SOFTWARE TOOLS FOR PV PERFORMANCE A COMPARATIVE STUDY

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Abstract:
The need for electrical power is increasing day by day due to increasing need of energy. But the power supplied by fossil fuels results into huge carbon emissions in the atmosphere, which leads the electrical engineers to generate the power by using the renewable energy sources. This article is a simulation, designing and modeling of a solar photovoltaic system based on renewable energy resources. Different tools are used to simulate the solar PV system and the results are compared. A solar panel of 370 watts is taken as an example and the characteristic of PV module is simulated by using PV syst and Matlab/ Simulink. The results are compared with the observations made by conducting an experiment on the same panel. The I-V and P-V curves are observed by using both the tools and the performance characteristics are obtained. The Matlab/Simulink program allows the prediction of PV module behavior under different physical and environmental parameters. This program can also be used to extract the physical parameters for a given solar PV module as a function of temperature and solar radiation.

Index Terms— Solar, PV Module, PV syst, irradiance, Simulink

1. INTRODUCTION

In electricity systems renewable energy sources are playing a significant and fundamental role, and utilization of photovoltaic solar energy is rising exceptionally day by day. Photovoltaic panels and electrical inverters are used to generate solar power. In nature, the output power generated by the photovoltaic panels is discontinuous and varies depending on the level of irradiancy, temperature, aging of the panels, various orientations etc [1]. The system will operate at its maximum possible efficiency only under uniform operating conditions. The performance of the PVsystems are always characterized by various parameters such as geographical location, panel orientation, mounting structure, climatic conditions etc.. Solar energy is the most efficient renewable energy source if it is efficiently harnessed by the modern technology [1]. In solar PV system, the sunlight is directly converted into the electrical energy. The energy that can be produced by a solar cell basically depends on the intrinsic properties of the cells and the amount of solar radiation which falls on the panel [2]. The typical size of the solar array as well as AC inverter required for solar PV applications depends on the type of loads connected. The energy from the panel can also be stored by using battery storage for later use. The basic disadvantage of solar PV system is its lower efficiency as panels are hugely dependent on highly unpredictable atmospheric parameters, i.e., the solar radiation and temperature.

Among the various software programs, PVsyst simulation software is the most popular. This software gives the detailed performance of the PV plants under operating as well as non-uniform operating conditions. It can be also used to investigate different loads on the system, to estimate the size of the system, to determine the optimal size of the panel, and to assess the energy production in the system. It can evaluate hourly, monthly as well as yearly energy production and performance. Its application performs a detailed simulation. The limitation of the software is that it can compute only a single layer of PV module. PVsyst has the For Simulation and Modeling of a PV System Matlab/Simulink is used.

2. CHARACTERISTICS OF SOLAR CELL

The performance characteristics of the solar cell are the open circuit voltage (Voc), Maximum Power point Voltage (Vmp) ,Short circuit current(Isc),Maximum Powerpoint Current(Imp),Maximum Power(Pmax),Parallel Resistance(Rp), Series Resistance(Rs).

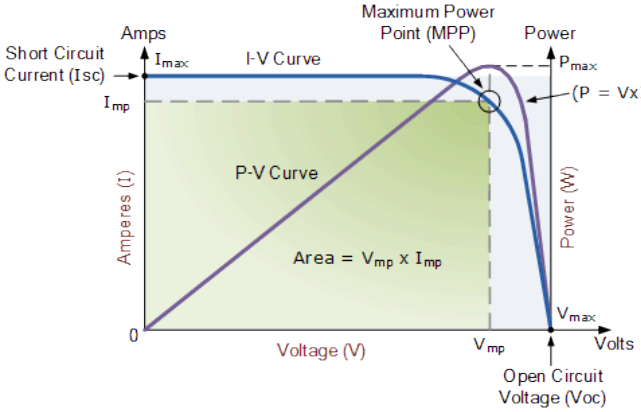

Fig 1: I-V and P-V characteristics of a solar PV system

So from above characteristics of I-V, we can observe if we want to obtain the maximum power from the panel then we have to control the output voltage and current at the maximum power point.

Short Circuit Current (Isc)

This is the maximum current that the cell can provide and it occurs when the cells is short circuited. Unlike other small scale electricity generating systems PV cells are not harmed by being shorted out.

Open circuit Current (Voc)

This is the maximum voltage that exists between the cells terminals and is obtained when there is no load connected across them

Maximum Power Point (Pmax) –

This is the point on the I-V curve at which maximum power

is being produced by the cell. Note that since the graph is not a straight line, the power produced will vary depending on the operating voltage; although the voltage at any point on the graph can still be calculated using P=IV. Pmax occurs on the 'knee' of the I-V curve.

3. METHODOLOGY

PV system requires special design considerations due to the varying nature of the solar power resulting from unpredictable and sudden changes in weather conditions, which change the radiation level as well as
the cell operating temperature. This mandates an accurate and reliable simulation of designed PV system prior to installation Solar photovoltaic systems performance depends on several environmental parameters like solar insolation, temperature, wind speed and shading. The performance of such system requires a precise knowledge of the I-V and P-V characteristics curve.

To demonstrate, a panel is selected with the specifications given in table 1, as an illustration to obtain I-V characteristics and performance using PVsyst. A total of five panels are used to get 370 watts.

Maximum Power(P_{max})	74Wp
Maximum Current	4.5A
Maximum Voltage	16.4V
Open Circuit Voltage	21V
Short Circuit Current	5A
Maximum System Voltage	1000V
Cell Temperature	25^{o}C

TABLE 1. PANEL SPECIFICATIONS

An experiment is conducted using the same panel and the observations are tabulated by using Standard test values and also the graph is drawn as shown in Figure.

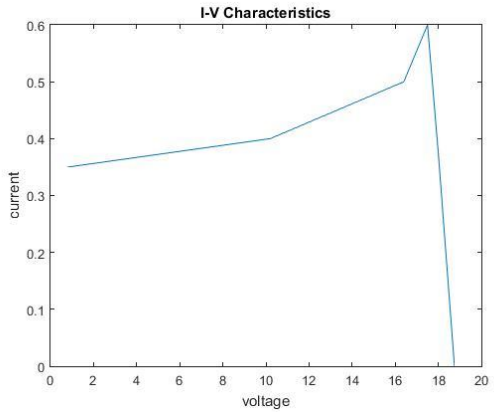

Fig 1: I-V Characteristics

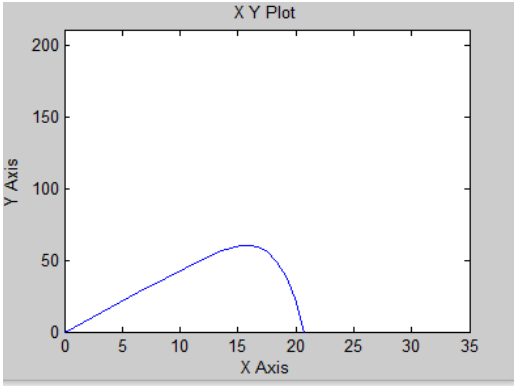

Fig 2: P-V Characteristics for the values shown in Table 1.(using Matlab/Simulink)

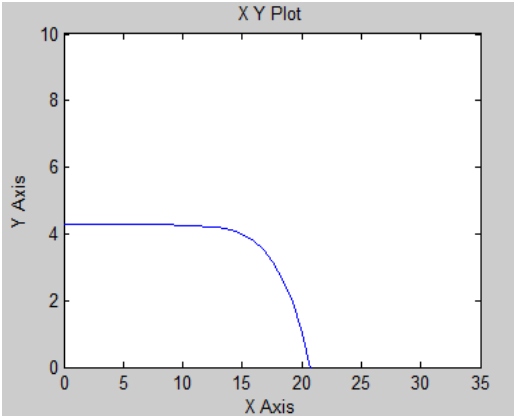

Fig 3 :I-V Characteristics for the values shown in Table 2 (using Matlab/Simulink)

4. SIMULATION RESULTS

Using PVsyst

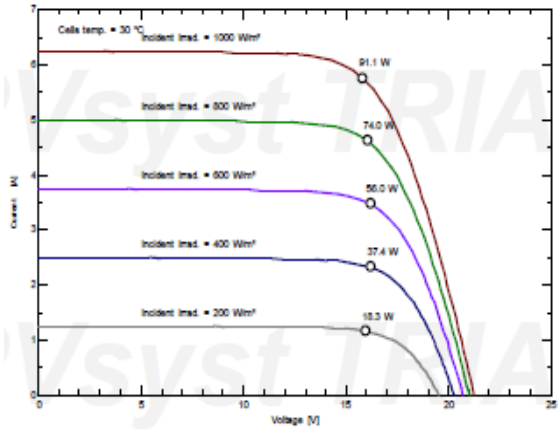

Fig 4: I-V Characteristics varying irradiance at constant temperature using PVsyst

Voltage verses current characteristics is obtained by running the software at cell temperature of 30^{o}C. It is observed that power varies with the variation in the incident irradiation. When irradiation is 1000 w/m2 maximum power is 91.1watts

and if the irradiation is 200w/m2, then minimum power is 18.3watts.

Using Matlab/Simulink

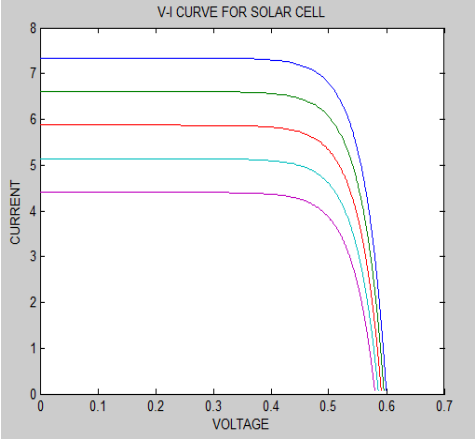

Fig 5I-V characteristic-varying irradiance- constant temperature using Matlab/Simulink

Shows the I-V output characteristics of
PV module with varying irradiance for the same values as shown in figure 2, at the constant temperatures. It is depicted that the PV output current varies drastically with insulation conditions and there is an optimum operating point such that the PV system delivers its maximum possible power to the load. The optimum operating points changes with the solar insulation, temperature and load conditions.

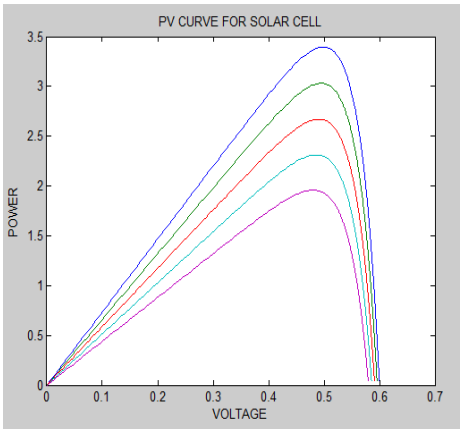

Fig4: P-V characteristic-varying irradiance-constant temperature using Matlab/Simulink

Shows the P-V out characteristics of
the PV module with varying irradiance at the constant temperatures. From the graphs when the irradiance increases, the current and voltage output also increases. This result shows the net increase in power output with an increase in irradiance at the constant temperatures, for a certain PV panel, the voltage-power characteristics are fixed for each insolation without intersection, as shown in Figure 4

5 RESULTS AND DISCUSSIONS

An accurate PV module electrical model is Presented and demonstrated in Matlab Simulink and also using PVsyst.Simulation using Malab/Simulink involves the step-by step method of PV modeling. The characteristics are also obtained through experimentation on the same panel. The performance is compared at standard test conditions. The comparison reveals that simulation results obtained using PVsyst and Matlab/Simulink software matches with that of the experimentation

CONCLUSION

Here the PVsyst Matlab/Simulink is used to simulate PV system and also the experimentation is done on the same panel. The I-V and P-V characteristics obtained by both are tools are nearly same. The simulation results also matches with that of experimentation results. PV provides a clear and concise understanding of the, I-V and P-V characteristics of PV module, which will serve as the model for researchers and expert in the field of PV modeling.

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