave radiation from both the sun and the sky, and a solar-tracking pyrheliometer is used to measure the direct normal component of the solar radiance. Following are few characteristics of instrument:

• Change of Response Due to Variation in Ambient Temperature during the Test: The change in the instrument's response due to variations in ambient temperature is less than ±1%.

• Variation in Spectral Response: Pyranometers and pyrheliometers have a constant sensitivity to within ±2% over the spectral range from 0.3 to 2.5 microns.

• Variation of Response with Angle of Incidence: Ideally the response of the pyranometer is proportional to the cosine of the incident angle of the direct solar radiation and is constant at all azimuth angles. Unless the pyranometer's deviation from a true cosine response is less than ±1% for the incident angles encountered during the test(s), the pyranometer used is with the latest calibration curve relating the response to the angle of incidence with accuracy within ± l%.

• Precautions for Effects of Temperature Gradient: The instrument used during the test(s) is placed in its test position and allowed to equilibrate for at least 30 minutes before data taking commences.

The pyranometer is mounted such that its sensor is coplanar with the plane of the collector aperture. It is not to cast a shadow onto the collector aperture at any time during the test
period. [11]

b) Temperature Measurement

The temperature difference measuring devices are calibrated for the range of temperatures and temperature differences encountered in the test. The range of thermometer is between $-50℃ \ to +300℃$ $(-58℉ \ to + 572℉)$ which is sufficient for over test. It is a digital type thermometer.

Figure 3: Thermometer

MATHEMATICAL FORMULATION AND CALCULATION

- **Analysis of collector**

In analyzing the solar parabolic collector, it is important to identify each part of the collector and the terms used on the solar collector. Figure 5.1 briefly describes the solar parabolic collector. In the concept and design of the parabolic collector, the first definition is strictly geometric as ratio of aperture area to receiver area. The ratio of these two areas defines the concentration ratio of the parabolic trough as: [12]

$$\mathbf{C} = \frac{A_a}{A_r}$$

$$A_a = W_a \times L$$

$$A_r = \pi DL$$

***where*:**

C = concentration ratio **W_a = aperture width (m)**

A_a = aperture area (m^2) **L = aperture length (m)**

A_r = receiver area (m^2)

- **The efficiency of Trough**

$$\eta_c = Q \,\&\, u / (A_c\, G)$$

- **The global irradiance G**

$$G = G_n \cos\theta_z + G_d$$

The amount of the beam irradiance received by the collector aperture Gb is less than the normal beam irradiance due to the cosine loss caused by the angle of incidence θ between the aperture normal and G_n.

- **The relation between the two irradiances is**

$$G_d = G_n \cos\theta$$

Concentrating solar collectors operate on the principle of concentrating the beam irradiance in clear sky conditions (low diffuse radiation). Therefore, the contribution of diffuse radiation in the useful power output and the collector efficiency will be neglected in the model development.

So, for parabolic trough collectors, the global irradiance in the dominator of equation is replaced with the beam irradiance received by the aperture G_b.

$$Q_u = m{*}c\,(T_o - T_i) = A_c \,.\, G_b \,.\, \eta_{op}(\theta) - A_{abs}.\, U_L\,(T_{abs} - T_a)$$

Where m: mass flow rate of the HTF (water in over system); $[Kg/s]$

C: Average specific heat of the HTF between inlet and outlet; $[J/Kg.K]$

T_o : HTF outlet temperature; [K]

T_i : HTF inlet temperature; [K]

T_a : Ambient temperature; [K]

T_{abs}: The average absorber surface temperature; [K]

A_{abs}: Absorber outer surface area; $[m^2]$

U_L: Overall heat loss coefficient from absorber surface; $[W/m^2.K]$

It is easier to express Q_u as a function of the fluid inlet temperature T_i due to the difficulty of measuring the absorber surface temperatureT_{abs}.

$$Q_u = A_c.\, F_R\,[G_b.\, \eta_{op}(\theta) - (A_{abs}/A_c).\, U_L\,(T_o - T_i)]$$

Where F_R is "the collector heat-removal factor" defined as the ratio of the actual power output of the collector to the imaginary output if the whole absorber surface was isothermal at the fluid-inlet temperature.

SUN TRACKING MECHANISM

a) Active Trackers

Active Trackers use motors and gear trains to direct the tracker as commanded by a controller responding to the solar direction. The Light-sensing trackers typically have two photo sensors, such as photodiodes, configured differentially so that they output a null when receiving the same light flux. Mechanically, tracker should be Omni directional (i.e. flat) and are aimed 90 degrees apart which will cause the steepest part of their cosine transfer functions to balance at the steepest part and thus translates into maximum sensitivity.

b) Passive Trackers

Passive solar Trackers use a low boiling point compressed gas fluid that is driven to one side or the other (by solar heat creating gas pressure) to cause the tracker to move in response to an imbalance.

c) Chronological Tracker

Chronological solar Tracker counteracts the earth's rotation by turning at an equal rate as the earth, but in the opposite direction. Actually, the rates aren't quite equal as the earth goes around the sun. so the position of the sun changes with respect to the earth by 360° every year or 365.24 days. A solar tracker is a device onto which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. Most solar panels are around 11-15% efficient. The efficiency rating measures what percentage of sunlight hitting a panel gets turned into electricity that you can use.

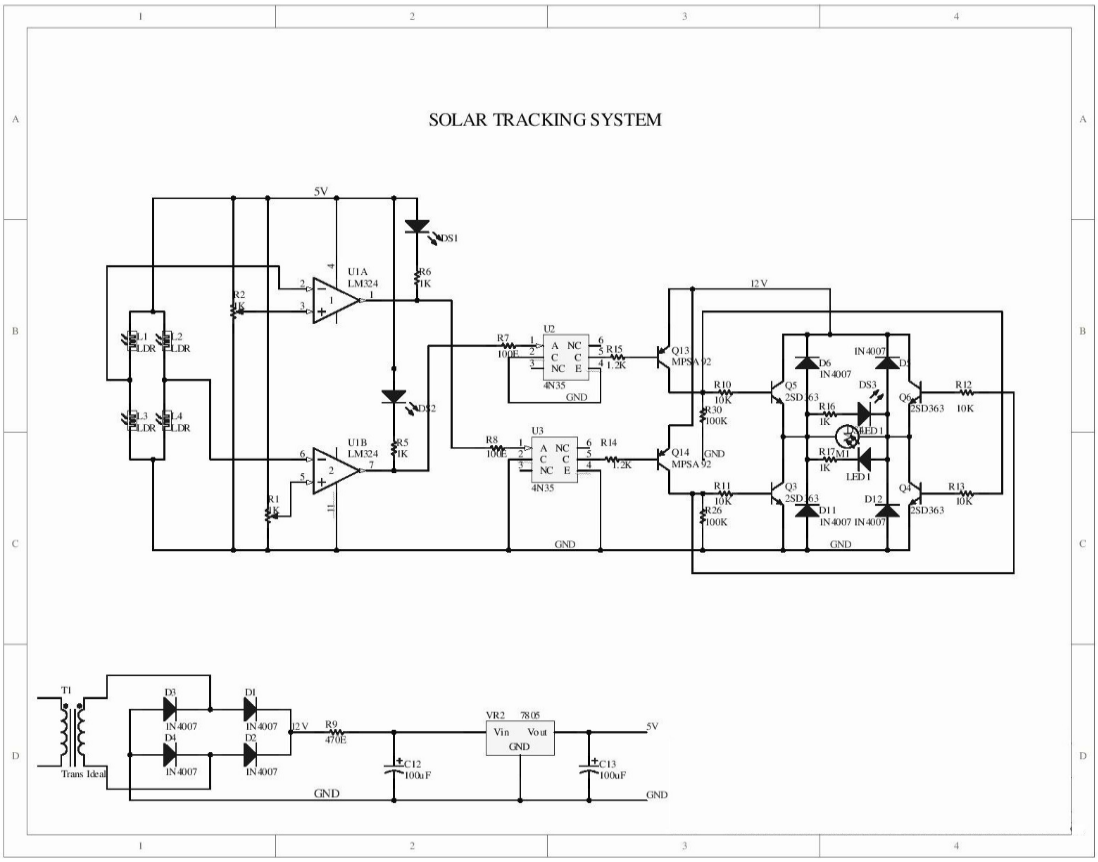

Figure 4: Schematic diagram of active tracking control

Table no 07. The following table summarises operation:

T1	T2	T3	T4	Result
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
1	0	1	0	Motor brakes
0	1	0	1	Motor brakes
1	1	1	1	Short power supply
1	1	0	0	Short power supply
0	0	1	1	Short power supply
0	0	0	0	Motor free runs

So the required current is supplied to let the motor run in desired way.

CONCLUSION

The major aim of this project work was to design, manufacture and conduct an experimental investigation on the performance of parabolic trough and prepare a mathematical model to verify the results obtained during the test period. In this chapter some basic concluding points and recommendation are indicated. Based on the current status of the Country a new method of a solar energy application has been tested and new technical and technological opportunities of a solar energy application in water heating and steam generation has been established. Stainless steel sheet material bends easily into the required parabolic trough shape. Black painted steel pipe is used as absorber tube. Temperature sensor thermocouples measure the changing water temperature at inlet and outlet of the central receiver. Daily data were collected from each material used as the absorber. Water temperature does increase in the absorber.

On a clear sky day, a maximum of 100℃ water temperature was recorded using stainless steel pipe absorber tube. On the average, the efficiency of the parabolic trough is about 81% and 85%. This is efficiency for Stainless steel absorber pipe use its improvement is also expected from parabolic troughs covered with glass or transparent material. This increases the efficiency of the parabolic trough by reducing convection heat loss from the absorber tube and prevents the reflector from dust particle. From the result, it can be observed that the parabolic trough is very efficient generating high temperature water for about five and a half working hours, from 10:00 to 15:30. The experimental and the analytical results are very comparable with some acceptable differences.

The environmental factor plays a major role in the performance analysis of the solar collector. Environmental or weather conditions such as wind and scattered clouds conditions are factors that bring down the efficiency of the solar collector. The result of this study gives guidance for the possible use of parabolic trough application for energy generation. In this experiment we are use different type of material in absorber pipe all the absorbers gives the different efficiency compare to stainless steel in this observation, we use different material like iron, mild steel, aluminum and getting the different efficiency.

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