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THE EFFECT OF TEMPERATURE ON THE CVC OF A PHOTOELECTRIC CONVERTER

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Abstract: *In this paper, a photovoltaic model analysis was carried out to simulate the actual behavior of a photovoltaic module using MatlabSimulink using the parameters of photovoltaic cells consisting of a single diode, series resistance and shunt resistance. The typical characteristics of a 150 W P 36 multicrystalline solar module were used to evaluate the model. The characteristic curves were obtained from the manufacturer's data sheet, which shows an exact match of the model, and this proves that the module is reliable.*

Keywords: *photovoltaic module**,** IV and PV performance , photovoltaic (PV), photovoltaic cells, Matlab , photovoltaic module, simulation.*

1. Introduction

Renewable energy sources are reliable and plentiful and have the potential to become very cheap once technology and infrastructure improves. Renewable energy is an important part of reducing global carbon emissions and the pace of investment has increased significantly as technology costs continue to fall and efficiency continues to rise. The photovoltaic solar cell has emerged as one of the most potential and promising renewable energy solutions. Photovoltaics offers the highest versatility among renewable energy technologies due to oil consumption and cost, increased energy demand, and the negative impact of pollution on the environment. Jordan is one of the first places in the world in dependence on alternative energy sources such as photovoltaic solar system.

Several previous studies have been carried out to develop and validate mathematical modeling of a photovoltaic module in order to better understand its operation.

For modeling a photovoltaic module, the use of equivalent circuits can be seen from the literature [1]-[4]. To make the photovoltaic model easy to solve, the equivalent circuit can be simplified to a single diode circuit [5]-[9]

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In addition, single diode models can be divided into two categories. The first is a four-parameter model, in which the shunt resistance is neglected and considered to be infinite [8] [9]. The second is called the five-parameter model, where the shunt resistance is considered to be finite [10]-[12].

In this paper, a simplified model is presented, followed by a simulation of a photovoltaic cell in accordance with the photomodule PS - P 36-150 Wp .

In recent years, there has been a significant deployment of photovoltaic systems, especially in many developed countries. In addition, photovoltaic energy will become an important source of solar radiation in the coming years. This latter consists of photons of different energies, and some of them are absorbed at the PN junction. Photons with energies below the band gap of a solar cell are useless and generate neither voltage nor electric current. Photons with energies greater than the band gap generate electricity, but only the energy corresponding to the band gap is used [1].

Solar cells are mainly made from semiconductors, which are produced using a variety of processes. These semiconductors convert sunlight energy directly into electricity through the photovoltaic effect. Many mathematical models have been developed to represent the highly non-linear behavior resulting from semiconductor junctions in order to evaluate the performance of a solar cell. In our case, we consider a model with one diode [2]. Renewable energy sources are reliable and plentiful and have the potential to become very cheap once technology and infrastructure improves. Renewable energy is an important part of reducing global carbon emissions and the pace of investment has increased significantly as technology costs continue to fall and efficiency continues to rise. The photovoltaic solar cell has emerged as one of the most potential and promising renewable energy solutions. Photovoltaics offers the highest versatility among renewable energy technologies due to oil consumption and cost, increased energy demand, and the negative impact of pollution on the environment. Jordan is one of the first places in the world in dependence on alternative energy sources such as photovoltaic solar system.

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The creation of new efficient photovoltaic cells is one of the urgent tasks in the development of solar energy. In recent years, photovoltaic cells have been used in water supply systems, pumping and air conditioning stations in remote and isolated areas where power lines are not available or not economically viable. In this regard, the evaluation of the effectiveness of their work is quite important. It is necessary to be able to determine the output dependences of solar panels (SP) under the influence of various environmental factors, compare the efficiency of using SP from different materials, and evaluate the behavior of photovoltaic converters in various operating modes. For the efficient use of photovoltaic cells, it is necessary to know the point of maximum power and ensure such a regime so that the output power when changing environmental conditions is the highest. When working out the joint venture, simulators of solar batteries are used, which make it possible to reproduce the characteristics of the joint venture under the influence of various external influences.

Determination of the behavior and reproduction of the characteristics of a solar cell (SC) and SP is carried out using simulation. Compared with the experiment, mathematical modeling is a faster, more flexible and cheaper way to work out the SP. To reproduce the characteristics of the ESS and SP, analytical models are most often used, which are built on the basis of an equivalent electrical circuit and the main SP equation. Work on modeling the characteristics of the joint venture is actively carried out abroad, the results of research are considered at international scientific and technical conferences [13]. The prospects [13] for the introduction of solar energy make Russian researchers also interested in the issues of SP modeling. This article discusses the issue of modeling a solar panel in the Matlab / Simulink program .

2 . Photocell circuit

The basic photovoltaic cell is represented by a diode of the same type. It consists of n- type silicon and p- type silicon doped semiconductor with a resulting space charge layer. Typically, an unirradiated solar cell behaves much the same as a diode. Therefore, a simple diode can describe an equivalent circuit [3]. The semiconductor is temperature sensitive and the current generated by the illumination of the photocell is linear with solar radiation and also with temperature.

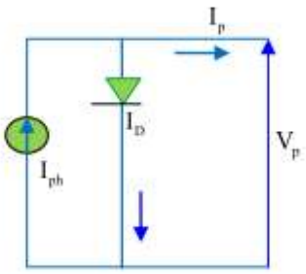


Fig.1. Ideal single diode model

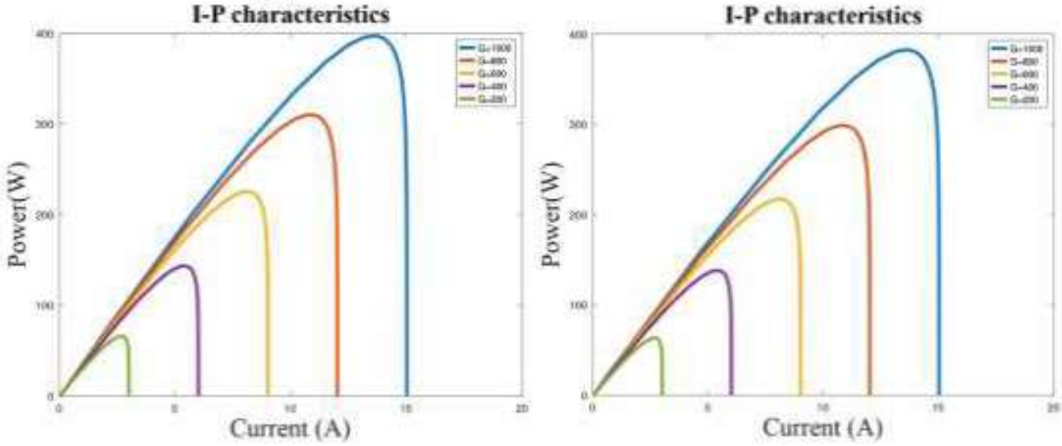
3. CVC of the photovoltaic module

The IV characteristic of a photovoltaic module depends on the relationship between current and voltage generated in a typical solar cell. The characteristic IV curve and most of the parameters affecting the characteristics of the photovoltaic cell refer to R_S, R_{sh} as well as on the intensity of the radiation level and temperature. The generated current I_{ph} of photocells, without taking into account series and parallel resistances, is difficult to determine. The specifications only state the standard short circuit current I_{SCM}, which is the maximum current available at the PV module's terminals. The semiconductor is temperature sensitive, and the current generated by the illumination of the photocell depends linearly on the solar radiation and also depends on I_{SC} the temperature. V_{oc}

$$I_{ph} = \left(I_{ph} + K_i(T- T_{rf})\right)\frac{G}{G_{rf}}. \tag{1}$$

$$E_g = E_g(0)(1- 0.0002677(T- T_{rf})). \tag{2}$$

The three models maintain a constant temperature at 25° C and vary the intensity of the radiation (250 W/m ^{2}, 500 W/m ^{2}, 750 W/m ^{2}, 1000 W/m ^{2}). On fig. 1 shows the results of the Matlab program under these conditions for the I–V characteristics and IV characteristics, respectively. It is clear that the current generated by the incident light depends on the irradiation, the higher the irradiation, the greater the current. On the other hand, the voltage remains almost constant and does not collect. The influence of irradiation on the point of maximum power is obvious, the higher the irradiation, the greater the point of maximum power [3]. Secondly , the irradiance is kept constant at 1000 W/m ^{2} and temperature changes (25° C , 50° C , 75° C , 100° C) will generate characteristic curves. The effect of increasing temperature reduces voltage and power. On fig. 6 shows the influence of both irradiation and temperature, it can be noted that the I–V and PV curves are similar to the curves of the influence of irradiation with slightly higher power values; the influence of temperature in this case is practically not taken into account [4].



Rice. 1. Influence of series resistance.

On fig. 1 shows the calculated characteristics of the current and power of the solar panel TCM 210 SB for the level of illumination of the solar cell E = 1000 W/m ^{2}. It can be seen from the figure that the greatest efficiency of the solar panel occurs at a fixed position of the operating point at maximum power.

the TCM 210 SB type was carried out at the Department of Electromechanics of the Ufa State Aviation Technical University with a change in the level of solar insolation from 1000 to 300 W / m 2 , which is the most accessible at the latitude of the Republic of Bashkortostan. The comparison results are given in table. 2 and fig. 7

The table shows that the results of the model coincide with the results of the experiment with an accuracy of 5% to 15%, large deviations are obtained at low values of the solar insolation level. It is important to note that the operating range of this model with tolerances (less than 5%) is valid for solar insolation levels of more than 300 W/m ^{2} . For values of Sx <300 Bt / m2 ' the model gives large deviations from the real SP, which is the main disadvantage of this model.

CONCLUSION

This article presents a mathematical model of a photovoltaic cell. The proposed procedure provides an accurate photocell model. The results of the Matlab model show excellent agreement with the manufacturer's data from the table. This model has been designed so that it can be used to show the effect of temperature, irradiation, shunt and series resistances on IV characteristics. The maximum power output by the photovoltaic module is about 150.04 W at parameters close to the values provided by the manufacturer: I = 8.15 A and V = 18.41 V

LITERATURE

1. Kaundinya DP, Balachandra P, Ravindranath NH (2009) Grid-connected versus standalone energy systems for decentralized power: A review of literature. Renew Sust Energ Rev 13:2041-50.

2. Parida B, Iniyanb S, Goicc R (2011) A review of solar photovoltaic technologies. Renew Sust Energ Rev 15: 1625-1636.

3. Himri Y, Malik AS, Stambouli AB, Himri S, Draoui B (2009) Review and use of the Algerian renewable energy for sustainable development. Renew Sust Energ Rev 13: 1584-91.

4. Mellit A, Kalogirou SA, Hontoria L, Shaari S (2009) Artificial intelligence techniques for sizing photovoltaic systems: a review. Renew Sust Energ Rev 13:406-19.

5. Hohm DP, Ropp ME (2003) Comparative study of maximum power point tracking algorithms. Prog Photovoltaics Res Appl 11:47-62.

6. Salas V, Olias E, Barrado A, Lazaro A (2006) Review of the maximum power point tracking algorithms for stand-alone photovoltaic systems. Sol Energy Mater Sol Cells 90: 1555-1578.

7. Esram T, Chapman PL (2007) Comparison of photovoltaic array maximum power point tracking techniques. IEEE Trans Energy Convers 22: 439-449.

8. Ahmad A., Okoye KO, Atikol W. (2016) Influence of latitude on the operation of various solar trackers in Europe and Africa. Applied Energy, 177, 896-906.

9. Ertekin S., Evrendilek F., Kulcu R. (2008) Simulation of spatio -temporal dynamics of optimal tilt angles of solar collectors in Turkey. Sensors, 8, 2913.

10. Khandoyo EA, Iksani D., Prabovo . (2013) Optimal solar collector tilt angle. Energy Procedia , 32, 166-175. Hartner M., Ortner A., Hisl A., Haas R. (2015) East to West - Optimal Tilt and Orientation of PV Panels from a Power System Perspective. Applied Energy, 160, 94-107.

11. Ahmad, MJ, Tiwari , GN (2009) Optimizing the tilt angle of solar collectors to obtain maximum radiation. Journal of Open Renewable Energy, 2, 19–24.

12. Gopinathan KK Optimization of the angle of inclination of the solar collector for maximum irradiation of inclined surfaces. Sol. Energy 1991 , 10.51–61.

13. Erbs , DG; Klein, SA; Duffy, JA Estimate of diffuse radiation fraction for hourly, daily and monthly global averages radiation. Sol. Energy 1982 , 28, 293.

14. Liu, BYH; Jordan, RS Relationship, characteristics and distribution of direct, scattered and total solar radiation. Sol Energy 1960 , 4, 1–19.

15. Musazadeh H., Keyhani A., Javadi A., Mobley H., Abrinia K., Sharifi A. "Overview of solar tracking principles and methods for maximizing the performance of solar systems." Reviews of Renewable and Sustainable Energy Sources . January 2009 Pages 1800, 1800, 1804, 1806 and 1812.