Effect of Temperature on the Performance of Photovoltaic Cell

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***ABSTRACT*:** *Solar energy being a clean, inexhaustible and eco-friendly, this source have higher potential among all renewable energy sources. But in present scenario, there is need for continuous supply of energy, which cannot be full filled by alone wind energy system or solar photovoltaic system due to seasonal and periodic variations. Therefore, in order to satisfy the load demand the combination of solar and conventional conversion units are now being implemented as photovoltaic (PV) systems. In the present work, electrical performances of amorphous silicon photo voltaic panels are studied experimentally .The experiments are carried out in GMIT campus, Bharathinagar, Mandya .A six sets of readings were recorded from Moring 10.AM to 4.PM . The experimental data are used for the calculation of electrical efficiency and power output of the PV systems. It was concluded that the high operating temperature of PV cells reduces the electrical efficiency of PV panels.*

INTRODUCTION

At present, there is a great interest towards solving the energy problems facing the world. This has led to research on alternative energy source that would complement the conventional fossil fuel. The alternatives energy sources include solar, nuclear and wind, but in this research work we focused on solar energy. Solar energy is the energy generated by the power of the solar radiation. It is the cleanest source of energy whose use can contribute to saving exhaustible energy sources. Photovoltaic panels convert the suns radiation to electricity.

The amount of power available from a photovoltaic panel is determine by three parameters first, the type of tracking system, material of the solar panel and the intensity of the sunlight. The research activity and development in PV field has usually been focused on solar radiation analysis, design and sizing of these systems. Previous papers analyze the PV module in terms of panel modeling and I- V characteristic. Solar cell efficiency is an important input parameter in PV-powered product design. Often, only limited space is available for the solar cells to be integrated. Cell efficiency can even become a criterion of principal system feasibility. As a basic parameter, cell efficiency serves as an input in calculating the optimal system configuration, e.g., as a cost related trade-off between the storage unit and its lifetime, PV size and its efficiency, and finally the demand side (with correlated consumption profiles).

A detailed analysis of the influence of temperature on the PV modules performance is proposed in this paper. Based on all these information the effects of the temperature on the PV panel's electrical performances have been highlighted. During the study of the performance of solar panel the following factors considered:

1. Solar Radiation v/s Time characteristics.

2. Cell Temperature v/s Time characteristics.

3. Panel efficiency v/s Time characteristics

4. Panel efficiency v/s Cell temperature

Experimental Methodology

The experiment is conducted by using the 10W solar panel mounted on a stand. The electrical parameters like voltage & current have been measured to study the effect of cell temperature .The net effect of Temperature on the power reduction was evaluated & analyzed. In this work, the system of measurements consists of a amorphous silicon solar panel of area 0.1088m2, a dc voltmeter for measurement of generating voltage, a dc ammeter for measurement of producing current, and also a suitable load resistance. The experimental study was done in the GMIT campus Bharathinagar, Mandya .The ambient temperature fluctuates in the range of 12 to 40 ºC during a year in Mandya. The solar photovoltaic panel was tested and the parameters like Voc, Isc, solar irradiance, and ambient temperature etc. needed for the evaluation of the systems were measured at interval of one hour between 10am to 4pm .The ambient temperature and the incident solar radiation intensity was measured using thermometer and the solar radiation readings for the respective day and time are obtained from KPTCL (Karnataka power Transmission Corporation limited) at shivanasamudra solar power plant

Fig.1-Experimental set up

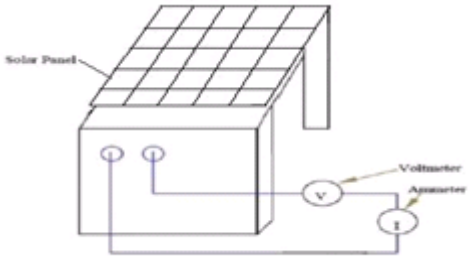

Fig.2- block diagram

Model	MS1210
Open circuit voltage	20V
Short circuit current	0.62A
Number of cells	64
Dimensions	340x320x18mm
Weight	2.5kg
Fill factor	0.72

Table 1: Specification of the PV module

We calculate the solar panel efficiency(%) and cell temperature by the following formula

1) T_{cell}

$$= T_a + \frac{0.32}{8.91+2Vwind} * G$$

Where,

Tcell = Cell temperature T_a = ambient temperature

V_{wind} = Velocity of wind in m/s G = Solar radiations in w/m²

2) Effiency $= \frac{V_{oc} * I_{sc} * FF}{A*I}$

Where,

V_{oc}-Voltage of electricity produced (volts) I_{sc} - Electrical current produced by the solar

PV panel (Ampere) FF-fill factor

A-Area of solar panel (cross-section of panel) I-Intensity of Solar Radiation (W/m²)

Results and discussion

Data obtained at GMIT campus on Date: 6 - 4 -2015 from morning 10am to 4pm is tabulated

Time	Ambient Temperature in (^{0}c)	Radiation in (w/m²)	Wind Velocity in (m/s)	Voltage in (V)	Current in (A)
10 AM	29.5	709.2	0.166	19.63	0.53
11 AM	31.5	789.9	0.11	19.44	0.57
12 PM	32	641.4	0.194	19.22	0.62
1 PM	34	925.5	0.166	19.21	0.60
2 PM	33.5	801.2	0.11	19.15	0.52
3 PM	32	536.3	0.22	18.64	0.19
4 PM	31.5	217	0.138	17.83	0.07

Table 2: Experimental Data

Tcell in (^{o}c)	Input in (w)	Output in (w)	Efficiency in (%)
54.055	77.16	7.49	9.71
59.215	55.94	7.98	9.28
54.074	69.78	8.85	12.30
66.04	100.69	8.30	8.24

61.581	87.17	7.17	8.16
50.35	58.34	2.55	4.37
39.57	12.72	0.89	3.8

Table 3: Calculated Data

The data obtained for Solar Radiation v/s Time characteristics, cell Temperature v/s Time characteristics, Panel efficiency v/s Time, cell temperature v/s panel efficiency analysis for the silicon solar panel under investigation shown in fig. 3, 4, 5, 6 respectively. From the graph it is observed that the cell efficiency increases with increase in solar radiation till the panel reaches the maximum allowable working temperature, beyond that temperature the efficiency decreases\. In order to overcome these problems or to maximize the efficiency of solar panel the cell temperature as to be maintained within optimum values.

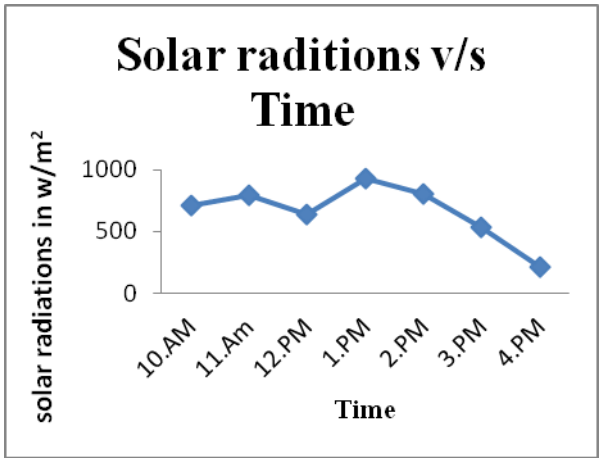

Fig.3 Solar radiations v/s time

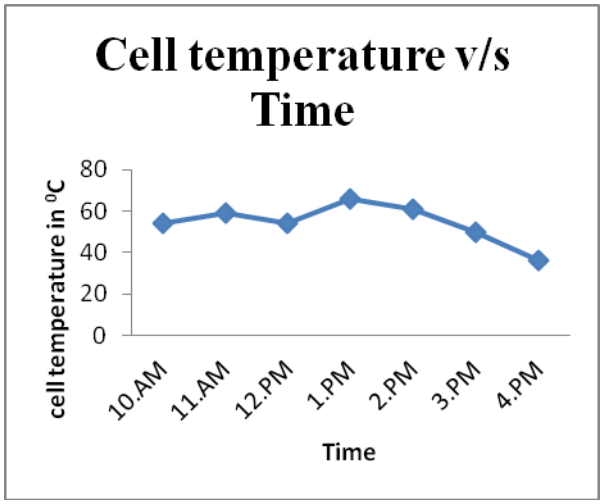

Fig4: Cell temperature v/s time

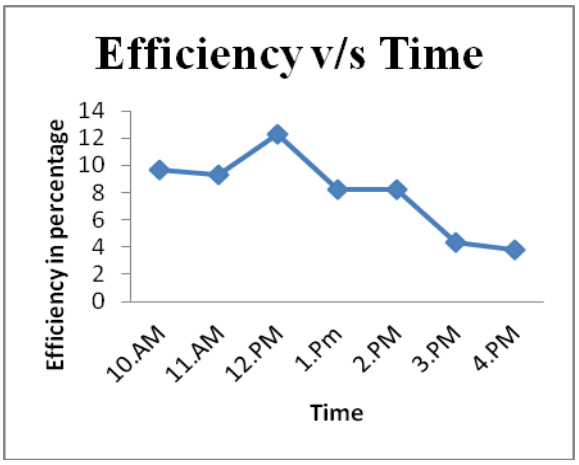

Fig5: Efficiency v/s Time

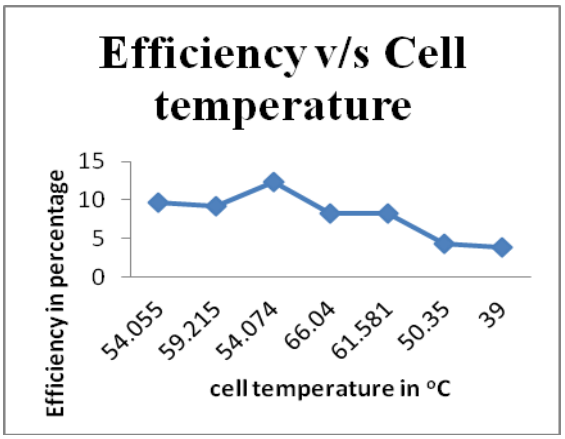

Fig 6: Efficiency v/s cell temperature Conclusion

The cell operating temperature plays a key role in photovoltaic conversion. With the increase in temperature the rate of photon generation increases thus reverse saturation current increases rapidly and this results in reduction in band gap. Hence this leads to marginal changes in current and voltage. The experimental results show that the best design is the one which keeps the operating temperature of the PV cells as minimum and uniform as possible, resulting in a maximum energy yield of the PV cells.

References

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