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Performance Analysis of Fresnel lens Based Solar Water Heater

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Abstract- **To overcome the freshwater crisis, throughout the countries many researches and innovative technologies are going on. But from these researches and innovations major models are still in experimental level. Therefore by reviewing these researches and innovations an attempts has been made to develop a new design of Fresnel lens based solar water heater system. The main objective of this project is to efficient production of hot water and identification of absorber performances on the production of hot water. In this project the use of a point Fresnel lens to concentrate the solar energy on a special designed absorber for the production of hot water. The proper focusing of solar intensity on special designed absorber is achieved with the help of tracking mechanism. Using this setup experiments are carried out by different water samples. The results for solar water heater system by Fresnel lens showed that yield of hot water depends on water flow rate and pressure inside the system. At the end of the experimentation period yield of hot water was from 5-8liters/hour on bright sunny day. From experimental results showed that by providing proper orientation of the absorber i.e. conical shaped coil can achieve maximum hot water than inverted orientation of same coil.**

Index Terms- **Solar Energy, Solar Collectors, Fresnel Collectors, Renewable Resources, Parabolic Concentrators, Fresnel lens; Concentrated solar power; Photovoltaic cell, Solar Concentrator, Steam generation.**

INTRODUCTION

The Energy demand over the world is increasing exponentially, while fossil fuel reserves have started depleting. In order to sustain the development, continuous supply of energy is required. There is need to find energy resources which can be regenerated, such as solar energy, geothermal, biomass or will not deplete with time. Renewable energy source is one which can be regenerated or does not deplete with time. Solar energy is the most important source of energy which can full fill future energy needs. There are many technologies developed to use solar energy for domestic use.

The Fresnel lens solar concentrator developed at school of energy studies, university of pune is designed for direct steam generation using solar energy. The solar concentrator system has been designed for generation of low pressure steam for various applications such as industrial process heat and steam cooking. The point focus and line focus Solar Concentrators are already been developed by industries in India and abroad. The glass and aluminium material are normally been used as reflectors in the solar concentrators. An unique attempt has been made to develop line focus refracting type solar concentrators for thermal applications. A procedure is developed for thermal performance evaluation of Fresnel lens solar concentrator for continuous fluid flow and direct steam generation. The Fresnel lens solar concentrator developed at school of energy studies, university of pune is designed with following objectives.

Fresnel lens have two type Fresnel collectors: The linear Fresnel reflector (LFR) and the Fresnel lens collector (FLC). The linear Fresnel mirror concentrator technology is still young and has taken place in the field of concentrating solar systems,. The work of Alessandro Battaglia is the origin of the concentration technique by linear Fresnel reflector. The Italian mathematician Giovanni (1911-1980),designed the first prototype of linear Fresnel concentrator with the downward facing aperture covered with glass honey comb tubes at Marseille builtin1962,he go to the performance equal to 60% and steam water temperature equivalent to 450 °C. In the general case and according to the literature searches, the performance of this type of concentrator is varied between 30% and 40% . In this day of many international institutions are investing

and working to develop this technology for instance at Almeria in Spain, the German
This paper aims to characterize the thermal performances of a solar system for heating water which is based on a linear Fresnel solar converter

LITERATURE REVIEW

Udawantet al (2016)"Study of Performance of Fresnel Lens Solar Concentrator". The demand for process heat particularly low pressure steam is increasing in recent past. Solar energy can be utilized for generating medium temperature (100°C -150°C) low pressure (T<200°C) steam. By using solar concentrators, low pressure steam can be generated by using low cost technology .fresnel lens solar concentrators are very useful to generate low pressure steam for industrial and cooking applications. The study of performance of Fresnel lens solar concentrator and steam generation using Fresnel lens solar concentrator is presented in this paper. The overall efficiency of Fresnel lens solar concentrator is around 51% and can generate process steam required in the industry. The thermal performance and cost benefits of Fresnel lens solar concentrator are also described. The studies presented in this paper concerns with Fresnel Lens Solar Concentrator System which are most useful for generating process heat for industrial applications. Thermal performance of Fresnel lens solar concentrator (FLSC) system can be studied by evaluating useful heat gain from the system when exposed to solar radiation [1]. FLSC system consists of Fresnel lens, receiver tracking system and heat removing device. An attempt has been made to evaluate the performance of FLSC system with two methods viz. continuous fluid flow test method and Steam generation test method. The study reveals that Fresnel lens Solar Concentrator system has a very good potential in generation of low pressure steam.

Nura & Kamarulazizi (2015) "Concept of Bee-Eyes Array of Fresnel Lenses as a Solar Photovoltaic Concentrator System". This paper presents a proposal of a new configuration of an optical concentrator for photovoltaic application which may enhance the efficiency of solar cells. Bee-eyes array Fresnel lenses concentrator proposed here provide high concentration factor which is greater than1000x at the 20th zone. In addition, the system also provides room for increasing the number of zones to achieve the high concentration factor if needs arise. The transmission efficiency greater than 90% has been achieved with f-number of 1.25. Mathematical relations derived to obtain flux distribution at the absorber plane and the transmission efficiency as well as the position of the solar cell were used in the ray tracing simulations for 6, 18, 36, 60, 90, 126, 168, 216, 270, and 330 suns concentration systems. Transmission efficiency is linearly decreasing with the increase in the number of arrays in which the transmission efficiency of 94.42% was recorded at the array of 6 suns and 74.98% at 330 suns.

Lei Jing et al (2014) "Design and Optimization of Fresnel Lens for High Concentration Photovoltaic System". A practical optimization design is proposed, in which the solar direct light spectrum and multi junction cell response range are taken into account in combination, particularly for the Fresnel concentrators with a high concentration and a small aspect ratio. In addition, the change of refractive index due to temperature variation in outdoor operation conditions is also considered in the design stage. The calculation results show that this novel Fresnel lens achieves an enhancement of energy efficiency of about 10% compared with conventional Fresnel lens for a given solar spectrum, solar cell response, and corrected sunshine hours of different ambient temperature intervals.

Kapurkar & Kurchania (2013):"Performance evaluation of fresnel lens concentrated solar water heater cum distillation unit" . A composite unit of Fresnel lens concentrated solar water cum distillation unit, having a capacity of 70 liters was developed to perform the functions of water heating and distillation. In this system two insulated tanks with glass cover were fabricated where one was used for water heating and the second tank was for condensation of water vapour. Solar energy concentrated by Fresnel lens was absorbed by the plate and surrounding water contained in water heating tank was heated by this absorber plate's heat through conduction. Water vapour from hot water was condensed in dehumidification tank by the comparatively colder surfaces of copper tube used to feed fresh water and top slanting glass surface. Condensed water was collected in a collection trough. Overall efficiency of solar water heater was found to be 77 per cent.

Iuliana&Constantin (2012):"Thermal Analysis of a Linear Fresnel Lens Solar Collector with Black Body Cavity Receiver". Aceastalucrareişipropunesaanalizeze un astfel de captator, care foloseşte o soluţieconstructivădiferită de celeclasice, şisă compare performanţaacestuia cu a captatoarelorcomercializateînprezent. Acestautilizeazălentileleliniare Fresnel pentru a concentraradiaţiasolarăpeun receptor cilindric tip cavitate. Suprafaţainterioară a tubului de sticlăesteacoperită cu un stratreflectorizant. Înconsecinţă, major it atearazelor care pătrundîncavitatesuntabsorbite(principiulcorpuluinegru). Evacuated tubes are among the most common collectors used in solar thermal energy conversion. This paper aims to analyse such a collector that uses a different constructive solution than the classical, and compare its performance with other currently marketed collectors. The collector uses linear Fresnel lens to concentrate solar radiation on a cylindrical cavity receiver. The inner surface of the receiver's glass tube is coated with a reflective layer. Consequently, most of the rays that penetrate the tube are trapped inside the cavity (black body principle).

Xiea et al (2011)"Renewable and Sustainable Energy Reviews". Solar energy concentration technology using Fresnel lens is an effective way to make full use of sunlight. This paper makes a review about the recent development of the concentrated solar energy applications using Fresnel lenses. The ongoing research and development involves imaging systems and non-imaging systems. Compared with imaging systems, non-imaging systems have the merits of larger accept angles, higher concentration ratios with less volume and shorter focal length, higher optical efficiency, etc. Concentrated photovoltaic is a major application and the highest solar-to-electric conversion efficiency based on imaging Fresnel lens and non-imaging Fresnel lens are reported as over 30% and 31.5 ± 1.7%, respectively. Moreover, both kinds of systems are widely used in other fields such as hydrogen generation, photo-bio reactors as well as photochemical reactions, surface modification of metallic materials, solar lighting and solar-pumped laser. During the recent two decades, such applications have been built and tested successfully to validate the practicality of Fresnel lens solar concentration systems. Although the present application scale is small, the ongoing research and development works suggest that Fresnel lens solar concentrators, especially non-imaging Fresnel lenses, will bring a breakthrough of commercial solar energy concentration application technology in the near future. Finally, the advantages and disadvantages of two systems are also summarized.

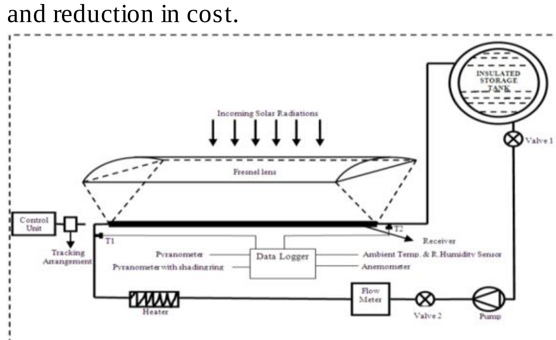
Mohammed S. Al-Soudet al. (2010) "A parabolic solar cooker with automatic two axes sun tracking system". A parabolic solar cooker with automatic two axes sun tracking system was designed, constructed, operated and tested to overcome the need for frequent tracking and standing in the sun, facing all concentrating solar cookers with manual tracking, and a programmable logic controller was used to control the motion of the solar cooker. The Results of the continuous test performed for three days from 8:30 h to 16:30 h in the year showed that the water temperature inside the cooker's tube reached 900Cin typical summer days, when the maximum registered ambient temperature was 360C.

OBJECTIVES

- To estimate thermal performance of Fresnel lens solar concentrator.
- To study the effect of mass flow rate, intensity of solar radiation and inlet temperature on efficiency of FLSC system.
- To estimate quantity and quality of steam.
- To estimate the efficiency of Fresnel lens solar concentrator at different operating pressures (steam temperatures).

DESIGN PROPOSED

By looking into the basic overview and all the advantages of using Fresnel lens, an innovative design is been presented in this paper that shows significant improvement in efficiency of the system and reduction in cost.



ASSUMPTION

- The fluid flow is one-dimensional.
- The all properties of the fluid (water) depend on the temperature.
- The temporal variation in the thickness of the absorber tubes is negligible.
- The exchange by conduction in the absorber is negligible.
- The thermal flux is uniformly distributed on the level of the absorber tubes.
- The temperature of the inlet water increases.
- The temperature of the absorber tubes increases.

FUTURE SCOPE

In near future means by which major portion electrical energy generated today may not fulfill the increasing demand. Hence it is essential to utilized non-conventional energies to generate electricity with higher efficiency. In solar electricity generation this increase in efficiency is possible by solar tracking. By application of current electrical tracking system the constrained on location is removed as well as virtually free and renewable energy is possible. Further research work will be suggested towards reducing the material cost. This is an ideal model so it can work for small capacity. But when we use actually this unit improvement is required. That improvement depends on Fresnel lens weight, size of mechanism that all are calculating otherwise it cannot work properly.

MOTIVATION AND NEED

After doing some amount of research we found out that a lot of energy is needed to heat the copper coil which is only possible with the help of Fresnel lens only because of its high heating capacity and most energy is wasted when the solar radiation is released at atmospheric pressure. Our project is mainly focused on utilizing that solar energy.

RESULT: The experimental result is taken at 20 th of may 2018

Sr.No.	Time(In hrs)0c	Temp(t1)0c	Temp(t2)0c	Temp(t2-t1)0c
1	10:00 AM	36	46	10
2	11:00 AM	37	47	10
3	12:00 NOON	38	48	10
4	13:00 PM	39	49	10
5	14:00 PM	40	50	10

CONCLUSION

The technologies used using Fresnel lens is been presented in this paper. Fresnel lens the solar thermal sector that can be used both for domestic and industrial usages. Cheaper and smaller water heaters for domestic purposes can be designed where electricity is scarce in developing and underdeveloped countries. Advanced technologies of manufacturing Fresnel lens like the FK concentrator and the F-RXI concentrator can be used for industrial and power plant sectors coupled with solar thermal systems. Fresnel lens temperature is faster which means that more quantity of water can be heated throughout the day. Fresnel lens is the most promising technology for the future designs of advanced water heaters.

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