Performance Enhancement In Solar Flat Plate Collector

T.Rajagopal, K.Aranganathan,R.V.Arun kumar, M.Boobalan

Abstract: Solar flat plate collectors are devices adapted excite solar thermal energy and use it for heating applications like water heating, house heating and totally different industrial applications. Flat plate collectors [FPCs] are normal for low and medium heating applications. Therefore, statistical and experimental studies were conducted on site in order to improve the thermal efficiency of FPCs.Coolant oil is utilized as fluids are the foremost effective ways in which to improve heat transfer. Comparison of varied heat transfer improvement methods, that cause choosing the foremost effective chance among them. The results of mode parameters just like the thickness and coating of the glass cowl, the thickness and material of the sorbent material plate, the air gap between the sorbent material plate and so the glass cowl, and so the space between risers and so the insulation materials are thought of to spice up the performance of FPCs. The influences of the atmosphere conditions, mass flow, angle and constant on the performance of the collector with clear insulating materials were analyzed.

Keywords: Solar Flat plate collector, heat transfer enhancement method, Environment conditions, Design parameters, Transparent insulating material, Coolant oil

1. INTRODUCTION

Sustainable power source might be a term acclimated check with sorts of vitality that square measure normally acquired from the environment and from sources that may renewed normally. These grasp elective vitality, wind vitality, heat, hydropower and biomass. The term sustainable power source shouldn't be mistaken for vitality, that portrays wellsprings of vitality outside the ordinary structures like fuel that square measure contemplated a great deal of condition inviting or less hurtful. The alternative energy is that the energy obtained by capturing heat and lightweight from the sun. The methodology of getting electricity from daylight is spoken because the electrical phenomenon method. this is often achieved employing a semiconductor material. The other type of getting alternative energy to drive is to thermal technologies that offers two sorts of energies. The first is sun based fixation that centers elective vitality to drive warm turbines. The subsequent strategy is warming and cooling frameworks utilized in sun based water warming. For boiling water reason, one of the most ordinarily utilized galaxies is level plate gatherer. It changes over sunlight based radiation vitality into heat vitality. Widely utilized in low warm applications.

2. LITERATURE REVIEW

Liqun Zhou et al.[1] investigated a collector with transparent insulation material suitable to be used in cold environment and find the collector with low solar radiation intensity, The collector with transparent insulation materials could maintain a decent efficiency .The change of wind speeds has a little effect on the FPC's performance and A small mass flow rate leads to greater heat loss. With the increase of mass flow rate, the change of the FPC's efficiency is insignificant.

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The operation of the collector with TIM at a small flow rate has more advantage. Ralph Eismann.[2] proposed for the expense and productivity improvement of level plate gatherers a precise diagnostic model and the transmission coefficient, spread plate, the absorptance, ingestion plate, of the safeguard covering and the transformation factor, g0, of the exact model. In this manner the vulnerability of the steady, C, was impressively diminished. The gatherer model was approved against exact information of 22 level plate authorities which were tried by the European standard EN 12975-2 (CEN, 2006). The vulnerability of the upgraded authority model lies well inside the vulnerability of experimental test outcomes. F. Giovannetti et al. [3] recommended a gatherer with New glass coatings with high sun powered transmittance and low emissivity dependent on straightforward conductive oxides (TCO) empower imaginative authority plans. His examines the aftereffects of our examinations on revealed, single-, and twofold coated level plate authorities. Based on the optical information of recently created covered glass, we examine its potential in contrast with ordinary spreads. The outcomes show that a huge increment in effectiveness is available both in single-coated gatherers with low or non-particular safeguards and in twofold coated authorities with profoundly specific safeguards. M.E. Zayed et al. [4] survey on the utilization of nanofluids for improving the fiery presentation of sun oriented Upstarting the FPSC with carbon nanostructure, copper oxide and aluminum oxide nanofluids, on similar conditions with point by point monetary investigation, along these lines, a significant examination might be acquired. Contemplating the presentation of the FPSC with half breed nanofluids for example a mix of at least two different nanoparticles scattered in the basic liquid as it is viewed as a promising HTF inside the sun powered FPCs. Xianli Lia et al. [5] examined the impact of changes in emissivity of safeguard plate on the authority execution and An extensive stretch presentation of safeguard plate to outside condition shows that the exhibition corrupts generally with dust collection except if the surface is cleaned by human activity. In any case, the outlet temperature and the proficiency don't diminish carefully, mostly because of that the uncovered sunlight based radiation force isn't indistinguishable which importantly affects the presentation corruption. Mirza Muneer Baig et al. [6] built up a sun powered FPC by utilizing mellow steel as a safeguard plate rather than aluminum we are getting effectiveness as

13.1796 changing the properties by applying dark shading covering on gentle steel plate. Along these lines, we get same absorbability (α) as in the event that on Aluminum plate. The Efficiency of level plate authority is done during under clear sky condition

3 METHODOLOGY

3.1 PRINCIPLE

The ideas of FPC are to acquire radiation vitality from the sun however much as could be expected through warmth retention. The gathered vitality is moved by working liquid (typically water) through course tubes that are fused with the warmth safeguard sheet. The warm water then transfers the heat to the hot water system or to the subsystem for processing that can be used during low sunlight.To design and fabrication of the solar flat plate collector to begin the design of the project, the literature survey the modified parameters are identified in the solar FPCs and optimizing the parameter by using design and analyzing and started fabrication of the FPC and take reading using by thermocouple and theoretical calculations of efficiency were done.

3.2 SELECTION OF DESIGN PARAMETERS

The choice of few important parameters affecting the quality of FPCs, i.e. The thickness and surface of the glass cover, the thickness and material of the absorber plate,The distinction between the safeguard plate and the spread and the hole between the risers and the protection materials.

3.2.1 GLASS COVER

To build the nature of the glass spread. The use of low emissivity coatings for glass covers is one of the approaches in this regard. Transmissive, reliability and price are incredibly important parameters influencing the FPCs glazing. One can list metals such as silver, copper, gold and metal oxides such as tin oxide and zinc oxide among the correct coatings used in the glass cover,Natural impacts including temperature and mugginess assume a noteworthy job in the nature of the covering. The impact of two covering including aluminum doped zinc oxide(AZO) and tin doped indium oxide (ITO) on twofold coated gatherer results.. They found that ITO has higher chemical resistance compared to AZZO and lower emissivity. The double-glazed quality with the single glazed collector. For a double glazed and single glazed device with the same condition as a the frequency and measurement of solar radiation, the collector output was 55% and 12%.

3.2.2 ABSORBTION PLATE

The plates or sheets of copper or aluminum, What's more, the trademark variables of the gatherers influenced by warm conductivity of the safeguard plate material impact the decision of the safeguard plate material.Such variables, for instance, increased from 12% to 19% when steel as replaced as an absorber plate by an aluminum sheet. In contrast, when using copper instead of an aluminum sheet they gained about 3 times. There is no benefit in using copper instead of aluminum unless there are serious corrosion problems are critical. There is a popularity for finding specific safeguard covering to improve the effectiveness of FPCs cermet, as material comprising of metal particles in earthenware structures, is extensively used as solar. Solar absorption ranged from 0.92 to 0.96 and emissivity ranged from 0.05–0.08. Thickness is another critical parameter in the safeguard plate that influences the exhibition of FPCs copper and aluminum as safeguard plates with thicknesses of 1 and 2 mm and shows the better of the aluminum safeguard plate to retain and store vitality. Table 1 shows the composition, Melting point, Strength, Density, Emissivity, Weight, Thermal conductivity, Resistance to corrosion of the aluminum. When considering and comparing with other materials of all above properties aluminum is selected as the absorber plate.

Table 1 *Properties of Aluminium*

PROPERTIES	ALUMINIUM
Composition (%)	Cu=0.05-0.2, Fe=0.7, Si=0.6, Zn=0.1
Melting point (^{0} c)	660.3
Strength (MPa)	70-700
Density (kg/m^3)	2800
Emissivity (ε)	1 for black body
Weight (kg)	Less
Thermal conductivity(K)	240
Resistance to corrosion	high

3.2.3 AIRGAP BETWEEN GLASS COVER AND ABSORBER PLATE

A few investigations were directed to limit the convective warmth move from the safeguard plate to the glass spread on the impact of the air hole between the safeguard plate and the glass spread. The straightforward calculation to join the speed and strain to change the predominant convection term into convection by expanding the air hole thickness. Moreover, The thickness change transformed an efficient stream into a riotous one, bringing about an expansion in heat misfortunes. Both convection misfortunes just as air hole concealing impacts in a FPC. We indicated the separation between the safeguard plate and the glass spread ought to be 4–5 cm to lessen these effects. Given three different lengths of air gaps of 25, 50, and 150 mm The FPC with 50 mm air gap consumed 11.64 percent and more than 25 mm and 150 mm air gaps, respectively, 7.72 percent power. The variability in collector output was negligible for air gaps exceeding 40 mm

3.2.4 RISER PIPE

The structure of the gatherer depends basically on the measurement of the riser and header tubing. Likewise, the riser breadth affected the gatherer's warmth expulsion factor and warm yield. To augment the warm presentation of FPCs, displaying and reenactment. The breadth of the riser and header extended from 6 mm to 35 mm hence. The riser and header distance across ought to be 8 mm and 22 mm, separately, a perfect design. Also, the quantity of riser tubes in this gadget ought to be 20. Impact of riser pipes removes on a FPC's productivity. Various setups with a separating of 0.125

m, 0.25 m, and 0.0625 m, including 4, 2 and 8 riser tubes, are considered. The variety of various riser pipes from 4 to 8 had no huge impact on the authority's yield. The FPC was picked as the best monetary dividing with 4 riser tubes.

3.2.5 INSULATING MATERIAL

It is important to use insulation materials to reduce convection and convection heat losses from the collector's bottom and sides. At high temperatures and climate tolerance, it should have chemical stability. It is popular to use rockwool, glass wool, mineral wool, polyurethane foam and other foams as insulation materials Because of its superior and a high proportion of solidarity to weight at low temperatures, polyurethane froth performs well among these materials. For medium temperature applications, the most extreme thickness of a TIM was 100 mm. It demonstrated that when the separations between the TIM and the spread and the TIM and the plate were 15 mm and 20 mm, the best decision was to lessen the front warmth misfortune coefficient.

4.SPECIFICATION

The optimized specifications should be evaluated for all design parameters used in the flat plate collectors the specifications are must be followed

4.1 GLASS COVER

The specifications of the glass cover such as thickness, Length, width should be represented by the table 2

Table 2 *Specifications of Glass Cover*

TYPE	VALUE (mm)
Glass thickness	4
Glass Length	1000
Glass Width	780

4.2 ABSORBER PLATE

The specifications of the aluminum such as Thickness, Length, Width should be represented by the table 3

Table 3 *Specification of Absorber Plate*

TYPE	VALUE (mm)
Plate Thickness	1
Plate length	940
Plate width	720

4.3 COLLECTOR

The specifications of the collector such as Thickness, Length, Width should be represented by the table 4

Table 4 *Specification of Collector*

TYPE	VALUE (mm)
Length of collector	1000
Width of collector	780
Thickness of collector	150
Riser pipe diameter	8
Header pipe diameter	22

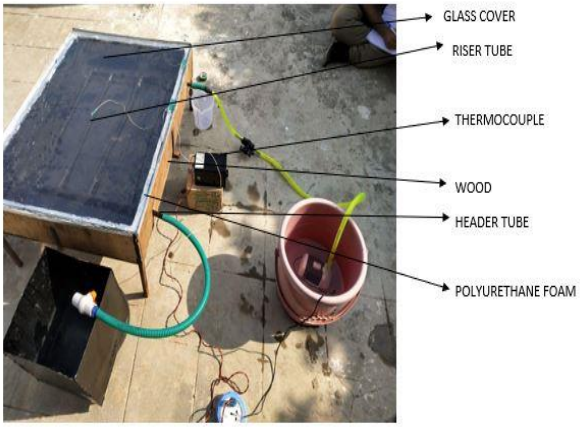
5 DESIGN AND FABRICATION

5.1 VIRUTUAL VIEW

Virtual view of the solar flat plate collector is designed by Creo parametric 5.0, by the optimized value can already find. every part should be designed and assemble the parts in optimized value. Figure 5.1 represent the virtual view of the FPC done by the software creo.

5.2 FABRICATED MODEL

The virtual model is analyzed and optimized value should be fabricated shown in the figure



6.CALCULATION

Level plate gatherer proficiency: FPC productivity is given over a similar timeframe by the proportion of the helpful addition over a predetermined timeframe to the episode sun oriented vitality. $\eta = Q_U / A.It$

Where Qu = Useful heat gain (watts)

$Qu = m.Cp\,\Delta T = m.Cp(t_0\text{-}ti)$ (watts)

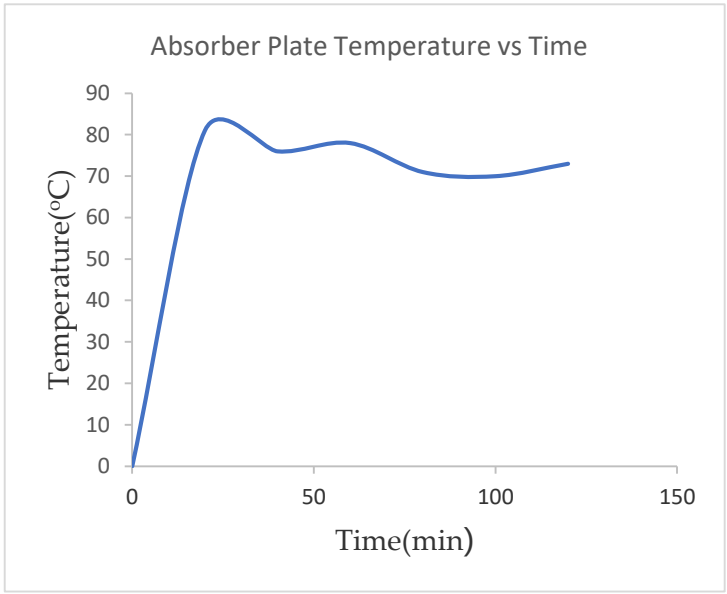
Day 2 readings are calculated using the above formula

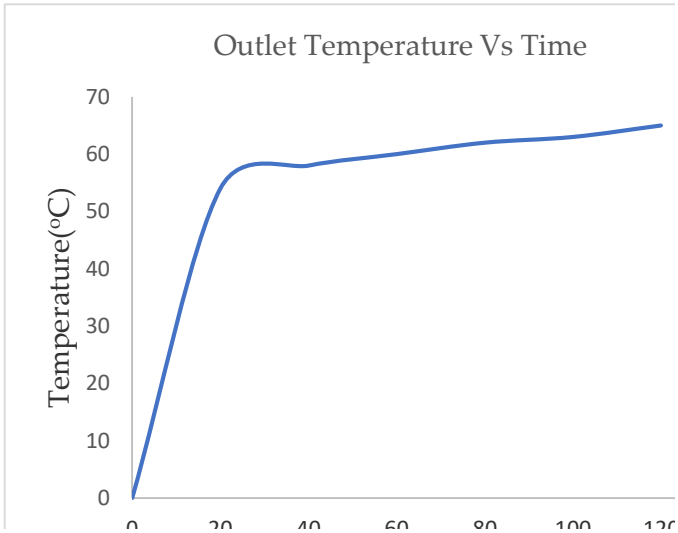
1) Mass
2) Temperature difference $\Delta T = (t_0\text{-}t_1)$
3) Useful heat gain $Q_u = mc_p\Delta T$
4) Area (A) = L×B
5) Efficiency (η) = Qu/A.It

The graph should be drawn for

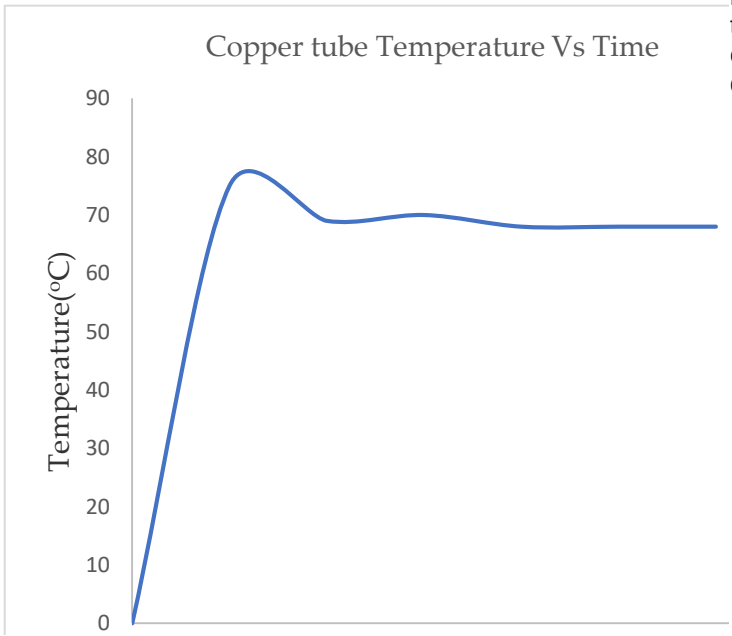
i) Absorber plate(^{0}C) Vs Time(min)
ii) Copper tubes(^{0}C) Vs Time (min)
iii) Outlet temperature(^{0}C) Vs Time(min)
iv) Efficiency(η) Vs Time(min)

(i) The graph shows the absorber plate temperature and the time in minutes. It represents when water presence timing increases the temperature of the water also increases. The temperature depends on the time of water present inside the copper tubes

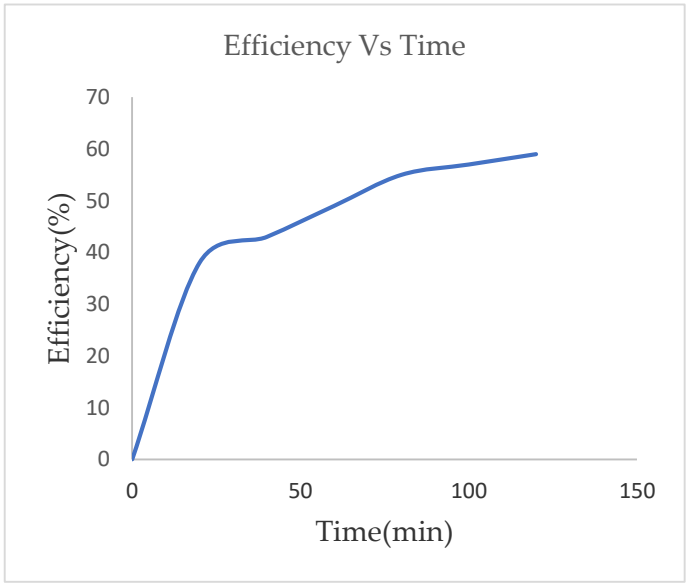




(iii) The graph shows the outlet temperature and the time in minutes. It represents when the temperature of the copper tubes and absorption plate increases the temperature of the outlet fluid also increases. The outlet fluid temperature depends on the copper tubes and absorption plate.



(ii) The graph shows the copper tubes temperature and the time in minutes. It speaks to when the temperature of the copper tubes expands the temperature of the water likewise increments. The Copper tubes temperature depends on the solar radiation on that time



iv) The graph shows the efficiency and the time in minutes. It represents when the temperature of the copper tubes, absorption plate, air gap, outlet fluid increases the efficiency also increases. The Efficiency depends on the copper tubes, absorption plate, air gap, outlet fluid. By setting the copper tubes, the safeguard plate (Aluminum) helpful warmth gain is determined. This result also indicates that when using Aluminum material as absorber plate efficiency is equal to 39% to 59%.

7.CONCLUSION

FPC's improvement and generation were done effectively. The fluctuation in outside conditions during tests, for example, sunlight based light recurrence, gulf temperature, and so on brings about thought of sun based gatherers ' dynamic conduct, which can accomplish advanced structure of FPCs.

The important parameters influencing the quality of FPCs are the density and surface of the glass cover, the material and the thickness of the absorber plate, the air gap between the absorber plate and the glass, the distance between the risers and the insulating materials. The impact on the warm proficiency of FPCs of separations between riser pipes and their thicknesses can be researched.

8.REFERENCES

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