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Performance Enhancement of Solar Cell

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Abstract: *Due to the cleaner and costless operation of solar energy the use of solar energy is increasing day by day. Power generation using solar panel is one of the major means of utilising this massive renewable source of energy. However one of the major drawback of solar panels is limiting it's use; it is seen that as the temperature of the solar panel is increasing then it's performance is decreasingq as a result of of this its output voltage is getting reduced. This has became a major barrier for using solar panels in hot regions or in desert areas. So, there is a need to cool solar panels. Available solutions for this problem are having either considerable capital cost or they consumes energy for it's operation. In order to overcome these drawbacks this paper introduces a new technique of cooling the solar panel that is Saur Urja Parivartak. Saur urja Parivartak uses thermoelectric effect and low cost natural evaporative cooling to increase the performance of the solar panel. The paper also compares the performance of polycrystalline and monocrystalline solar cells. The results have shown that the achieved output voltage is more than the rated voltage of the PV module. Study is done on a small prototype still major changes in the performance of solar PV power plant are expected.*

Keywords: *PV Panel, thermoelectric effect, natural evaporative cooling, PV module, polycrystalline solar cell, monocrystalline solar cell.*

I. Introduction

I.1 Temperature and Performance relationship of PV panel:

The major drawback in case of PV cells is that as the temperature increases efficiency of the solar panel decreases. The figure shows the characteristics of ideal solar cell under varying atmospheric conditions. The characteristics are plot by keeping solar irradiance, E, and module temperature, Tm constant. The relation between the electrical power output and output voltage, V called as P–V characteristic is are drawn for temperature range between 0°C to 75°C.

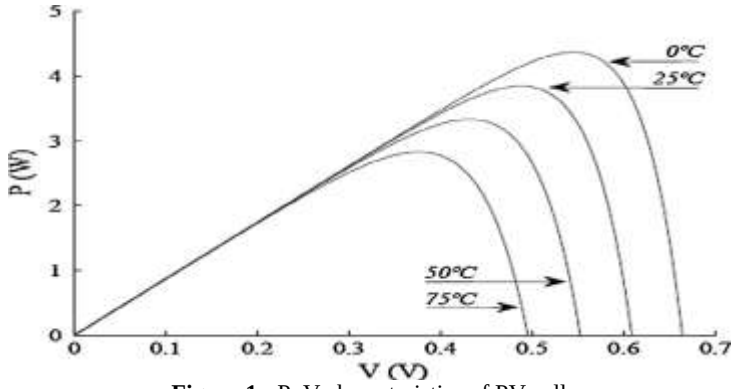


Figure 1: P–V characteristics of PV cell

As shown in graph maximum power output from the solar cell decreases as the cell temperature increases. As per the resource every 1°C of temperature rise causes the drop in the efficiency by 0.5%. Due to this power generation capacity at higher atmospheric temperature becomes low. Characteristics are discussed by K. A. Moharram and D. M. Febba

I.2 Techniques of cooling solar panel:

For eliminating undesirable high temperature effect on PV panels Cooling of the solar panel becomes necessary. In Earlier pump operated or passive cooling system it consumes the energy for doing operation and as a result of that the power output and efficiency of the PV panel again decreases. So, Different cooling techniques have been developed experimentally and numerically to reduce the impact of the operating temperature of the cells on the performance of the PV cells. Following are the various evaporative cooling

techniques discussed by Swar A. Linus Idoko has used multi cooling system which combines two or more cooling techniques.

1) Heat sink

Heat sink is one of the cooling ways which uses a high thermal conductivity metal to remove the heat from the photovoltaic cell. As per the Catalin George the temperature reduction of the PV panels during a clear day of summer by using different arrangements of ribbed wall heat sink of air and passive cooling is possible.

2) Air channels

Several studies investigated the performance of the PV cells with active cooling by using air channels connected to the back of the PV panel.

3) Evaporative cooling and Water spray

Several studies have investigated experimentally the performance of the PV cells with active cooling water. Researches also investigated experimentally the impact of water spray cooling on the performance of the PV panel in highest solar irradiation level environment. Both sides of the PV panel were cooled at the same time by utilizing twenty nozzles, ten on each side. The researches indicated that the water spray cooling has achieved a suitable effect on the PV panel performance and the best case was the simultaneous front and back sides cooling PV panel. Evaporative cooling techniques are discussed by O. Amer, R. Boukhanouf and H. G. Ibrahim

4) Heat exchanger

Several studies have investigated numerically and experimentally the performance of the PV cells using active cooling water with the aid of heat exchanger. Experimental investigation of improving the electrical efficiency of photovoltaic thermal system by using water cooling technique is done. The cooling mechanism was contained of heat exchanger and seven pipes of water attached to the back of the PV panel.

5) Fins cooling

Several studies have investigated numerically and experimentally the performance of the PV cells using different types and shapes of fins. Researchers used aluminium fins combined with cotton wick as a passive cooling system to maintain the temperature of the PV panel. The cooling system was consisted of three aluminium fins (630 × 100 × 60 mm) with cotton wick attached to the back side of the crystalline silicon PV cells.

In all above techniques some techniques were using energy for performing it's operation and some techniques were not showing considerable results compared to their capital cost for installation.

II. Saur Urja Parivartak

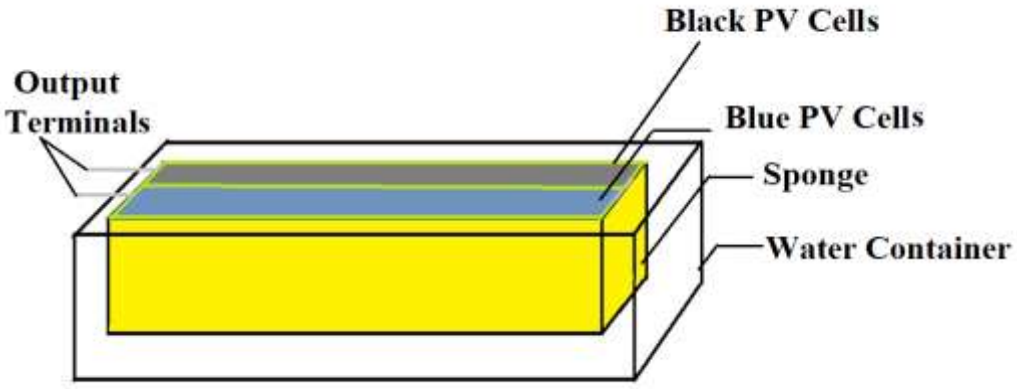
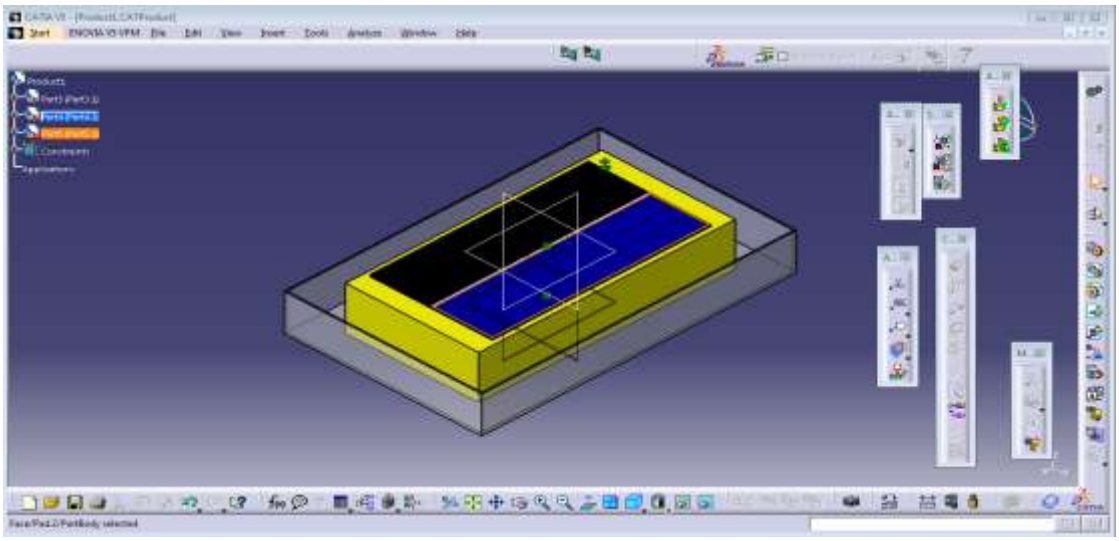


Fig 1: Saur Urja Parivartak

Saur urja parivartk consists of water container , callous sponge ,laminated blue and black solar modules , terminals .at the base of saur urja parivartak water container is kept at the center of water container sponge is attached above that sponge a solar pv module of blue and black cells is kept . Whole solar module is made up of 18 cells from which 9 cells are of polycrystalline type and 9 cells are of mono crystalline types . Both polycrystalline and mono crystalline cells are connected in series so that voltage will get added and current will remain constant.

III. Constructional Details



Following are the parts of Saur Urja Parivartak:

1. Tray: Tray is used to store water. Here we are using plastic as a material of tray. It's dimensions are 295*185*38mm^3

2. Sponge: We are using cellulose as a material of sponge. It is used in the evaporation system. Dimensions of sponge are 240*125*45 mm^3

3. Solar plate: A thin metal plate of size400*400*1 mm^3 is used to collect sun rays.

IV. Principle Of Operation

Saur Urja Parivartak works on principal of thermoelectric effect and evaporative cooling.

IV.1 Thermoelectric effect

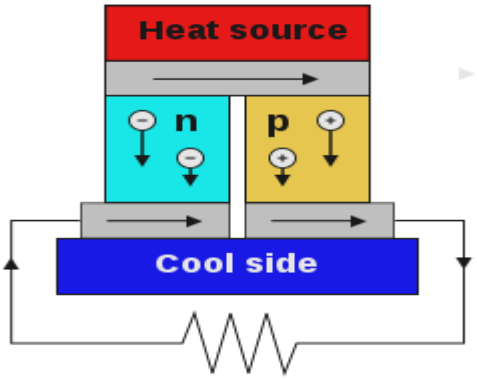


Fig 2: Thermoelectric effect

Thermoelectric effects demonstrate the existence of coupling between electrical and thermal phenomena and include the well-known Seebeck effect and Peltier effect. As per the Seebeck Effect heating one junction of a circuit and cooling the other produces emf in the circuit. Seebeckeffect was introduced by seebeck in 1821 hence named as seebeck effect. Semiconductors are important areas of interest for thermoelectric phenomena. Thermocouples made of semiconductors can develop large electromotive potentials and are used to convert heat into electricity.

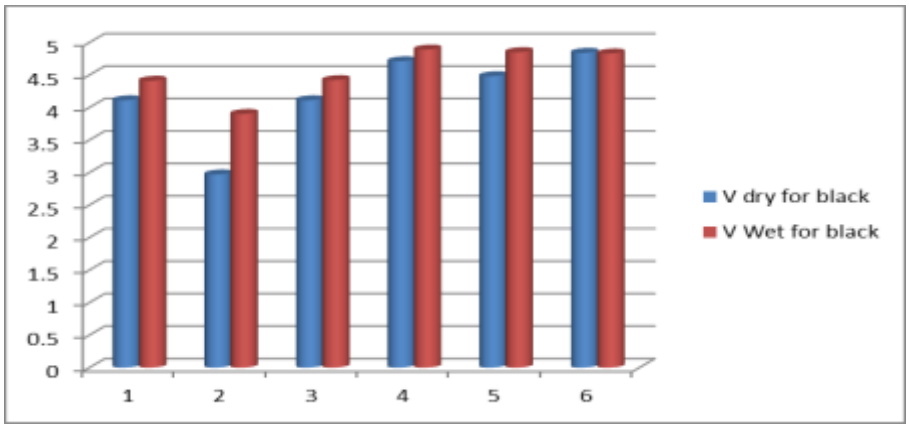
IV.2 Natural evaporative cooling

Natural evaporative cooling is simplest, clean and environmental friendly mode of cooling. Natural evaporative cooling occurs when water comes in contact with atmospheric air. In evaporative cooling there is no involvement of mechanical system which can consume electricity hence this cooling is self operated.

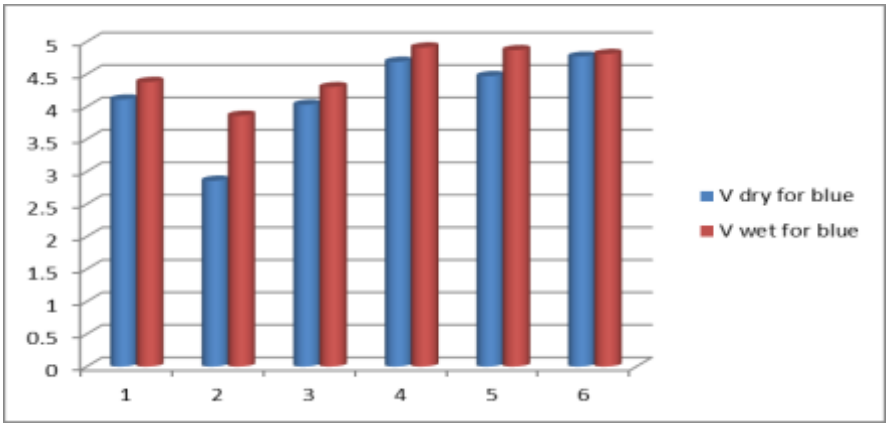
V. Experimental Results

Result table

	voltage for dry (V)		voltage for wet (V)	
sr. no	Black	Blue	black	Blue
1	4.11	4.11	4.41	4.38
2	2.97	2.86	3.9	3.86
3	4.11	4.03	4.42	4.3
4	4.71	4.69	4.89	4.91
5	4.48	4.47	4.85	4.87
6	4.84	4.77	4.83	4.81



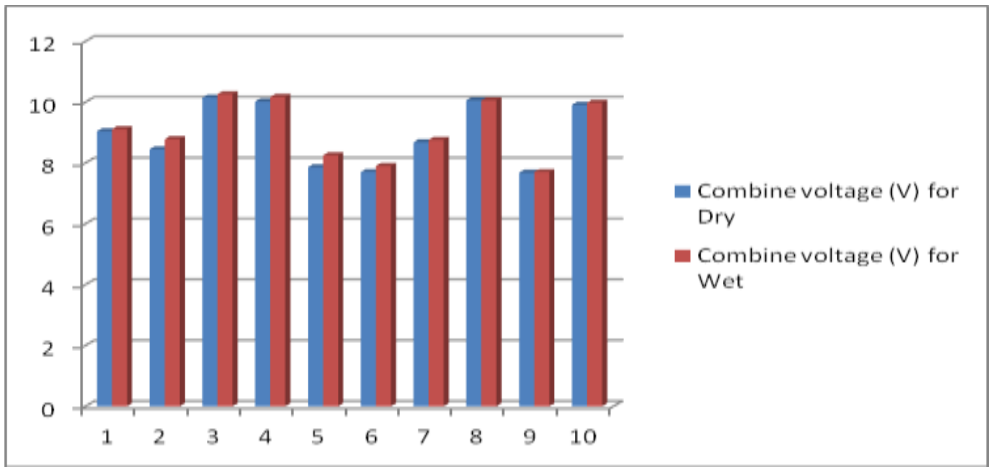
V dry for Monocrystalline Vs V wet for Monocrystalline



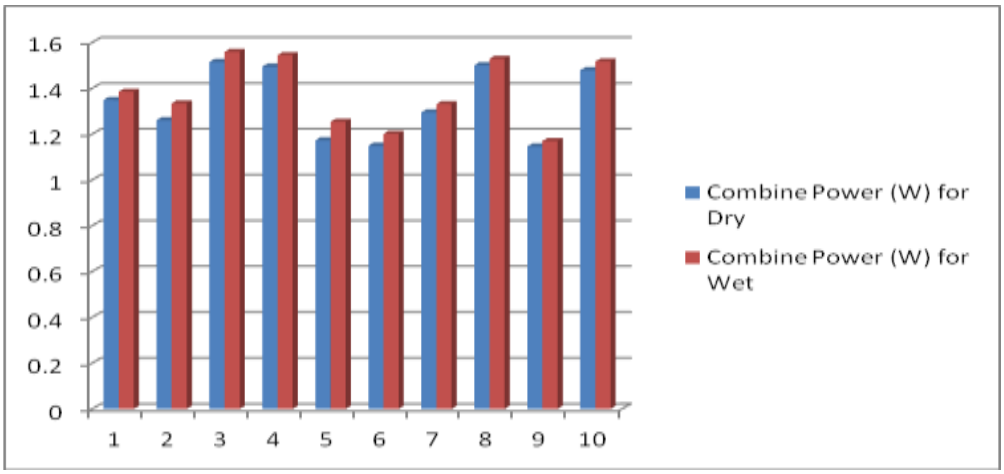
V dry for polycrystalline Vs V wet for polycrystalline

	Combined voltage (V)		Combined Power (W)	
Sr. no	Dry	Wet	Dry	Wet
1	9.04	9.11	1.349	1.385
2	8.45	8.78	1.261	1.334
3	10.15	10.26	1.515	1.559
4	10.02	10.17	1.495	1.545
5	7.86	8.25	1.173	1.254
6	7.7	7.9	1.149	1.201
7	8.68	8.76	1.295	1.331
8	10.06	10.06	1.501	1.529
9	7.68	7.7	1.146	1.17
10	9.91	9.98	1.479	1.517

Current for dry = 149.3 mA
Current for wet = 152.0 mA



Combined voltage for dry Vs Combined voltage for wet



Combined power for dry Vs Combined power for wet

VI. Conclusion

The research is done to cool the solar panels; specially to cool lower junction of solar panel using low cost natural evaporative cooling. Thermoelectric effect and natural evaporative cooling techniques are used for operating Saur Urja Parivartak. Saur Urja Parivartak makes it possible to cool the panels during all day. It can be concluded from the result as

1) Performance enhancement in blue solar cells is more than black solar cells
2) Rate of cooling in natural evaporative cooling is largely depend on velocity motion of air hence performance variation is possible.

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