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Research Article

TO IMPROVE THE EFFICIENCY OF SOLAR PANEL BY USING WATER CIRCULATION

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ABSTRACT

Solar energy has the greatest potential of all the sources of renewable energy. It potential is 178 million MW per year. This is about 20,000 times worlds demand. In the case of the developing countries the energy sector assumes a critical importance in view of the increasing energy needs requiring huge investments of meet them. Photovoltaic power generation is a method of producing electricity using solar cells. The photovoltaic (PV) cells are able to produce energy from the abundant resource of sunlight. A solar cell converts solar optical energy directly in to electrical energy. The major problem related to the solar cell is their lower efficiency. So, our aim to improving efficiency and reducing the rate of thermal efficiency and reducing the rate of thermal degradation of a solar panel module is by reducing the operating temperature of its surface. This can be achieved by cooling the module reducing the heat stored inside the panel and warm water use for many purpose

INTRODUCTION

The performance of the PV system is affected by several parameters including temperature. The part of absorbed solar radiation that is not converted into the electricity converts into thermal energy and causes a decrease in electrical efficiency. This undesirable effect which leads to an increase in the PV cell's working temperature and consequently causing a drop of conversion efficiency can be partially avoided by a proper method of heat extraction.

Intensive efforts are being made to reduce the cost of photovoltaic cell production and improve efficiency and narrow the gap between photovoltaic and conventional power generation methods such as steam and gas turbine power generators. In order to decrease the cost of PV array production, improve the efficiency of the system and collecting more energy for unit surface area different efforts have been made.

The PV/T solar systems consisting of photovoltaic modules and thermal collectors are applied to cool photovoltaic panel and use the heat generated by the panel and increase total energy output of the system. By proper circulation of a fluid with low inlet temperature, heat is extracted from the PV modules keeping the electrical efficiency at satisfactory values. The extracted thermal energy can be used in several ways, increasing total energy output of the system. Many researchers have investigated and proposed different methods for design and optimization of the PV/T systems to improve the system efficiency by cooling PV module and collecting more energy.

Today's technology allows for the harnessing of solar energy through cells known as solar cells. These are also called photovoltaic cells. Photovoltaic cells are placed in direct sunlight and as the sun hits these cells, a chemical reaction takes place to produce electric currents. These currents are then converted into electricity that can be used to power everyday items or even households.

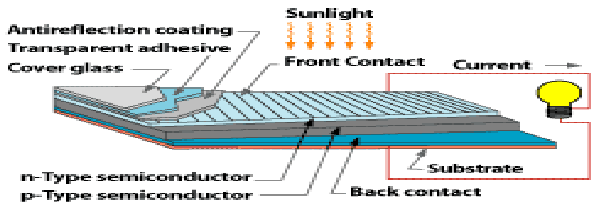

Figure 1 Block diagram of Solar Panel

Solar Photo Voltaic (SPV) Module

The power generated by a single cell is small and therefore several cells are interconnected. In series/parallel combination to get the required voltage and current. When a number of solar cells are connected in series to get a specific voltage the unit so formed is called as Solar Module. Charging batteries is the primary use of SPV module. Therefore normally 36 cells are

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joined in series to form a standard module, which is capable of charging 12 volts battery. A terminal box is provided on the backside of the module for external connections. A Bypass diode is connected across +ve and –ve in the terminal box. Cathode of the diode will be at +ve terminal and Anode will be at –ve terminal of the module. This diode protects the module cells from overheating due to shadowing of the module or any cell breakage. Generally the rating of bypass diode is 1.52 times of the maximum current of module.

Solar Cell

The basic photovoltaic device, which generates electricity when exposed to sunlight, shall be called a "Solar Cell".

Solar Module

The smallest complete environmentally protected assembly of interconnected solar cells shall be called "Module".

Solar Panel

A group of modules fastened together, pre-assembled and interconnected, designed to serve as an installable unit in an Array shall be called "Panel".

Solar Array

A mechanically integrated assembly of modules or panels together with support structure, but exclusive of foundation, tracking, thermal control and other components, as required to form a dc power producing unit shall be called an "Array".

Figure2 Sketch showing front view of Solar cell, Solar panel & Solar PV Array

Measuring PV Efficiency

Efficiency of the tested solar cell was calculated by applying the following relation:

$$\eta = (V_m \cdot I_m / I \cdot S) \cdot 100\% \qquad \text{.......(1)}$$

Where:
Vm – maximum voltage [V],
Im – maximum current [A],
I – intensity of radiation [W/m^2],
S – area of the cell [m^2].

Fill factor of current – voltage characteristic of solar cells can be calculated by using the following relation:

$$FF = V_m \cdot I_m / V_{oc} \cdot I_{sc} \qquad \text{.......(2)}$$

Where:
Voc– open circuit voltage [V],
Isc – short circuit current [A].

Measuring Maximum PV Efficiency

Efficiency in photovoltaic solar panels is measured by the ability of a panel to convert sunlight into usable energy for human consumption. Knowing the efficiency of a panel is important in order to choose the correct panels for your photovoltaic system. For smaller roofs, more efficient panels are necessary, due to space constraints. How do manufacturers determine the maximum efficiency of a solar photovoltaic panel though? Read below to find out.

Let us first start out by saying that the maximum power, also known as Pmax, of a 200W panel is 200W regardless of the panel efficiency. It is the area the solar panels use up to get those 200W that determines how efficient the panel is. The panel efficiency determines the power output of a panel per unit of area. The maximum efficiency of a solar photovoltaic cell is given by the following equation:

$$\text{max (maximum efficiency)} = \frac{\text{Pmax (maximum power output)}}{\text{(E)(incident radiation flux)*A(area of collector)}}$$

The incident radiation flux could better be described as the amount of sunlight that hits the earth's surface in W/m^2. The assumed incident radiation flux under standard test conditions (STC) that manufacturers use is 1000 W/m^2. Keep in mind though, that STC includes several assumptions and depends on your geographic location.

Experimental Setup

An experimental setup been developed to study the effect of cooling by water on the performance of photo vatic (pv) panel. The electrical characteristics of the pv modules are show in the table.

A cooling system has been built up as shown in fig., and further details can be found in. the cooling system consists of sis main parts as follows.

1. Solar panel
2. Water tank
3. Heat exchanger
4. Centrifugal pump
5. Pipe for collecting water and return it back to the tank.

The water pump sucks the water from the middle of the water tank via a suction pipe to avoid sucking any dust. The suction pipe consists of a non-return valve and a strainer to avoid sucking of large particles sucked water passes through the water filter, and then, it is sprayed over the pv module for cooling.

Water is passing using water nozzles, which are installed at the back side of the panel, as shown in the fig. Water is used cooling controlled at the lower part of pv module via drain pipe, and then it returns back to the water tank such that the water cycle is closed.

Experimental Setup

Experimental Results

Experimental measurements of the efficiency and the modules temperature of the pv panel, during January and february2016 in measure the voltage, current, temperature and intensity of radiation is measure at different angle 30,32,34,36,38 and 40 on the without heat exchanger.

And then in february2016 solar panel with heat exchanger at longitudinal angle at 34 measure the current, voltage, temperature and intensity of radiation during the 10:00 am to 4:00 pm. It is conclude that the proposed cooling system could solve the problem of overheating the pv panels due to excessive solar radiation and maintain the efficiency of the solar panels at an acceptable level by the least possible amount of water

Calculation

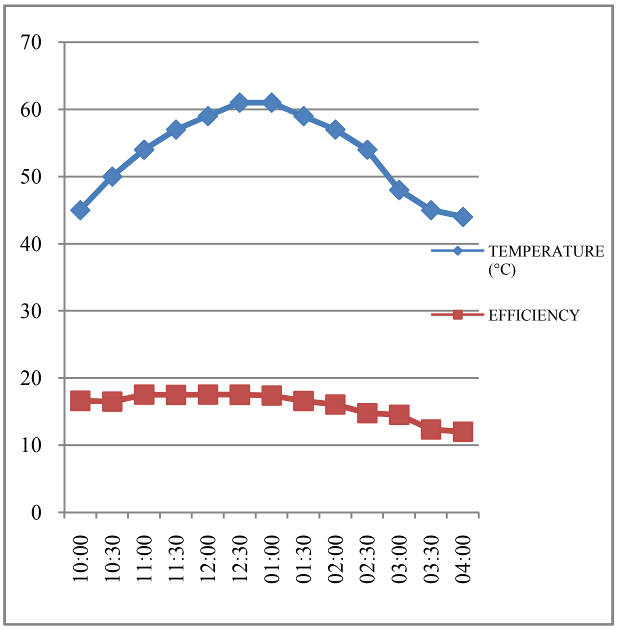
Different angle measure voltage, currant, Intensity of radiation, temperature and efficiency

Angle 30^{0}

Table 1

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.07	2.94	324	0.5504	45	16.6
10:30	9.87	3.4	370	0.5504	50	16.47
11:00	9.96	3.7	382	0.5504	54	17.52
11:30	9.85	3.93	402	0.5504	57	17.49
12:00	9.79	4.01	407	0.5504	59	17.52
12:30	9.68	4.13	415	0.5504	61	17.5
1:00	9.70	3.96	401	0.5504	61	17.4
1:30	9.74	3.6	384	0.5504	59	16.59
2:00	9.73	3.18	350	0.5504	57	16.06
2:30	9.74	2.32	278	0.5504	54	14.76
3:00	9.80	2.01	246	0.5504	48	14.54
3:30	9.75	1.38	198	0.5504	45	12.34
4:00	9.77	1.3	192	0.5504	44	12.01

Overall efficiency:15.90%



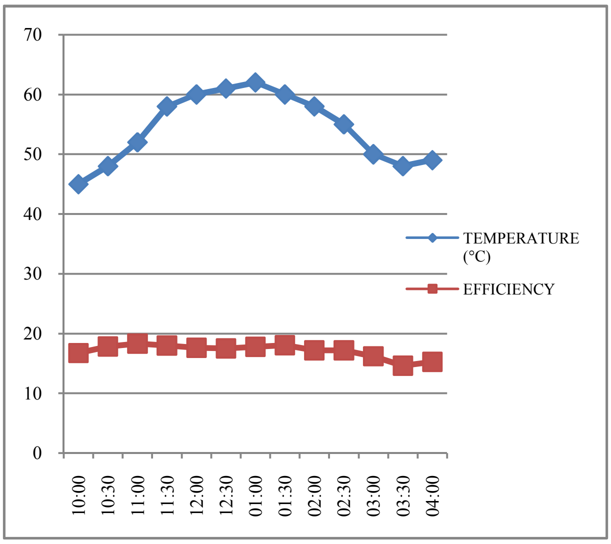
Time vs Temperature and Efficiency

Angle 32^{0}

Table No 2

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.05	3.3	360	0.5504	45	16.73
10:30	10.04	3.77	385	0.5504	48	17.86
11:00	10.01	4.01	398	0.5504	52	18.32
11:30	9.99	4.18	421	0.5504	58	18.02
12:00	9.85	4.21	427	0.5504	60	17.64
12:30	9.71	4.39	442	0.5504	61	17.52
1:00	9.69	4.33	429	0.5504	62	17.76
1:30	9.84	4.18	414	0.5504	60	18.04
2:00	9.75	3.92	404	0.5504	58	17.18
2:30	9.78	3.58	370	0.5504	55	17.19
3:00	9.74	3.23	353	0.5504	50	16.19
3:30	9.89	1.87	230	0.5504	48	14.6
4:00	9.72	2.33	270	0.5504	49	13.23

Overall efficiency:16.93%



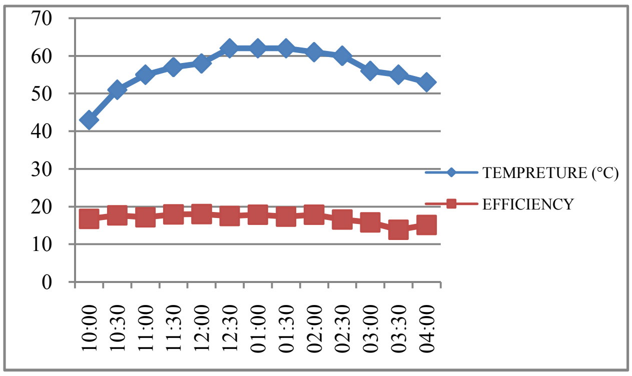
Time vs Temperature and Efficiency

Angle 34^0

Table No 3

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:30	10.13	3.69	381	0.5504	51	17.72
11:00	10.03	4.00	423	0.5504	55	17.23
11:30	9.92	4.24	426	0.5504	57	17.93
12:00	9.94	4.37	437	0.5504	58	18.05
12:30	9.74	4.29	432	0.5504	62	17.57
1:00	9.79	4.35	435	0.5504	62	17.91
1:30	9.75	4.20	429	0.5504	62	17.34
2:00	9.76	3.94	390	0.5504	61	17.91
2:30	9.78	3.63	388	0.5504	60	16.62
3:00	9.73	3.32	370	0.5504	56	15.86
3:30	9.74	2.82	360	0.5504	55	13.86
4:00	9.81	2.3	270	0.5504	53	15.18

Overall efficiency: 16.91%



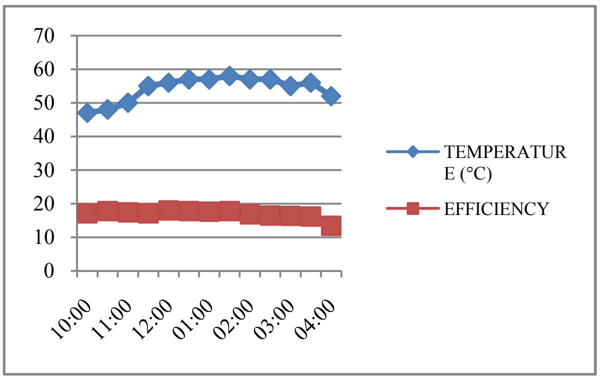
Time vs Temperature and Efficiency

Angle 36^0

Table No: 4

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.21	3.67	397	0.5504	47	17.14
10:30	10.12	3.91	403	0.5504	48	17.83
11:00	10.06	3.66	405	0.5504	50	17.04
11:30	9.98	4.08	431	0.5504	55	17.16
12:00	9.99	4.35	439	0.5504	56	17.88
12:30	9.9	4.32	436	0.5504	57	17.82
1:00	9.91	4.16	425	0.5504	57	17.62
1:30	9.85	3.95	408	0.5504	58	17.42
2:00	9.76	3.60	378	0.5504	57	16.88
2:30	9.74	3.40	365	0.5504	57	16.48
3:00	9.81	2.88	313	0.5504	55	16.39
3:30	9.69	2.34	254	0.5504	56	16.21
4:00	9.77	1.97	260	0.5504	52	13.44

Overall efficiency:16.89%



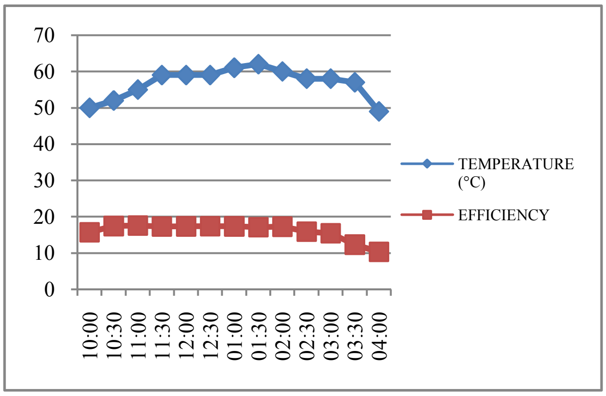
Time vs Temperature and Efficiency

Angle 38^0

Table No 5

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.04	3.1	360	0.5504	50	15.70
10:30	10.02	3.64	380	0.5504	52	17.43
11:00	9.98	3.85	395	0.5504	55	17.54
11:30	9.91	4.03	420	0.5504	59	17.27
12:00	9.85	4.11	424	0.5504	59	17.34
12:30	9.83	4.24	426	0.5504	59	17.35
1:00	9.87	4.06	420	0.5504	61	17.33
1:30	9.85	3.97	413	0.5504	62	17.13
2:00	9.84	3.81	395	0.5504	60	17.24
2:30	9.66	3.44	380	0.5504	58	15.88
3:00	9.63	3.08	349	0.5504	58	15.44
3:30	9.64	2.1	299	0.5504	57	12.30
4:00	9.60	1.06	179	0.5504	49	10.32

Overall efficiency:16.06%



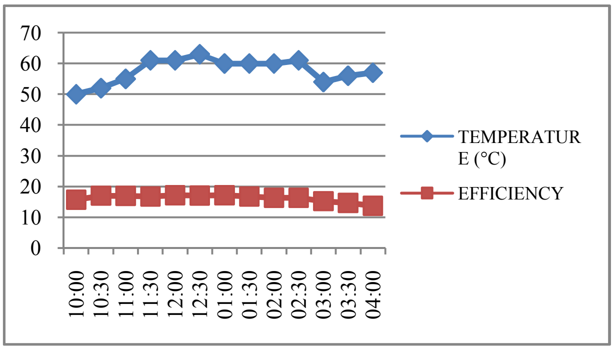
Time vs Temperature and Efficiency

Angle 40^0

Table No 6

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.03	3.13	363	0.5504	50	15.71
10:30	10.03	3.47	372	0.5504	52	16.99
11:00	9.93	3.75	399	0.5504	55	16.95
11:30	9.72	3.89	410	0.5504	61	16.75
12:00	9.80	3.98	413	0.5504	61	17.15
12:30	9.72	4.00	414	0.5504	63	17.06
1:00	9.8	3.93	409	0.5504	60	17.10
1:30	9.70	3.76	397	0.5504	60	16.69
2:00	9.70	3.53	381	0.5504	60	16.32
2:30	9.64	3.08	330	0.5504	61	16.34
3:00	9.72	2.74	318	0.5504	54	15.21
3:30	9.79	2.48	302	0.5504	56	14.60
4:00	9.71	2.18	273	0.5504	57	13.69

Overall efficiency:16.19%



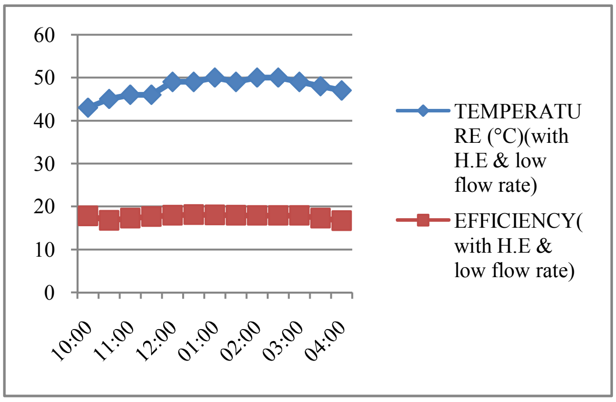
Time vs Temperature and Efficiency

Angle 34^0 (with H.E & low flow rate)

Table No 7

Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.35	3.45	365	0.5504	43	17.77
10:30	10.32	3.55	397	0.5504	45	16.76
11:00	10.30	3.70	401	0.5504	46	17.3
11:30	10.29	4.13	438	0.5504	46	17.62
12:00	10.26	4.35	451	0.5504	49	17.97
12:30	10.28	4.46	460	0.5504	49	18.1
1:00	10.25	4.43	460	0.5504	50	17.99
1:30	10.24	4.40	455	0.5504	49	17.93
2:00	10.22	4.36	452	0.5504	50	17.91
2:30	10.20	4.01	415	0.5504	50	17.9
3:00	10.20	3.99	413	0.5504	49	17.9
3:30	10.18	3.51	376	0.5504	48	17.26
4:00	10.16	3.10	343	0.5504	47	16.68

Overall efficiency:17.62%



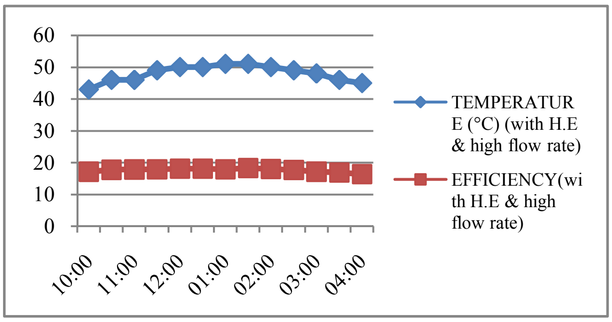
Time vs Temperature and Efficiency

Angle 34^0 (with H.E & high flow rate)

Table No 8

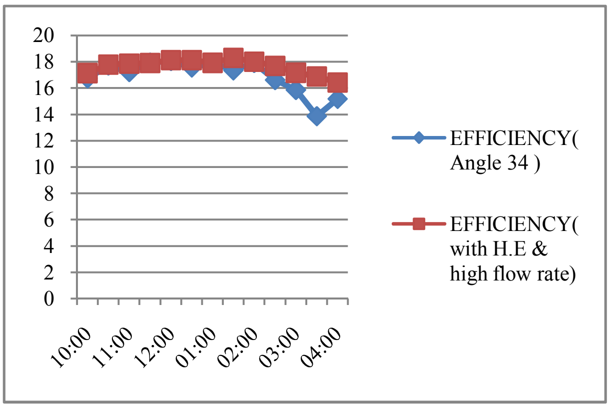
Time	Voltage	Current	Intensity radiation	Area of cell	Temperature	Efficiency
10:00	10.36	3.28	360	0.5504	43	17.14
10:30	10.33	3.58	380	0.5504	46	17.78
11:00	10.28	3.94	412	0.5504	46	17.86
11:30	10.21	4.14	439	0.5504	49	17.9
12:00	10.14	4.39	446	0.5504	50	18.13
12:30	10.02	4.5	452	0.5504	50	18.12
1:00	10.00	4.36	452	0.5504	51	17.92
1:30	10.00	4.37	434	0.5504	51	18.29
2:00	10.05	4.2	426	0.5504	50	18
2:30	10.06	3.96	409	0.5504	49	17.69
3:00	10.1	3.66	491	0.5504	48	17.17
3:30	10.1	3.24	452	0.5504	46	16.89
4:00	10.06	2.68	278	0.5504	45	16.43

Overall efficiency:17.63%



Time vs Temperature and Efficiency

Compare the efficiency of with and without heat exchanger



Time vs Efficiency without and with H.E

Overall efficiency of without heat exchanger : 16.91%
Overall efficiency of with heat exchanger : 17.63%
Increase the efficiency of solar panel : 0.72%

CONCLUSION

We take reading with different angle of temperature, current voltage, intensity of radiation and the calculate efficiency with heat exchanger. The cell efficiency can be increased by lowering the temperature of the panel; this can be achieved by passing continuously water with the help of a copper tube on the rear side of the panel. Use of heat exchanger with solar panel system temperature reduce, increase efficiency and reduce the thermal pollution are achieve.

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