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Investigation of solar panel efficiency with water cooling and filter papers

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Abstract

Due to the global warming there is limitation to the thermal power generation in the next decade. Because of this, there will be a scarcity to the power supply in the next decade due to high population growth and industrial establishment. We can meet this demand throughout the year by using renewable energy resources[2] .We are having plenty amount of unconventional fuel sources among that one source is sun. The countries like India and Ethiopia having high sun intensity to generate solar power efficiently. Generally the panel efficiency is not up to considerable range. We can improve the conventional panel efficiency by the application of water cooling and by placing filter paper on the panel. The filter papers like green, blue and red used for this experiment. Our paper suggesting better utilization techniques of sun energy among water cooling and filter papers. Finally the efficiency and fill factor of all cases measured.

Keywords: Decade; Fill Factor; intensity; solar panel; water.

1. Introduction

The generation of electric power with very less emissions is possible with only few sources. In that solar cell is one. A photo voltaic cell is device which converts solar energy into electric energy by the electron movement. A solar module as efficiency in the range of 23% to 26%. Whereas the remain sun energy emitted in the form of heat to the atmosphere by the radiation process. The efficiency of the panel varies from place to place and time to time because of the wavelength of the incident light and also over heating of the panel. The comparative among the power of wave length and the photon of brightness is converse. In general the wave lengths of light vary from 400 nanometers to 750 nanometers which are related to violet and infra respectively. At less wave lengths and upper energies PV cell energies and current will flow. Whereas less wavelengths and upper photon energies do not communicate with an enlarge in electrical power. We are having differ semiconductor material for manufacture solar cells even though

2

cost and quality basis still we are using Silicon cells. The efficiency of silicon is lower compared to other semiconductor materials. But based on availability silicon cell is in use.

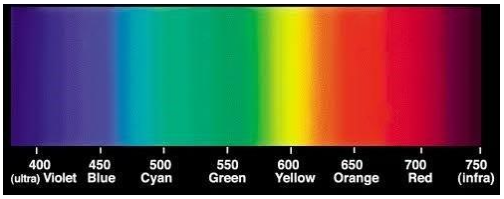

Figure:1. Light Wavelength in nanometers

2. Experimental setup

This experiment conducted at a time on 6 solar panels [1] among that one is without extra setup, 4 with red, green, yellow and blue filter papers. One setup is connected to water cooling setup. The experiment is conducted 2 months in most sunny days, the effective power generation day's values considered. The set up consists of following

1. Solar PV modules (6 Quantity)
2. Filter papers (4 types)
3. Pump
4. Millimeters (6 Quantity)
5. Water tank
6. Connecting cables

Table: 1. Specifications of PV Module

Poly crystalline Blue cells	100 W
No of cells	72
Minimum power output	85 %
Maximum power	75 W
Current at Pmax	4.0 A
Short circuit current	4.6 A
Open circuit voltage	26.9 V
Cell operating temperature	-40^{o} C to 80^{o} C
Dimensions	Dimensions 990 L X 680 W X 40 mm
Power tolerance	+ / - 6%
Colour	Sky blue
Voltage pmax	25 V
Weight	10.2 Kg

The filter papers are placed on the panel with the help of plastic clips without touching the panel. The cooling water is applied at the bottom of the panel with additional case attachment to the panel. The cooling water supplied at the case of panel overheated case. Poly crystalline panels of having area 990 mm X 680 mm used for this experiment.
The photographic view of experimental set up is shown in Figure 2. The solar panel is located on 4.5 feet mild steel stand with a tilt angle of 30°. The solar panel is connected to the positive terminal and negative terminals of the battery through the voltmeter and ammeter. Battery is discharged with bulb load.

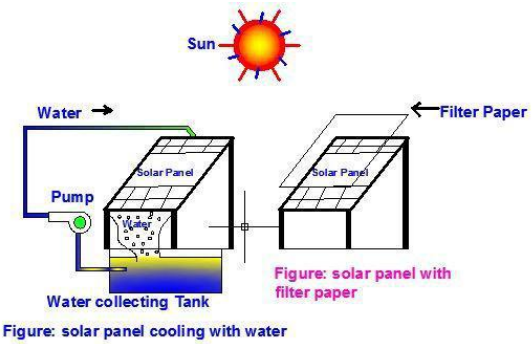

Figure:2. Experimental setup

3. Experiment calculation:[2]

The efficiency of the panel calculated by following correlations
ŋ= (Vm. Im / I.A)[2]
FF = Vm·Im/Voc·IsC

The calculated values of PV Module [3] showed in the following Table2, 3, 4, 5, 6 and 7. The values tabulated without any additional setup , water cooling, green filter, red filter, yellow filter and blue filter in the following. Morning 8 am consider as the I hour and evening 5 pm consider as X hour.

Table:2. Solar module output without any additional setup

Time	Max. V	Max.I	Intensity	Fill Factor
I	21.025	1.016409	740	0.324599
II	21.895	1.171044	775	0.389458
III	22.91	1.417722	790	0.493355
IV	23.78	1.873844	810	0.676844
V	23.925	2.3014	830	0.836348
VI	24.215	2.20145	850	0.809723
VII	23.78	2.174937	830	0.7856
VIII	23.2	1.471121	815	0.518417
IX	22.62	0.684792	790	0.235285
X	21.605	0.639204	760	0.209767

Table:3. Solar module output (water cooling)

Time	Max. V	Max.I	Intensity	Fill Factor
I	15.8	1.00	740	0.5054
II	16.1	1.3	775	0.6291
III	16.2	1.95	790	0.6402
IV	16.5	2.2	810	0.7366
V	16.9	2.40	830	0.8222
VI	16.9	2.45	850	0.8397
VII	16.8	2.4	830	0.8120
VIII	16.6	2.3	815	0.7736
IX	16.4	2.25	790	0.7478
X	16.1	2.2	760	0.7177

Table:4 Solar module output (Green filter paper)

Time	Max. V	Max.I	Intensity	Fill Factor
I	18.531	1.202531	738	0.338484
II	19.2978	1.121965	768	0.328875
III	20.1924	0.692944	785	0.212535
IV	20.9592	0.8341	815	0.265544
V	21.087	1.2745	825	0.408223
VI	21.3426	1.4124	855	0.457876
VII	20.9592	1.6984	828	0.540702
VIII	20.448	2.0164	820	0.626283
IX	19.9368	2.1457	795	0.649782
X	19.0422	2.214	765	0.64038

Table:5 Solar module output (Red filter paper)

Time	Max. V	Max.I	Intensity	Fill Factor
I	14.5	1.090115	735	0.240095
II	15.1	1.228256	770	0.281714
III	15.8	1.711814	785	0.410825

4

IV	16.4	2.10813	800	0.525151
V	16.5	2.763232	825	0.692539
VI	16.7	2.576447	845	0.653553
VII	16.4	2.354472	825	0.586517
VIII	16	1.673333	820	0.406673
IX	15.6	0.766239	795	0.181565
X	14.9	0.63132	770	0.142882

Table:6 Solar module output (yellow filter paper)

Time	Max. V	Max.I	Intensity	Fill Factor
I	16.6779	1.0139166	740	0.25685426
II	17.36802	1.0962677	775	0.28920787
III	18.17316	1.4438876	790	0.39857219
IV	18.86328	1.7748769	810	0.50854409
V	18.9783	2.3100067	830	0.66590719
VI	19.20834	2.0308887	850	0.59254196
VII	18.86328	1.4440755	830	0.41376168
VIII	18.4032	1.2514128	815	0.34981393
IX	17.94312	0.3438644	790	0.09371915
X	17.13798	0.314562	760	0.08188589

Table:7 Solar module output (Blue filter paper)

Time	Max. V	Max.I	Intensity	Fill Factor
I	21.75	1.090115	730	0.360143
II	22.65	1.228256	770	0.422572
III	23.7	1.711814	785	0.616238
IV	24.6	2.10813	805	0.787727
V	24.75	2.201	820	0.827444
VI	25.05	2.2111	845	0.841316
VII	24.6	2.145	835	0.801504
VIII	24	1.673333	820	0.61001
IX	23.4	0.766239	790	0.272348
X	22.35	0.63132	770	0.214324

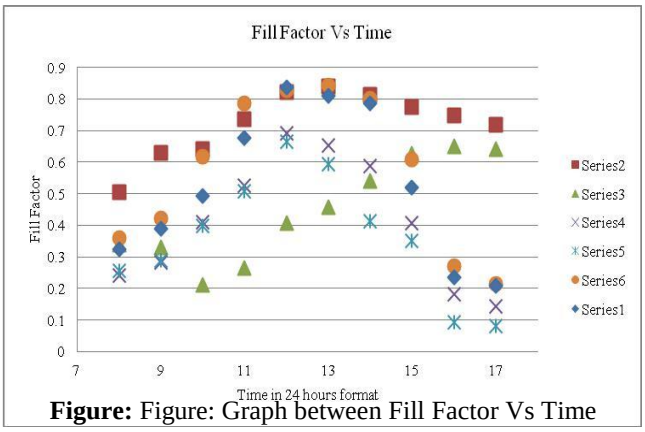

Figure: Figure: Graph between Fill Factor Vs Time

Figure: 3.Graph between Fill Factor Vs Time (where s-1 is general panel, s-2 is water cooling, s-3 is s-4 is red, s-5 is yellow, s-6 is blue)

4.Results:

Based on above fill factors Water cooling panel and blue filter paper having effective values.
ŋ= (Vm. Im / I.A)
1. Efficiency of the water cooling panel:
ŋ = (26.9 X 4.6) / (740 X 0.6566)

= 123.74/485.884 = 0.25467.
The average efficiency of the water cooling panel =2.362627/10 = 0.2362627.
The average fill factor of the water cooling panel= 7.2443/10 = 0.7244
Sun intensity = 7990/10 = 799 W/M^2

2. Efficiency of the Blue filter panel:
ŋ = (26.9 X 4.6) / (730 X 0.6566)
= 123.74/479.318 = 0.258158.
The average efficiency of the Blue filter panel =2.36875/10 = 0.2368.
The average fill factor of the Blue filter panel = 0.5753626/10 = 0.57536.
Sun intensity = 7970/10 = 797 W/M^2

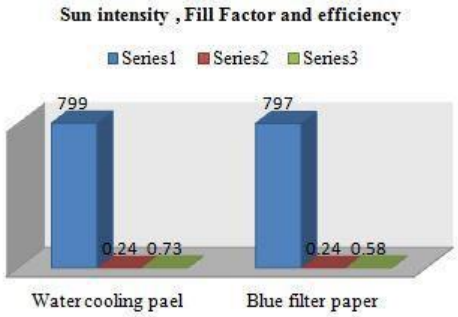

Figure:4 The final results (s-2 Efficiency and s-3 fill factor)

CONCLUSION

It is clearly shows the water cooling and Blue filter paper panels having almost same output values. The normal panel also having up to considerable values. The yellow colour and red colour filters drops the efficiency of the panel. Green colour filter does not effect in the increase of panel efficiency. The efficiency of the panel also increases in the case of water cooling and blue filter. We enhanced much effectiveness of the panel and also Fill Factor.

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