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DESIGN AND FABRICATION OF SOLAR PARABOLIC TROUGH AND EXPERIMENTAL ANALYSIS

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ABSTRACT

In this thesis the parabolic trough solar system use for electricity production or steam generation for industrial processes. An experimental setup has been developed to investigate the performance of the parabolic trough. Measurements of total direct radiation on the plane of the collector, ambient temperature, wind speed, water flow rate, and inlet and outlet temperatures of the water inside the absorber tube are collected and studying the performance of the parabolic trough. The material used is stainless steel sheet as a reflector and plywood material as a sub frame; The Different type of pipe use for water circulation that is stainless steel pipe, iron pipe, Mild steel pipe , Aluminium pipe that is covered with glass tube and also comparers which of the efficiency High in all the materials use in this.

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

INTRODUCTION

Now a days energy is primary demand for human culture. The country within which a lot of energy produce is a lot of developed than alternative. That is classified into 2 groups; renewable and non-renewable. Renewable energy comes by natural processes which are resupply constantly. In its numerous forms, it derives directly from the sun.

Energy generated from solar, wind, ocean, tidal, hydropower, biomass, energy resources, bio fuels and hydrogen is renewable resources. Non-renewable energy is energy sources that can't resupply within the close to future like coal, oil, oil and gas. Renewable and non-renewable energy sources are accustomed produce secondary energy sources as electricity.

Energy is one among the crucial inputs for socio-economic development the rate at which energy is being consumed by a nation typically reflects the amount of prosperity that it might come through and total energy consumption has enhanced along with economic and population growth and, at a similar time, varied environmental issues related to human activities became more and more serious.

Additionally to a rise in value of fuel product and resources are going to be exhausted in an exceedingly comparatively short amount of your time. This high cost of fuel resources square measure poignant economic and social development worldwide. The impact of energy crises is especially felt in less developed countries where a high percentage of national budgets for development should be pleased to the purchase of fuel product. To reduce the dependency on foreign fuels with high worth, most countries have initiated programs to develop energy sources supported domestic renewable resources.

Solar thermal power plants square measure one among the foremost promising choices for renewable electric power production not like traditional power plants, concentrating solar energy systems offer an environmentally friendly supply of energy, produce nearly no emissions, and consume no fuel other than sunlight. The goal of this project is to identify general strategies and specific design ideas for achieving increased collector efficiency.

This thesis has investigated enhancements within the design of a parabolic trough module by wanting 1st at the structural conception of the collector to scale back quality whereas maintaining structural stability. The water is applied because the heat transfers fluid in an exceedingly solar parabolic trough collector system. Firstly, the system dynamic model was established and valid by the important in operation information in typical summer and spring days in references. Secondly, the alteration characteristics of much radiation, recess water temperature and rate of flow are analysed and compared with the standard operating condition.The model use for learning, system design, and much understanding of the performance of parabolic trough systems. Efficiency of parabolic trough done with the help of

$$Q_u = m*c\,(T_{out} - T_{in}) + L*m)$$

Research Objective

The general objective of this research is to design, manufacture and by experimentation investigate the performance of the model parabolic trough solar energy generation system. The experimental investigation determines the temperature variations of the current fluid, the solar energy absorption rate, the temperature variations of the ambient temperature and therefore the instant efficiency of the system as a perform of time.
The specific objectives of the project are:-

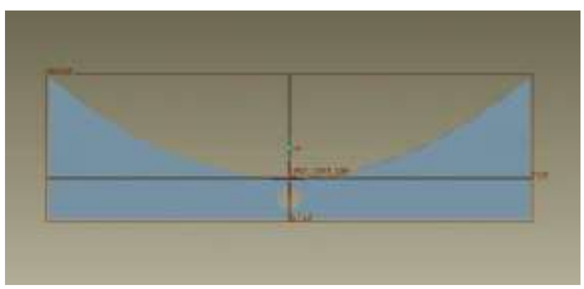
- Design and modelling of Parabolic Trough solar energy Generation System victimization acceptable software system.
- Manufacturing the system victimization acceptable materials.
- Experimental investigation of the system considering totally different parameters.

Methodology

- Literature Survey: Books, journals and articles are reviewed in solar technology, performance improvement and the current solar technology practice of different countries.
- Prototype Design: A prototype of the parabolic trough is designed with some specified dimensions. To simplify the design process, appropriate software is used. The applied software also helps to visualize the prototype before manufacturing.
- Manufacturing prototype: After the design process is completed, the prototype is manufactured. Based on the design parameters and design materials, the prototype of the parabolic trough is manufactured in the Mechanical Engineering Department workshop.
- Installation of Prototype: The prototype of the parabolic trough is installed at the site very close to the Mechanical Engineering Department.
- Experimental Investigation: After the prototype is installed, experimental investigation were conducted by recording data.
- Analysis and Interpreting the Result: The test results are compiled and compared with the results obtained using a mathematical model to check the validity of the result & compare all the result.

Dimensional modelling of the system.

The Parabolic concentrating collector assembly was modelled by using CRE-O



Solar Parabolic Trough Collector Assembly

Component	Typical dimension
Diameter of tube (od)	25 cm
Width	100 cm
Focal Length	30 cm
Length	300 cm
Aperture Area	3 m^2

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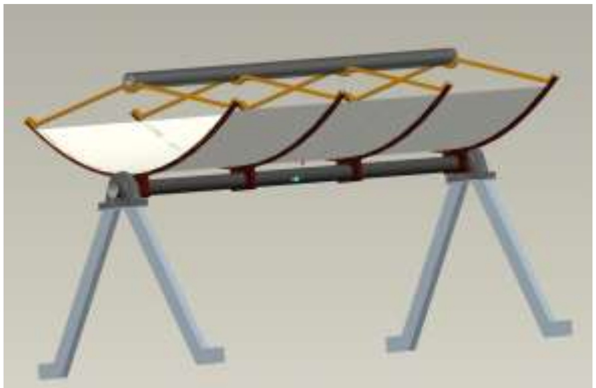
Individual components were designed in 3 D and then were assembled.



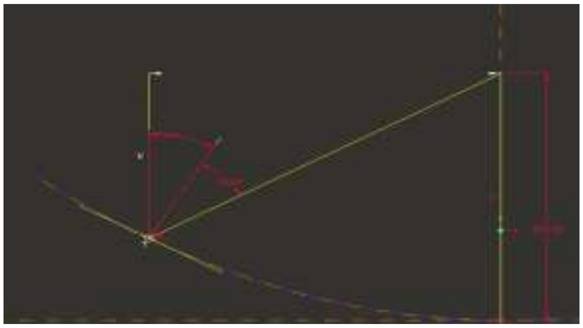
The components modelled were

1. Support structure

2. Absorber support

3. Absorber pipe along with glass cover

4. Reflector sheet



Angle verification

Ply-wood specimens were taken in order to create a base for parabolic trough.

Calculation when change in Flow rate of water

When flow rate 1.ml/sec

- Q_u = m∗c ($T_{out} - T_{in}$)+ L*m
- **Mass flow rate m**= 0.001kg/sec or 1ml/sec
- Specific heat= 4.187 kJ/ kg k
- Ambient temperature of surrounding T_a= 311 K
- Inlet temperature of fluid T_{in}= 314 K
- Outlet temperature of fluid T_{out}= 373 K
- L = 2230 kJ/ kg (Latent Heat of evaporation of water)
- Q_u = 0.001*1000{ (4.187) (100 - 41) + 2230} = 2477.03W
- Average radiation coming from the son (G)=968w/m^2,
- Total heat input =G∗A =961∗3 = 2904W
- Efficiency of parabolic trough=heat output/heat input
  2477.03/2904 = 85%

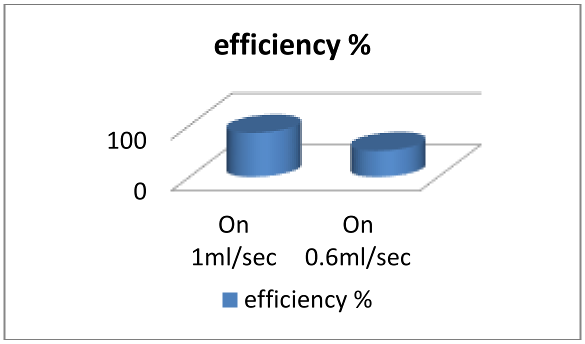


Figure For 51.09% & 85% efficiency calculation Useful Output

At flow rate of 0.6 ml/sec the efficiency of parabolic trough is collected to be 51.09% and at flow rate of 1ml/sec the high efficiency parabolic trough is collected to be 85 % on comparing the above two we get to conclude that high flow rate is more efficient Therefore, we take 1ml/sec for further reading.

Absorber pipe

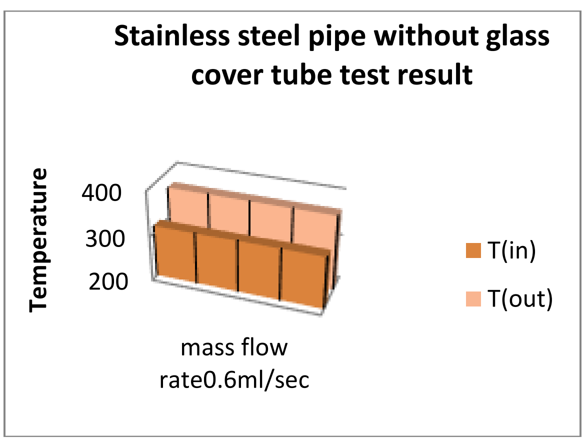
The absorber is design according to the limitation of the collector, with considering parameters like piping, working fluid velocity, fabrication and heat loss. Thereby, the absorber is fabricated by the seamless pipe, with the inner diameter of 24 mm, outer diameter 25 mm and 3680 mm in length.

REFLECTOR

Stainless steel-304

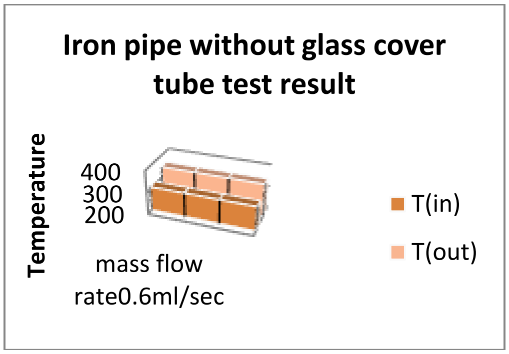
To obtain the desired parabolic trough stainless steel sheet is used.
In parabolic trough the most costly part is reflector. The life of reflector should be long
and handling should be easy so that the maintenance cost and the system cost can be reduced. Stainless steel has a long life and low handling as compare to glass.

Stainless steel pipe without glass cover tube test result when flow rate of water 0.6 ml/sec



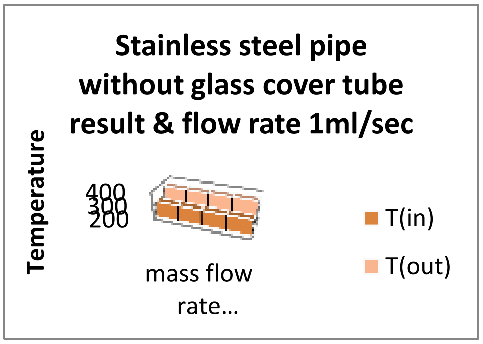
The graph above shows that inlet temperature for the experiment is 315K and outlet temp. 366K at the flow rate 0.6ml/sec.

Iron pipe without glass cover tube test result when flow rate 0.6ml/sec



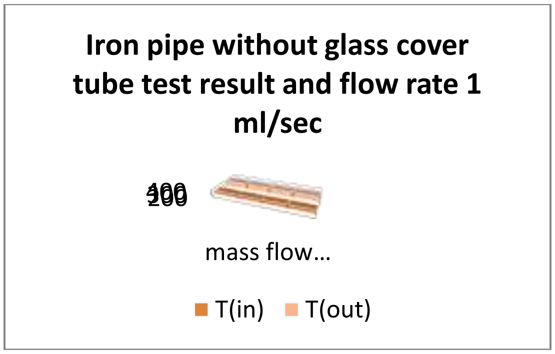
The graph above shows that inlet temperature for the experiment is 311K and outlet temp. 349K at the flow rate 0.6ml/sec.

Stainless steel pipe without glass cover tube result & flow rate 1 ml/sec



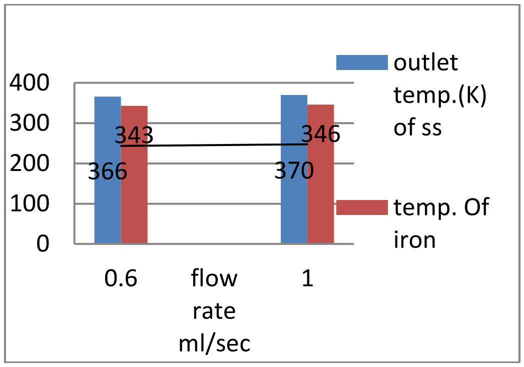
The graph above shows that inlet temperature for the experiment is 314K and outlet temp. 370K at the flow rate 0.6ml/sec.

Iron pipe without glass cover tube test result and flow rate 1ml/sec.



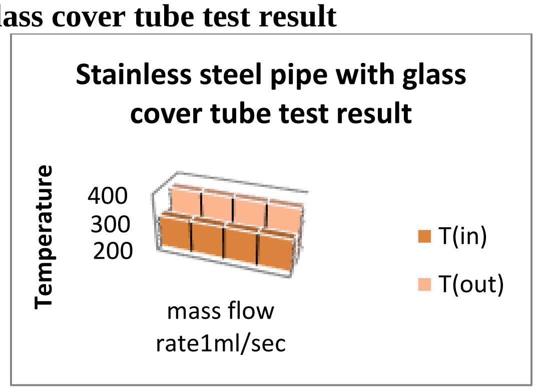
The graph above shows that inlet temperature for the experiment is 311K and outlet temp. 358K at the flow rate 0.6ml/sec.

Comparison between Stainless steel pipe & Iron pipe without glass cover tube test result with the help of graph



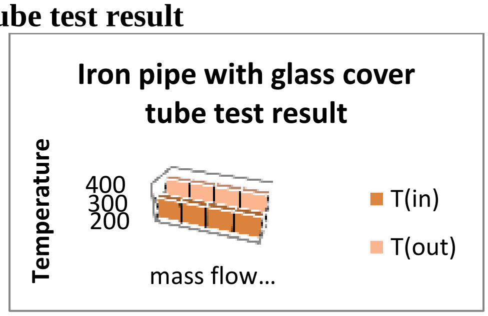
At flow rate of 0.6 ml/sec the temperature of parabolic trough is collected to be 366K outlet temperature where inlet temperature of parabolic trough is 349K and at flow rate of 1ml/sec the high temperature of parabolic trough is collected to be 370K on comparing the above two we get to conclude that high temperature of SS without glass cover. In this graph tilt line shown the difference b/w 366K and 370K temperature of parabolic trough at flow rate 0.6ml/sec and 1ml/sec nothing to else.

Stainless steel pipe with glass cover tube test result



The graph above shows that inlet temperature for the experiment is 314K and outlet temp. 373K at the flow rate 0.6ml/sec.

Iron pipe with glass cover tube test result



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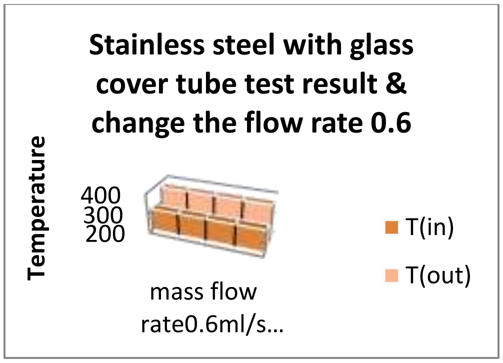
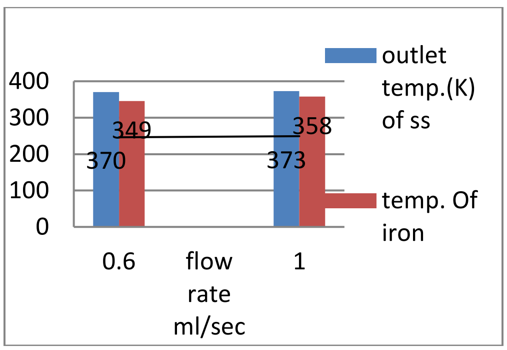
The graph above shows that inlet temperature for the experiment is 314K and outlet temp. 368K at the flow rate 0.6ml/sec.

Stainless steel with glass cover tube test result & change the flow rate 0.6



The graph above shows that inlet temperature for the experiment is 312K and outlet temp. 374K at the flow rate 0.6ml/sec

Comparison between Stainless steel pipe & Iron pipe with glass cover tube test result with the help of graph



At flow rate of 0.6 ml/sec the temperature of parabolic trough is collected to be 370K outlet temperature where inlet temperature of parabolic trough is 349K and at flow rate of 1ml/sec the high temperature of parabolic trough is collected to be 373K on comparing the above two we get to conclude that high temperature of SS with glass cover tube. In this graph tilt line shown the difference b/w 370K and 373K temperature of parabolic trough at flow rate 0.6ml/sec and 1ml/sec nothing to else

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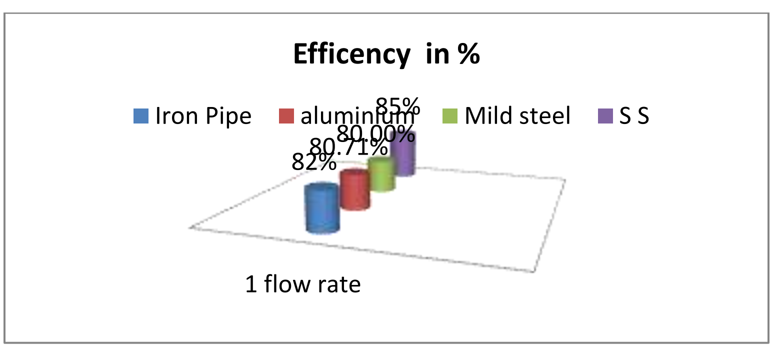
Comparison between Stainless steel pipe & Iron pipe, Aluminium Pipe , Mild steel pipe with glass cover tube test result with the help of graph.



we use different material like Stainless steel iron, mild steel, aluminum and getting the different efficiency And comparing the output for getting the efficiency. The efficiency of the parabolic trough where use absorber of stainless steel highest efficiency 87%. 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. On the same setup we use different material aluminium there we getting highest efficiency 80.71% also covered with glass or transparent material for increases the efficiency of the parabolic trough. Also use same setup for the Mild steel and get the highest efficiency in this 80% also covered with glass or transparent material for increases the efficiency of the parabolic trough. And the last we use the material Iron in form of absorber pipe and cover with glass tube get the efficiency 81.78%. Compare to all the materials use in absorber pipe we get the highest efficiency in the stainless steel pipe 85 %.

CONCLUSION

The efficiency of the parabolic trough where use absorber of stainless steel highest efficiency 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 on the same setup we use different material aluminium there we getting highest efficiency 80.71% also covered with glass or transparent material for increases the efficiency of the parabolic trough. Also use same setup for the Mild steel and get the highest efficiency in this 81.578% at time 12:30 also covered with glass or transparent material for increases the efficiency of the parabolic trough and the last we use the material Iron in form of absorber pipe and cover with glass tube get the efficiency 81% compare to all the materials use in absorber pipe we get the highest efficiency in the stainless steel pipe 85% from the result we can observed that the parabolic trough is very efficient generating high temperature water if we use the Stainless steel observer pipe getting high efficiency compare to other material of absorber pipes

REFERENCES

I. Energy, US department of. Energy basics. www.eere.energy.gov. [Online]
II. http://www.eere.energy.gov/basics/renewable_energy/solar_resources.html#.
III. International, Pilkington Solar.Status Report on Solar Trough Power Plants. Cologne :
IV. Pilkington Solar International GmbH, 1996. ISBN 3-9804901-0-6.
V. Prairie, M.Overview of Solar Thermal Technology. 200.
VI. Ruiz, Pablo Fernández.European Research on. Belgium : Luxembourg, 2004.
VII. http://www.encyclopedia.com/article-1G2-3451200023/solar-energy.html. [Online]
VIII. Solar energy installations for pumping irrigation water. Pytlinski, JT. 1978.
IX. Kreider JF, kreith F.Solar energy handbook. New York : McGraw Hill, 1981.
X. LC, Spencer. A comprehensive review of small solar-powered heat engines. 1989.
XI. Terrestrial solar thermal power plants: on the verge of comercialization. Romero M,
XII. Martinez D, Zarza E. 2004.
XIII. Exergy analysis of low and high temperature. OZTURK, Murat. Turkey : Department of
XIV. Physics, Science-Literature Faculty, Suleyman Demirel University,.
XV. American society of heating, refrigerating and air conditioning engineers.method of testing to determine the thermal performance of solar collector. Atlanta: tullier circle, 1991. issn 1041-2336.
XVI. Design, manufacture and testing of fiberglass reinforced. A. Valan Arasu *, T. Sornakumar. 10, Tamilnadu, India : science direct, 2007, Vol. 81. ISSN: 0038092X.
XVII. Garud S.Making solar thermal power generation in india reality overview of technologies, opportunities and challenges, The energy and resources institute(TERI)India, http://www.aprekh.org/files/SolarThermalPowergeneration_Final.pdf.
XVIII. Administration, U. E. I., 2010. International energy outlook. Tech. Rep. DOE/EIA-0484(2010), Office of Integrated Analysis and Forecasting, U.S. Department of Energy, Washington, DC.