ANALYSIS AND COMPARING THE VARIOUS SHAPES OF EXTENDED SURFACE TO INCREASE THE HEAT DISSIPATION FOR PV MODULE

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ABSTRACT

The aim of this research was to design and install a new system of passive cooling for the thermal management systems of integrate. A self-operating, maintenance and reliable using Fins will be presented as a result of this research. The passive cooling proposal will improve the life and the effectiveness of the concentration of solar cells for the production of electricity which are both limited by the methods of passive cooling. Theoretical and experimental research has been conducted to study the concept described above and to develop a practical system based on this concept.

Keywords: Solar Energy, Pv Module, Solar Power Generation

1. INTRODUCTION

Solar Panel has helped all to further solar energy. Alexander explained photo voltaic effect, how the electrode dipped in conductive solution convert solar light (energy) into electricity [26]. Solar panels are made up of many solar cells, these solar cell also known as photo cell or photo voltaic cell. This is a type of junction diode only. Excess of holes in p-part but n-part has low holes. On the contrary n-part abundant with electron as compare to p-part.As soon as the sun's light falls on these solar cells p-part of electrons starts moving towards n-part. And n-part of holes stat moving towards p-part. And in this way, the current starts flowing in the cell. And the voltage which is generated into the panel is known as p-v –emf [26] .and these energy can be stored in battery for further use Due to the limitation of traditional sources the use of solar panel becomes important.

Solar panel are generally designed to work at temperature of 25 ^{0}C, but as our country falls in tropical region so we are surplus in solar energy as the tropic of cancer passes through the center of country [16].Due to the geological situation of our country, the average temperature crosses 25^{0}C and reaches 38^{0}C -45^{0}C, Sometimes this temperature also crosses 45^{o}C especially in the summer. Which causes the decrease in efficiency of solar panel by 13-18 % Therefore; it is necessary that the temperature of the solar panel base does not increase even during the summer from the average temperature [12]. Keeping this in mind, in the past to reduce the base temperature water spraying, reflecting glass and fin technique used, which was quite effective. Here we have used different kind of fin shapes and calculated heat transfer rate, efficiency and effectiveness.

Fins are the extended portion which is directly attached to back side of panel to reduce its temperature up to moderate[19],In this thesis five types of fins i.e. rectangular fin, closely wide rectangular fin, trapezoidal fin , half elliptical shapes fin fitted at 240 watt panel. Between the base and the fin tip point temperature difference created by the extended portion. The higher the temperature, the greater the heat transfer will be. Conduction and convection takes place simultaneously due to the heat coming from the base of the fin. In general fin is used in transformer two wheeler vehicles, electronics chips for cooling purpose, but, its use in solar panel is an important step. As the power of solar panel increase the weight of panel increase, Therefore, it is advisable to use the aluminum fin in the panels so that the weight does not increase [17]. Aluminum is

good conductive material and its weight per unit length is also less as compare to other metal.[25]

1.1.Review of Solar Energy in Bhopal

Raja Bhoj airport is ready to become the primary airport in Madhya Pradesh to use solar energy for running its utility grid system. The solar energy plant is predicted to be created operational from June 30.A solar energy plant are put in at the airport at Gandhinagar to save electricity price and use renewable energy sources. The tender for putting in the plant has been awarded to a Baroda-based solar module producing company WAA solar.

The figure 1 shows monthly average solar irradiation in Bhopal throughout the year from January to December. The monthly average for Bhopal city is 5.51kwh/m2/day having lowest in the month of August and maximum in the month of May.

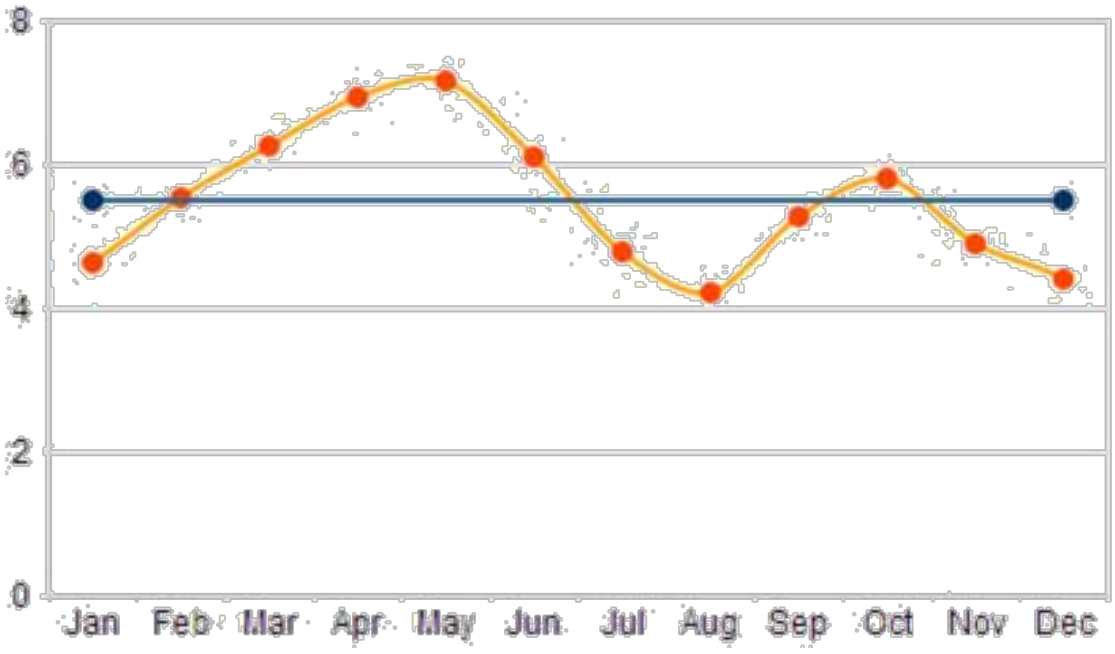
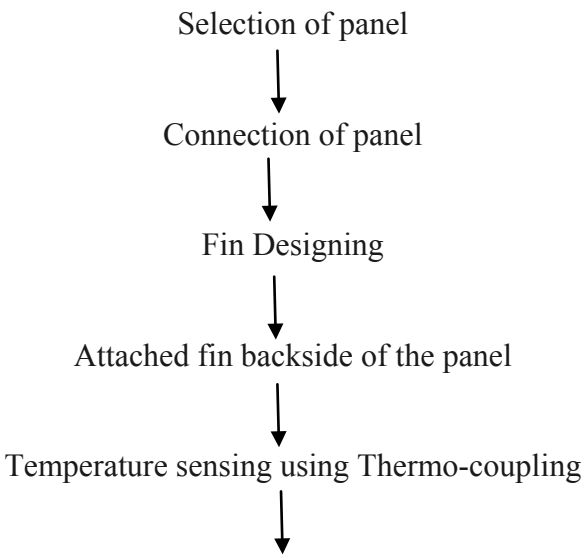


Fig.1 Monthly average solar irradiation in Bhopal, Madhya Pradesh

2. METHODOLOGY

To improve the efficiency of the panel an attempt is made for the improvement of the panel efficiency by reducing the temperature of the panel when the temperature of the panel crosses 60˚C heat transfer is occurred by using fin and the excess amount of heat is exhausted to the ambient through the extended surface from the panel. For making the system efficient fin is cooled through the ambient air, heat gained by the fin from the solar panel is transfer to the ambient.



Temperature at tip point and base has been noted

↓

Calculating heat transfer,efficiency and effectiveness

↓

Comparing fin withrespect to efficiency and effectiveness

↓

Result and discussion

Fig.2 Flowchart for Experiments Methodology

3. MATHEMATICAL MODAL

3.1.Steady Flow Of Heat Along A Rod

Heat Transfer from Extended Surface (Fin): to increase the rate of heat transfer by convection between a surface and therefore the fluid by attaching to the surface thin metallic strips known as Fins[8]. Adding a fin to an object, will increase the surface area and may generally be an economical resolution to heat transfer issues [5].

The rate of heat transfer from a solid surface to atmosphere can be calculated by newton's cooling law which is $Q = hA\,\Delta\,T$ where, h and ΔT are not controllable[19].

So, to increase the value of Q surface area should be increased. The extended surface which increases the rate of heat transfer is known as fin.

Generalized Equation for Fin Rectangular fin[24]

$$\frac{d^2\theta}{dx^2}+\frac{1}{A_c}\frac{dA_s}{dx}\frac{d\theta}{dx}-\frac{h}{kA_c}\frac{dA_s}{dx}0-0$$

Where Ac and As are cross-sectional and surface area.

And $\theta(x)=t(x)-t_a$

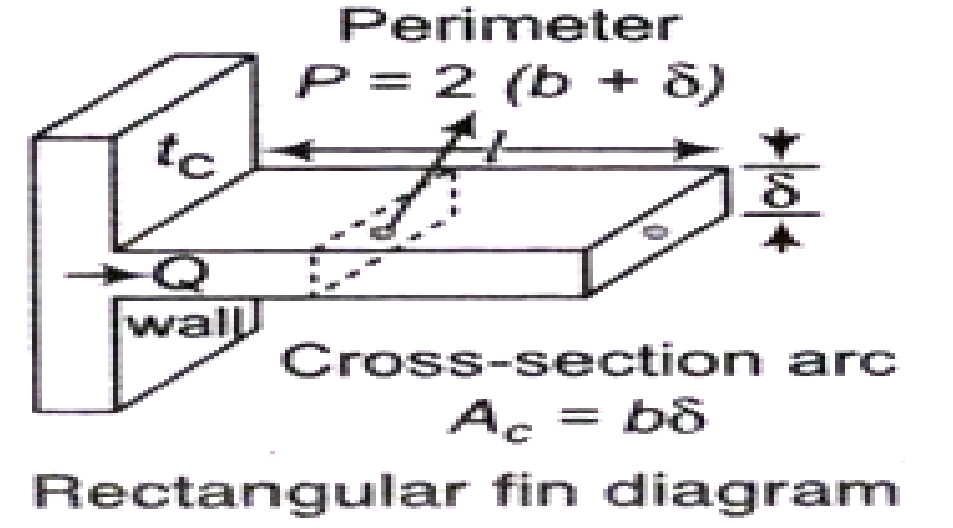


Fig.3 rectangular fin diagram

Heat balance equation if Ac constant and As ∞ P(x) linear

$$\frac{d^2t}{dx^2}-\frac{hp}{k\,A_c}(t-t_a)=0$$

$$\frac{d^2\theta}{dx^2}-m^2\theta=0$$

$$m=\sqrt{\frac{hp}{k\,A_c}}$$

General equation of 2nd order $\theta = c1e^{mx} + c2e^{-mx}$

Heal dissipation can be takes place on the basis of three cases[24]

FIN EFFICIENCY: The performance of an actual fin to that of an ideal or fully effective fin. Fin efficiency is given by[19]

$$\eta = \frac{\text{Actual heat rate from fin Q}}{\text{Maximum heat transfer rate } Q_{max}}$$

If $l \to \infty$ (infinite length of fin)

$$\eta = \frac{\sqrt{hPkA_c}\ \theta_0}{h(Pl + b\delta)\theta_0} = \frac{1}{l}\sqrt{\frac{kA_c}{hP}}$$

If fin is with insulated tip,

$$\eta = \frac{\theta_0 \sqrt{hPkA_c}\ \tan h\ ml}{hPl\theta_0}$$

If finite length of fin,

$$\eta_{fin} = \frac{1}{mL} \times \frac{\tanh(ml) + \frac{h}{km}}{1 + \frac{h}{mk}\tanh(ml)}$$

FIN EFFECTIVENESS: Fin effectiveness is dented by ε.[23]

$$\varepsilon = \frac{\text{Actual heat transfer from fin surface (Q)}}{\text{Rate of heat transfer without fin}}$$

$$\varepsilon = \frac{Q}{hA\theta_0} = \frac{\theta_0 \sqrt{hPkA_c}\ \tanh\ ml}{hA\theta_0} = \frac{\tan hml}{\sqrt{\frac{hA_c}{Pk}}} \quad (\text{if } l \to \infty)$$

If $\sqrt{\frac{Pk}{hA_c}} \leq 1,$ then ε≤1⇒ It means there will be reduction in rate of heat transfer due to its very high convective coefficient of heat transfer. (in case of boiling condensation and high velocity fluid)[19].

4. RESULT & DISCUSSION

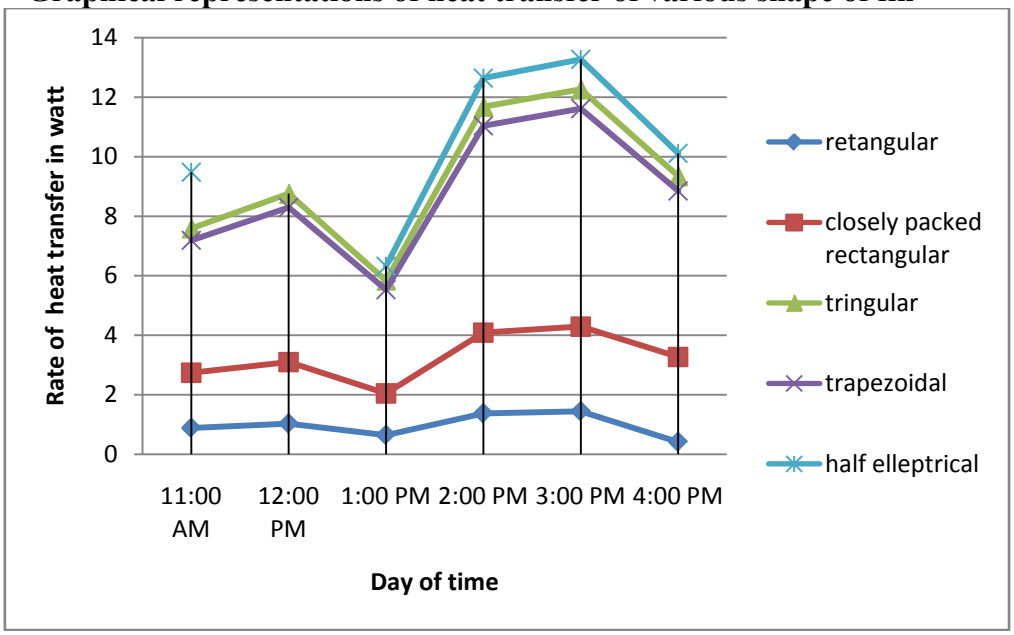
4.1.Experimental Set-Up

Fig. 4 Experimental set-up (front view)

S.N.	TYPE OF FIN	TIME	TOTAL HEAT TRANSFER
1	Rectangular fin	11:00 am 12:00 pm 01:00 pm 02:00 pm 03:00 pm 04:00 pm	0.8947 Watt 1.032 Watt 0.6456Watt 1.376Watt 1.4452 Watt 0.4129 Watt
2	**CLOSELY PACKED RECTANGULAR FIN**	11:00 am 12:00 pm 01:00 pm 02:00 pm 03:00 pm 04:00 pm	2.74Watt 3.098Watt 2.044Watt 4.088Watt 4.2924Watt 3.2704Watt
3	**TRIANGULAR SHAPE OF FIN**	11:00 am 12:00 pm 01:00 pm 02:00 pm 03:00 pm 04:00 pm	7.592 Watt 8.76 Watt 5.84 Watt 11.68 Watt 12.264 Watt 9.344Wat
4	**TRAPEZOIDAL SHAPE OF FIN**	11:00 am 12:00 pm 01:00 pm 02:00 pm 03:00 pm 04:00 pm	7.1916 W 8.298 Watt 5.532 Watt 11.04Watt 11.6172 Watt 8.8512 Watt
5	**HALF ELLEPTRICAL SHAPE FIN**	11:00 am 12:00 pm 01:00 pm 02:00 pm 03:00 pm 04:00 pm	8.216Watt 9.48Watt 6.32Watt 12.64Watt 13.272 Wat 10.112 Watt

Table 1 Total heat transfer from the various shape of fin

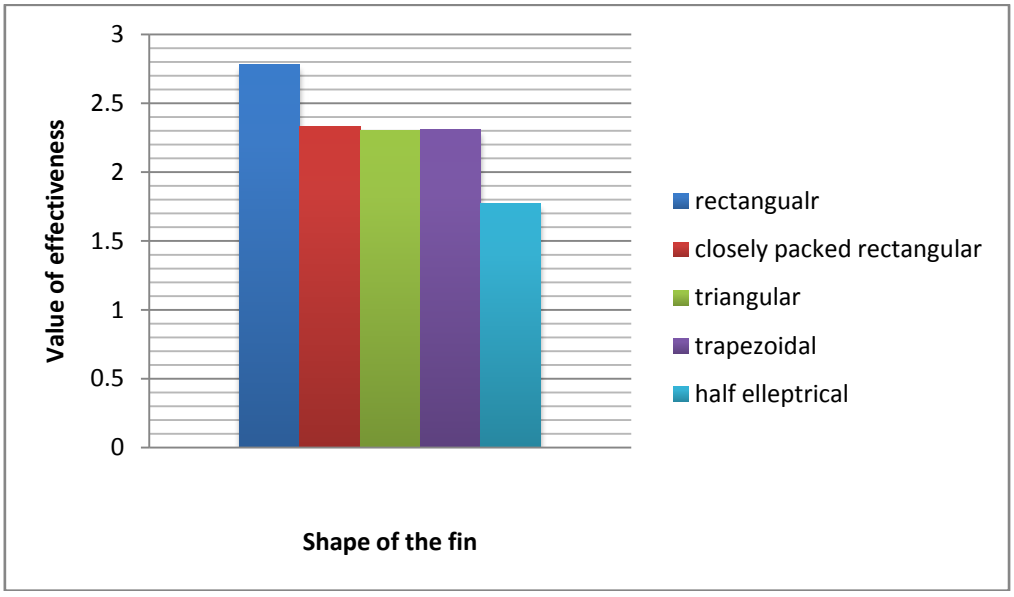
Graphical representations of heat transfer of various shape of fin-



Graph 1 heat transfer rate of various shape of fin

Table 2 effectiveness of various shape of fin-

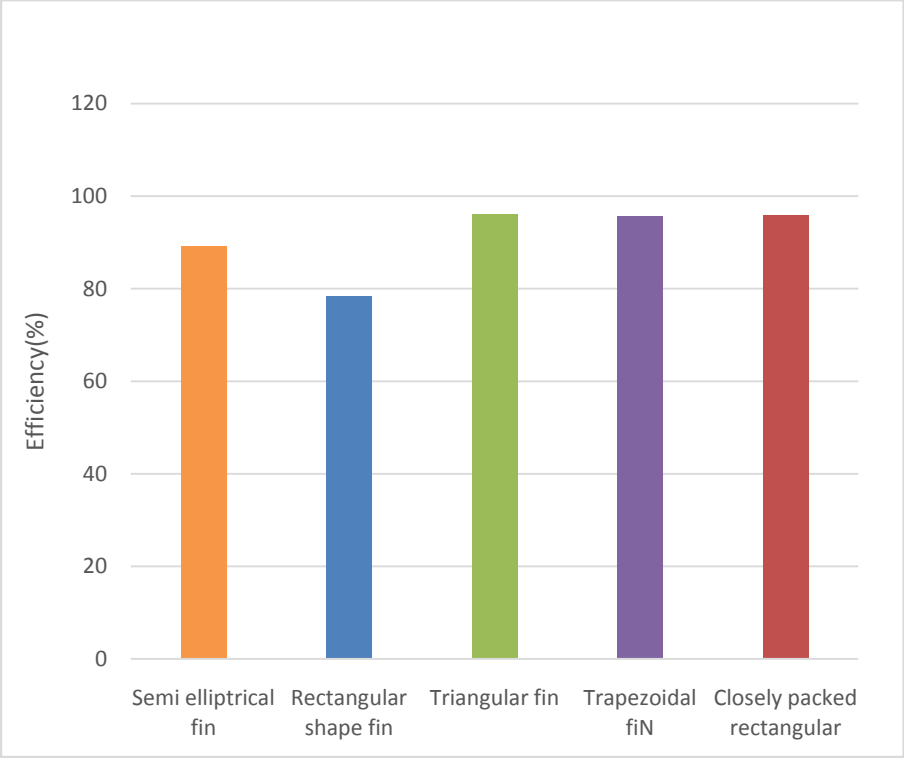
S.N.	SHAPE OF THE FIN	EFFECTIVENESS
1	RECTANGULAR FIN	2.78
2	CLOSELY PACKED RECTANGULAR	2.33
3	TRIANGULAR FIN	2.30
4	TRAPEZOIDAL FIN	2.31
5	HALF ELLEPTRICAL FIN	1.77



Graph 2 Effectiveness of various shape of fin

Table 3 Efficiency of various shape of fin

S.No.	Shape of fin	Efficiency (%)
1.	**Semi elliptrical fin**	**89.08%**
2.	**Rectangular shape fin**	**78.28%**
3.	**Triangular fin**	**96.01%**
4.	**Trapezoidal fin**	**95.63%**
5.	**Closely packed rectangular**	**95.89%**



Graph 3 Efficiency comparisons Figure for various shape

5. CONCLUSION

From above result following things can be concluded:-

1. For the same length, same thickness and same length of fin trapezoidal shape fin tip has least temperature.
2. Similarly tip point temperature of closely wide shape fin has higher temperature.
3. On the basis of total heat transfer rectangular shape fin transmit least amount of heat and semi elleptrically shape fin transmits higher rate of heat compare to other shape of fin.
4. If the pitch length of the rectangular shape of fin decreases than total rate of heat transfer will increase and corresponding efficiency will also increase.
5. On the basis of efficiency among semi elleptrical, rectangular, trapezoidal and triangular shape of fin, triangular fin is best.
6. Rectangular shape of fin shows higher effectiveness compare to other shape of fin(closely packed rectangular shape,semi elleptrical, triangular and trapezoidal).

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