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Modification and Design of Paraboloid Reflector and Receiver to Enhance Heat transfer rate

Asst. Prof. Pravin P. Gavade[1], Mr Tejas R. Chudmunge[2], Mr Rahul S. Jadhav[3], Mr Nitin B. Hulage[4], Mr Manoj N. Shendage[5]

Professor, Mechanical Engineering, Adarsh Institute of Technology and Research Centre, Vita, India [1]

Student, Mechanical Engineering, Adarsh Institute of Technology and Research Centre, Vita, India [2,3,4,5]

Abstract: CSP systems use direct solar radiation. There are two different systems point-focusing and line-focusing systems. Point-focusing systems (solar Paraboloid reflector and solar tower systems) need a two-axis tracking system, while line-focusing systems (parabolic trough and linear Fresnel systems) only require one-axis tracking. As the radiation intensity is the function of traveling length, many of research organization are working on how to reduce traveling length. In case of centre receiver system the focal is at greater distance than the solar parabolic trough system and the solar Paraboloid concentrator. The function of solar Paraboloid reflector is to concentrate diffused solar radiation at less focal distance. Heat is absorbed at receiver by conduction, convection to use it for various applications. The use of helical coil in evacuated receiver enhance heat transfer rate as compare to straight pipe because of greater surface area. Evacuated tube is generally used as receiver in parabolic trough concentrator to reduce convective and radiation heat loss from receiver tube.

Keywords: CSP (Concentrated Solar Power), Paraboloid Reflector, Helical coil Receiver, Evacuated Glass tube, Focal length.

I. INTRODUCTION

Solar energy is available in varying intensity and discrete form on Earth. Due to Sun-Earth geometry and other factor like Radiation extinction processes, cloudiness etc. The different extinction processes prove that not all radiation that reaches the Earth atmosphere reaches the ground. Actually, only about 52% hits the Earth's surface. Additionally, part of the radiation, that reaches the ground, gets there as diffuse radiation rather than direct radiation (or beam radiation). Diffuse radiation does not have a preferred direction. Solar Paraboloid system consist of parabolic shaped reflector which concentrates the direct component of solar radiation to receiver system the concentrated beam radiation is converted into thermal energy in the receiver part and it is absorbed by heat transfer fluid (HTF). Concentration ratio of Paraboloid reflector is high (20-200) **[1]** as compare to other reflectors. In this study helical coiled tube is addressed as heat absorber in evacuated tube receiver. Helical coil is complicated due to the formation of secondary flow induced by centrifugal force. Secondary flow provides better thermal contact between the surface of tube and fluid. This is due to the creation of turbulence and resulting the mixing of fluid which improves temperature gradient which is essential for increasing heat transfer. The overall heat transfer coefficient of helical pipe is approximately 0.35 of that straight pipe **[3]**. Nano fluids are prepared by dispersing Nano particle of different materials such as $AgNO_3$, CuO, TiO_2 and Al_2O_3 etc. in base fluids such as water, Ethylene

Glycol or various oils (pump oil, engine oil transformer oil and synthetic oil). Addition of these particles of higher Thermal conductivity to the fluids mentioned above enhances the thermal conductivity of fluid and thereby increasing the heat transfer coefficient. In this study $AgNO_3$ Nano fluid is use to transfer the heat to water at high temperature and pressure. Results show that the silver Nano particle which reach approximately 36% increase in the convection heat transfer coefficient and 21% Decrease in overall heat loss coefficient than Other Nano particles **[7]**.

II. BASIC METHODOLOGY

1. Solar radiations which are in discrete form on earth are concentrated by paraboloid concentrator on receiver (as point focal image).

2. Due concentrated solar radiation the receiver which consist of helical coil get heated and heat flows through helical coil to heat transfer fluid (HTF).

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3. Heat transfer fluid continuously circulated through the receiver by natural convection to carry heat in receiver and transfer it to the water in heat exchanger.

4. In heat exchanger the heat is exchanged from hot heat transfer fluid to water.

III. LITERATURE REVIEW

Manav Sharma et.al [1]: Author focuses on design of solar parabolic dish concentrator and given different design parameters. Concentration ratio for different collectors is studied. The variation of output temperature with respect to change in helical coil geometry has been studied it is concluded that the output temperature of the system is increased for the non-zero pitch coil as compared to zero pitch coil.

A. W. Dahmani et.al [2]: In this paper solar collector system has been designed and experimentally studied. Experimental measurements of solar flux and temperature distribution on the receiver have been carried out. Also new solar concentrator design has been installed. They give the different formulae to calculate the focal distance, opening surface of concentrator and geometric concentration.

B. Chinna Ankanna et.al [3]: Helical coil tube is compared with the straight tube. They give various geometric parameters of coil tube and also experimental results of straight tube, Helical tube (parallel and counter) in tabulated form for reference.

P.P.Gavade et.al [4]: In this paper they did experimental comparative study on helical coil tube heat exchanger with straight tube heat exchanger and found that the inside overall heat transfer coefficient for helical pipe is approximately 0.35 of that straight pipe.

P.K. Nagarajan et.al [5]: In this paper author concluded that Nano fluids are embryonic fluids that exhibit thermal properties superior than that of conventional fluid. The application of Nano fluids is to achieve the highest possible thermal properties at the smallest possible concentrations, by homogenous dispersion and stable suspension of Nano particles in the host fluids. Also they have discussed the details of classifications, thermo physical properties, thermal conductivity, viscosity, convective heat transfer and application of Nano fluids.

T. Srinivas et.al [6]: In this paper heat transfer studies have been carried out in an agitated shell and helical coil heat exchanger using CuO/Water Nano fluid. They concluded that maximum heat transfer rate enhancement was obtained for 2% Wt. Of CuO/Water Nano fluid. The experiments were carried out with water and subsequently with Nano fluid of different concentration as shell side fluid.

P.C. mukesh kumar et.al [7]: studied that the heat transfer coefficient increase with increasing the particle volume concentration. The conventional heat transfer fluids can be replaced with Al2O3/water Nano Fluids in helically coiled tube heat exchanger for enhancing more heat transfer with negligible pressure drop penalty. It is concluded that the Al2O3 Nano fluid can be applied as coolant in helically coiled tube heat exchanger to enhance heat transfer with negligible pressure drop.

Nabil Banbours et.al [8]: In this paper they have studied numerically thermal performance of parabolic through collector working with different Nano fluids. The particles that have been suspended in the base fluid (Syltherm 800) are the Al2 O3, Cu, CuO, Ag.) Results show that the silver Nano particle which reach approximately 36 % increase in the convection heat transfer coefficient and 21% Decrease in overall heat loss coefficient than Other Nano particles.

G.Kumaresan et.al [9]: In this paper author discusses various receiver systems like Central receiver system, parabolic dish system, Parabolic through and linear Fresnel system. He describe numerical and experimental analysis of heat transfer enhancement by minimizing heat losses, by application of Nano fluid , by using selective coating on receiver tube. He also gives comparative study on heat transfer enhancement method by various researchers. Technic used to enhance heat transfer by placing tabulators in the receiver.

Fareed. M. Mohamed et.al [10]: we studied portable solar dish concentrator, reported design and fabrication of solar dish concentration with diameters 1.6 meters for water heating application and solar steam was achieved. The dish was fabricated using metal of galvanized steel, and its interior surface is covered by a reflecting layer with reflectivity up to (76%0, and equipped with a receiver (boiler) located in the focal position .the dish equipped with tracking system and measurement of the temperature and solar power. Water temperature increased up to 80°c, and the system efficiency increased by 30% at mid noon time.

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Midhun Baby Neerkuzhi et.al [11]: This paper aims to find out the opportunities of solar energy in a dairy processing plant. They work on first design of solar voltaic panel for electrical energy applications & estimate total equipment cost + installation cost to calculate payback period. After that they study parabolic through collector for heating applications within the plant also check economic feasibility for same. Finally, concluded that parabolic trough system is suitable for heating applications in the plant in sunny days. But there is lot of practical limitations to implement this.

Gong Xiangtao et.al [12]: In this paper, tube receiver with pin fin arrays inserting was introduced as the absorber tube of parabolic trough receiver to increase the overall heat transfer performance of the tube receiver for parabolic trough solar collector system. The numerical results indicate that introduce of absorber tube with pin fin arrays inserting design for the absorber tube of the parabolic trough receiver can effectively enhance the heat transfer performance.

Kadri Yosra et.al [13]: In this paper they have given the different dimensions of parabolic collector with experimental results to obtain highest geometric concentration. For that they give the parameters like rim angle, opening ratio, active area, reflector active diameter, focal length, receiver diameter and aperture diameter.

Asepta Surya Wardhana et.al [14]: In this paper they mention that the non-imaging system is also highlighted to show its efficiency over the imaging systems concentrating larger acceptance angles, higher concentration ratios with less volume and shorter focal length, higher optical efficiency.

IV. CONCLUSION

1. The use of Nano fluid will increase heat transfer rate.
2. Design of receiver with helical coil will give better performance.
3. Reduction in focal length of Paraboloid dish & use of evacuated tube over receiver will reduce radiation and convective heat losses.
4. Dual axis tracking system track suns precisely form east to west and also south to north.

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BIOGRAPHIES

Asst. Prof. PRAVIN. P. GAVADE

Master of engineering in Heat and Power
Bachelor of Engineering (Mechanical Engineering)

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Mr. TEJAS R. CHUDMUNGE

Bachelor of Mechanical Engineering at Adarsh institute of technology and research Centre vita.

Mr. RAHUL SHIVAJI JADHAV

Diploma in Mechanical Engineering from Govt. polytechnic Thane.
Bachelor of Mechanical Engineering at Adarsh institute of technology and research Centre vita.

Mr. NITIN.B.HULAGE

Bachelor of Mechanical Engineering at Adarsh institute of technology and research Centre vita.

Mr. MANOJ N. SHENDAGE

Bachelor of Mechanical Engineering at Adarsh institute of technology and research Centre vita.