Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 3, March-2016

A Review: Performance of Cylindrical Parabolic Concentrator (CPC) Type Solar Water Heater

Parabolic Through

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Abstract *— Renewable energy source play a major role. Solar energy uses do not contribute to emission of greenhouse gases and other pollutants to the environment. So, this source of energy can fulfill this role is commercial solar water heater by solar collectors used. The resent study of this project experimental platform based on development and performance of water heating by Cylindrical Parabolic Concentrator collector. The main objective of this work is the investigation and improvement of thermal performance of Cylindrical Parabolic Concentrator type solar collector.*

Keywords *– Cylindrical Parabolic Concentrator Type Solar collector, Reflector, Absorber Tube, Supporting Structure, Water Container, Inlet and Outlet Pipe, Pump, Solar Energy, Receiver.*

I. INTRODUCTION

Based on the some reference books and reviews the flat plate collector is a one kind of non-concentrating type solar collector so, its solar radiation incident in to the main point is absence. In other words it has a no concentrating type collector. And also it has a very low concentration ratio. So, the solar radiation or a heat gain by the collector per unit area per unit time is very low compared to the other solar collector. Due to the low concentration ratio, the temperature attained by the absorber area of the collector is lower, so it is not possible to attain higher efficiency and output/outcomes of the collector compares to the other solar collector. And also in to the Flat-Plate Collector the absorber area for absorbing the solar radiation is high compared to other solar collector absorber area. So its isolation intensity is not greater than other solar collector. And also this isolation intensity of radiation is effected in to the whole systems of the solar collector's like e.g. thermal power plants, electricity generation, hot water generations are with the help of solar collector. So, the Flat-Plate Collector is very costly compare to the collector. So, we are thinking about that and in order to maintain a balance between demand and supply of energy, there is a need to exploit renewable sources to the maximum limit possible there by providing a clean, eco-friendly source of energy. So, our main goals are sets for hot water generation with the help of the Cylindrical Parabolic Concentrating Type Solar Collector. Because of the absorber area of a concentrating system is much smaller than that of Flat Plate Collector. So, based on our investigation and models we are getting high efficiency compared to the other solar collector.

II. LITERATURE REVIEW

A. Santosh Kumar Singh, Arvind Kumar Singh, and Santosh Kumar Yadav, "Design and fabrication of parabolic trough solar water heater for hot water generation", ISSN: 2278-0181, Vol. 1 Issue 10, December-2012 [1].

Solar Energy is a renewable source of energy. Its uses do not contribute to emission of greenhouse gases and other pollutants to the environment. It is sustainable since it cannot be depleted in a time relevant to the human race. In this paper, the potential for a solar- thermal system for hot water generation has been studied. A parabolic trough concentrator (PTSC) is made of an aluminum sheet which is covered by a cloth on which rectangular mirror strips (1.20mx 0.05m) are pasted. Two different absorber tubes were taken and the efficiencies of the PTSC where compared without glass cover on the absorber tubes. They were designed with principal focus at 0.3m so that the receiver heat loss was minimized.

Conclusion

The efficiencies for the PTSC were as follows: when without glass cover: aluminum tube receiver: 18.23%, copper tube receiver 20.25%. The efficiencies observed for parabolic trough concentrator demonstrates that this with appropriate absorber tube systems can produce hot water that is hot enough for solar thermal conversion power systems. This can be achieved by use automatic tracking system and smoother reflecting surfaces. In this case higher temperatures and higher efficiencies would be realized.

B. Praveen Math, Nageshwar Rao T., Rhushi Prasad P., "Experimental analysis of cylindrical parabolic collector with and without tracking systems", ISSN 2349-2082 Volume: 01 Issue: 06 - Jun – 2014 [2].

The present study of this project work presents experimental platform based on the design, development and performance characteristics of water heating by tracking and non-tracking solar cylindrical parabolic concentrating system. The performance of the concentrator is experimentally investigated with the water circulated as heat transfer fluid. The tests will be carried out with both tracking and non-tracking mechanisms of cylindrical parabolic collector. The collector's efficiency will be noted. The collector's efficiency for both tracking and non-tracking system is compared. It was observed that for non-tracking system efficiency was 11.58%, for tracking it observed 18.8%. Obviously efficiency for tracking system was more and percentage of increase in efficiency was approximately 35%.

Conclusion

The efficiency of both tracking and non-tracking is calculated and it is found to higher for the tracking system. The percentage of efficiency increased for tracking system is approximately 36%, hence the CPC with tracking system has found more efficient. In another term, using this solar equipment we can extract eventually 27% of direct solar energy and convert it into thermal energy that can be used directly for several applications such as water heating, electricity generation using Sterling engine, vapor production etc.

C. Irving Eleazar Perez Montes, Arturo Mejia Benitez, Omar Mercado Chavez, Alvaro Eduardo Lentz Herrera, "Design and construction of a parabolic trough solar collector for process heat production", Energy Procedia 57 (2014) 2149 – 2158, 2013 ISES Solar World Congress, Published by Elsevier Ltd [3].

In this paper are presented the results of designing a parabolic trough solar collector (PTSC), and its application in a solar thermal system for the production of process heat. Implementing a series of innovations in the structural form, the material selection and the adoption of new manufacturing processes; enables a faster erection on installation site and reduction in production costs. Drawing on the experience acquired during five years in the manufacture of PTSC modules, are identified a series of design requirements that allow to do improvements in the PTSC modules, including increased optical efficiency through the selection of materials with less weight and greater mechanical strength; the application of a new design that avoids structural deformations on the PTSC module and which are optimal to implement a motion system of low power consumption and high precision in angular positioning. By means of a control system and data acquisition based on a Programmable Logic Controller (PLC), is possible to manipulate and record variables as temperature and angular position, in order to ensure the conditions of solar radiation incidence on the receiver and record all the variables involved in the system. This data is stored in a database for its posterior analysis. The improvements achieved at this project generate a new method to reduce the logistics times and labor for this type of solar thermal systems as well as manufacturing costs. As a result is obtained a PTSC module with best features strength / weight and stiffness / weight, and other technical advantages.

Conclusion

The results obtained from the construction of the PTSC system indicate that times of erection are short, and direct costs in manufacture are low. it has been observed the behavior of a first order system, as outlined in the mathematical design, the peak temperature has been 80°C, which coincides with the preliminary design information for solar radiation conditions above 19 MJ/m 2/day, in a day with excellent weather conditions. The volume flow was 0.5 liters/ second, and the water volume was 0.3m, which means an average thermal efficiency of 60%.

D. Mr. Mohd. Rizwan, Mr. Md. Abdul Raheem Junaidi, Mr. Mohammed Suleman, Mr. Mohd. Aamer Hussain, "Experimental verification and analysis of solar parabolic collector for water distillation", Volume No.3, Issue No.10, pp.: 588-593, ISSN: 2319-6890) (online), 2347-5013(print), 01 Oct. 2014 [4].

The paper is concerned with an experimental study of parabolic trough collector with its sun tracking system designed and manufactured to facilitate rapid diffusion and widespread use of solar energy. The paper focuses on use of alternative source of energy (through suns radiation) which is easy to install, operate and maintain. Also, to improve the performance of solar concentrator, different geometries were evaluated with respect to their optical and energy conversion efficiency. To assure good performance and long technical lifetime of a concentrating system, the solar reflectance of the reflectors must be high and long term stable. During the research carried out, focus had been shifted from evaluation of the performance of concentrating solar collector to analysis of the optical properties of reflector and absorbing materials. The shift of focus was motivated by the need to assess long term system performance and possibilities of optimizing the optical efficiency or reducing costs by using new types of reflector materials and absorbing materials. The Solar Parabolic Trough Collector (SPTC) was fabricated in local workshops and the sun tracking system was assembled using electric and electronic components in the market, while the mechanical components making up the driving system were procured from the local market. The objective of the research is to obtain distilled water by heating it to a higher temperature by solar parabolic trough collector. Solar distillation is used to produce potable water or to produce water for lead acid batteries or in chemical laboratories as in this case. The level of dissolved solids in solar distilled water is less than 3 ppm and bacteria free. The requirements for this specific design are a target for distilling water regularly with low maintenance.

Conclusion

The results obtained in Case – I was great. Highest temperature obtained was 104 degree calcius and efficiency of the parabolic trough was 53.4%. It was noted that heat was not sufficient enough for water to convert into steam but temperature of the water could go further more if water in the absorber pipe is at higher pressure. So, it was decided to test it a location where there is sufficient sunlight and pressure of the water is very high. Hence, the results obtained in Case – II were good. Highest temperature obtained was 106 degree calcius and efficiency of the parabolic trough was 28.29%. Efficiency of the system was decreased but water was successfully converted into steam. The desired purpose of the research work was accomplished successfully which was to perform water distillation by heating the water to a higher temperature with the use of solar parabolic trough collector.

E. Mayur G. Tayade, R E Thombre, Subroto Dutt, "Performance Evaluation of Solar Parabolic Collector Trough", International Journal of Scientific and Research Publications, Volume 5, Issue 1, ISSN 2250-3153, January 2015 [5].

This paper was concerned with an experimental study of parabolic trough collector designed and manufactured. A Parabolic trough solar collector uses aluminum sheet in the shape of a parabolic cylinder to reflect and concentrate sun radiations towards an absorber tube located at the focus line of the parabolic cylinder. The receiver absorbs the incoming radiations and transforms them into thermal energy, the latter being transported and collected by a fluid medium circulating within the absorber tube. The Designing and Fabrication of parabolic trough solar water heater for water heating was executed, the procedure employed includes design, construction and testing stages. The model which is made up of reflector surface, reflector support, absorber pipe and a stand with manual tracking arrangement was fabricated using locally sourced material for rural applications point of view.

Conclusion

In the present work, the performance of a new parabolic trough collector with hot water generation system is investigated through experiments over one full day in winter period. The maximum value of each of those parameters is observed around noon, when the incident beam radiation is at its peak. The fabrication and design of a solar parabolic trough using locally available materials is possible hence low temperature trough will be a better solar thermal device for the rural and remote area. From the result It has been seen that the parabolic trough is better option during winter season to reducing the water heating cost. This research has its own special features Maintenance cost is minimum and hence economical, running cost is nil, the labor cost is minimized on account of its simple design. As other forms of energy are fast depleting and polluting the atmosphere, nonconventional energy resources like solar energy are best suited to use. The solar Parabolic Trough is among the best way to use solar energy efficiently due to its advantages to convert abundantly available solar energy into effective and convenient form of heat energy which can be used for various purposes.

III. CURRENT SYSTEM

3.1. Definition and Components

In this type of collector, the solar absorbing surface is flat with no means for concentrating the incoming solar radiation. In this case solar collecting area is same as the solar energy absorbing area. The Non-Concentrating Type (Flat-Plate) Collector absorbing the beam as well as diffused radiation. A Non-Concentrating Type (Flat-Plate) Collector is simple in construction and it does not require sun tacking system. Therefore it can be properly mounted on a rigid platform and hence becomes mechanically stronger than that of collector having tracking system. The Flat-Plate collector consists of following basic components as shown in figure

i. One or two transparent covers- it made from glass or transparent plastics.
ii. Blackened absorber plate usually of copper, aluminum or steel.
iii. Tubes, channels or passage attached to the absorber plate to circulate the liquid required to remove the thermal energy from the plate.
iv. Thermal insulation is provided at the back and side of the absorber plate to minimize the heat losses.
v. Weather tight container to enclose the above components.

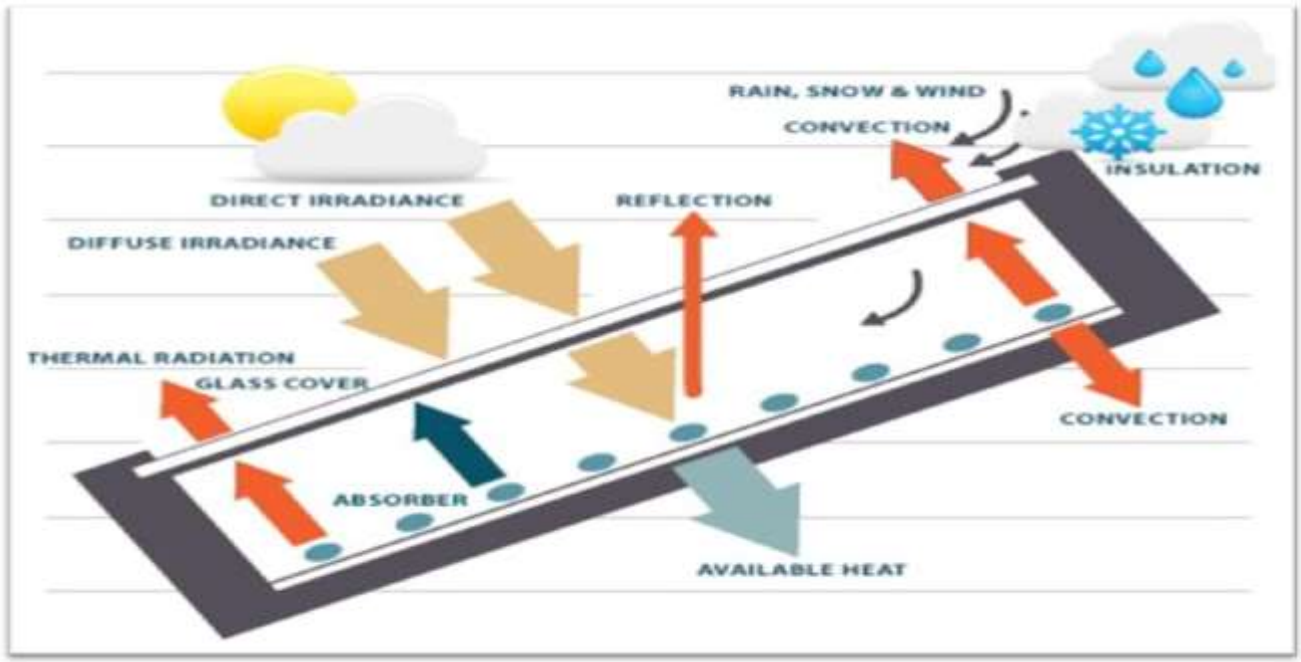

Figure 3.1 Schematics Arrangement of Flat-Plate Solar Collectors

3.2. Working

The performance of solar collector is described by an energy balance that represents the distribution of incident solar radiation into the useful energy gain and variation losses as shown in figure 2.1. The solar radiation strikes on an absorber plate. Absorber absorbs heat and its temperature rises. Therefore, heat is transferred to the heat transfer liquid circulating in the tube or channels. This hot water is utilized for particular purpose. The liquid heated is generally water.

3.3. Advantages and Disadvantages

Advantages

- Flat-Plate Collectors absorbs direct, diffused and reflected components of solar radiation.
- Flat-Plate collector can be fixed in the tilt and orientation and hence there is no need of tracking.
- It is simpler than concentrating reflectors, absorbing surfaces and orientation devices of concentrating collector.

- It requires less maintenance and easy making and also it has low costs.

Disadvantages

- Its solar radiation incident in to the main point is absence. It means it has a no concentrating type collector. So, it has a very low concentration ratio.
- The temperature attained by the absorber area of the collector is lower, so it is not possible to attain higher efficiency and output/outcomes of the collector compares to the other solar collector. So its isolation intensity is not greater than other solar collector.
- Hence total or an overall heat loss to the surroundings per unit of the solar collector collecting area is high.
- Also cost of insulation is very high. And the Non-Concentrating type solar collector is very costly.
- Due to these problem and limitations collector efficiency is very low.

IV. FUTURE SCOPE

Related to the Concentrating Type Cylindrical Parabolic Collector scope of future works are very expandable into the industrial purpose level, for commercialization purpose. It is totally depends on the collector efficiency/outputs with its market price less costly compared to the other collector also. So, Concentrating type Cylindrical Parabolic Collector whole system is testing and after it is screening for validate or a not. And if product is success or a validated then after it is launch into the markets. And also maximum uses of the renewable energy source for only the eco-friendly systems and no pollutant in the environment purpose.

Figure 4.1 Cylindrical Parabolic Concentrator

And also we are thinking about the future work related to the Concentrating Type (Cylindrical Parabolic) Collector for attaining high temperature. The parabolic trough or cylindrical parabolic collector is line focusing type concentrating collector. In which the solar radiation coming from the particular direction is collected over the area of the reflecting surface and is concentrated at the focus of the parabola. It consists of absorber tube located at the focal axis through which the liquid to be heated flows, the cylindrical reflector and concentric transparent cover as shown in figure 4.1. The absorber tube and concentric tube together constitute the receiver while the reflector and support structure constitute the concentrator. In case of concentrating type collector, for the solar radiation to be brought to a focus by parabolic trough reflector the sun must be in such a direction that it lies on the plane passing through the focal line and the vertex of the parabola. Actually, as per above information's making the cylindrical parabolic concentrator like solar collector for

getting high efficiency with the hot water generations with its reliable costs compared to the low costs. And its temperature range is 70

V. REFERENCES

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