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SOLAR WATER HEATER THROUGH ALUMINIUM FOIL - A REVIEW

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Abstract - *Solar energy is one of the freely available clean forms of renewable energy. Many technologies have been developed in India for extracting energy from available renewable energies, but the maximum extraction of thermal energy from solar energy is the most challenging process. This paper covers the performance and efficiency of solar parabolic trough collector. It also states the pertinent applications of solar energy such as water heating system, heat transfer fluid, heat transfer model, desalination, industrial heating purposes and power plants. Also recent developments on heat transfer enhancement methods for CSP technology with PTC system were highlighted. Moreover the rupture of glass covers was frequently observed during application, methods of thermal deformation restrain for tube receivers were reviewed as well. Finally, the possible further developments of CSP plants with PTC system were outlined.*

1. INTRODUCTION

In modern world utilize the energies are renewable and non renewable energy. Many countries started running behind renewable energy of various applications like, desalination, air-conditioning, refrigeration. The energy are used in small scale industry ,large scale industries and electric power generation. Maximum energy trapped from various renewable energy sources of the efficient technique are to be used to gain more amount of energy. Now days most of countries uses solar energy, because it is the most abundant source from sun to earth receives high amount of sunlight radiation .The amount of photons in sun light converted into some of solar energy the countries like, Morocco, Mexico, India and Egypt the energy used to develop energy. The energy used to heating applications like solar water heater, solar cooker, thermal power generations, the lighting house and industrial applications. The developing country concentrate the high level solar power for electricity[1].

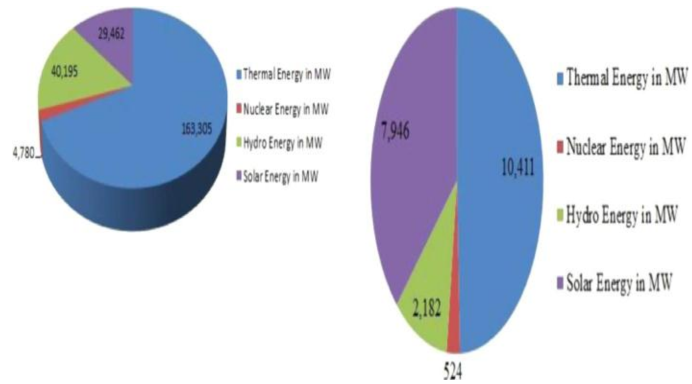

Fig – 1.1 Types of Energy

The renewable energy like solar, tidal, wind, geo thermal can be used maximum to generate power and heating application. The electricity generation of tamilnadu consist a four way of power plant i.e thermal , nuclear, hydro, solar . the national energy laboratory survey give an power generation in tamilnadu. Thermal power plant generate 10411 MW power by using goal as a source of electricity. It is the major amount power generation in tamilnadu solar energy produce the 7946 MW amount power . it's the second largest power generation in tamilnadu, the main source is sunlight .The sunlight radiation started from morning 7.30 am to evening 5.00 pm the peak time period is 11.00 am to 3.00 pm have more amount if energy from sun .hydro power plant produce 2182 MW of power .finally nuclear power plant provide 524 MW of power .The solar collector absorb the heat from source of sun light and the heat transferred into working fluid.. The fluid consist water.[1] Oil, air and some organic fluid . The solar collector directly utilized the thermal energy from sun. The thermal energy converted into heat energy it can be transformed into the working fluid. The types of solar collector namely, Flat-plate collector, flat plate collector with reflectors, Parabolic Trough Collector (PTC), Compound parabolic collector and Fresnel lens concentrating collector. Most of the Flat plate collector used to generate hot water the temperature is (120-140)°C. The flat plate collector have spherical silicon cells it increase the efficiency [2]. In Parabolic Trough Collector absorb the energy from sun by using collector it have silicon mirror. The maximum temperature up to

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(350–400)°C .the collector efficiency is based on the concentration ratio which is the ratio of the effective area of the aperture to the surface area of the absorber. Most of the Power plant require non- renewable energy like coal and petroleum product.it has to be pollute the environment they are main disadvantage of non-renewable energy .future development depend upon the solar energy .

2. SELECTION OF MATERIALS FOR THE CONSTRUCTION

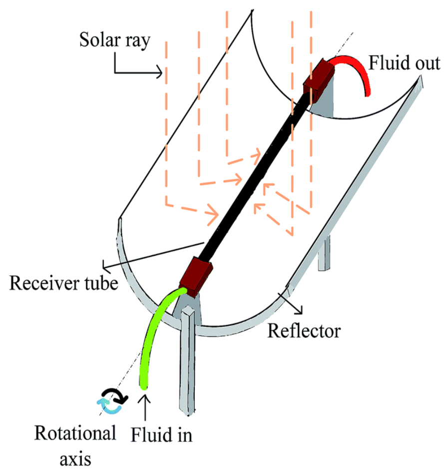

Fig – 2.1 Experimental Setup

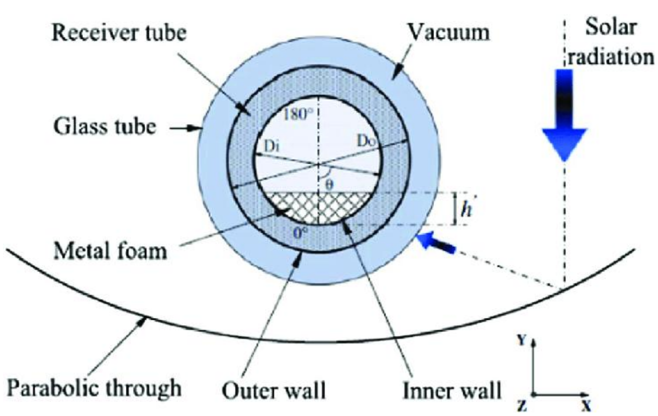

Fig - 2.2 Working Model

2.1 ABSORBER

The absorber tube is made upon copper and bounded by 0.96 absorbance of cermet selective surface and 0.14 emittance at 350 Co Dudley et al. [4].There are two material used in absorber tube copper and cermet. The fluid passes through the tube line working fluid is heated absorbed the solar radiation from reflector [3].

2.2 HEAT TRANSFER FLUID

The working fluid has been used in Syltherm 800. It is a low viscosity, excellent heat transfer and also non-toxic , non-odor. The fluid is highly stable silicone fluid operating temperature of -40 to 400)°C heat transfer fluid[6] . Syltherm is acting on heat transfer fluid increase the performance we are adding silicon polymer with the help of fluid acting on low temperature. Fluid has no toxic viscosity is 25 The syltherm flash point is open cup at 47°C [5].

2.3 HEAT TRANSFER MODEL

Three type of Heat transfer occurred in the system thus the type of heat transfer are conduction, convection and radiations in PTC collector. Energy flow between the collector and receiver indicated in Fig-2.3. Heat flux and temperature uniformly distributed over the collector to receiver [6]

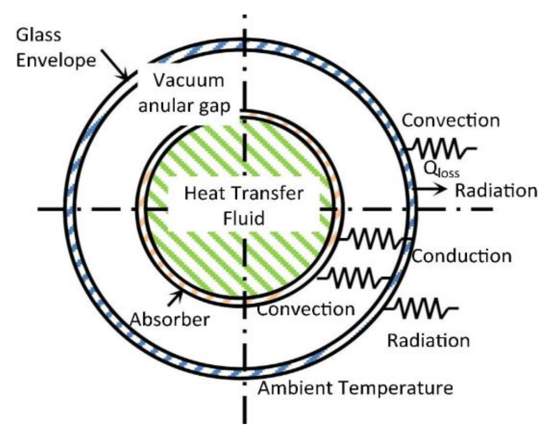

Fig – 2.3 Heat Transfer Model

2.4 CONDUCTION

Heat Transfer occurred in solid body object heated the amount of heat transferred in one region to another region. In PTC collector conduction process occurs in four form heat transfer receiver pipe wall through the steel pipe wall. The internal flow energy of conduction occurred in higher temperature region to lower temperature region. it consist a steel pipe wall and bounded by a glass envelop are connected by using Fourier Law [7,11].

$$Q=-KA(dT/dX)$$

K is the thermal conductivity of cylindrical shell (W/m^2 °C)

A is the area of collector

dT is the temperature difference of glass envelope (To-Ti) °C

2.5 CONVECTION

The bulk motion of molecule moved into one place into another place of fluid is called convection. The heat transfer depend upon the fluid properties and involvement solid surface geometry roughness [7,8]. Convection process of heat transfer between high transfer of fluid and glass envelop.

$$Q = -h A \Delta T$$

h is heat transfer coefficient of inside pipe (W/m^2 °C)

A is area of pipe

ΔT is the temperature difference of fluid temperature

2.6 RADIATION

Radiation process is heat transfer can be reflected, absorbed or transmitted of exchange radiant energy. The two stage of heat transfer in system first stage is steel pipe to glass envelop. second stage of heat transfer in wall and sky [9,10].

$$q=\sigma T^4/A$$

σ = *The Stefan-Boltzmann Constant-5.6703* 10^{-8} (W/m^2K^4)

T = absolute temperature in (K)

A = area of the emitting body (m^2)

3. PERFORMANCE ANALYSIS OF PARABOLIC TROUGH COLLECTOR

The main parts of parabolic trough collector consist upon absorber, receiver and working fluid. The working fluid like a oil, water, air and organic fluid. The absorber fixed permanently it focused on the reflector. The absorber tube protected by using concentric transparent cover is from the heat losses .when heat is reduced hence a vacuum pressure is maintained the system. The collector can be developed parabolic shape the entire structure placed over the tracking mechanism. The tracking mechanism used to adjusting the structure of collector due to variation of solar radiation .The reflecting material placed over the collector surface the material are Garcia-Cortes et al .it reflect the sun light to absorber the solar collector is self-weight [12].The experimental prototype testing we have choose the materials of Eckhard and Michael .it should be self-weight [13].The another material is Vasquez Padilla et al. we used in absorber and collector it is a one dimensional heat transfer analysis. The result of convective heat loss is improved and solar receiver reduction is 41.81%[14]. Naeeni and Yaghoubi have performed wind flow analysis on PTC by changing the orientation of the collector with wind velocities of 2.5, 5, 10 and 15 m/s. The resultant force of normal and pressure fields acting on the collector structure are found 15–20 times lesser than the collector aperture area [15].Rojas et al. have focused on a capillary system on the absorber tube for direct steam generation which can be used for many applications [16].comparing solar power plant and thermal power plant the coal consumption around 24%[17]. This statement gives innovation on sustainable solar energy.

4. THERMAL EFFICIENCY OF PARABOLIC TROUGH COLLECTOR

Solar tracking mechanism is one of the main component in parabolic trough collector to improve the efficiency of parabolic collector. The tracking device kept over the parabolic trough collector towards sun radiations adjusting the direction towards the solar radiation. The Michael and Eckhard have developed the two performance of parabolic trough collector [Eurotrough 100 and Eurotrough 150] the optical concentration ratio of 82:1.The system operating temperature over 500°C and also performed in Finite Element Analysis (FEA) and wind channel for analyzing the collector geometrical structure finally concluded the result of thermal was concluded. The result say that annual output of thermal efficiency increased in 20%[18].The major component of improve the thermal efficiency considered in tracking mechanism. They are two type of tracking mechanism available. There are one axis tracking mechanism and another one is two axis tracking mechanism. Bakos has been designed in two axis tracking mechanism for the system of PTC. Bakos concluded the thermal efficiency was improved in moving surface of collector has 46.46%.it have a more efficient then fixed surface[19]. Valan Arasu and Sorna kumar have designed SPTC by using fiber reinforced plastic. The result of PTC Thermal efficiency was improved in less cost[20].The performance was done by considering parameter such as like flux density, concentration ratio for absorber, optical efficiency. The optical efficiency based on the collector properties of reflection, transmission and absorption[21]. The study of Optimization for improving the heat transfer rate on the absorber tube. The absorber tube with parameters like as diameter, length and heat transfer fluid flux and intensity of incident radiation of absorber tube[22].

5. EXPERIMENTAL STUDY

The most important application of PTC is the Direct steam generation technology (DSG) PTC plants are a promising option to reduce the cost by using water as a Heat transfer fluid (HTF). In this study a parabolic reflector has been designed with 1.8 m of length, and height 0.8 m, and aperture width 1.6 m, which gives a geometrical concentration ratio of 42.14. The reflector was made of stainless steel mirror with thickness of 0.6 mm, the absorber tube is placed in the focal line, whereas the focal length is 20 cm, in Fig. 1. It is made of copper of 2.5 cm inner diameter and 2.8 cm outer diameter, and it is enclosed by glass tube of inner and outer diameter of 5.1 cm and 5.3 cm, respectively. An external flat glass cover for the PTC, of 2.5 mm thickness, increases the thermal isolation of the absorber tube and protects the optical properties of the reflector. The stainless steel tube receiver with solar parabolic trough collectors had experienced frequent deflection and glass envelope rupture during the experimental test and application at the solar power plant of the National University of Mexico. Therefore, Almanza and Flores [24-26] had proposed a compound copper-steel type tube receiver, which was composed of two parts. The internal tube stratified was made of copper to achieve a superb thermal performance and decrease temperature gradients, and the external tube stratified was made of steel to strengthen the tube receiver. The compound wall copper-steel tube receivers had been applied in the solar power plant of the National University of Mexico [24-26]. The experimental test results presented that, when operated at low pressure, a large thermal shock was generated, which induced thermal deformation in the steel receiver causing a deflection of over 50 mm, whereas the maximum deflection measured was only 10 mm in the compound copper-steel type tube receiver.

6. ADVANCED MATERIALS

In the solar power plant of the National University of Mexico, the stainless steel tube receiver for the PTC deflected as a wave during the experimental tests that examined the receiver behavior. When a copper tube receiver was used instead of a steel one, no appreciable bending was observed during application [24–26]. Low cycle fatigue tests of materials for the tube receiver were performed at different temperatures by Lata et al. [27]. The experimental results indicated that high nickel alloys exhibited superb thermo-mechanical properties compared with austenitic stainless steels.

Thermal stress analyses of tube receiver for solar PTC system under concentrated solar irradiation condition with four different materials were numerically studied by Wang et al. [23]. The numerical results indicated that the temperature gradients and effective stresses of stainless steel and silicon carbide (SiC) materials were much higher than those of aluminum and copper materials. The stress failure ratio was introduced by the authors to assess the thermal stress level for each material. As shown in stainless steel has the highest stress failure ratio whereas copper has the lowest value. The numerical results obtained by Wang et al. [23] were consistent with the experimental results tested in the solar power plant of the National University of Mexico.

7. CONCLUSION

This paper focuses on the current energy crisis that has lead to the innovative study on renewable energy. The solar energy is a perfect remedy for future power demand. The solar collectors contribute to more advancement in thermal applications. The PTC has the ability to handle about 400 °C temperature of heat. The various studies show the following Structural and optical performance analysis on PTC shows the major parameters such as; optical efficiency, heat transfer coefficient of working fluid, heat flux, reflection, transmission, adsorption, diameter of absorber, length of the collector etc. should be optimized to withstand against environmental conditions. Thermal analysis on PTC shows that a consecutive improvement can be done in thermal efficiency by optimizing the major affecting parameter such as absorber materials, coatings on absorber and differing working fluid.

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