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Experimental Analysis of Solar Panel Efficiency with Water Bottle Based Cooling System

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ABSTRACT :

The dependence of efficiency of photovoltaic panels on their temperature during operation is a major concern for solar energy harvesters. Finding a solution for this with Eco-friendly technology is the key issue in recent times. In this work, Eco-friendly cooling system is designed using waste empty plastic bottles for a 10W mono-crystalline solar panel and subjected to power efficiency analysis. The experiment is carried out in GMIT campus, Bharathinagar, Mandya. Experiment is conducted for three consecutive days. Three sets of readings were recorded from Moring 10.30AM to 3.30PM with one-hour interval. The experimental data are used for the calculation of electrical efficiency and power output of the PV systems. The average irradiance throughout data collection was found to be 650W/m^2 and highest irradiance was 830 W/m$^{2.}$ The average solar panel temperature was 40.6ºC and a maximum temperature of 51ºC was at the center of solar panel. Upon analysis, it is identified that the power output and efficiency of solar panel increased with the said cooling system.

Key words: TIM (Thermal Interface Materials)

INTRODUCTION

One of the main obstacles that face the operation of photovoltaic panels (PV) is overheating due to excessive solar radiation and high ambient temperatures. Overheating decreases, the efficiency of the panels drastically. To increase the efficiency of the solar panels, several cooling methods have been implemented . Generally, there are two types of cooling: active cooling, which consumes energy (pump, fan, etc.) and passive cooling, which uses natural principles such as convection/conduction to enable heat extraction. Active cooling methods are popular in the market as these systems are simple to design and their design is based on water and air cooling.

Plastics have become a vital asset for humanity, often providing functionality that cannot be easily or economically replaced by other materials. Plastic products have brought benefits to society in terms of economic activity, jobs and quality of life. Most plastics are robust and last for hundreds of years. They have replaced metals in the components of most manufactured goods, including for such products as computers, car parts, Containers and refrigerators, and in so doing have often made the products cheaper, lighter, safer, stronger. Plastics have taken over from paper, glass and cardboard in packaging, usually reducing cost and also providing better care of the items.

Plastic is one of the major toxic pollutants of present time. Being composed of toxic chemicals and most importantly a non-biodegradable substance, plastic pollutes earth and leads to air pollution and water pollution. This also mixes with food chain effecting Environment Humans and animals. There is no safe way to dispose plastic waste and waste causes serious damage to environment during its production process, during its usage and during its disposal process.

The motto of this work is to provide a novel eco-friendly solution to improve the efficiency of photovoltaic panels. To achieve this, a special type of Passive cooling system is designed by making use of empty waste plastic bottles.

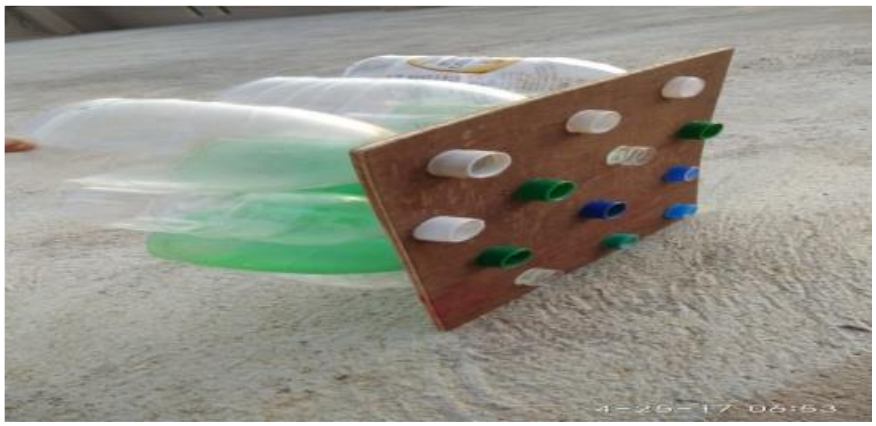


Fig 1: Water Bottles System

In this work, a Waste plastic bottle based cooling system is designed for photovoltaic panels mounted on a metal stand and tested under outdoor conditions. The effects of the waste plastic bottle based cooling system on various parameters related to electrical output of the solar panel were studied

EXPERIMENT SETUP

The Experimental setup consists of four panels consisting of only panel, panel with water bottle, panel with fins, and combination of both water bottle and fins. The experiment setup consists of solar panel of capacity 10W, Multi-meter to measure the voltage and current of solar panel, Thermometer to measure the ambient temperature.

The experimental is carried out in GMIT campus Bharathinagara for three days continuously between 10:30 AM to 3:30 PM in the experiment the voltmeter, thermometer and ammeter readings are recorded and tabulated for each hour between 10:30 AM to 3:30 PM. Though the availability of radiation measuring instruments which are highly expensive so, the radiation readings for the repetitive day and time are collected from KPTCL (Karnataka power Transmission Corporation Limited) at Shivanasamudra solar panel power plant.By utilizing the obtained readings and suitable formulas we have calculated the efficiencies of the solar cell for each and every hour and generate the graph for each day readings and calculations. The experimental set up is shown below figure

Fig 2: Panels Attached with cooling system

RESULTS AND DISCUSSION

Data Obtained at GMIT Campus

Time	Ambient Temp^r (^{o}C)	Tcell (^{o}C)	Radiation (w/m^2)	Wind Velocity (m^2/s)	V	I	Input Power (w)	Output Power (w)	Efficiency (%)
10:30 AM	29	38.79	510	3.88	19	0.46	53.65	6.29	11.72
11:30 AM	31	43.47	650	3.88	19	0.73	68.38	9.99	14.60
12:30 PM	32	46.58	760	3.88	19	0.52	79.95	7.11	8.89
01:30 PM	30	45.10	840	4.44	19	0.51	88.36	6.98	7.89
02:30 PM	29	39.32	610	5	19	0.50	64.17	6.84	10.65
03:30 PM	29	36.01	390	4.44	19	0.66	41.02	9.03	22.01

Table 1.1 Readings of solar panel without cooling

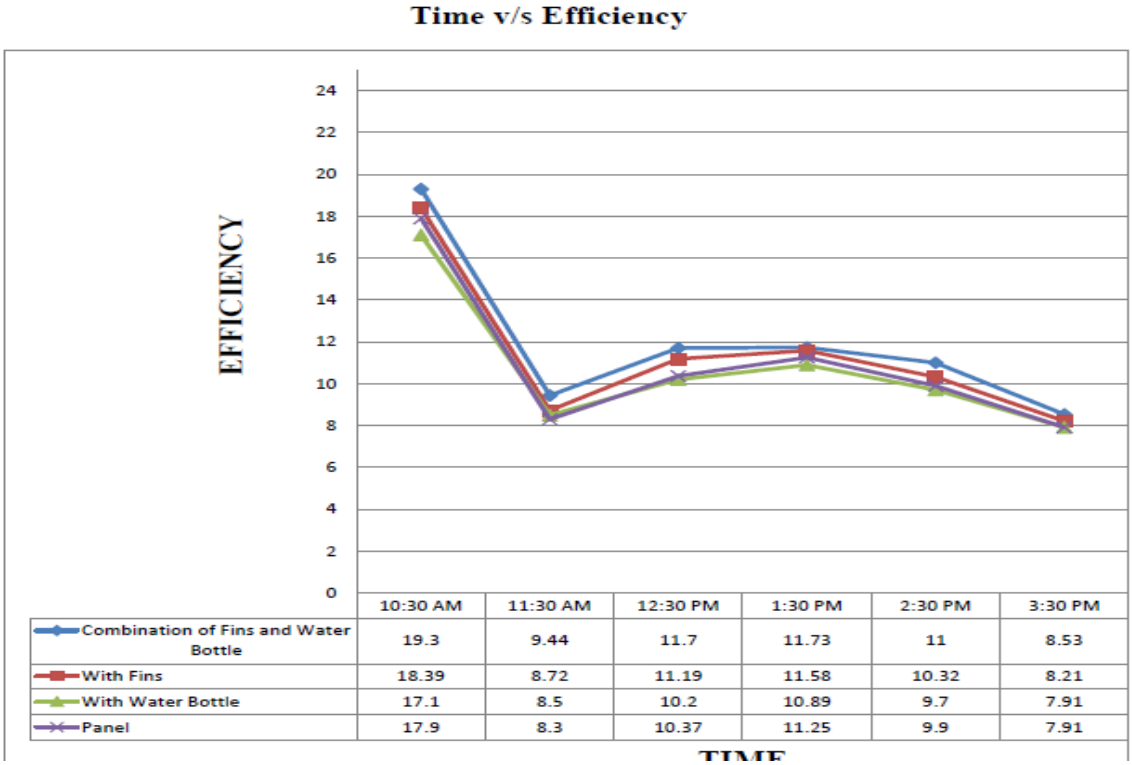
Time	Ambient Temp^r (^{o}C)	Tcell (^{o}C)	Radiation (w/m^2)	Wind Velocity (m^2/s)	V	I	Input Power (w)	Output Power (w)	Efficiency (%)
10:30 AM	29	38.79	510	3.88	19	0.43	53.65	5.88	10.95
11:30 AM	31	43.47	650	3.88	20	0.75	68.38	10.80	15.79
12:30 PM	32	46.58	760	3.88	19	0.53	79.95	7.25	9.06
01:30 PM	30	45.10	840	4.44	19	0.52	88.36	7.11	8.04
02:30 PM	29	39.32	610	5	19	0.51	64.17	6.98	10.87
03:30 PM	29	36.01	390	4.44	20	0.65	41.02	9.36	22.81

Table 1.2

Table 1.2 Readings of solar panel with cooling (water bottle)

Time	Ambient Temp^{r} (^{o}C)	Tcell (^{o}C)	Radiation (w/m^2)	Wind Velocity (m^2/s)	V	I	Input Power (w)	Output Power (w)	Efficiency (%)
10:30 AM	29	38.79	510	3.88	19	0.48	53.65	6.57	12.24
11:30 AM	31	43.47	650	3.88	20	0.79	68.38	11.38	16.64
12:30 PM	32	46.58	760	3.88	20	0.59	79.95	8.5	10.63
01:30 PM	30	45.10	840	4.44	19	0.55	88.36	7.52	8.51
02:30 PM	29	39.32	610	5	19	0.53	64.17	7.25	11.29
03:30 PM	29	36.01	390	4.44	20	0.69	41.02	9.94	24.23

Table 1.3 Readings of solar panel with cooling (Fins)



The above graph compares the efficiency of the panel with respect time from morning 10:30 AM to 3:30PM the readings were tabulated by using ammeter and voltmeter. The efficiency of the panel is calculated by simple empirical formulas. From the above graph it is clear that the combination of both water bottles and fins gives more power output than that of other three panels.

Conclusion

By the experiment conducted, it can be observed that the solar panel fitted with combination of fins and water bottle is providing more output than that of other three panels, (only panel, panel attached with fins, panel attached with water bottles). Also it is noticed that the efficiency of panel fitted with water bottles and fins is much higher than that of other three panels. So from the project work it is concluded that the combination of water bottles and fins is the better cooling system for cooling the solar panel.

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