ISSN 2349-6193
Impact Factor: 2.805

IJESMR

International Journal OF Engineering Sciences &Management Research

ANALYSIS & MODELING OF DUST AND SHADING EFFECTS ON THE PERFORMANCE OF SOLAR PHOTOVOLTAIC SYSTEM UNDER VARIOUS WEATHER CONDITIONS

Himanshu Kumar Srivastava[*1], Ashish Singh Chauhan[2] & Rahul Saraswat[3]
[*1]Research Scholor BIT Kanpur Dehat
[2]A.P. BIT Kanpur Dehat
[3]A.P. HITM AGRA

Keywords: *Solar Photovoltaic, System Efficiency, Electrical Efficiency, Module Efficiency.*

ABSTRACT
In this papers basically the analysis and modeling of the effects of dust and shading on the performance of the solar panel has been performed. The solar photovoltaic (PV) system has been simulated on Matlab/ Simulink simulation environment. The results are prepared using the experimental data and simulation model that has been prepared on Matlab/Simulink environment. After the preparation of the required graphs these graphs are compared. This research paper is based on general behavioral model forPV cell modeling & solar radiance for the conversion of solar intensity to electrical power.

INTRODUCTION
The cells that are used to convert the solar energy to electrical energy are called solar cells. These are sometimes called as simply Photovoltaic (PV) cells.It is basically a semi conductor PN junction device. A PV cell is the basic unit which produces voltage in that varies in the range of 0.5 to 0.8 volts depending on cell manufacturing technology used. This much generation cannot of much useful for commercial applications but when we look physically in a PV system is the module that is available commercially; which can be further reconnected to get the desired energy. [1]

The PV system is a structure that can be understood by the means of a whole connection of physically connected modules that are available commercially which are reconnected to provide the desired current and voltage ratings. When experiments are made with solar cells in order to analyze the behavior of it, it comes out as a time consuming & costly work. This problem can be sorted using various modeling & simulation techniques that are very useful to model & simulate the performance of a solar PV cells under different operating techniques.

The solar cell Hybrid model of simulation using Matlab / Simulink was initially made by Jiang, et al Hybrid model of simulation which is simulated using MATLAB / Simulink contains the PV cells and the stage which converts the power to desired stage*[2]*. The model is capable of simulating both the characteristics curves such as I-V & P-V Characteristics. The simulation model is developed to study various parameters and various effects variations effects on the PV system

In this paper the simulations of SPV systems are made to analyze the following three conditions
:

1. Analysis & simulation for cleaned panel
2. Analysis & simulation for dust effect on Solar PV System
3. Analysis & simulation for shading on Solar PV System

Solar photovoltaic technologies are generally capable as either passive or active depending on the way they grab, change over and distribute sunlight. Active solar competencies use photovoltaic arrays to convert sunlight (photon packets of energy) into electricity outputs. Passive solar techniques comprise of selection of materials with required thermal properties, and placing them on appropriate position of a building with respect to the Sun. The separate PV Systems are very much useful for solar street lighting, home lighting system and SPV water pumping system

ISSN 2349-6193
Impact Factor: 2.805

IJESMR

International Journal OF Engineering Sciences &Management Research

MODELING & SIMULATION OF SPV SYSTEM UNDER VARIOUS CONDITIONS

Solar PV Cell Model

The most important component that affects the accuracy of the simulation is the PV cell model. Simulation and mathematical modeling of PV cell involves the evaluation of the I-V and P-V characteristics curves to follow the real PV cell under various environmental conditions. The most popular approach is to use the equivalent circuit solar PV cell, which is mainly based on diode. The solar cell functional block shown in Fig.2.1 shows the symbol of solar cell in Sim- Electronics, Fig.2.2 shows the equivalent circuit.[4]

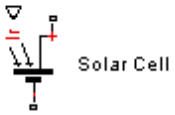


Fig.2.1 symbol of solar cell [Courtesy-www.Mathworks.com]

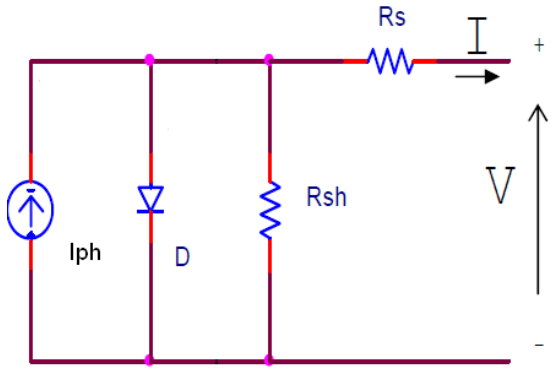


Fig.2.2 Equivalent Circuit of Solar Cell [Courtesy-www.Mathworks.com]

The Output current equation can be written as follows:

$$Iso = Ip - Is\left[\exp\left(\frac{V+I*Rs}{NVt}\right) - 1\right] - \frac{V+Iso}{Rsh} \ldots..(1)$$

Where

Iso = output current of PV cell

Is-= reverse saturation current of diode

V = voltage across the PV cell electrical ports

N= diode quality factor (It varies according to the diode)

Ip=Solar induced current

Further Ip is related to the irradiance of sun by the following equation

$$Ip=Ipo*(Ir/Iro)\ldots. (2)$$

Where

Ipo= photo-current for the reference 1000 Watts/m^2 irradiance

Ir=irradiance from the sun or simply light intensity in W/m^2 falling on the cell

Iro= Reference irradiance(1000W/m^2

Solar Photovoltaic Module

As the voltage generated by a single solar cell is very low(around 0.5-0.6V). Hence a number of solar cells are connected in both series and parallel connections to achieve the required output. In special case of partial shading, diodes may be used to avoid reverse current in the panel. Good ventilation behind the solar panels are connected to avoid the possibility of less efficiency at high temperatures

ISSN 2349-6193
Impact Factor: 2.805

IJESMR
International Journal OF Engineering Sciences &Management Research

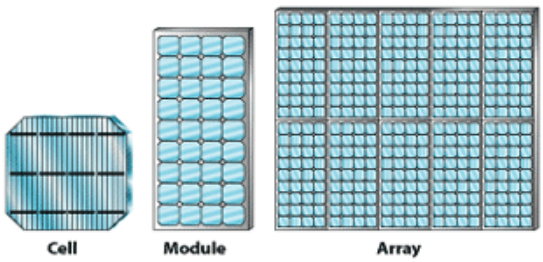


Fig 2.3 Solar PV cell , Module, array

Photovoltaic Array

Again the power produced by a single module is not sufficient to satisfy the power demands for most of the common practical purposes. PV arrays can use inverters to convert the dc output into ac and use it for motors, lighting and other loads. The modules can be connected in series for sufficient voltage rating and then in parallel to satisfy the current specifications.

The physical look of solar PV Cell, Module & array is shown in the figure 2.3.

Simulink model of Solar PV System

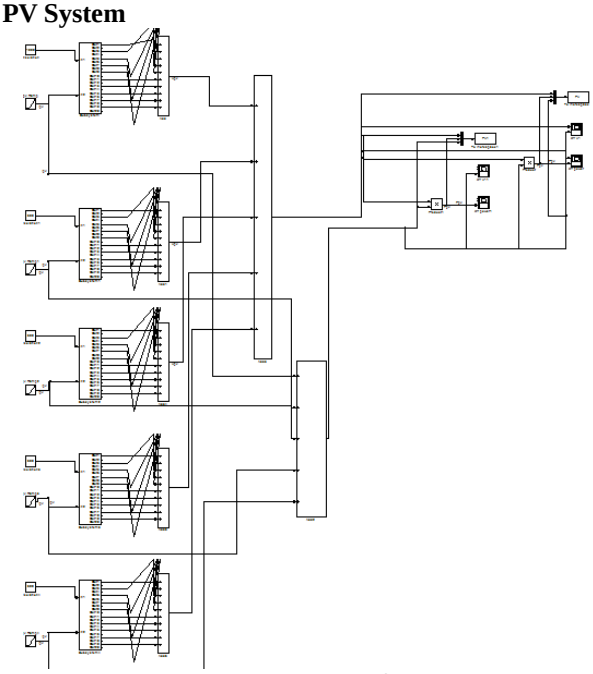


Fig 2.4 Simulink model of solar panel

The above simulink model has been prepared for the analysis of solar PV array system for the analysais of the different conditions.The power characterstics for the system are as shown below

ISSN 2349-6193
Impact Factor: 2.805

IJESMR
International Journal OF Engineering Sciences &Management Research

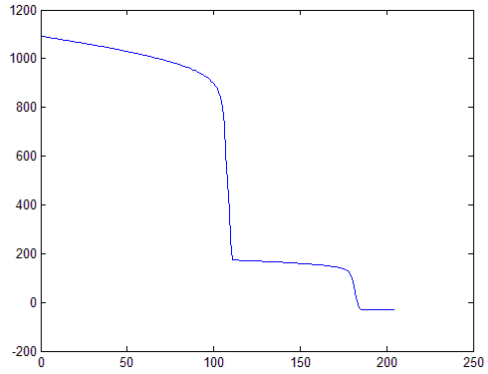


Fig 2.5 Characteristics of solar panel

Simulation of Solar PV System using MATLAB

The simulation of solar photovoltaic system has been done suing MATLAB software and the graphs between various parameters are plotted .V-I curves are plotted for different solar irradiance from solar. These solar irradiance are 1000 watts/$m^{2,}$,750 watts/m^2,500 watts/m^2, 250 watts/m^2.From the above characteristics graphs we can conclude that as the solar irradiation decreases the current output of solar panel decreases so as the power. Also as the temperature of the environment increases there is a decrement in the performance of the solar panel The graphs are as follows:-

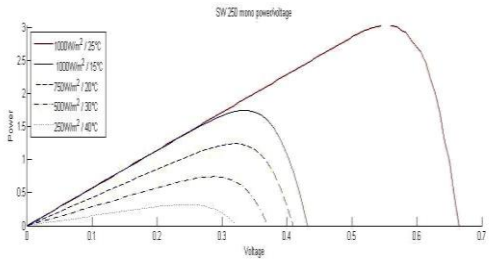


Fig 2.6 Simulated P-V Characteristics of Solar PV System

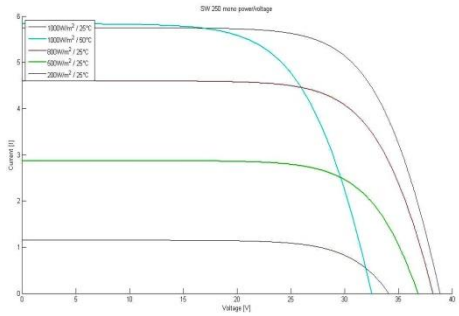


Fig 2.7 Simulated I-V Simulation Characteristics

From the above characteristics we see that the power increases as the voltage of the solar array increases but when the operating temperature of the array increases there is a notable decrement in the performance of the Solar PV system has occurred.

ANALYSIS & SIMULATION OF SOLAR PV SYSTEM UNDER SPECIFIC CONDITIONS

The simulation of Solar PV System has been made using MATLAB to study the effect of various operating conditions on the performance. These operating conditions are as follows

ISSN 2349-6193
Impact Factor: 2.805

IJESMR
International Journal OF Engineering Sciences &Management Research

Analysis & simulation for cleaned panel

The irradiation of sun increases on the solar panel when it moves around the panel and after afternoon the irradiation decreases .As it is known as the current of the panel increases as the irradiation from Sun increases so the data has been taken from morning to evening and the simulated curves from the practical and simulated data have been compared. The unit of solar irradiation is watts/meter square. The reference solar irradiation is 1000 watts/meter square. The practical and simulated curves for power and current are as follows:

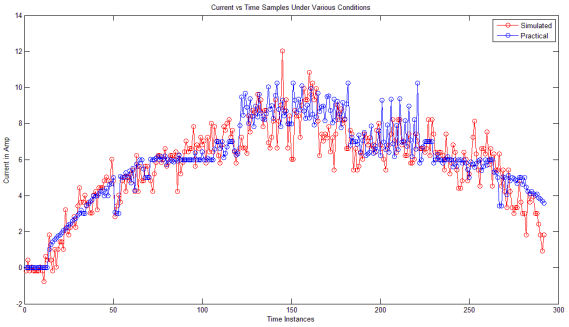


Fig 3.1 Current Characteristics with respect to time

From the above curves we can state that the current & power of the solar panel depends increases as the irradiation of sun increases and when the day moves towards evening these parameters begins to decreases and they are zero in the night when there is no irradiation from sun.

Analysis & simulation for dust effect on Solar PV System

Dust accumulation on solar panel is the natural phenomenon. It has been found that the accumulation of dust reduces the performance of solar PV system. This reduction in the performance of solar PV system can be up to 50%.The aim of this paper to simulate the effect of dust on the solar panel and comparison with practical data taken using data logger is plotted .The picture of Solar Panel under dust is as shown in the figure 3.3

Fig 3.3 Panel under dust effect

Due to accumulation of dust a dust layer is formed on the surface of the panel so the effective irradiation is decreased due to which the performance of the system is degraded. The plots for power current for the dust effect (Practical and simulated are as shown in the figure 3.4 and 3.5

Comparing figure 3.1 & 3.4 we can say that there is a significant reduction in the power and the current and power under dust condition.

ISSN 2349-6193
Impact Factor: 2.805

IJESMR
International Journal OF Engineering Sciences &Management Research

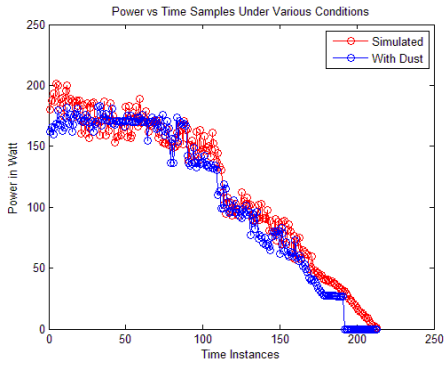


Fig 3.4 Power characteristics under dust effect

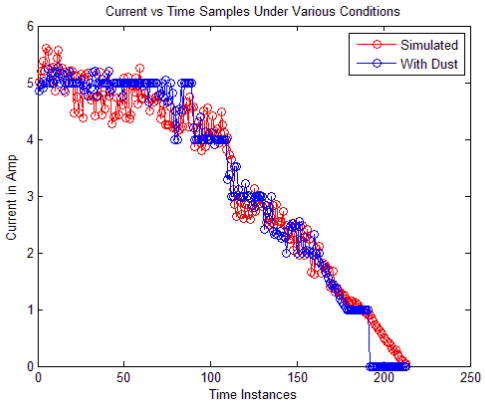
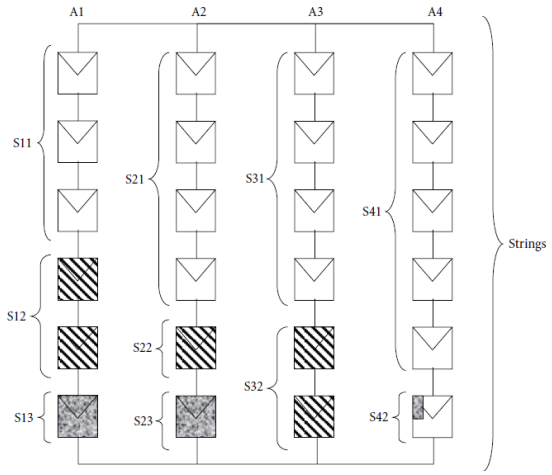


Fig 3.5 Current characteristics under dust effect

Analysis & simulation for shading on Solar PV System

Solar photovoltaic array is made by connecting Solar PV modules in series/parallel combination in order to get desired power and current level. The main challenge in using a SPV source having a number of cells in series is to deal with its nonlinear characteristics. In a combination of series connected solar cells, all the cells give the same current. But still few cells that are under shade generate less photon current, but these cells are forced to pass the same current just like others cells which are fully illuminated . The cells under shade maybe get reverse biased, acting as loadsand draining power from fully Illuminated cells

Shading analysis plays an important role in the PV design process. It is used to select the appropriate location for panels and making sure that sufficient energy production should take place. The PV array characteristic current-voltage (I-V) curve changes as a result of shading. The shading on the panel is shown in the figure 3.6



ISSN 2349-6193
Impact Factor: 2.805

IJESMR
International Journal OF Engineering Sciences &Management Research

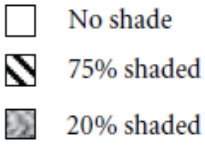


Fig 3.6 Shading effect on solar PV System

The simulated characterstices for power and current with respect to the time are simulated and they are compared with the practical data curves which are shown in the figure 3.7 and 3.8

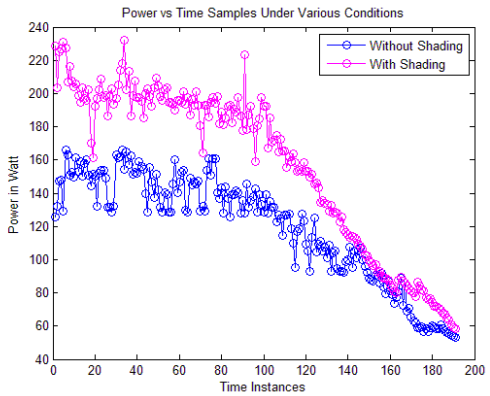


Fig 3.7 Power characteristics under partial shading

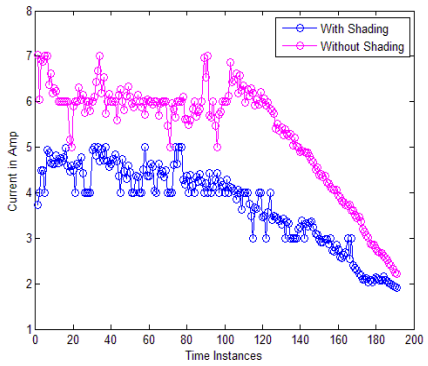


Fig 3.8 current characteristics under partial shading

From the above curves we can see that due to shading the performance of solar panel is decreased about 28%.So the shading is one of the cause due to which there is a significant decrement in the performance of the solar panel.

CONCLUSIONS

The main conclusions of this paper are as follows:

i. When we take the cleaned panel then the output parameters of solar panel are proportional to the solar irradiation. But as we know solar parameters sare inversely proportional to the operating temperature of the system so increment in the temperature like 40°C the performance decreases as we can see from figure 2.6.

ii. When we analyze the effect of dust on the solar panel then we can see from the figure 3.4 &3.5 that the current as well as the voltage & power ratings of the solar panel has been decreased by a significant amount .Also larger the width of the dust accumulated layer on the solar panel higher there will be the decrement in the performance of the solar panel. This decrement is about 20 percent than the cleaned panel.

ISSN 2349-6193
Impact Factor: 2.805

IJESMR

International Journal OF Engineering Sciences &Management Research

iii. The major factor that decrease & affect the performance of the solar panel is shading and sometimes it is called partial shading. Observing the characteristics of the solar panel under shading we can see from the figure 3.7 & 3.8 that there is a remarkable decrement in the current and the power ratings of the solar panel. If the shading is of diagonal type then there will be more decrement in the characteristics.

REFERENCES

1. *VandanaKhanna, Bijoy Kishore Das "MATLAB / SIMELECTRONICS Models Based Study of Solar Cells", International Journal Of Renewable Energy Research., Vol.3, No.1, 2013.*
2. *Yuncong Jiang, Qahouq, J.A.A., Orabi, M. "Matlab/Pspice hybrid simulation modeling of solar PV cell/module", Applied Power Electronics Conference and Exposition (APEC), 2011 Twenty-Sixth Annual IEEE.*
3. *Feba Thamar Tomy, R.Prakash "Load Frequency Control of a Two Area Hybrid System Consisting of a Grid Connected PV System and Thermal Generator" International Journal of Research in Engineering and Technology, Vol. 03 May 2014.*
4. *G. Venkateswarlu , Dr.P.Sangameswar Raju International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 5, May 2013*
5. *Chandani Sharma, Anamika Jain "Solar Panel Mathematical Modeling Using Simulink" Internatioonal. Journal of Engineering Research and Applications Vol. 4, Issue 5 (Version 4), May 2014, pp.67-72.*
6. *Ekpenyong, E.E and Anyasi, F.I "Remedyto the Shading Effect on photovoltaic Cell" IOSR Journal of Electrical and Electronics Engineering Volume 8, Issue 2 (Nov. - Dec. 2013), PP 07-15.*
7. *Hussein A Kazem,, Tamer Khatib, K. Sopian, Frank Buttinger,Wilfried Elmenreich, Ahmed Said Albusaidi "Effect of Dust Deposition on the Performance of Multi-Crystalline Photovoltaic Modules Based on Experimental Measurements" International Journal Of Renewable Energy Research Vol.3, No.4, 2013*
8. *Huan-Liang Tsai, Ci-Siang Tu, Yi-Jie Su, "Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK", Proceedings of the World Congress on Engineering and Computer Science WCECS, San Francisco, USA, 2008.*
9. *S. Rustemli, F. Dincer, "Modeling of Photovoltaic Panel and Examining Effects of Temperature in Matlab/Simulink", Electronics and Electrical Engineering, ISSN 1392-1215, no. 3(109), pp. 35-40, 2011.*
10. *I.H. Atlas, A.M. Sharaf, "A Photovoltaic Array Simulation Model for Matlab-Simulink GUI Environment", International Conference on Clean Power, pp. 341-345, 2007*
11. *Dorado ED, García AS, Carrillo C, Cidras J, 2010, Influence of the PV modules layout in the power losses of a PV array with shadows, University of Vigo, Spain, [http://webs.uvigo.es/carrillo/publicaciones/EPE-PEMC-2010 Influence of the PV modules layout in the power losses of a PV system.pdf]; 1-5.*
12. *Mani A,Handbook of solar radiation data for India, New Delhi:Allied Publishers, p 451-462. (1980)*