The Comparative And Experimental Study Of Solar Panel With And Without Cooling System

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Abstract- *the over consumption of fossil fuels not only reduces its quantity but also a reason for global warming hence there is an immense demand for alternative source of energy which is renewable and also eco friendly. One such energy is solar energy which is completely natural and it is considered as a clean energy source. The power from the sun intercepted by the earth is approximately 1.8×10^11 MW, greater than any other resources. The photovoltaic cell converts only a small fraction (~less than 20%) of irradiation into electrical energy and remaining energy is converted into heat. This heat increases the operating temperature of the solar panel. The effects of heat on the solar panel are Damage the solar panel, Reduce in Life span, and lowering the conversion efficiency. For every 10deg centigrade rise in temperature there is a reduction of photovoltaic conversion efficiency by 0.2-0.5%. So the study on enhancing the efficiency of solar panel is very necessary. Therefore to rectify this problem a cooling system of PCM is used so as to maintain the temperature of the cells. In order to accomplish this study, two solar panels with and without cooling system using PCM has been tested. During testing, solar cell parameters such as open circuit voltage, short circuit current, surface temperature, panel temperature and ambient temperature have been observed. The results obtained clearly show that solar panel with PCM cooling has generated the maximum open circuit voltage and short circuit current while comparing to other solar panel without any cooling system.*

Keywords- Solar Panel, Operating Temperature, Phase Change Material.

I. INTRODUCTION

The need of renewable energy has gradually come to be considered a way to weaken the negative effects brought about by global warming and climate change. The renew-able energy sources, such as Photovoltaic energy, wind energy and fuel cells are able to reduce considerable carbon dioxide emission1,2. When the PV modules are operated in an outdoor environment, due to frequent changes in the environmental temperature and irradiation intensity, it gives rise to critical thermal-related factors which affect their performance and reliability of PV modules. Generally Photovoltaic directly converts solar radiation into electricity with efficiency in the range 9-12% depending on solar cell type. More than 80% of solar radiation falling on PV cells is not converted to electricity but either reflected or converted to thermal energy3This leads to an increase in the PV cell's working temperature and consequently, a drop of electricity conversion efficiency. Due to increase in the temperature of PV cells by 1 K, there is a reduction of electrical efficiency by 0.4–0.5%.

II. THE EFFICIENCY FORMULAE

A. The electric power of the solar panel us given by

$$P = Voc \times Isc \quad \text{.....Eq.1}$$

Where
P → Electric power of the solar panel
η_e→ Electrical efficiency of the solar panel
Voc →open circuit voltage
Isc→ short circuit current
Am→ total area of the solar panel in m2
FF→ Fill Factor (constant 0.7199)
G→ Solar Irradiations

B. The electric efficiency of the solar panel is given by

$$\eta_e = \frac{Voc \times Isc \times FF}{Am \times G} \quad \text{.....Eq2}$$

Where
P → Electric power of the solar panel
η_e→ Electrical efficiency of the solar panel
Voc →open circuit voltage
Isc→ short circuit current
Am→ total area of the solar panel in m2
FF→ Fill Factor (constant 0.7199)
G→ Solar Irradiations

III. METHODOLOGY

In turn to conduct a comparative evaluation of Performance of the solar panel with and without cooling system, two similar **Mono-Crystalline Silicon** PV panels were used in this experimental study.

A solar panels of 10Wp with Open circuit voltage (Voc) –21.6V, Short circuit current (Isc) – 0.59A, Maximum power voltage (Vmp) – 18V and Maximum power cur-rent (Imp) – 0.56A is taken for the experimental analysis. In this experimental model, a simple thermal combination of a PCMTS at the rear of the panel was implemented. The PCMTS consisted of a simple rectangular containment filled with PCM. This containment was fully sealed with silicone sealant to avoid leakage of melted PCM.

The containment was made of aluminium and had a high thermal conductivity (~200 W/m K).

The PCM used in the experiment was paraffin wax (RT 27).

The paraffin wax RT27 has a melting temperature of 27 °C, is non-corrosive and has high latent heat storage capacity (184 kJ/kg) which makes it attractive for use in the PCMTS. Due to the fact that the thermal expansion of the PCM was approximately 16 % at40 °C (liquid state), the paraffin wax was charged to 80 % of the containment volume to allow thermal expansion during heat absorption.

The remaining 4 % of the containment volume allowed for thermal expansion if the PCM temperature exceeded 40 °C. The solar panels are mounted on a fitting and the solar panel is analysed in two different cases they are the solar panel without cooling, the solar panel with PCM cooling and the readings are noted from that readings power and electrical efficiency is calculated for all the cases. The readings are taken for 12 hours (6 am to 6 pm).

The Figure 1 shows the experimental setup for solar panel with and without PCM cooling and Figure 2 shows the experimental setup for solar panel with Aluminium chamber at rare end with PCM.

The solar panel is analysed under different ambient conditions and different irradiations, the open circuit voltage (Voc), short circuit current (Isc) are measured by using multimeter and the surface temperature (T) are noted by using temperature indicator. The experimental values are listed in the Tables 1, 2 and 3.

The Table 1 gives the experimental values of solar panel without cooling and Table 2 gives the experimental values of solar panel with PCM cooling. The power and efficiency are calculated by using Equations 1 and 2.This PCMTS- coupled panel is referred as a "PV-PCM" system" and the schematic diagram is shown in Fig.1 below. From the observations it is seen that there is constant drop in voltage with increase in temperature which results in drop in power generated.

Figs. 3 show the inner configurations of the PCMTS pre-filled containment.

Figure 1 the Experimental setup with two solar panels with and without PCM cooling.

Figure 2 the solar Panel with aluminium chamber containing the PCM.

IV. RESULTS AND DISCUSSION

Table3. Experimental values of solar panel without cooling system

s.no	Time	G (W/m²)	Voc (V)	Isc (A)	Temp(°c)	Power (W)	η %
1	10AM	972	23.10	0.43	52.2	9.93	10.33
2	11AM	974	22.61	0.47	53.4	10.62	11.03
3	12PM	976	22.53	0.49	58.7	11.03	11.43
4	1PM	971	22.07	0.47	62.8	10.37	10.80
5	2PM	967	22.09	0.42	60.4	9.27	9.70
6	3PM	960	22.66	0.29	57.3	6.57	6.92

Table4. Experimental values of solar panel with PCM cooling system

s.no	Time	G (W/m²)	Voc (V)	Isc (A)	Temp(°c)	Power (W)	η %
1	10AM	972	23.80	0.44	40	10.47	10.89
2	11AM	974	23	0.49	47.6	11.27	11.69
3	12PM	976	22.71	0.52	52.2	11.80	12.23
4	1PM	971	22.34	0.50	56.7	11.17	11.63
5	2PM	967	22.24	0.45	57.1	10.0	10.46
6	3PM	960	22.34	0.33	55.8	7.37	7.76

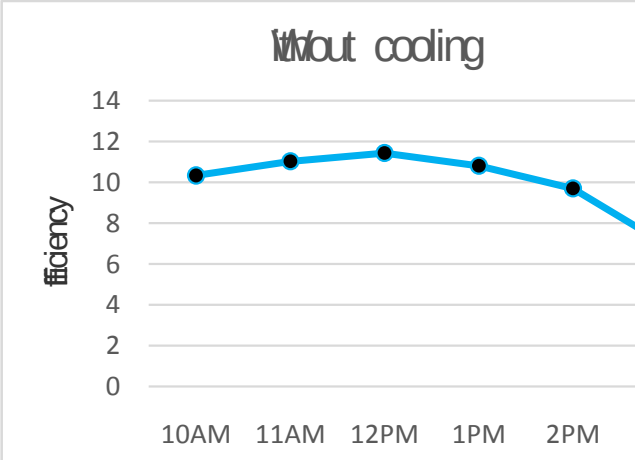

Fig. 1 Effeciency-Time Graph for soalr panel without PCM

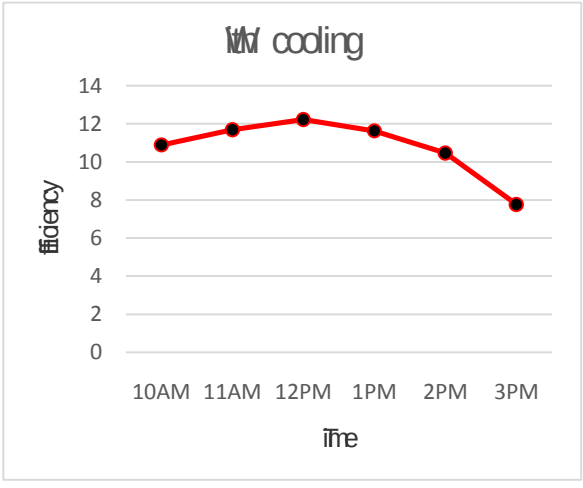

Fig. 2 Efficiency-Time Graph for soalr panel with PCM

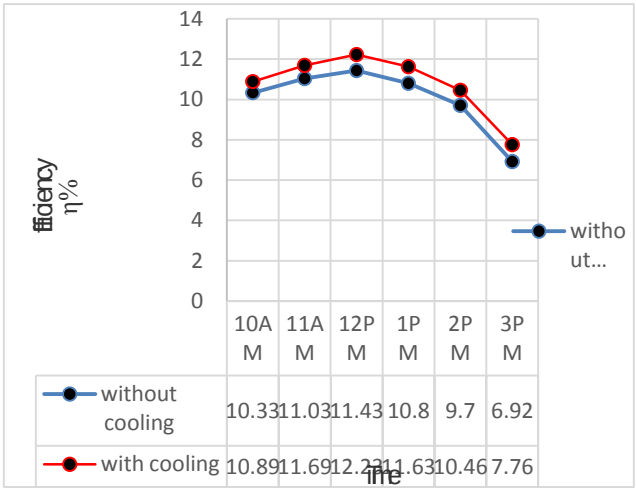

Fig. 3 Efficiency-Time Graph comparing the solar panel with and without PCM

V. CONCLUSIONS

The present work, the Mono crystalline solar panel was tested in two different cases. The result was discussed and compared with other cases. From the observation, the solar panel with PCM cooling could give the higher open circuit voltage, short circuit current and better efficiency over the whole day, because the panel temperature rise was reduced by PCM.

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