Solar Cell Photovoltaic Model Shell Sp 75

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ABSTRACT

For the calculation of the voltage and current of the PV model ,several theoretical models have been developed. In this work, we presented a simple model to a single exponential. The photovoltaic model is typically represented by an equivalent circuit and parameters are calculated experimentally .Using Matlab as a tool for simulation ,we have considered three sizes :short-circuit, open circuit voltage, voltage and current at maximum power point of the photovoltaic model characteristics shell SP 75 in condition standard test .The results were compared with those provided by other researchers.

Keywords: Photovoltaic model-specific parameters of the characteristics IV Crystalline-Si- Solar Cell-Models.

INTRODUCTION

Photovoltaic solar energy comes from the direct transformation of part of the solar radiation into electrical energy. This conversion of energy takes place via a so-called photovoltaic (PV) cell, based on a physical phenomenon called a photovoltaic effect, which consists in producing a electromotive force when the surface. of this cell is exposed to light, In most of the literature, we mainly find the model equivalent to four parameters based on modeling mathematics of the current voltage curve I-V [1,7].In this model, the effect of the shunt resistor is neglected because its value is important, especially for Si-crystalin modules [2,3,7].

The model uses four quantities, which are not generally measurable quantities or included in the manufacturing data, namely I_L (the photocurrent), I_0 (the saturation current), A (the ideality factor) and R_s (the series resistance

MATHEMATICAL MODEL

The photovoltaic module is shown by the equivalent circuit of FIG.1. below:

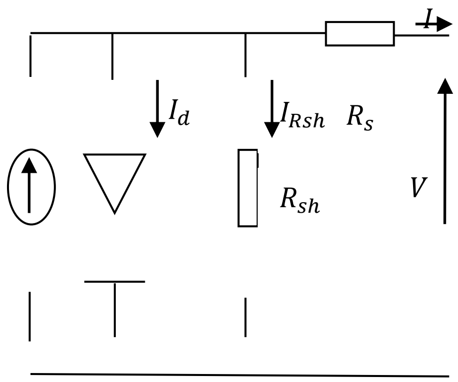

Fig 1. Equivalent model of an exponential model, L5P [7]

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The model, known as L5P. [7], uses the following five unknown variables: I_L (current photo), I_0 (saturation current), A (ideality factor), R_s (series resistance) and R_{sh}. By neglecting the effect of R_{sh}, the equation characterizing the four-parameter L4P model is as follows:

$$I = I_L - I_0[\exp\left(\frac{q(V+I.R_s)}{N_s AKT}\right) - 1]\ldots(1)$$

These quantities are to be determined from the measurement of the voltage-current characteristic IV for an illumination torque and reference temperature (E_{ref}, T_{ref}) given to STC (Standard Test Conditions, $1000W/m^2$,25°C , spectrum AM1.5) by the manufacturer, or resulting from the direct measurement on the module.

Table 1: Electrical characteristics of the Shell SP 75 photovoltaic module in standard test condition [7,8].

Values	
Standard illumination, E	1000W/m^2
Standard temperature, T	25 ° C
Maximum peak power, P_m	75 W
Maximum voltage, V_m	17 V
Maximum current, I_m	4.4 A
Open circuit voltage, V_{c0}	21.7 V
Short-circuit current, I_{cc}	4.8 A

These measurements are necessary in order to specify the basic data necessary for the characterization of the various parameters of the model (V_{c0} open circuit voltage, I_{cc} short-circuit current of the module, I_{mp}, V_{mp} voltage and current to the maximum power point). Three remarkable points of the characteristic $(0, I_{cc}), (V_{c0},0), (V_{mp}, I_{mp})$ [4,7] , can be used to determine the parameters (I_L,I_0, A, R_s) with :

$$I_{cc} = I_L - I_0[\exp\left(q\frac{I_{cc}.R_s}{N_s AKT}\right) - 1] \ldots(2)$$

$$0 = I_L - I_0[\exp\left(q\frac{V_{c0}}{N_s AKT}\right) - 1] \ ...(3)$$

$$I_m = I_L - I_0[\exp\left(q\frac{V_m + I_m.R_s}{N_s AKT}\right) - 1]\ldots(4)$$

By observing the equations (2, 3, 4), we are confronted with a classical problem of solving four unknowns and three equations, this gives a multiplication of choices of the additional equation to be added. The literature on the subject proposes a dozen methods of resolution, with varying precision from one method to another.

Our choice is based on the simplified explicit method, based on a purely mathematical solution, based on certain simplifications.

EXPLICIT METHOD SIMPLIFIED

This method considers as a first approximation: I_L = I_{cc}, after simplification of the equations, (2), (3) and (4), the following relations are obtained [2,5,6,7].

$$I_L = I_{cc} \ldots(5)$$

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$$0 = I_L - I_0[\exp\left(q\frac{V_{c0}}{N_s AKT}\right)]\ldots(6)$$

$$I_m = I_L - I_0[\exp\left(q\frac{V_m + I_m \cdot R_s}{N_s AKT}\right)]\ldots(7)$$

From the relation (6), it is possible to deduce the current of saturation I_0

$$I_0 = I_{cc}\left[\exp\left(\frac{q}{N_s AKT}V_{c0}\right)\right]\ldots(8)$$

From equation (8), equation (1) can be rewritten as follows:

$$I = I_{cc}[1 - \exp\left(q\frac{V - V_{c0} + I.R_s}{N_s AKT}\right)]\ldots(9)$$

The equation at the point of power becomes

$$I = I_{cc}[1 - \exp\left(q\frac{V_m - V_{c0} + I_m.R_s}{N_s AKT}\right)]\ldots(10)$$

From this equation, one can derive the value of the series resistance R_s explicated by:

$$R_s = \frac{\frac{N_s AKT}{q}\ln\left(1 - \frac{I_m}{I_{cc}}\right) + V_{c0} - V_m}{I_m}\ \ldots(11)$$

The last parameter to be determined is the ideality factor A, using the fact that the derivative of the maximum power is zero (dP / dV = 0), and using equation (1) and the following formulation:

$$\frac{dP}{dV} = 0 = \frac{\partial I}{\partial V}V + I\frac{\partial V}{\partial V}dP/dV = 0\ \ldots(12)$$

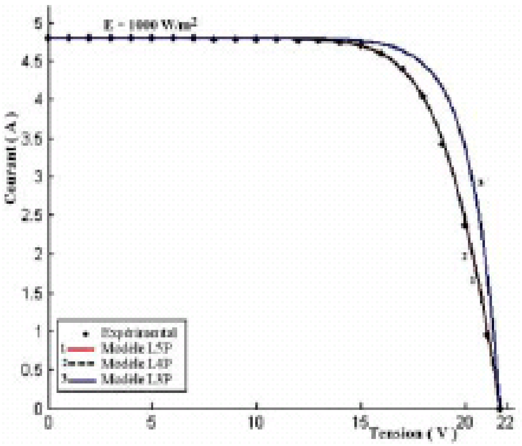
We find,

$$A = \frac{q(2V_m - V_{c0})}{N_s KT[\frac{I_{cc}}{I_{cc} - I_m} + \ln\left(1 - \frac{I_m}{I_{cc}}\right)]}\quad\ldots(13)$$

The substitution of the various parameters by their respective formulas in equation (1) gives a simple equation connecting the current I and V to the different temperatures and sunshine.

Using the Matlab software as a simulation tool, we considered the three variables: short circuit current I_{cc}, open circuit voltage V_{c0}, voltage and current at the maximum power point, the characteristics of the photovoltaic module Shell SP 75 in test condition standard (Table 1).

The simulation results are illustrated in Fig 2.



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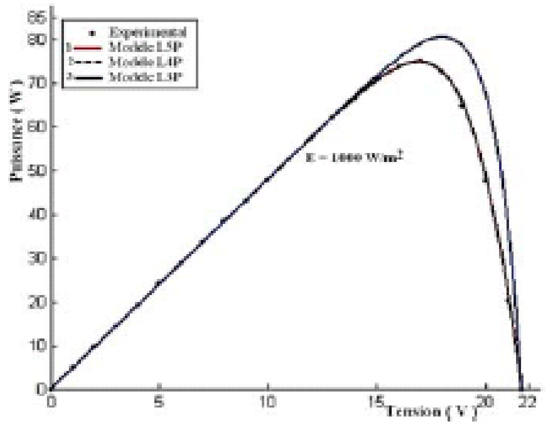

Fig.2. Characteristic I (V), P (V), for the model with an exponential obtained by our simulation.

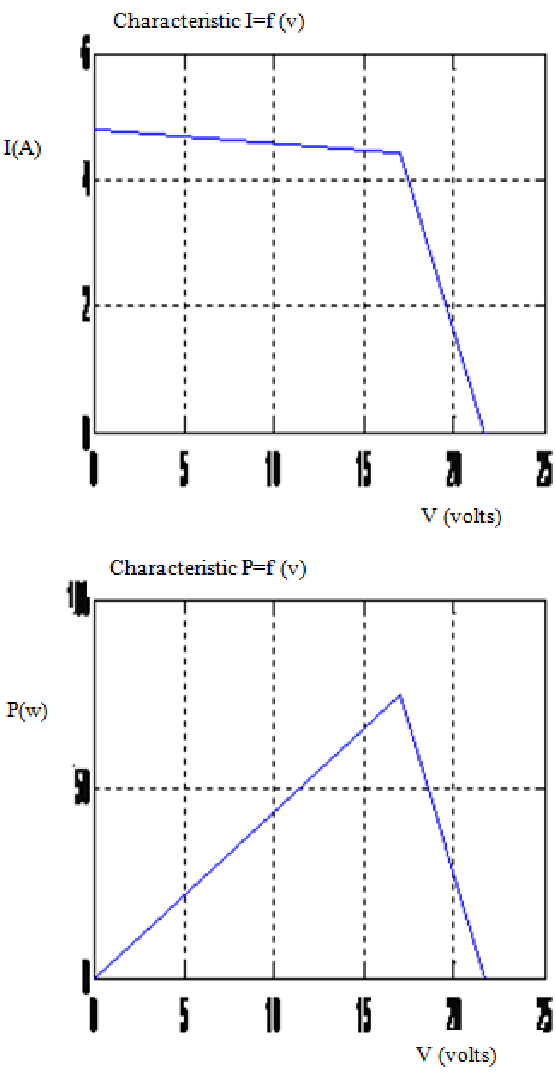

Fig.1. Characteristics I (V), P (V), for the one-exponential model [7].

We neglect the effect of the shunt resistance by considering it R_{sh} is infinite gives the model with 4 parameters L4P [1, 2,7,9-12], and we take into consideration the importance of the series resistance, as our results illustrated in Fig. 2 to the results illustrated in Fig. 1, therefore this model combines simplicity and precision.

CONCLUSION

The objective of modeling solar panels is obviously to describe their behaviors in all conditions use. in this work we tried to confirm the simplicity and precision of the L4P model using the simplified explicit method based on the analytical resolution in order to determine the different parameters specific to the current-voltage characteristic. Comparing our results with results from other researchers on the Shell SP 75 photovoltaic module, we concluded that the L4P model is simple and accurate.

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