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Experimental Study of Optimum Tilt Angle for Solar PV Panel in Jaipur (Rajasthan)

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Abstract: ***Solar energy is one of the best efficient in the production of electricity in European countries. From past few years India has also use solar panel for the generation of electricity. So study of various parameters is useful which affect the Performa of solar panel. In this study we show the optimum tilt angle of a solar photovoltaic panel for May and June month in jaipur. We use an experimental setup consists of power control unit (pcu),a 40w p-v panel ,a solar flux meter &dial angle gauge. So we have a experimental based study that how voltage and current may be affected as the slope of a panel get altered for jaipur, (India) location. In order to evaluate the power performance and efficiency of solar pv panel it is significant to perceive effect of tilt angle. The experimental result shows that at different position of solar panel we have different power & efficiency. From the observation data we obtained in our research we concluded that the optimum tilt angle for May is 5^o-10^o and for June it is $5^0 \pm 2^o$.***

Keyword: Experimental setup, solar photovoltaic panel, power control unit, solar flux meter, optimum tilt angle, dial angle gauge.

1. Introduction

Solar energy is one of the most useful renewable energy in India these days. The working of a solar panel is based on the photovoltaic effect. According to photovoltaic effect the semiconductor device produce electric current if light falling on it .As sun lights falls on solar panel made up of semiconductors in forms of small packets called photon, then it produce electricity as output. Since the conversion efficiency of solar panel are too much low so various research are on progress which affect the power of solar panel. Various ideas will be given to improve the solar power of a PV system. So many people are study & work on various parameters so as to increase the efficiency of a PV module. Tilt angle is one of the most important parameter to enhance the efficiency of a solar panel. Most of the researcher said that to place the solar panel on an optimum tilt to get maximum solar insolation so that module give more energy as output.[1] It is important that the efficiency of PV panel depends upon the solar insolation fall on it and the orientation of panel. So panel may be placed at angle so that it can get high intensity if solar radiation. The tilt angle for different season is varying seasonally to get high solar radiation on its surface. The study of Amita chandrakar & yogesh tiwari for Raipur said that the optimum tilt angle of winter season is 37° and that of summer it is 12°. The annual average optimum tilt angle is 23.5° or nearly equal to the latitude of Chhattisgarh which is about 24.5°.[5] It is reported in the literature for northern hemisphere the orientation of PV panel is south faced and placed at a tilt angle equal to its latitude. Most of the authors suggest a various range for tilt angle according to exclusive location and a variety of method used to evaluate optimal tilt theoretically and practically.[2] In some application placing of panel to its optimal tilt is not possible. So it is important to monitoring the effect of tilt angle on solar panel performance. The present study observes the optimal or a range of tilt angle for the month of May-June in JAIPUR, RAJASTHAN.

2. Experimental Apparatus & Procedure

A set of various types of accessories used in my experimental study which is explained below:-

2.1 Solar Photovoltaic Panel

The panel which we use is manufactured by VIKRAM SOLAR PVT. LIMITED and the model no. is ELDORA40. The specification of solar panel is given below

Parameters	Rating
Rated maximum power(P_{mpp})	40W
Open circuit voltage(V_{oc})	21.90V
Short circuit current(I_{sc})	2.45A
Temperature of panel	25^oc
Rated voltage(V_{mpp})	17.40V
Rated current(I_{mpp})	2.3A
Area	$0.2m^2$
Radiation	$1000W/m^2$
Material	Polycrystalline
Air mass	1.5

2.2 Dial Angle Gauge

This instrument is used to find the tilt angle of the solar panel. It consist of a moving needle which measure and display the angle similar to protractor with a magnetic base. The advantage of magnetic base is that it can be fix on the iron frame which holds the panel and angle is easily observable.

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2.3 Power control unit

Power control unit consists of a number voltmeter, ammeter, and a potentiometer of range 0-200Ω & of capacity 150W.Other measuring equipment like thermostat, diode, battery, solar charge controller are also up build in the control unit.

3. Experimental Procedure

To find the optimum tilt angle for the month of May & June we have taken the observation for different position of potentiometer. The data have taken from 1st May 2014 to 23rd June 2014. The observations have taken twice in a week. The radiation of sun is measured by solar flux meter with an error of $\pm$20W/m^2. Since India is situated at northern hemisphere so the orientation of solar panel is south facing to get maximum power and the tilt angle varies from 0^o to 40^o. Since the intensity of sun is maximum from 10am to 2pm so all the data is obtained hourly in a day. We have taken the solar radiation at 0^o tilt and the radiation is constant over all variation of tilt for an hour. The position of pot meter is fixed over a day. The values of voltage and current have taken from the power control unit and the graph between power and tilt can be drawn at different radiation level of sun. The graph between power and tilt (β) have observed date wise describe below:-

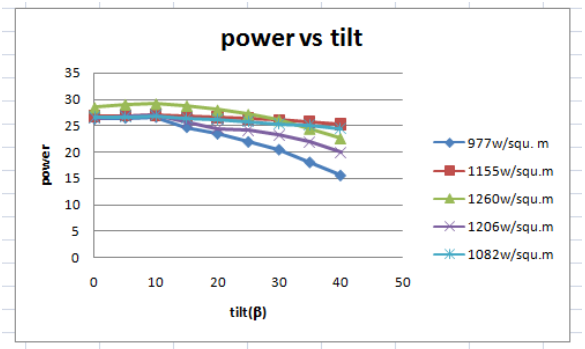

Figure 1: Graph b/w power & tilt on 1st May

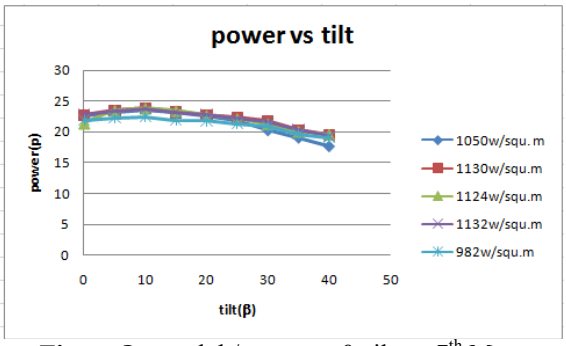

Figure 2: graph b/w power & tilt on 7th May

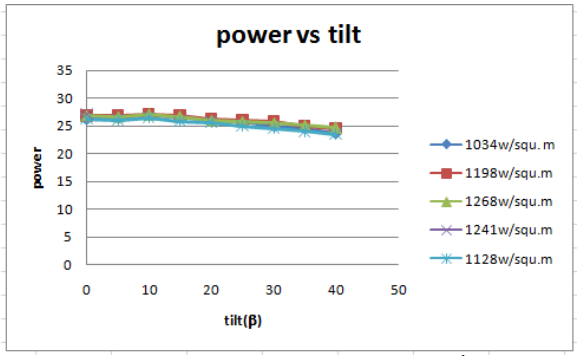

Figure 3: graph b/w power & tilt on 9th May

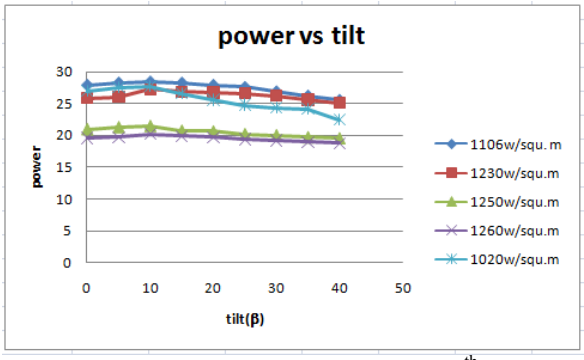

Figure 4: graph b/w power & tilt on 15th May

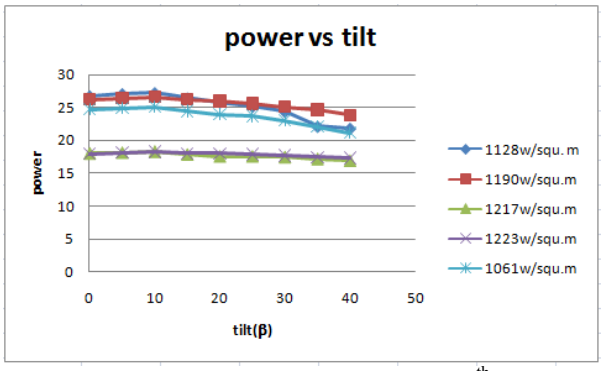

Figure 5: graph b/w power & tilt on 16th May

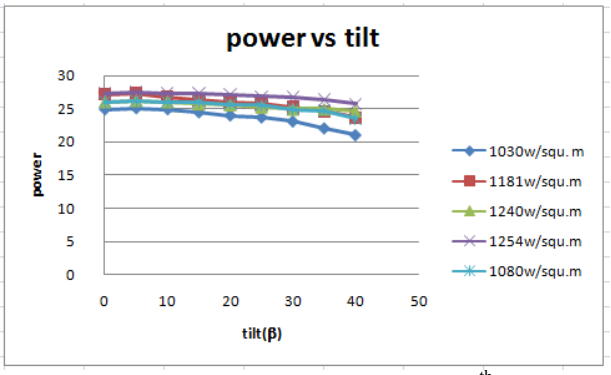

Figure 6: graph b/w power & tilt on 19th May

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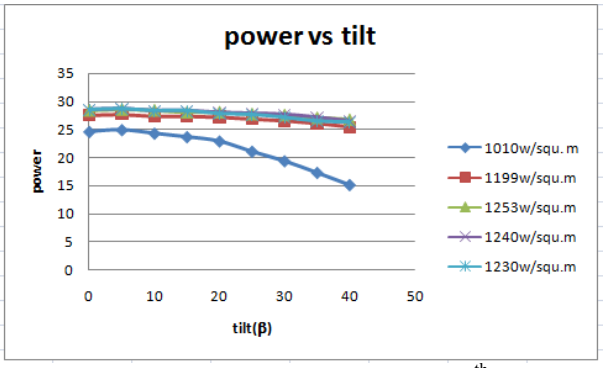

Figure 7: graph b/w power & tilt on 21th May

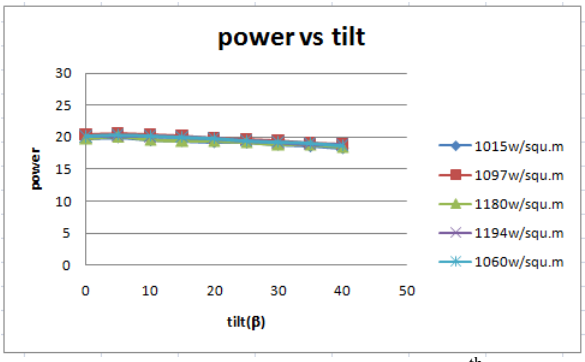

Figure 11: Graph b/w power & tilt on 4th June

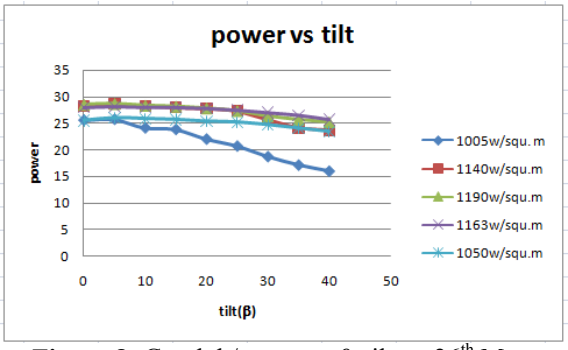

Figure 8: Graph b/w power & tilt on 26th May

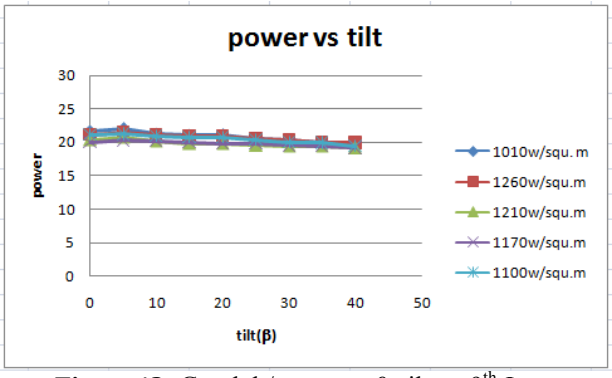

Figure 12: Graph b/w power & tilt on 9th June

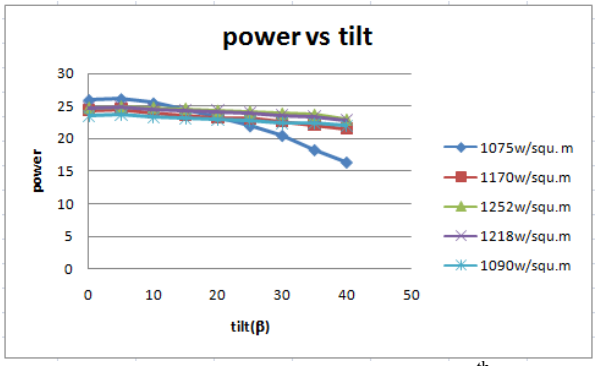

Figure 9: Graph b/w power & tilt on 28th May

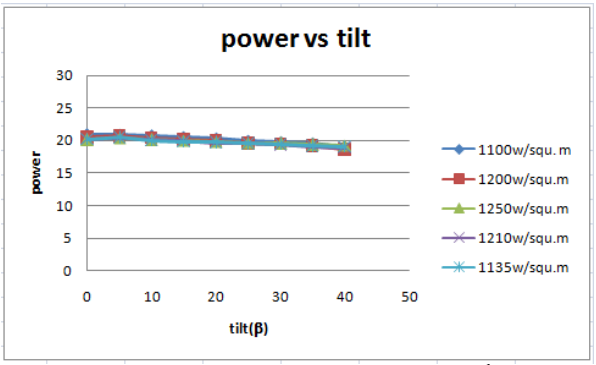

Figure 13: Graph b/w power & tilt on 11th June

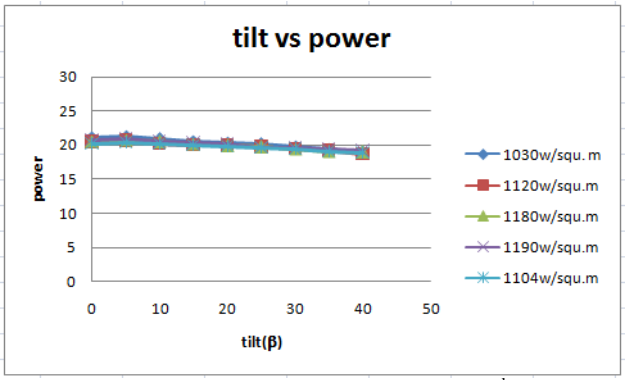

Figure 10: Graph b/w power & tilt on 2nd June

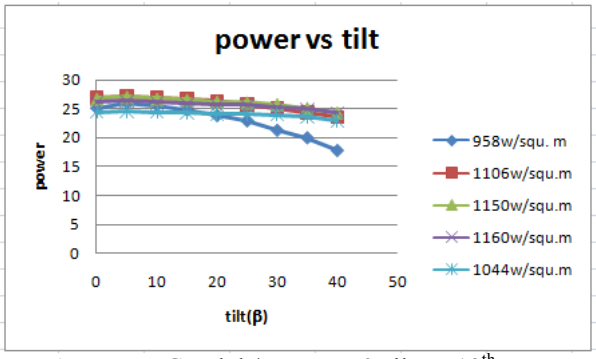

Figure 14: Graph b/w power & tilt on 18th June

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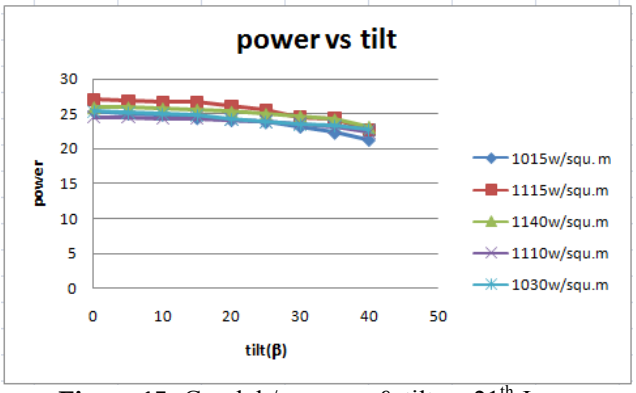

Figure 15: Graph b/w power & tilt on 21th June

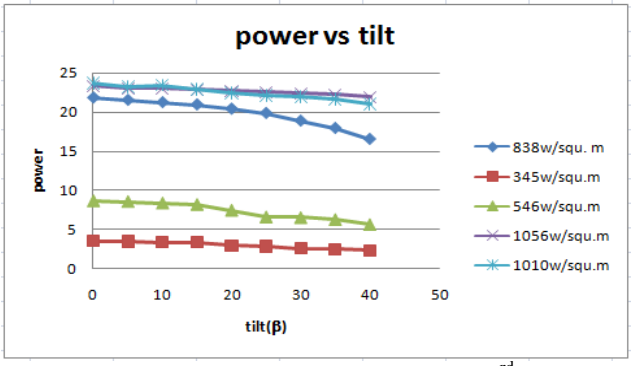

Figure 16: Graph b/w power & tilt on 23rd June

4. Result & Conclusion

From the above reading we found that for different position of pot meter the power from the solar panel is different at different radiation level. In the month of May the power obtained up to 16th may is maximum at tilt of 10° and after that maximum power obtained at a tilt of 5°.Similarly on the month of June maximum power obtained at an tilt angle of 5°, Since declination of sun is mostly perpendicular to earth surface on 20th June to 23rd June, hence maximum power between these days is at a tilt of 0°. so, we concluded that graph between power and tilt shows that for the month of May the tilt angle is 5°-10° and the tilt angle for June month it is 5°±2°.As the value of tilt angle increase the power decrease accordingly.

5. Future Scope

Since the use of solar panel is increased day by day hence to increase the efficiency one can put the panel on its optimum tilt angle. To get maximum power from a solar panel one can use single or double axis tracker to get optimum tilt .But the cost of these tracker is much higher which cannot be affordable for general people. There is many applications are invented these days from solar panel, but most of the application the use of tracker is impossible, so one can fix the panel to optimal angle and get the maximum power from the solar panel.

6. Acknowledgment

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Author Profile

Saurav Kumar born in Bihar (India) in 1990 received the B Tech degree in 2013 from Electrical Engineering and pursuing M Tech in Energy Engineering from Suresh Gyan Vihar University, jaipur, Rajasthan, India. During 2013-14 the experimental work has been done to finding the optimum tilt angle of solar panel in the solar lab provided by the Suresh Gyan Vihar University.

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